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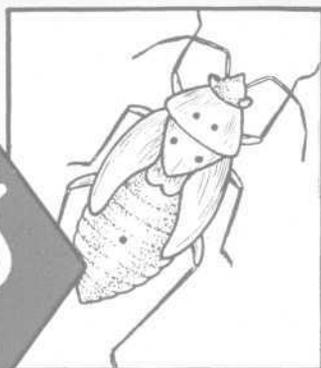
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arizona cotton insects

Bulletin A-23

DESCRIPTIONS
&
HABITS



The University of Arizona
Cooperative Extension Service
& Agricultural Experiment Station

Sincere thanks are extended to the following persons for their helpful contributions and criticisms: William Kauffman (deceased) and Louis W. Sheets of the Cotton Insects Section, Entomology Research Branch, U. S. Department of Agriculture; George D. Butler, Jr., Leon Moore, James N. Roney, Donald M. Tuttle, and Floyd G. Werner, staff entomologists of the College of Agriculture, The University of Arizona.

This is a revision of the former Bulletin 286 of The University of Arizona Agricultural Experiment Station published in June 1957.

ON THE COVER is shown one of the most important cotton insects in Arizona — Lygus Bug. At left is the nymph, at right the adult, below at right the damaged square. (See also page 39).

The University of Arizona
College of Agriculture
Cooperative Extension Service
George E. Hull, Director

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DESCRIPTIONS AND HABITS OF Arizona Cotton Insects

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INTRODUCTION

Cotton, the most important agricultural crop in Arizona, is attacked by numerous insect pests. It is estimated that these pests cause an annual loss to Arizona cotton growers of from 10 to 12 million dollars, as measured by reduced yields, reduced grades, and costs of insecticides and their application.

This bulletin has been designed to help readers (1) identify the injurious cotton insects, (2) recognize the damage caused by these insects, and (3) identify the common beneficial insects found on cotton.

The text is a compilation of the

available information. It has been assembled from scattered and usually fragmentary published sources and from previously unpublished notes and field observations of entomologists familiar with cotton insects in Arizona. Many details relating to the life history and habits of these insects are still unknown, and await further investigation.

Control recommendations are not included in this bulletin. The most recent recommendations will be found in the latest edition of The University of Arizona Bulletin A-2, "Cotton Insect Control In Arizona," which is revised annually. You may obtain a copy from your local County Agricultural Agent.

Kinds of Insect Injury Found on Cotton in Arizona

MAJOR PESTS IN CAPITALS

<i>Plant Part</i>	<i>Injury</i>	<i>Pest</i>	<i>Pages</i>
Seeds (in ground)	—eaten; poor germination	seed corn maggot	50
Seedling roots	eaten; plants wilted and deformed	wireworms	48
Stalks	of seedlings cut off just above ground	cutworms ants	24 51
	of seedlings gouged at or above ground	darkling beetles crickets	45 51
	deeply punctured	cicadas	33
Cotyledons (seed leaves)	deformed; plants stunted	APHIDS thrips	33 15
	ragged, eaten	beet armyworm cabbage looper crickets	16 20 51
Leaves	LEAVES ESSENTIALLY ENTIRE, OCCASIONALLY TORN cupped and torn. seedlings stunted	thrips	15
	deformed, covered with honeydew	APHIDS mealybugs	33 36
	deformed, covered with honeydew, with waxy scales on lower surfaces	whiteflies	35
	deformed, scarred; plants whip-like	cotton fleahopper black fleahoppers	37 38
	discolored, yellow to red or brown above, usually webbed beneath	SPIDER MITES	53
	webbed together, chewed beneath webbing	webworms	25
	rolled and webbed; terminals chewed	omnivorous leaf roller	28
	irregularly mined, often with many small "windows"	cotton leaf perforator	22
	with long, twisting mines	leaf miners	49

<i>Plant Part</i>	<i>Injury</i>	<i>Pest</i>	<i>Pages</i>
	LEAVES SKELETONIZED, SOMETIMES WITH "SHOT" HOLES OR "WINDOWS"		
Leaves	skeletonized or with small "windows"	cotton leaf perforator	22
	with "shot holes," skeletonized, occasionally ragged	cucumber beetles Colaspis beetles	45 44
	with upper or lower surfaces skeletonized	various young caterpillars (feeding in groups): beet armyworm fall armyworm yellow-striped armyworm cotton leafworm salt-marsh caterpillar	16 17 32 21 30
	LEAVES RAGGED OR TOTALLY CONSUMED		
Leaves	ragged; plants occasionally defoliated	various older caterpillars: beet armyworm yellow-striped armyworm cabbage looper cotton leafworm cutworms salt-marsh caterpillar white-lined sphinx caterpillar grasshoppers crickets	16 32 20 21 24 30 32 52 51
	punctured, disfigured, flared, eventually dropped	STINK BUGS	40
	punctured, disfigured, flared, with shiny excrement spots, eventually dropped	LYGUS BUGS and relatives	38
Squares	with holes, hollowed out, eventually dropped	BOLLWORM beet armyworm cotton square borer yellow-striped armyworm (rarely)	18 16 24 32
	with bracts rolled and webbed, bracts and squares chewed	omnivorous leaf roller	28

<i>Plant Part</i>	<i>Injury</i>	<i>Pest</i>	<i>Pages</i>
Flowers	punctured, disfigured	STINK BUGS	40
	"wartly," disfigured, flared, with shiny excrement spots	LYGUS BUGS and relatives	38
	with holes, eaten out	BOLLWORM beet armyworm cotton square borer yellow striped armyworm (rarely)	18 16 24 32
	with petals rosetted	PINK BOLLWORM	26
	ragged, with large beetles in "cup"	June beetles	46
Bolls	with slightly depressed reddish brown spots; injured small bolls turn yellow and drop	STINK BUGS	40
	with smaller reddish-brown specks, shiny excrement spots, - injured small bolls turn yellow and drop	LYGUS BUGS and relatives	38
	with holes, eaten out, small bolls drop	BOLLWORM beet armyworm cotton square borer yellow-striped armyworm (occasionally)	18 16 24 32
	bored at tips, often chewed	cotton leaf perforator (occasionally)	22
	with short mines (1 inch) and (or) exit holes in carpels, holes thru lint and between locks; small pink larvae within seeds of large bolls	PINK BOLLWORM	26
	with small and large holes in carpels, holes thru lint between locks, weevil pupae or adults within hollow cells in lint	thurberia weevil	47
	honeydew on lint	APHIDS whiteflies mealybugs	33 35 36

Field Guide to Recognition of Insects Commonly Associated with Cotton in Arizona

MAJOR PESTS IN CAPITALS. *Beneficial insects in italics.*

I. INSECT EGGS OFTEN FOUND ON COTTON PLANTS.

	<i>Pages</i>
Laid in groups or clusters	
White to cream, round, variously sculptured; usually on underside of leaves and near top of plant.....	30
<i>salt-marsh caterpillar</i>	
Pearly white to gray, with purplish bands and definite ridges, clusters indiscriminately placed.....	24
<i>cutworms</i>	
Pale green covered with velvety hair.....	16
<i>beet armyworm</i>	
Pale blue-green, flat, overlapping, on upper surfaces of leaves.....	28
<i>omnivorous leaf roller</i>	
Nearly transparent, overlapping, on underside of leaves.....	25
<i>webworms</i>	
Mostly white to gray, like little barrels.....	40
STINK BUGS	
Orange, cigar-shaped, standing on end.....	59
<i>lady beetles</i>	
Laid singly	
Greenish to red, oval, ridged like a peanut, at bases of bolls and on inside of bracts.....	26
PINK BOLLWORM	
Whitish-green, flattened "domes," depressed on top, covered with small hexagonal depressions, on foliage.....	24
<i>cotton square borer</i>	
Blue-green to dirty white, flattened "saucers," ribbed, usually on undersides of leaves.....	21
<i>cotton leafworm</i>	
Pearly white, ridged, inverted "cups" with brownish band on upper third soon after deposition, as tall or taller than width at base, usually in terminals on upper third of plant.....	18
BOLLWORM	
White, shallow inverted "cups," never with brownish band, shorter than width at base, on foliage.....	20
<i>cabbage looper</i>	
White to green, on silken stalks, mostly single but occasionally in groups, on foliage.....	56
<i>green lacewings</i>	

II. CATERPILLARS (WORM-LIKE IMMATURE STAGES OF BUTTERFLIES AND MOTHS)

Descriptions apply most accurately to nearly mature caterpillars.

Pages

In soil (during day)	Mottled gray to brown, smooth, fat, "greasy," curl up when disturbed; usually feed at night.....cutworms	24
	and head; false legs on 6th segment not fully developed.....salt-marsh caterpillar	30
	Black with yellow and brown stripes.....yellow-striped armyworm	32
	Pale yellow to black with white stripes and dark spots on back Very hairy.....cotton leafworm	21
Exposed on	Yellowish to green, tubular, only two pairs of legs under middle of body, moves with looping gait.....cabbage looper	20
foliage	Large, pale green to black, with white lines on body and yellow horn at rear.....white-lined sphinx caterpillar	32
	Greenish with faint lighter stripes, with black spot on each side behind head.....beet armyworm	16
	Light to dark brownish gray, with three white lines on dark plate behind head; sometimes with lighter inverted "Y" on head; paired dark spots on each segment along back.....fall armyworm	17
	Small (1/4 inch long when mature), dull amber-green with gray-black spots and lighter "bumps" over body.....cotton leaf perforator	22
Within webbed or rolled leaves and bracts	Small, active, olive-green, with chalky spots on each segment; in rolled and webbed leaves or bracts.....omnivorous leaf roller	28
	Dark green to pale green with black spots on each segment; in loose, webbed shelter.....webworms	25
Within leaf mines	Minute (one-sixteenth inch), white.....young cotton leaf perforators	22

