

# **Insect Pests of Arid Fruit Crops**

**(Practical Manual for Field Identification and Damage Symptoms)**



**Shravan M. Haldhar**  
**S.K. Sharma**  
**R. Bhargava**  
**R.S. Singh**  
**B.D. Sharma**  
**Dhurendra Singh**



**Central Institute for Arid Horticulture**  
**(Indian Council of Agricultural Research)**  
**Bikaner-334 006, Rajasthan**





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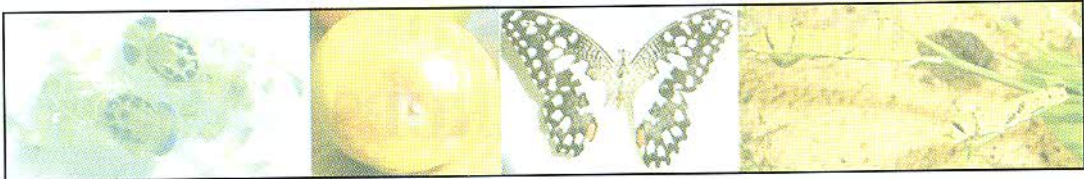
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Director  
Central Institute for Arid Horticulture  
Sri Ganga Nagar Highway,  
Beechwal Industrial Area P.O.  
BIKANER-334 006, Rajasthan  
Phone: 0151-2250960, 2250147  
Fax: 0151-2250145  
E-mail: [ciah@nic.in](mailto:ciah@nic.in)  
Website: [ciah.ernet.in](http://ciah.ernet.in)

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**and designing** Sh. P.P. Pareek  
Sh. M.K. Jain

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E-mail: [yugpress01@gmail.com](mailto:yugpress01@gmail.com), [yugpress@rediffmail.com](mailto:yugpress@rediffmail.com)



## PREFACE

Arid fruits are becoming popular for nutritional and health security point of view as they are excellent sources of minerals, vitamins, protein, antioxidants and photochemical. Among the arid fruit crops ber (*Ziziphus mauritiana*), date palm (*Phoenix dactylifera*), lasora (*Cordia myxa*), aonla (*Embllica officinalis*) and bael (*Aegle marmelos*) are the major crops which can be grown easily in hot arid ecosystem of the country. Date palm provides a wide range of essential nutrients, very good source of dietary potassium and energy. There are many reasons for low productivity of the arid fruits. Hot arid region are marked by abiotic limitations such as high temperature, high potential evapo-transpiration, low erratic rainfall, low soil fertility, poor quality of ground water, *etc.*, which lead to poor crop growth and yield. Apart from the climatic limitations, the biotic factors like pest and diseases are also one of the limiting factor for crop production in hot arid ecosystem.

A central problem is to identify and understand patterns of distribution and abundance of species of the insect pests. In this endeavour, useful information has been generated on identification, host and damage symptoms of the pest in different fruit crops at various research institutions and SAUs of the country. Earnest efforts have therefore, been made to compile information on identification, host and damage symptoms of pest in a systematic manner, grouped in different chapters and presented in the form of a bulletin entitled “**Insect-Pests of Arid Fruit Crops (Practical Manual for Field Identification and Damage Symptoms)**”. Correct identification of the insect, their damage and host preference is the prerequisites for effective pest control. This publication contains excellent colored photographs depicting salient identification characteristics of insect and their damage on plants under natural condition so as to update the knowledge of extension agencies and farmers with to the pests in the field.

The authors are grateful to Dr. S. Ayyappan, D. G., ICAR and Secretary, DARE and Dr. N. K. Krishna Kumar, D. D. G. (Hort.), ICAR, New Delhi for their constant inspiration, encouragement and valuable suggestion to bring out this publication. We are highly thankful to Dr. S. K. Sharma, Director, CIAH, Bikaner, who encouraged and provided valuable suggestions and ideas to improve the authenticity and quality of this bulletin.

It is hoped that this publication will be useful for research workers, extension personnel, teachers, students, planners and NGOs.

Place: Bikaner  
Date: 11.03.2013

  
Shравण M Haldhar





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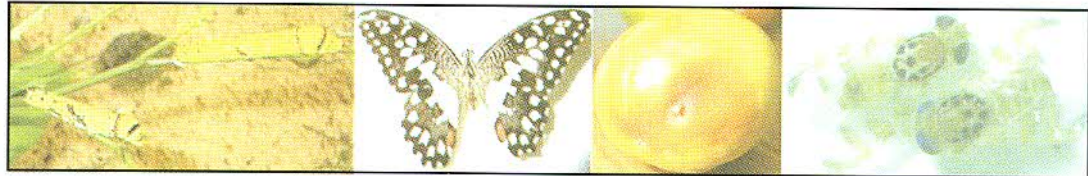
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## Chapter: 1

# INTRODUCTION

In India, nearly 3, 17,090 sq km area falls under arid region, of which 70, 300 sq km is classified as cold arid and remaining is under hot arid region. About 61% of total hot arid area lies in Rajasthan. Arid fruits are becoming popular for nutritional and health security as they are excellent sources of minerals, vitamins, antioxidants and photochemical. The fruit production of India during 2011-12 was 76.42mt from an area of 6.70mha and productivity was 11.4 t/ha.

Among the fruit crops ber (*Ziziphus mauritiana*), date palm (*Phoenix dactylifera*), lasoda (*Cordia myxa*), aonla (*Embllica officinalis*) and bael (*Aegle marmelos*) are the main crops of arid parts of the country. Date palm provides a wide range of essential nutrients, and is a very good source of dietary potassium. The sugar content of ripe dates is about 80%; the remainder consists of protein, fiber, and trace elements including boron, cobalt, copper, fluorine, magnesium, manganese, selenium, and zinc. Ber fruits contain 20 to 30% sugar, up to 2.5% protein and 12.8% carbohydrates. It is quite nutritious and rich in vitamin C. The aonla fruit is valued high among indigenous ayurvedic medicine for balanced diet and sound health. The fruit contains a chemical substance known as polyphenols which retards the oxidation of ascorbic acid. Aonla is a rich source of vitamin C (630 mg/100g fruit) next to Barbados cherry in fresh as well as dried form. The importance of bael lies in its curative properties, which make the tree one of the most useful medicinal plants of India. The main active ingredients in bael are marmelosin and psoralen. Bael fruit is rich source of riboflavin (1.19 mg/100g pulp). Since arid fruits play a vital role in balance diet as they supply all main components of human diet. Hence it is necessary to enhance the production and productivity of fruits to meet the demand of growing population to ensure nutritional security.

There are many reasons for low productivity of the arid fruits. Hot arid region are marked by abiotic limitations such as high temperature, high potential evapo-transpiration, low erratic rainfall, low soil fertility, poor quality of ground water, etc., which lead to poor crop growth and yield. Apart from the climatic limitations, the biotic factors like pest and diseases are also one of the limiting factor for crop



production in hot arid ecosystem. The major pest of this area fruit fly, stone weevil, fruit borers, aphids, thrips, lemon butter fly, scales and chaffer beetles are major constraints which causing the considerable economic loss and increasing the cost of fruit production of rain fed farmers. Ber fruit fly (*Carpomyia vesuviana*) is the most destructive pest of ber. It contributing towards low yield and poor quality of fruits and it caused yield loss up to 80% under severe infestation. The severe incidence of fruit weevil (*Aubeus himalayanus*) has been recorded in arid region that caused considerable damage to ber fruit on Gola (28.8 %) and Seb (51.8 %) from tree sample and Gola (74.10) & Seb (89.80) in fallen fruits during December. In date palm, the scales, *Parlatoria blanchardi* and lesser date moth, *Batrachedra amydraula* are an important insect pest of date palm infesting leaves and fruits. The incidence of scale insect was found 6.46 per cm<sup>2</sup> of leaves and incidence of lesser date moth was around 16 to 20 %. Therefore, the highest fruit damage was recorded in the varieties Medjool (16.01%) followed by Khalas (14.54%) and Nagal (13.78%), whereas, lowest fruit damage was recorded in the varieties Zagloul, Medini and Zahidi as 1.43, 1.51 and 2.30 per cent due to lesser date moth.



## Chapter: 2

# INSECT-PESTS OF FRUIT CROPS IN ARID REGION

## 2.1 Pests of ber crop

### 2.1.1 Ber fruit fly (*Carpomyia vesuviana*)

- This fruit fly is the most destructive pest of ber. It is the monophagous pest that infesting only on *Zizyphus* species growing under arid and semi arid region in India also in Oriental Asia, Middle East, temperate Asia, china and south Europe. It contributing towards low yield and poor quality of fruits and it is causing yield loss up to 80% under severe infestation.

### Host range

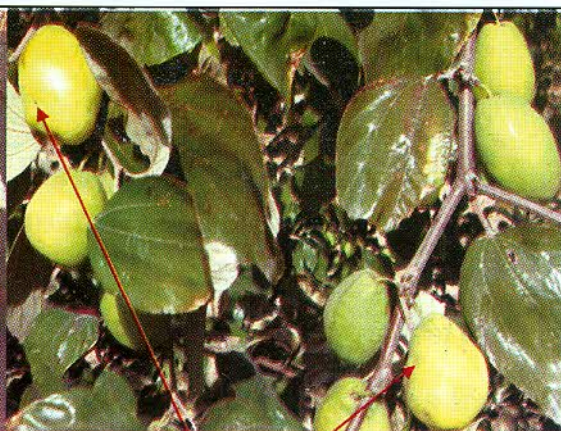
- Ber (*Zizyphus mauritiana*, *Z. numularia*, *Z. rotundifolia*)

### Nature of damage

- The maggots start infestation with the onset of fruit setting.



Maggot feeding inside the fruit



Damage symptoms of fruit fly

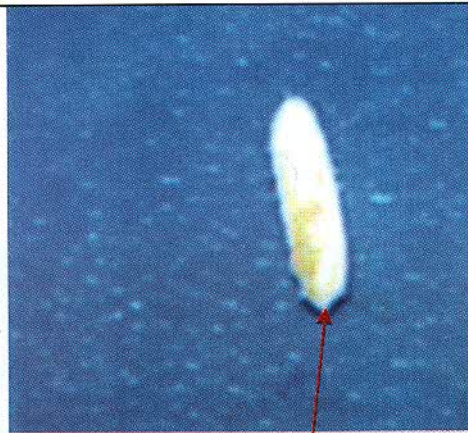




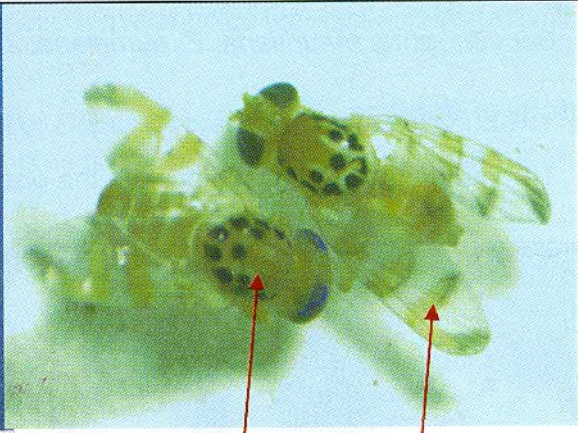
- The fly lays eggs singly in the young developing fruits after 2 to 5 days the newly hatched maggot's starts feeding on the pulp and make galleries with accumulated excreta and result in rotting of fruits.
- The larva is burrow in the flesh round the centre leaving excreta that give fruits a bitter taste.
- In arid region, the infestation starts from end of September and the higher incidence was during December-January.

### Description

- The fruit fly is easily distinguished in having distinctive pattern of black marks on the scutum and scutellum, and distinct yellow and brown bands on the wings.



**Maggot white tapering anteriorly**



**Distinctive pattern of black marks on scutellum, and distinct brown bands on wings**

- Two to three generations are completed from November to April.
- Eggs are laid in cavities made on the fruit with the ovipositor.
- The punctures appear as black spots in depression later on.



