STUDIES ON THE PESTS OF *Chromolaena (Eupatorium odoratum)* IN KERALA

By

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THESIS

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the requirements for the degree of

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Faculty of Agriculture
Kerala Agricultural University

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DECLARATION

I hereby declare that this thesis entitled "Studies on the pests of Chromolaena (Eupatorium odoratum) in Kerala" is a bonafide record of work done by me during the course of research work and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Vellanikkara,
1.9.1983.

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CERTIFICATE

Certified that this thesis entitled "Studies on the pests of Chromolaena (Eupatorium odoratum) in Kerala" is a record of research work done independently by Smt. Lyla, K.R. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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INTRODUCTION

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Chromolaena odorata Linn. (= *Eupatorium odoratum*) is a native of South America from where it has spread to other parts of tropics. At present the plant populations have reached alarming proportions all along south-western region of India. In Kerala, *C. odorata* is one of the major weed species and this has spread the State over the hill tops and coastal belts, extending from Trivandrum to Kasaragod.

C. odorata is an obnoxious weed, herbaceous and succulent when young, but woody at maturity. The plant grows upto a height of 8 m (Dayakar Yadav *et al.*, 1981) and are capable of growing throughout the year. Its capacity for rapid spreading through seeds and power of regeneration are remarkable. For the control of the weed, biological method seems to be more desirable as compared to chemical and other methods which are more expensive and laborious. A study of the indigenous phytophagous insects associated with the weed will be worthwhile as a primary requisite for formulating suitable biological control programmes against the weed.

In Hawaii, Australia and North India the related weed *Eupatorium adenophorum* Spreng. (Crofton weed) was

effectively brought under control as a result of the introduction of Procecidochares utilis St.in a matter of few years (Bess and Haramoto, 1972; Kapoor and Malla, 1978). A fortunate development in this project was the build up of a leaf spot disease of the Crofton weed incited by Cercospora eupatorii Peck. which was coincidental with the introduction of P. utilis (Lodo, 1960).

According to Moni and Subramoniam (1960), there is an essential oil in C. odorata and the non-susceptibility of the plant to insect pests may be due to the insect repellent properties of the plant oil. However, Schroder (1970), Ivens (1974) and Sugathan (1979) suggested a promising insect - Apion brunneonigrum B.B. for the biological control of the weed in Nigeria and India. Besides, Esuruoso (1971) reported various seed eating fungi of C. odorata namely Fusarium culmorum, F. moniliforme, F. semitectum and F. solani in Nigeria.

The objective of this study was to survey the various natural enemies occurring in Kerala in association with C. odorata and to ascertain their potential in the biological control programme.

REVIEW OF LITERATURE

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As many as 50 insect pests were recorded from various parts of the world infesting C. odorata and other related species of Eupatorium. The extent of damage inflicted varies widely with the species and a strict classification as major or minor pests has not been attempted. The insect associated with the weed classified under different families and a review of available literature on the topic is attempted here.

Zonocerus variegatus Linn. (Acrididae : Orthoptera)

Toye (1974) reported the attack of Z. variegatus on C. odorata from Nigeria. Oyidi (1976) observed certain nematodes and the larvae of a dipterous fly as natural enemies of the grasshopper.

Dysdercus koenigii Fabr. (Pyrrhocoriedae : Hemiptera)

Jalaskar et al. (1974) recorded D. koenigii as a pest of C. odorata from Maharashtra. Prabhu and John (1975) noted the feeding activity of the same insect on various species of Eupatorium in India.

Dysdercus delaunayi Leth. (Pyrrhocoriedae : Hemiptera)

Sands (1916) found D. delaunayi feeding on C. odorata in St. Vincent. However, it was not found to breed on this weed (Sands, 1917).

Carvalhoia arecae Miller (Miridae : Hemiptera)

Mariamma Daniel and Premkumar (1976) reported C. odorata as an alternate host plant of C. arecae in Kerala.

Galeatus peckhami Ashm. (Tingidae : Hemiptera)

The tingid G. peckhami was found in New York State occurring on Eupatorium in great numbers (Drake, 1922). He reported that the eggs were inserted singly close to the surface of the soil. According to the author there was only one generation in a year for the insect.

Entylia bactriana Germar (Membracidae : Hemiptera)

Whitehead (1919) studied the life-cycle of the membracid on E. purpureum and found the eggs in irregular masses along the midrib on lower surface of the leaf

causing leaf curl. The nymphs are very sluggish and feed on the lower surface of leaves. The adult emerged in about 30 to 40 days.

Entylia carinata Forst. (Membracidae : Hemiptera)

Lenicov (1973) observed E. carinata causing damage to Eupatorium sp. in Argentina by insertion of the ovipositor and also due to desapping.

Tomaspis rubra Germ. (Membracidae : Hemiptera)

In Trinidad, Urich (1913) reported T. rubra as a pest of C. odorata and Williams (1921) as a pest of Eupatorium sp.

Bemisia tabaci Gennadius (Aleyrodidae : Hemiptera)

van der Laan (1940) observed B. tabaci as a common pest of C. odorata in Sumathra and reported that C. odorata is a reservoir of viruses.

Pseudococcus paludinus Green (Pseudococcidae : Hemiptera)

Green (1921) observed P. paludinus feeding on E. cannabinum.

Pseudococcus maritimus Ehrh. (Pseudococcidae : Hemiptera)

Whitney (1926) recorded P. maritimus as a pest of Eupatorium from New Jersey.

Icerya purchasi Mask. (Coccidae : Hemiptera)

Ramachandran and Ramakrishna Ayyar (1979) reported I. purchasi as a pest of E. glandulosum in Ootacamund.

Aphis craccivora Koch. (Aphididae : Hemiptera)

Baychaudhuri (1973) reported A. craccivora feeding on C. odorata from India. The food plants of the aphid pest include Boninesaa cerifera, Desmodium sp., Dolichos lablab, Oonanthe stolonifera, Solanum sp. and Vicia faba.

Aphis gossipii Glov. (Aphididae : Hemiptera)

Goff and Tissot (1932) and Watson (1932) observed A. gossipii throughout the winter on E. pentaloideum in Florida.

Ponniah and Subramanyan (1967) reported E. glandulosum as an alternate host plant of A. gossipii from Nilgiris.

Raychaudhuri (1973) found A. gossipii on C. odorata and E. wallichii in North East India.

Aphis nasturtii Kalk. (Aphididae : Hemiptera)

According to Raychaudhuri (1973) A. nasturtii is a pest of C. odorata and E. glandulosum in North East India.

Aularcorthum solani Kalt. (Aphididae : Hemiptera)

A. solani was found feeding on E. glandulosum in Nilgiris (Ponniah and Subramanyan, 1967).

Aphis spiraecola Patch (Aphididae : Hemiptera)

Dharmadhikari and Ramaseshiah (1970) found A. spiraecola on C. odorata in the plains of Assam throughout the year. Hall et al. (1972) reported A. spiraecola as a pest of C. odorata from Ghana.

Raychaudhuri (1973) found the same aphid feeding on E. wallichii and other Eupatorium spp. in India.

Wijs (1974) recorded these aphids on E. convzoides in Netherland.

Joy et al. (1979) reported A. spiraecola as an important pest of C. odorata in Kerala. According to

them the attack was mostly confined to the succulent leaves and stem at the terminal portion of the plant.

Aphis fabae Scopoli (Aphididae : Hemiptera)

Raychaudhuri (1973) reported A. fabae as feeding on E. wallichii from India.

Joy et al. (1979) observed the same aphid on C. odorata in the plains of Kerala. According to them these aphids are greenish in colour and the affected leaves presented a mottled appearance.

Brachycaudus helichrysi Kltb. (Aphididae : Hemiptera)

Raychaudhuri (1973) reported B. helichrysi feeding on C. odorata and E. wallichii from India.

Joy et al. (1979) found the same aphid on C. odorata in Idukki and Wynad Districts of Kerala. According to them these aphids are absent in the plains. The symptom of attack was wilted appearance of the plants with the affected leaves folded or rolled longitudinally.

Capitophorus hippophaes indicus Ghosh and Raychaudhuri (Aphididae: Hemiptera)

Ghosh and Raychaudhuri (1981) reported the above

aphid on E. wallichii from north east part of India.

Capitophorus hippophaes javanicus Hrl. (Aphididae:Hemiptera)

Raychaudhuri (1973) recorded the aphid on E. wallichii in India.

Komyzus levipes Basu and Raychaudhuri (Aphididae:Hemiptera)

Basu and Raychaudhuri (1974) observed K. levipes on C. odorata in India.

Eulachnus thumbergii Wilson (Aphididae: Hemiptera)

Basu (1971) reported E. thumbergii on C. odorata from Shillong and neighbouring areas.

Macrosiphum eupatoricolens Patch (Aphididae: Hemiptera)

Patch (1919) recorded M. eupatoricolens feeding on E. purpureum in England.

Macrosiphoniella hikkosanensis moritsu Raychaudhuri (Aphididae : Hemiptera)

Raychaudhuri (1973) reported the above aphid on C. odorata from North East India.

Myzus persicae Sulz. (Aphididae : Hemiptera)

According to Raychaudhuri (1973) C. odorata and E. wallichii are two alternate hosts of M. persicae in India.

Myzus ornatus Laiug (Aphididae : Hemiptera)

Ponniah and Subramanyan (1967) reported M. ornatus feeding on E. glandulosum in Nilgiris. Raychaudhuri (1973) found this aphid on C. odorata and E. wallichii in India.

Myzus sigesbeckicola Strand (Aphididae : Hemiptera)

Raychaudhuri (1973) found M. sigesbeckicola as a pest of C. odorata in North East India.

Ghosh (1977) reported the above aphid feeding on C. odorata from India and adjacent countries.

Neomyzus circumflexus Backt. (Aphididae : Hemiptera)

According to Raychaudhuri (1973), C. odorata and E. wallichii are two alternate host plants of N. circumflexus in India.

Rhopalosiphum maidis Fitch (Aphididae : Hemiptera)

C. odorata acts as a food plant of R. maidis in Tripura (Ganguli and Raychaudhuri, 1980).

Toxoptera aurantii Boy. (Aphididae : Hemiptera)

According to Raychaudhuri (1973) T. aurantii is a pest of C. odorata in India.

Toxoptera odinae van der Goot (Aphididae : Hemiptera)

Dayakar Yadav et al. (1981) found T. odinae feeding on the inflorescence and tender shoots of C. odorata in India. According to them T. odinae has a better synchronization with the climate and the growth phases of the plant. They observed that during the early spring, there is flush growth which increases the number of oviposition sites. Continuous heavy attack of the aphids during spring and autumn caused leaf curl and death of growing tips.

Destruction of shoot tips and procumbent growth each year prevented flowering and seed production appreciably which in turn reduced the plant population in India.

Eurythrips osborni Hinds (Thripidae : Thysanoptera)

Watson (1924) reported the above thrips on E. serotinum from Florida.

Pareuchaetes pseudoinsulata Rego Barros (Ammalo insulata Walk.) (Arctiidae : Lepidoptera)

Wolcott (1948) reported the larvae of P. pseudoinsulata feeding on Eupatorium. Cruttwell (1968) conducted a preliminary survey on the potential biological control agents of C. odorata in Trinidad and stated that the larvae feed on leaves of the weed. According to her the life-cycle of the arctid is as follows: After two to four days of emergence female of P. pseudoinsulata lay 50 to 180 eggs in groups on the underside of the leaves. In the wet season, adults are larger as a result of more abundant food in the larval stage and most of the moths lay 150 to 250 eggs, the maximum being 580. She found the larvae as nocturnal in feeding habit. Pupation occurs at the base of the plant in a shelter of flimsy cocoon constructed out of larval setae, leaf particles and other debris. The life-cycle was completed in 40 to 60 days and the breeding was continuous throughout the year.

Cruttwell (1969) reared *P. pseudoinsulata* in the laboratory in Trinidad for shipment to Nigeria for controlling *C. odorata*. She observed that the eggs of *P. pseudoinsulata* were heavily parasitized by a scelionid, *Telenomus* sp. and the larvae by four species of tachnids, *Calocarcelia aursocephala* Thomp; *Lespesia pollinosa* Thomp; *Pygophorinas peruvianae* Towns and *Uromacquaritia trinitatus* Thomp.

Schorder (1970) described the arctiid as a leaf feeder restricted to *C. odorata* and related species in Nigeria.

Giriraj and Bhat (1970) successfully bred disease free *P. pseudoinsulata* on *C. odorata* in laboratory at Bangalore. They found that first instar and 10 days old larvae did not feed on any of the 18 test plants.

Sankaran (1971) noted the arctiid as a pest of *C. odorata* in India.

Bennett and Cruttwell (1973) showed that in Trinidad, *P. pseudoinsulata* was unable to complete its development on plants other than the species of *Eupatorium* and that only *C. odorata*, *E. ivaefolium* and *E. microstemon* were more suited for normal development.

They also noted that though feeding occurred in a few other plants tested, it is not very likely that any crop of economic importance would suffer as a result of introduction of the arctiid to control C. odorata.

Ivens (1974) observed the larvae of P. pseudoinsulata defoliating C. odorata in Nigeria.

Akanbi (1978) stated that P. pseudoinsulata as a major pest of C. odorata in Nigeria.

Cock and Holloway (1982) reported P. pseudoinsulata as a pest of C. odorata.

Ammalo arravaca Jordan (Arctidae : Lepidoptera)

Bennett and Rao (1968) found A. arravaca defoliating C. odorata and leaving untouched all Compositae of economic value.

Cruttwell (1968) studied A. arravaca and conducted host specificity tests. She found that the larval development was completed on three species of Eupatorium and not on any of the crop species tested in Trinidad.

Estigmene acraea Drury (Arctidae : Lepidoptera)

In Lousiana, the larvae of E. acraea was found feeding on E. capillifolium (Stracener, 1931).

Agrotis ypsilon Rotl. (Noctuidae : Lepidoptera)

Sen (1952) reported A. ypsilon as a pest of C. odorata in Bihar.

Trichotaphe supatoriella Nov.(Gelechidae : Lepidoptera)

Chambers (1872) studied T. supatoriella in detail. According to him, the adults are dark-grey in colour with 5 to 6 mm body length and 12 to 14 mm wing span. He found the eggs on either surface of young leaves of C. odorata and they were 0.6 to 0.8 mm long, oval, flattened, with a pitted and semi-transparent chorion. The first instar larvae hatched out after six to seven days and the first and second larval periods were two to three days. But the third and fourth instars took about four to five days. Fifth instar pupated after seven to eight days feeding. Pupal period was seven to nine days. He observed all the larval instars in tubes constructed by rolling the leaves. The larvae made larger tubes on new leaves as they grew. They came out of the tubes for feeding using both entrances. He observed the insect breeding on C. odorata throughout the year.

Cruttwell (1971) reported Trichotaphe sp. on C. odorata from Belem. Cruttwell (1973) recorded the

same insect as a leaf roller on C. odorata throughout the neotropics.

Pyrausta ainsliei Heinr. (Pyraustidae : Lepidoptera)

According to Heinrich and Bur (1919) Eupatorium is a food plant of P. ainsliei in America.

Pyrausta penitalis Grote (Pyraustidae : Lepidoptera)

Chittenden (1918) reported P. penitalis feeding on Eupatorium from U.S.A. According to him, the larvae destroyed the buds and interior of stem by burrowing.

Welch (1919) recorded Eupatorium sp. as a food plant of P. penitalis.

Adaina microdactyla Hb. (Pterophoridae : Lepidoptera)

Mellini (1954) reported A. microdactyla as a pest of E. cannabinum near Balogna.

Mescinia parvula Sch. (Phycitidae : Lepidoptera)

Bennett and Yaseen (1978) recorded Mescinia sp. as one of the promising insects for the biological control of C. odorata.

Yaseen and Bennett (1979) made attempts to establish laboratory cultures of M. parvula for the control of C. odorata in Nigeria.

Procecidochares utilis Stone (Tephritidae : Diptera)

Bess and Haramoto (1972) reported that P. utilis introduced from Mexico gave effective control of E. adenophorum over several thousands of acres in certain areas of Hawaii. At the same time they found that P. utilis had moderate influence on the weed in a limited area on the wet, steep slopes on the windward side of East Maui. According to them in many places the tephritid was abundant enough to cause many galls per plant and thereby caused the death of thousands of the weeds. As the plants in the thickets became weakened and dead, they found the remaining ones as more sparsely distributed. The fly persisted in sufficient numbers causing heavy galling and stunting of these isolated plants which also eventually died and left the land completely free of these weeds. This occurred in thousands of acres of grazing land despite a high degree of parasitism often exceeding 50 per cent by Opius tryoni, Opius longicaudatus, Bracon terryi, Eupelmus ashmeni and Eurytoma tephritidis.

According to Dodd (1960) introduction and establishment of P. utilis had not been successful in destroying the dense stands of Eupatorium in Queensland, but has reduced their vigour and checked the spread of the weed.

Hoy (1960) observed that P. utilis which had been introduced into Jamaica, Hawaii, Australia and New Zealand for the control of E. adenophorum dispersed widely and caused extensive galling of the plant.

Dodd (1961) recorded a partial control of E. adenophorum in Queensland by P. utilis.

Haseler (1965) gave an account of his observations in Queensland on the bionomics of P. utilis which was introduced for the control of the noxious weed E. adenophorum. According to him the eggs were laid at the stem tip between the unexpanded pair of leaves. The newly hatched larvae penetrated to epidermis through petioles. After penetrating 6 to 7 mm, they hollowed a cell by feeding in the parenchyma. The second instar larvae fed on the sap which later cuased the proliferation of plant tissue and the formation of galls. He stated that the egg stage, the first, second and third instars

and the combined fourth larval instar and the pupal stage lasted for 6 to 9, 9 to 20, 9 to 10, 6 to 10 and 10 to 20 days respectively. According to Haseler *E. adenophorum* was the only plant from which *P. utilis* had been recorded in Queensland.

Given (1965) reported these gall midges as an important pest of *E. adenophorum*.

Haseler (1966) recorded that the combined action of *P. utilis*, the introduced fungus - *Cercospora eupatorii* and the native Lamiid - *Dihammus argentatus* which attacks the base of the stem had reduced the viability and limited the dispersal of the weed.

Given (1966) found that *P. utilis* successfully established in New Zealand after its introduction in 1958 for the control of *E. adenophorum*. The level of infestation in this country was sufficient to reduce the vigour of the plant.

Nakao (1966) reported that *P. utilis* had controlled *E. adenophorum* in Hawaii.

According to Auld (1969) the combined action of *P. utilis*, a fungus and *Dihammus argentatus* showed the

decrease in rate of spread of the weed in the Richmond region of New South Wales.