	Pages
Velvety-green, slug-shaped..... cotton square borer	24
Greenish to rose brown, with light and dark stripes on sides; bolls with entrance hole; excrement pellets usually visible..... BOLLWORM	18
Greenish with faint lighter stripes, with black spot on each side behind the head..... beet armyworm	16
Black with yellow and brown stripes; rarely enters bolls..... yellow-striped armyworm	32
Pink on back and sides. lighter beneath, relatively stubby, bolls with short mines (no noticeable entrance holes)..... PINK BOLLWORM	26
Small (1/4 inch long when mature), dull amber-green with gray-black spots and lighter bumps over body, occasionally bore into tips of bolls and chew outside of carpeis..... cotton leaf perforator	22
<hr/>	
III. OTHER LARVAE	
White to cream, 1/4 inch long, in soil and on seed or underground parts of seedling (maggot)..... seed corn maggot	50
White to cream, about 1/8 inch long, in leaf mine (maggot)..... leaf miner fly	49
Usually pale green, 1/4-1/2 inch long, found near aphids (maggots)..... <i>syrphid flies</i>	61
White to cream, about 1/4 inch long, in bolls..... thurberia weevil	47
Tan to yellow, up to one inch long, in soil..... wireworms	48
Black with orange and (or) white marks, about 1/4 inch long, active, usually associated with aphids on plant..... lady beetles	59
Mottled brown and cream, tapering at both ends, sickle-shaped "jaws," active on plants..... lacewings (<i>aphid lions</i>)	56
<hr/>	
IV. PUPAL SHELTERS	
Portions of leaves or bracts rolled and tightly webbed..... omnivorous leaf roller	28
Portions of leaves loosely webbed, pupa sometimes exposed and hanging by a silken thread..... cotton leafworm	21
Loosely-webbed protective coverings on leaves..... cabbage looper	20
Silvery, round, pea-sized cocoons..... <i>green lacewings</i>	56

V. HEMIPTEROUS INSECTS (TRUE BUGS, WITH A SUCKING BEAK, FOREWINGS MEMBRANOUS AT TIPS)

	Pages
Shield-shaped, $\frac{1}{4}$ - $\frac{1}{2}$ inch long.....	40
$\frac{7}{8}$ inch long, straw-green to dark brown, rear half of wings bent downward.....	STINK BUGS
Oval-shaped.....	38
$\frac{3}{8}$ inch long, dark brown or black, reddish triangle behind head with two dark spots, outer wing margins orange to red, (resembles large lygus bug).....	LYGUS BUGS (adults)
superb plant bug	43
Larger than $\frac{1}{8}$ inch.....	40
$\frac{1}{4}$ - $\frac{3}{8}$ inch long, oval to round, wingless various colors	STINK BUS (nymphs)
Slender, forelegs held as in prayer.....	56
$\frac{1}{2}$ inch long, green and wine or brown, legs long and thin, neck narrow, spines prominent.....	<i>assassin bugs</i>
$\frac{3}{4}$ inch long, gray to buff, almost cigar-shaped, spines not conspicuous.....	<i>habids</i>
58	
Pale green with black specks over body, about $\frac{1}{8}$ inch long; resemble small lygus bugs.....	fleahoppers
37	
Same as above, but black.....	black fleahoppers
38	
Buff to dark brown or black, $\frac{1}{8}$ inch long or smaller, with dark protruding eyes and a silvery triangle where wings cross on back.....	<i>big-eyed bugs</i> (adults)
58	
Shiny gray to brown or black, wingless with protruding dark eyes.....	<i>big-eyed bugs</i> (nymphs)
58	
Black with three silver-white areas on back, tiny ($\frac{1}{8}$ inch long).....	<i>minute pirate bugs</i> (adults)
59	
Amber to orange, wingless, $\frac{1}{8}$ inch long or smaller.....	<i>minute pirate bugs</i> (nymphs)
59	
Bright green or shiny tan, wingless, with spots on abdomen (resemble aphids but are more active).....	LYGUS BUGS (nymphs)
38	

VI. OTHER SMALL TO MINUTE INSECTS AND MITES

	Pages
Body round or oval, often in colonies	
Body with white, waxy filaments or "powder"	
Oval, 1/4 inch long, covered with powdery wax. Seldom moves.....	36
Oval to round, scale-like, bordered with white, waxy filaments.....	35
Like tiny white moths.....	35
whiteflies (nymphs)	
whiteflies (adults)	
Almost globular, most with less obvious waxy covering, 1/8 inch long, six legs, slow-moving, associated with honeydew.....	33
APHIDS	
Body naked	
Round, green to reddish, almost invisible to the naked eye, eight legs, active.....	53
SPIDER MITES	

Slender, not in colonies	
Usually greenish, wedge-shaped 1/8 to 1/16 inch long, wings held roof-like over body.....	36
various leafhoppers	
Usually yellow to straw-colored, 1/25 inch long, two pairs of fringed wings held flat over back, move actively.....	15
thrips (adults)	
Yellow to straw colored, wingless, similar in habit to adult thrips.....	15
thrips (immature)	

VII. BEETLES (SMALL TO RELATIVELY LARGE INSECTS, OFTEN PILL-SHAPED, HARD, VARIOUSLY COLORED)

1/2 inch or larger	
Rust to dark brown with buff wing covers, 1/2 inch long.....	46
desert June beetles	
Metallic green with irregular buff margin on wing covers, robust, 1 to 1 1/2 inches long.....	46
Texas June beetles	
Rust, with sparse golden hairs, prominent snout, 1/4 inch long.....	47
thurberia weevil	
Yellow to buff, with fine longitudinal ridges on wing covers, 1/4 inch long.....	44
Colaspis beetles	
Dull brown to black, robust, 1/4 inch or longer, hidden during day.....	45
darkling beetles	

Harmful and Non-injurious Insects and Related Pests

THRIPS

Thrips found on cotton in Arizona are predominantly of the genus *Frankliniella*. They are small, slender insects about one twenty-fifth inch long.

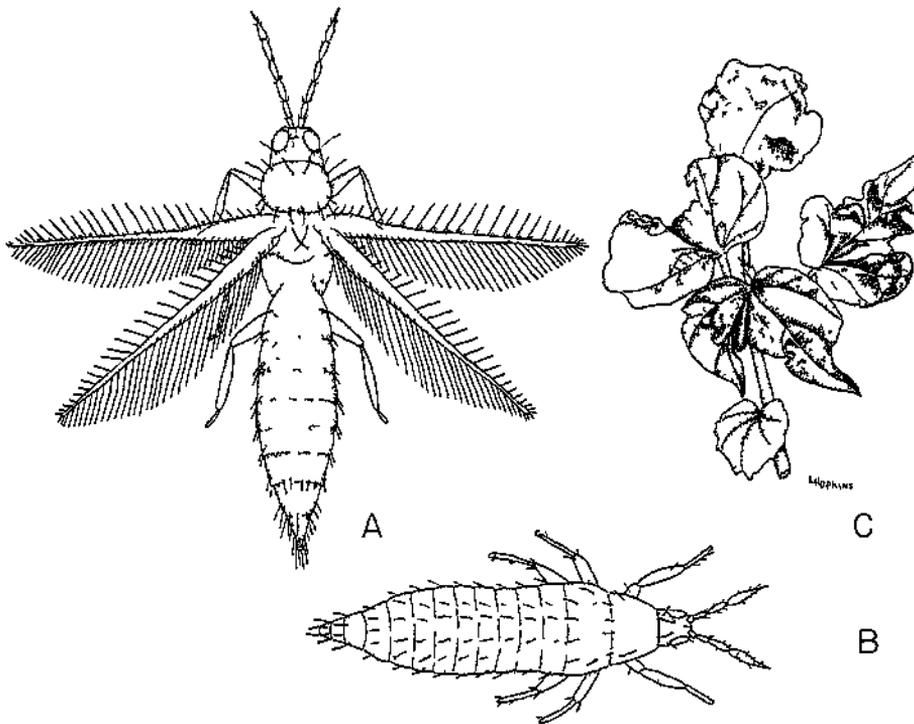
The adults are a brownish straw color and have fringed wings. Immature individuals are usually lighter in color and wingless.

Thrips overwinter as pupae in the ground. In the spring, enormous numbers of newly emerged adults feed and reproduce on the flowers and new growth of numerous culti-

vated and wild plants. During the seedling and early leaf stages, young cotton plants are particularly attractive to emerging thrips.

Females insert their eggs into the tissues of the young plants. After hatching, the young thrips take approximately three weeks to mature. Pupation occurs in the soil. These insects are present in cotton throughout the growing season, but are harmful primarily in the spring.

Thrips puncture the cells of young



Frankliniella thrips. A—Adult; B—Mature nymph; C—Cupping and tearing of leaves caused by thrips feeding on a young cotton plant.

cotton leaves and consume the escaping juices. Injured areas do not grow normally and cause the leaves to twist, become distorted and tear as they increase in size. The outer edges of affected leaves usually curl up and in, causing "cupping."

This damage generally differs from aphid injury, which most often causes the leaves to curl down at the edges. Severe infestations, of 25 or more thrips per plant, may kill seedling plants outright. An average of less than one thrips per plant before the first true leaf unfolds may cause severe damage during a prolonged cold period. During warm weather (good growing weather), or after the first true leaf unfolds, seedling plants can

tolerate greater thrips populations

In Yuma, Maricopa and Pinal counties, where growing seasons are long, seedling plants can usually overcome (or outgrow) severe thrips injury. In higher elevations, such as in Cochise and Graham counties, with short growing seasons and cool spring weather, severe thrips infestations may retard plant growth so much that insecticides may be required for maximum yields

During a warm spring, even in the higher elevations, seedling plants can usually outgrow thrips injury. When the maximum daily temperature reaches 85° or above, thrips populations on seedling cotton will disappear in a short time.

BEET ARMYWORM

Spodoptera exigua (Hbn.)

This insect is found throughout the Southwest. It is harmful to sugar beets, cotton, vegetables, and forage crops.

The pale to olive green caterpillars grow to an inch or more at maturity. A darker stripe is evident down the middle of the back, and pale stripes run along the sides. There is a characteristic small black dot on each side above the second pair of true legs.

The moths are about three-fourths inch long with a wing span of one to one and one-fourths inches. They are dusky, mottled gray with distinct lighter markings on the fore wings.