- Maggots bore into the pulp forming reddish brown galleries.
- The full grown maggot falls to ground to pupate in soil 5 to 7.5 cm deep for periods varying from 14 to 300 days depending upon the climate.

### 2.1.2 Ber stone weevil (*Aubeus himalayanus*)

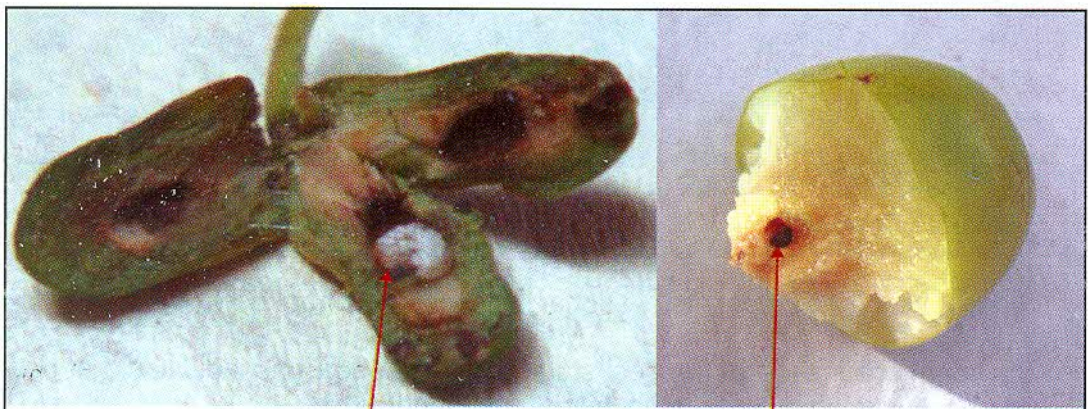
- Ber stone weevil, *Aubeus himalayanus* was recorded as a new pest of ber for the first time from Karnataka state of India in 1993. In addition, recently the severe incidence of fruit weevil has been recorded in the Experimental Farm of Central Institute for Arid Horticulture, Bikaner during 2008-2009.

#### Host range

- Ber

#### Nature of damage

- When such fruits were cut open, the developing seed was completely eaten away by the pest.
- In the hollowed area, each of these fruits had a grub, a pupa or an adult which was identified as ber seed weevil.



Early stage of fruit damage by stone weevil

Later stage of fruit damage by stone weevil

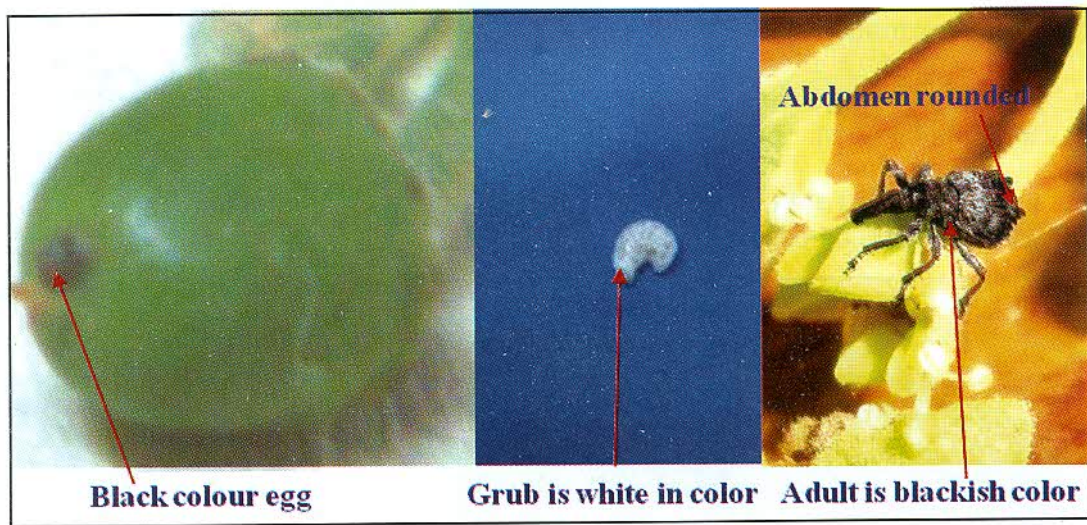




- The infested fruits were round in shape and varied in size ranging from pea to pebble.
- The fruits did not attain maturity and never increased in size more than pebble.

### Description

- Black colour egg laid marking in the stylar end of fruits.
- Mouth parts are converted in to snout.
- The grubs are white in color.
- The adult is blackish color with abdomen rounded.



- Since it was a new pest, its seasonal incidence was not known.
- Seasonal occurrence of the pest studied over two seasons indicated that only one peak was observed during July-August months.



### 2.1.3 Ber butter fly (*Tarucus theophrastus*)

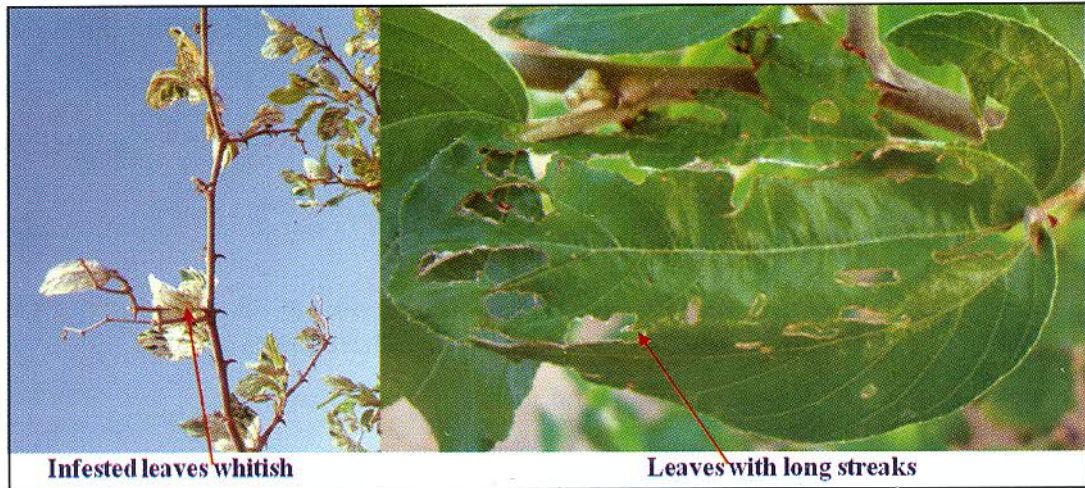
- It is found in Northern and Western Africa; Arabia; Persia; Baluchistan; N.W. Himalayas; the Punjab; Western, Central and Southern India; Ceylon; Assam; Upper Burma.

#### Host range

- Ber

#### Nature of damage

- The ber trees are always severely pruned during May-June and the newly sprouting tender shoots and leaves are attacked by ber butterfly.
- Due to its attack, the leaves dried up and tender shoots do not grow properly.
- Larvae feed on sprouting tender shoots, leaves and flower buds. Infested leaves gives whitish look due to chlorophyll feeding finally the leaves remain with long streaks.



Infested leaves whitish

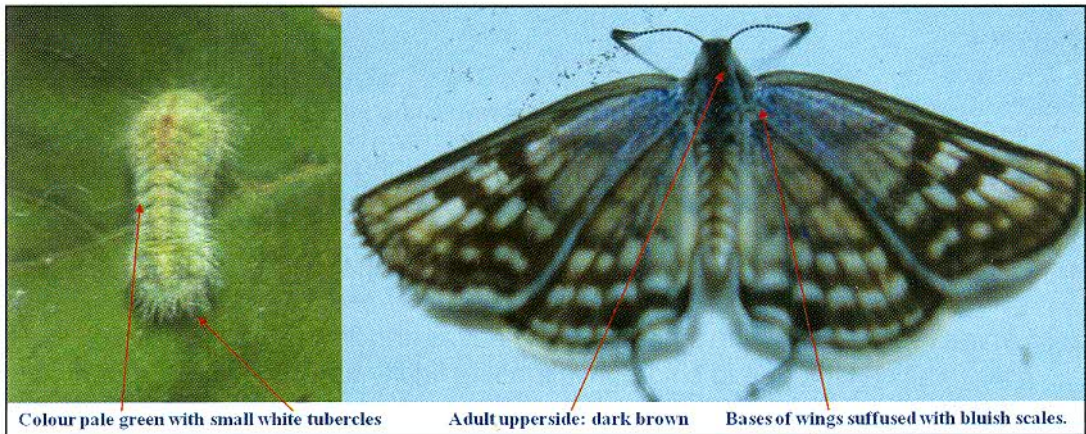
Leaves with long streaks





## Description

- Female upperside: dark brown; bases of the wings suffused with bluish scales.
- Fore wing: the transverse discocellular spot as in the 6 but continued posteriorly by a black spot in interspace 2 coalescent with a similar spot in interspace 1.



Colour pale green with small white tubercles

Adult upperside: dark brown

Bases of wings suffused with bluish scales.

- The larva just half an inch in length when full grown, much flattened, the head pale ochreous and completely hidden under the second segment.
- Colour pale green, the whole upper surface covered with a shagreening of small white tubercles.

### 2.1.4 Ber fruit borer (*Meridarchis scyroides*)

- It is distributed all over the country. It is not a major pest of Bikaner area but it is major in sirohi, Jalore , Badmer districts of Rajasthan and Gujarat.

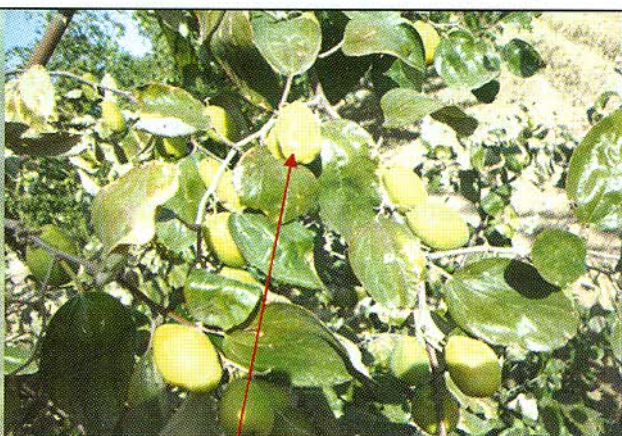
## Host

- It is a polyphagous pest like ber, aonla etc.



## Nature of damage

- The larva bores into the fruit feeding on the pulp and accumulating faecal frass within.
- Up to 40% of the fruits are damaged during July and August.



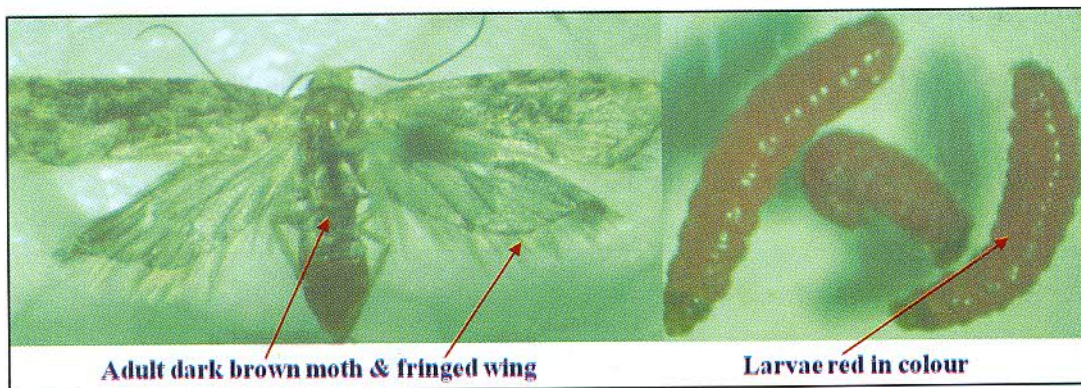
**Larvae feeding inside the fruit**

**Damage symptoms of fruit borer**

## Description

- Adult is a small dark brown moth. Eggs are laid on young fruits.
- Early instar larva is light yellowish and full-grown larva is red in colour.
- Pupation takes place in the soil.
- Adult emerges from the soil.