In Trinidad, a stem gall forming trypetid, possibly P. utilis, showed promise to control C. odorata (Cruttwell, 1969). Nakao (1969) recorded that in Hawaii, E. adenophorum was controlled by the larvae of this gall fly.

Harley (1971) reported that P. utilis introduced from Hawaii dispersed well and produced galls on every Crofton weed at several release sites of Australia.

Rao et al. (1971) observed that P. utilis imported to India in 1963 became widespreaded and achieved local control over E. adenophorum in Nilgiris and Darjeeling.

Sankaran (1971) found P. utilis as a pest of the Crofton weed in India.

Bess and Haramoto (1972) described a remarkable control of E. adenophorum achieved by P. utilis in Hawaii. According to them, control of the weed proceeded at a rapid rate in habitats of low moisture and at a slower rate in habitats of moderate moisture but was not

effective in areas of high rainfall. It was also noted that in areas freed from the weed by P. utilis no regrowth has taken place.

Kapoor and Malla (1978) reported that P. utilis released in large numbers in Darjeeling showed promising results for the control of C. odorata.

Procecidocharoides penelope Osten Sacken (Tephritidae:Diptera)

Stoltzfus (1974) reported P. penelope as a pest of E. riscosum.

Agromyza subpusilla Meig. (Agromyzidae : Diptera)

A. subpusilla was found making linear mines on Eupatorium in America (Frost, 1943).

Melanagromyza sp. (Agromyzidae : Diptera)

Bennett and Yaseen (1978) reported Melanagromyza sp. as one of the promising insects for the biological control of C. odorata from Trinidad.

Tiphia parallela Smith (Scolidae : Hymenoptera)

Bodkin (1937) recorded E. pallescens as a food plant of T. parallela.

According to Moutia (1946) E. pallescens was an excellent food plant of the adult Scolids in Mauritius.

Apion brunneonigrum Beguin - Billicocq (Apionidae:Coleoptera)

Cruttwell (1970) observed the adult A. brunneonigrum feeding on C. odorata in Trinidad. According to her, the weevil fed on the young leaves and buds from March to November and on flower buds from November to February. She found the insect infesting E. ivaefolium also. The attack of A. brunneonigrum on any of the economic plants in Trinidad or South America was on record. One larva distroyed 30 to 60 seeds during development and the ovipesiting female destroyed many young flowers by feeding. Thus it was concluded that the coincidence of feeding and ovipositing capacity of the weevil shows its potential in controlling the weed in Trinidad.

Schroder (1970) described a species of weevil the adults of which consumed the young leaves and flower buds while the larvae fed on the florets and achenes of C. odorata in Nigeria.

Cruttwell (1973) studied A. brunneonigrum and found the adult female as 3.0 mm long with dark brown head and prothorax and chestnut coloured elytra and abdomen.

The males were slightly smaller and had a shorter and stouter rostrum. The eggs were oval, translucent white or pale yellow with a size of 0.5 to 0.3 mm and the newly hatched larvae were 0.6 to 0.7 mm long and translucent yellow in colour. The pupae were white or pale yellow when first formed but darkened shortly before the adult's emergence. She observed the ovipositing female cutting a small circular hole with her mandibles through the side of the bud and inserting the eggs through this into the flower bud. The eggs were covered with a thin adhesive secretion and hence they stuck to the bracts or to the surface of the florets. According to her the female rarely fed and oviposited in the same bud under field conditions. She stated that the adult females collected from the flowers in November seemed to be the best for introduction into fields.

Ivens (1974) recorded this seed eating beetle as a pest of C. odorata in Nigeria.

Sugathan (1979) conducted feeding/oviposition tests of A. brunneonigrum on 33 species of plants belonging to 22 families and had confirmed its host specifity for the biological control of C. odorata in India.

Smicronyx quadrifer Csy. (Curculionidae : Caleoptera)

S. quadrifer (=*S. lato*) was found in association with *E. rugosum*, *E. perfoliatum* and *E. fistulosum* (Anderson, 1970).

Cyllene robinae Forst. (Cerambycidae : Coleoptera)

Garman (1921) reported *E. serotinum* and *E. perfoliatum* as food plants of *C. robinae*.

MATERIALS AND METHODS

MATERIALS AND METHODS

A detailed survey was conducted in Trichur District during the period from November 1980 to October 1981 to study the species of insects occurring on *C. odorata*. The sampling design adopted was stratified multistage random sampling. The villages of the district were listed out and divided into two groups according to topography, namely, plains and medium hilly areas. From each group (stratum) four villages were selected randomly. The list of villages thus selected is given below.

I. Plains

1. Pushakkal
2. Chazhoor
3. Urakom
4. Engandiyoor

II. Medium hilly areas

1. Vellanikkara
2. Pananchery
3. Puthur
4. Parlikkad

From these selected villages, a list of areas where the weed was found in abundance was prepared and

two such areas were selected in each village so that one area was partially shaded and other area was exposed to direct sunlight. Then three plots of 2 m^2 were chosen. A random sample of five plants were selected from each plot for taking observations. Observations were taken at monthly intervals.

In addition to this study, another survey was carried out in five other districts of Kerala, namely, Palghat, Malappuram, Ernakulam, Idukki and Kottayam during January 1981.

The aphid population on a plant was counted using a tally counter. The population of aphid predators were also noted during the survey work.

Intensity of aphid attack

The total count of leaves and the number of crinkled leaves on a plant were noted and the intensity of attack of aphids was calculated by using the expression, I = a/b x 100 where 'a' is the number of crinkled leaves and 'b' is the total number of leaves present on the plant.

Other insect pests

The population of other insect pests was also noted. The flowers were opened with the help of fine

needles for collecting thrips. The immature stages collected during the survey were reared in the laboratory for further study.

Studies on the nature of damage

The nature of damage of bugs, jassids and thrips was studied in specimen tubes of size 10 x 2.5 cm. A tender shoot was wrapped in moist cotton at its basal portion and inserted into the tube containing test insects. The mouth of the tube was closed with muslin cloth. The nature of damage of lepidopterans was studied while rearing them in the laboratory.

Collection, preservation and identification of insects

During the survey, all the insects attacking C. odorata were collected and preserved. Later the insects were identified by insect taxonomists.

Biology studies

Biology of A. spirnecola and A. fabae was studied under laboratory conditions during October-November 1982. Conical flasks of 50 ml capacity were used for keeping the tender shoots of the weed. Adult aphids were released on these shoots for biology studies. Windproof cages were used for protecting the aphid colonies in the laboratory.

The newly born young ones were collected and placed singly on tender Chromolaena shoots kept immersed in water and the insects were continuously examined for moulting. The exuviae were removed after each moulting and preserved. The breeding vessels were placed on a black cloth for easy collection of the moulted skin. Permanent slides of the various instars were made for taking morphometric measurements and sketching.

Preparation of slides

The specimens of aphids were taken in a 75 x 15 mm tube to which 5% KOH was gently poured. The same was boiled for five minutes over a spirit lamp and kept for clearing. With the help of fine needles the pigments and embryos were removed from the aphid body. When the specimen became transparent, it is transferred to acetic acid to which acid fuchsin was dropped. The alkalinity of the specimen was thus got neutralised. After that, they were transferred to carbol-xylol (1:3) for dehydration.

The dehydrated aphids were transferred to a shallow watch glass of small size for easy manipulation. Well cleaned slides were placed in position and the required quantity of canadabalsam mountant placed at the centre of the slides by means of a glass rod. Three or

four specimens were placed carefully in the mountant and their antennae and legs were properly set with fine needles. Circular cover slips were placed on them in such a way that one edge came to contact with the mountant first. The cover slip was then slowly allowed to drop into position by means of spatulate forceps. Excess mountant was removed with filter paper. After the slides were made, these were placed for 12 to 24 hours in an oven set at about 50°C. Later these were labelled and stored in slide trays.

Statistical analysis

For comparing the density of population of aphids in different topographic situations in different villages, under different conditions and in different months, the analysis of variance technique as described by Snedecor and Cochran (1967) was made use of. Correlation studies of population of aphids and their predators were also undertaken. Before the analysis, data were transformed by using $\sqrt{X + 1}$ transformation in order to effect normality as the data showed considerable deviation from the expected normal distribution. The significance of the difference between medium hilly areas and plains was tested by using the Student's 't' test.

Graphical representation of aphid population

A periodic function of the form $Y = a+b \cos (2 \frac{\Pi}{n} X) + C \sin (2 \frac{\Pi}{n} X)$ was fitted to show the expected population fluctuations of aphids during different months (Thomas Little and Jackson Hills, 1978). In this equation Y represents the population of aphids in different months; X indicates the code values of months, i.e., X = 0, 1, ... 11 (from January to December); n shows the number of months = 12; a, b, c are the parameters to be estimated and $\Pi = 180^{\circ}$.

As the function allowed both positive and negative frequencies, the expected population counts which were negative were equated to zero.

Coefficient of multiple determination (R^2) was calculated using the formula $R^2 = \frac{\text{Total S.S.} - \text{Residual S.S.}}{\text{Total S.S.}}$.

(Total S.S. = $\varepsilon y^2 - C F$

$$C F = \frac{(G T)^2}{n}$$

y = Observed value

Residual S.S. = εd^2

εd^2 = Observed value - estimated value)

The expected period at which aphid population would be maximum was determined by the formula $\theta = \tan^{-1} (c/b)$ where $\theta = 2 \frac{\Pi}{n} x$.

RESULTS

RESULTS

From November 1980 to October 1981 a detailed survey of the pests associated with C. odorata was conducted in Trichur District. Besides an objective survey was carried out in selected districts of Kerala. Observations on the nature of damage and population density have been made during the survey. Studies on the biology and morphology of the selected species are also attempted. The results obtained are given below and the insects collected are listed in Appendix XIII.

1. Aphis spiraecola Patch (Aphididae : Hemiptera)

Pale green in colour. Length 0.92 to 1.45 mm and width 0.46 to 0.75 mm. Both apterous and alate forms were present and it had been found to breed by parthenogenetic viviparity throughout the year. In apterous viviparous females, dorsum of abdomen is without polygonal reticulation and siphunculi distinctly longer than cauda. Both siphunculi and cauda dark, the latter being elongated and rather tapering with 8 to 13 hairs. Process terminalis is 2 to 2.5 times as long as the base of the segment and longer than the third antennal

segment. Siphunculi about 0.16 to 0.2 times as long as body and 1.5 to 1.6 times as long as cauda. In alate viviparous females post siphuncular sclerites present either singly or in combination with other sclerites distributed on different portions of the abdomen. Ultimate rostral segment longer than second segment of hind tarsi. Femoral hairs of different lengths, shorter ones nearly equal to and longer ones about twice the basal diameter of third antennal segment which is with six to eight secondary rhinaria. Fourth antennal segment is without any rhinaria. Cauda with 9 to 11 hairs (Fig.1.A.B).

There were four instars and each instar normally lasted in about one to two days at room temperature (Fig. 2.A.B.C.D1.D2). Adult life span was about 6 to 11 days and the life-cycle ended in 12 to 18 days. Parthenogenetic females gave birth to 10 to 25 young ones under laboratory conditions during September-October (Table 1).

1.1. Length of body of A. spiraecola in different instars

Statistical analysis showed that the length of first (0.537 mm) and second (0.643 mm), second and third (0.722 mm) and fourth (1.163 mm) and adult (1.225 mm) are

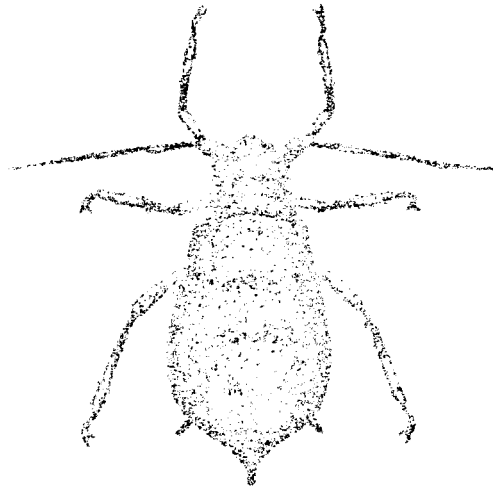


Fig. 12. Apterous female

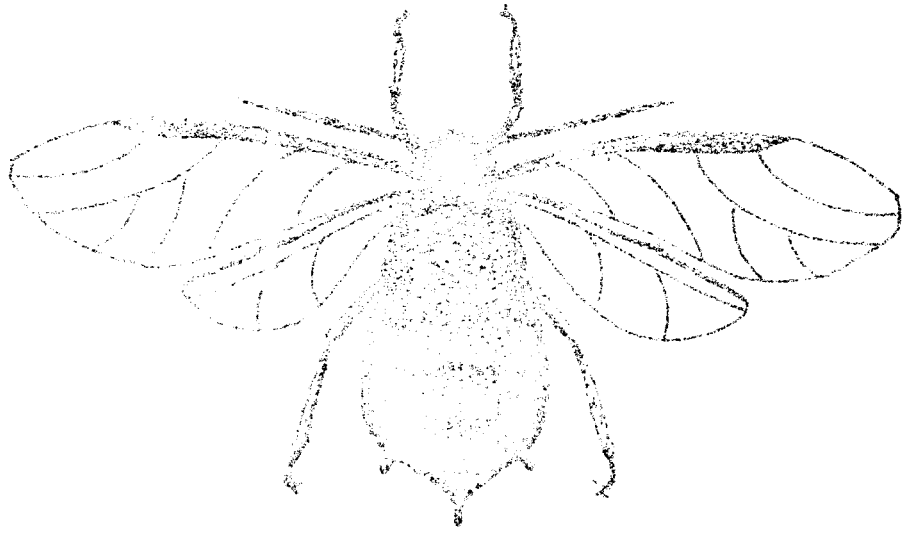


Fig. 13. winged female

Aphis pinicola

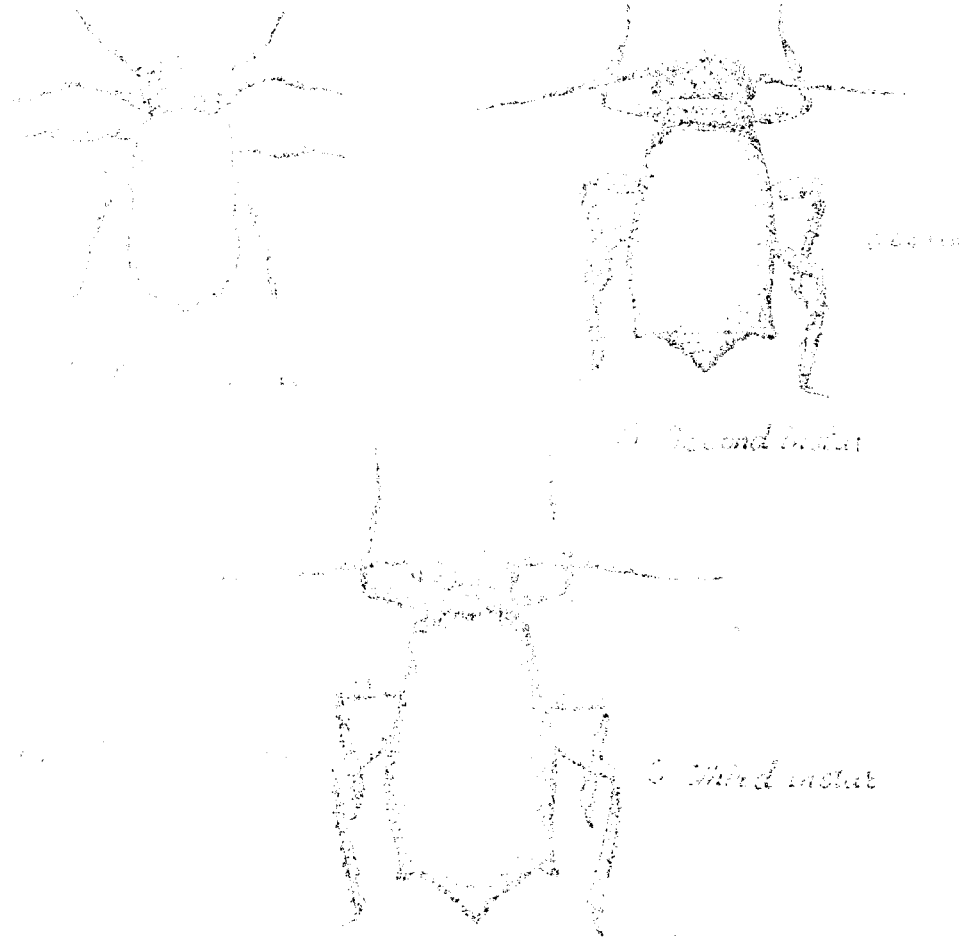


Table 1. Details of life-cycle of *A. spiraecola* under laboratory conditions

Sl. No.	No.of days for completing each stage					Total life span (days)	No.of young-ones/ adult
	First instar	Second instar	Third instar	Fourth instar	Adult		
1	2	1	1	2	7	13	19
2	2	1	1	2	10	16	17
3	2	1	1	2	10	16	20
4	1	2	2	2	9	16	20
5	2	2	2	1	11	18	22
6	2	2	1	1	6	12	24
7	1	2	1	1	8	13	13
8	1	2	1	2	7	13	13
9	1	2	2	1	6	12	10
10	2	2	1	1	7	13	14
11	1	1	1	2	9	14	20
12	2	2	2	2	6	15	24
13	2	1	2	1	8	14	20
14	1	2	1	2	6	12	13
15	2	2	1	1	6	12	14
16	2	1	1	1	7	12	13
17	1	1	2	2	6	12	25
18	2	1	2	1	6	12	12
19	1	2	2	1	6	12	13
20	1	2	2	2	6	13	10
Mean days	1.55	1.60	1.50	1.50	7.35	13.3	16.8

not significantly different. But the third and fourth varies significantly. The third has got significantly higher length than first as well as the adult has recorded significantly higher length than first, second and third instars (Table 2.A). Analysis of variance table is presented in Appendix I.

1.2. Maximum width of body of A. spiraecola in different instars

Adults showed the maximum width (0.650 mm) and this was significantly higher than first (0.255 mm), second (0.287 mm) and third (0.360 mm) instars. First and second and second and third instars seemed to be on par with regard to width of body. But fourth instar (0.575 mm) was found significantly higher in width than first, second and third instars (Table 2.B). Analysis of variance table is presented in Appendix II.