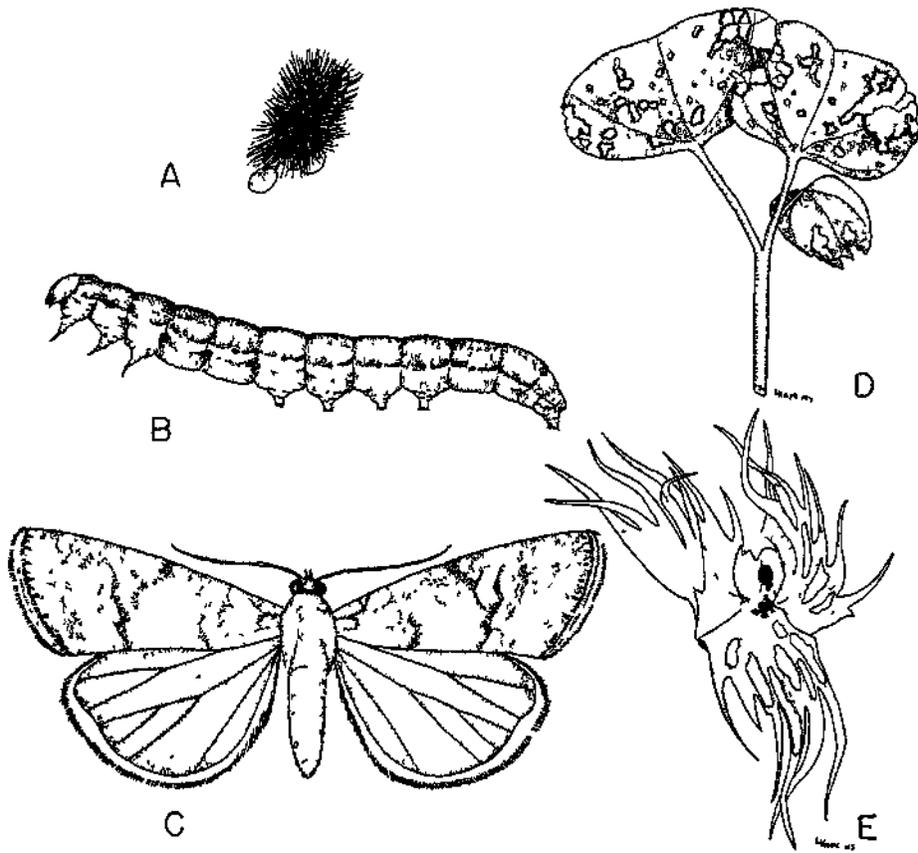
On seedling cotton plants, eggs are laid in small masses on the lower leaf surfaces. The masses are covered with a velvety material exuded by the female moth. After hatching, the young larvae skeletonize the egg-mass leaves before dispersing to other leaves or plants.

The growth and feeding rates are very rapid. Half grown or larger larvae may consume entire leaves, thereby destroying seedling plants. When

abundant, beet armyworms have destroyed entire stands of cotton, particularly in the Marana and Maricopa areas. Effective parasitism has controlled a majority of these infestations on seedling cotton.

When preferred host plants such as desert vegetation or alfalfa dry up during May and June, beet armyworm adults migrate to nearby cotton fields, causing destructive infestations. On half-grown cotton plants, the larvae confine their feeding to the leaves although, in a number of instances, populations have been so heavy that larvae have also fed on squares and half-grown bolls, as done by the bollworm

In extremely severe infestations, after bolls have been destroyed, larvae have been observed to bore into stems about 6 inches below the terminals, causing a die-back to a short distance below the entrance holes. During periods of heavy infestations egg masses may be laid on both the lower and upper leaf surfaces.



Beet armyworm. A—Egg cluster; B—Mature larva; C—Adult; D—Damage to cotyledons by young larvae; E—Damage to square by nearly mature larva. Note the characteristic injury to the bracts.

Mature caterpillars pupate in the soil. There are five or more generations during a year. The rate of development varies with the temperature. Under the high temperatures of July and August a generation may be completed in less than three weeks.

In the Salt River Valley, after cotton has matured, beet armyworms continue to develop on sugar beets and alfalfa. In the spring, before the cotton plants have emerged, infestations may

again be found on these host plants. The winter period is passed as a pupa in the soil.

The fall armyworm, *Laphygma frugiperda* (J. E. Smith), is similar to the beet armyworm. It survives the winter in tropical areas and the moths migrate northward each season. Its preferred hosts are grasses and other forage crops. The fall armyworm is an incidental pest of cotton in Arizona and is most likely to cause damage in poorly managed, weedy fields.

BOLLWORM

Heliothis zea (Boddie)

The bollworm is a primary pest of cotton in southwestern United States. It is also commonly known as the corn earworm and the tomato fruitworm because of its damage to these crops. Alfalfa, beans, lettuce, and soybeans are among the many other crops attacked.

One female moth may lay from 1,000 to 3,000 eggs, normally during a period of from one to two weeks. The eggs are minute and are placed singly, usually on the tender terminals in the upper third of the cotton plant.

A bollworm egg is characteristically taller than its width at the base and resembles a small, finely ribbed, inverted cup. Each egg is pearly white when first laid but within 24 to 36 hours a purplish brown band appears on the upper third. Ordinarily, hatching occurs in from two to four days.

The young larva is at first cream to tan colored with conspicuous black dots, each of which bears a single hair. As the larva grows, these dots become less conspicuous.

Mature bollworms are approximately one and one-half inches long and vary in color from pale green through rose to dark brown. Light and dark bands extend along the back and sides. The head of an older larva is usually yellowish-brown in color. The spiracles (breathing pores) along the sides of the body are usually conspicuous.

Slight magnification reveals numerous tiny spines arising from the skin. These spines or spicules are found only on the bollworm and its nearest relatives.

The bollworm passes through six larval growth periods in from 17 to 21 days during the summer. The mature larva drops from the plant and bur-

rows a few inches into the ground where it pupates.

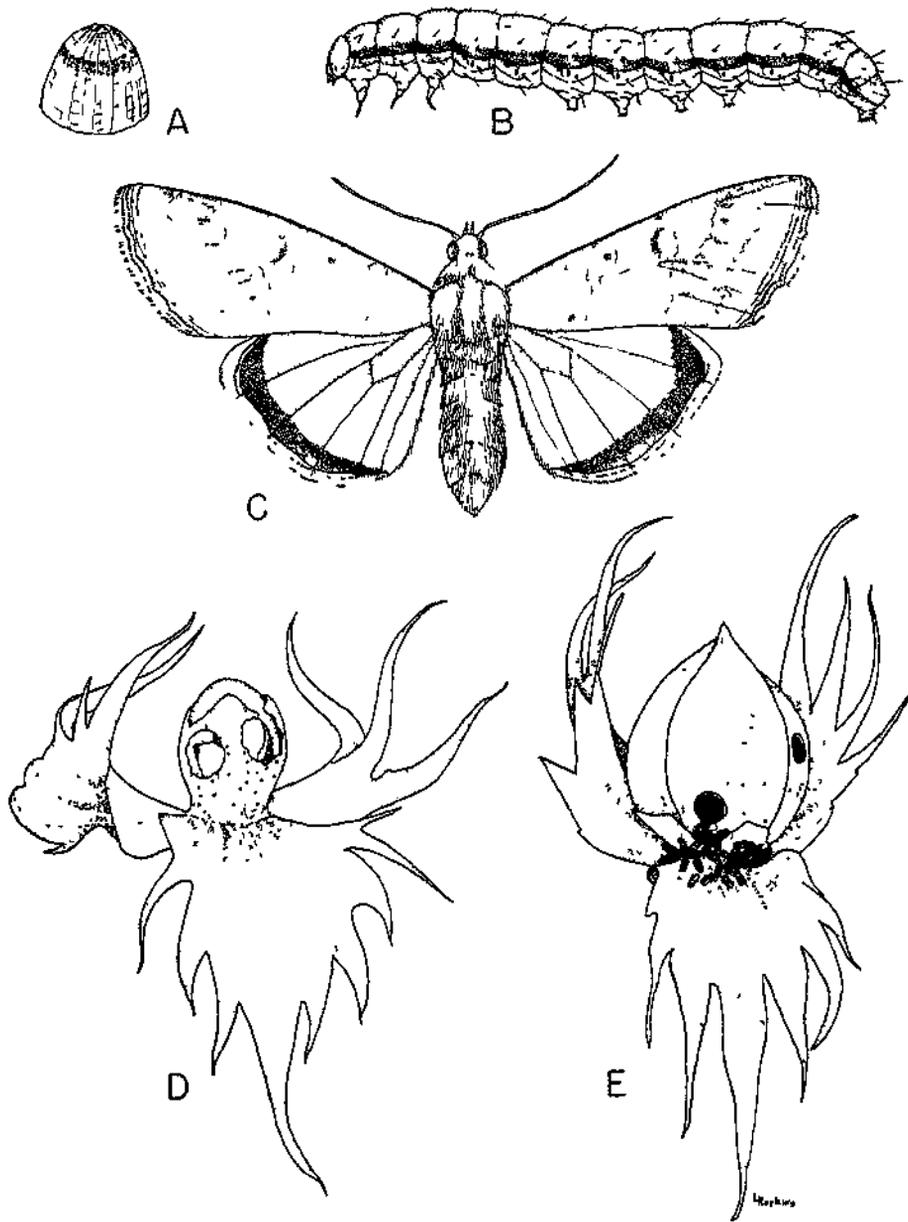
The dark brown pupa resembles a hard, compact mummy upon which various features of the developing moth may be recognized. Normally the pupal stage extends from one to two weeks in mid-summer. The pupae of the last generation hibernate in the soil until the following spring, when a new generation of moths emerges.

The moth has a wing span of one and one-half inches. The fore wings are buff to tan, marked with irregular dark lines and spots. A rather large, dark crescent near the center of each forewing helps to identify the species. The hind wings are light gray with a dark band at the trailing edges. These moths are most active at dusk.

The entire life cycle requires from 25 to 30 days during mid-summer. In Arizona, approximately six to eight generations are produced annually, three to four of which occur on cotton.

The early generations of bollworms develop on preferred hosts such as lettuce, corn, and sorghum. Until the bolls are half grown, cotton is not favored for the development of bollworm larvae. Infestations on cotton usually begin when preferred host plants have matured and the cotton plants have developed bolls. This period begins about the first of August in the Salt River Valley. The damage is worst in rainy weather.

