STUDIES ON THE INSECT PESTS OF CARDAMOM

in

TRAVANCORE.

THESIS

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of

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by

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This is to certify that this thesis entitled "Studies on the Insect Pests of Cardamom in Travancore" for the award of M.Sc. Degree by Research is a record of bonafide research carried out by Mr. S. Ponna Aiyar under my supervision and no part of the thesis has been submitted for any other Degree. The assistance and help received during the course of the investigations have been specifically acknowledged by him in the preface as well as in the body of the thesis.

Trivandrum,
14th Aug. 45.

Supervising Teacher.

CONTENTS

P R E F A C E.

A detailed study of the important insect pests of cardamom was made by me while I was a Research Student, in the Central Research Institute, University of Travancore, and the present thesis embodies the results of my investigations.

The life histories of seven hairy caterpillars* attacking cardamom have been studied with special reference to their alternate food plants, feeding capacity, external differences between different instars, pupation, hibernation, number of broods in a year, longevity of the adults, preoviposition period, sex ratio, natural enemies etc. Of these six hairy caterpillars are recorded for the first time on cardamom. The life histories of Euproctis cardamomi (sp. nov.), E. Carverica M.,M.

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*At the time of the commencement of the present work there existed a great confusion regarding the identity of the different hairy caterpillar pests of cardamom and every hairy caterpillar found on cardamom was considered to be a serious pest. This confusion has been removed now and the economic status of each caterpillar has been determined by the present work.

E. testacea Wlk., and Loandora vittata Wlk., have been worked out in detail for the first time.

Observations on the seasonal incidence of Taeniothrips cardamomi Ank., have been made with special reference to the influence of temperature, humidity, and rainfall. The observations, recorded for two years, have been statistically analysed and the vulnerable period in the incidence of this important pest has been found out.

Life history studies of 20 minor pests have been made of which 16 are recorded for the first time on cardamom.

It gives me great pleasure to acknowledge my indebtedness to Dr. K.S. Padmanabha Aiyer M.A., L.T., D.Sc., Honorary Professor of Applied Biology for general direction and supervision regards the work and to Mr. S. Jones, Entomologist, University of Travancore, under whose immediate supervision and guidance the work was conducted. I am much indebted to Mr. J.C.M. Gardner, Forest Entomologist, Forest Research Institute Dehra Dun, for the

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Trivandrum, 14 15 August '45. G. Ranga Aiyer.

I N T R O D U C T I O N

Cardamom is an important money crop of Travancore and about 70,000 acres are under this crop in the dense forests of the High Range Division (Fig. 1) (Peermade and Devicolam Taluks) yielding an annual income of about 150 - 200 lakhs of Rupees. The State produces more than two thirds of the total output of cardamom in India. The chief use of cardamom is as a spice. In medicine it is used as an aromatic, stimulant and diuretic. "On the Continent of Europe the capsules are crushed and mixed with flour and baked into bread for its warmth giving properties".

The plants are cultivated in altitudes ranging between 2000 - 4000 feet in "Evergreen sholas" under the tall shade trees.

Two varieties of cardamom are common.

(1) Malabar variety. "Leaves velvety on the under surface; Racemes arise from the base of the stem and creep on the surface of the ground, around the clumps. Fruits, or capsules, angled

shorter and globular than the Mysore type."

(2) Mysore Variety. "Leaves larger with a coarser under surface, not silky; but hard and smooth, racemes rise erect; fruit oblong and larger than those of the Malabar type." (Mollegode 1938)

A hybrid between the two varieties is also common. Leaves may have the dominant characters of the Mysore variety, or of the Malabar variety.

The rainfall in the cardamom growing areas varies from 80 - 100 inches per year, the bulk falling in South West Monsoon (June and July). The temperature varies from 64°F to 84°F., the hottest part of the year being February to April. The soil is fine clayey loam very rich in humus, typical of the forest lands of Travancore.

In many estates propagation is by stools, from specially selected stocks. Planting by seedling is carried in a few estates.

The plants reared from seeds take 5 years to attain the yielding stage whereas those from stools take 2½ to 3 years. Weeding and mulching

is done twice or some times thrice an year.

The main flowering season is from May to December and the main picking season is from the beginning of August to the middle of april. The yield is at its maximum during October and the best period is during October to January.

Very little manuring is done. In some estates compost manure is added. This accelerates the vegetative growth but does not influence the yield. In certain estates soil erosion is prevented by silt trenches and the finely decomposed leaf mould etc., that are washed down the slopes, after the rains, form a rich manure to the plants.

The yield varies considerably with the age of the plantation, the nature of the soil, and the climatic conditions. Some plantations have yielded as much as 2000 lbs. of green berries per acre. At lower elevations and in old plantations there is a general reduction in crop.

Green curing of cardamom is now practiced. The return of cured cardamoms is usually 25 to 28

percent by weight. The cured berries are polished sorted, and graded before marketing.

Place of work.

Most of the observations and field work were done at the Cardamom Research Station, Pampadumpara. Pampadumpara is situated 22½ miles north east of Kumily on Kumily - Devicolam trace in the High Range Division of Travancore. From Kumily, Pampadumpara is reached by a motorable road of about 15 miles up to Vandanettu, and from there by a bridle path of 7½ miles. The altitude of the place is about 3500 feet and the annual rainfall amounts to 80 - 90 inches. The estate has about 1200 acres under cardamom and is one of the biggest and the oldest plantations under this crop in Travancore, containing plants of different ages, varying from 3 to 40 years. The variety under regular cultivation is the "Mysore" though it is not unusual to find the "Malabar" and the hybrids.

PREVIOUS WORK

Since cardamom is cultivated in dense forests where access is difficult and conditions of life not easy, very little is known about the insect pests of this important money crop of South India.

The earliest recorded pest is the root borer Hilarographa eminodes Meyr., from Ceylon (Green 1905). The caterpillar of a Lycaenid butterfly, Lampides elpis Godt., is noted to attack the pods and flowers (Lefroy 1909). Dichocrocis punctiferalis Guen., a pod and stem borer and a Scolytid beetle, Thaumatrides cardamomi. have been recorded (Fletcher 1914). Stephanitis typicus Dist., has been noted from Ceylon by Green (Fletcher 1914). Kunhikannan (1925) mentions Eupterote sp., as a serious pest of cardamom in Mysore. Ischnodemus vochna Tol., has been referred to as a minor pest (Ramakrishna Aiyer and Kylasam 1935). During 1934 - 1935 a wide spread attack of thrips, Taeniothrips cardamomi Ramk., in the Anamalais was reported by Ramakrishna Aiyer and Kylasam (1935). This pest has subsequently spread practically

throughout the cardamom growing areas in South India (Padmanabha Aiyer and Jones 1940, and Mayne 1941).

In 1937 - 38 a serious outbreak of hairy caterpillars was noticed in some of the Travancore plantations causing complete defoliation of the plants for two seasons. A similar wide-spread attack was also reported from Mysore. (Cir.No.65 Mysore. Agric. Depart. 1939). The weevil Prodioctes haematicus chevr., was reported from Travancore (Jones 1941) as a rhizome borer.

INSECT PESTS OF CARDAMOM IN TRAVANCORE DEALT WITH IN THIS THESIS.

LEPIDOPTERA

Eupterotidae

Eupterote fabia Cram.,

Eupterote cardamomi (sp. nov.)

Eupterote canarica M.

Eupterote testacea Wlk.

Lasiocampidae

Lenodora vittata Wlk.

Lymantriidae

Euproctis lutifacia Hmpsn.

Arctiidae

Alphaea biguttata Wlk.

Pyralidae

Dichocrocis punctiferalis Guen.

Psychidae

Acanthopsycho bipars Wlk.

Geometridae.

Eumelia rosalia Cram.

Anisodes denticulatus Hmpsn.

Saturnidae

Attacus atlas Linn.

Tortricidae

Nemona sp.

Noctuidae

Arcilasia plagiata W.

Plutellidae

Hilarographa eminodes Meyr.

The shoot borer

Hesperiidae

Plesioneura alyson M.

COLEOPTERA

Curculionidae

Prodioctes haematicus Chevr.

Chrysomelidae (Galerucinae)

Lema sp.

THYSANOPTERA

Thripidae

Taeniothrips cardamomi Rmk.

RHYNCHOTA

Jassidae

Tettigoniella sp. ferruginea

Coreidae

Riptortus pedestris F.

Coccidae

Mytilaspes sp.

Aphidae

Pentalonia nigronervosa Coq.

Cercopidae

Aphrophora nuwarana Dist.

Tingidae

Stephanitis typicus D.

DIPTERA

Cecidomyidae

Cecidomyia sp. Hallomyia cardamomi Nayar

ORTHOPTERA

Acrididae

Orthacris sp.

PART. I.

CARDAMOM HAIRY CATERPILLARS OF TRAVANCORE

Till the advent of the thrips (Heeliothrips cardamomi Mak.,) into the cardamom plantations of Travancore in 1937, the hairy caterpillars were the most serious pests. Seven hairy caterpillars have been found by the writer to attack cardamom, of which four belong to the family Eupterotidae, and the three others to Lasiocampidae, Lymantridae and Arctiidae. Of these, two Eupterotids (Eupterote canarica M., and Eupteroto cardamomi (sp. nov) were responsible for the wide spread damage during 1937 to 1939 defoliating about 10,000 acres of cardamom in south of Vandamettu pakuthy. A similar outbreak during 1918 - 1919 is also recorded.

* This information was given by Mr. S. Jones, Government Entomologist, Travancore.

KEY FOR IDENTIFICATION OF THE GARDENER HAIRY CATERPILLARS OF TRAVANCORE

1. Caterpillars with tufts of black bristles in the mid dorsal region of the meta thorax and first abdominal segment; downwardly directed prominent hair bundles from the sides. Lamoora vittata Wlk.

2. Caterpillars with prominent erect hairs and bristles from the dorsal and dorsolateral regions.

a. Two prominent protuberances on the mid-dorsal region of the 6th and 7th abdominal segments. Euproctis lutifucia Hmpsn.

b. Head, body, and setae black. Ventral side brown; crochets of the sucker feet heteroides. Alphaea biguttata Wlk.

c. Head pale brown; body blue black; hairs white tipped; mid dorsal conical tufts of light brown hairs. Euproctis cardamomi (sp.nov.

d. Head red with a black inverted V in the middle outlining the border of the vertex. Euptoreta canadica H.

e. Head black; the long hairs grey at the tips, prolegs and ventral sides red. Euptoreta fabia Grum.

f. Head yellow with black markings; middorsal silvery white line. Euptoreta testacea Wlk.

Rupteroto cardamomi (sp. nov.)

Male (Fig.2)

Body ochraceous; an yellow collar; a pair of raised hair patches on the prothorax. The costal margin of the fore wing bent at the apex Double post medial lines. Inner to them six highly waved lines, those towards the base being indistinct. Outer to the post medial lines a series of triangular greyish white patches one behind the other. On the centre of the 2nd and 6th triangular patches, a black area. On the apex a whitish area. In the hind wing 4 waved lines inner to the double post medial lines; one highly waved line towards the outer margin. At the basal angle a black spot. expanse 62 - 65 mm.

Female (Fig.3)

The double post medial lines prominent and straight. Close to the outer margin a reddish tinge; antennae with the branches short. General colour of the fore wings fuscous ochraceous. expanse 70 - 80 mm.

Genitalia (Fig.55) consists of a pair of claspers, (uncus), a pair of parameres, (valve), a penis-sheath and a penis (Intromisive part and a sheath). Claspers broad, pointed, and bent downwards. Parameres sickle shaped, the tip and blunt and well chitinised. On the sides several chitinous folds forming a series of ridges and a few scattered hairs.

Out of 400 moths bred in the laboratory 4 males and 2 females were found to exhibit great variation. The variants are described below.

Male (Fig.4) Head and body fulvous yellow. Forewing ochreous, suffused with brown. Within the single post medial line 5 waved lines. Outer to the post medial lines two ~~apical~~ apical brown spots; two more towards the basal angle. The post medial line slightly curved in the hind wing. Expanse 55 - 60.

Female (Fig.5).

Head thorax and abdomen fuscous. The costal margin of the fore wing darker. Inner to

the two highly waved post medial lines three waved lines. The antennae black, thin with short branches. Expanse 60 - 65.

Holotype. A male and female of the normal and variant specimens are deposited in the Entomology laboratory of the Central Research Institute, University of Travancore, Trivandrum.

Systematic position.

This species is closely related to Euptoeta undata Blanch., from which it differs in the following respects.

1. Triangular greyish white patches outer to the post medial lines.
2. 2nd and 6th, greyish white patches. have a black area in the middle.
3. The apex of the fore wing whitish.
4. A reddish tinge close to the outer margin of the wings in the female.

Life history

Just after the commencement of the South west monsoon in June and July, the moths emerge,

mate, and begin to lay eggs on the tall shade trees of cardamom. A large number of eggs have been collected from Macaranga indica Wight., locally known as "Vatta" or "Vattathaneri".

Eggs are laid usually on the under side of the leaf in a flat mass of single tier, the number in each mass varying from 50 - 160 (Fig.6). On an average a single moth lays about 400 - 500 eggs and the maximum number recorded is 637.

The egg (Fig. 7 & 7a) is dome shaped having an approximate diameter of 1.25 mm. and a height of 1 mm. At first it is yellow and as development proceeds, a dark tinge appears. The chorion is leathery, translucent, and has a pitted appearance under the microscope. The basal side of the egg fixed to the leaf is usually flat and rarely concave. When the egg is about to hatch, the head of the embryo becomes visible through the chorion as a dark circular patch and the body is seen as a pair of pale white lines with the setae as 8 - 9 pairs of black lines. The larva bites off a circular opening at the apex of the shell and comes out. The incubation period lasts for 15 - 17 days.

Newly hatched caterpillar (Fig.C)

Just after emergence the caterpillar has an approximate length of 2 mm. and a head width of nearly 0.5 mm. The hairs on the body are wet and glued together. The caterpillar remains close to the egg shell for some time wriggling its body at intervals and this helps to dry its hairs. When the hairs have become dry the caterpillar begins to feed on the egg shell. The head is smooth and shining black; the body is yellowish white. The hairs and setae are pale white. By the second day the larva begins to feed by cutting small portions of 'Vatta' leaf and the body gradually develops a greenish tinge due to the food consumed.

The prothoracic shield is black, narrow and well defined. On the dorsal side of each of the segments behind the prothorax, there is a pair of circular black spots, situated on either side of the mid dorsal line, those on the last abdominal segment, being very close to each other These spots may be designated as the dorsal spots.

Just below the dorsal spots on each side of each segment is a black spot, the lateral spot, bearing white hairs. The prothoracic lateral spots are situated immediately behind the spiracles. In the first eight abdominal segments the lateral spots are situated just above the spiracles. There is also a series of ventrolateral spots one on each side of each segment, those on the thoracic segments being larger.

Setae. There are two kinds of setae on the dorsal spots.

1. Long white hairs and
2. Short black bristles.

The hairs are plumose, and nonirritant. The bristles are sharp, stiff, and easily detachable. In coming in contact with human skin they cause considerable irritation and pain. The lateral and ventrolateral spots bear short white hairs.

First instar caterpillar grows to a length of about 8 mm. in 12 days. On the 14th or 15th day it ceases to feed; an yellowish tinge gradually

appears over the body. The prothorax becomes paler and gets distended. The larva remains motionless and moulting takes place on the 13th or 14th day.

Moulting. Immediately before moulting, a longitudinal split occurs in the left side of the meso and meta thoracic segments. The middle portion of the body is then pushed out in the form of a V which gradually straightens. The head is then pulled out suddenly. The thoracic legs grip the substratum and the rest of the body is drawn out: the exuviae is left behind fixed. The moulting is completed within 2 - 4 minutes. The process is similar in all instars.

Second instar caterpillar (Fig.9).