### 2.1.5 Bark eating caterpillar (*Indarbela quadrinotata*)

- It is found worldwide, in India that is found in Madras, Orissa, Bombay, Rajasthan, Gujarat *etc.*

#### Host range

- It is a polyphagous pests like ber, aonla, mango, citrus *etc.*

#### Nature of damage

- The freshly hatched larvae feed on the surface of tree trunks.
- Its make winding galleries of frassy web on the stem near the forks and angles of branches.
- When strong enough, they bore inside the trunks and move about inside the concealed silken gallery and feed on the bark by scraping which interrupts the translocation of cell sap adversely affecting growth and fruit setting capacity of the tree.
- Ribbon like or pipe like webbings on the stem near forks or angles of branches and the tree trunk is the clear indication of its damage.



- The caterpillar is hidden in the stem in the day-time and becomes active at night, eating the bark.
- Heavy infestation by this pest stunts the trees and adversely affects fruit yield.

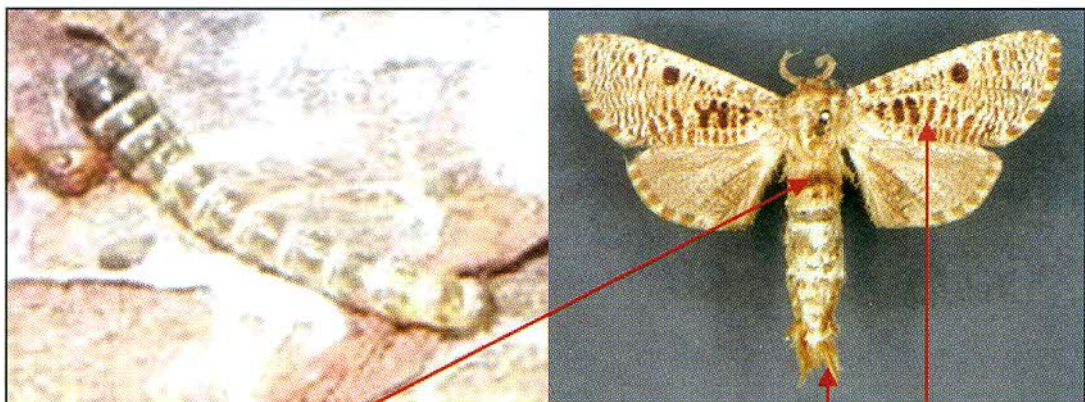


**Ribbon like or pipe like webbings on the stem near forks or angles of branches**

## Description

- The female moths are pale brownish with forewings having row of dark rusty red spots. In females, abdomen has a tuft of hairs at its tip.
- Males, length varies from 22- 25 mm while in females 32-34 mm.
- It lays eggs with the onset of the rainy season in batches of 15 to 25.
- After emerging, the caterpillars start devouring the bark. The caterpillars pupate during the summer for about four weeks and from the pupae adult moths emerge, mate, and lay eggs again.
- Only one caterpillar is seen in a gallery.





**Moth pale brownish with forewings having row of dark rusty red spots & abdomen has a tuft of hairs at its tip**

#### 2.1.6 Ber weevil (*Myloccerus dentifer*, *M. blandus* & *Amblyrrhinus poricollis*)

- Ber weevil, *Myloccerus dentifer*, *M. blandus* & *Amblyrrhinus poricollis* are minor pest of ber.

#### Host range

- It is a polyphagous pest major occurring on ber.

#### Nature of damage

- The adult beetles feed on leaves of ber.
- Damage can range from notching on the leaf margins to much more extensive feeding along the leaf veins.



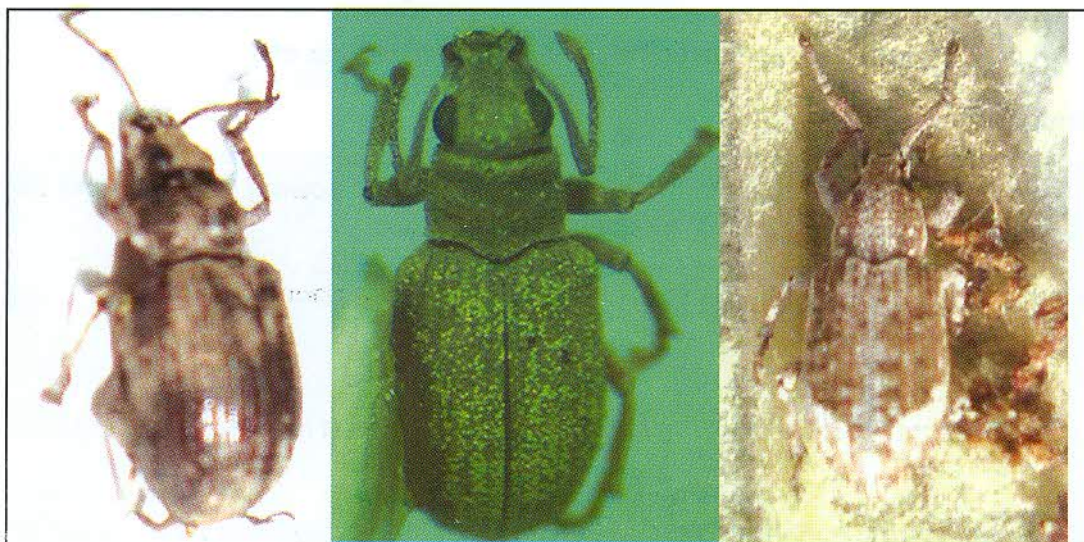


Notching on the leaf margins to much more extensive feeding along the leaf veins

Beetles feed on leaves

## Description

- Adults lay their eggs in the soil.



*Mylocerus dentifer*

*M. blandus*

*Amblyrrhinus poricollis*





- Larvae are small, creamy white, and legless. They are root feeders.
- Adults can cause severe feeding damage to the foliage.
- *Mylocerus dentifer* body is blackish in color with brownish spots. *M. blandus* body is dark brown in color.
- *Amblyrrhinus poricollis* body is light brown in color with whitish strips on body.

### 2.1.7 Termite (*Odontotermes obesus*)

- Termites or white ants are warmth loving insects and inhabit the entire tropical and subtropical regions of the world except higher altitudes where temperature are too low and the deserts where there is no food. They devour not only the live plant material but also the dead wood.

#### Host range

- They are polyphagous and have the widest range of host plants.
- Like ber, aonla, datepalm, pomegranate, lasora, phalsa etc.

#### Nature of damage

- Termites attack wheat and barley from the time of sowing onwards and the damage is severe in sandy and sandy-loam soils.
- It cannot thrive under conditions of bad aeration and poor drainage.
- The damage may vary from 40 - 50%.
- The internal part of plants are eaten away up to 1-2 feet height of stem and filled with earth.
- Termites also appear and cause havoc in orchards that have been raised on virgin lands.



- The damage is more severe in nurseries and young newly planted orchards where the entire seedlings or saplings may dry and die away.

### Description

- The termites are heliphobic and either remains underground and feed on roots and then move upwards making the trunks completely hollow or they construct mud galleries on tree trunks.
- Formation of earthen galleries on tree trunks decreases with rise in temperature from March onwards and it again increases from September onwards.
- These different functionaries constitute well-defined castes like the soldier caste, the worker caste, the reproductive caste and the royalty.



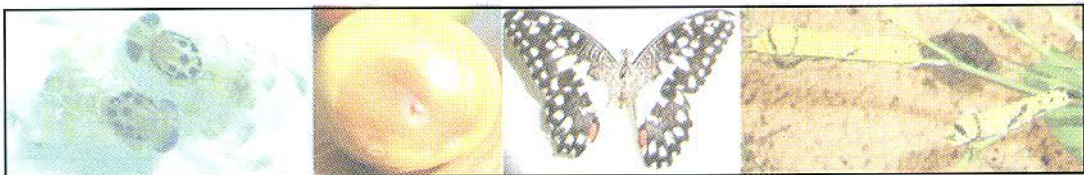
**Termite queen**



**Termite workers**

- The queen is the largest individual, the size of which at times exceeds five centimetres in length and one centimetre in thickness due to the enlargement of the abdomen which is full of eggs.
- The rest of the colony consists of the king, the functional consort of the queen, three sub-castes of fertile reproductives and two sterile castes of workers and soldiers.





- The sterile castes the workers, which constitute the main labour force of the colony, have undergone reduction in brain and eye development.
- Winged sexual forms appear with the first shower of monsoon.
- The mating takes place either up in the air or on the ground and soon after mating the insects lose their wings, re-enter the soil and start a new colony.
- The Queen lays one egg every 2 - 3 seconds continuously during her entire life span of 7 - 10 years.

## 2.2 Pests of date palm crop

### 2.2.1 Date palm scale (*Parlatoria blanchardi*)

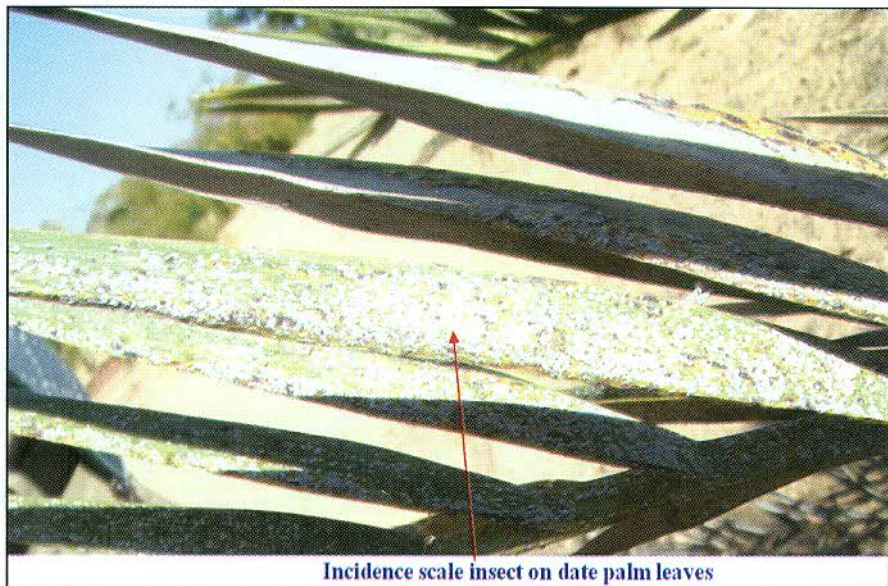
- Date palm scale is widely present in most date palm growing areas of the world. It is considered a serious pest in Algeria, Kuwait, Libya, Mauritania, Morocco and Tunisia.

#### Host range

- Date palm

#### Nature of damage

- Date palm scale is very serious on young palms between two to eight years of age, but even under severe attacks, the palm and its offshoots do not die.
- Nymphs and adults suck the sap from the leaflet, midribs and the dates.
- Under each scale insect, a discoloured area appears on the leaflet.
- Heavy infestation causes leaflets to turn yellow and contributes to the premature death of the fronds.



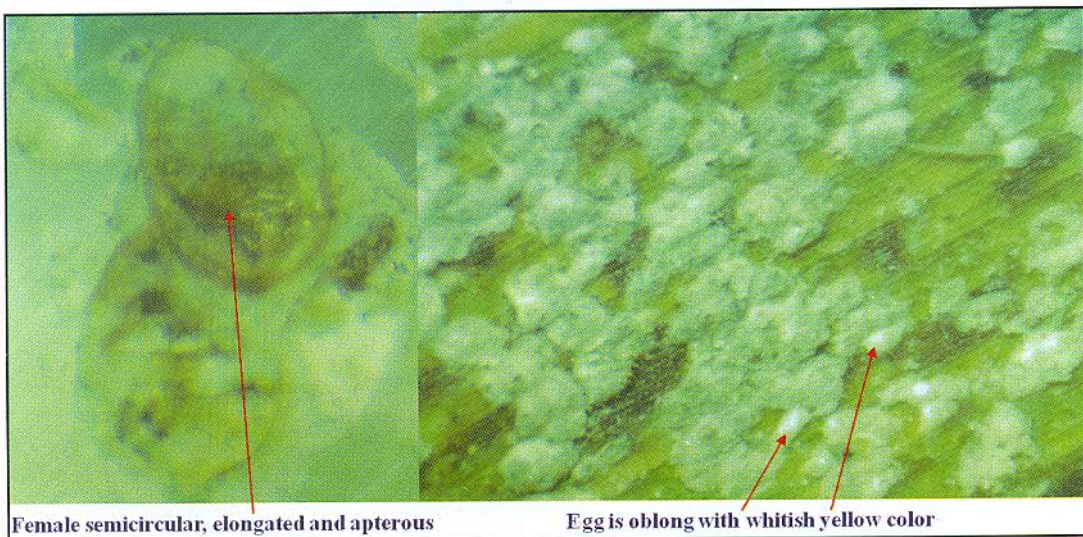
Incidence scale insect on date palm leaves

- Population of this pest was mild during May and June then on the onset of monsoon its population builds up and reached to severe form during December and January months.
- The scale insect was observed as major pests in all the orchards in mild to severe form ranging from 1.10 cm<sup>2</sup> at Dantore to 18.77 cm<sup>2</sup> at Bikaner.