Newly hatched larvae usually feed on the tender leafy portions of the plant. After feeding for a few days these young larvae molt to a second instar which prefers to feed on squares and flowers. When half-grown or larger, the larvae attack bolls exclusively. (See drawing at right.)



Bollworm. A—Egg. Note characteristic dark band; B—Mature larva; C—Adult; D—Damaged square; E—Damaged boll.

A nearly full-grown larva will bore into a large cotton boll and completely destroy it in about two days. While completing its development, a single larva can destroy from 8 to 15 squares and bolls. Although bollworms primarily damage fruiting structures, they may occasionally rag the foliage and bore into the stems.

To adequately detect bollworm infestations, fields should be examined weekly after mid-season (July 15 in the Salt River Valley). Approximately 100 plants should be examined in each of 4 or 5 areas of the field. The terminals of the plants should be examined for eggs and small bollworms.

If only eggs are found, the field should be re-examined for small boll-

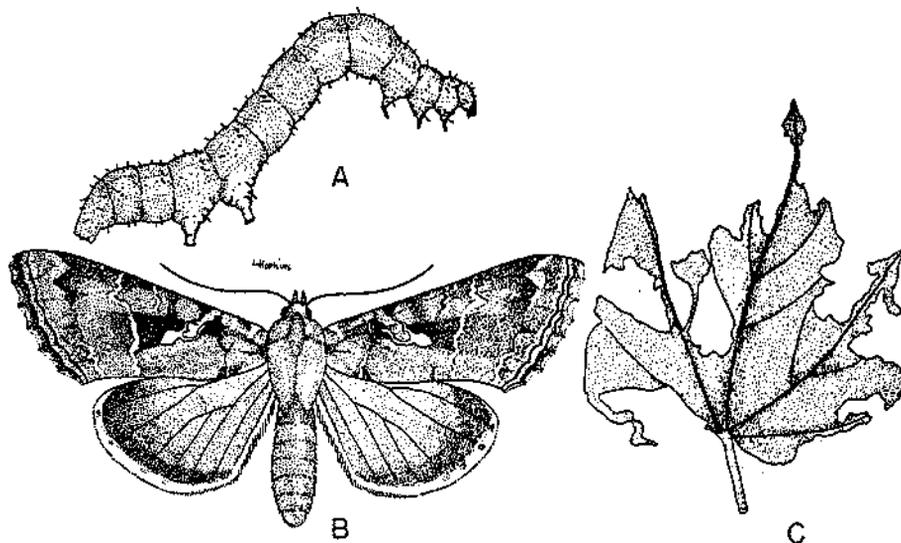
worms in about 3 days since beneficial insects, such as parasitic wasps, minute pirate bugs (*Orius*), and lacewing larvae, will often destroy bollworm eggs and prevent the development of an infestation. If an average of 3 or 4 small worms per hundred plants is found, insecticide treatments should begin at once, since bollworms over one-half inch long are very difficult to control.

The improper choice of insecticides for the control of lygus bugs or cotton leaf perforators may intensify the bollworm problem, probably due to the destruction of natural enemies, even when applications are made as long as three weeks before the start of the bollworm season.

CABBAGE LOOPER

Trichoplusia ni (Hbn.)

Cabbage loopers are commonly found ragging cotton leaves in Arizona during July and August. They are generally distributed over the state, and



Cabbage looper. A—Mature larva; B—Adult. Note "Y" shaped markings on fore wings; C—Typical leaf injury.

also attack lettuce, alfalfa, and other crops.

Mature loopers attain a length of approximately one inch. They vary from light to dark green, generally with a paler head.

These caterpillars have but two pairs of legs under the mid-section of the body and move about with a looping gait. The moth is about an inch long, with a wing span of one and one fourth to one and one half inches. Its body and hind wings are dull gray or brown. The fore wings are mottled gray or brown, each with a conspicuous silver mark near the middle.

Eggs shaped like shallow, inverted cups are deposited individually on the leaves and other tender parts of the plant. During the growing season it takes approximately three weeks for

the newly hatched caterpillars to reach maturity. The mature caterpillars pupate beneath a loose web covering usually on a leaf. In Arizona there are several generations annually on cotton.

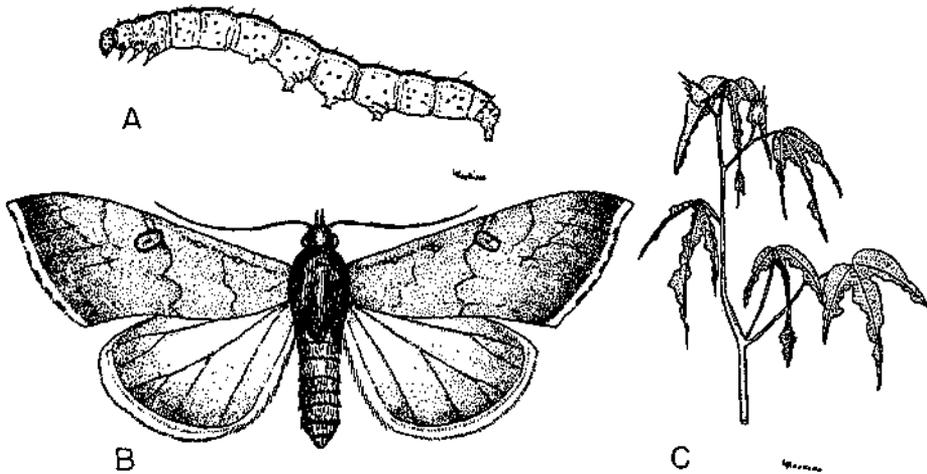
Cotton foliage attacked by loopers has a ragged appearance. When looper populations and humidity are high, infestations are commonly controlled by a polyhedral virus disease, which causes the loopers to turn yellow and die. Under such conditions the plants outgrow the looper injury in a short time.

When the humidity is low, the virus disease is slower and less effective in its action, so that cotton fields may be defoliated before loopers are controlled by this natural agent. Under such conditions insecticides may be required.

COTTON LEAFWORM

Alabama argillacea (Hbn.)

In the United States the cotton leafworm is frequently injurious in the humid Southeast but is seldom a pest in the arid Southwest. In Arizona in-



Cotton leafworm. A—Mature larva; B—Adult; C—Leaf Injury.

jurious populations rarely develop, and harmful infestations have not been reported since 1944. The cotton leafworm cannot survive the winters in temperate United States, but infestations occur when the moths migrate north from the tropics.

Full grown cotton leafworm larvae are slender and about one and one-half inches long. They vary in color from light yellowish-green to nearly black. There are three narrow white stripes along the back and a white line along each side.

In addition, two parallel rows of black spots extend along the back. Each spot bears a black spine surrounded by a white ring. On the dark forms, the black spots are joined together.

The moth has a wing span of one and one-eighth to one and one-half inches and is light brown, tinged with olive and red. The fore wings are

crossed with wavy, reddish lines. Each wing has a distinct spot near its center and three equidistant white specks near the base. The posterior edges of the fore wings are fringed with a narrow white stripe broken by dark spots.

Cotton is the only host plant upon which this insect can complete its development. Eggs are laid individually on the undersides of the leaves. After hatching, the young larva feeds on the under surface of the leaf. Upon molting it moves to the tender terminals.

Larger larvae feed upon all parts of the plant. Pupation occurs on the plant in a loose cocoon which usually incorporates a folded corner of a leaf.

In the past, insecticide treatments have been required for small, localized infestations in Graham, Greenlee, and Cochise counties. Since 1958, only very light infestations have been observed in these counties, for which no insecticides have been required.

COTTON LEAF PERFORATOR

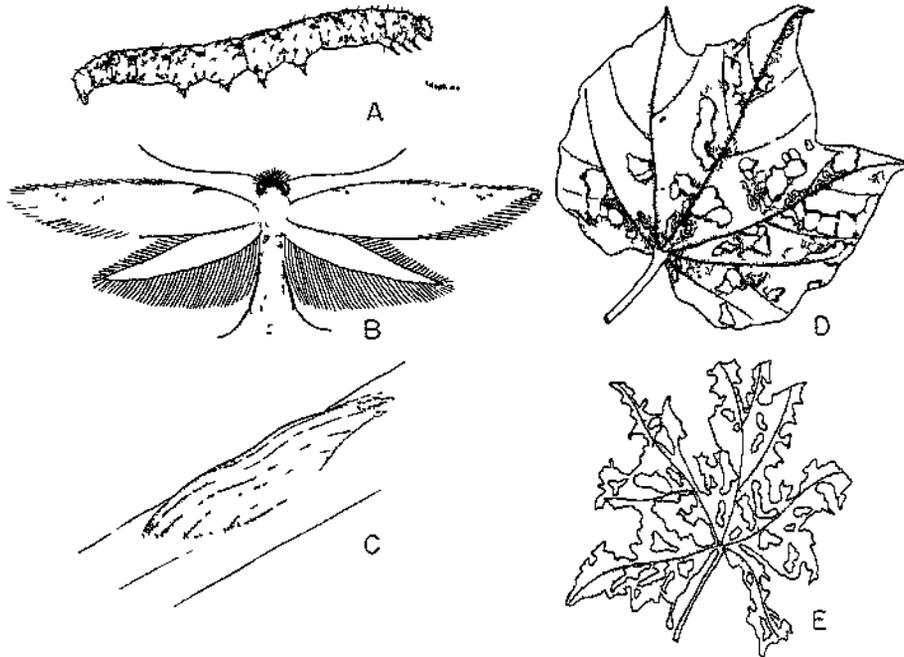
Bucculatrix thurberiella Busck

The cotton leaf perforator has been present in Arizona for many years, but it has recently become more prominent as a pest. Particularly severe infestations have been reported in Yuma, Maricopa, and Pinal counties.

Adult cotton leaf perforators are tiny white moths about one-eighth inch long. The females lay minute, vertically ribbed, bullet-shaped eggs singly on the leaves, bracts and bolls. The eggs are at first milky, but change to a rust color before hatching. Because of their small size, these eggs are seldom noticed on the plants.