Just after moult the caterpillar has a length of about 6 mm. and a head width of 0.7 mm. The head and body are pale white. After a day the head develops a black tint. Thoracic legs turn black and prolegs turn white. Active feeding begins by the second day and the body develops a

greenish tint due to the contents of the alimentary canal.

The caterpillar resembles the first instar in the arrangement of dorsal, lateral, and ventro-lateral spots. In addition to these, close to each spiracle, there is a faint black spot. The ventro lateral spots are borne on tubercles except those of the prolg-bearing segments.

Within 12 to 13 days the second instar caterpillar attains a length of 10.5 mm. On the 11th day feeding is gradually stopped and the body gets reduced to 8.5 mm. An yellowish tinge prevails over the body, and the caterpillar moults on the 15th day.

Third instar caterpillar (Fig.10).

Length just after moult 8 mm.

Length after one day 9.5 mm.

Head width 1 mm.

The body is comparatively stouter than the previous instar. The mid dorsal region of meso and metathoracic segments have a swollen appearance.

Inter segmental regions throughout the body have two shallow grooves. On the meso and metathoracic segments close to each spiracle one more spot is present.

Though in nature the 3rd instar caterpillars and previous instars feed on the leaves of the shade trees, cardamom leaves offered in the laboratory are also devoured voraciously. The caterpillar grows to a length of about 16 mm. in 12 - 13 days when it gradually abstains from food and the body shrinks to 9 mm. Moulting takes place on the 14th day.

Fourth instar caterpillar (Fig.11).

Length immediately after moult is	9	mm.
do. after one day	10.5	mm.
Head width	1.2	mm

On the abdomen the dorsal spots on each side are joined by a faint longitudinal black line which is very characteristic of this instar.

Between the line of spiracles and ventro lateral spots, on each intersegmental region of

abdomen, one black spot bearing short white hairs is present.

In about 13 - 14 days the caterpillar grows to a length of about 20.5 mm. As in the last instar an yellowish tinge appears over the body and the caterpillar gradually stops feeding. On the day prior to moulting the body measures only 11 mm. and the line joining the dorsal spots on each side becomes almost indistinct. Moulting takes place on the 15th day.

Fifth instar caterpillar (Fig.12).

Length after moult 10 mm.

do. after a day 12.5 mm.

Head width 1.5 mm.

External features.

The lines joining the dorsal spots are thick and distinct. In the intersegmental spaces between the pairs of dorsal spots three or four faint black transverse lines are present. The intersegmental grooves are more prominent here. The disposition of different spots is as in the last instar.

In about 12 days the caterpillar grows to a length of 26 mm. After the 15th day it stops feeding and body shrinks to 1¼ mm; the caterpillar moults on the 13th or 14th day.

Sixth instar caterpillar (Fig.13).

Length soon after moult	1¼	mm.
do. after a day	18	mm.
Head width	2	mm.

Head and body pale white with black tipped thoracic legs. The mid dorsal region of the body carrying the dorsal spots has developed a faint black tint. Head turns light brown with dark brown streaks on the genae. The ventral side and thoracic legs turn black, the prolegs remain white.

External features.

The sixth instar caterpillar differs markedly in appearance from the previous instars. Surrounding each dorsal spot is a narrow white ring. Running along the mid dorsal region is a narrow white line. Just below the dorsal spots on each side is a broad light yellow longitudinal band. In the band is a black wavy line.

The long white hairs from the dorsal spots measure 9 mm. while the short bristles measure about 2.5 mm.

The caterpillars of this instar remain close together during day, and spin a lot of silken webbing around themselves. When disturbed they readily fall off the leaf suspended by fine silken threads. In about 12 days the caterpillars grow to a length of about 31.5 mm. They gradually abstain from food and the body shrinks to 26 mm. before moulting. On the 12th day the caterpillar moults.

Seventh instar caterpillar (Fig.14).

Length just after moult 16 mm.

do. after a day 21 mm

Head width 3 mm.

External features.

Head is light brown. Thoracic legs are reddish brown, and prolegs are pale white with brown streaks. Prothoracic shield is brown. The white narrow ring surrounding the dorsal

spots noticed in the last instar have now become very marked. Mid dorsal region is light brown due to the presence of short brown hairs. This is the beginning of the development of conical tufts of brown hairs, which is a conspicuous feature in the later instars. Of the two spots present near each spiracle, the upper one turns red.

On an average a single caterpillar consumes about 1 - 1.5 square inches of leaf in a night. Usually the feeding is done during night and they remain in closely packed up colonies during day, in some sheltered places, as under the barks of trees, crevices in wood, etc.

In about 10 - 12 days the caterpillars grow to a length of 37 mm. Moulting takes place on the 14th or 15th day and before moulting the body contracts to 14 mm.

Eighth instar caterpillar (Fig.15).

Length after moult 22 mm.

Length after one day 26 mm.

Head width 4 mm.

External features

Arising from the mid dorsal line behind each pair of dorsal spots is a median tuft of short brown hairs. Setae rising from the dorsal spots have white tips. The long hairs, measure about 12 mm. and the short stiff bristles 4 mm.

On an average a single caterpillar consumes about 2 - 2.5 square inches of leaf in a night and within 10 - 12 days grows to a length of 52 mm. It gradually stops feeding and the body gets reduced to 43 mm. The prothorax swells; the caterpillar remains motionless and moults on the 13th or 14th day.

Ninth instar caterpillar (Fig.16).

Length just after moult	37 mm.
Length after a day	42 mm.
Head width	5 mm.

The mid dorsal conical tufts of light brown hairs are now more conspicuous. The broad yellow lateral band has developed a reddish tinge. The lateral spots are now joined by an indistinct black line.

The long white-tipped hairs from the dorsal spots measure about 20 mm. Shorter ones from the lateral spots measure about 9 mm. The light brown hairs from the mid dorsal conical tufts measure about 2.5 mm. Short black bristles from dorsal spots measure about 4 mm.

Within 13 - 14 days the caterpillar grows to a length of 65 mm. A single caterpillar consumes about 3 - 4 square inches of leaf in a night. The feeding is gradually stopped after the 14th day and the body gets reduced in length to 58 mm. Moulting takes place in the 15th day.

Tenth instar caterpillar (Fig.17).

Length just after moult 49 mm.

do. after a day 62 mm.

Head width 6 mm.

External features:

Head is light brown, thoracic legs are dark red and the prolegs are pale brown. The lateral bands have a predominant reddish tinge. The dorsal conical tufts of hairs are distinctly separated

from each other. The light brown hairs from the conical tufts are plumose and measures about 3 - 4 mm. These hairs cause considerable irritation and pain on coming in contact with human skin. The black white-tipped hairs from the dorsal spots measure about 22 mm. and the shorter ones about 12 mm. The hairs from the ventro lateral spots measure 4 - 6 mm.

The crochets of the sucker feet are arranged in two rows in a uniordinal mesoseries. Each crochet in the outer row bears an unidentate spine.

Tenth instar caterpillar is a voracious feeder consuming about 5 - 9 square inches of leaf in one night. A grating sound is heard while the caterpillar feeds due to the working of the mandibles. In about 19 days it grows to a length of 90 mm.

After about 20 days the caterpillar abstains from food and the body contracts to 3¼ - 39 mm, bringing the mid dorsal conical tufts of hairs close to each other, and the larva turns pale. After selecting a suitable place in the ground near

the clump for pupation, the caterpillar enters into the loose soil to a depth of about 2 to 2½ inches. It constructs a silken cocoon to which particles of sand, debris and short urticating hairs adhere closely. The cocoon when finished looks like a globular sand mass. The propupal stage lasts for 9 to 10 days within the cocoon.

In the laboratory if no soil is supplied the caterpillar pupates within a silken cocoon.

The cocoon and pupa.

The cocoon (Fig.18) is composed of two layers of silken webbing the outer one is compactly spun to which sand particles, debris and short urticating hairs adhere. The inner layer is formed by a loose webbing of silk. The short urticating hairs derived from the mid dorsal region of the caterpillar are, compactly arranged on the inner surface of the cocoon.

Pupa (Fig.19 & 20) is dark shining brown measuring about 2½ x 11 mm. The last segment bears about 30 cremaster hooks arranged in concentric

circles. The spiracles are oval with raised brown rims. The pupal duration lasts for 7 to 8 months.

Nature of larval habits

The larvae hatch out in swarms from the egg masses and remain in close congregation. Feeding usually takes place in the night and during day the caterpillars remain in closely packed up colonies in the stem or leaf. Up to the 6th or 7th instar they remain on the shade trees feeding on their leaves. The descent on to the cardamom usually takes place during or after the 6th instar. In nature the attainment of the 6th or 7th instar coincides with the cessation of the monsoon and the onset of sunny weather. Perhaps to escape the increasing heat of the sun they come down from the tall shade trees suspended by silken threads on to the cardamom, the leaves of which they begin to devour voraciously. Thus defoliation over a large area occurs in a short time. After the work of defoliation of the cardamom plants is complete, they collect in large groups on the barks of the shade trees.

Feeding capacity and the damage.

A single caterpillar during the 6th, 7th, 8th, 9th and 10th instars consumes about 290 square inches of leaf. On an average a single leaf presents 80 to 90 square inches and a clump bears 56 - 60 leaves; hence 16 caterpillars can completely defoliate a clump. On a modest estimate the brood of a single moth can easily destroy as many as 32 clumps. Therefore the caterpillars of 13 moths can destroy all the cardamom plants in one acre. The defoliation results in the shrivelling up of the pseudostem, which necessarily weakens the plant and thereby affects the yield. The damage to the plants in the nurseries is almost fatal.

Economic status.

This is one of the two major caterpillar pests of cardamom occuring sporadically in Travancore. There was a serious outbreak in 1918 - 19 and 1937 - 39. On both occasions about 10,000 acres, south of Pandamotha patathy in the south-east corner of cardamom hills, were completely

defoliated. Though small numbers of caterpillars are found every year, serious outbreaks are only periodical at intervals of several years.

Parasites and Natural enemies.

Sturmia sericariae. This tachnid parasitises the caterpillar. Nearly 10 - 15 percent of the caterpillars are attacked.

Aphanistes cuptorotes. This Ichneumonid parasitises the caterpillar occasionally.

An unidentified braconid is also found to parasitise the caterpiller occasionally.

During rainy season a white mould attacks the caterpillars and choke them to death.

Alternate food plants.

In the jungle the caterpillars have been found breeding on the following plants :-

Polygonum chinense Linn.

Solanum nigrtenm Jacq.

Mucuranga indica Wight.

Distinguishing features of different instars of Enteroto cardamomi (sp.nov.).

1st instar. Head black; body pale green with a pair of black dorsal spots on each segment. Length 2 - 6 mm.

2nd instar. Close to each abdominal spiracle a faint black spot. Ventro lateral spots borne on tubercles. Length 7 -11 mm.

3rd instar. The mid dorsal region of meso and meta thorax swollen. Each intersegmental region of abdomen has two shallow transverse grooves. Length 9 - 16 mm.

4th instar. The dorsal spots of each side except those of meta thorax are joined together by a faint black line. Behind each abdominal spiracle there are two spots one above the other. Between the line of spiracles and ventro lateral spots, in each intersegmental region of abdomen, one black spot bearing short white hairs is present. Length 10 to 20 mm.

5th instar. The lines joining the dorsal spots are thick and distinct. In the space in between the dorsal spots there are three or four faint black transverse lines. Length 12 - 26 mm.

6th instar. Head is brown with dark brown streaks. Body black in the mid dorsal region. Surrounding the dorsal spots narrow white rings are present. Mid dorsal region has a narrow white line; on each side is a prominent light yellow band. Length 18 to 37 mm.

7th instar. Prothoracic shield brown. The narrow white rings surrounding the dorsal spots are very clear. Mid dorsal region is brown. Length 21 - 37 mm.

8th instar. Mid dorsal region is light yellow. In the spaces in between the dorsal spots, tufts of short brown hairs arise. The upper spot near the spiracle is red. Setae rising from the dorsal spots measure 4 mm. Length 26 - 52 mm.

9th instar. The lateral band has a reddish tinge. In the mid dorsal region there are conspicuous conical tufts of brown hairs. The lateral spots are joined by a faint black line.
length 37 - 65 mm.

10th instar. The dorsal conical tufts are separated into distinct groups. The lateral bands have predominant reddish tinge.
length 49 - 90 mm.

Euproctis canarica M. (Fig.21)

After the heavy south west monsoon in June and July when the ground gets soaked with rain water moths emerge in large numbers, mate and begin to lay eggs on the leaves of tall shade trees of cardamom. Eggs have been collected from Erythrina indica Lam., and Cinnamomum zeylanicum Breyr. Eggs are laid in a flat mass the number in each mass varying from 40 to 120 (Fig.22). The oviposition lasts for 9 to 12 days and on an average a moth lays about 480 eggs.

The egg (Fig.23) is light yellow, hemispherical with a diameter of 1.5 mm. and a height of 1 mm. As development proceeds the yellow attenuates and a light brown sets in. One or two days before hatching the head of the embryo becomes visible through the translucent chorion as a black circular disc. The body of the embryo is seen as pale white streaks with the setae arranged in 8 to 9 bundles. Before hatching the top portion of the egg shell becomes thin and fragile due to

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I take this opportunity to thank Mr.B.Krishnamoorthy, State Entomologist, Mysore, for sending me a specimen of Euproctis canarica M., for comparison.

a liquid that oozes from the larva inside. The larva bites off a small circular disc at the top of the shell and issues out. The actual hatching process takes about an hour. The incubation period lasts for about 20 days.

Newly hatched larva (Fig.2h).

It has a length of about 3 mm. and a head width of nearly 0.5 mm. Head is shining black with a few short hairs. Body is dull white with a pair of dorsal spots on each segment. The prothoracic shield is black and narrow. The thoracic legs and prolegs are glassy white. The larva remains near the egg shell for a few minutes drying the wet hairs by wriggling movements of the body and then the egg shell is completely eaten. Within two hours the prolegs and thoracic legs develop a black tint. The caterpillar starts feeding on the second day and the body develops a green tint due to the food contents of the alimentary canal

Distinguishing features.

There is a pair of dorsal black spots on each

segment, one on either side of the mid dorsal line. A lateral spot is present below each dorsal spot. Ventrally to the line of lateral spots the ventro lateral spots are present.

In about 15 days the caterpillar grows to 7 - 8 mm. and on the 16th day an yellowish tinge develops over the body. The prothorax gets swollen. The caterpillar stops feeding and moults on the 18th or 19th day.

Second instar caterpillar (Fig.2f).

Soon after moult the body of the caterpillar measures 8 mm. and has a head width of nearly 1 mm. The head is black and the body pale green. The prothoracic shield is black and narrow. The thoracic legs are black and the prolegs are glassy white. Surrounding each dorsal spot is a faint halo of black. Bordering the inner half of each dorsal spot is a semicircular whitish region. The least pair of dorsal spots are coalesced together. The prothoracic lateral spot is in front of the prothoracic spiracle, and in line with it.

Arising from the dorsal spots are short glassy white bristles and long plumose hairs. The hairs and bristles cause considerable irritation and pain on coming in contact with our body.

Within 8 to 10 days the caterpillar grows to a length of 15 mm. Before moulting the body contracts to 13 mm. The stadium lasts for 16 to 17 days.

Third instar caterpillar (Fig.26).

Length soon after moult 16.5 mm.

Head width 1.5 mm.

Head is light brown; body is pale green. There is a faint black interrupted mid dorsal line. The whitish region mentioned in the last instar as bordering the inner half of the paired dorsal spots, now surrounds the entire spot as a ring, the two rings on a segment just touching in the mid dorsal line.

The small bristles rising from the dorsal spots have now a light yellow tinge.

In about 8 to 10 days the caterpillars grow to 20 to 21 mm. and they always remain in close congregation. At this stage they begin to descend down from the shade trees to the cardamom plants suspended by fine silken threads.