1.3. Length of cornicles of A. spiraecola in different instars

Statistical analysis showed that maximum cornicle length is in adult stage (0.161 mm) followed by fourth instar (0.113 mm) and third instar (0.068 mm) and the difference in cornicle length between these stages was

Table 2.A. Means of body length of different instars of *A. spiraecola* (in mm)

I	0.537				
II	0.643				
III	0.722				
IV	1.163				
A	1.225				
C.D.	0.05 = 0.164				
Ranks	1	2	3	4	5
	A	IV	III	II	I

Table 2.B. Means of maximum width of body of different instars of *A. spiraecola* (in mm)

I	0.255				
II	0.287				
III	0.360				
IV	0.575				
A	0.650				
C.D.	0.05 = 0.092				
Ranks	1	2	3	4	5
	A	IV	III	II	I

found to be significant. The length of cornicles in the first (0.029 mm) and second (0.051 mm) and second and third instars were on par, but the third instar had got significantly higher cornicle length than first instar (Table 2.C). Analysis of variance table is presented in Appendix III.

1.4. Antennal length of A. spiraecola in different instars

Adults had the maximum antennal length (0.753 mm) followed by fourth instar (0.580 mm), third instar (0.492 mm), second instar (0.368 mm) and first instar (0.287 mm). Each stage was significantly different in antennal length (Table 2.D). Analysis of variance table is presented in Appendix IV.

There were four antennal segments for the first instar and six segments for the adults while second, third and fourth instars had got five segments each. In certain cases it was noticed that the right antennae and right cornicles were little longer than the left ones. Usually the cornicles were darker in later instars.

Cauda was not clear in the early instars and it was prominent in fourth instar (0.05 mm to 0.09 mm long) and adult (0.10 mm to 0.16 mm long).

Table 2.C. Means of cornicle length of different instars of *A. spiraecola* (in mm)

I	0.029
II	0.051
III	0.068
IV	0.113
A	0.161
C.D. 0.05 =	0.024

Ranks	1	2	3	4	5
	A	IV	III	II	I

Table 2.D. Means of antennal length of different instars of *A. spiraecola* (in mm)

I	0.287
II	0.368
III	0.492
IV	0.580
A	0.753
C.D. 0.05 =	0.065

Ranks	1	2	3	4	5
	A	IV	III	II	I

Moulting started from the head region and the exuviae got detached from posterior end of the body with the help of legs. The process took about three to four minutes. The exuviae maintained the shape of its parent body and was white in colour. The wing pads developed in the fourth instar in alate forms and the markings of the wing pads were clearly seen on its exuviae. Freshly moulted aphids had shiny colouration. The process of giving birth to young ones took three to five minutes. Initially the posterior end of the young ones came out and finally the head region. One female gave birth to 12 to 25 young ones under laboratory conditions in its life span.

1.5. Seasonal fluctuation of A. spiraecola (apterous) population per plant under direct sunlight and partially shaded conditions in medium hilly areas

Among the medium hilly areas maximum population count was recorded in Pananchery Village (194.915) followed by Vellanikkara (181.170), Puthur (167.013) and Parlikkad (166.651) (Table 3.A). However, the differences between the villages were not significant.

There was no significant difference in the population count of A. spiraecola (apterous) under the

Table 3.A. Means of *A. spiraecola* (apterous) population per plant in different villages in medium hilly areas

	Villages	Means of transformed data	Means of original data (retransformed)
V_1	Vellanikkara	13.497	181.170
V_2	Pananchery	13.996	194.915
V_3	Puthur	12.962	167.013
V_4	Parlikkad	12.948	166.651

Ranks	1	2	3	4
	V_2	V_1	V_3	V_4

Table 3.B. Means of *A. spiraecola* (apterous) population per plant under different conditions in medium hilly areas

	Conditions	Means of transformed data	Means of original data (retransformed)
C_1	Partially shaded condition	13.832	190.324
C_2	Direct sunlight condition	12.870	164.637

Ranks	1	2
	C_1	C_2

direct sunlight (164.637) and partially shaded condition (190.324) in medium hilly areas. But a comparatively higher population was noted under the partially shaded condition (Table 3.B).

In July (1300.690) the population of A.spiraecola was significantly higher than all other months. Moderate aphid population was noted in June (720.621), August (672.710) and September (528.180). The population was significantly lower in October (270.230), November (99.802) and May (172.840) when compared to the above months. In December (1.468), January (5.880), February (7.214), March (0.265) and April (1.053) the population of the aphid was negligible (Table 3.C). Analysis of variance table is presented in Appendix V.

1.6. Seasonal fluctuation of A. spiraecola (apterous) population per plant under direct sunlight and partially shaded conditions in plains

There was no significant difference in the aphid population in different villages in plains. A maximum population was recorded at Chazhur Villa e (144.130) and a minimum at Engandiyoor Village (112.316) (Table 4.A).

Table 3.C. Means of *A. spiraecola* (apterous) population per plant in different months in medium hilly areas

	Months	Means of transformed data	Means of original data (retransformed)
M_1	January	2.623	5.880
M_2	February	2.866	7.214
M_3	March	1.125	0.265
M_4	April	1.433	1.053
M_5	May	13.185	172.840
M_6	June	26.863	720.621
M_7	July	36.079	1300.690
M_8	August	25.956	672.710
M_9	September	23.004	528.180
M_{10}	October	16.469	270.230
M_{11}	November	10.040	99.802
M_{12}	December	1.571	1.468

C.D. 0.05 = 5.045

Ranks

1	2	3	4	5	6	7	8	9	10	11	12
M_7	M_6	M_8	M_9	M_{10}	M_5	M_{11}	M_2	M_1	M_{12}	M_4	M_3

Under direct sunlight condition the population count was slightly higher (141.158) than under the partially shaded condition (108.558). But the difference between these two was not significant (Table 4.B).

A significantly higher population was seen during July (708.690) when compared to all other months except June (706.030) and August (657.440). September (503.450) and October (336.090) also recorded a higher population count. May (37.190) recorded a medium population and during November (0.390), December (1.200), January (2.640), February (3.489), March (0) and April (0) the population of the aphid was practically nil (Table 4.C). Analysis of variance table is presented in Appendix VI.

1.7. Comparison of A. spiraecola (apterous) population per plant in medium hilly areas and plains in different months

It was found that there is no change in A. spiraecola (apterous) population in medium hilly areas and plains (Student's 't' - 0.277). Maximum population count was recorded in medium hilly areas during July (1300.690).

Table 4.A. Means of *A. spiraecola* (apterous) population of different villages in plains

	Villages	Means of transformed data	Means of original data (retransformed)
V_1	Puzhakkal	10.978	119.516
V_2	Chazhoor	12.047	144.130
V_3	Urakom	11.109	122.409
V_4	Engandiyoor	10.645	112.316

Ranks	1	2	3	4
	V_2	V_3	V_1	V_4

Table 4.B. Means of *A. spiraecola* (apterous) population under different conditions in plains

	Conditions	Means of transformed data	Means of original data (retransformed)
C_1	Partially shaded condition	10.467	108.558
C_2	Direct sunlight condition	11.923	141.158

Ranks	1	2
	C_2	C_1

Table 4.C. Means of A. spiraecola (apterous) population in different months in plains

	Months	Means of transformed data	Means of original data
M_1	January	1.908	2.640
M_2	February	1.868	3.489
M_3	March	1.0	0
M_4	April	1.0	0
M_5	May	6.180	37.190
M_6	June	26.590	706.030
M_7	July	26.640	708.690
M_8	August	25.660	657.440
M_9	September	22.460	503.450
M_{10}	October	18.360	336.090
M_{11}	November	1.180	0.390
M_{12}	December	1.490	1.200

C.D. 0.05 = 4.130

Ranks

1	2	3	4	5	6	7	8	9	10	11
M_7	M_6	M_8	M_9	M_{10}	M_5	M_2	M_1	M_{12}	M_{11}	M_3 M_4

1.8. Seasonal fluctuation of *A. spiraecola* (alate) population per plant under direct sunlight and partially shaded conditions in medium hilly areas

Significant difference was not observed between villages with regard to the aphid population. Maximum population count was recorded at Puthur Village (3.448) followed by Parlikkad (2.729), Pananchery (2.028) and Vellanikkara (1.592) (Table 5.A).

The aphid population was higher in partially shaded condition (3.012) than direct sunlight condition (2.007), the difference between these two was not significant (Table 5.B).

A significantly higher population was recorded during July (14.016) as compared to all other months. Significant difference was not found between June (7.922), August (5.755) and September (4.239). In all other months *A. spiraecola* (alate) was practically nil (Table 5.C). Analysis of variance table is presented in Appendix VII.

1.9. Seasonal fluctuation of *A. spiraecola* (alate) population under direct sunlight and partially shaded conditions in plains

It was found that the maximum *A. spiraecola* (alate) population under direct sunlight condition was

Table 5.A. Means of A. spiraecola (alate) population in different villages in medium hilly areas

	Villages	Means of transformed data	Means of original data (retransformed)
V_1	Vellanikkara	1.610	1.592
V_2	Pananchery	1.740	2.028
V_3	Puthur	2.109	3.448
V_4	Parlikkad	1.931	2.729

Ranks	1	2	3	4
	V_3	V_4	V_2	V_1

Table 5.B. Means of A. spiraecola (alate) population under different conditions in medium hilly areas

	Conditions	Means of transformed data	Means of original data (retransformed)
C_1	Partially shaded condition	2.0025	3.012
C_2	Direct sunlight condition	1.734	2.007

Ranks	1	2
	C_1	C_2

Table 5.C. Means of A. spiraecola (alate) population in different months in medium hilly areas

	Months	Means of transformed data	Means of original data (retransformed)
M_1	January	1.233	0.520
M_2	February	1.091	0.190
M_3	March	1.0	0
M_4	April	1.0	0
M_5	May	1.696	1.876
M_6	June	2.987	7.922
M_7	July	3.875	14.016
M_8	August	2.599	5.755
M_9	September	2.289	4.239
M_{10}	October	1.708	1.917
M_{11}	November	1.818	2.305
M_{12}	December	1.125	0.266

C.D. 0.05 = 0.818

Ranks

1	2	3	4	5	6	7	8	9	10	11
M_7	M_6	M_8	M_9	M_{11}	M_{10}	M_5	M_1	M_{12}	M_2	M_3 M_4

at Engandiyoor Village (2.367) followed by Chazhoor (1.449), Urakom (1.326) and Puzhakkal (1.301). But the difference in the population level was not significant (Table 6.A).

In the plains, the population count was higher in direct sunlight condition (1.759) than in partially shaded condition (1.465) (Table 6.B).

The population of A. spiraecola (alate) was maximum during July (8.431) and it was significantly higher than all other months. During October (1.525), November (0), December (0), January (0.510), February (0.395), March (0), and April (0) the aphid population was negligible (Table 6.C). Analysis of variance table is presented in Appendix VIII.

1.10. Comparison of A. spiraecola (alate) population per plant in medium hilly areas and plains in different months

It is found that there was no significant difference in the population of A. spiraecola (alate) in medium hilly areas and plains (Student's 't' -0.271). Maximum population count was recorded from medium hilly areas during July (14.016).

Table 6.A. Means of *A. spiraecola* (alate) population in different villages in plains

	Villages	Means of transformed data	Means of original data (retransformed)
V_1	Puzhakkal	1.517	1.301
V_2	Chazhoor	1.565	1.449
V_3	Urakom	1.525	1.326
V_4	Engandiyoor	1.835	2.367

Ranks	1	2	3	4
	V_4	V_2	V_3	V_1

Table 6.B. Means of *A. spiraecola* (alate) population under different conditions in plains

	Conditions	Means of transformed data	Means of original data (retransformed)
C_1	Partially shaded condition	1.570	1.465
C_2	Direct sunlight condition	1.661	1.759

Ranks	1	2
	C_2	C_1

Table 6.C. Means of A. spiraecola (alate) population in different months in plains

	Months	Means of transformed data	Means of original data (retransformed)
M_1	January	1.229	0.510
M_2	February	1.181	0.395
M_3	March	1.0	0
M_4	April	1.0	0
M_5	May	1.051	0.105
M_6	June	2.798	6.828
M_7	July	3.071	8.431
M_8	August	2.416	4.837
M_9	September	2.053	3.215
M_{10}	October	1.589	1.525
M_{11}	November	1.0	0
M_{12}	December	1.0	0

C.D. 0.05 = 0.679

Ranks

1	2	3	4	5	6	7	8	9
M_7	M_6	M_8	M_9	M_{10}	M_1	M_2	M_5	M_3
								M_4
								M_{11}
								M_{12}

2. Aphis fabae Scopoli (Aphididae : Hemiptera)

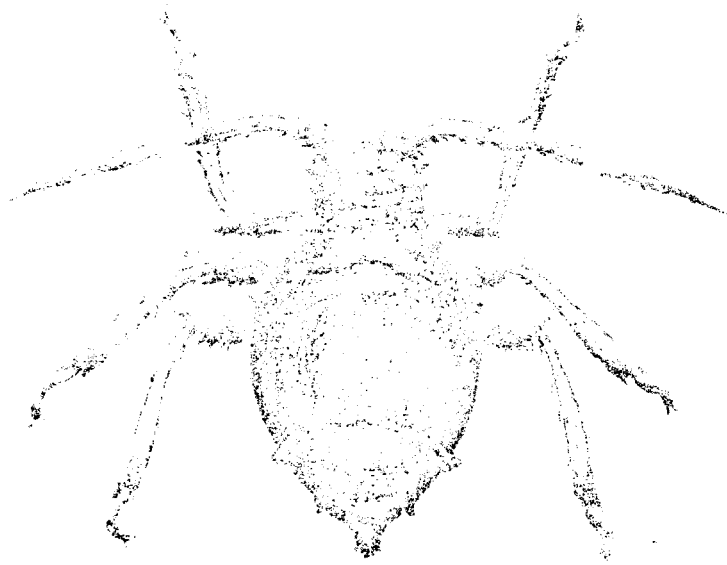
Both alate and apterous forms were present but alate forms were negligible. Adults were dark green in colour. There were four larval instars and each instar period lasted about one to two days. The total life span lasted 12 to 18 days under laboratory conditions (Fig.3.A.B).

2.1. Seasonal fluctuation of A. fabae population per plant under direct sunlight and partially shaded condition in medium hilly areas

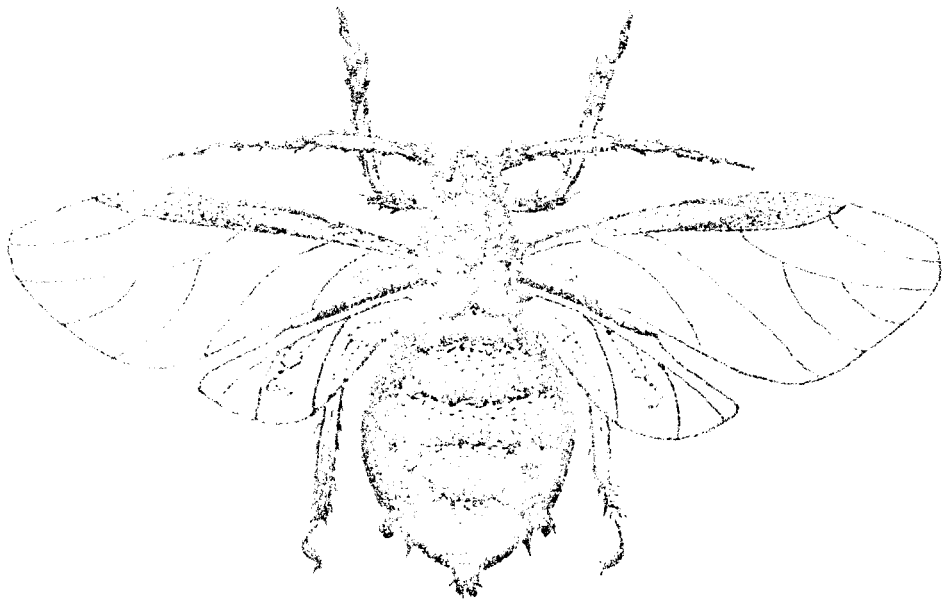
These aphids were present on the weed from May to October in all villages both under direct sunlight and partially shaded conditions and these were practically nil during November, December, January, February, March and April.

There was no significant difference between the villages with regard to aphid population in medium hilly areas. Maximum population was noticed in Puthur Village (7.803) followed by Parlikkad (6.416), Pananchery (6.117) and Vellanikkara (5.838) (Table 7.A).

Under partially shaded condition, the population mean was 9.266 and under direct sunlight condition,



A. Apicerus femelle



B. Abeille femelle

Fig. B. Abeille femelle.

it was 8.812 and hence it is evident that there was no significant variation in aphid population under these two conditions (Table 7.B).

Aphid population was maximum in July (59.820) and was significantly higher than all other months. July is closely followed by June (25.420), August (19.912), September (16.481) and October (12.418). June has significantly higher population of A. fabae than other months except July. A medium population count was recorded in May (3.800). A fabae was practically nil during November (0.563), December (0), January (0.266), February (0), March (0.105) and April (0.105) (Table 7.C). Analysis of variance table is given in Appendix IX.

2.2. Seasonal fluctuation of A. fabae population under direct sunlight and partially shaded conditions in plains

Statistical analysis showed that there was no significant changes in A. fabae population in different villages in plains. Maximum population was recorded in Chazhoor Village (6.274) followed by Engandiyoor (5.933), Urakom (4.622) and Pushakkal (4.380) (Table 8.A).

The population count was higher under direct sunlight condition (5.713) than the partially shaded

Table 7.A. Means of *A. fabae* population in different villages in medium hilly areas

	Villages	Means of transformed data	Means of original data (retransformed)
V_1	Vellanikkara	2.615	5.838
V_2	Pananchery	2.849	6.117
V_3	Puthur	2.977	7.803
V_4	Parlikkad	2.901	6.416

Ranks	1	2	3	4
	V_3	V_4	V_2	V_1

Table 7.B. Means of *A. fabae* population under different conditions in medium hilly areas

	Conditions	Means of transformed data	Means of original data (retransformed)
C_1	Partially shaded condition	2.875	9.266
C_2	Direct sunlight condition	2.795	8.812

Ranks	1	2
	C_1	C_2

Table 7.6. Means of *A. fabae* population in different months in medium hilly areas

	Months	Means of transformed data	Means of original data (retransformed)
M_1	January	1.125	0.266
M_2	February	1.0	0
M_3	March	1.051	0.105
M_4	April	1.051	0.105
M_5	May	2.191	3.800
M_6	June	5.140	25.420
M_7	July	7.799	59.820
M_8	August	4.573	19.912
M_9	September	4.181	16.481
M_{10}	October	3.663	12.418
M_{11}	November	1.250	0.563
M_{12}	December	1.0	0

C.D. 0.05 = 0.813

Ranks

1	2	3	4	5	6	7	8	9	10
M_7	M_6	M_8	M_9	M_{10}	M_5	M_{11}	M_1	M_3 M_4	M_2 M_{12}

condition (4.852). But the difference was not significant (Table 8.B).

July (25.041) and August (25.041) recorded the maximum aphid population followed by June (19.349) and September (18.141). But the difference in population between these months was not significant. June, July, August and September showed significantly higher aphid population count than October (10.601). Very low population was noted in May (1.434) and during November 1980 to April 1981, A. fabae was practically absent in the plains (Table 8.C). Analysis of variance table is given in Appendix X.