The small, white, newly hatched caterpillars make irregular mines in the foliage. After molting once, they leave the mines to feed externally. During the second molt they are protected within a white, U-shaped, silken covering. This is frequently referred to as the "horseshoe stage."

The second stage and mature larvae are dull amber-green with gray-black spots and lighter "bumps" over the body. Full-grown larvae are about three-sixteenths inch long. The mature caterpillars pupate on the plant in small, white, ribbed cocoons. Although



Cotton leaf perforator. A—Mature larva; B—Adult; C—Cocoon; D—Cotton leaf showing mines of first instar larvae and "windows" made by older larvae. E—Cotton leaf severely damaged by mature larvae.

generations tend to overlap as the season advances, at least five distinct generations were reported at Yuma between June 30 and August 20, 1955.

Cotton leaf perforator infestations are characterized by small "windows" or perforations in the leaves. Severe infestations may skeletonize the leaves and can cause partial or complete defoliation.

This defoliation forces the cotton plants into a stunted condition for a prolonged period when very little new leaf growth is formed. As a result, squares, flowers, and small bolls are dropped by the plant. The remaining bolls open prematurely, with lowered yields and grades. When the plants are nearly defoliated, the larvae in their search for food have been observed entering tips of bolls and feed-

ing internally.

Cotton leaf perforator infestations are usually first found on small or stunted plants, localized near the edges of fields. By the time such plants show typical ragging injury, the infestation will usually have spread over entire fields, often in less than a week. Insecticides effectively control leaf perforators only if applied before migrating populations have had time to build up to destructive numbers within a field.

The insect is known to attack only domestic and wild cotton. Stub cotton and unplowed fields harbor the pest during the winter, providing a source of reinfestation the following year. Early removal of post-harvest stubble will discourage the cotton leaf perforator and other injurious insects that overwinter in standing cotton.

COTTON SQUARE BORER

Strymon melinus (Hbn.)

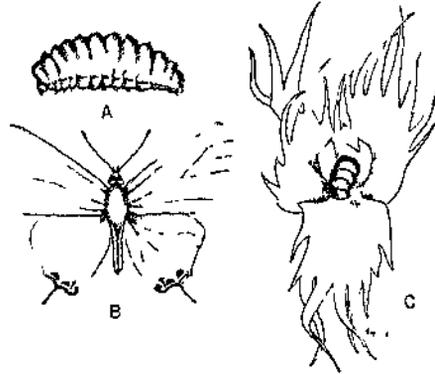
The cotton square borer has a wide range of hosts throughout the United States and is generally considered to be of minor importance on cotton. The adult is a small, bluish butterfly with a wing span of about an inch.

The upper surfaces of the wings are velvety brownish blue; the under surfaces are silvery gray. The posterior margin of each hind wing has a conspicuous tail-like projection with orange spots near its base.

The mature caterpillar is slug-shaped, about half an inch in length, and less than half as broad. It is green and covered with fine, short hairs which give it a velvety appearance. The brown pupa is attached to the plant.

The small, round, whitish-green eggs are laid upon young foliage. The young larvae feed primarily upon the leaves but, when older, attack the squares and

bolts in the manner of the bollworm. Heavy parasitism usually prevents the cotton square borer from becoming a serious pest in Arizona.



Cotton square borer. A—Mature larva; B—Adult; C—Nearly mature larva feeding in a square.

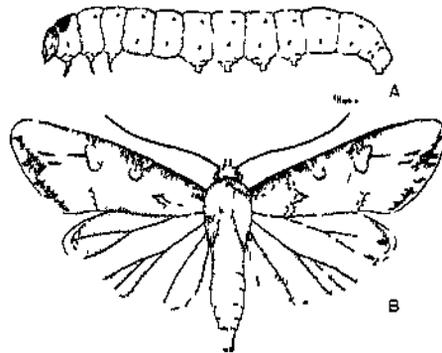
CUTWORMS

(Various Species)

Each year in Arizona a great number of cotton seedlings are lost to these insects. However, because they are not concentrated, these losses attract little attention.

Occasionally cutworms are locally abundant and cause serious damage in restricted areas. Cutworms are often abundant on cotton that follows alfalfa.

The soft, fat, greasy-looking caterpillars are approximately an inch long when fully grown. They are mostly gray-brown or mottled above and lighter beneath.



Black cutworm. A—Mature larva; B—Adult.

The moths are approximately an inch long, with a wing span of one and one fourth to one and one half inches. They are mottled grayish brown with lighter, more uniformly colored hind wings.

Cutworms hide in the soil during the day but emerge at night to feed. When disturbed they curl up and remain motionless. They are particularly

injurious to seedling cotton and may completely devour the young plants or cut them down by severing the stem at ground level. Minor cutworm injury leaves seedlings vulnerable to damping-off fungi.

Winter and spring plowing, disking and other cultivation will reduce the number of overwintering larvae and pupae.

WEBWORMS

The garden webworm, *Loxostege similalis* (Guen.), and the sugar beet webworm, *Loxostege sticticalis* (L.), have a wide range of weed hosts and attack many crops in the Southwest. They are not major pests of cotton but injurious populations are occasionally found, particularly in weedy and poorly managed fields.

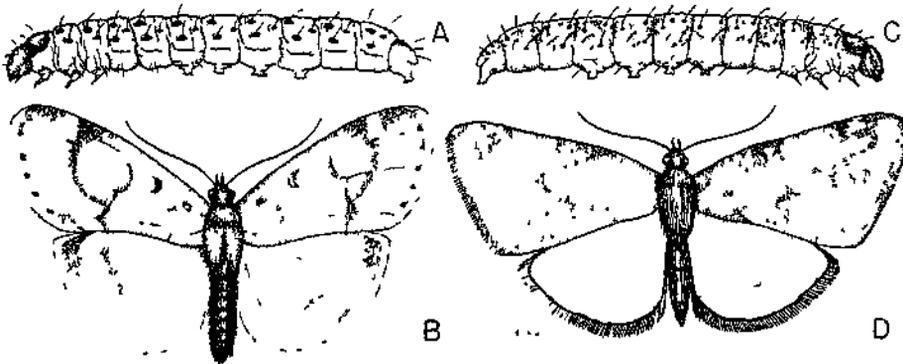
The garden webworm ranges from yellow to pale green with three black dots on the upper portion of each segment. The moth varies from yellow to buff, with darker markings on the fore wings. It has a wing span of approximately one inch.

The sugar beet webworm is pale

to dark green with three longitudinal stripes. and many black and white tubercles. The moth, although similar to the garden webworm, is purplish brown with paler wing bands.

The eggs of these species are laid singly or in clusters on the host plants. The caterpillars feed within loosely-webbed leaves or leaf parts, but frequently abandon these shelters to move from plant to plant. After growing to approximately one inch in length, the mature caterpillars pupate in the soil.

Keeping fields free from weeds will do much to prevent webworm infestations. Fall plowing destroys many overwintering pupae.



Webworms. A—Garden webworm, mature larva; B—Garden webworm, adult; C—Sugar beet webworm, mature larva; D—Sugar beet webworm, adult.

PINK BOLLWORM

Pectinophora gossypiella (Saunders)

Pink bollworm infestations have been observed continuously in Arizona since 1926 in Graham county and since 1927 in Greenlee county. Since 1927 an occasional infestation has been found in Pima and Santa Cruz counties. Occasionally infestations have been found in Pinal and Maricopa counties.

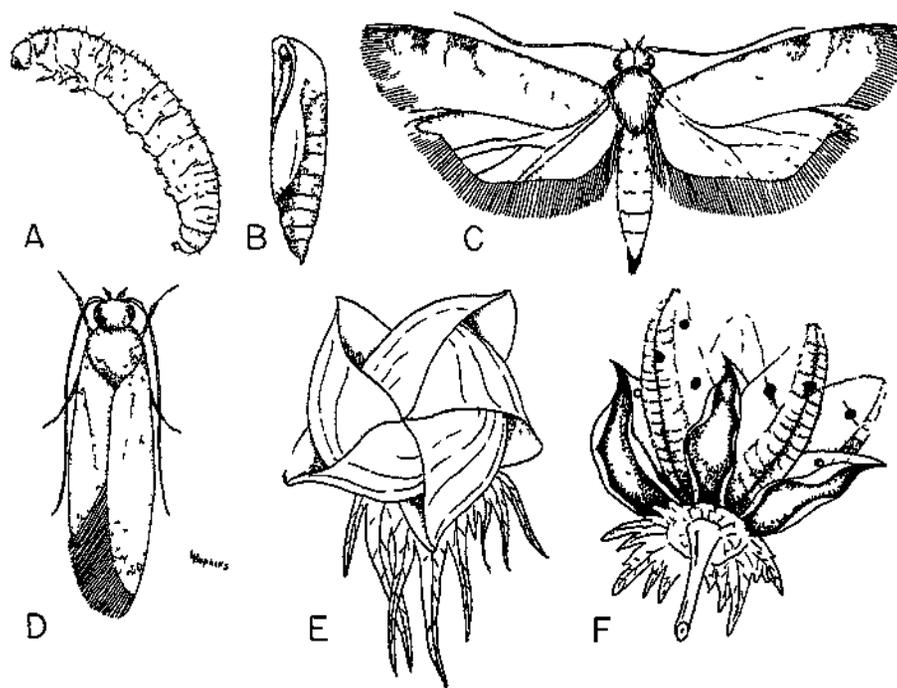
In July, 1958, two damaging infestations on stub cotton were found in Maricopa county, together with a number of non-injurious infestations. Quarantine regulations and eradication programs throughout the years have prevented the pink bollworm from causing serious plant injury in Arizona.

The full-grown caterpillar is about

one-half inch long and is pink on the back and sides. Younger caterpillars are glossy white and difficult to see against the maturing lint.

The adult is a small, mottled, grayish-brown moth. It is approximately three-eighths inch long with a wing span of one-half to three-fourths inch. The fore wings are more slender than the hind wings; both pairs are relatively pointed at the tips. The moths may be carried long distances by air currents.