Body contracts to 17 mm. before moulting which ~~which~~ takes place on the 13th or 14th day.

Fourth instar caterpillar (Fig.27).

Length soon after moult 19 mm.

Head width 2 mm.

Soon after moult head is pale orange and the body is pale green. In the mid dorsal region of the body conspicuous short yellow hairs are present. Two or three days after moult the ground colour of the body changes to intense green.

Between the line of spiracles and the ventro lateral spots is a row of intersegmental spots without hairs. A black mid dorsal line is present here, more prominent than in the previous instar.

In about 12 to 13 days the caterpillar grows to a length of 30 mm. after consuming about 0.5 square inches of leaf each night. While the

caterpillars feed by night, they hide themselves during day in groups in leaf folds formed by silken webbing. Moulting takes place on the 15th or 16th day.

Fifth instar caterpillar (Fig.28).

Length seen after moult 24.5 mm.

Head width 2.7 mm.

Head is orange red with a prominent black mark in the middle of the head. Labrum and mandibles are dark brown. The prothoracic shield is broad and dark brown. The yellow hairs on the mid dorsal region are now more prominent.

Behind the paired dorsal spots on the last segment, there is a transverse black line.

The caterpillar consumes about 1.25 square inches of leaf in a night and it grows to a length of nearly 3½ cm. in about 16 - 17 days. The body shrinks to 28 mm. before moulting. This stadium lasts for about 20 days.

Sixth instar caterpillar (Fig.29).

Length seen after moult 29.5 mm.

Head width 3.2 mm.

Head bright orange red with a narrow streak just above the labrum. The body is pale green with an yellowish tinge. Prothoracic shield is dark brown.

The spots and hairs are as in the last instar. The yellow hairs in the mid dorsal region extend around the paired dorsal spots almost encircling them.

~~By about 12 to 13 days it grows to a length of 40 mm.~~ A single caterpillar during this instar consumes about 2 square inches of leaf in a night and in about 12 to 13 days grows to a length of 40 mm. After about 17 days the length of the body gets gradually reduced to 40 mm. and by the 20th or 21st day moulting takes place.

Seventh instar caterpillar (Fig.30).

Length soon after moult 32 mm.

Head width 4.1 mm.

Head bright orange red as in the last instar. The body dark brown. Thoracic legs and prolegs have a pale reddish tint. The prothoracic shield

is dark red. The yellow hairs on the mid dorsal region of the previous instar have been replaced by ashy grey hairs. These like the former extend around the dorsal spots which are dark brown in this instar. Behind each pair of dorsal spots a big black median patch of velvety hairs is present. The ground colour of the body is black.

On the dorsal side of the 1st abdominal segment there are three small orange spots. On each side just below the line of spiracles is an intermittent orange line. A similar line is present just above the line of lateral spots also.

Within 20 or 21 days the caterpillar grows to a length of 62 mm. On an average a single caterpillar consumes about 5 square inches of leaf in a day. After 23 or 24 days the body gets reduced in length and feeding is stopped. On the 29th day the body measures only 50 - 40 mm. At this stage the caterpillar enters the loose soil for pupation. In rare cases the caterpillar is found to pass through another instar.

Eighth instar caterpillar (Fig.31).

Length soon after moult 42 mm.

Head width 4.5 mm.

Head is pale orange red. The hairs surrounding the paired dorsal spots are white. In front of each pair of dorsal spots a thick black patch of hairs is present.

The crochets of the sucker feet are arranged in two rows in a uniordinal mesoseries. Each crochet of the outer row has a serrated edge.

The caterpillar grows to a length of about 75 mm. within 22 to 25 days. The caterpillars consume about 4 to 5 square inches of leaf in a night. The body gets reduced to 20 to 25 mm. before pupation. This stadium lasts for 28 to 35 days. The caterpillar then pupates in loose soil though some have been found pupating among dead leaves. The prepupal period lasts for 6 - 9 days.

Pupa and Cocoon.

Cocoon (Fig.33) is oval and consists of a loose outer layer and a tough inner layer of silk.

Sand particles, debris, and the urticating hairs of the caterpillar adhere to the outer layer. The cocoon measures 25 x 9 mm.

Pupa (Fig.34). The last segment bears about 26 cremaster hooks arranged in concentric circles.

The pupal duration lasts for 7 - 8 months.

Adult habits.

The moths emerge in July - August. By day they hide themselves in crevices in the trunks of shade trees. The moths have been found attracted to light.

Economic status.

This is the second species of Euproctis caterpillar that periodically attains the status of a serious pest. During serious outbreak in 1937 - 1939 the caterpillar completely defoliated about 10,000 acres of cardamom, south of Vandanattu palathy in the south east corner of cardamom hills. This caterpillar like E. cardamomi (sp.nov.) occurs in small numbers every year.

Alternate food plants.

In the jungles the caterpillars are found feeding on the following plants.

Erythrina indica Lam.

Solanum giganteum Jacq.

Pectona grandis Linn.

Macaranga indica Wight.

Parasites and Natural enemies.

Sturmia sericaria is found to parasitise the caterpillar

Occasionally the caterpillars are subjected to the attack of braconids (Fig.32).

During the outbreak in 1979 large numbers of caterpillars were found attacked by a white mould which caused heavy mortality among them.

Euptorete testacea Wlk.(Fig.35)

During south west monsoon (June and July) eggs are laid in clusters on the underside of the leaves of Erythrina indica Lam. The number of eggs in the cluster varies from 62 to 90, and a single female lays about 300 - 350 eggs in a period ranging from 8 - 9 days.

The egg (Fig.36) is pale yellow, hemispherical having an approximate diameter of 1 mm. and a height of 0.5 mm. The chorion is smooth leathery and translucent. As development proceeds the egg develops a black tint. The incubation period lasts for 13 to 15 days.

First instar caterpillar (Fig.37).

Just after hatching, the tiny caterpillar has an approximate length of 2.5 mm. and a head width of 0.5 mm. The head and thoracic legs are black. The body and prologs are pale white. On

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Eggs have been collected from garden bean Dolichos lablab Linn.

hatching the caterpillars feed on the empty egg shell. The caterpillars are gregarious and feeding begins late in the second day. By the third day the caterpillars grow to 5 mm. in length. The prothoracic shield is black and narrow. On the dorsal side of each of the remaining segments of the trunk there is a pair of black circular spots, the dorsal spots. The pair of spots on each segment are joined together by a faint black transverse line. Immediately below each dorsal spot is a lateral spot just visible to the naked eye. Ventro lateral spots occur in the ventro lateral region.

In about 10 days the caterpillar grows to a maximum length of 6 mm. After the 11th day it stops feeding and the body gradually gets reduced in length and measures 4 - 5 mm. The prothorax swells and an yellowish tinge appears over the body which grows deeper. Moulting takes place on the 12th or 13th day.

Second instar caterpillar (Fig.38).

Just after moult the caterpillar has a length of about 5 mm. and a head width of 0.8 mm. Head and body are dull white. Within 4 to 5 hours the head and thoracic legs turn black. By the next day the caterpillar grows to 6 mm.

External features.

In addition to each pair of dorsal spots being connected together by a faint transverse black line, the dorsal spots on each side are joined together by a long longitudinal black line. This is very characteristic of this instar. Within 6 or 7 days the body grows to a maximum length of about 9.5 mm. The caterpillar moults on the 9th or 10th day.

Third instar caterpillar (Fig.39).

Just after moult the caterpillar has a length of about 8.5 mm. and a head width of 1.3 mm. Head and body are pale white and the mandibles and ocelli are dark brown. Thoracic legs have black tips. Within a day the caterpillar grows to 10 mm;

the head and the thoracic legs turn black and the body pale black.

External features.

The head is dark brown with an irregular white patch on the frons. The longitudinal lines joining the dorsal spots become thick and prominent. In the mid dorsal region of the body is a faint white line. Behind each abdominal spiracle there are two additional spots placed one above the other. In each intersegmental region, just below the line of spiracles is a small black spot.

Within 6 to 7 days the caterpillar grows to a maximum length of 16.5 mm. after which feeding is gradually reduced. Moulting takes place on the 10th or 11th day.

Fourth instar caterpillar (Fig.40).

The caterpillar measures 12 mm. and has a head width of about 2 mm. The head and body are pale white. By the second day it grows to 14 mm. Mid dorsal region of the body is yellow. The head and thoracic legs turn dark brown.

External features.

The head is dark brown with seven white patches. Ventro lateral sides and prolegs are black. Mid dorsal region is yellow due to the presence of large number of short yellow hairs. On each side just above the line of lateral spots is a broad dull white band on which is a black wavy interrupted line.

Within 8 to 9 days the caterpillar grows to a maximum length of 24 mm. On an average it consumes about 1 square inch of leaf in a night. After the 12th day no feeding takes place. The body gets reduced to 20 mm. and on the 13th day the caterpillar moults.

Fifth instar caterpillar (Fig.4f).

Soon after moult the caterpillar has a length of about 17 mm. and has a head width of 3 mm. Head is pale yellow with black streaks. Mid dorsal region is dull white. By the next day the caterpillar grows to a length of 26 mm. The head is marked with black lines. Mid dorsal region of

the abdomen turns bright yellow and that of the thorax black. Thoracic legs are dark brown. Ventral side is black. The setae are white tipped.

External features.

The mid dorsal region of abdomen is bright yellow due to the large number of small yellow hairs. On either side of the mid dorsal line a faint interrupted white line is seen. By about 9 to 10 days the caterpillar grows to a length of about 45 mm. This instar caterpillar spins a lot of silken webbing. On an average a single caterpillar consumes about 2 square inches of leaf in a night. From the 10th day feeding is gradually reduced and moulting takes place on the 12th or 13th day.

Sixth instar caterpillar (Fig.42).

The caterpillar has a length of about 26 mm. and has a head width of 4 mm. immediately after moult. The head is pale yellow with prominent black transverse streaks. Mid dorsal region is bright yellow. Thoracic legs and prolegs are rosy red.

External features.

In each intersegmental region, there is a pair of transverse rows of black bristles. Of the two spots behind each abdominal spiracle the upper one is dark red.

Within 8 or 9 days the caterpillar grows to a length of about 53 mm. On an average a single caterpillar consumes about 4 to 5 square inches of leaf in a night. On the 17th day it stops feeding; shrinks to 45 mm. and it moults on the 18th day.

Seventh instar caterpillar (Fig.45).

Immediately after moult the caterpillar has a length of about 42 mm. and has a head width of 5 mm. By the next day body grows to a length of about 47 mm. Mid dorsal region of the body has now developed conical tufts of short grey hairs.

External features.

On the mid dorsal region is an interrupted silvery white line and on either side of it is a red line. The broad lateral band has a reddish tinge. The upper spot near the spiracle is bright

red. All the long hairs are white tipped. The crochets of the sucker feet are arranged in two rows in a unilateral association. Each crochet of the outer row has an unidentate spine.

By about 18 to 19 days the caterpillar grows to a length of 72 mm. In an average a single caterpillar consumes about 5 to 7 square inches of leaf. By the 25th day feeding stops and body shrinks to ½ cm bringing the tufts of ashy grey bristles close together. The caterpillar selects a suitable place in the ground for pupation. Usually sheltered spots at the foot of a tree or crevices in dead wood etc., are selected. It goes into the soil 1 or 1 ½ inches deep and constructs a silken cocoon. The pupal period lasts for 4 to 6 days.

The cocoon (fig.44) is made of loose silk mixed with sand particles, debris, and urticating hairs derived from the body.

Pupa (Fig.45) is shining dark brown measuring 23 mm. x 10 mm. About 90 cremaster hooks are present in the last abdominal segment.

The pupal duration lasts for 7 to 8 months.

Emergence and mating.

Usually the moths emerge late in the evening and at night and mating takes place on the 2nd or 3rd day after emergence. The sexes appear to be about equal in number. The male moth has been found to live for about 11 days and females for 15 - 16 days after emergence.

By day the moths are found resting among the low bushes close to the cardamom plants or in the crevices of some old shade trees.

Alternate food plants.

The caterpillars on Erythrina indica Lam feed on the leaves of the tree till the 3rd instar and afterwards they descend on to the cardamom, the leaves of which are devoured voraciously. Caterpillars have also been found to breed on the garden bean Dolichos lablab Linn., and on a low growing weed Polygonum chinense Linn.

Status.

Though the caterpillars are found in large

numbers they have not attained the status of a serious pest.

Euptorote fabia Cram.,Fig.46).

The caterpillars are found in small numbers during August to October, on cardamom.

The full grown caterpillar (Fig.47).

Length 75 mm.

Head width 5.5 mm.

The head is smoky black with an yellowish white mark on the vertex and genae. The ocelli are dark red. The prothoracic shield is also black with a row of greyish white hairs rising from it. On the dorsal side of each segment there is a pair of dorsal spots one on either side of the mid dorsal line. Behind each pair of dorsal spots in the mid dorsal line, there is a pair of spots bearing pale red hairs. Behind these hair tufts there is a transverse row of grey hairs and bristles. The lateral spots are situated below each dorsal spot. In between the lateral

spots on each intersegmental region is a tuft of black bristles and hairs. The ventro lateral spots are situated below the lateral spots. The spiracles are dark brown with black rims. The crochets of the sucker feet are arranged in two rows in uniordinal mesoseries. Crochets in outer circle have serrated edge.

The cocoon (Fig.48) as in other species of Euproctis consists of two layers of silk mingled with urticating hairs and sand particles. The pupa (Fig.49) is dark brown measuring 31 x 12 mm. There are about 60 - 70 cremaster hooks on the last abdominal segment. The pupal duration lasts for 7 to 8 months.

The caterpillars are sometimes found in large numbers on Tectona grandis Linn., feeding on the leaves.

Parasites. A Tachinid, Sturmia pericaridae (Fig.50) parasitises the larva.

Status. Since the caterpillars are found only in small numbers no serious damage has been reported so far.

Lenodora vittata Wlk.(Fig.59).

Large numbers of moths emerge just after the south west monsoon in June, mate and begin to lay eggs on the cardamom leaves. Eggs are laid at night in a row either on the upper or on the under surface of the leaves (Fig.60). Oviposition which commences 2 or 3 days after emergence continues for a period ranging from 6 to 9 days. A single moth lays in all about 100 - 130 eggs. The egg (Fig.61) is green coloured, dome shaped with a diameter of about 2.9 mm. and a height of 1.6 mm. Chorion is smooth, leathery, and translucent. After about 5 to 7 days, the head of the embryo is seen as a dark circular patch on the side, which gradually comes to occupy the top of the dome as development proceeds. The body is seen as a pair of dark lines with the setae fringing its margins. When about to hatch a circular portion of the shell on the top of the egg is bitten off, as a result of which the apex of the dome comes off as a thin lid and the larva wriggles out. The incubation period lasts for 10 to 15 days.

First instar caterpillar Fig.62).

The newly hatched caterpillar has a length of about 7.3 mm. and a head width of 1.5 mm. The head is shining black and disproportionately large. The body is uniform dull white. In about an hour the body grows to a length of 8.2 mm. On emergence from the egg shell the hairs on the body are wet and glued together The caterpillar moves a short distance from the egg shell and performs wriggling movements for some time apparently to dry the hairs. It first feeds on the empty egg shell and for one day it remains without further feeding but grows to a length of 10 - 12 mm. The caterpillar feeds only slightly on the second day, but active feeding begins from the 3rd day onwards when the body develops a greenish tinge due to the green contents of the intestines. By the fifth day it grows to 15 mm. and the head appears to be quite proportionate to the body.

External features.

Head is shining black with a few scattered

hairs. On each side of the head there are 6 ocelli arranged in the form of a crescent, and a small three jointed antenna. The prothoracic shield is black and conspicuous, the middle portion is broad and the shield extends down a little on either side.