## Description

- Anterior and posterior ends without minute “teeth”; rear abdominal segments formed into pygidium (diaspidid or armored scales)
- The egg is oblong with whitish yellow color.
- After hatching, the 1<sup>st</sup> instar, crawler that gets out from beneath the scale is also oblong yellowish white in color.





Female semicircular, elongated and apterous

Egg is oblong with whitish yellow color

- The female passes through two nymphal instars, while the male passes through four.
- The female becomes semicircular, elongated, and apterous, while the male is elongated and winged.
- The scale is protecting itself with an armoured scale composed of exuviae and other secreted materials.
- After the last nymphal moult, the male usually emerges from beneath the scale, while the female remains motionless.

### 2.2.2 Lesser date moth (*Batrachedra amydraula*)

- Lesser date moth is an important insect pest of date palm infesting fruits. This is one of the most important pests of the date palm in UAE that may cause more than 50% loss of the crop if not properly managed. In Rajasthan, the incidence of this pest was around 16 to 20 %.

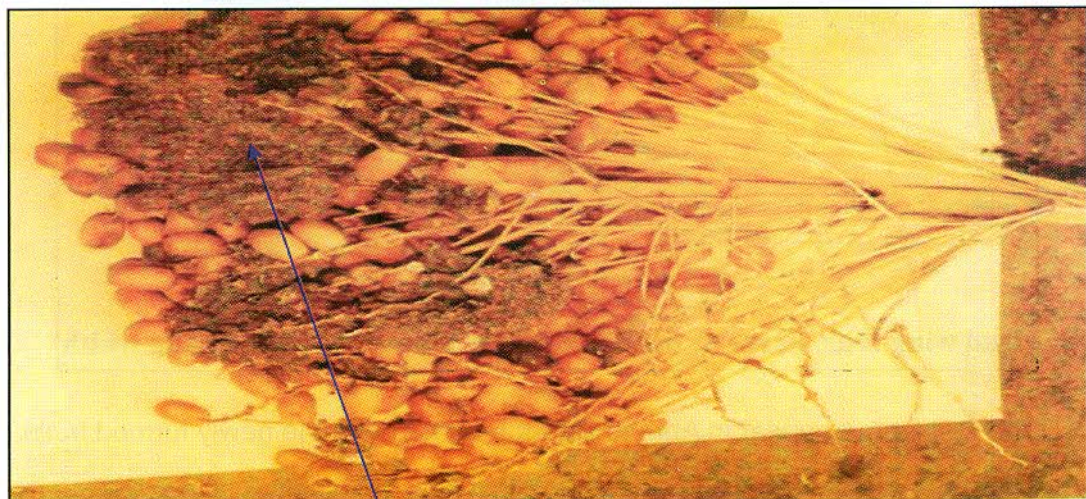


## Host range

- Date palm

## Nature of damage

- It starts its activity in date palm plantations, is then transmitted into storage with infested dates and can go through multiple generations within stored dates.



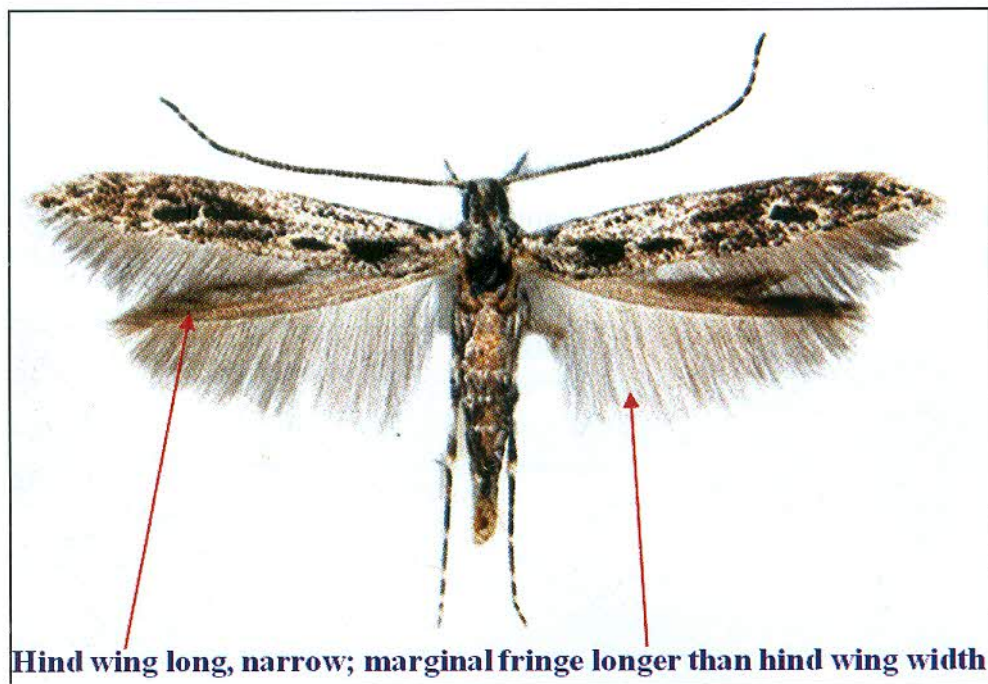
**Dates bunch damage with lesser moth**

- The highest fruit damage was recorded in the variety Medjool (16.01%) followed by Khalas (14.54%) and Nagal (13.78%), whereas, lowest fruit damage was recorded in the varieties Zaghloul, Medini and Zahidi as 1.43, 1.51 and 2.30 per cent.

## Description

- Hind wing long, narrow; marginal fringe longer than hind wing width (case-bearing moths).





- The first larvae appear in April to start the damage on the newly formed fruits.
- The larva has a period of dormancy August till March of the next year between the bases of the terminal fronds.
- Pupation takes place in March and adults of the new cycle emerge in April, giving more larvae in 3 overlapping generations to damage different growth stages of dates.

## 2.3 Pests of aonla

### 2.3.1 Aonla mealy bug (*Nipaecoccus viridis*)

- Found in several countries in the Afrotropical, Australasian (including Hawaiian islands), Oriental and Palearctic regions.



## Host Range

- It is highly polyphagous pest in India. It is mainly infected to aonla, citrus, cotton, jute *etc*

## Nature of damage

- Primarily occurring on foliage and fruit of host.
- The attacked new shoots are found bending and twisting with yellowing of leaves.



- In case of severe infestation, twigs become leafless and dry.
- Excessive excretion of honeydew is noticed.
- Flowers dry up and drop





## Description

- Body round or broadly oval; somewhat flattened dorso-ventrally; purple or blue green; covered by thick white, creamy, or pale yellow wax.
- Ovisac covering dorsum; probably with 5 or 6 pairs of lateral wax filaments.



- Apparently oviparous, eggs purple.
- Dorsum probably with waxy filaments.
- Ventral multilocular pores usually on all abdominal segments and on head.

## 2.4 Pests of pomegranate

### 2.4.1 Pomegranate butterfly (*Deudorix isocrates*)

- It is widely distributed all over India and is found wherever pomegranates are grown.



## Host range

- It is a polyphagous pest having a very wide range of host plants, including, aonla, apple, ber, citrus, guava, litchi, loquat, mulberry, peach, pear, plum, pomegranate, sapota and tamarind.

## Nature of damage

- On hatching, the caterpillars bore inside the developing fruits and are usually found feeding on pulp and seeds just below the rind.
- As many as eight caterpillars may be found in a single fruit.
- The conspicuous symptoms of damage are offensive smell and excreta of the caterpillars coming out of entry holes, the excreta are found stuck around the holes.



- Sometimes the holes may also be seen plugged with the anal end of a caterpillar.
- The affected fruits ultimately fall down and are of no use.

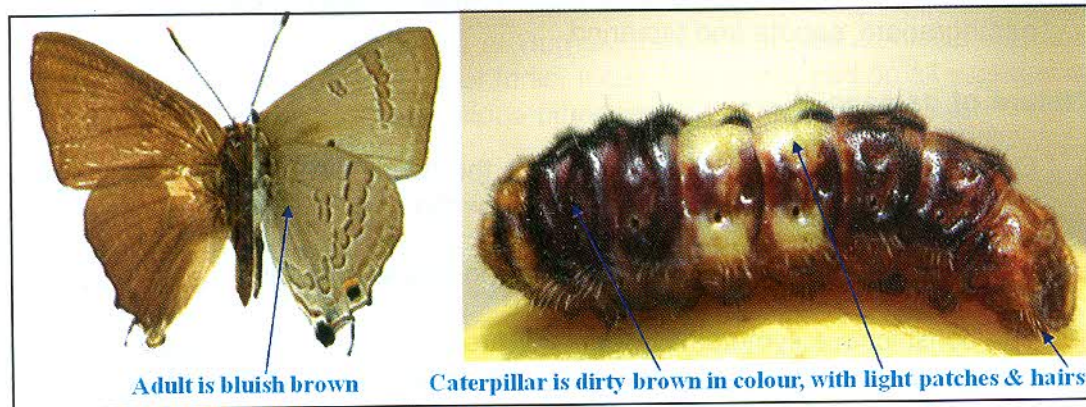
## Description

- Eggs are laid singly on calyx of flowers or tender fruits.





- Caterpillar is stoutly built dirty brown in colour, with light patches, a few short hairs and measures about 16-20 mm long.



- Larval period is 18-47 days.
- The adult is bluish brown.
- On female adult V shaped patch on forewing.

#### 2.4.2 Fruit sucking moths (*Eudocima fullonica* & *E. maternal*)

- This pest is distributed in Australia, China, Japan, Korea, Philippines, Hawaii, Thailand, India etc. The caterpillars of these are leaf defoliators on weed hosts viz., *Tinospora cardifolia*, *Cocculus pendulus* and *C. hirsutus*.

#### Host range

- Besides citrus, it also attacks on pomegranate, grapes, apple, castor, ber, guava etc.

#### Nature of damage

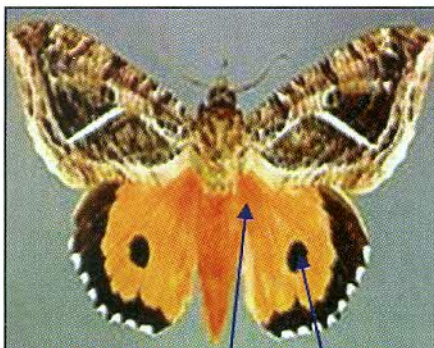
- It is only the moths that are destructive to citrus fruits.



- The moths are distinguished by having particularly well developed proboscis with dentate tips with which they are able to pierce the ripening fruits.
- The moths are nocturnal in habit and may be seen flying about in orchards after dusk especially during rainy season.
- The damaged fruits soon start rotting as the punctured regions are easily infected with bacteria and fungi and ultimately the fruits drop prematurely.

## Description

- The adults of *O. fullonica* has pale orange brown body with forewings dark greyish and the hind wings orange red with two black curved patches.
- The adults of *O. materna* has pale greenish gray upper wings with pale white markings and the lower wings with a marginal dark brown region mixed with white spots and a circular dark spot.