The oval, greenish to red eggs are laid on all parts of the plant, but the bases of bolls and the inside of bracts seem to be preferred. Immediately



Pink Bollworm. A—Mature larva; B—Pupa; C and D—Adult; E—Rosetted cotton blossom; F—An open boll showing tight locks and damaged lint.

upon hatching, the young caterpillars search for food. Without food they die within 24 hours. It is estimated that 90% of the newly hatched young die before feeding.

Although larvae prefer to attack nearly mature bolls, they will also feed upon squares and flowers. Pupation normally takes place within the bolls but may occur in ground litter or in the soil. In the summer the pink bollworm completes development in three to four weeks. It can have as many as five or six generations a year.

There are two types of pink bollworms: (1) short-cycle larvae that pupate when mature and (2) long-cycle larvae that remain inside the bolls, usually within the seed, to overwinter. Long-cycle larvae may remain dormant as long as two years before pupating.

Injured squares and flowers usually drop from the plant. The larvae cut the lint by mining through the maturing bolls. Lint from infested bolls is short, discolored and of low grade. Oil content of the seed and its germination are greatly reduced.

Infestations can be detected by a number of signs. Caterpillars in the squares web the tips of the flower petals together. When these squares bloom, the *flowers are rosetted*. (See "E" in illustration.) This is particularly evident in fields of short staple cotton during the first week of blooming.

Very small tunnels in the carpels of bolls are a good sign of pink bollworm infestations, but these can only be detected by examining cut bolls.

The larvae make clean-cut holes as they move between the locks or leave the bolls. Late in the season they often web two seeds together before overwintering. *Double seeds* are characteristic of the pink bollworm.

Because this insect tunnels into the bolls and enters the seeds, it is very difficult to control. The prolonged dormancy of long-cycle larvae adds to the problem of yearly reinfestations.

In infested areas the following precautionary measures should be employed. Check fields frequently shortly after blooming starts. At this time, rosetted flowers indicate the presence of pink bollworm. After larger bolls develop, larvae show a preference for them and fewer rosetted flowers are found.

Pink bollworm infestations can be reduced by picking cotton as soon as possible and destroying the stalks and trash as soon as harvesting is completed. Stalks should be destroyed with an efficient shredder that will spread the residue evenly on the ground. Many overwintering larvae are killed during shredding and by exposure of the crop residues to the sun.

Plowing to a depth of six inches or more is preferred. The deeper the plowing, the fewer the surviving larvae. Follow plowing by an irrigation that will wet the soil to the depth of the residue. Irrigation in dry areas helps to decay the residue more rapidly.

If it is not possible to shred the stalks, pasturing with sheep and cattle is recommended.

The growing of stub cotton in the southeastern counties of Arizona encourages pink bollworm survival. Plants standing throughout the winter afford excellent protection for the dormant larvae. Growing stub cotton is, therefore, not recommended in infested areas. Planting non-infested certified seed, delayed planting, proper fertilization, clean cultivation, and early harvesting are all practices that aid in controlling the pink bollworm.

OMNIVOROUS LEAF ROLLER

Platynota stultana (Wlsm.)

This insect has a wide distribution on alfalfa, celery, sugar beets, and many other host plants. It has been reported as a cotton pest in Arizona, New Mexico, and the Imperial Valley of California. In Arizona, it was first recorded on cotton at Buckeye in 1952.

Recent cotton insect surveys report harmful infestations primarily in Maricopa county and moderate infestations in Yuma county. In Maricopa county, severe infestations in cotton have been caused by larval migrations from sugar beet fields recently harvested for seed. Leaf rollers have been observed in fields from early July until September and are probably distributed throughout the state.

Eggs are laid tightly cemented in smooth, usually irregular masses about five-sixteenths inch long and are located primarily on the upper surfaces of the newer leaves. The egg masses are at first a pale green color similar to that of the cotton leaf, but become increasingly darker with age. The eggs of each cluster overlap one another, like scales on a fish. On cotton, the number of eggs per mass usually ranges from 50 to 125.

Upon hatching, young larvae crawl to the top of the plant or to the tip of a branch where they may conceal themselves in a leaf or square. These larvae may commence feeding immediately or may wander about over the plant for several hours.

Usually leaf roller larvae molt once or twice before constructing their char-

acteristic shelters of rolled leaves and bracts. Pupation occurs on the plant within the protection of these shelters.

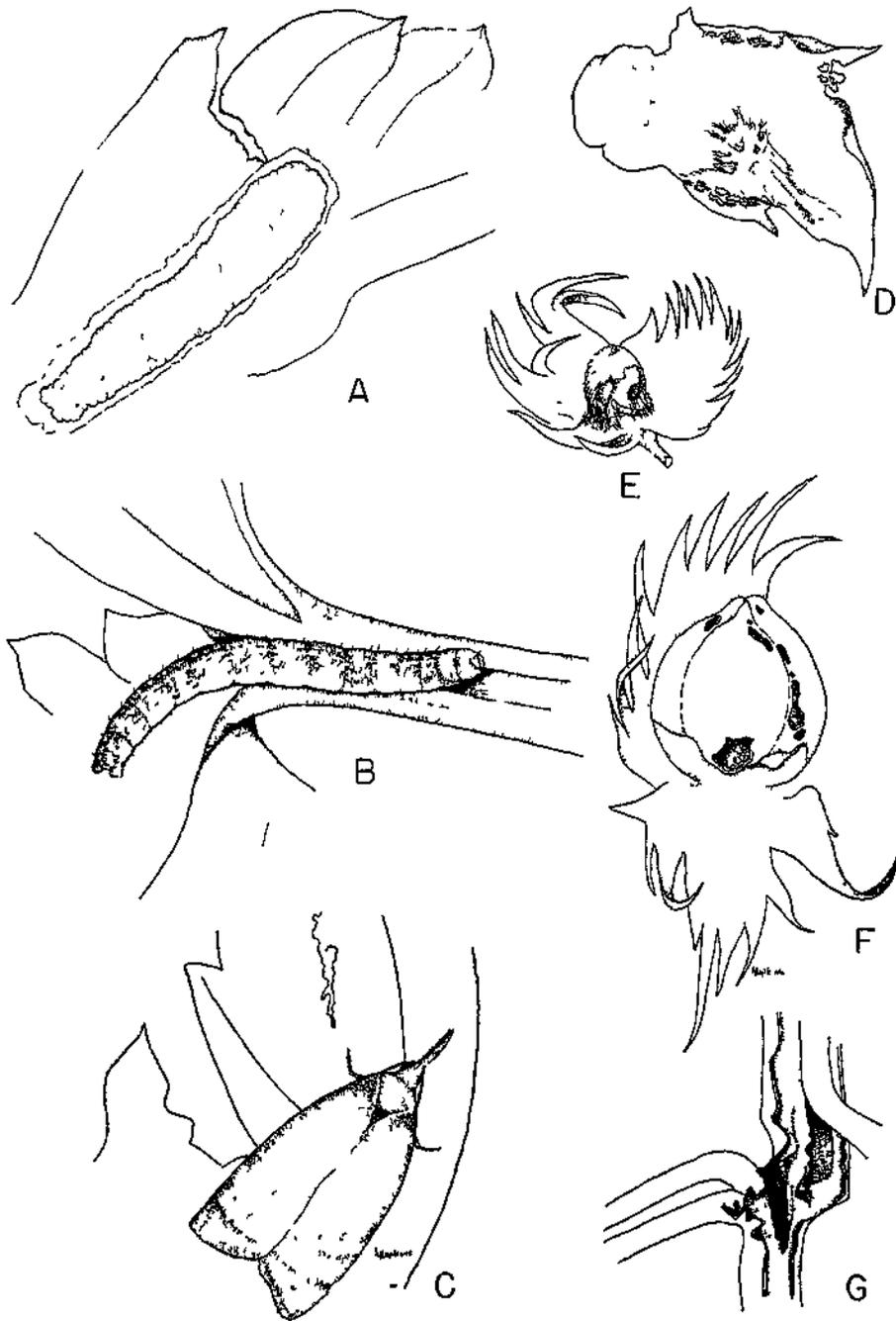
The caterpillars feed in the terminals, on the leaves, bracts, and bolls, and frequently enter the stems. Because they are protected by web structures and plant parts, immature leaf rollers are generally difficult to control with insecticides.

The moths are generally tan or rust-colored and are triangular or bell-shaped when at rest. The females are nearly one-half inch long; the males are slightly smaller and darker in color. Their heads are prolonged anteriorly into distinctive scaly snouts.

The omnivorous roller produces numerous generations each season. Although developmental time varies considerably between individuals, on cotton approximately one month is required from egg to adult during mid-season.

Investigations in southern California indicate that the most practical means to evaluate omnivorous leaf roller populations in cotton is the time-search-basis method. All the living larvae found anywhere on the plants during a given period of time are counted. If living larvae are found at an average rate of 100 per hour (or 25 per 15-minute-search period) control measures are indicated. It is advisable to take numerous counts at different locations in a field in order to adequately evaluate omnivorous leaf roller infestations.

(See drawing at right). 



Omnivorous leaf roller. A—Egg cluster; B—Mature larva; C—Adult at rest; D—Damaged leaf with webbing; E—Injured square with young larva feeding beneath a web shelter; F—A large green boll showing typical surface injury; G—A stem cut away to show internal damage by larval boring.

SALT-MARSH CATERPILLAR

Estigmene acrea (Drury)

The salt-marsh caterpillar is a pest in all cotton-growing areas of Arizona. The caterpillars usually appear on cotton in early August, are most abundant from late August to mid-September, and usually decline in numbers after the first of October.

Young caterpillars are light buff with clusters of long, dark hairs over the body. With an increase in size, the larvae become more hairy. For this reason they are called "wooly worms."

Mature caterpillars are approximately two inches long and are mottled yellow, orange, and black beneath a dense covering of long buff to black hairs. Moths are about one inch long with a two-inch wing span. They are predominantly white with the abdominal segments orange on top, each with a black spot at the middle.

The wings of both sexes are spotted with black. The hind wings of the males are orange. Both wings of the females are white.

Each female may lay as many as a thousand eggs in masses on the under surfaces of the leaves. After hatching, the young caterpillars feed in a group until they have molted twice. They then separate to become independent feeders.

After two additional molts, mature caterpillars hide in the ground litter to pupate.