On the dorsal side of each of the segments except that of the prothorax, there are a pair of black spots one on either side of the mid dorsal line. The dorsal spots of meso and meta thoracic segments are larger. On the 9th segment, the spots are close together and on the 10th, they almost merge into one. Between the dorsal spots of each side, are a few inconspicuous lines and spots (Fig.62a). Lateral spots are situated immediately below the dorsal spots, one on either side of each segment. On the ventrolateral region below the lateral spots are the ventrolateral spots, and the latter on the thoracic segments are larger.

Setae and their arrangement.

On the dorsal spots there are 3 kinds of setae (1) long white flexible hairs about 10 mm. long

(2) short white hairs about ¼ mm. and (3) short black bristles 1.5 mm. long. The hairs are serrated, non irritant and flexible. The bristles are short, sharp, smooth, and easily detachable. They are capable of causing considerable irritation and pain on coming into contact with human skin. The black bristles of this instar caterpillar, are slightly dilated in the middle. The lateral and ventro lateral spots also bear short white hairs measuring about ⅓ - ½ mm.

The spiracles are oval with brown rims and are situated immediately below the lateral spots. The prothoracic spiracle is situated anterior to the lateral spot.

In about 16 days the caterpillar grows to a length of 17 mm. It gradually stops feeding and moults.

Moulting.

Two or three days before moulting the body gets reduced in length, and develops an yellow tinge. The prothorax gets swollen and the

caterpillar remains motionless with the prolegs firmly fixed on to the substratum. On the prothorax a longitudinal split in the skin occurs on the left side. The middle portion of the body of the caterpillar pushes itself out in the form of a U. The bend gradually straightens out and in a few minutes the head is pulled out with a sudden jerk. Thoracic legs plant themselves on the ground and then the hind portion of the body is drawn out. The exuviae is left behind, fixed on to the substratum. The moulting is completed within 2 - 4 minutes. The process is the same in all instars.

Second instar caterpillar (Fig.63).

Immediately after moult the caterpillar has a length of about 14.5 mm. and a head width of 2.3 mm. The head is pale flesh coloured with distinct ocelli and reddish brown mandibles. Thoracic legs and prolegs are pale white. The caterpillar begins feeding on the next day by which it grows to a length of 17.5 mm. A predominent black tinge appears over the body and the ocelli become indistinct as the head turns dark.

External features.

Though the arrangement of the spots is similar to that of the previous instar they are indistinct due to the dark ground colour of the body. Below the line of lateral spots is a pale white wavy line. A similar interrupted dull white wavy line is also present joining the lateral spots. Arising from the mid dorsal region of the meta thoracic segment and from the first abdominal segment is a tuft of small yellow bristles measuring about 1.5 mm.

Setae.

Short yellow clothing bristles from the body measure approximately 2.5 mm. and they are uniformly distributed over the whole body. The dorsal spots bear black bristles about 5 mm. long, besides long white hairs measuring about 10 mm. From the meso thorax, meta thorax and the last abdominal segment a few long hairs arise with the basal half black and rest white.

In 12 days the caterpillar grows to a length of about 30 mm. A caterpillar consumes about one square inch of leaf in a night. On the 14th day no feeding takes place and the body gradually gets reduced to 24 or 25 mm. Most of the long hairs are shed; the usual moulting signs appear and the caterpillar moults on the 18th or 19th day.

Third instar caterpillar (Fig.64).

Just after moult the caterpillar has a length of about 22 mm. and a head width of 3.4 mm. The head is pale white with a greenish tinge. Thoracic legs are rosy red and prolegs are pale white. Body has a pale dark colour but the last abdominal segment is pale green. The head is almost hidden by the long pencils of hairs borne on the meso and meta thoracic segments. Within a day the caterpillar grows to a length of about 27 mm. and active feeding begins after this period. By this time the head turns dark brown with a narrow but prominent transverse white streak just about the clypeus.

External features.

In the mid dorsal region of the metathoracic segment and in the first abdominal segment there is a tuft of black bristles.

The arrangement of the different spots is as in the last instar. The dorsal spots become less defined due to the dark ground colour of the body.

The hairs arising from the dorsal spots measure about 9 mm. and the black bristles measure about 4.5 mm. White hairs borne on lateral spots measure about 7 mm. The clothing bristles of the body measure approximately 2.5 mm. and they are arranged in 2 transverse rows in each segment, the anterior row in front of the dorsal spots, and the posterior behind. The long hairs rising from meso and meta thoracic segments measure about 15 mm.

In 12 days the caterpillar grows to a length of about 46 mm. On an average a single caterpillar consumes about 1½ square inches of leaf in a night. On the 17th day the caterpillar stops feeding and moulting takes place on the 18th or 19th day.

Fourth instar caterpillar Fig.6).

Just after moult the caterpillar measures about 36 mm. and has a head width of 4.5 mm. Head is pale white with a light greenish tinge and a ∧ mark in the middle bordering the outline of vertex.

The last abdominal segment is also light green. Mandibles are reddish brown and basal portions of the antennae are yellow; thoracic legs are pale white with brown tips. Mid ventral side is deep yellow with lighter shade on the sides. Within a day the caterpillar grows to a length of about 40 mm. and the greenish tinge in the last abdominal segment disappears. Head develops a dull yellow tint with a broad brown band, above the ∧ mark which turns dark red. Thoracic legs turn red while prolegs turn pale brown.

External features

The dorsal spots are oval and dark brown. In front of each pair of dorsal spots is a pair of roughly circular black spots. These spots appear

for the first time. The short black bristles measuring 3 mm. arise from the dorsal spots. Some of the hairs rising from the lateral spots of the thoracic segments have capitate ends and they measure 5 to 8 mm. Long yellow hairs measuring about 23 mm. rise from the mesothoracic and meta thoracic segments.

The caterpillars feed voraciously and grow to a length of about 60 - 62 mm. in 16 to 17 days. A single caterpillar consumes about 2½ square inches of leaf in a night. During day it usually remains on the pseudostem. After 18 days, feeding is gradually stopped and moulting takes place on the next day.

Fifth instar caterpillar (Fig.66).

Immediately after moult the caterpillar has a length of about 45 mm. and a head width of 5.2 mm. Within 24 hours it grows to a length of 56 mm.

External features.

The spots that have appeared in the last instar in front of the dorsal spots are now more distinct.

The lateral spots bear black hairs measuring about 4 mm. The hairs rising from the ventro lateral spots measure 9 mm. and have capitate ends. This is a distinguishing characteristic of this instar. Long pale yellow hairs rising from meso and meta thoracic segments measure about 9.5 mm.

Within 11 or 12 days the caterpillar grows to a length of 80 - 81 mm. On an average a single individual consumes about 5 to 6 square inches of leaf in a night. From the 17th day feeding is gradually stopped and body gets reduced in length to 70 - 72 mm. On the 20th or 21st day moulting takes place.

Sixth instar caterpillar (Fig.67).

Soon after moult the caterpillar has a length of about 50 mm. and a head width of nearly 6 mm. By the next day the caterpillar grows to 57 mm.

External features.

There are two prominent transverse pairs of black bristles on each segment. Almost all the

clothing hairs of the body are capitate and they measure about 3 mm. Long yellow hairs from the meso and meta thoracic segments measure about 18 mm. The black bristles from dorsal, lateral, and ventro lateral spots measure about 5 mm.

The crochets of the sucker foot are arranged in biordinal mesoseries.

The caterpillar is a voracious feeder and in a single night it consumes about 9 - 10 square inches of leaf. During severe attacks, complete defoliation of the clump results leaving only the pseudostem and the mid ribs of the leaves. Within 18 or 19 days the caterpillar grows to 106 - 110 mm. On the 24th or 25th day the caterpillar stops feeding and the body gradually gets reduced to 35 - 40 mm. The sides now develop a greenish tinge and the head turns grey. At this stage it enters the loose soil at the base of the plant and pupates 2 to 2½ inches below the surface, without constructing a cocoon or any protective covering. In the laboratory if no soil is supplied it pupates in a

corner of the breeding cage. The pupa is at first white with a greenish tinge in the region of the wingpads. About an hour later, the lower region develops a brownish tint in the form of a ring around each segment which in two hours, extends above, and the whole pupa gradually turns dark brown.

Pupa (Fig. 68 & 69).

On the ventral side of the 6th and the 7th abdominal segments there is a pair of small tubular protuberances. On the last segment there are two sets of cremaster hooks, four in each set. The pupa measures ¾ cm. long and 1/4 cm. across in the thoracic region. The pupal period lasts for 5 to 7 months.

Natural enemies.

A Tachind fly (Carcelia kockiana) has been found to parasitise the caterpillar. Large number of red mites have been also found on the caterpillars.

Status.

The caterpillar is found in large numbers

during August - December causing heavy defoliation. Since it occurs only in widely scattered patches and no wide spread outbreak has occured so far, it cannot be considered yet as a major pest.

Distinguishing features of different instars of the cardamom lasiocampid, Londodora vittata, Wlk.

First instar. Body pale green; head black; setae only of two kinds. Short black bristles and long white hairs. Length 10 to 16 mm. Head width 1.5 mm.

Second instar. Dorsal side black; head dark brown; setae more than two kinds. A tuft of yellow bristles on the metathorax and the first abdominal segment. On each side two faint yellow lines. Length 18 - 30 mm; head width 2.5 mm.

Third instar. A tuft of black bristles in the region of meta thorax and first abdominal segment. Length 28 - 46 mm; head width 3.5 mm.

Fourth instar. Ventro lateral, and lateral spots of thorax have capitate hairs. The dorsal spots pale brown with only bristles. Lateral spots have a few black bristles. In front of the dorsal spots a pair of

indistinct black spots. Length 39 to 60 mm. Head width 4.5 mm.

Fifth instar. All hairs rising from the ventro lateral and lateral spots capitate. Length 50 to 80 mm. Head width 5.2 mm.

Sixth instar. Two conspicuous transverse rows of black bristles on each segment. Short yellow bristles clothing the body capitate; length 56 to 110 mm. Head width 7 mm.

Feeding capacity of Euploeta cardamani (sp.nov)

Sl. Expt. No.	Date	Time Hrs.	No. of Caterpillars	Different stage caterpillars (area eaten in sq. inches			
				7th Instar	8th Instar.	9th Instar	10th Instar.
1	23.11.42	12	5	3.2.	6.24	12.27	29.42
2	24.11.42	12	5	4.52	7.10	14.72	31.27
3	25.11.42	12	5	3.92	6.90	12.72	30.42
4	26.11.42	12	5	4.10	6.21	16.72	34.21
5	27.11.42	12	5	3.27	7.10	13.21	29.52
6	28.11.42	12	5	3.91	7.20	19.21	42.92
7	29.11.42	12	5	3.84	6.92	14.21	42.12
8	30.11.42	12	5	4.21	6.82	13.21	43.12
9	1.12.42	12	5	4.00	7.21	16.27	42.13
10	2.12.42	12	5	4.12	7.10	18.20	47.12
11	3.12.42	12	5	4.21	7.10	17.54	32.42
12	4.12.42	12	5	3.92	6.60	14.46	46.15
13	5.12.42	12	5	3.91	5.92	16.29	41.54
14	6.12.42	12	5	4.12	7.10	17.20	32.27
15	7.12.42	12	5	4.00	6.92	13.42	49.13
16	8.12.42	12	5	4.21	7.21	16.20	44.12
17	9.12.42	12	5	4.00	6.82	14.26	47.14
18	10.12.42	12	5	3.71	7.20	17.21	46.12
19	11.12.42	12	5	3.54	7.12	17.21	44.71
20	12.12.42	12	5	2.94	6.92	16.54	41.21

Feeding capacity of Lenodora vittata Wlk.

Sl. Expt. No.	Date	No. of caterpillars	Time (Hrs.)	(Caterpillars) area eater in square inches.					
				1st instar	2nd instar	3rd instar	4th instar	5th instar	6th instar
1	5-10-42	5	12	1.55	2.57	4.00	6.71	18.4	49.17
2	6-10-42	5	12	1.38	3.1	3.72	5.92	19.42	54.12
3	7-12-42	5	12	1.42	3.10	4.21	6.43	23.42	52.12
4	8-12-42	5	12	1.41	3.75	3.21	6.72	24.10	52.10
5	9-12-42	5	12	1.27	4.23	3.91	4.92	19.21	53.10
6	10-12-42	5	12	1.81	3.21	4.00	5.12	23.20	55.10
7	11-12-42	5	12	1.72	3.10	3.71	5.10	18.17	65.05
8	12-12-42	5	12	1.42	4.21	3.21	5 02	22.11	60.00
9	13-12-42	5	12	1.76	3.71	4.61	5.12	19.10	57.81
10	14-12-42	5	12	1.56	3.23	4.21	5.27	18.10	62.10
11	15-12-42	5	12	1.23	2.90	3.91	5.10	24.10	61.02
12	16-12-42	5	12	1.51	2.00	3.41	5.17	21.02	61.21
13	17-12-42	5	12	1.27	3.10	3.21	5.92	23.12	59.12
14	18-12-42	5	12	2.00	3.00	3.94	5.10	22.12	61.21
15	19-12-42	5	12	1.80	2.90	4.00	4.20	20-12	67.23
16	20-12-42	5	12	2.10	2.00	4.20	5.91	23.12	66.21
17	21-12-42	5	12	1.10	1.78	4.10	5.27	21.20	62.10
18	22-12-42	5	12	2.10	2.20	4.20	5.10	19.17	62.16
19	23-12-42	5	12	2.20	2.71	4.10	5.27	21.12	58.10
20	24-12-42	5	12	1.17	2.44	4.10	5.12	21.00	61.20

Family. Lymantriidae.

Euproctis lutifacia Swpn. (Fig.70).

These caterpillars are found on cardamom during December to January feeding on the foliage.

The full grown caterpillar (Fig.71).

Length 25mm.

Head width 3 mm.

Head is ochraceous; mid prothorax is broad with a slight prolongation on either side from which arise tufts of black hairs measuring about 7 mm. Dorsal region is pale brown and bordering this, is a pale yellow colour on either side. A mid dorsal black line divides the dorsal region into two halves. On either side of the mid dorsal line is a pair of spots on each segment with four or five brown bristles. From the mid dorsal region of the first and the second abdominal segment arises a conspicuous tuft of brown hairs. Surrounding the tuft a few white hairs are seen. In the abdomen just below each dorsal spot is a tuft of white hairs. Below each tuft is the lateral

spot surrounded by a white ring. Below the lateral spots are the spiracles. Below the line of lateral spots are the ventro lateral spots. They bear white glucose hairs spreading sideways. In the sixth or seventh abdominal segments there is on the middle of the dorsal side of each, an eversible glandular organ.

The crochets on the prolegs are arranged in unilateral heterories.

Larval Habits.

The caterpillars prefer tender foliage and feed by night. They usually rest in leaf folds during day time to avoid sun light. During the early stages the caterpillars are gregarious though later they disperse. Two or three days before pupation they abstain from food and gradually the length gets reduced to 1½ - 1⅝ in. Pupation takes place in the soil within a silken cocoon to which soil, debris and leaf bits adhere. Pupae have also been found under fallen leaves.

The cocoon consists of a loose layer of soft silk to which sand particles, hairs and debris are found adhering. Pupa (Fig.72) is short and dark brown measuring 11 x 3 mm. The pupal period lasts for 16 - 18 days.

The adult is a vinous brown moth with an antemedial orange red maculate line on the fore wings. They are attracted to light.

Status.

The caterpillars are usually found in small numbers. The damage done is not serious though defoliation takes place to some extent.

Family. Arctiidae.

Alphaea biguttata lk.(Fig.73).

These black hairy caterpillars are found on cardamom during the months of June to December.

Full grown caterpillar (Fig 74)

length - 60 - 65 mm.

Head width - 5 mm.