**Hind wings orange red with circular dark spot**



**Hind wings dark yellow with black curved patch**

- The caterpillar is a semilooper, dark brown with yellow and red spots.
- Full grown caterpillars are 50 - 60 mm long, stout, velvety-blue with yellow patterns on dorsal and lateral sides and having a hump at anal end.





## 2.5 Pests of bael

### 2.5.1 Lemon butter fly (*Papilio demoleus*)

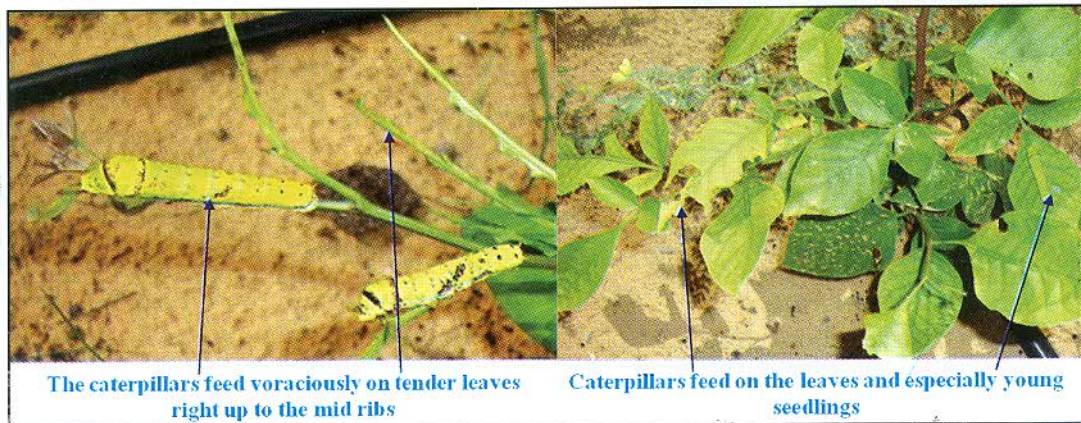
- This pest is widely distributed in Burma, Bangladesh, Sri Lanka, India and Pakistan. It is distributed all over India. It can feed and breed on all varieties of cultivated or wild citrus and various other species of family Rutaceae.

#### Host range

- These are most destructive pests of citrus seedlings. Besides citrus, it also attacks bael, ber, wood apple, curry leaf *etc.*

#### Nature of damage

- The caterpillars feed on the leaves and especially young seedlings and trees are seriously affected.
- Complete defoliation occurs in severe attack.



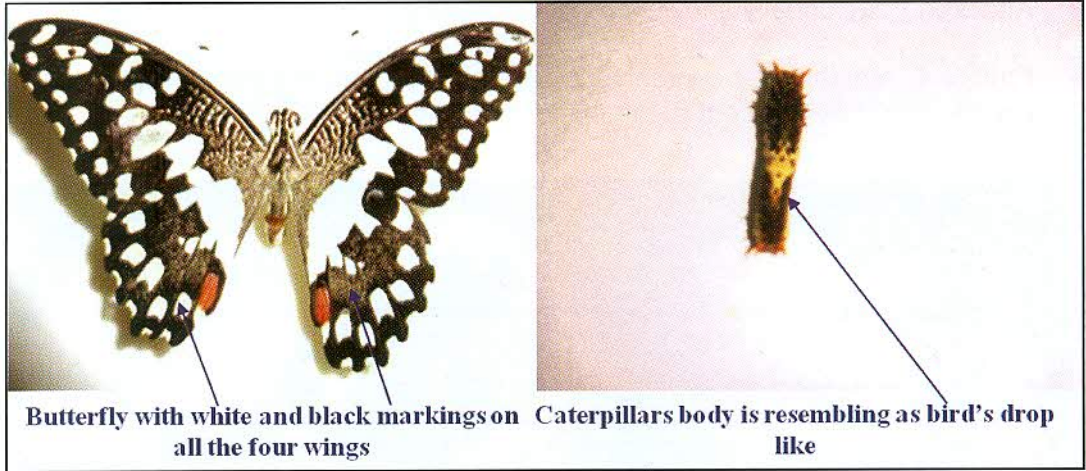
- Freshly hatched caterpillars are dark brown and soon develop irregular white markings on their body resembling bird's drop.



- The caterpillars feed voraciously on tender leaves right up to the mid ribs and defoliate the entire seedlings or the tree leaving behind the only midribs.
- It is present throughout the year.

### Description

- This is a big beautiful butterfly with yellow and black markings on all the four wings, having wing expanse of about 50-60 mm.
- Its hind wings have a brick red oval patch near the anal margin and there is no tail like extension behind.



- Yellowish white, round, smooth eggs are laid singly on tender leaves and shoots.
- On disturbance the caterpillar everts out two orange coloured osmeteria with a characteristic smell.
- Full grown caterpillar is stout and about 40 mm in length.





### 2.5.2 Bael fruit fly (*Bactrocera zonata*)

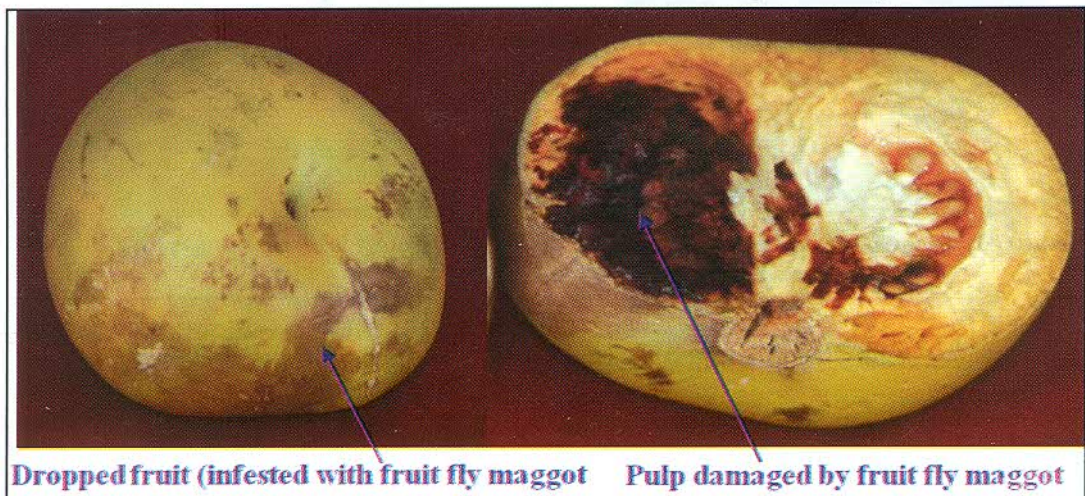
- This species are widespread in south Asia from Pakistan, India and Sri Lanka to Southeast Asian countries such as Thailand, Laos, Vietnam and Indonesia.

#### Host range

- The main hosts of fruit fly are guava, mango and peach. Secondary hosts include bael, apricot and citrus. *B. zonata* has been recorded on over 50 cultivated and wild plant species.

#### Nature of damage

- Attacked fruits usually show signs of oviposition punctures.
- Fruits with a high sugar content, such as peaches, exude a sugary liquid, which usually solidifies adjacent to the oviposition site.

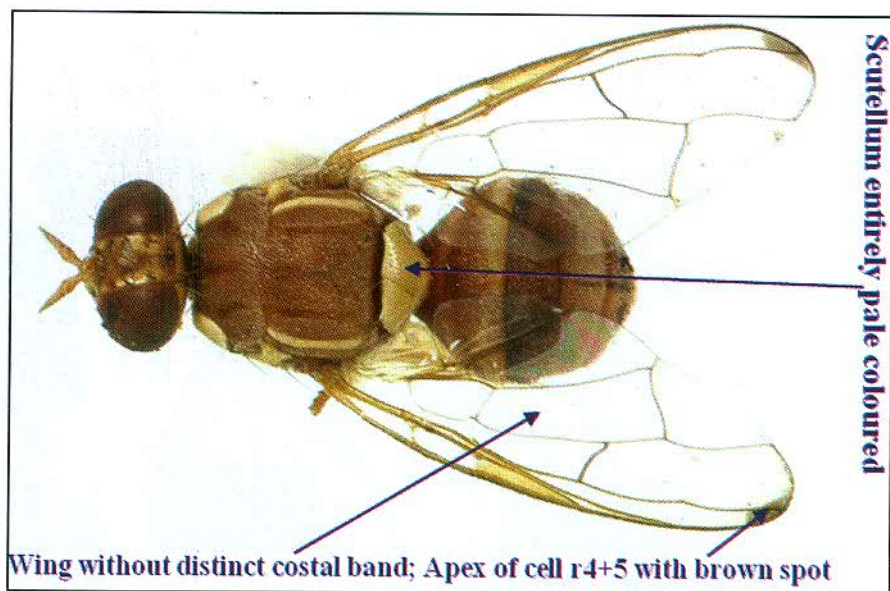


#### Description

- Wing without distinct costal band; apex of cell r4+5 with brown spot.



- Thorax and abdomen pale orange.
- Scutellum entirely pale coloured, except sometimes for a narrow black line across the base.
- Wing vein sc abruptly bent forward at nearly 90°, weakened beyond this bend and ending at subcostal break; vein R1 with dorsal setulae.



## 2.6 Pests of citrus

### 2.6.1 Citrus leaf miner (*Phyllocristis citrella*)

- It is widely distributed from Australia to Africa. It is found in all the states where *Citrus* spp. is grown.





### Host range

- It attacks all species of citrus but prefers sweet oranges. It also infests Pongamia, jasmine *etc.* The pest is active all-round the year, except during severe winter (December – February).

### Nature of damage

- The minute caterpillars mine into the leaf tissues of tender leaves and feed on them leaving the outer tissue intact.
- Making silvery appearance presence on the lower surface of leaves

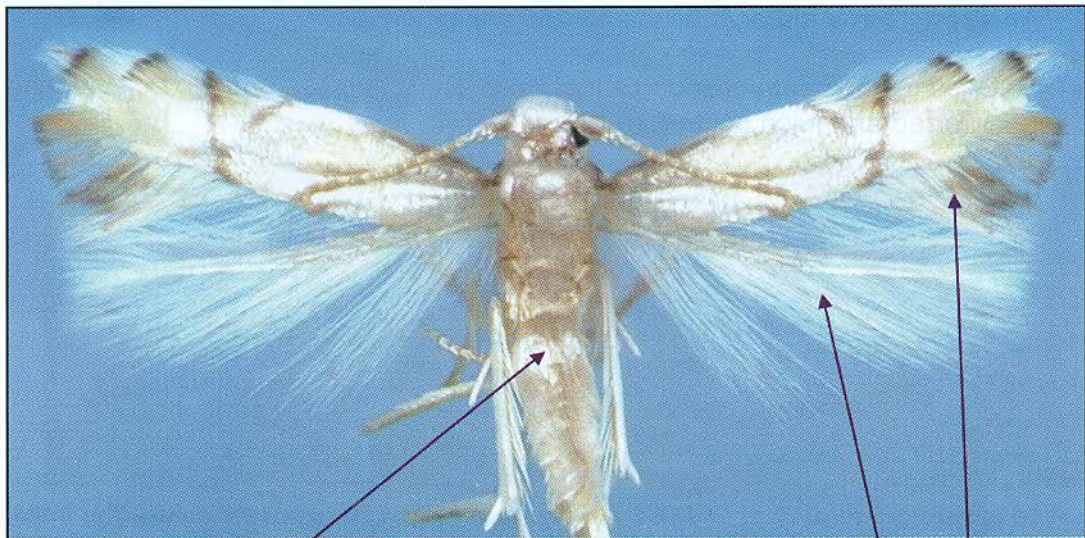


**Leaves become crinkled with whitish lines Leaves turn pale, curl badly and dry off**

- Leaves become crinkled with whitish lines.
- In case of severe infestation leaves turn pale, curl badly and dry off.