2.3. Comparison of A. fabae population in medium hilly areas and plains in different months

There was no significant difference in aphid population in medium hilly areas and plains (Student's 't' - 0.033). In certain months medium hilly areas recorded higher population and plains lower and in certain other months vice versa. The maximum populations recorded in medium hilly area was during July (59.820).

1.2.1. Graphical representation of aphid population in medium hilly areas and plains in different months

A periodic function was fitted to study the fluctuation of aphid population in plains and medium

Table 8.A. Means of *A. fabae* population in different villages in plains

	Villages	Means of transformed data	Means of original data (retransformed)
V_1	Puzhakkal	2.320	4.380
V_2	Chashoor	2.697	6.274
V_3	Urakom	2.371	4.622
V_4	Engandiyoor	2.633	5.933

Ranks	1	2	3	4
	V_2	V_4	V_3	V_1

Table 8.B. Means of *A. fabae* population under different conditions in plains

	Conditions	Means of transformed data	Means of original data (retransformed)
C_1	Partially shaded condition	2.419	4.852
C_2	Direct sunlight condition	2.591	5.713

Ranks	1	2
	C_2	C_1

Table 8.C. Means of A. fabae population in different months in plains

	Months	Means of transformed data	Means of original data (retransformed)
M_1	January	1.0	0
M_2	February	1.0	0
M_3	March	1.0	0
M_4	April	1.0	0
M_5	May	1.560	1.434
M_6	June	4.511	19.349
M_7	July	5.103	25.041
M_8	August	5.103	25.041
M_9	September	4.375	18.141
M_{10}	October	3.406	10.601
M_{11}	November	1.0	0
M_{12}	December	1.0	0

C.D. 0.05 = 0.973

Ranks	1	2	3	4	5	6
	M_7	M_6	M_9	M_{10}	M_5	M_{11}
	M_8					M_{12}
						M_1
						M_2
						M_3
						M_4

hilly areas in different months (Fig.4 and 5). Observed and expected number of aphids per plant in medium hilly areas and plains during different months are given in Table 9.

It can be seen from the table that there is considerable agreement between observed population count and expected population count on the basis of the fitted periodic function. R^2 was 79 per cent in the case of medium hilly areas which indicates that 79 per cent of the total variation in the population count could be explained by the fitted trignometric function. In the case of plains R^2 was 91 per cent which also shows the most suitability of the data to the fitted curve.

The maximum aphid population was estimated from the graph to be in July in medium hilly areas. This also agrees with the observed data. In the case of plains the graph shows the expected maximum aphid population during August but the observed maximum population was in July. The discrepancies found may be due to sampling fluctuations.

Table 9. Observed and expected number of aphid population per plant in medium hilly areas and plains in different months

Months	Medium hilly areas		Plains	
	Observed population count	Expected population count	Observed population count	Expected population count
January	8.16	0	8.8	0
February	4.25	0	4.9	0
March	0.33	0	0	38
April	3.42	177.15	0	139
May	181.09	433.37	46	351
June	693.41	661.9	716	539
July	1351.83	801.67	852	654
August	723.0	661.9	651	665
September	496.50	566.84	517	539
October	352.75	483.41	376	390
November	141.75	227.79	1	178
December	7.42	0	2	0

Fig. 1

OBSERVED AND EXPECTED APHID POPULATION IN DIFFERENT MONTHS IN MEDIUM HILLY AREAS.

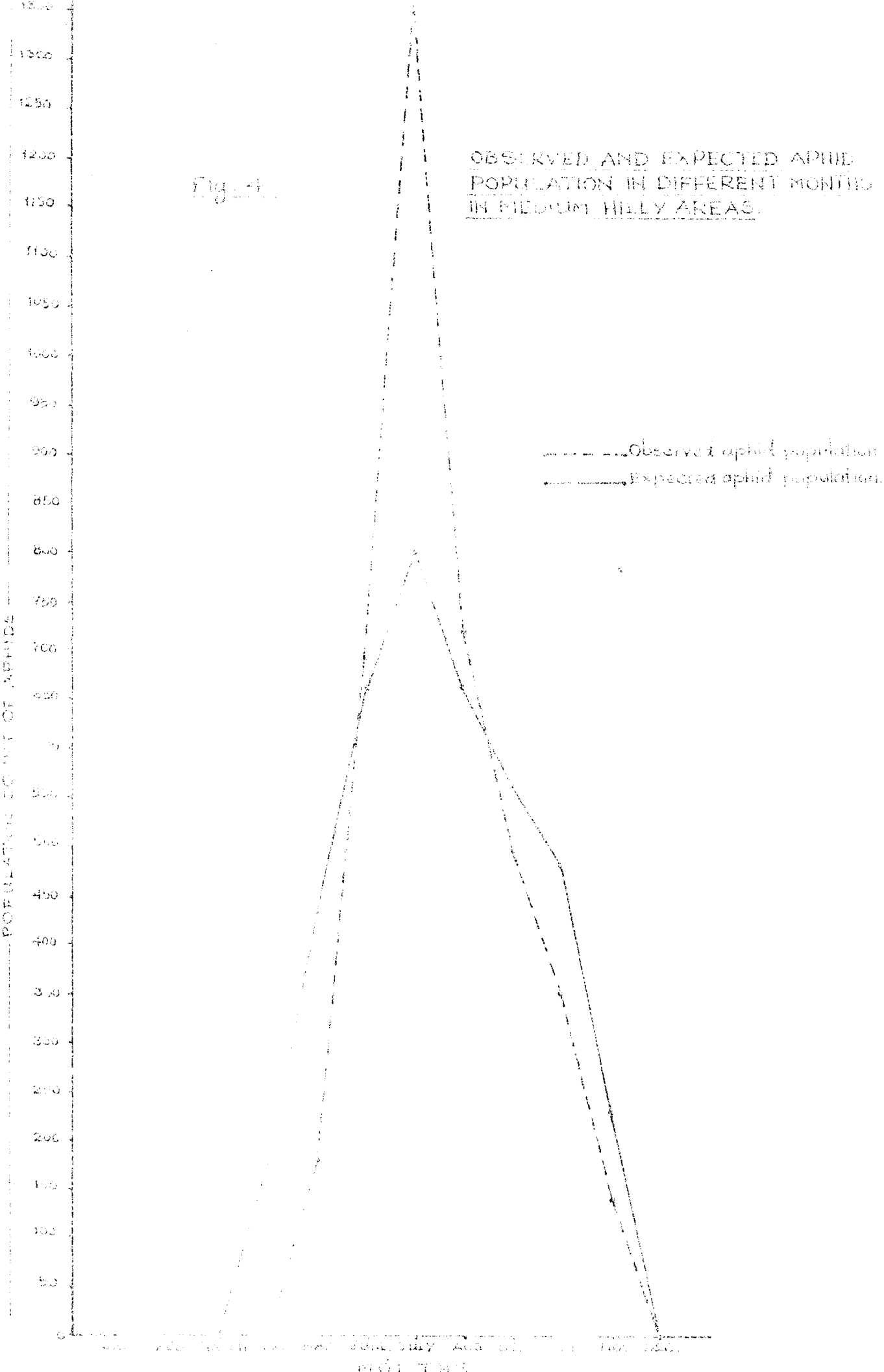
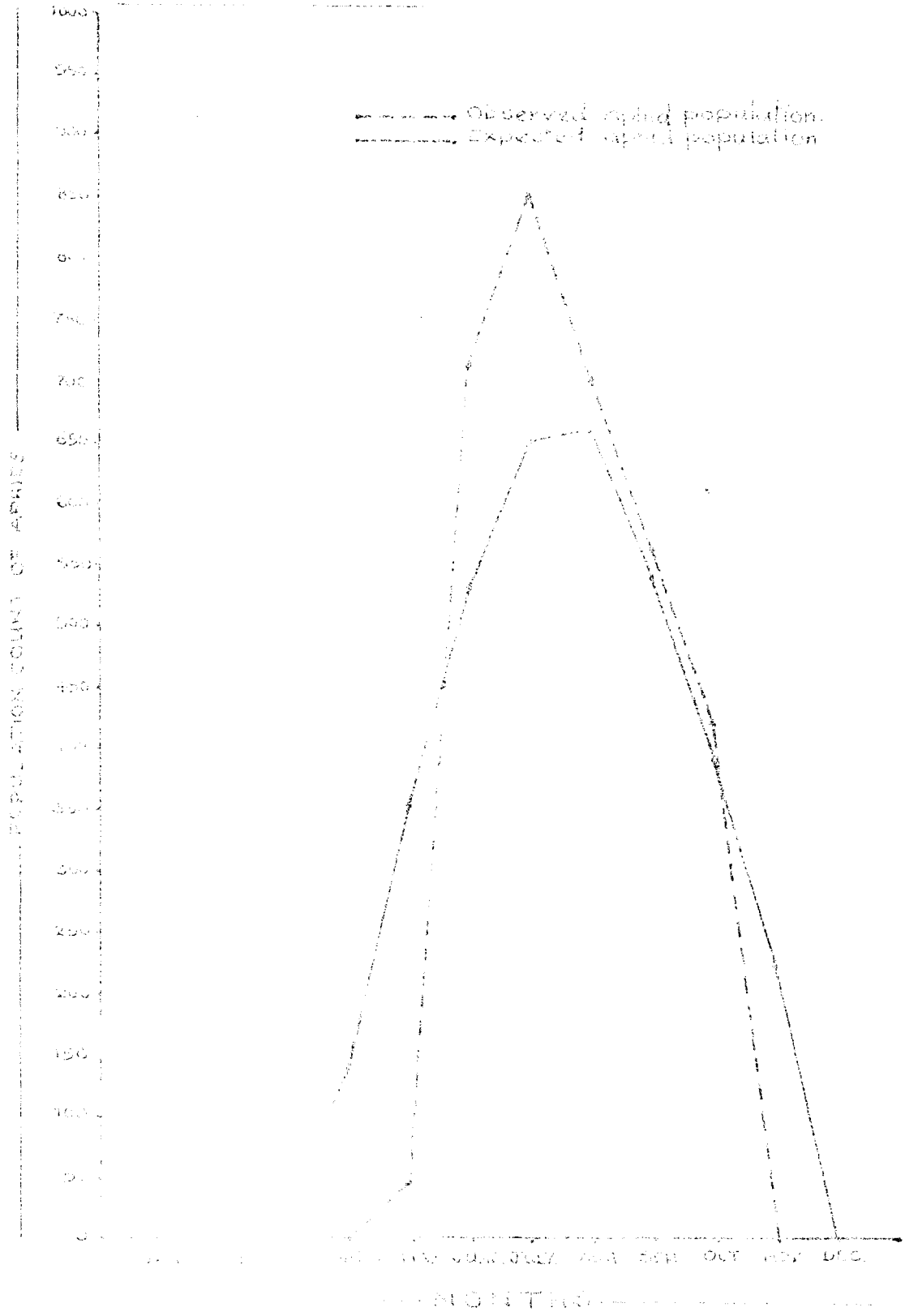


Fig. 5 — OBSERVED AND EXPECTED APHID POPULATION IN DIFFERENT MONTHS AT DELAINS



1.2.2. Nature of damage of *A. spiraecola* and *A. fabae*

Nymphs and adults suck sap from tender shoots and leaves causing severe crinkling of the leaves. As a result the plants got stunted and the leaves had a crinkled appearance (Fig.6).

1.2.3. Intensity of attack of aphids per plant in medium hilly areas in different months under different conditions

In medium hilly areas the maximum attack was at Pananchery Village (1.256) followed by Puthur (1.028), Parlikkad (1.025) and Vellanikkara (1.005) (Table 10.A).

When different conditions were compared it was seen that partially shaded condition (1.149) recorded slightly higher intensity of attack than direct sunlight condition (0.977) (Table 10.B).

July (2.877) recorded maximum intensity of attack and it was significantly higher than all other months except August (2.356). Lesser intensity of attack was noticed during December (0.520), January (0.311), February (0.212), March (0.113) and April (0.059) (Table 10.C). Analysis of variance is given in Appendix XI.

Fig 8 Nature of damage of
Aphis spiraecola and *Aphis fabae*

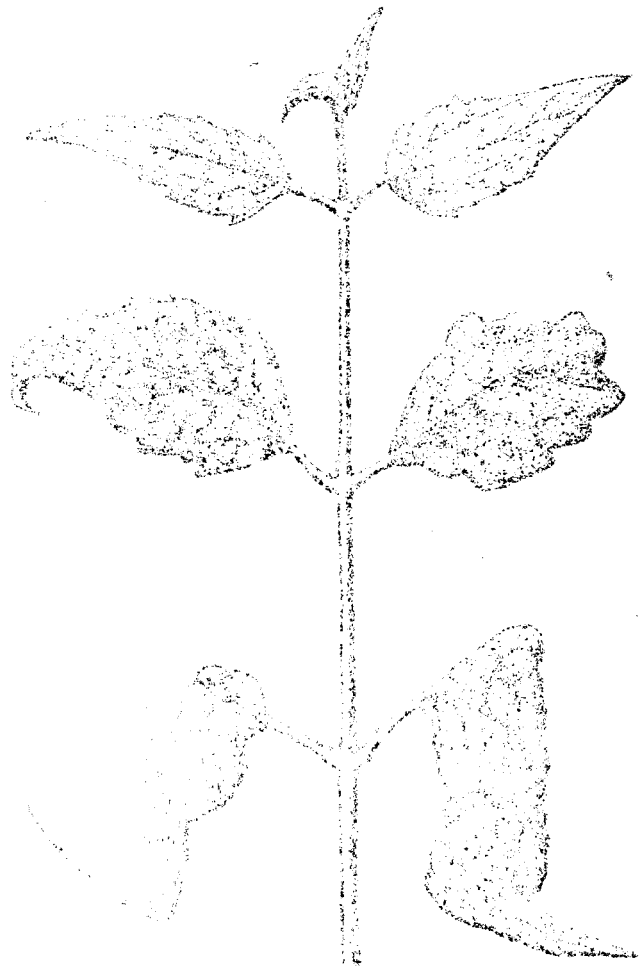


Table 10.A. Mean score values indicating the intensity of attack of aphids in different villages in medium hilly areas

	Villages	Means of transformed data	Means of original data (retransformed)
V_1	Vellanikkara	1.416	1.005
V_2	Panangchery	1.502	1.256
V_3	Puthur	1.424	1.028
V_4	Parlikkad	1.423	1.025

Ranks	1	2	3	4
	V_2	V_3	V_4	V_1

Table 10.B. Mean score values indicating the intensity of attack of aphids under different conditions in medium hilly areas

	Conditions	Means of transformed data	Means of original data (retransformed)
C_1	Partially shaded condition	1.466	1.149
C_2	Direct sunlight condition	1.406	0.977

Ranks	1	2
	C_1	C_2

Table 10.C. Mean score values indicating the intensity of attack of aphids in different months under medium hilly areas

	Months	Means of transformed data	Means of original data (retransformed)
M_1	January	1.145	0.311
M_2	February	1.101	0.212
M_3	March	1.055	0.113
M_4	April	1.029	0.059
M_5	May	1.560	1.434
M_6	June	1.708	1.917
M_7	July	1.969	2.877
M_8	August	1.832	2.356
M_9	September	1.625	1.641
M_{10}	October	1.464	1.143
M_{11}	November	1.513	1.289
M_{12}	December	1.233	0.520

C.D. 0.05 = 0.214

Ranks

1	2	3	4	5	6	7	8	9	10	11	12
M_7	M_8	M_6	M_9	M_5	M_{11}	M_{10}	M_{12}	M_1	M_2	M_3	M_4

1.2.4. Intensity of attack of aphids in plains in different months under different conditions

In the plains, maximum intensity of attack was at Engandiyoor (1.045) followed by Pushakkal (1.014), Urakom (0.880) and Chazhoor(0.836). But the difference in intensity of attack was not significant (Table 11.A).

Higher intensity of attack was noticed under direct sunlight condition (1.016) than partially shaded condition (0.866) (Table 11.B).

July recorded the maximum intensity (2.952) and it was significantly higher than all other months except August (2.337). June (1.941) and September (1.789) recorded almost the same intensity of attack. The intensity of attack was negligible during November (0.388), December (0.438) January (0.450), February (0.395), March (0.199), April (0.119) and May (0.428) (Table 11.C). Analysis of variance table is given in Appendix XII.

1.2.5. Comparison of intensity of aphid attack in medium hilly areas and plains in different months

There was no significant difference in intensity of attack of aphids between medium hilly areas and plains (Student's 't' - 0.516). Maximum

Table 11.A. Mean score values indicating intensity of attack of aphids in different villages in plains

	Villages	Means of transformed data	Means of original data (retransformed)
V_1	Puzhakkal	1.419	1.014
V_2	Chazhoor	1.355	0.836
V_3	Urakom	1.371	0.880
V_4	Engandiyoor	1.430	1.045

Ranks	1	2	3	4
	V_4	V_1	V_3	V_2

Table 11.B. Mean score values indicating intensity of attack of aphids under different conditions in plains

	Conditions	Means of transformed data	Means of original data (retransformed)
C_1	Partially shaded condition	1.360	0.866
C_2	Direct sunlight condition	1.420	1.016

Ranks	1	2
	C_2	C_1

Table 11.C. Mean score values indicating the intensity of attack of aphids in different months in plains

	Months	Means of transformed data	Means of original data (retransformed)
M_1	January	1.204	0.450
M_2	February	1.181	0.395
M_3	March	1.095	0.199
M_4	April	1.058	0.119
M_5	May	1.195	0.428
M_6	June	1.915	1.941
M_7	July	1.988	2.952
M_8	August	1.827	2.337
M_9	September	1.670	1.789
M_{10}	October	1.406	0.977
M_{11}	November	1.178	0.388
M_{12}	December	1.199	0.438

C.D. 0.05 = 0.199

Ranks

1	2	3	4	5	6	7	8	9	10	11	12
M_7	M_8	M_6	M_9	M_{10}	M_1	M_{12}	M_5	M_2	M_{11}	M_3	M_4

intensity of attack was in July in plains (2.952) and minimum in medium hilly areas during April (0.059).

1.2.6. Correlation studies of aphids and its predators

In order to find out the relationship between population of aphids and population of its predators simple linear correlation coefficients were worked out and their significance was tested by using the 't' test. The results showed that there was no significant association between the population of aphids and population of its predators.

3. Brachycaudus helichrysi Kltb. (Aphididae : Hemiptera)

These aphids were found in Idukki and Wynad areas of Kerala and were entirely absent in the plains. As a result of attack of the aphids the plants presented a wilted appearance and most of the leaves on the plant became folded and rolled longitudinally (Fig.7 and 8).