Within a few days the moths emerge to renew the cycle. A single generation may take three weeks or longer,

depending upon the weather. Mature caterpillars or pupae pass the winter in ground litter.

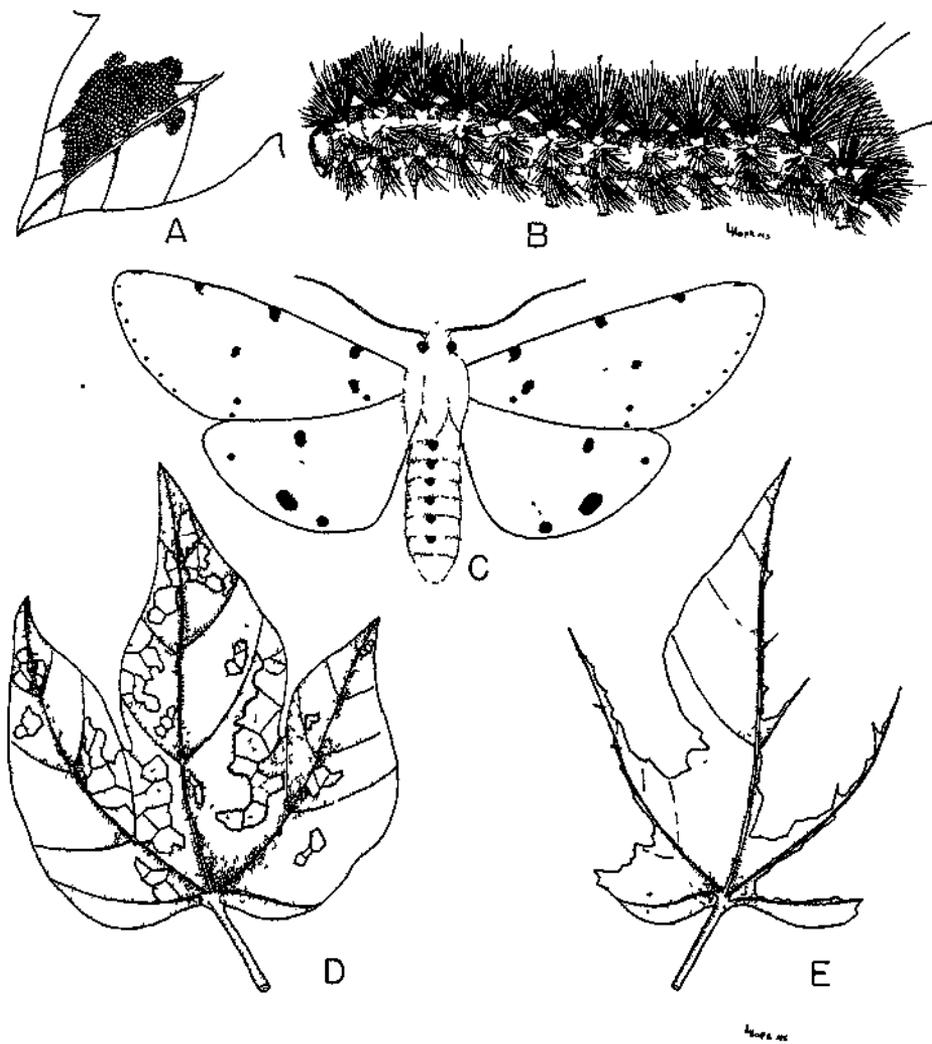
Young larvae, feeding gregariously on the lower surfaces of the leaves, leave the leaf veins and upper surfaces intact. Damaged leaves then have the appearance of fancy lace work. Older larvae, feeding independently, eat through the leaves and consequently rag the foliage.

Severe infestations can defoliate a field in a short time. Once a field is defoliated, the caterpillars leave in search of food.

Defoliation of cotton up to the early part of September results in decreased yields because the small bolls are exposed to the sunlight and open prematurely. Late infestations, occurring in October, may actually be a benefit because the loss of leaves permits sunlight to penetrate the lower portions of the plant, enabling bolls to open faster, thereby preventing boll rot. Late insecticide applications are often made not because they benefit an existing cotton crop but in order to kill caterpillars which would otherwise migrate to damage adjacent crops.

During periods of high humidity, a fungus disease has been very effective in reducing salt-marsh caterpillar infestations. Parasites have also been effective in reducing the numbers of caterpillars entering overwinter hibernation.

(See drawing at right). 



Salt-marsh caterpillar. A—Egg cluster; B—Mature larva; C—Adult female; D—Cotton leaf skeletonized by gregarious young larvae; E—Cotton leaf damaged by a nearly mature larva.

WHITE-LINED SPHINX MOTH

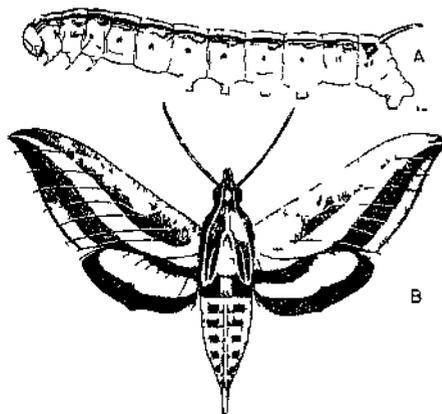
Celerio lineata (F.)

White-lined sphinx caterpillars are very common on grasses and other weed hosts throughout the state during the growing season. In July and August when populations occasionally become large, these caterpillars sometimes invade neighboring cotton fields.

Full-grown larvae attain a length of three inches. They vary from pale green to black, displaying dusky spots and narrow longitudinal white stripes. A characteristic yellow horn is found at the posterior end.

Because of their characteristic shape and habit of darting and hovering in flight, the large moths are said to resemble hummingbirds. They are robust, with a wing span of three inches or more. The fore wings are dark with

broad white lines; the hind wings have a wide, purplish to rose colored band.



White-lined sphinx moth. A—Mature larva; B—Adult.

YELLOW-STRIPED ARMYWORM

Prodenia ornithogalli (Guen.)

In Arizona the yellow-striped armyworm is a common alfalfa pest and frequently causes serious injury to cotton, vegetables, and other crops.

The caterpillars are velvety black to brownish with yellow stripes along the sides, and are reddish beneath. Full grown, they range from one and two-thirds to two inches in length. The gray-brown moths have a wing span of about one and one-half inches.

The fore wings have lighter markings which give them a marbled appearance; the hind wings are silvery gray. These moths fly at night and may become abundant about lights during the summer.

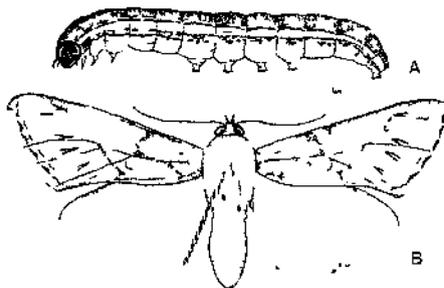
Infestations in cotton may be caused by mass movements of armyworms from nearby crops and weeds or may originate from eggs laid on plants within the field. Serious damage to

border rows is often caused by an invasion of nearly mature caterpillars.

Harvesting nearby alfalfa fields containing large larval populations is the most common cause of these mass invasions. When a food source is depleted or removed, yellow-striped armyworms are capable of traveling a considerable distance in search of a new food supply.

Half-grown or larger larvae may be very destructive to cotton and are difficult to control with insecticides.

Female moths often deposit velvety egg masses on cotton plants. The newly hatched caterpillars at first skeletonize the leaves by feeding in groups. They then slowly radiate from the hatching site as they grow larger and eventually feed independently.



Yellow striped armyworm. A—Mature larva; B—Adult.

Larger caterpillars feed upon all parts of the cotton plant, defoliating, cutting off stems and occasionally consuming the bolls. Injurious populations are frequently localized within a field near their hatching sites.

CICADAS

(Various Species)

Cicadas are medium to large, robust insects with tubular, sucking mouth parts and two pairs of membranous, net-veined wings. The shrill song of the males is a familiar sound during sunny summer afternoons. Wingless immature cicadas inhabit the soil where they feed upon the roots of various plants.

Female cicadas make deep, slit-like, egg punctures in the stems and branches of cotton plants. When these punctures are particularly deep and numerous, the plants may be broken over, especially during periods of strong winds. This injury is of only sporadic importance.

COTTON APHIDS

Aphis medicaginis Koch

Aphis gossypii Glover

Two species of aphids attack cotton in Arizona. Both species damage plants by inserting their beaks into leaf tissue and sucking out the plant juices.

Heavy populations of either species can cause a considerable amount of damage.

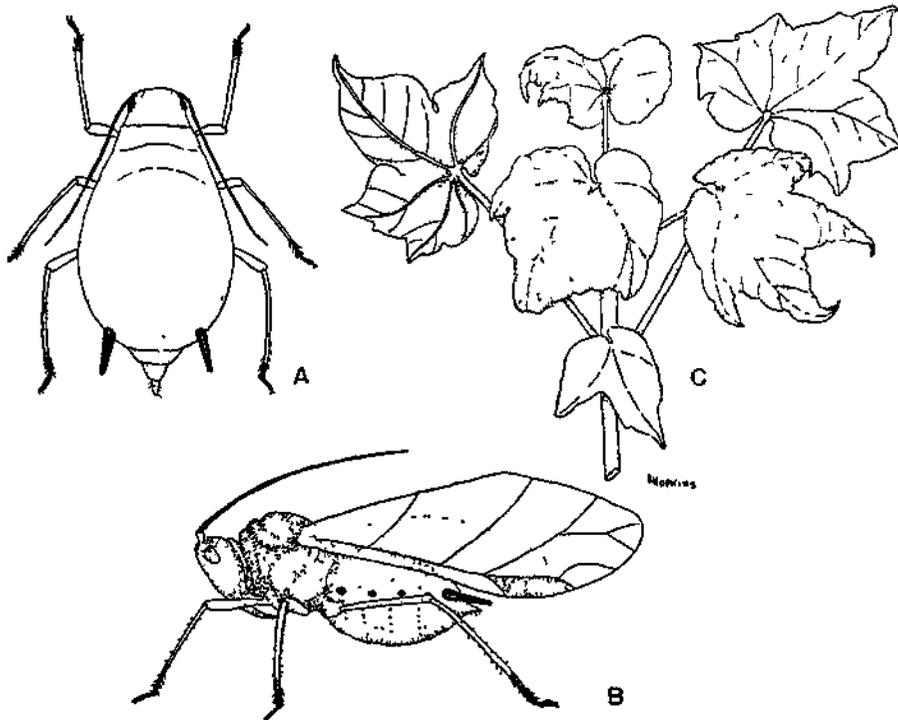
The cowpea aphid, *Aphis medicaginis* Koch, has a shiny black body, with white legs and white markings on the bases of the antennae. The cotton aphid, *Aphis gossypii* Glover, is usually green in color, but under certain ecological conditions can also be yellowish green, brown, or even black in color. Both species migrate into cotton fields as winged aphids and, if conditions are ideal, immediately give birth to living young.