The head and body black, with black bristles and hairs. There is a faint white mark on the head outlining the border of vertex. A few short hairs arise from the head.

The prothoracic segment is narrow and provided with a well developed black shield on which arise four bundles of setae arranged transversely. Thoracic legs and prolegs are dark brown. The crochets of the prolegs are heteroides. In each of the segments behind the prothorax there are 8 - 9 transverse bundles of black setae. Each bundle consists of two kinds of plumose setae, a short variety measuring about 4 mm. and a long variety measuring about 11 mm.

Before pupation the caterpillar stops feeding and after selecting a suitable place in the ground, it enters into the loose soil to a depth of 2 - 2½ inches. A cocoon (Fig.75) of black silk is spun to which hairs and sand particles adhere.

The pupa (Fig.76) is dark brown measuring 16 x 6 mm. Ten to twelve cremaster hooks are found on the last abdominal segment.

The pupal duration lasts for 22 - 25 days. The adults are seen attracted to light.

Status.

The caterpillars occur only occasionally and the damage done is not serious.

Seasonal incidence of Cardamom thrips, *Taeniothrips cardamomi* Ramk.*

Introduction and Previous work.

This important pest of cardamom was first reported from Anamalais in 1934 (Ramakrishna Ayyar 1935) and was subsequently noted from almost all the cardamom growing areas in South India (Coyne 1941). The life history, status and control of the pest have been described by various authors, Ramakrishna Ayyar and Kylasam (1935), Subramaniam (1940), Padmanabha Ayyar and Jones (1940), Beeson (1941), and Jones (1943). In this paper observations on the population fluctuations of the pest in relation to the influence of temperature, humidity and rainfall, an aspect that has not received much attention, are recorded in some detail.

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*Shumsher Singh (1942) erected a new genus Ramakrishnothrips to include Taeniothrips cardamomi and T. formaphila.

Life history and habits of the pest.

The insects inhabit the leaf sheaths and the bracts of the racemes, as many as a dozen individuals including nymphs occuring inside a single leaf sheath. During flowering season nymphs and adults can be seen inside the bracts in the racemes. The injury caused to the leaf sheath is little except for an occasional brown coloration. On the other hand, the damage caused to the inflorescence is considerable. The flower buds and very young pods are lacerated for the sap and injured portions get malformed with a corky growth. Many of the affected flowers and pods wither and fall off. Even the inflorescence stalk which is subjected to the attack at a tender age gets stunted and malformed as a result of which the number of pods borne by it gets considerably reduced.

Eggs are laid in slits made by the ovipositor in the plant. Each egg is a minute, translucent pea shaped object. The egg membrane first splits and the quiescent embryo can be seen

with their eyes as red spots. These come out as milky white wingless nymphs, move about and feed on the sap of the plant by laceration and suckling. The nymphs undergo four moults before they become adults. There is nothing remarkable in the second and third instars except a progressive increase in size and the presence of wing rudiments in the latter stage. The next stage is interesting in that the insect remains comparatively quiescent like a pupe. This moults and becomes the adult. The life cycle from egg to adult is completed in about a month and there are about 12 generations in a year.

Though both males and females are present the usual mode of reproduction is parthenogenetic. The female which lives for about a month and in rare cases up to two months lays about forty eggs.

Technique and design of the experiment.

In counting the insects it was necessary to separate the leaf sheath from the pseudostem and

in so doing occasionally some fell off and others were left exposed to the mercy of their predators. Are there any to the possibility of including the progeny of these during the next observation was limited. Therefore, it was necessary to adopt a new method.

A preliminary experiment was conducted first to see whether there was any significant variation from plant to plant with regard to the pest in the area under observation. Observations on three blocks selected at random containing 24 plants each were made and independent tests of analysis of variance for each of the blocks for plant difference were carried out. The results of analysis of variance are given in Table I e.

Table I a.

Block I.

Sl. No.	Adult	Pupae	Nymphs
1	2	5	0
2	5	2	0
3	0	1	2
4	4	3	1
5	3	0	0
6	1	2	1
7	2	2	0
8	0	3	2
9	5	0	0
10	4	0	3
11	0	2	0
12	4	4	5
13	2	1	0
14	4	5	0
15	2	6	5
16	2	2	0
17	1	4	0
18	0	0	0
19	0	2	0
20	3	2	0
21	5	1	1
22	2	0	0
23	1	7	2
24		0	

	Freedom.	Sum of squares	S/f	F
Inter block plant	24	99.6537	4.15223	1.18
Inter group thrips	2	32.1067	16.05335	4.55
Error	48	169.2263	3.5255	
Total	74	300.9867		

Inference : The plant difference not significant.

Table I a. contd.

Block II.

Sl. No.	Adult	Pupae	Nymphs
1	1	3	1
2	1	1	1
3	5	7	0
4	2	3	0
5	2	1	3
6	7	7	4
7	2	3	0
8	1	2	1
9	3	1	0
10	2	1	1
11	1	0	2
12	2	3	0
13	0	2	0
14	0	1	3
15	3	5	2
16	2	6	0
17	4	7	2
18	1	4	7
19	2	2	4
20	0	2	2
21		7	3
22		2	
23			
24			

	Freedom.	Sum of squares	S/f	F
Inter block (plant)	24	54.67	2.2779	1.07
Inter group (thrips)	2	35.63	18.815	7.88
Error	48	102.37	2.1327	
Total	74	190.67		

Inference : Plant difference not significant.

Table I a. contd.

Block III.

Sl. No.	Adult	Pupae	Nymphs.
1	1	1	6
2	2	2	0
3	5	3	2
4	2	2	0
5	0	0	4
6	1	1	0
7	1	1	3
8	0	0	5
9	1	0	1
10	6	7	3
11	1	0	0
12	4	1	6
13	1	0	4
14	4	3	6
15	1	3	0
16	2	2	7
17	4	2	6
18	2	5	0
19	2	7	7
20	1	5	6
21	2	4	3
22	2	1	4
23	5	7	1
24	5	7	6

	Freedom.	Sum of squares	S/f	F.
Inter block (plant)	24	133.920	5.58	1.30
Inter group (thrips)	2	6.427	3.2135	1.34
Error	48	230.240	4.2967	
Total	74	370.587		

Inference: Plant difference not significant.

The plants are equally or uniformly affected by the pest. Therefore the following experiment was designed.

Experiment

Twenty five plants selected at random from an area of about 1000 acres were examined regularly once in a week for two years. In observing the plants, the leaf sheath was removed from the pseudostem without disturbing any organism. The number of individuals were counted quickly with the help of a lens, sorted according to their different stages and entered. The temperature, rainfall and humidity were also recorded for two years and the results were statistically* analysed.

Results.

The following table gives the correlation coefficient between the number of thrips in each stage and the climatic conditions (temperature, humidity and rainfall).

	Temperature	Rainfall	Humidity
Adult thrips	.1261	.0178	.0539
Pupae	.5753	.1254	.7139
Nymphs	.2579	.3972	.2537

* I am greatly obliged to Dr. M.S. Nair, and Mr. S. Ramachandra Aiyer

It is not difficult to see that the correlations are not very high. The adult thrips are the least affected. In the order of their influence on the adult thrips, temperature comes first, humidity second and rainfall, the last.

The pupae and nymphs are more seriously affected by these factors. Rainfall is the most influential factor among them. Rainfall and humidity tend to destroy the thrips while temperature helps their growth.

The relationship between the intensity of the thrips and climatic conditions has also been studied by the method of analysis of variance. Observations for ten consecutive weeks during which definite changes in these factors viz. temperature, rainfall and humidity are known to have taken place are considered and the test of analysis of variance carried on them to see whether there exists any significant difference between the means from week to week. A significance in this test shows the existence of seasonal variations in the intensity which establishes the foregone conclusions. Below are given the results of analysis.

Table III a.

col.	Total number of thrips.	Total No. of pupae.	Total No. of nymphs.	Total
1	79	64	35	198
2	90	41	16	103
3	65	57	27	149
4	25	55	26	106
5	51	17	51	176
6	77	103	17	201
7	36	56	10	205
8	32	96	26	190
9	04	32	11	95
10	01	15	7	23
Total	657	628	330	1515

	Difference.	Sum of squares.	S/f	F.
Inter block	9	697.2	77.9	2.56
Inter group	2	134.0	2122.9	8.00
Error	18	938.5	302.75	
Total	29	1769.5		

Inference : both inter block and inter group are significant.

Table III b.

Block	Total No. of adults.	Total No. of pupae.	Total No. of nymphs.	Total
1	109	105	92	306
2	127	94	144	365
3	62	61	32	155
4	63	62	34	159
5	58	64	33	155
6	79	47	55	181
7	50	57	10	117
8	65	55	27	147
9	25	35	26	86
10	18	77	51	176
Total	689	644	509	1842

	Differ-ence.	Sum of squares.	M.S.	F.
Inter block	9	22450.5	2494.5	11.10
Inter group	2	1755.0	877.5	3.91
Error	18	4043	224.65	
Total	29	28249.2		

Inference: Both inter block and inter group are significant.

Table III c.

Cook	Total No. of adults.	Total No. of pupae.	Total No. of nymphs.	Total
1	66	72	21	159
2	67	80	61	208
3	58	10	2	70
4	79	74	42	195
5	64	17	2	83
6	42	4	1	47
7	30	4	5	39
8	26	25	6	57
9	38	26	13	77
10	34	7	1	42
Total	504	319	184	1007

	Differences.	Sum of squares.	S/f	F.
Inter block	9	12711.37	1412.374	6.94
Inter group	2	4475.0	2257.5	11.12
Error	18	3604.33	203.57	
Total	29	20790.7		

Inference: Both inter block and inter group are significant.

Table III d.

Week.	Total No. of adult.	Total No. of pupae.	Total No. of nymphs.	Total
1	33	35	12	80
2	32	37	4	50
3	23	21	7	51
4	32	27	11	70
5	37	28	19	76
6	32	30	34	96
7	30	29	15	131
8	31	32	17	148
9	32	32	16	101
10	22	18		86
Total	349	339	169	977

	Differ-ence.	Sum of squares.	M/S	F.
Inter block	9	3095.97	343.997	3.62
Inter group	2	1939.4	969.7	10.21
Error	18	1709.53	94.96	
Total	29	6744.7		

Inference: Both inter block and inter group are significant.

A linear line of regression just to indicate approximately the distribution of the intensity of the thrips according to changes in temperature, rainfall and humidity is fitted to the different stages of thrips. The calculations are fairly simple and the equations are given below :

$$(N_1 - \bar{N}_1) = a_{1.1}\ (X_1 - \bar{X}_1) + a_{1.2}\ (X_2 - \bar{X}_2) + a_{1.3}\ (X_3 - \bar{X}_3)$$

$$(N_2 - \bar{N}_2) = a_{2.1}\ (X_1 - \bar{X}_1) + a_{2.2}\ (X_2 - \bar{X}_2) + a_{2.3}\ (X_3 - \bar{X}_3)$$

$$(N_3 - \bar{N}_3) = a_{3.1}\ (X_1 - \bar{X}_1) + a_{3.2}\ (X_2 - \bar{X}_2) + a_{3.3}\ (X_3 - \bar{X}_3)$$

Where

X_1 - Average temperature for the week	$\bar{X}_1 = 70.06^{\circ}$
X_2 - Total rainfall for the week	$\bar{X}_2 = 1.95"$
X_3 - Average humidity for the week	$\bar{X}_3 = 91.17$

N_1 - Number of adult thrips $\overline{N_1} = 44.57$

N_2 - Number of pupae $\overline{N_2} = 45.0$

N_3 - Number of young nymphs $\overline{N_3} = 30.84$

$$\begin{Bmatrix} a_{1.1} & a_{1.2} & a_{1.3} \\ a_{2.1} & a_{2.2} & a_{2.3} \\ a_{3.1} & a_{3.2} & a_{3.3} \end{Bmatrix} \begin{Bmatrix} .043955 & -.243840 & -.142184 \\ .311580 & -4.226229 & -.289654 \\ .140125 & -3.852695 & -.207665 \end{Bmatrix}$$

PART III.

MINOR PESTS

Fam. Psychidae.

Acanthopsyche bipars Wlk (fig.77).

During June to August large numbers of this psychid (bag worm) are found eating circular holes in the leaves of cardamom. The adult is a smoky black moth with hyaline wings. Since the female is undescribed a brief description of the same is given.

Female (Fig.78).

Wingless, ~~worm like~~ vermiform, the head and thorax black and well chitinized. The hood segment bears vestiges of the antennae. Eyes not present. The thoracic segments bear vestiges of legs as small stumps. The abdomen, a cream yellow massive egg sac, filled with eggs; the posterior portion narrow, tapering to a point.

Length 2½ mm. Broadth in the thoracic region - 5 mm.

Oviposition.

The eggs are laid by the female in a mass of about 250 inside the larval case. They are spherical with a diameter of 0.2 mm. Freshly laid eggs are pale yellow, but turn grey by the next day. The incubation period lasts for 13 - 14 days.

The newly hatched larva measures about 1.2 mm. As it comes out of the case a loose coating of adhesive silk is secreted over the body. The caterpillar begins to feed on the cardamom leaf by scraping off the epidermis. Comminuted fragments of leaves are attached to its back while feeding. Within 5 to 7 days a compact conical case is formed which is carried upright when the caterpillar moves. By the 1st month it grows to 3.5 mm. In the second 8 mm, in the third about 10.5 mm, and in the fifth 15 mm. During the period of growth the case is also enlarged by adding more leaf bits. The caterpillar drags the bag along while it moves. While at rest during day, it attaches the upper end of the bag with a silken thread to the leaf

or pseudostem. The case is roughly conical with the upper end broad and the lower end narrow and tapering. The wall of the case is tough and leathery due to the thick inner lining of silk. During early stages the outer surface of the case is rough due to the presence of a large number of leaf bits. As the caterpillar grows, the surface of the case (Fig.20) gets smooth due to the gradual wearing away of the free edges of the leaf bits.

The full grown caterpillar (Fig.19).

The full grown caterpillar is stout measuring about 25 - 30 mm. long and has a girth of nearly 5.5 mm. The head is pale brown, with dark brown transverse streaks and irregularly distributed short hairs. The terga of the thoracic segments are well chitinized. Thoracic segments are larger and have dark brown longitudinal markings. The abdomen is short, stout, and cylindrical. On either side of the mid dorsal line of each segment there are 3 spots. On the ninth segment the spots are not clear and on the tenth the tergum is well chitinized

and black. Close to each spiracle a faint spot is noticed. The prolegs are little developed except those of the last pair which are provided with powerful muscles and well developed crochets. In about 7 to 8 months the larva attains full growth. Five or six days before papation the larva abstains from food. It suspends the case by the upper end by means of a silken cord, closes the upper end with silk, and after reversing its position in the case pupates inside it.

The male case measures 25 - 30 mm. The female case is longer and measures 40 - 45 mm.

Male pupa (Fig.67).

It is similar in form to the other lepidopteran pupae, and is dark brown, short and compactly built and measures 11.5 mm. x 4 mm. The dorsal side of meso and meta thoracic segments is swollen. On each side seven spiracles are easily noticed. In the mid dorsal region each of the 6th, 7th and 8th abdominal segments, is a transverse row of 10 to 12 spines. At the extremity of the last segment

there are two cremaster hooks. A loose silken covering round the pupa represents the cocoon.

Female pupa (Fig.62).

It is brown, more or less cylindrical, with both ends rounded. All segments except the first three, and the last three are demarcated by thick transverse black bands. The cocoon is more compactly spun.

The pupal duration lasts for 20 - 26 days.

Emergence

The front half of male pupa wriggles out through the lower opening of the case and the pupal skin splits, allowing the moth to escape. The female ruptures the pupal skin and remains inside the case. Rarely it is seen protruding out the head through the lower hole of the case. The male moths have strongly built wings for rapid flight. During day time they remain in the crevices in the barks of trees.