4. Coptosoma sp. (Plataspididae : Hemiptera)

Body broadly ovate, moderately convex above, very slightly convex beneath (Fig.9). Head usually small, eyes somewhat prominent. Ocelli nearer to the eyes than to each other. Scutellum covering almost the

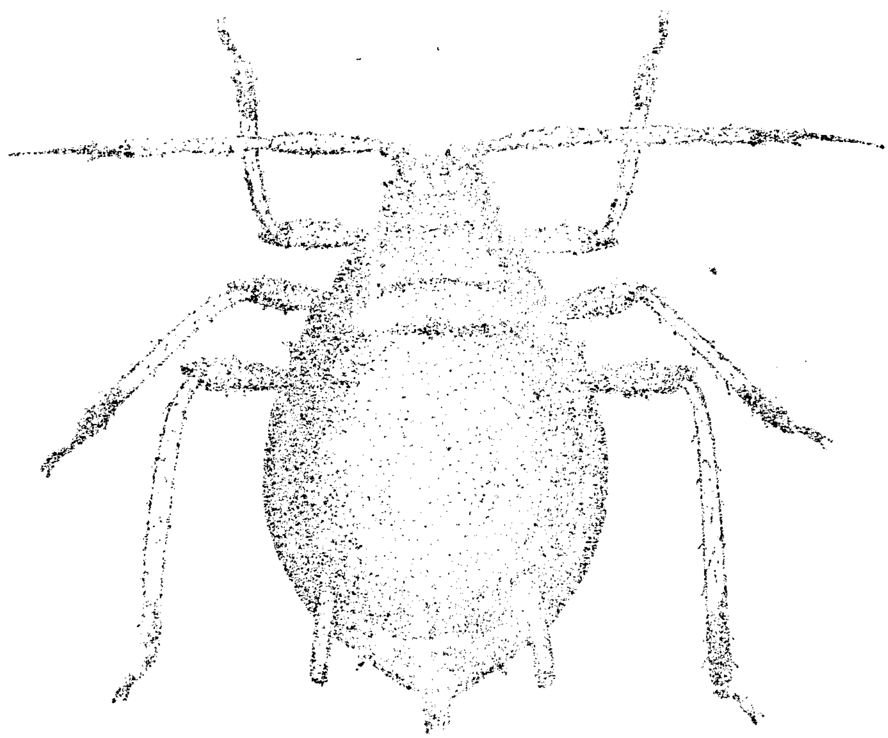
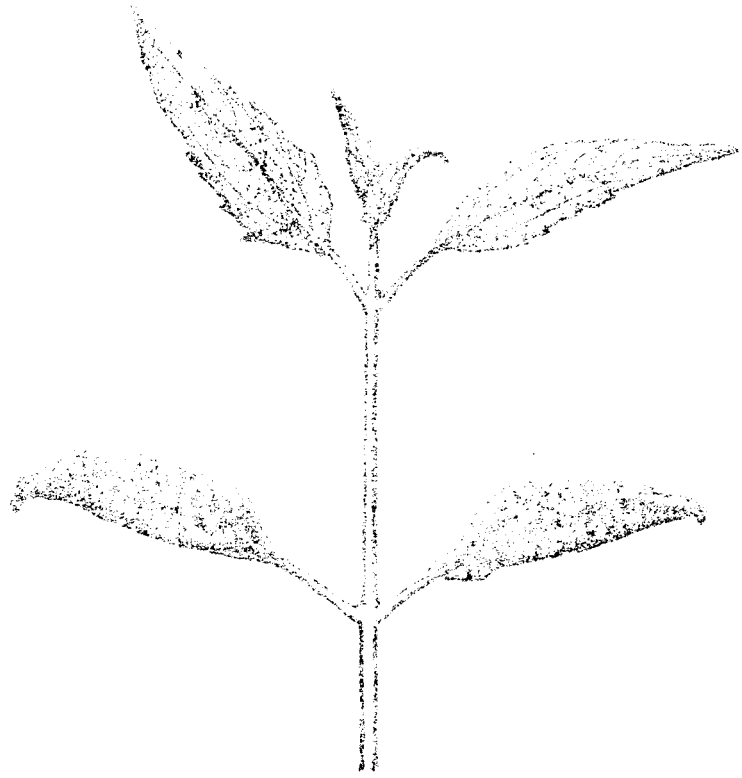


Fig. 7 *Brachycaudus helichrysi*

Fig 8 - Nature of damage of
Brachycaudus helichrysi



entire abdomen. Hemelytra long and bent beneath scutellum. Tarsi two segmented. Length 2 to 3 mm, width 2.5 mm.

Adults suck sap from tender parts of the plant.

These bugs were present on Chromolaena throughout the growth phase of the weed and were collected from all villages in Trichur District and other districts of Kerala where survey was conducted.

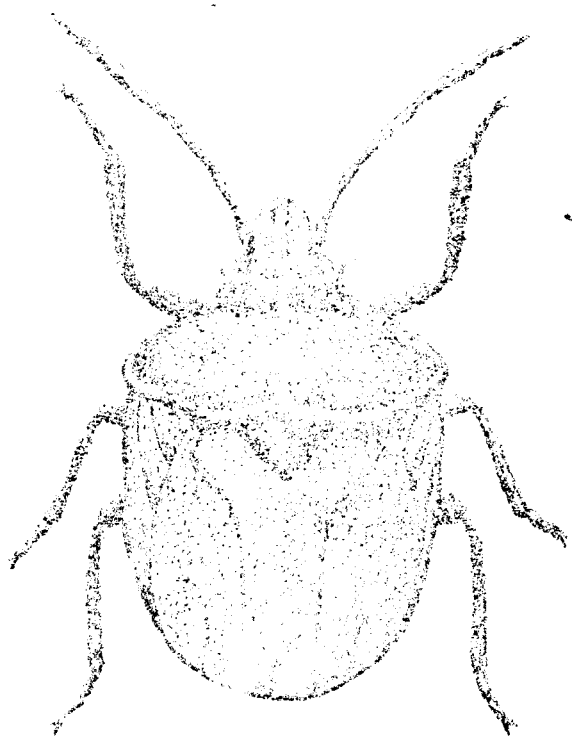
5. Sephtia nigrofusca Dist. (Plataspididae : Hemiptera)

Body obovate, very convex above and beneath. Head depressed antriorly. Rostrum reaching the third or fourth abdominal segment. Antennae five jointed and basal joint not reaching the apex of head. Pronotum strongly deflexed anteriorly, scutellum large, convex, extending to the apex of the abdomen. Length of body 4 mm (Fig.10).

The adults suck sap from the tender leaves and stem.

6. Tettigella ceylonica Melich. (Cicadellidae : Hemiptera)

Body is pale yellowish and eyes are brown. Tegmina hyaline, pale yellowish with tender veins and



membrane hyaline. Legs pale yellowish. Dorsum commonly orange yellowish with a black spot. Length about 5 to 5.25 mm (Fig.11).

Adults suck sap from tender shoots and these were present in very few numbers to cause any appreciable damage.

7. Bemisia tabaci Gen. (Aleyrodidae : Hemiptera)

Very small insect with seven segmented antennae, two ocelli and a pair of reniform compound eyes. Wings are opaque and whitish. Rostrum is three segmented. Tarsi are two segmented terminating into pad like empodium. The adult is about 1 mm long and the whole body is covered with a white, waxy bloom (Fig.12).

B. tabaci is only an occasional feeder of C. odorata.

8. Leptocorisa acuta Thunb (Coreidae : Hemiptera)

The adult bug is olive brown and ventrally green. The legs are ochraceous brown. It measures about 15.5 to 17 mm long, with antennae inserted well up on sides of head and a four segmented rostrum. The pale yellowish green nymphs possess odoriferous glands in the fifth abdominal segment (Fig.13).

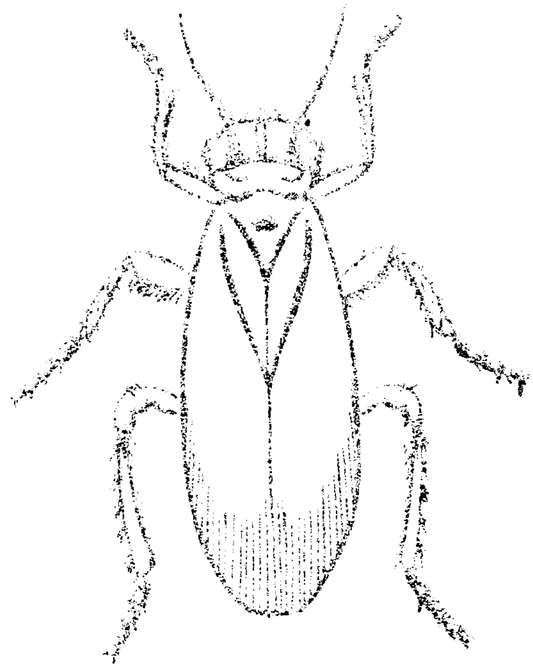
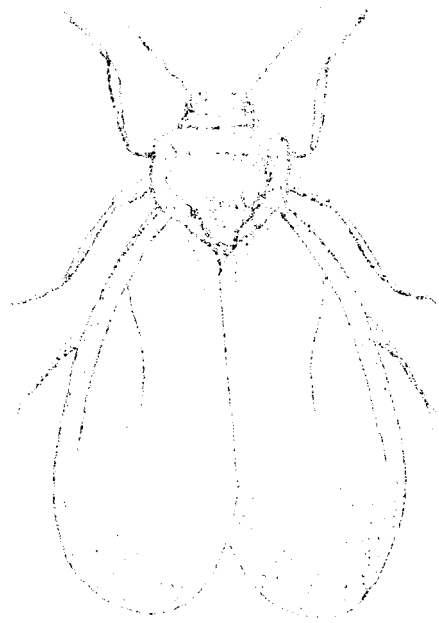


Fig. 11 Stettigella ceylonica



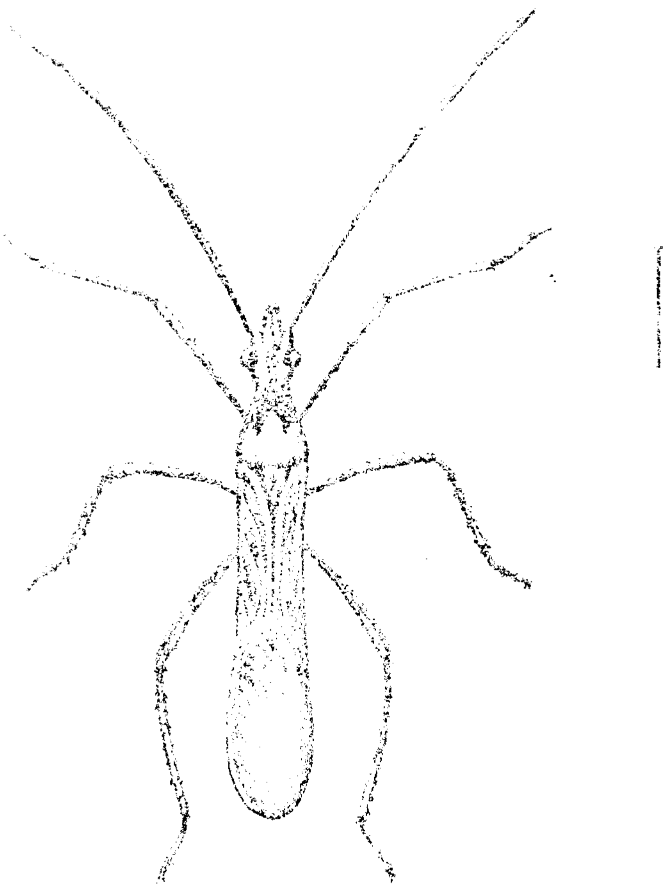


Fig 15. *Leptocorisa acuta*

The adults as well as the nymphs suck sap from the tender parts of the plant and found in numbers in certain areas.

9. Riptortus pedestris Fb. (Coreidae : Hemiptera)

The adult is a dark brown elongated bug with two black bands ventrally on the abdomen. It is about 15 mm to 16 mm long and 3 mm to 4 mm broad across the thorax. Sternum somewhat reddish-ochraceous with prominent pale ochraceous spots placed near coxae. Legs ochraceous (Fig.14).

The adults suck sap from tender shoots and it was recorded only in few numbers.

10. Dysdercus koenigii Fb. (Pyrrhocoridae : Hemiptera)

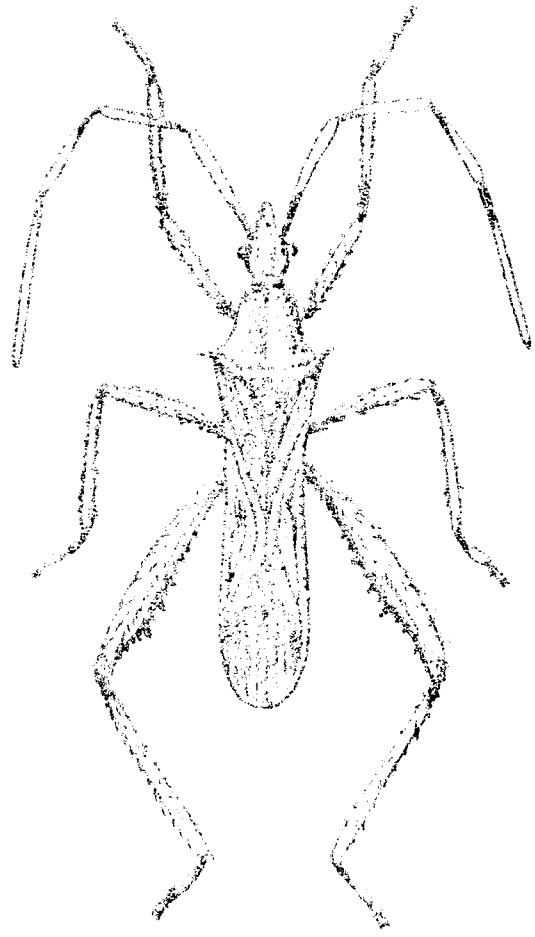
The bug is medium sized with blackish marking on the wings and white bands on abdomen. The rostrum is four segmented. The legs possess rotatory coxae, three-segmented tarsi and pulvilli (Fig.15).

The adults suck sap from the tender shoots and the population count was very low.

11. Leptocentrus sp. (Membracidae : Hemiptera)

Adults are 6 to 8 mm long and 5 to 6 mm broad at lateral pronotal process. Front of pronotum more or

Fig 24. Reduvius personatus



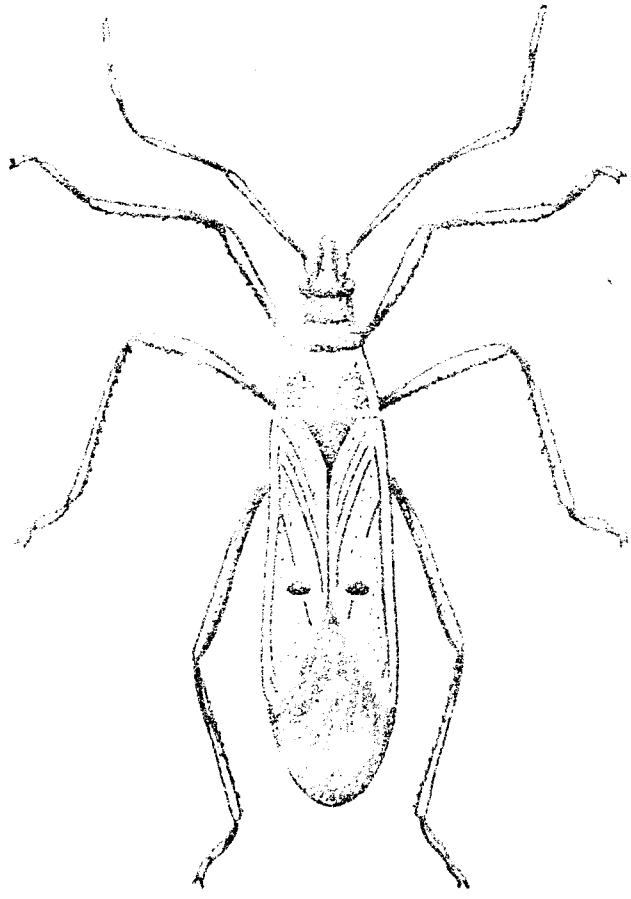


Fig. 15 - *Dysdercus koenigii*

less obliquely prominent towards face pronotum with anteriorly produced transverse processes, posterior process slender, emitted a little before posterior margin of the pronotum and well separated from the scutellum and abdomen (Fig.16).

These bugs suck sap from the plant throughout the growth phase of the weed, but the population count was very low.

12. Coccosterphus minutus Fabricius (Membracidae:Hemiptera)

The adults are dark brownish with a length of 2 to 3 mm. Eyes hemispherical and dull white. Ocelli nearer to eyes than to each other. Pronotum black with large tubercles and granules. Posterior process broadly triangular and slightly elevated. Tegmina without pterostigma and the apical area tinted with reddish brown patches. Tegminal veins are large (Fig.17).

Theseinsects were present throughout the growth phase of the plant and these suck sap from the tender shoots. But the population count was low to cause any appreciable damage.

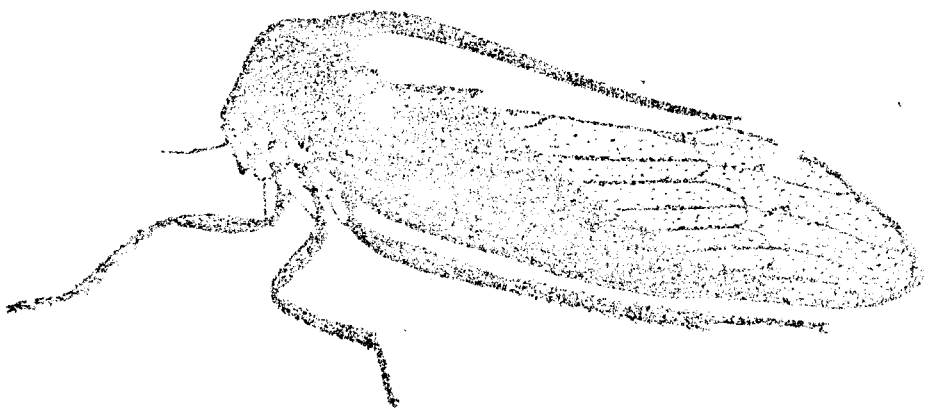


Fig. 16 - *Leptocanthus* sp.

Fig 17. *Coccotrophus minutus*

13. Apion sp. (Apionidae : Coleoptera)

The adult is a minute weevil measuring 2 to 2.5 mm long with a conspicuous, curved snout. It is dull black in colour. Rostrum straight, first segment of antennae (scape) is small and the remaining ones are not geniculate or elbowed with the scape. Elytra with deep furrows and covered with hairs. Abdomen is globular and the body is longer than the rostrum and head (Fig.18).