### Description

- Adult is a silvery white small moth with brown striped forewings having a prominent black spot near the tip and white hindwings.
- Both pairs of wings are fringed with hairs.



**Adult is a silvery white small moth, both pairs of wings are fringed with hairs**

- The adult moth measures 6 mm in wing span.
- On hatching, the caterpillar enters tissue and starts mining between the two layers. It is thin and yellowish green in colour.





- This results in V shape curling and cupping of leaves.
- Defoliation and death of young shoot in severe infestation and the fruits turning undersized and juice content reduced.



## Description

- Adults are reddish with jumping legs.
- Nymphs are flattish, oval in shape and light orange colour.





- Adult is small, brown in colour and brown colour band present on the half of fore wing
- Eggs are laid in tender shoots and anchored in the tissues by means of short stalks.
- There are five nymphal instars and the nymphal period is 9-38 days.
- Adult life span is 135 days for males and 145 days for females and has 16 generations per year.

## 2.7 Pests of kinnow

### 2.7.1 Kinnow fruit fly (*Bactrocera dorsalis*)

- It is widely distributed in the Orient region from Australia and Hawaii to Pakistan. The pest is active throughout the year in South India whereas in northern parts the pest hibernates during winter.

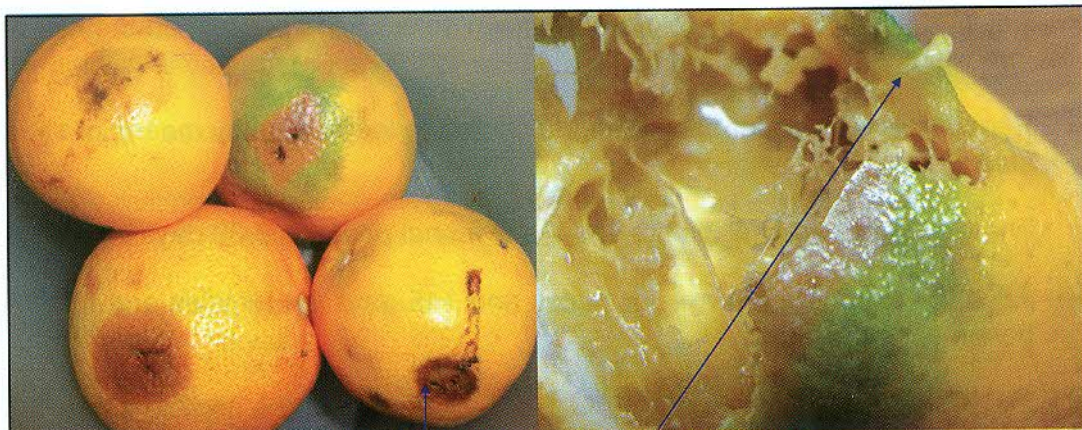
#### Host range

- It is one of the major pests of mango in India. It also infests kinnow, guava, peach, citrus, ber, banana, papaya *etc.*

#### Nature of damage

- On hatching the maggots feed on pulp of those fruits.
- As a result a brown patch appears around the place of oviposition and the infested fruits start rotting.
- These affected fruits drop down prematurely and the maggots come out from these fallen fruits to pupate in the soil.

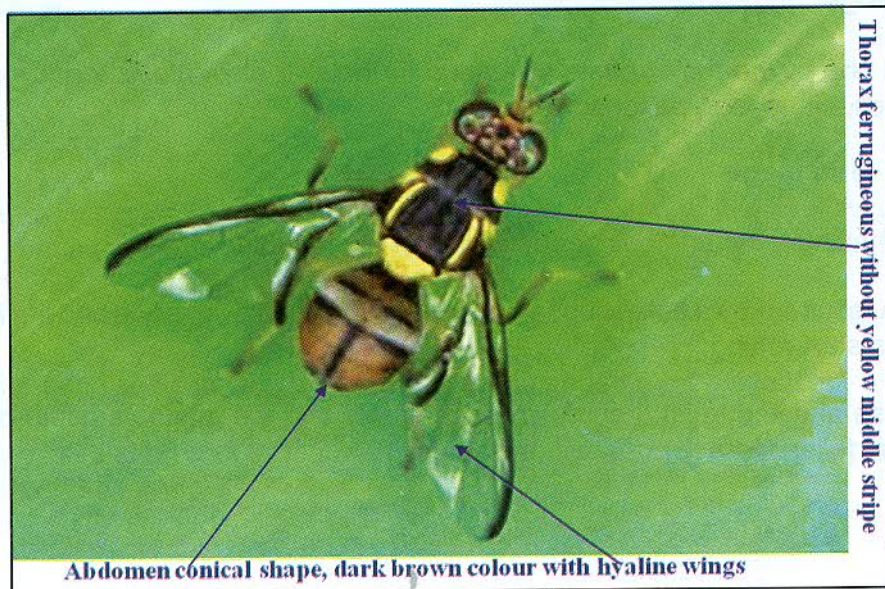




Damage symptoms of fruit fly and maggot feed on fruit

## Description

- Adult fly is a brown or dark brown with hyaline wings and yellow legs.
- The adult fly is light brown with transparent wings.







- Adult flies are very conspicuous.
- These are about 7 mm long, with hyaline wings (expanse : 13 - 15 mm), thorax ferrugineous without yellow middle stripe, legs yellow, abdomen conical in shape and dark brown in colour.
- Pupation usually takes place 80 - 160 mm below the soil surface.

## 2.8 Pests of Lasora

### 2.8.1 Lasora tingid bug (*Dictyla cheriani*)

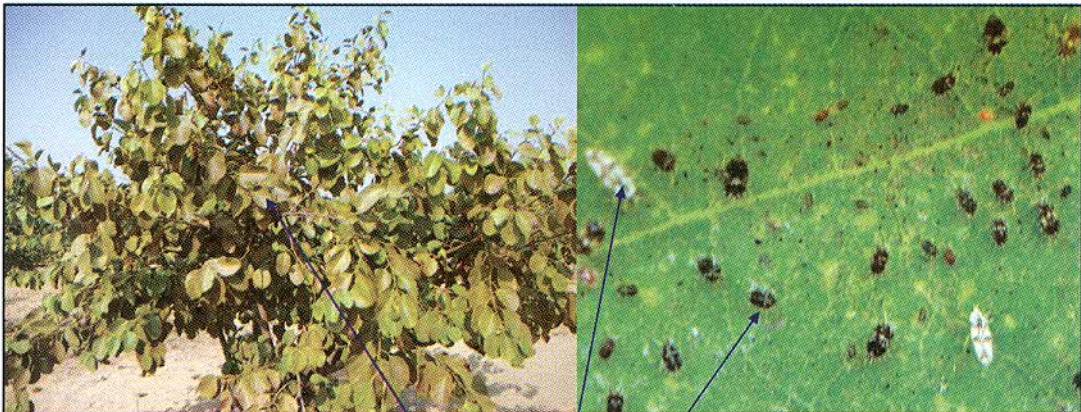
- The tinged bug, *Dictyla cheriani* was recorded first time on Indian Cherry, *Cordia myxa* in 2010 at experimental farm of Central Institute for Arid Horticulture, Bikaner. The *D. cheriani* has been earlier reported on *Cordia sp.* from Coimbatore in 1936.

### Host range

- Lasora

### Nature of damage

- The nymph and adult damage to the leaves of plant.



Damage symptoms of bug, adult and nymphs feed on leaves

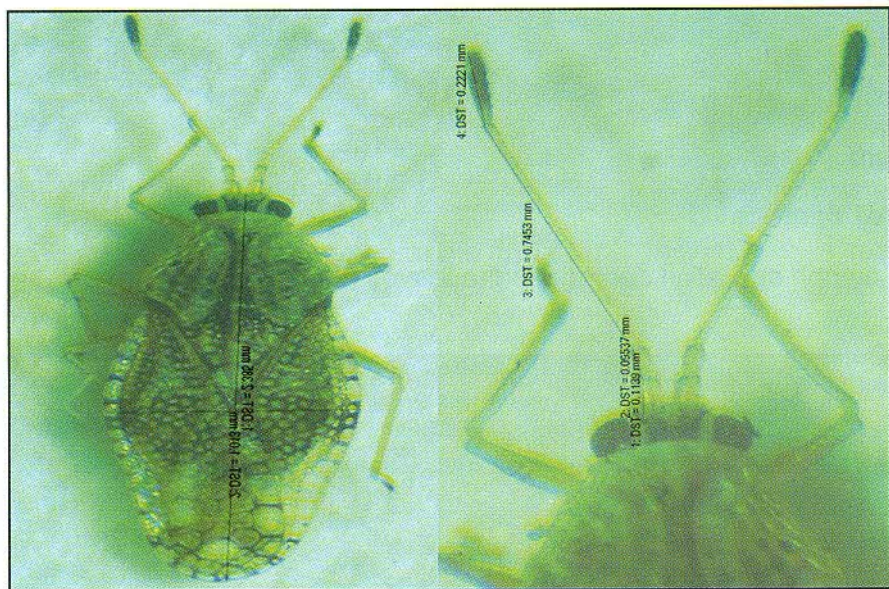




- Due to attack of this pest, the leaves turned yellow and finally dry.
- The maximum incidence of tinged bug was recorded in the second fortnight of October on broad leaves (25.00/ leaves) and small leaves (9.00/ leaves) followed by first fortnight of November on broad leaves (22.20/ leaves) and small leaves (5.80/ leaves).

## Description

- The body is oblong, pale testaceous with brownish or fuscous markings, with collar and hood yellowish brown, body beneath reddish dark with thoracic sterna darker.



- Labium is brownish with dark apex, reaching to base of mesosternum.
- Antenna is yellowish brown; 1/3 part of 4 segment blackish.



- Antenna is rather slender, segmental measurements: I, 0.12 mm; II, 0.09 mm; III, 0.80 mm; IV, 0.22 mm. Length of body is 2.25 mm and width 0.88.
- Pronotum is very strongly convex, tricarinate, with discal part on each side covered by the reflexed paranotum up to the lateral carina; backward projection of pronotum triangular, areolate; hood small, feebly produced anteriorly at the middle.
- Hemelytra are wider than width of pronotum across humeral angles, longer than abdomen.
- Hind wings are longer than abdomen and hyaline.

## 2.9 Pests of Ker

### 2.9.1 Ker butter fly (*Anaphaeis aurota*)

- *Capparis decidua* (Forsk.) was found to be heavily infested with *Anaphaeis aurota* commonly known as the Pioneer or Caper white butterfly in various parts of Rajasthan. The Pioneer is a dry zone butterfly, found in savannahs, scrub and dry and deciduous forests.

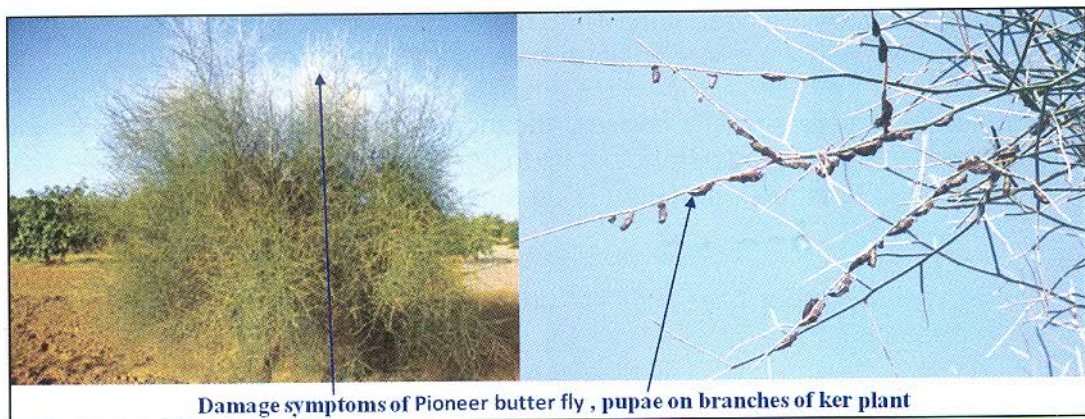
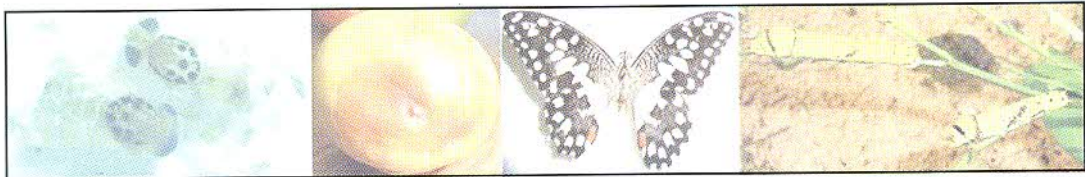
#### Host range

- *Capparis decidua*, *C. pyrifolia*, *C. rheedii*, *C. sepiaria*, *C. spinosa*, *C. zeylanica*, *Cadaba fruticosa* and *Maerua oblongifolia*

#### Nature of damage

- The caterpillars only caused the damage to mostly upper portion leaves of plant.
- The grown caterpillars of *A. aurota* easily strip off the branches, devouring leaf after leaf causing great damage.