Mating and oviposition.

The female moth inside the partially broken

pupal skin is ready for mating on the second day, while the winged male is found to mate on the 3rd or 4th day. The highly extensible abdomen of the male is introduced into the case containing the female, and copulation takes place. An unmated male lives for 15 to 17 days in the laboratory; a female lives for 7 to 9 days. The mated individuals live a shorter period. Male 8 to 9 days; and female 5 to 9 days. There is only one brood in the year.

An Ichneumonid, Melcha mursei has been found to parasitise the larva.

Fam. Plutellidae.

Hilarographa cominodes Meyr.(Fig.85)

This pest was recorded from cardamom in Ceylon by Green (1905). It was first noticed as a pest of cardamom in Travancore by Jones (1941). This is a common and widespread pest in all the cardamom growing areas in the State, and very few

clumps are free from the attack. Eggs are laid on the exposed portions of the roots and the caterpillars that hatch out bore into them (Fig.87). The feeding tunnel gets filled with excreta, and the distal portion of the attacked root beyond the injury dies. In several cases the caterpillars bore along the root as far as its origin from the rhizome but never into the rhizomes.

Full grown caterpillar (Fig.86).

Length 8 - 10 mm.

Head width .82 mm.

The head is pale brown with dark red mandibles; an inverted V outlining the border of vertex is present. The ocelli have the same colour as the mandibles. There is no well developed prothoracic shield. Body cream yellow; thoracic legs pale white and well developed. Crochets are borne on the ventral side of the respective segments in a circle.

During January - April full grown caterpillars are found in a state of rest or suspended animation

at the junction between the rhizome and roots. A resting state or diapause is passed in this condition before pupation (Jones 1944).

Larvae were reared in the Laboratory in roots kept moist by covering their tips with wet cotton wool.

Pupation takes place in the feeding tunnel without a cocoon.

Pupa is cream yellow measuring 8 x 2 mm (Fig.93). Three to five cremaster hooks are present on the last abdominal segment.

A few hours before emergence the whole pupa turns dark brown. The pupal duration lasts for 13 - 16 days.

The Shoot borer (Fig.95).

In the months of June to August large numbers of tender shoots of cardamom are found bored by a small pale blue caterpillar. As a result of the attack, the shoots get discoloured and begin to decay.

The caterpillar usually bores upwards (Fig.99) and the burrow gets filled with faecal refuse and chewed up fragments of leaf.

The full grown caterpillar (Fig.96)

Length 9 - 11 mm.

Head width 1.5 mm.

The head is black and body pale blue. The Thoracic shield is black and prominent. The anal shield is a thick, black, chitinous plate with a few hairs. Thoracic legs are pale white. On the dorsal and dorsulateral region of each segment there are three to four tubercles bearing fine short hairs. The thoracic legs are black and well developed. The prolegs of the last abdominal segment are elongated and have long crochets. The spiracles are oval with brown rims.

Pupation.

When full grown the caterpillar drops to the ground and spins a loose silken cocoon (Fig.97) mixed with the soil and debris. The cocoon consists of two layers of cream coloured silk and measures 8 x 5 mm.

The pupa (Fig.98) is pale brown with a light greenish tint and measures 5 x 3 mm. The spiracles are placed on elevated tubercles. The prothoracic spiracle is fairly prominent. On the last abdominal segment there are 7 - 9 cremaster hooks which firmly holds the pupa to the cocoon. The pupal period lasts for 30 - 32 days. In cold season it is prolonged by 6 - 7 days.

The adult is a black moth with golden yellow transverse marks on the fore wings.

Fam. Geometridae.

Eumelea rosalia Cram. (Fig.89).

The caterpillars are found feeding on the leaves during January - March.

The full grown caterpillar (Fig.90).

Length 53 - 58 mm.

Head width 4.2 mm.

The head and body has the colour of dry twigs. The head has a ∧ shaped prominent mark

forming the outline of vertex. Two prominent black patches are present on the vertex. On the second thoracic segment there is a black transverse dorsal band. The mid dorsal region and the sides have a dark shade. On either side of the mid dorsal line of each abdominal segment, there is a pair of black spots which can be made out with a little difficulty. On the mid dorsal line of each of the fourth, fifth, and sixth abdominal segments, there is a pair of faint black lines. On the dorsal side of the 8th abdominal segments, there is a pair of diagonally placed black lines. The prolegs, as in the loopers are present only on the 6th and last abdominal segments. The last pair is well developed.

Pupation.

Before pupation the body contracts considerably and measures only 29 - 30 mm. The caterpillar remains in a leaf and covers itself by a fold, fixed in position by strong silken strands.

Pupa (Fig.91) is dark red measuring .27 x 5 mm. On the ventral side of cephalothoracic region two

conspicuous circular spots are noticeable. The pupal duration lasts for about 15 - 17 days.

The adults have been found hovering over cardamom on cloudy days.

Anisodes denticulatus. Lmpsn. (Fig.92).

The larva is a small pale brown caterpillar with greenish tinge. These are found in fairly large numbers feeding on the leaf during June to December.

The full grown caterpillar (Fig.93).

The head and body pale brown. The mid ventral side is pale green due to the green contents of the alimentary canal. On the mid dorsal line a faint dark colour is noticed. On the dorsal side of each of the thoracic segments a transverse row of fine setae, is present. In the abdomen, on the dorsal side of each segment there are two transverse rows of fine setae borne on small tubercles, four on each row.

On the ventral and ventrolateral regions of each segment 2 - 4 fine setae are present. The spiracles are oval with black rims. When full grown the caterpillar measures 25 - 38 mm. and has a head width of 2.4 mm.

Before pupation the body shrinks 17 - 20 mm., develops a pale green colour on the sides and falls to the ground. Pupation takes place in the soil inside an earthern cell. The pupa is pale green but turns brown after a day. The ventral side of cephalothorax retains the greenish tinge. The pupa (Fig.94) measures 14 mm. long, and 4 mm. across in the cephalothoracic region. The last segment bears about 10 needle shaped cremaster hooks.

The pupal duration lasts for 17 to 18 days.

The adults are attracted to light.

Fam. Noctuidae.

Agrotis ypsilon H.

These dark brown cutworms are found feeding on the tender cardamom leaves during January - March.

The full grown caterpillar.

The head is orange red; the body is dark brown with a lighter shade in the ventral and ventrolateral regions. The thoracic legs are dark brown. On each side of the first and second abdominal segment there is a prominent light yellow longitudinal marking. Similarly there is another on each side of the 8th abdominal segment. On either side of each abdominal segment there are three fine short hairs borne on tubercles. There is a prominent hump like projection on the dorsal side of the 8th segment. On the mid dorsal side of each of the fifth and sixth abdominal segment is a black ⌊⌋ marking.

The caterpillars as a rule prefer the tender leaves. The full grown caterpillar enters the loose soil to a depth of 2 inches and pupates inside an earthern cell. The pupa is light brown measuring 20 x 7 mm. There are about 7 to 12 cremaster hooks on the last abdominal segment. The spiracles on each side, are prominent with brown rims. The pupal duration lasts for 17 to 18 days.

Adults have been found attracted to light.

Fam. Eurallidae.

Dichocrocis punctiferalis Guen.

During November to June pseudostems of cardamom are attacked by this caterpillar borer. The presence of this pest in the stem is easily detected by the ejected mass of faecal refuse. The caterpillar damages the plant by boring into the central core of the pseudostem as a result of which it becomes fragile and unhealthy and breaks off at the slightest touch.

The caterpillar is also often found attacking the pods and heavy damages is sometimes caused.

When full grown the caterpillar measures about 30 mm. The head width is nearly 3.6 mm.

It pupates in the feeding chamber within a loose silken webbing. Pupa is dull red brown measuring 12 x 4 mm. The pupal period lasts for 10 - 12 days.

The adults have been found mostly on cloudy days.

Fam. Saturnidae.

Attacus atlas Linn.

The caterpillar of this giant moth is seen occasionally on cardamom. A single individual can defoliate a whole clump. The caterpillar is pale green with spiny growths on the back and grows to a length of about 107 mm. It pupates on the leaf in a long cocoon of tough silk.

The caterpillar is seen from October to February and adults in March - April.

A Tachinid (Tarycolyga sorbillens) has been found to parasitise the caterpillar.

Fam. Tortricidae.

Homona sp. (Fig.100).

During the months of September - March large numbers of the caterpillars are found folding the leaf tips of cardamom with silken webbing and feeding from inside. The caterpillar is an active creature and jumps off when disturbed.

The full grown caterpillar. (Fig.101).

The body is pale green with a shining black head. The prothoracic shield has the same colour as the head. Thoracic legs are black and the prolegs are of the colour of the body. On either side of the mid dorsal line of each segment there is a pair of tubercles with a short setae on each. On the mid dorsal region of the fifth abdominal segment there is a pair of yellow oval spots. The caterpillar always remains within a silken webbing inside the fold and is rarely seen out. The body measures 25 - 26 mm. and has a head width of about 3 mm.

Pupation takes place inside a loose silken cocoon usually made within the leaf fold. The pupa measures 11 x 3 mm. There are about 10 - 12 cremaster hooks at the last abdominal segment. The pupal duration lasts for 13 to 15 days in the warm weather.

The adults have been found attracted to light.

Fam. Hesperiidae.

Plesioneura alycos. M. (Fig.83).

The pale green caterpillar of this skipper is found feeding on the leaves of cardamom during May to December. The adults are found hovering over cardamom plants on bright days.

Oviposition.

Eggs are laid on cardamom leaves on the upper as well as on the lower sides. The egg is pale red, dome shaped, with a diameter of 0.75 mm. and a height of 0.5 mm. The top is slightly flattened. Just before emergence of the caterpillar the reddish tinge grows deeper. The incubation period lasts for 9 to 12 days.

The newly hatched caterpillar has a length of about 1.7 mm. and is pale grey with a reddish tinge. The head is black and the prolegs and thoracic legs are well developed. After 6 to 8 hours the larva begins feeding, remaining inside a leaf fold, made with silken strands. By the 2nd day a greenish tinge appears due to the contents of the intestines.

Within 7 days the caterpillar measures 9 to 10 mm. The body is greenish and head is black. When removed from the leaf fold the caterpillar appears sluggish; but afresh the fold is made quickly. The full grown caterpillar (Fig.24) measures 32 to 34 mm; head width is nearly 2 mm. The body is pale green with four to five transverse white bands in the middle of each segment. A white lateral line is also noticeable.

The pupa is fastened to the leaf fold by two fine threads, one passing over the thorax, and the other over the last abdominal segment. It measures ¾ x ¼ mm. The anterior end of the pupa is tapering, a feature characteristic of the family. A shining white powdery substance is also formed as a coating over the pupa.

The pupal duration is 17 to 18 days.

The imago is a black skipper with white bands on the wings.

Fam. Curculionidae.

Prodicetes haematicus chevr.,

The weevil was first recorded as a serious pest of cardamom in Travancore (Jones 1941).

The grub tunnels into the rhizome. It has been found that a reddish colour develops in the galleries made by the grub and gradually the attacked rhizome and then the neighbouring ones die resulting in the destruction of the clump.

The adult is a reddish brown weevil half an inch in length with three longitudinal lines in the pronotum and three black marks on each elytron, two anteriorily and close together and one posteriorly. The newly emerged ones are lighter in colour than older specimens. The female is slightly larger in size and its rostrum is smoother than that of the male.

After the early monsoon showers in April the weevils come out in fairly large numbers and mating

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A detailed account of the pest is in the course of publication in the Indian Journal of Entomology by Jones (1945).

begins. After copulation they go down the base of the clump and females begin to deposit their eggs one by one at fairly long intervals in the feeding grooves made in the rhizomes. The egg is 2 mm. long and 1 mm. broad and has the shape of an elongated pea. The incubation period is 8 - 10 days.

The newly hatched grub is 2.5 mm. long. Immediately on hatching it eats its way into the rhizome and continues tunnelling into it and also the basal portion of the pseudostem without providing any exit opening. Occasionally it burrows into the associated rhizomes also. By three months it grows to a length of 12 mm. Feeding is gradually stopped and after widening a part of the tunnel the grub closes up the passage at either end with frass and remains as the prepupa for about a week.

The pupa that comes splitting out the larval cuticle is first white and gradually turns yellowish brown and finally brown. After three weeks of pupal duration the adult emerges.

It moves about and feeds on the third day and lives for a period of 7 to 8 months. The complete life history of the insect takes about one year.

Fam. Chrysomelidae.

Lema sp. (Fig.102).

After the premonsoon showers in May, large numbers of these beetles emerge and begin to lay eggs on the tender leaves of cardamom.

The eggs are laid on the upper as well as on the lower sides. A single beetle lays about 90 to 95 eggs in a period ranging between 45 - 50 days, at the rate of 2 or 3 per day.

When freshly laid eggs are golden yellow, cylindrical rounded at both ends, measuring 1 mm. x ½ mm. By next day a black tint appears on either side, and before hatching the tint is uniform throughout. The incubation period lasts for 7 - 8 days. The grub emerges by eating its way through the shell.

Length 1.5 mm.

Head width .2 mm.

It begins feeding by scraping off the epidermis. The grub moves about slowly and for one or two days it remains in the vicinity of the place

of hatching. Within two or three days the body is covered over by the faecal refuse.

Extornal characters.

The head is shining black with a few short hairs. The body is dull white with a few brownish streaks. The hind end is globular with a hump. The anus is shifted a little on the dorsal side in correlation with the insect's habit of carrying the faecal refuse over the body. There are three pairs of well developed glassy white thoracic legs. The last pair is the longest. While moving the grub drags the massive abdomen along the leaf. The grub moults 5 times within 25 days. When full grown, (Fig.103) the body measures 8 - 9 mm. and has a head width of nearly 1.2 mm. The faecal refuse that passes out accumulates over the body and covers the dorsal side. This mode of concealment protects the grub from its natural enemies.

Pupation takes place in the soil within a cocoon of papery material (Fig.105). The cocoon measures 10 mm. x 6 mm. and the pupa 6 x 3 mm.

After about 30 - 33 days the beetle emerges by gnawing off a portion of the cocoon. The pupal period is shorter during summer.

The beetle completes 3 or 4 active generations before October - November. After this a period of rest follows until May.

The beetles have been found to mate one or two days after emergence and egg laying usually begins on the next day.

Status

Both the adult and the grub damage the tender foliage (Fig.104). The adults eat off lines along the leaf and the larvae scrape off the epidermis causing irregular patches on the leaf.

A Tachinid parasite has been reared from the grub.

Fam. Tingidae.

Stephanitis typicus. Dist.

This lace winged bug found on Banana, and Anmoria occurs on cardamom during January - April.

Nymphs and adults suck the tender leaves as a result of which leaves turn yellow and unhealthy. The presence of these pest in large numbers covering the undersurface of a leaf is fairly common.

Fam. Coreidae.

Riptortus pedestris. F.

This coreid bug which is a pest of pulses is found on cardamom during February to April, sucking juice from tender leaf shoots. The damage is by no means appreciable.

Fam. Cercopidae.

Aphrophora muraeana Dist.

The nymphs of this spittle bug sucks up the juice of the roots during July to December. The reddish brown adults are found on the tender shoots during June to August.

Fam. Aphidae.

Pentalonia sp.

These dark brown aphids are found during August to June, in the narrow spaces in between the pseudostem and the leaf sheath. A sort of brown discoloration is noticed as a result of feeding by these insects. The winged males are sometimes found on the tender leaves.

Fam. Coccidae.

Mytilaspis sp.

In certain years during December to May large numbers of these scales are found on the green berries in clusters. In severe infestations the stalk of the berry gets shrivelled up. Some are found in the space in between the pseudostem and the leaf sheath. The winged males are found in large numbers during February - April resting on the underside of tender leaves.

Fam. Jassidae.

Tettigoniella sp.