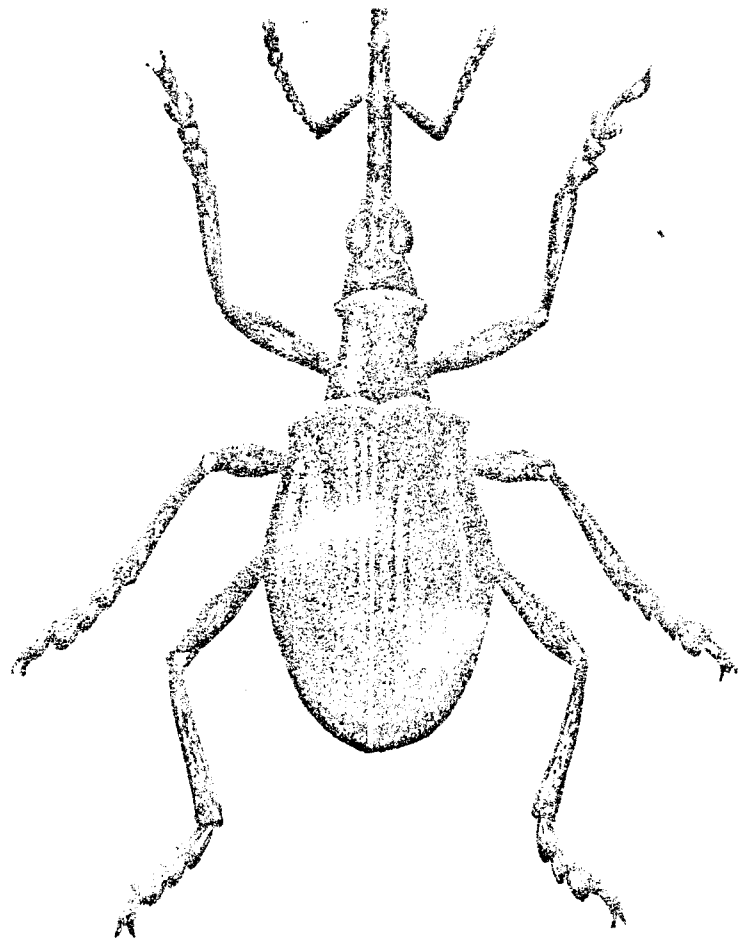
These are usually seen on the lower leaf surfaces. As a result of feeding, small irregular holes are seen on leaf surface. These feed on the flowers during the flowering season.

These were common at Vellanikkara, Puzhakkal, Pananchery and Parlikkad when there are new flushes on the plant.

14. Unidentified curculionid (Curculionidae : Coleoptera)

The adult beetle is small, 2.5 mm long and dull black in colour. Rostrum is abruptly turned downwards and head is more or less sunken into the prothorax. First segment of antennae (scape) is long and the remaining

Fig 18 - Apion sp



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ones are elbowed. Furrows are not so deep as in Apion. Abdomen elongate and with hairs. Rostrum and head together is as long as the remaining body (Fig.19).

They eat away portions of the leaf creating holes on the surface.

15. Astycus aurovittatus Heller (Curculionidae : Coleoptera)

A weevil with 7 to 10 mm length and 3 to 5 mm width. Eyes lateral, rostrum deflected and longer than head. Antennae inserted before the middle of the rostrum, the scape reaching about the middle of the eye. Legs with the front pair rather longer and distinctly stouter than the others. Each elytron with two broad lateral green stripes enclosing a narrower black stripe. The sides of the prothorax are less narrowed behind and therefore less strongly rounded. The apical fringe of the elytra is shorter (Fig.20).

The weevil was present in numbers in the Wadakkanchery area during December 1982 and found feeding the foliage of the weed.

16. Amblyrhinus sp. (Curculionidae : Coleoptera)

A small brown weevil with light green markings on the sides of the body. Antennae geniculate. Prothorax

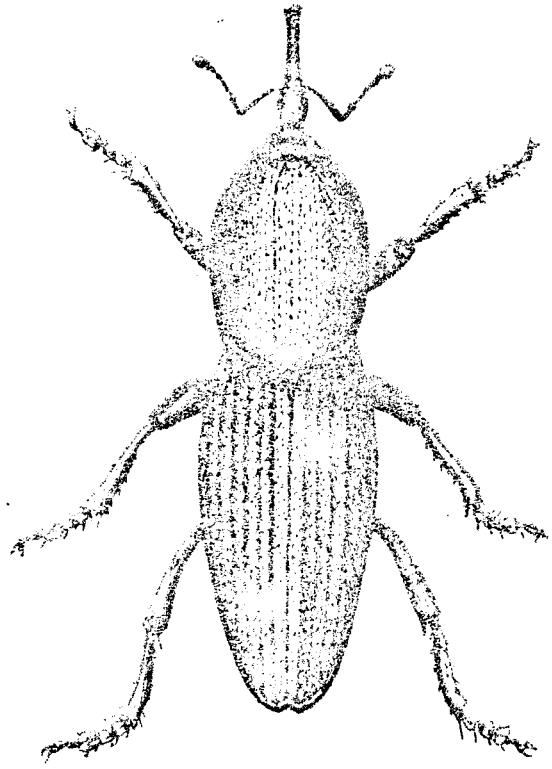


Fig. 19. Unidentified curculionid

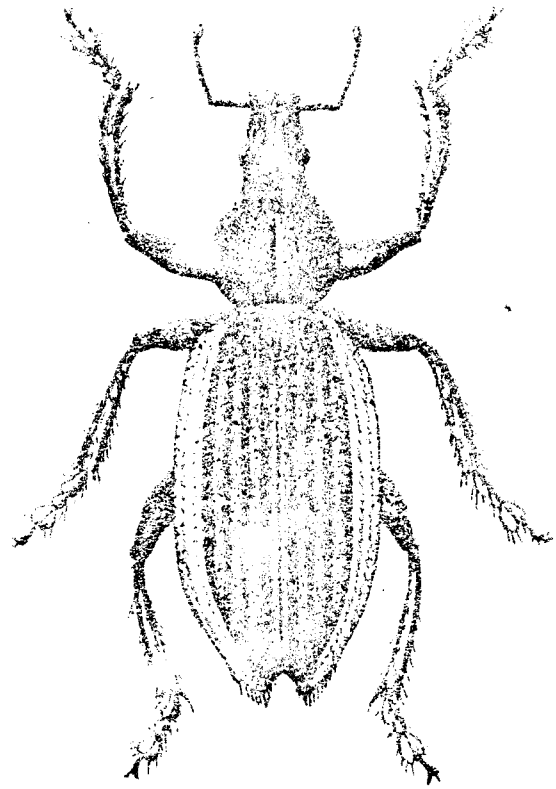


Fig. 20. *Sotyeus aurovittatus*

little longer than broad and longer than the head. Elytra ovate. Legs slender. Femora flattened. Tibiae straight and simple. Total length 4 to 5 mm and width 2 mm (Fig.21).

This was very common in Wadakkanchery area in the months of October-November 1979. They feed on the leaves and flowers by cutting small holes on them.

17. Mylabris sp. (Meloidae : Coleoptera)

Beetles are medium sized, 1.25 to 2 cm long. Body blackish. Conspicuous red lines on the elytra. The head is hypognathous and is joined to the prothorax by a distinct neck (Fig.22).

These feed on the weed flowers occasionally.

18. Corynodes sp. (Chrysomelidae : Coleoptera)

Adult beetles are dark violaceous or purplish. Body is subcylindrical, sides nearly straight and very slightly narrowed at the apex. Dorsal side as well as the legs are bluish green. Body length about 5 to 6 mm (Fig.23).

These beetles feed on the leaves making irregular holes here and there and were present only at Vellanikkara Village in few numbers.

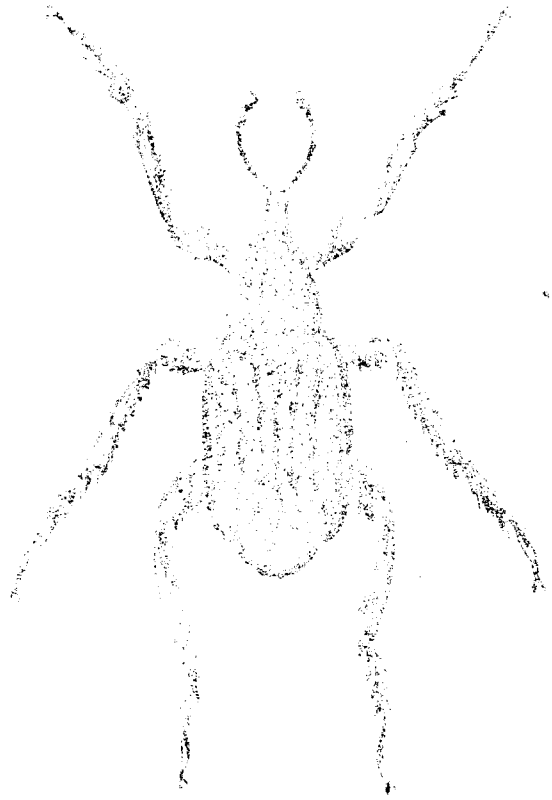


Fig. 21 - *Amblyrhinus* sp

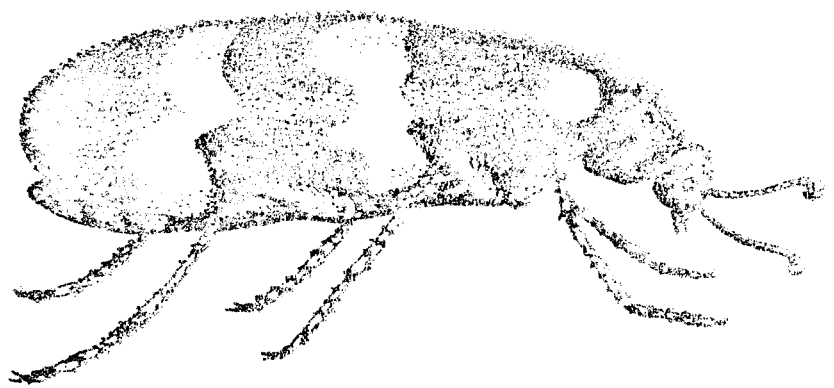


Fig. 23. *Mylabris* sp.

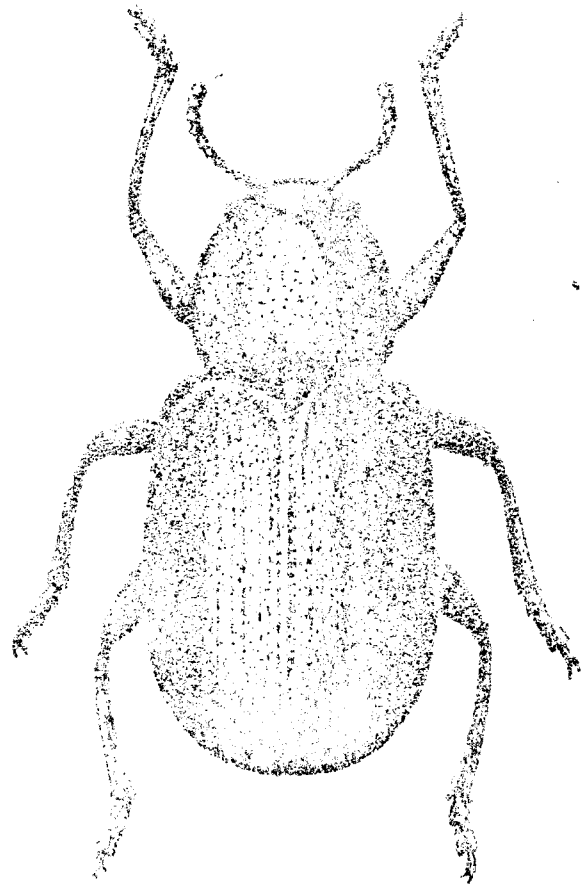


Fig. 23 - Coxynotus sp.

19. Caryedon sp. (Bruchidae : Coleoptera)

These dull brownish beetles are stout bodied and are 4 to 6 mm in length. Head constricted behind the eyes; eyes bulging, hardly emarginate in front and frons carinate. Elytra are short striated and do not cover the tip of abdomen. Hind tibia strongly curved, its inner apical angle produced into a long process. The tarsi are five segmented ending in claws hooked at base (Fig.24).

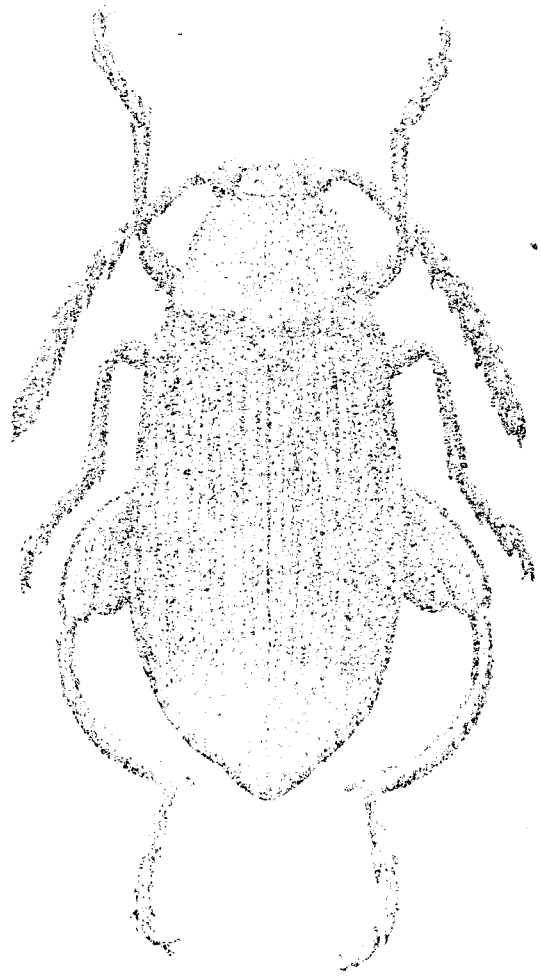
These beetles were found feeding on the flowers occasionally.

20. Pericallia ricini Fb. (Arctiidae : Lepidoptera)

The moth is stout with a body length of 1.6 cm and wing span of 5.1 cm. The forewings are fuscous brown with pale ringed dark spots. The hind wings are crimson with four bands including a marginal band of black blotches. The abdomen is crimson with black bands (Fig.25).

The young larvae feed on the surface tissue of young leaves and in the later instars they feed both by scrapping and by devouring the whole tissue. These were collected only from one location in Vellanikkara during June-July 1982.

Fig. 24. Cetyadon sp.



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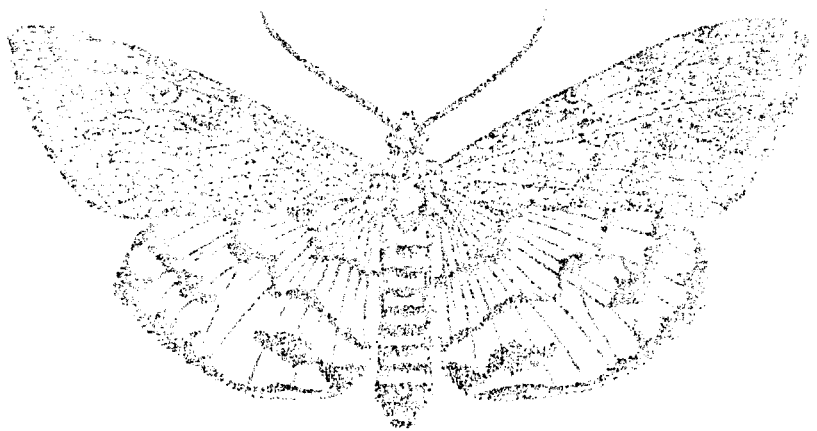


Fig. 25 - *Pericallia ricini*

21. Diacrisia obliqua Wlk. (Arctiidae : Lepidoptera)

Medium sized insect, yellowish in colour with black spots and bands on the wings. Larvae found defoliating the weed in Peechi area during November-December 1982 and pupate in boat shaped cocoons. Totally the life-cycle occupied about four to five weeks (Fig.26).

22. An unidentified agromyzid (Agromyzidae : Diptera)

Very minute fly, blackish, wings are hyaline (Fig.27).

The larvae mine into the leaves and eat through the mesophyll leaving the two epidermal layers intact. It pupates in the larval mine and puparium is long, oval and pale red in colour. These were collected only from Vellanikkara area.

23. Haplothrips gowdeyi Franklin (Phaeothripidae :Thysanoptera)

Small, dark brown slender bodied insects. Antennae six to eight segmented. Head with a pair of small compound eyes. Wings membraneous, very narrow and fringed with long setae. The abdomen long tapering posteriorly and composed of 11 segments. Length 2 mm (Fig.28).

Both nymphs and adults feed by lacerating the tissues of the inflorescence and found in numbers.