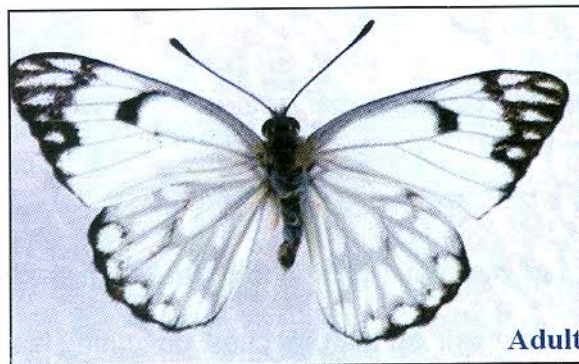




Damage symptoms of Pioneer butter fly , pupae on branches of ker plant

## Description

- Fore wing: deep black on apical area, the enclosed white elongate spots more or less obsolete.
- Hind wing: the black terminal border much broader and of a deeper black, the enclosed white spots.



- Caterpillar is grass-green; dorsal line very distinct, dark green; lateral line very broad, plum-coloured and mottled, dentated into the ground colour.



- Due to seasonal variation, geographical distribution and sexual dimorphism there is a marked difference in colour of wings and thickness of veins of *A. aurota* Fabricius.
- The females are larger and with thicker and broader veins, apex and outer margins.
- It was observed that the males had thinner black bands as compared to the females in wings.





## Chapter: 3

# NATURAL ENEMIES OF FRUIT CROPS IN ARID REGION

### 3.1 Praying mantid (*Mantis religiosa*)

- Praying mantises or praying mantids are carnivorous (meat-eating) insects. There are about 2,000 different types of mantids.

#### Prey habitat

- Praying mantids are highly predacious and feed on a variety of insects, including moths, crickets, grasshoppers and flies.
- They lie in wait with the front legs in an upraised position. They intently watch and stalk their prey. They will eat each other.

#### Description

- The biggest are over 15 cm long and the smallest are about 1 cm long.
- Three distinct body regions: head, thorax (where the legs and wings are attached), abdomen. Part of the thorax is elongated to create a distinctive 'neck'.





- Front legs modified as raptorial graspers with strong spikes for grabbing and holding prey.
- Large compound eyes on the head which moves freely around (up to 180°) and three simple eyes between the compound eyes.
- Incomplete or simple metamorphosis (hemimetabolous).
- A distinct Styrofoam-like egg case protects Mantid eggs throughout the winter.
- Up to 200 or more nymphs may emerge from the egg case.
- The nymphs look like adults except for size and the sexual definition.

### 3.2 Zigzag ladybird beetle (*Cheilomenes sexmaculata*)

- Almost throughout India and the Oriental region, Iran, Australasia *etc.*

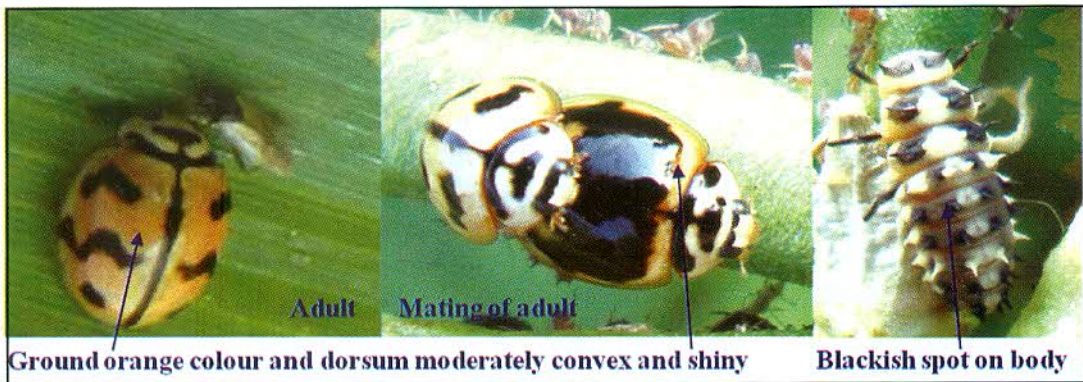
#### Prey habitat

- Aphidophagous, also feeds on psyllids, whiteflies, mealybugs, tingids, leaf and planthoppers, mites, and early instar lepidopteran larvae.

#### Description

- Body is oval to subrounded, dorsum moderately convex and shiny.
- Length 3.3-6.2 mm and width 3.0-5.3 mm.
- Ground colour orange, light red, yellow or pinkish with the following markings in the typical form.
- Head with a black marking in posterior half.
- Pronotum with a T-shaped median marking connected to a broad black band along posterior margin.





- Elytra with six black maculae including two zigzag lines and a posterior black spot.

### 3.3 Strip lady bird beetle (*Brumoides suturalis*)

- Widespread almost throughout India (Andhra Pradesh, Goa, Jammu & Kashmir, Karnataka, Kerala, Manipur, Punjab, Tamil Nadu, Uttar Pradesh, West Bengal), Nepal, Bhutan, Sri Lanka, etc.

#### Prey habitat

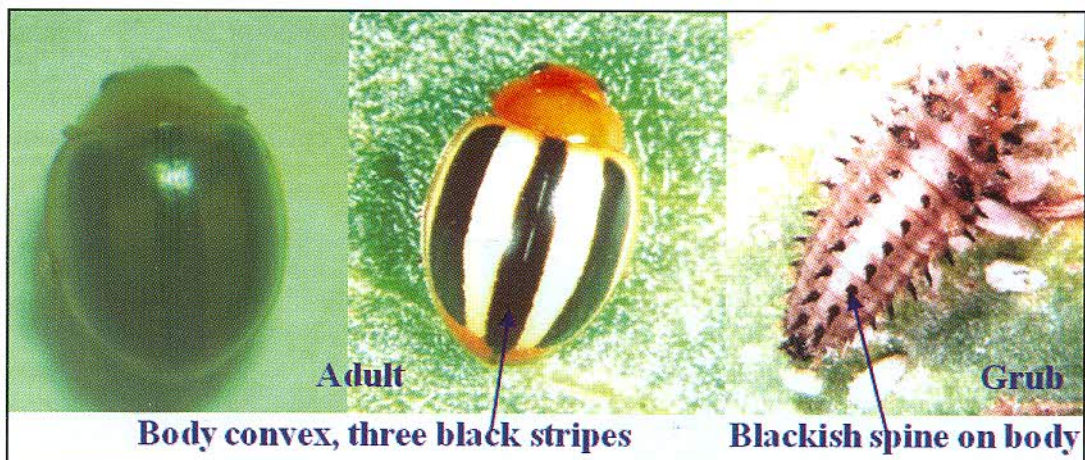
- This species departs from the normal food habits of the other genera of Chilocorini, which are mainly scale feeders.
- It is more polyphagous and largely predatory on aphids, whiteflies, psyllids, scales, mealybugs and mites.

#### Description

- Body is oval, dorsum convex.
- Body length 4.0 mm and width 2.7 mm.
- Head and pronotum orange yellow.



- Scutellum black.
- Elytra satiny white to creamy yellow, with three black stripes, one on each elytron in a mid-dorsal position not extending to apex and one along sutural line nearly extending to apex.



- Apical portion yellowish to reddish brown.
- Last visible abdominal segment with posterior margin emarginate in male and narrowly rounded in female.
- Larva slaty grey, with prominent spiny protuberances on dorsal side.

### 3.4 Green lacewing (*Chrysoperla carnea*)

- It is found in many parts of America, Europe and Asia. It was originally considered to be a single species with a holarctic distribution but it has now been shown to be a complex of many cryptic, sibling species.





## Prey habitat

- The adults feed on nectar, pollen and aphid honeydew but the larvae are active predators and feed on aphids and other small insects.

## Description

- The green lacewing eggs are oval and secured to the plant by long slender stalks.
- The larvae are brown and resemble small alligators, crawling actively around in search of prey.



- They have a pair of pincer-like mandibles on their head with which they grasp their prey, sometimes lifting the victim off the leaf surface to prevent its escape.
- Adult green lacewings are a pale green colour with long, threadlike antennae and glossy, golden, compound eyes.
- They have a delicate appearance and are from twelve to twenty millimetres long with large, membranous, pale green wings which they fold tent-wise above their abdomens.
- They are weak fliers and have a fluttery form of flight.



### 3.5 Ker butterfly parasitoid (*Brachymeria albicrus*)

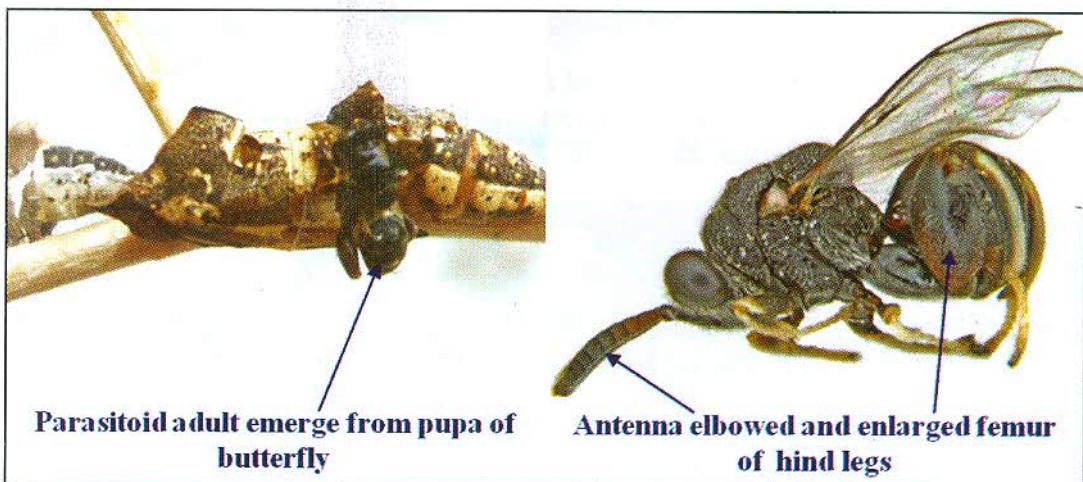
- The parasitoid has a worldwide distribution. During the surveys conducted in Rajasthan *Brachymeria albicrus* was found parasitizing *Anaphaeis aurota* infesting ker plant.

#### Parasitoid habit

- It is a parasitoid of ker butter fly, *Anaphaeis aurota*

#### Description

- The parasitoid have elbowed antenna and have a typically enlarged femur (thigh) segment on the hind legs.
- The female typically lays eggs inside the larva of a Lepidopteron using its ovipositor.



- The adult parasitoid emerges typically from the pupa.
- The mean percent parasitism of the butterfly by *B. albicrus* at CIAH farm and at Desnok, Bikaner was 49.5 and 47.5 respectively and the mean percent emergence of the mature adult parasitoids from the parasitized pupae was 15.5 and 14.0 respectively.