The adult is found in large numbers during May to August on the tender shoots. The head and thorax cream yellow. On the head there are two dark spots one behind the other. Two ocelli are present in space in between the compound eyes. Four black spots are present in the pronotum in the shape of a trapezium. The abdomen is dark brown. The front pair of legs have the colour of the body. The 2nd and 3rd pairs are white. The front pair of wings held against light are light orange red. The inner pair is smoky black. These bugs are found in large numbers sucking the juice from tender leaf shoots. Heavily damaged leaves begin to decay.

Fam. Cecidomyidae.

Cecidomyia sp.(Fig.106). Hallomyia cardamomi N

This is a cecidomyid gall gnat, the maggots of which remain usually in the bent state in a small

cavity in the soft portion of the roots (Fig 109). The cortex of the root is not attacked. There is hardly a single exposed root that is free from this pest. A full grown maggot (Fig.107) measures 5 - 7 mm. and has a bright pink colour with distinct sternal spatula. The portion of root surrounding the maggot becomes spongy and the outer surface scalls (Fig.108) cut into the form of irregular spheres. No appreciable damage is caused to the plant except that it is devitalised to some extent.

The pupa, is frost pink in colour but turns dark red before the emergence of the adult.

The adult makes a hole on the outer covering of the root and comes out.

Fam. Acrididae.

Orthacris sp.

During July to December large numbers of these wingless grass hoppers are found feeding on the tender leaves cutting irregular holes. The damage done is not serious.

APPENDIX.

In newly planted areas the bonnet monkeys come down in large numbers and pull out and eat the young shoots. Since the cardamom plantations of Travancore are within the game reserve and since most of the jungles have been cleared for cardamom cultivation, wild elephants cross the estates in herds trampling down hundreds of clumps. The tender shoots form favourite food for the young calves.

The animals are usually frightened off by crackers, gun-shots, and slings. The ripe cardamom pods are eaten by toddy cats, squirrels, and birds.

Diseases of Cardamom.

1. Mosaic. This is considered to be a virus disease. The affected plants have their leaves discoloured with yellow streaks. The vitality of the clump gets reduced and the clump becomes stunted in size and shows a tendency to excessive tillering. New shoots are slender and unhealthy. The raceme production is retarded and the clumps die in a year or two. The disease easily spreads to the neighbouring

clumps. The insect vector has not been definitely determined.

2. Clump rot. This disease is characterised by the falling down of the pseudostems which break off from the clump at a gentle pull. The rhizome and pseudostem loose their healthy colour and become reddish brown. The roots also die and begin to rot. It has been found that if a single rhizome in a clump gets the attack, the associated ones are also affected. As mentioned already in the portion dealing with the cardamom weevil, all clumps attacked by the weevil grub invariably gets this disease. The exact relationship between the weevil and the disease has not been worked out.

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EXPLANATION OF PLATES.

Figs.

1 Map of Travancore showing the Cardamom growing areas.

Conogethes cardamomi (sp.nov.)

2	A male	X 5/1 + ½
3	A female	X ½
4	Variant male	X ½
5	Variant female	X ½
6	A group of eggs on Hecarenia indica leaf	X 1
7	Single egg side view	X 3
7 a	do. top	X 3
8	Newly hatched caterpillar	X 2
9	Second instar caterpillar	X 1
10	Third instar caterpillar	X ½
11	Fourth instar caterpillar	X 2/3
12	Fifth instar caterpillar	X ½
13	Sixth instar caterpillar	X 2/5
14	Seventh instar caterpillar	X 2/3
15	Eighth instar caterpillar	X ½ .

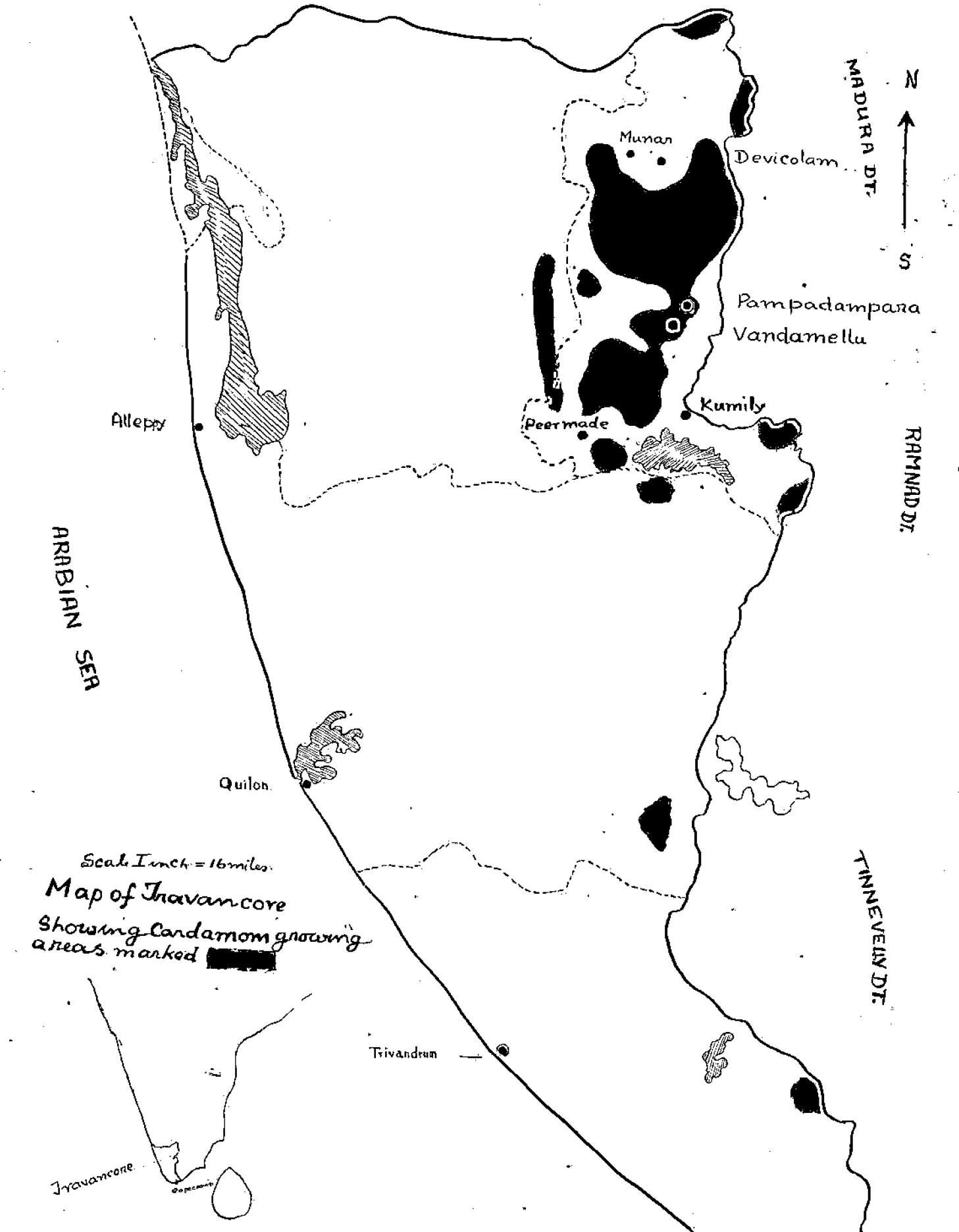
16	Ninth instar caterpillar	X	½
17	Tenth instar caterpillar	X	½
18	Cocoon	X	2/3
19	Pupa (side view)	X	2/3
20	do. (ventral view)	X	2/3
21	Euproctis cenarica M.	X	3/5
22	Egg mass	X	3/4
23	Single egg enlarged showing side view and top	X	2½
24	First instar caterpillar	X	1
25	Second instar caterpillar	X	½
26	Third instar caterpillar	X	⅓
27	Fourth instar caterpillar	X	⅓
28	Fifth instar caterpillar	X	⅓
29	Sixth instar caterpillar	X	⅓
30	Seventh instar caterpillar	X	⅓
31	Eighth instar caterpillar	X	½
32	A caterpillar attacked by Braconids.	X	⅓
33	Cocoon	X	3/4
34	Pupa	X	3/4

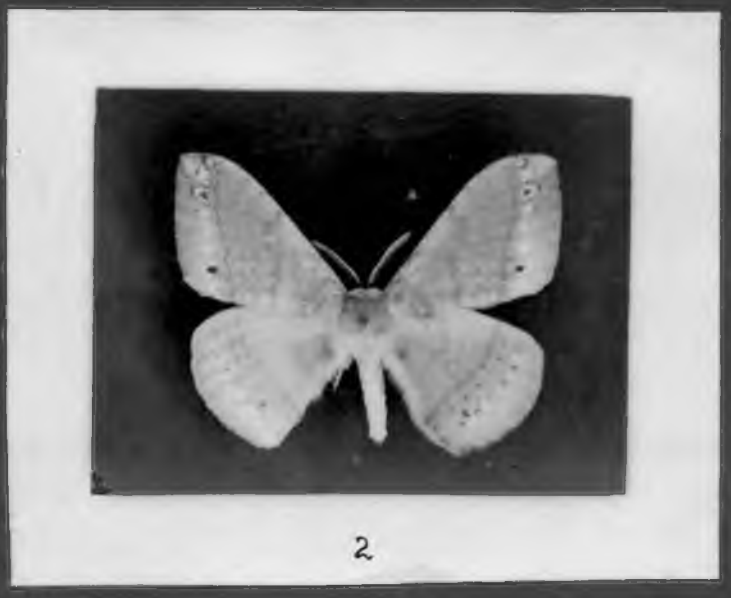
35	Euptoroto testacea Wlk.	X	3/5
36	Eggs enlarged to show side view and top	X	4
37	First instar caterpillar	X	2
38	Second instar caterpillar	X	3/4
39	Third instar caterpillar	X	3/4
40	Fourth instar caterpillar	X	2/3
41	Fifth instar caterpillar	X	1/2
42	Sixth instar caterpillar	X	1/2
43	Seventh instar caterpillar	X	1/2
44	Cocoon	X	1/2
45	Pupa	X	1/2
46	Euptoroto fabia Cram.	X	1/2
47	Full groun caterpillar	X	2/3
48	Cocoon	X	2/3
49	Pupa	X	2/3
50	Tachinid parasite, Sturmia sericariae.	X	5/4
51	Wings of a side showing the veins in Euptoroto cardenasi (sp.nov.)	X	1
52	Wings of a side showing the veins in Euptoroto canariea H.	X	1

53	Wings of a side showing the veins in *Eupterote testacea* Wlk.	X	1
54	Wings of a side showing the veins in *Eupterote fabia* Cram.	X	½
55	Genitalia of *Eupterote cardamomi* (sp.nov)	X	12
56	do. *Eupterote canarica* M.	X	12
57	do. *Eupterote testacea* Wlk.	X	12
58	do. *Eupterote fabia* Cram.	X	12
59	*Lenodora vittata* Wlk.	X	5/7
60	Eggs on cardamom leaf	X	1
61 & 61 a.	Eggs magnified to show side view and top	X	2
62	First instar caterpillar	X	3/4
62 a.	do. enlarged showing different spots.	X	12
63	Second instar caterpillar	X	⅓
64	Third instar caterpillar	X	2/5
65	Fourth instar caterpillar	X	⅓
66	Fifth instar caterpillar	X	½
67	Sixth instar caterpillar	X	½
68	Pupa ventral view	X	⅔
69	do. side view	X	⅔

70	Euproctis lutifacia Hmpsn.	X	1/2
71	Full grown caterpillar	X	5/4
72	Pupa	X	1
73	Alphaea biguttata Wlk.	X	3/4
74	Full grown caterpillar	X	1/2
75	Cocoon	X	3/4
76	Pupa	X	3/4
77	Acanthopsyche bipera Wlk. (male)	X	1
78	do. (female)	X	2/3
79	Full grown caterpillar	X	2/3
80	Larval case	X	8/9
81	Male pupa	X	1
82	Female pupa	X	1
83	Plesiopoura alyses H.	X	1
84	Full grown caterpillar	X	1
85	Hilarographa caminodes Meyr.	X	9/4
86	Full grown caterpillar	X	3/2
87	A portion of the root split open to show the caterpillar inside and the nature of damage	X	1/2
88	Pupa	X	5/4

89	Eu elia rosalia Cram	X	½
90	Full grown caterpillar	X	3/5
91	Pupa	X	3/5
92	Anisodes denticulatus Kapen.	X	2/5
93	Full grown caterpillar	X	½
94	Pupa	X	½
95	The Plutellid (shoot borer)	X	2
96	Full grown caterpillar	X	2
97	Cocoon	X	2
98	Pupa	X	2
99	A portion of the shoot showing the nature of damage	X	3/4
100	Noaona sp.	X	1
101	Full grown caterpillar	X	1
102	Long sp.	X	2
103	Full grown grub	X	1
104	Attacked leaf	X	1/7
105	Pupal case split open	X	3/2
106	Cecidomyia sp.	X	3/2
107	Full grown maggot	X	1
108	Attacked root showing galls	X	1
109	do. split open showing the maggots.	X	1


N
S
MADURA DT.
Munar
Devicolam
Pampadampara
Vandamellu
Kumily
Peermade
Allepy
RAMNAD DT.
ARABIAN SEA
Quilon
Scal. Inch = 16 miles.
Map of Travancore
Showing Cardamom growing areas marked
TINNEVELLY DT.
Trivandrum
Travancore