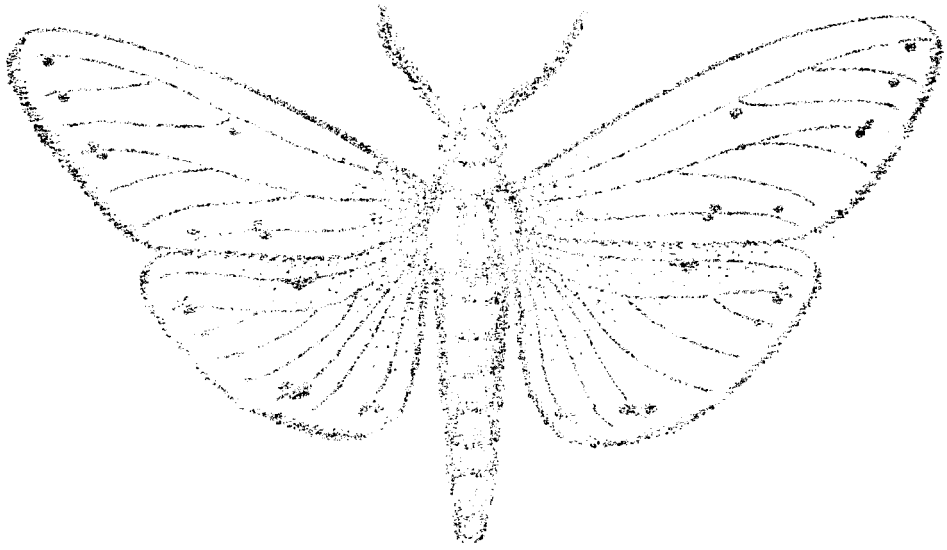
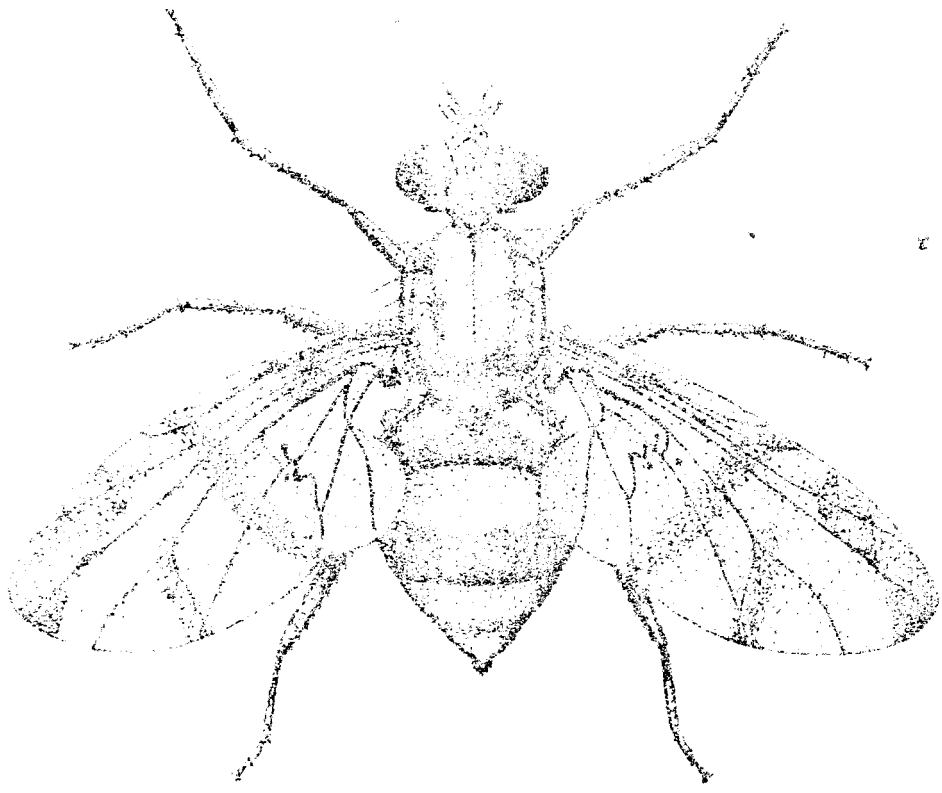


Fig. 26. Diacrisia Virgula



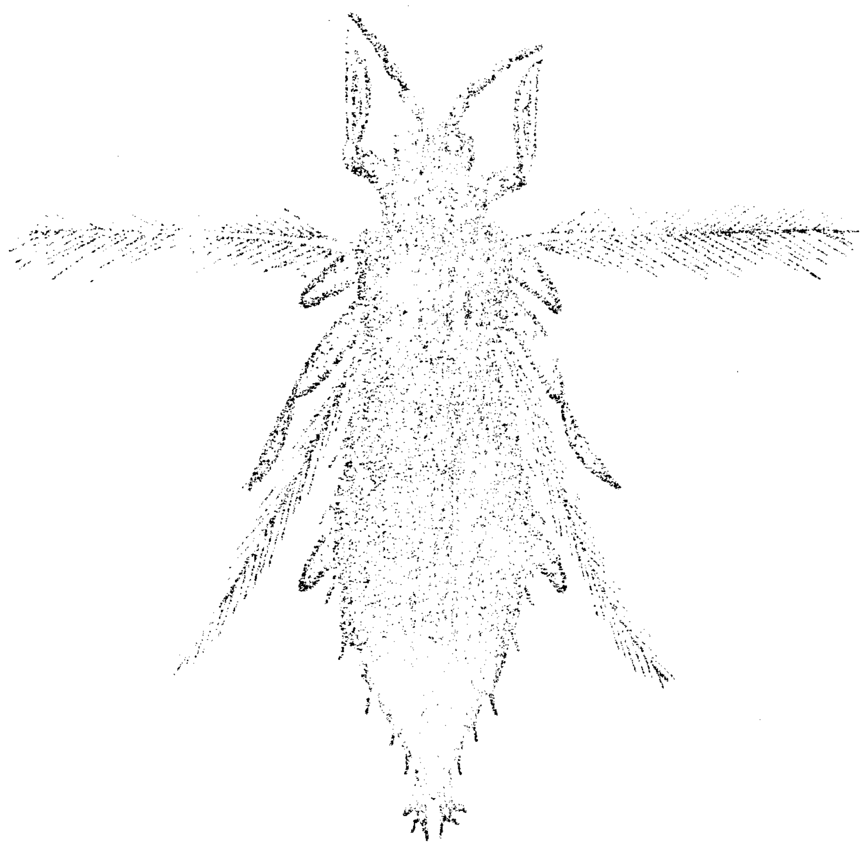


Fig. 26. *Haplothrips gowdeyi*

DISCUSSION

DISCUSSION

A detailed survey of the pests associated with C. odorata was conducted in the Trichur District from November 1980 to October 1981. In addition to this, an objective survey was carried out in five other selected districts of the Kerala State. The insect pests occurring on C. odorata in different localities were recorded. Studies on the biology and seasonal fluctuations of the different species of pests were attempted. The results obtained in the studies are discussed below.

1. Aphis spiraecola

Morphological studies showed that the antennal characters were most useful in separating the instars. Antennal length was maximum in adult (0.753 mm) followed by fourth (0.580 mm), third (0.492 mm), second (0.368 mm) and first (0.287 mm) instars. Statistical analysis showed that the difference in antennal length was significantly different in various instars. Number of antennal segments was another important character used for distinguishing certain of the instars. A nymph of first instar possess four segmented antenna, while the second,

third or fourth instars have five segmented antennae. The adults usually have six antennal segments. According to Eastop and van Emden (1972), the number of segments in the antenna of aphids is four or five in the first instar, five in second instar five or six in third instar and six in fourth instar and adult.

Other characters that were used in separating the different stages were body length, body width, cornicle length and colour and caudal length. The difference in body length between first and second instar, second and third instar, fourth instar and adult were found to be insignificant. Cornicle length was found to be significantly different in third (0.068 mm), fourth (0.113 mm) and adult (0.161 mm) stages. Besides, the cornicle was much darker and cauda was more prominent in the later instars. The first instar cauda was not distinct, but it was about 0.10 mm to 0.16 mm long in the adult.

In the alate forms, the wing buds were well developed in the fourth instar and usually the fore wing buds were found overlapping the hind wing buds.

1.1. Population density of A. spiraecola (apterous) per plant

The population density was relatively higher under partially shaded condition in medium hilly areas

(190.324). Contrary to the above, a higher population was seen under direct sunlight condition (141.158) than partially shaded condition in the plains.

Out of four villages surveyed in medium hilly areas, a maximum aphid population was in Pananchery Village (194.915) and the minimum was in Parlikkad (166.651). In plains Chazhur Village (144.130) the population was relatively higher than all other villages. But there was no significant difference between the villages in the medium hilly areas and in the plains with regard to the aphid population.

Further, in medium hilly areas the month of July (1300.690) recorded a significantly higher population followed by June (720.621), August (672.710) and September (528.180). During December, January, February, March and April the population count was very low. The same was the case in plains too with a maximum aphid population in July (708.69) followed by June (706.030), August (657.440) and September (503.450). Eventhough a relatively higher aphid population was noticed in medium hilly areas than in plains, this difference was not found to be significant.

1.2. Population density of *A. spiraecola* (alate) per plant

Compared to apterous form, these were few in number. In medium hilly areas maximum population was noted in Puthur Village (3.448) followed by Parlikkad, Pananchery and Vellanikkara. A higher population was recorded in Engandiyoor (2.367) in plains than all other villages surveyed. No significant difference was noticed in the aphid population between the villages of both the plains and medium hilly areas.

In medium hilly areas, alate forms were higher under partially shaded conditions (3.012) than in exposed conditions (2.007). But in plains the alate forms were more under exposed condition (1.759) than partially shaded condition (1.465). The difference between the two conditions in various topographies was not, however, significant.

In both medium hilly areas (14.016) as well as plains (8.431) the alate form was significantly higher in count during July than all other months. During October, November, December, January, February, March and April these aphids were practically nil in both the topographies.

As a result of attack of the aphid, the vigour of the plant was considerably reduced and in severe cases the plant became stunted, thereby curtailing seed production considerably. Thus a partial failure of the weed in competition with the other weeds of the plains was observed.

A. spiraecola has a wide host range like Ageratum conyzoides, Amaranthus viridis, Bougainvillaea sp , Capsicum annum, Chenopodium album, Citrus aurantifolium, Colocasia antiquorum, Cosmos sp., Cucumis sativa, Cucurbita maxima, Dahlia sp., Gardenia sp., Heliotropium indicum, Hibiscus rosasinensis, Lycopersicum esculentum, Prunus domestica, Pyrus sp., Pyrus communis, Raphanus sativus, Solonum melongena, S. nigrum, Vicia faba and Zinnia elegans.

2. Aphis fabae

These aphids were present on the weed in all the villages both under direct sunlight and partially shaded conditions from May to October.

Statistical analysis showed that in medium hilly areas maximum population was in Puthur Village (7.803)

and in plains it was in Chashur Village (6.274). In medium hilly areas A. fabae was maximum under partially shaded condition (9.266) and in plains in direct sunlight condition (5.713. The maximum populations occurred in July (59.820) followed by June (25.430), August (19.912), September (16.481) and October (12.418) in medium hilly areas. In plains, July and August recorded the maximum levels of population (25.041) followed by June (19.349) and September (18.141). In both cases maximum population was in July. The favourable climatic conditions and tender stage of weed growth may perhaps be the factors that led to rapid multiplication of the aphid during that period.

The aphid-attacked leaves presented a crinkled appearance of leaves and the crinkling was often less intense than that caused by A. spiraecola. However, only a relatively few plants were seen affected by these aphids and in some cases, both the species of aphids were found existing together in the same plant.

Host plants of A. fabae includes Beans, Sugarbeat, Dock, Poppies, Euonymus spp., Viburnum spp., Alternanthera philoxeroides, Cestrum sp. Mirabilis sp. Solanum nigrum, Vicia faba etc.

In general, maximum population was recorded in July followed by June, August, September and October. Dayakar Yadav et al. (1981) recorded high population of Toxoptera odinae during the months of August and September in India. According to van Emden (1972) light, wind, precipitation, air humidity and air temperature are the important conditions which regulate the population density of aphids. The number of A. spiraecola taken in traps were correlated with rainfall two weeks before trapping (Wijs, 1974). This clearly indicates that aphids survive better in moist climatic condition with low temperature. The stage of the weed is also an important factor regulating the abundance of aphids. From June to October Chromolaena produces new flushes and so also the higher aphid population in that period. A high population of Toxoptera odinae was found on the new flushes of C. odorata in India (Dayakar Yadav et al., 1981).

From November onwards, the weed starts flowering and the aphid population decreased considerably during November, December, January, February, March and April due to lack of favourable food material and adverse climatic conditions like high temperature.

Besides various predatory coccinellids like Menochilus sexmaculata, Stethorus sp., Scymnus sp. and syrphids like Paragus serratus were found preying on A.spiraecola and these appeared to play an important role in checking the aphid population. Even then, there was no positive correlation between the predatory population and aphid population.

1.2.1. Correlation studies of aphids and its predators

The correlation coefficient between the population of aphids and population of coccinellids was found to be 0.185. This was slightly lesser than the critical value 0.195. It seems that there is some positive relationship between population of aphids and population of coccinellids. Non-significance of correlation coefficient may be due to smallness of the observed sample. Correlation coefficient between aphids and syrphids was 0.052 which was too low to be given any importance.

1.2.2. Intensity of aphid attack per plant

Intensity of aphid attack was maximum at Pananchery Village (1.256) in medium hilly areas and

in the Engandiyoor Village (1.045) in the plains. When different conditions were compared, high intensity of attack was under partially shaded condition in medium hilly areas (1.149) and it was under direct sunlight condition in plains (1.016). In both plains (2.952) and medium hilly areas (2.877) maximum attack was in July. From the results obtained it could be seen that the maximum intensity of infestation by A. spiraecola and A. fabae was 2.952. This level of infestation is too low to achieve the desired level of control of the weed.

On account of the polyphagous nature and very low infestation levels of the two species of aphids namely, A. spiraecola and A. fabae, these cannot be considered as potential agents for the bio-control of Chromolaena.

3. Brachycaudus helichrysi

These aphids are pale yellowish in colour and were noted in Idukki and Wynad areas of Kerala. It was totally absent in the plains. The aphid may be adapted to the cooler climatic conditions of the hilly tracts and as such the candidate is unsuitable for any biological control work in the plains.

The attacked plants presents a wilted appearance and the leaves become folded and rolled longitudinally, as against the crinkling caused by A. spiraecola. Often the whole plants exhibited the symptoms, whereas a number of leaves may be left unaffected when infested by A. spiraecola or A.fabae.

Alternate host plants of B. helichryfi are Anaphilis sp., Calamintha sp., Chenopodium sp., Nicotiana tabacum, Prunus triflora, P. armeniaca, P. persiaca, Pyrus domestica etc. Since the host range include plants of economic importance the insect cannot be considered as a bio-control agent of promise.

4. Coptosoma sp.

These bugs were collected from all the areas surveyed and were present mostly on the tender parts of the weed. Adults sucked sap from the weed without causing any serious damage to the weed and so the bug is ineffective to check the growth of the weed.

It is a notorious pest of pulses and other plantation crops like Cashew and Mango. It has also reported on avenue trees like Pongamia glabra, medicinal

plants like Rauvolfia serpentina and green manure plants like Sesbania grandiflora. Since Coptosoma is a serious pest of many economically important plants it cannot be considered as a biological control agent.

The record of Coptosoma sp. on C. odorata is reported for the first time.

5. Sepontia nigrofusca

The infestation by this was observed in the Pananchery Village during November-December. These were found resting on the under surface of the leaves and incurring negligible damage to the plant. However, it has not been recorded as a pest of economic plants in Kerala.

6. Tettigella ceylonica

These jassids were noted at Pananchery and Vellanikkara Villages in medium hilly areas. These appeared only as casual feeders of C. odorata and their population was extremely low for effecting any appreciable damage on the weed.

Bala Subramanyam (1981) recorded nymphs and adults of T. ceylonica as feeding on tender leaves and

inflorescence of cashew in Kerala. Hence the release of the jassid for bio-control cannot be recommended in view of the risk to the cashew plantations.

7. Bemisia tabaci

The incidence of the pest was noted in the tender stage of the plant and the population count was too low to cause perceivable damage. van der Laan (1940) observed B. tabaci as a common pest of C. odorata in Sumathra. According to him C. odorata was a reservoir of virus and these flies act as a carrier of it.

There are many host plants for B. tabaci and the important ones are Gossypium sp., Nicotiana tabacum, Solanum nigrum, S. melongena, S. tuberosum, Pisum sativum, Manihot utilissima, Capsicum frutescens, Ipomoea sp., Coriandrum sativum, Zinnia elegans, Phyllanthus sp., Momordica charantia, Cucumis sativus, C. pubescens, C. melo, Lagenaria vulgaris, Citrullus vulgaris, Brassica oleracea, B. rapa, B. compestris, Raphanus sativus, Sida cordifolia and Cleome viscosa. The wide host range of B. tabaci hinders its field release as the biological control agent.

8. Leptocorisa acuta

During the present survey this insect was noted

at Puzhakkal Village during September-October and at Vellanikkara during December. This may be an occasional feeder of C. odorata and has not brought any commentable destruction to the weed.

The important host plants of L. acuta are Oryza sativa, Panicum crusgalli, P. colonum, P. flavidum, P. miliare, Sorghum vulgare, Digitaria consanguinalis, Eleusine coracana, Setaria italica, S. glauca, Cyperus rotundus, C. pdystachys, Paspalum dilatatum, Pennisetum, typhoideum, Saccharum officinarum and Myristica fragrans. Since these are all economically important plants, the question of considering the insect for bio-control work does not arise.

9. Riptortus pedestris

Collected from Puthur and Chazhur Villages during November-December. Eventhough the bugs were found sucking sap from the weed, they were found to be very few in number to check the growth of the weed.

Moreover the bug is a serious pest of pulses and cardomom and causes heavy damage to the crops.

10. Dysdercus koenigii

These bugs were observed at Urakom Village during August, at Vellanikkara during September-October and at Parlikkad during August. Jalamkar et al. (1974) recorded D. koenigii on C. odorata in Maharashtra and Prabhu and John (1975) observed the feeding activity of the same insect on Chromolaena in Kerala.

It attacks Cotton, Abelmoschus esculentus, Zea mays, Pennisetum typhoideum, Hibiscus cannabinus, Solanum verbacifolium etc. and so the release of it for the control of the weed has to be prevented.

11. Leptocentrus sp.

These were collected from all villages surveyed and noted at Malappuram and Idukki Districts of Kerala. The low population count accomplished any obvious ruin on the weed by feeding.

Leptocentrus sp. was found feeding on many other economically important plants like Citrus, Ber, Tamarind, Sorghum, Sugarcane, Cotton, Redgram, Pea, Mango, Sunflower, Rose etc. and its wide host range seems to be a disadvantage in selecting it as a natural enemy for the biological control of the weed.

12. Coccosterphus minutus

This seemed to be very common in Trichur, Malappuram, Idukki, Kottayam and Ernakulam Districts. The damage inflicted by this insect was found to be negligible.

Since it is not a serious pest of any of the economic plants, it may be considered as a possible agent for the bio-control of the weed.

Previous records of cowbugs on Eupatorium sp. include Entylia bactriana, E. carinata and Tomaspis rubra. However, during the present survey they were not observed on C. odorata.

13. Apion sp.

Apion seemed to be a pest of C. odorata at Vellanikkara, Puzhakkal, Pananchery and Parlikkad areas and this was present in all the stages of the weed except in the senescence stage. Feeding cause small holes on the leaves and flowers of the weed but the overall damage is negligible.

According to Sugathan (1979) A. brunneonigrum is a promising pest for the biological control of C. odorata

in India. Cruttwell (1970), Schroder (1970) and Ivens (1974) also recommended this seed eating beetle as a good biological control agent of C. odorata. However, the Apion sp. reported above is distinctly different from A. brunnescnigrum and hence requires further study to prove its effectiveness against Chromolaena.

14. Astycus aurovittatus

The weevil was present in Wadakkanchery area and this was found feeding the foliage of the weed, but not to any appreciable extent.

Since A. aurovittatus has not recorded as a serious pest of any of the economic plants, that may considered as a candidate for bio-control of the weed.

15. Amblyrrhinus sp.

The weevil was very common in Wadakkanchery area during October-November causing minor damage to the plant. This has so far not been recorded as a pest of economic plants in Kerala. Further studies are required to evaluate the potential of this insect for bio-control of the weed.