## Chapter: 5

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## Appendices

### Appendix: 1. List of insect –pests of fruit crops in arid region

S. No.	Insect-pests of fruit crops	Family	Order
<b>1.</b>	<b>Ber pests</b>		
1.	Ber fruit fly ( <i>Carpomyia vesuviana</i> )	Tephrididae	Diptera
2.	Ber stone weevil ( <i>Aubeus himalayanus</i> )	Curculionidae	Coleoptera
3.	Ber butter fly ( <i>Tarucus theophrastus</i> )	Lycaenidae	Lepidoptera
4.	Ber fruit borer moth ( <i>Meridarchis scyroides</i> )	Carposinidae	Lepidoptera
5.	Bark eating caterpillar ( <i>Indarbela quadrinotata</i> )	Cossidae	Lepidoptera
6.	Ber leaf webber ( <i>Synclera univocolis</i> )	Pyraustidae	Lepidoptera
7.	Ber weevil ( <i>Myloccerus dentifer</i> )	Curculionidae	Coleoptera
8.	Ber weevil ( <i>Myloccerus blandus</i> )	Curculionidae	Coleoptera
9.	Ber weevil ( <i>Amblyrrhinus poricollis</i> )	Curculionidae	Coleoptera
10.	Ber lygaeid bug ( <i>Nysius</i> sp.)	Lygaeidae	Hemiptera
11.	Termite ( <i>Odontotermes obesus</i> )	Termitidae	Isoptera
<b>2.</b>	<b>Date palm pests</b>		
12.	Date palm scale ( <i>Parlatoria blanchardi</i> )	Diaspididae	Hemiptera
13.	Lesser date moth ( <i>Batrachedra amydraula</i> )	Batrachedridae	Lepidoptera
14.	Termite ( <i>Microtermes diversus</i> )	Termitidae	Isoptera
15.	Date stone weevil ( <i>Coccotrypes dactyliperda</i> )	Curculionidae	Coleoptera
16.	Date palm flour beetle ( <i>Tribolium castaneum</i> )	Tenebrionidae	Coleoptera
17.	Date palm weevil ( <i>Rhynchophorus ferrugineus</i> )	Curculionidae	Coleoptera
<b>3.</b>	<b>Aonla pests</b>		
18.	Aonla shoot gall maker ( <i>Betousa stylophora</i> )	Thyrididae	Lepidoptera
19.	Aonla fruit borer ( <i>Meridarchis scyroides</i> )	Carposinidae	Lepidoptera





S. No.	Insect-pests of fruit crops	Family	Order
20.	Aonla aphids ( <i>Schoutedenia</i> (= <i>Cerciaphis</i> ) <i>emblica</i> )	Aphididae	Hemiptera
21.	Aonla bark-eating caterpillar ( <i>Indarbela tetraonis</i> )	Cossidae	Lepidoptera
22.	Aonla mealy bug ( <i>Nipaecoccus viridis</i> )	Pseudococcidae	Hemiptera
23.	Aonla leaf rollers ( <i>Gracilaria acidula</i> )	Gracillariidae	Lepidoptera
<b>4.</b>	<b>Pomegranate pests</b>		
24.	Pomegranate butterfly ( <i>Deudorix isocrates</i> )	Lycaenidae	Lepidoptera
25.	Fruit sucking moths ( <i>Eudocima fullonica</i> & <i>E. maternal</i> )	Noctuidae	Lepidoptera
26.	Pomegranate aphids ( <i>Aphis punicae</i> )	Aphididae	Hemiptera
27.	Pomegranate whitefly ( <i>Siphoninus phyllyreae</i> )	Aleyrodidae	Hemiptera
28.	Pomegranate thrips ( <i>Scirtothrips dorsalis</i> )	Thripidae	Thysanoptera
29.	Pomegranate mealy bugs ( <i>Ferrisia virgata</i> )	Pseudococcidae	Hemiptera
<b>5.</b>	<b>Bael pests</b>		
30.	Bael fruit fly ( <i>Bactrocera zonata</i> )	Tephrididae	Diptera
31.	Lemon butter fly ( <i>Papilio demoleus</i> )	Papilionidae	Lepidoptera
32.	Red scale ( <i>Aonidiella aurantii</i> )	Diaspididae	Hemiptera
33.	Citrus leaf minor ( <i>Phyllocnistis citrella</i> )	Gracillariidae	Lepidoptera
<b>6.</b>	<b>Citrus pests</b>		
34.	Citrus leaf miner ( <i>Phyllocristis citrella</i> )	Gracillariidae	Lepidoptera
35.	Lemon butter fly ( <i>Papilio demoleus</i> )	Papilionidae	Lepidoptera
36.	Citrus psylla ( <i>Diaphorina citri</i> )	Psyllidae	Hemiptera
37.	Fruit sucking moths ( <i>Eudocima fullonica</i> & <i>E. maternal</i> )	Noctuidae	Lepidoptera





S. No.	Insect-pests of fruit crops	Family	Order
<b>7.</b>	<b>Kinnow pests</b>		
38.	Kinnow fruit fly ( <i>Bactrocera dorsalis</i> )	Tephrididae	Diptera
39.	Kinnow psylla ( <i>Diaphorina citri</i> )	Psyllidae	Hemiptera
40.	Kinnow mite ( <i>Eutetranychus orientalis</i> )	Tetranychidae	Acarina
41.	Kinnow leaf-folder ( <i>Psorosticha zizyphi</i> )	Oecophoridae	Lepidoptera
42.	Kinnow whitefly ( <i>Dialeurodes citri</i> )	Aleurodidae	Hemiptera
<b>8.</b>	<b>Lasora pests</b>		
43.	Lasora tingid bug ( <i>Dictyla cheriani</i> )	Tingidae	Hemiptera
44.	Lasora mirid bug ( <i>Nesidiocoris tenuis</i> )	Miridae	Hemiptera
<b>9.</b>	<b>Ker pest</b>		
45.	Ker butter fly ( <i>Anaphaeis aurota</i> )	Pieridae	Lepidoptera
46.	Ker pentatomid bug ( <i>Stenozygum speciosum</i> )	Pentatomidae	Hemiptera
<b>10.</b>	<b>Phalsa pests</b>		
47.	Phalsa bug ( <i>Gargara mixta</i> )	Membracidae	Hemiptera
48.	Phalsa psyllid ( <i>Psylla sp.</i> )	Psyllidae	Hemiptera
49.	Bark-eating caterpillar ( <i>Indarbela tetraonis</i> )	Cossidae	Lepidoptera
50.	Chaffer beetle ( <i>Oxycetonia sp.</i> )	Scarabaeidae	Coleoptera





## Appendix: 2. List of natural enemies of horticultural crops in arid region

S. No.	Name of natural enemies	Host
1.	<i>Cheilomenes sexmaculata</i> (Fabricius)/ <i>Menochilus sexmaculatus</i> (Fabricius)	Aphidophagous, also feeds on psyllids, whiteflies, mealybugs, tingids, leaf-hoppers and mites.
2.	<i>Coccinella septempunctata</i> Linnaeus	Aphidophagous, also feeds on psyllids, whiteflies, mealybugs, tingids, leaf-hoppers and mites.
3.	<i>Brumoides suturalis</i> (Fabricius) ( <i>Brumus suturalis</i> (Fabricius))	Aphidophagous, also feeds on psyllids, whiteflies, mealybugs, tingids, leaf-hoppers and mites.
4.	<i>Cymnus coccivora</i> Ayyar	Aphidophagous, also feeds on psyllids, whiteflies, mealybugs, tingids, leaf-hoppers and mites.
5.	<i>Chrysoperla carnea</i>	Soft body insects
6.	Preying Mantids	Soft body insects and larvae of lepidopteron pests
7.	Spiders	Insect-pests of arid vegetable crops
8.	Syrphid fly	Feeds on aphids
9.	Rove beetle	Feed on soft body insects
10.	Birds (King crow and Indian Mynah)	Insect-pests of arid vegetable crops
11.	Parasitoid, <i>Brachymeria albicrus</i> (Klug)	Ker pioneer butterfly, <i>Anaphaeis aurota</i>
12.	Parasitoid, <i>Apanteles</i> sp	Ber leaf webber/roller, <i>Synclera univocolis</i>
13.	Parasitoid, <i>Opius carpomyiae</i>	Ber fruit fly, <i>Carpomyia vesuviana</i>





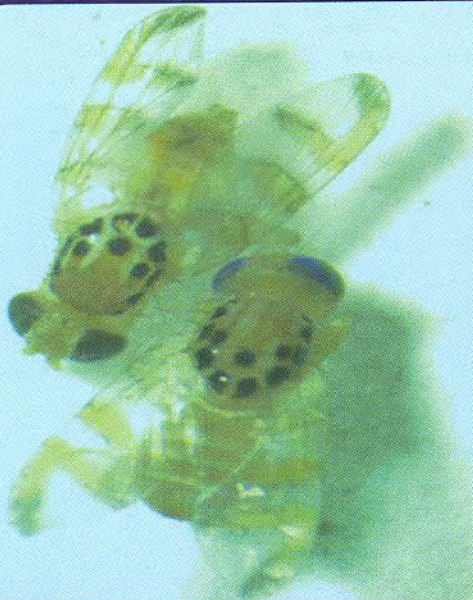
### Appendix: 3. Pesticides banned/ withdrawn/ refused registration and restricted use in India

S. No.	Name of pesticides	S. No.	Name of pesticides
<b>(a) Pesticides banned for manufacture, import and use</b>			
1.	Aldrin	15.	Pentachlorophenol
2.	Benzene Hexachloride	16.	Phenyl Mercury Acetate
3.	Calcium Cyanide	17.	Sodium Methane Arsonate
4.	Chlordane	18.	Tetradifon
5.	Copper Acetoarsenite	19.	Toxafen
6.	Clbromochloropropane	20.	Aldicarb
7.	Endrin	21.	Chlorobenzilate
8.	Ethyl Mercury Chloride	22.	Dieldrine
9.	Ethyl Parathion	23.	Maleic Hydrazide
10.	Heptachlor	24.	Ethylene Dibromide
11.	Menazone	25.	TCA (Trichloro acetic acid)
12.	Nitrofen	26.	Metoxuron
13.	Paraquat Dimethyl Sulphate	27.	Chlorofenvinphos
14.	Pentachloro Nitrobenzene	28.	Lindane banned dated 25/03/2011
<b>(b) Pesticide banned for use but their manufacture is allowed for export</b>			
1.	Methomyl 24% L	2.	Captafol 80% Powder
<b>(c) Pesticide formulations banned for import, manufacture and use</b>			
1.	Methomyl 24% L	3.	Phosphamidon 85% SL
2.	Methomyl 12.5% L	4.	Carbofuron 50% SP



S. No.	Name of pesticides	S. No.	Name of pesticides
<b>(d) Pesticide withdrawn</b>			
1.	Dalapon	5.	Paradichlorobenzene (PDCB)
2.	Ferbam	6.	Simazine
3.	Formothion	7.	Warfarin
4.	Nickel Chloride		
<b>(e) Pesticides refused registration</b>			
1.	Calcium Arsonate	10.	Azinphos Ethyl
2.	EPM	11.	Binapacryl
3.	Azinphos Methyl	12.	Dicrotophos
4.	Lead Arsonate	13.	Thiodemeton / Disulfoton
5.	Mevinphos (Phosdrin)	14.	Fentin Acetate
6.	2,4, 5-T	15.	Fentin Hydroxide
7.	Carbophenothion	16.	Chinomethionate (Morestan)
8.	Vamidothion	17.	Ammonium Sulphamate
9.	Mephosfolan	18.	Leptophos (Phosvel)
<b>(f) Pesticides restricted use in India</b>			
1.	Aluminium Phosphide	8.	Monocrotophos
2.	DDT	9.	Endosulfan
3.	Lindane	10.	Fenitrothion
4.	Methyl Bromide	11.	Diazinon
5.	Methyl Parathion	12.	Fenthion
6.	Sodium Cyanide	13.	Dazomet
7.	Methoxy Ethyl Mercuric Chloride (MEMC)		





हर कदम, हर डगर  
किसानों का हमसफर  
भारतीय कृषि अनुसंधान परिषद

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