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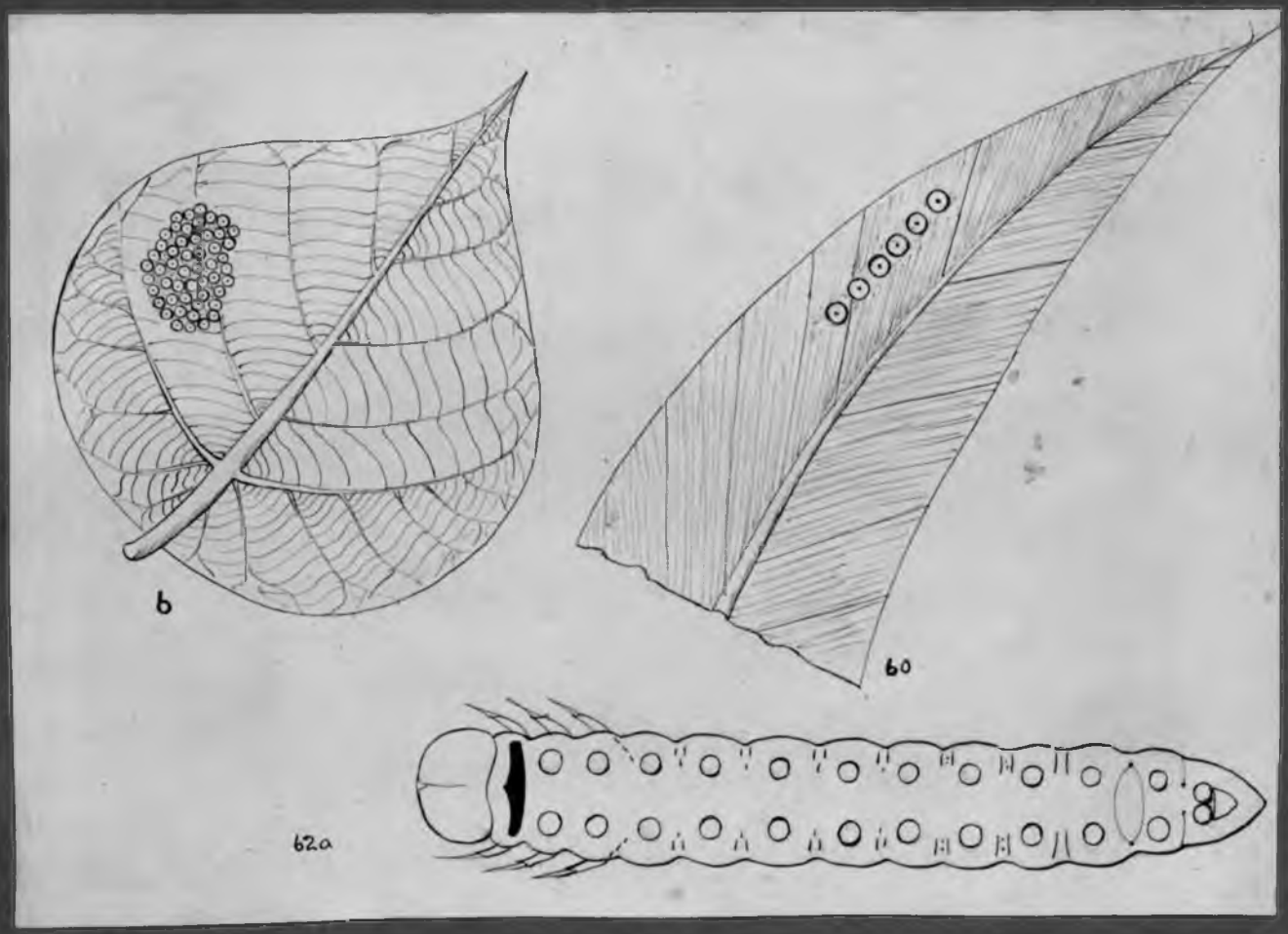
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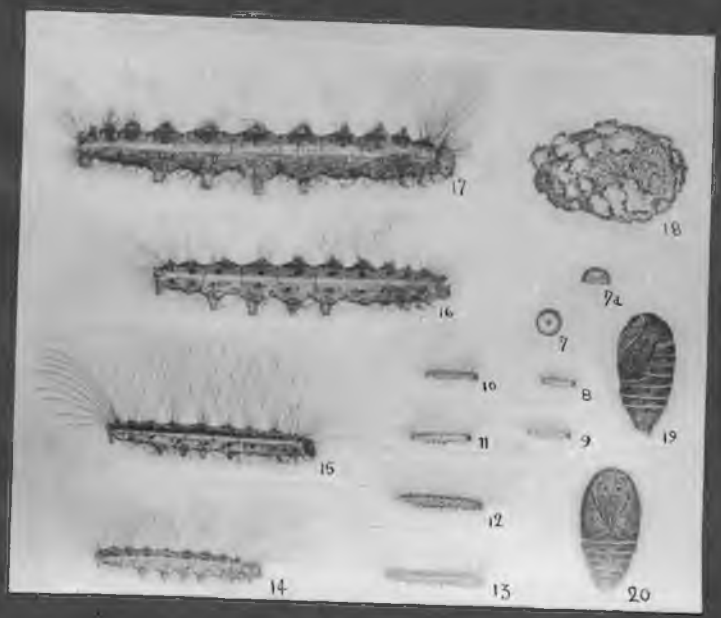
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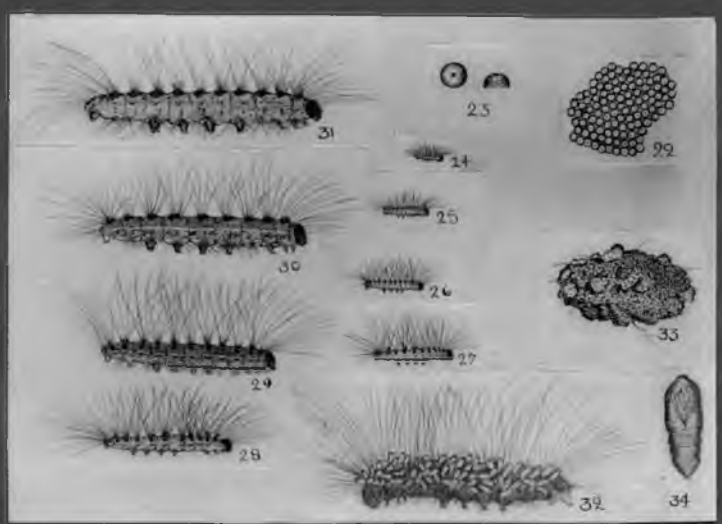
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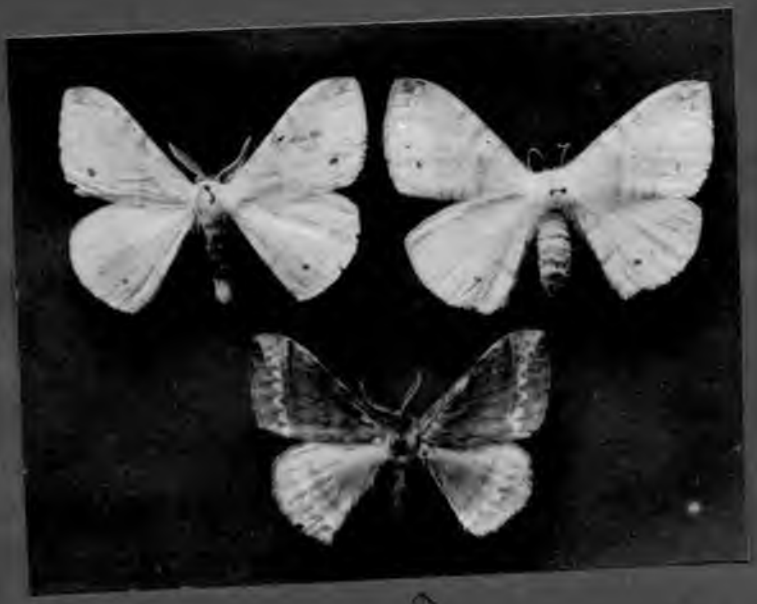

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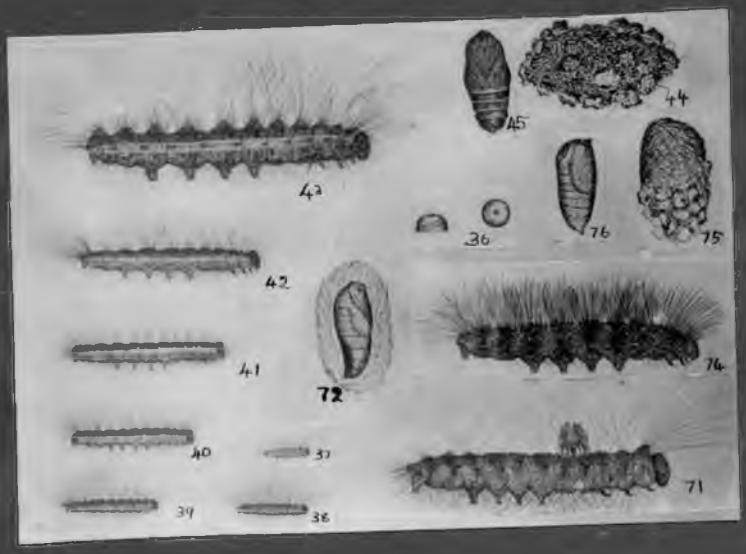
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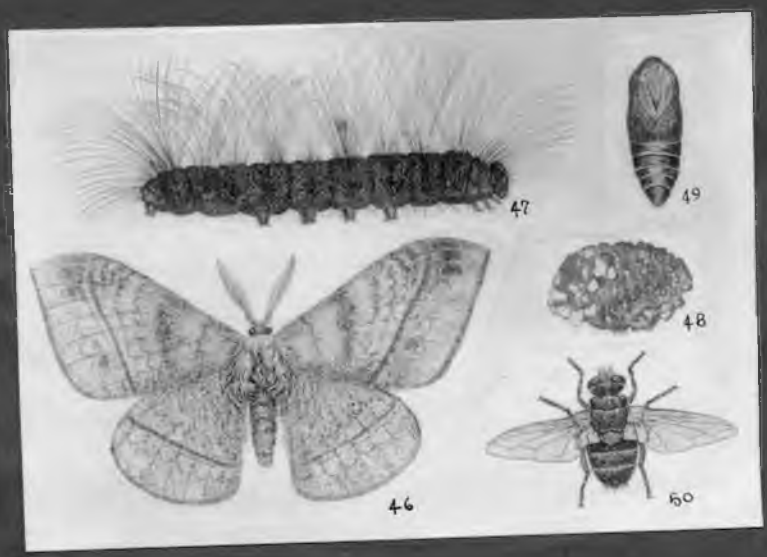
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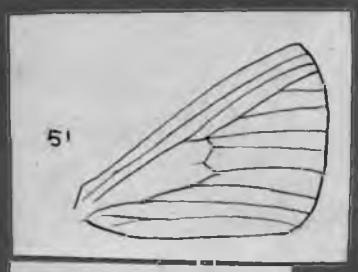
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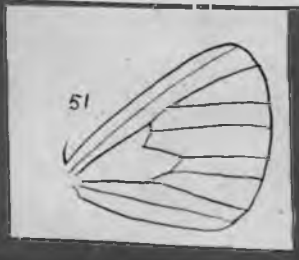
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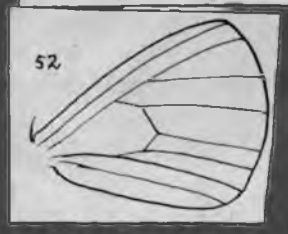
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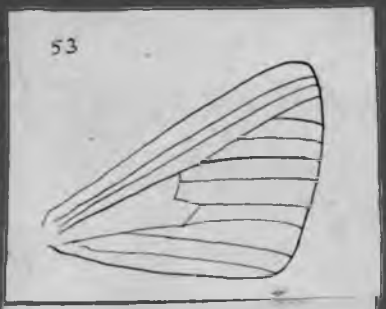
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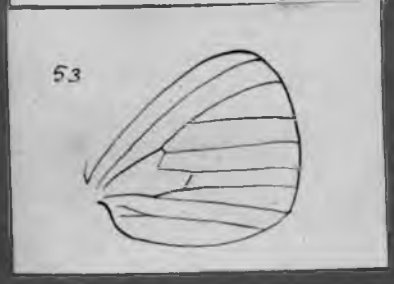
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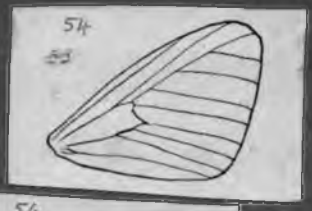
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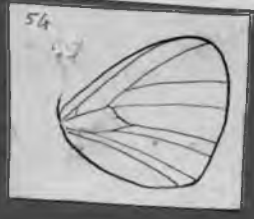
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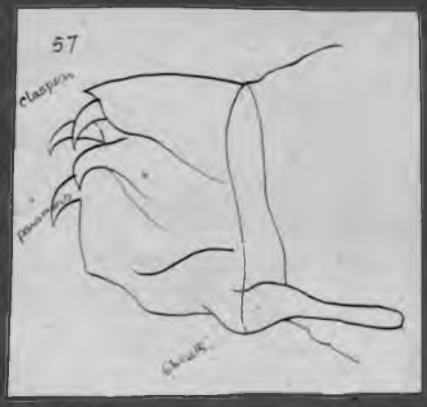
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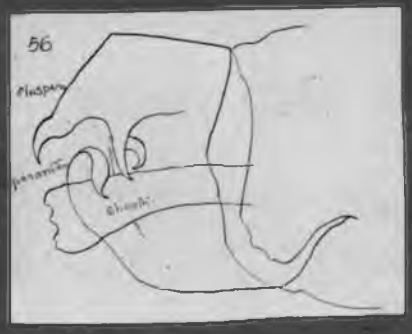
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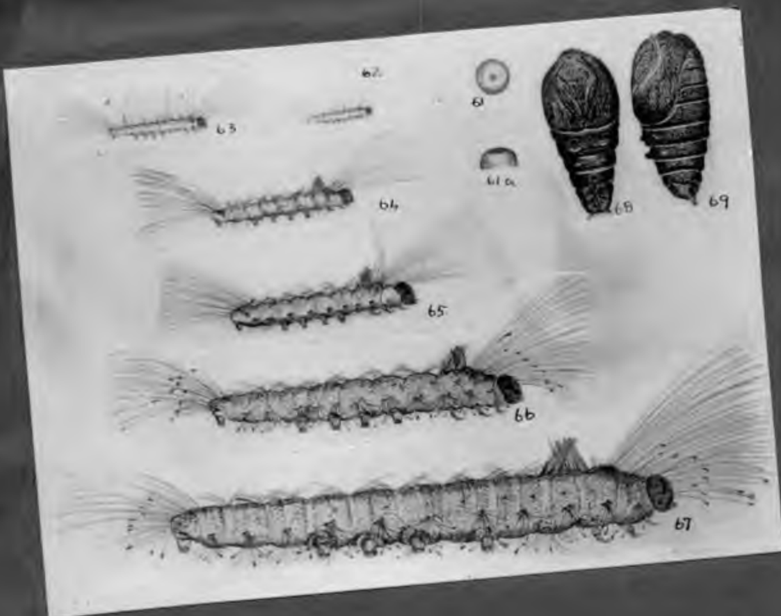

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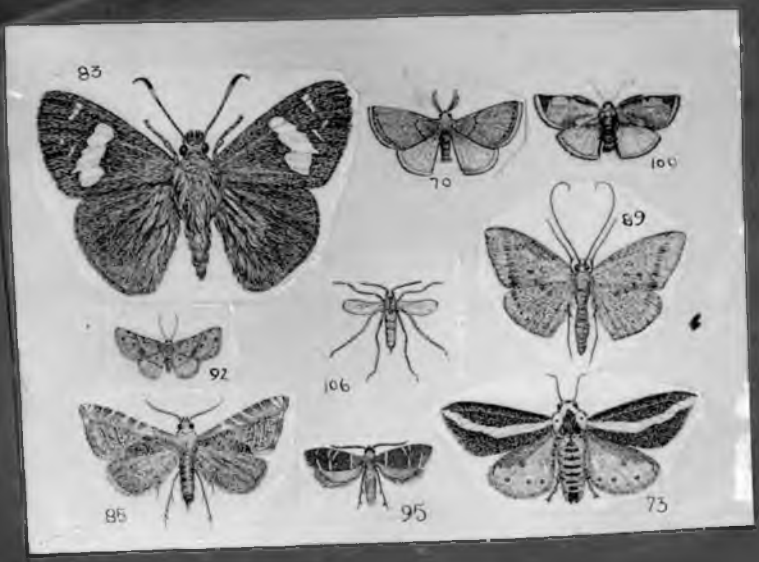
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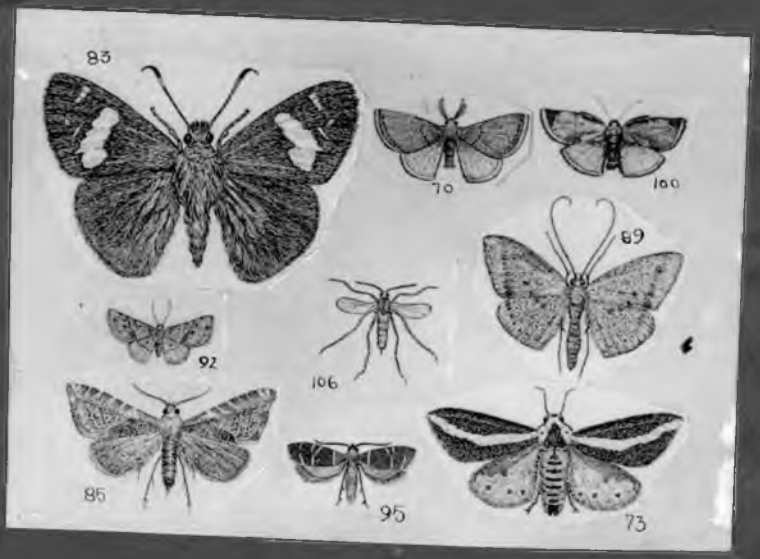
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