16. Mylabris sp.

This was collected from Vellanikkara during January and found feeding on the flowers of the weed. There is no previous record of Mylabris sp. on Chromolaena.

Mylabris was recorded as a flower feeder of Groundnut, Bhendi, Cucurbits, Cowpea, Redgram and Blackgram and hence its release as a biological control agent of C. odorata in Kerala cannot be recommended.

17. Corynodes sp.

These beetles were collected from Vellanikkara during November-December and they were found feeding on the leaves making scattered irregular holes. This was found feeding voraciously on Hemedesmus indicus which was seen commonly in between Chromolaena. Being a minor pest, its use for bio-control work is doubtful.

18. Carvedon sp.

This was observed during December-January at Vellanikkara Village and found feeding on the flowers.

The host range of Carvedon sp. include Tamarindus indica, Cassia fistula, C. tora, C. occidentalis, Albizzia

lebbek, Acacia arabica, A. pennata and Chrysanthemum c.ineriaefolium. The insect cannot therefore, be considered as a biological control agent of C. odorata in Kerala.

19. Pericallia ricini

The larvae of P. ricini collected from Vellanikkara during June-July were found feeding on the leaves of C. odorata. It cannot be considered as a bio-control agent for the control of C. odorata due to its polyphagous nature.

20. Diacrisia obliqua

Previous records of arctiids on C. odorata include Pareuchaetes pseudoinsulata, Amsalo arravaca and Estigmene acraea. However, any of these insects was not observed on Chromolaena during the present survey.

21. Haplothrips gowdeyi

Adults and nymphs found feeding on the inflorescence without cau ing any serious damage to check the growth of the weed. This insect is reported to has a wide host range including Bhendi, Hollyhocks, Pennisetum typhoideum, Zea mays etc. This cannot therefore, be considered as a bio-control agent.

SUMMARY

SUMMARY

A survey was conducted in the Trichur, Palghat, Malappuram, Ernakulam, Idukki and Kottayam districts of the Kerala State during November 1980 to October 1981 to study the phytophagous insects associated with *Chromolaena odorata* L. and to ascertain the scope of using some of the promising ones for bio-control. In the Trichur District, the area was demarcated into medium hilly areas and plains and sampling was conducted once in every month. In the other districts a rapid random survey was conducted. Altogether the following 23 species of insects were recorded on the weed.

1. Hemipteran pests

1.1. *Aphis spiraecola* Patch

Alate and apterous forms of these aphids were noted in all the areas surveyed. Studies on their biology showed that there are four instars, each occupying for about one to two days. The adult life span is about 6 to 10 days.

The maximum number of apterous form was recorded in Pananchery Village of medium hilly area (194.915 per plant). In the plains the maximum number was found in Engandiyoor Village (112.316 per plant). The population level was at its peak during July in medium hilly areas (1300.690per plant) and in the plains (708.690 per plant). During December, January, February, March and April the populations remained at very low levels.

The alate form occurred at relatively low levels. In medium hilly areas, maximum population was noted in Puthur Village (3.448 per plant) while in the plains, this was in Engndiyoor (2.367 per plant). In both medium hilly areas (4.016 per plant) and plains (8.431 per plant) the alate form was significantly higher in population during July.

Both the nymphs and adults suck sap from the tender shoots thereby reducing the vigour of the plant often leading to stunting of the plants.

1.2. Aphis fabae Scopoli

In medium hilly areas, maximum population was detected in Puthur area (7.803 per plant) and in plains

in Chazhoor (6.274 per plant). The population attained peak level in July both in medium hilly areas (25.420 per plant) and plains (25.041 per plant). The leaves infested by A. fabae presented a crinkled appearance. The feeding habits of A. fabae are similar to A. spiraecola.

1.3. Brachycaudus helichrysi Kltb.

These were noted in Idukki and Wynad at higher elevation areas and these were totally absent in the plains. The aphid attacked leaves showed wilting and the leaves become folded and rolled longitudinally.

1.4. Coptosoma sp.

These bugs were observed in all the surveyed areas and were detected mostly on the tender parts of the weed. Adults suck sap from the weed without causing any serious damage.

1.5. Sepontia nigrofusca Dist.

These were found in the Pananchery Village during November-December causing negligible damage to Chromolaena.

1.6. Tettigella ceylonica Melich.

Noted at Pananchery and Vellanikkara Villages. These appeared only as casual feeders of C. odorata and their populations were extremely low for affecting any appreciable damage to the weed.

1.7. Bemisia tabaci Gen.

The adults suck sap from tender parts of the plant and the population level was very low.

1.8. Leptocorisa acuta Thunb.

The adults as well as the nymphs suck sap from the tender parts of the plant. These were found in the Puzhakkal Village.

1.9. Riptortus pedestris Fb.

The adults suck sap from tender shoots and were found in few number in Vellanikkara Village.

1.10. Dysdercus koenigii Fb.

The adults suck sap from tender shoots and the population count was very low.

1.11. Leptocentrus sp.

These bugs suck sap from the plant throughout the growth phase of the weed but the population count was low to cause any appreciable damage.

1.12. Coccosterphus minutus Fabricius

These insects were present in all the villages surveyed and found sucking sap from the tender parts of the weed.

2. Coleopteran pests

2.1. Apion sp.

Adults of Apion sp. was common at Vellanikkara, Puzhakkal, Pananchery and Parlikkad areas and were found feeding on the tender leaves and flowers of the weed.

2.2. Unidentified curculionid

The curculionid was present at Vellanikkara Village and it eats away portions of the leaf creating holes on the surface.

2.3. Astycus aurovittatus Heller

The weevil was present in low population levels in Wadakkanchery area during December 1982 and these

were found feeding the foliage of the weed.

2.4. Amblyrrhinus sp.

This was quite common in the Wadakkanchery area in the months of October and November 1979. They feed on the leaves and flowers by cutting small holes on them.

2.5. Mylabris sp.

These beetles were found feeding occasionally on the weed flowers in the Vellanikkara Village.

2.6. Corynodes sp.

The chrysomelid feed on the leaves making irregular holes and was present only in Vellanikkara area.

2.7. Carvedon sp.

The beetles found feeding on the flowers occasionally.

3. Lepidopteran pests

3.1. Pericallia ricini Fb.

The young larvae feed on the surface tissue of tender leaves and in the later instars the caterpillars

feed both by scrapping and by eating the entire foliage. These were collected only from Vellanikkara area.

3.2. Diacrisia obliqua Wlk.

Larvae were found defoliating the weed in Peechi area during November-December.

4. Dipteran pest

4.1. Unidentified agromyzid

The larvae mine into the leaves and eat through the mesophyll leaving the two epidermal layers intact. These were collected only from Vellanikkara area.

5. Thysanopteran pest

5.1. Haplothrips gowdeyi Franklin

Both nymphs and adults feed by lacerating the tissues of the inflorescence. These were found in numbers in all the areas surveyed.

Out of 23 species of insects recorded to occur on C. odorata Coptosoma sp. (Plataspididae : Hemiptera), Sepontia nigrofusca (Plataspididae : Hemiptera) Tettigella ceylonica (Cicadellidae : Hemiptera), Leptocorisa acuta (Coreidae : Hemiptera), Riptortus pedestris (Coreidae :

Hemiptera), *Leptocentrus* sp. (Membracidae : Hemiptera) *Coccosterphus minutus* (Membracidae : Hemiptera), *Astycus aurovittatus* (Curculionidae : Coleoptera), *Amblyrrhinus* sp. (Curculionidae : Coleoptera), *Mylabris* sp. (Meloidae : Coleoptera), *Corynodes* sp. (Chrysomelidae : Coleoptera), Caryedon sp. (Bruchidae : Coleoptera), *Pericallia ricini* (Arctiidae : Lepidoptera), *Diacrisia obliqua* (Arctiidae : Lepidoptera) and *Haplothrips gowdeyi* (Phloeothripidae : Thysanoptera) are reported for the first time. Among the insects, the most widespread and numerous were *A. spiraecola* and *A. fabae* in that order. But in view of the wide host range including cultivated crops of these two species, the scope of their utilisation in bio-control appears to be very limited. The other insects occurred sparsely causing negligible damage.

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* Originals not seen

APPENDICES

Appendix I

Analysis of variance table showing the length of body (in mm) of *A. spiraecola* in different instars

Source	SS	df	MS	F
Total		29		
Instars	2.375	4	0.594	31.260**
Error	0.468	25	0.019	

** Significant at one per cent level

Appendix II

Analysis of variance table showing the maximum width of body (in mm) of *Ae. spiraecola* in different instars

Source	SS	df	MS	F
Total		29		
Instars	0.752	4	0.188	31.330**
Error	0.157	25	0.006	-

** Significant at one per cent level

Appendix III

Analysis of variance table showing the length of cornicles of *A. spiraecola* in different instars

Source	SS	df	MS	F
Total		29		
Instars	0.067	4	0.170	42.50**
Error	0.010	25	0.0004	-

** Significant at one per cent level

Appendix IV

Analysis of variance table showing the antennal length of *A. spiraecola* in different instars

Source	SS	df	MS	F
Total		29		
Instars	0.800	4	0.200	66.670**
Error	0.079	25	0.003	-

** Significant at one per cent level

Appendix V

Analysis of variance table of *A. spiraecola* (apterous) population for seasonal fluctuations in medium hilly areas under different conditions

Source	SS	df	MS	F
Total		95		
Villages	18.018	3	6.006	0.243
Months	13193.426	11	1199.402	48.550**
Conditions	22.195	1	22.195	0.898
Months x conditions	116.693	11	10.608	0.429
Error	1704.604	69	24.704	1.00

** Significant at one per cent level

Appendix VI

Analysis of variance table of *A. spiraecola* (apterous) population for seasonal fluctuations in plains under different conditions

Source	SS	df	MS	F
Total		95		
Villages	25.979	3	8.660	0.523
Months	11713.383	11	1064.853	64.304**
Conditions	50.911	1	50.911	3.074
Months x conditions	313.036	11	28.458	1.718
Error	1142.621	69	16.5597	1.00

** Significant at one per cent level

Appendix VII

Analysis of variance table of *A. spiraecola* (alate) population for seasonal fluctuations in medium hilly areas under different conditions

Source	SS	df	MS	F
Total		95		
Villages	2.608	3	0.809	1.339
Months	72.930	11	6.630	10.211**
Conditions	1.728	1	1.728	2.661
Months x conditions	2.789	11	6.254	0.391
Error	44.862	69	0.649	1.00

** Significant at one per cent level

Appendix VIII

Analysis of variance table of *A. spiraecola* (alate) population for seasonal fluctuations in plains under different conditions

Source	SS	df	MS	F
Total		95		
Villages	1.561	3	0.520	1.161
Months	52.178	11	4.743	10.589**
Conditions	0.199	1	0.199	0.444
Months x conditions	4.516	11	0.411	0.916
Error	30.909	69	0.448	1.00

** Significant at one per cent level

Appendix IX

Analysis of variance table of *A. fabae* population for seasonal fluctuations in medium hilly areas under different conditions

Source	SS	df	MS	F
Total		95		
Villages	1.758	3	0.586	0.914
Months	435.330	11	39.576	61.731**
Conditions	0.153	1	0.153	0.238
Months x conditions	9.306	11	0.846	1.320
Error	44.236	69	0.641	1.00

** Significant at one per cent level

Appendix X

Analysis of variance table of *A. fabae* population for seasonal fluctuations in plains under different conditions

Source	SS	df	MS	F
Total		95		
Villages	2.546	3	0.849	0.923
Months	290.490	11	26.410	28.723**
Conditions	0.714	1	0.714	0.777
Months x conditions	6.468	11	0.588	0.639
Error	63.440	69	0.919	1.00

** Significant at one per cent level

Appendix XI

Analysis of variance table for seasonal fluctuations of intensity of attack of aphids in medium hilly areas under different conditions

Source	SS	df	MS	F
Total		95		
Villages	0.146	3	0.049	1.095
Months	8.937	11	0.816	18.415**
Conditions	0.088	1	0.876	1.978
Months x conditions	0.124	11	0.113	0.255
Error	3.050	69	0.044	1.00

** Significant at one per cent level

Appendix XII

Analysis of variance table for seasonal fluctuations of intensity of attack of aphids in plains under different conditions

Source	SS	df	MS	F
Total		95		
Villages	0.099	3	0.033	0.854
Months	9.028	11	0.821	21.289**
Conditions	0.715	1	0.072	1.855
Months x conditions	0.349	11	0.032	0.823
Error	2.659	69	0.039	1.00

** Significant at one per cent level

Appendix XIII

List of insects collected from *Chromolaena odorata* in Kerala

Scientific name	Family	Order
Aphis spiraecola Patch	Aphididae	Hemiptera
Aphis fabae Scopoli	Aphididae	Hemiptera
Brachycaudus helichrysi Kltb.	Aphididae	Hemiptera
Coptosoma sp.	Plataspididae	Hemiptera
Sepontia nigrofusca Dist.	Plataspididae	Hemiptera
Tettigella ceylonica Melich.	Cicadellidae	Hemiptera
Bemisia tabaci Gen.	Aleyrodidae	Hemiptera
Leptocorisa acuta Thunb.	Coreidae	Hemiptera
Riptortus pedestris Fb.	Coreidae	Hemiptera
Dysdercus koenigii Fb.	Pyrrhocoridae	Hemiptera
Leptocentrus sp.	Membracidae	Hemiptera
Coecosterphus minutus Fabricius	Membracidae	Hemiptera
Apion sp.	Apionidae	Coleoptera
Unidentified curculionid	Curculionidae	Coleoptera
Astycus aurovittatus Heller	Curculionidae	Coleoptera
Amblyrhinus sp.	Curculionidae	Coleoptera
Mylabris sp.	Meloidae	Coleoptera
Corynodes sp.	Chrysomelidae	Coleoptera
Caryedon sp.	Bruchidae	Coleoptera
Pericallia ricini Fb.	Arctiidae	Lepidoptera
Diacrisia obliqua Wlk.	Arctiidae	Lepidoptera
Unidentified agromyzid	Agromyzidae	Diptera
Haplothrips gowdeyi Franklin	Phloeothripidae	Thysanoptera

STUDIES ON THE PESTS OF *Chromolaena (Eupatorium odoratum)* IN KERALA

By

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ABSTRACT OF A THESIS

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ABSTRACT

A detailed survey was conducted in Trichur District and an objective survey in five other selected districts of the Kerala State during November 1980 to October 1981 to study the pests of Chromolaena odorata Linn. Observations on the nature of damage and population density have been made during the survey. Details of the insects recorded on the weed are given below.

1. Hemipteran pests

1.1. Aphis spiraecola Patch

These aphids were recorded in all the areas surveyed and alate and apterous forms were available. There are four instars each occupying one to two days and the adult six to ten days. The alate forms occurred at relatively lower levels compared to apterous form. In both cases, maximum population was in July irrespective of the topographic conditions. Both the nymphs and adults suck sap from the tender shoots thereby reducing the vigour of the plant.

1.2. *Aphis fabae* Scopoli

Both apterous and alate forms were observed. Here also the aphid population attained peak level in July both in medium hilly areas and plains. The aphid infested leaves presented a crinkled appearance.

1.3. *Brachycaudus helichrysi* Kltb.

These were noted in higher elevations like Idukki and Wynad areas and were absent in Trichur District. The aphid attacked leaves become folded and rolled longitudinally.

1.4. *Coptosoma* sp.

These bugs were observed throughout the growth phase of the weed. Adults suck sap from tender parts of the plant without causing any serious damage.

1.5. *Nezara nigrofusca* Dist.

These bugs suck sap from the weed causing negligible damage and were present in very few number at Pananchery Village.

1.6. *Tettigella ceylonica* Melich.

These appeared only as casual feeders of *C. odorata*

and their populations were extremely low for affecting any appreciable damage.

1.7. Remisia tabaci. Gen.

The adult suck sap from tender parts of the weed and the population level was very low.

1.8. Leptocorisa acuta Thumb.

These were found in the Puzhakkal Village and the bugs suck sap from the weed.

1.9. Riptortus pedestris Fb.

The adults suck sap from tender shoots and were found in few number.

1.10. Dysdercus koenigii Fb.

The adults suck sap from the weed without causing any appreciable damage.

1.11. Leptocentrus sp.

These bugs suck sap from the plant throughout the growth phase of the weed, but the population count was very low.

1.12. Coccosterphus minutus Fabricius

These insects were present in few numbers and suck sap from the weed.

2. Coleopteran pests

2.1. Apion sp.

As a result of feeding of the weevil irregular holes are formed on leaf surface. These feed on the flowers during the flowering season.

2.2. Unidentified curculionid

They eat away portions of the leaf creating holes on the surface.

2.3. Astycus aurovittatus Heller

The weevil was found feeding the foliage of the weed during December.

2.4. Amblyrrhinus sp.

They feed on the leaves and flowers by cutting small holes on them.

2.5. Mylabris sp.

These feed on the weed flowers occasionally.

2.6. Corynodes sp.

These beetles feed on the leaves making irregular holes here and there.

2.7. Carvedon sp.

These insects were found feeding on the flowers occasionally.

3. Lepidopteran pests

3.1. Pericallia ricini Fb.

The young larvae feed on the surface tissue of young leaves and in the later instars they feed both by scrapping and by eating the whole leaf lamina.

3.2. Diacrisia obliqua Wlk.

Larvae found defoliating the weed.

4. Dipteran pest

4.1. Unidentified agromyzid

The larvae mine into the leaves and eat through the mesophyll leaving the two epidermal layers intact.

5. Thysanopteran pest

5.1. Haplothrips gowdeyi Franklin

Both nymphs and adults feed by lacerating the tissues of the inflorescence and found in numbers.

Out of 23 species of insects recorded to occur on C. odorata Coptosoma sp. (Plataspididae : Hemiptera), Sepontia nigrofusca (Plataspididae : Hemiptera), Tettigella ceylonica (Cicadellidae : Hemiptera) Leptocorisa acuta (Coreidae : Hemiptera), Riptortus pedestris (Coreidae : Hemiptera), Leptocentrus sp. (Membracidae : Hemiptera) Coccosterphus minutus (Membracidae : Hemiptera), Astycus aurovittatus (Curculionidae : Coleoptera), Amblyrrhinus sp. (Curculionidae : Coleoptera), Mylabris sp. (Meloidae : Coleoptera), Corynodes sp. (Chrysomelidae : Coleoptera), Caryedon sp. (Bruchidae : Coleoptera), Periallia ricini (Arctiidae : Lepidoptera) Diacrisia obliqua (Arctiidae : Lepidoptera) and Haplothrips gowdeyi (Phloeothripidae : Thysanoptera) are reported for the first time. Among the insects, the most widespread and numerous were A. spiraecola and A. fabae in that order.