The cowpea aphid is an important pest of seedling cotton during cool weather. Heavy infestations can stunt or even kill seedling plants. The first

injury symptom is a distorted, inverted, cupping of leaves.

Chemical control of this aphid should be delayed until injury is noticed, and then applied only if aphid populations are large. Many times, especially if the weather is warm, predators and parasites will destroy an aphid infestation by the time, or even before, a heavy population starts causing noticeable injury.

As cotton progresses beyond the seedling stage, the true cotton aphid may appear at any time. While feeding, these aphids secrete honeydew which falls and sticks on the lower leaves. When populations are large, the amount of honeydew on the leaves will be so great that they glisten in



Cotton aphid. A—Wingless adult; B—Winged adult; C—Damaged cotton leaves, typically deformed and curled down at the edges.

the sunlight.

During the bollworm season, the adult moths are attracted to this honeydew, intensifying bollworm infestations. Various fungi also develop on this honeydew, giving the leaves a sooty mold appearance. If the sticky honeydew drops on open cotton bolls, ginning can be more difficult. The

sooty mold gives the lint an off-color which results in a lower grade and price.

Heavy aphid infestations on leaves also will stunt the plants; many times leaves will turn yellow and drop. Predators and parasites will often eliminate an aphid infestation before it builds up to destructive levels.

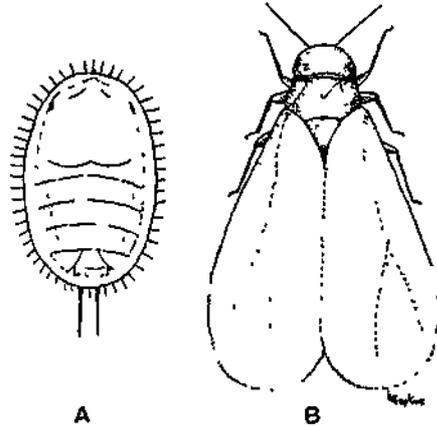
WHITEFLIES

Mainly *Trialeurodes abutilonea* (Haldeman)

These insects are frequently seen in great numbers on the lower surfaces of cotton leaves, particularly in the spring. Wingless, immature whiteflies are about one-twenty-fifth inch long and look like little oval caps surrounded by waxy fringes. The adults are about one-sixteenth inch long and resemble tiny white moths.

Immature whiteflies feed on plant juices like aphids and mealybugs. They seldom, if ever, cause significant damage to healthy cotton plants. Insect parasites and predators are important in suppressing potentially larger whitefly populations. A fungus parasite which becomes active when the humidity is high is also instrumental in reducing these pests.

Each year the initial increase of whiteflies occurs primarily on small weeds found along roadsides and ditch banks. The adults leave their wild hosts to infest young cotton plants in the spring. Elimination of weed hosts before seedling cotton appears will help to reduce the spring increase.



Whitefly. A—Nymph; B—Adult.

Whiteflies are undesirable because they secrete honeydew. However, because infestations are not considered economically injurious to healthy plants, control measures are seldom suggested.

MEALYBUGS

Phenacoccus sp.

Mealybugs are small, oval, soft-bodied insects covered with a powdery white wax which gives them a "mealy" appearance. Immature mealybugs resemble the adults except for their smaller size.

Because these insects are gregarious and sedentary, the white colonies are easy to see on the green cotton foliage. The young, or crawlers, are active and move about in search of a favorable feeding site. Crawlers may disperse to nearby plants where they start new colonies.

Like aphids, mealybugs prefer to feed on the tender tissue. Infestations frequently occur in fields stressed for water. Large colonies deform the foliage, stunt and eventually kill the plant. These pests also secrete honeydew which may lower the grade of affected lint. Parasites and predators ordinarily keep infestations below the economic level.

Mealybugs are generally a minor pest of cotton in Arizona. Restricted outbreaks have been periodically reported from the Salt River Valley.

LEAFHOPPERS

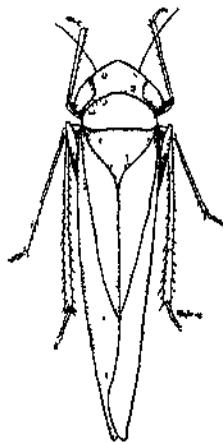
Empoasca spp. and others

Leafhoppers are frequently found on cotton throughout Arizona, but only in Yuma county to they occur in numbers large enough to be destructive. Large populations of feeding leafhoppers will suck the juices from the leaves, causing them to turn yellow. Occasionally some of the injured lower leaves will drop off.

Most of the adults are slender, green, wedge-shaped insects about one-eighth inch long. Their longer, more powerful hind legs enable them to "hop" with great agility. The nymphs are similar but smaller and wingless.

Adults overwinter on native plants and in plant debris. Each spring they migrate into various cultivated crops, including cotton. Although leafhoppers have been reported to lay eggs and grow to maturity on cotton, it is

not considered to be a preferred host plant.



Leafhopper adult.

COTTON FLEAHOPPER

Psallus seriatus (Reut.)

The cotton fleahopper occasionally becomes destructive in localized areas in Arizona. The cumulative effect of this pest in combination with other cotton pests can cause considerable crop damage.

The adults are about one-eighth inch long, a third as broad, and look like small lygus bugs. They are light green with fine black speckling over the body. The older nymphs resemble adults, but lack wings. Newly-hatched nymphs are very small, white and elongated, with slender legs.

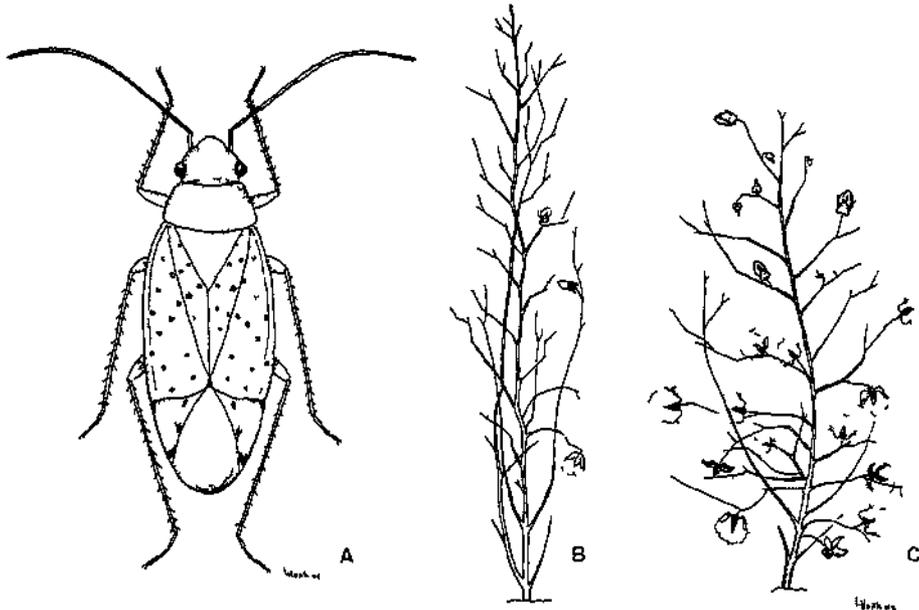
Eggs are inserted into the plant tissues. Upon hatching, the young bugs move to the growing tips to feed. The older nymphs and adults usually feed in the terminals but also attack squares and small bolls. During the summer

fleahoppers mature in approximately three weeks.

The cotton fleahopper is particularly attracted to weed hosts but migrates during the summer to more succulent cotton plants. When cotton plants become mature and tough, the fleahopper returns to weed hosts until the following summer.

Cotton plants injured by fleahoppers are often subnormal in appearance, with long, whip-like main stems and a suppression of the fruiting branches. The number of vegetative branches may be increased. Leaves and stems may be scarred or deformed.

Control measures are indicated when approximately 20 fleahoppers are found per 100 sweeps of a standard net. Samples should be taken in several locations in the field.



Cotton fleahopper. A—Adult; B—Damaged mature cotton plant. (Note whip-like stems and suppression of bolls); C—Normal mature cotton plant.

BLACK FLEAHOPPERS

Spanogonicus albofasciatus (Reut.)

Rhinacloa forticornis (Reut.)

Black fleahoppers are frequently found on cotton in large numbers during the early part of the season. The relationship between black fleahopper populations and early square shedding is not fully understood. Black fleahoppers have been observed to cause a considerable amount of shedding in slow growing cotton fields, whereas fields with vigorous growing cotton were able to tolerate large populations, as indicated by the smaller amount of square shedding.

Black fleahopper infestations are usually a mixture of two species, *Spanogonicus albofasciatus* (Reut.) and *Rhinacloa forticornis* (Reut.). The difference between these two species can only be detected under magnification. Both species are slightly smaller than the cotton fleahopper but are black, whereas the cotton fleahopper is green. *S. albofasciatus* has lighter colored tibiae than does *R. forticornis*.

Black fleahoppers have been observed on seedling cotton. Nymphs have been found on small cotton long before any squares have appeared. Both adults and nymphs have been observed feeding on the tender leaves.

Populations on cotton start to build up during May and peak populations are found by the middle of June. In late June the populations decrease and very few individuals are found by August first. One important factor in this seasonal population decline is that, as the season develops, the cotton leaves become progressively less succulent and therefore less desirable for feeding.

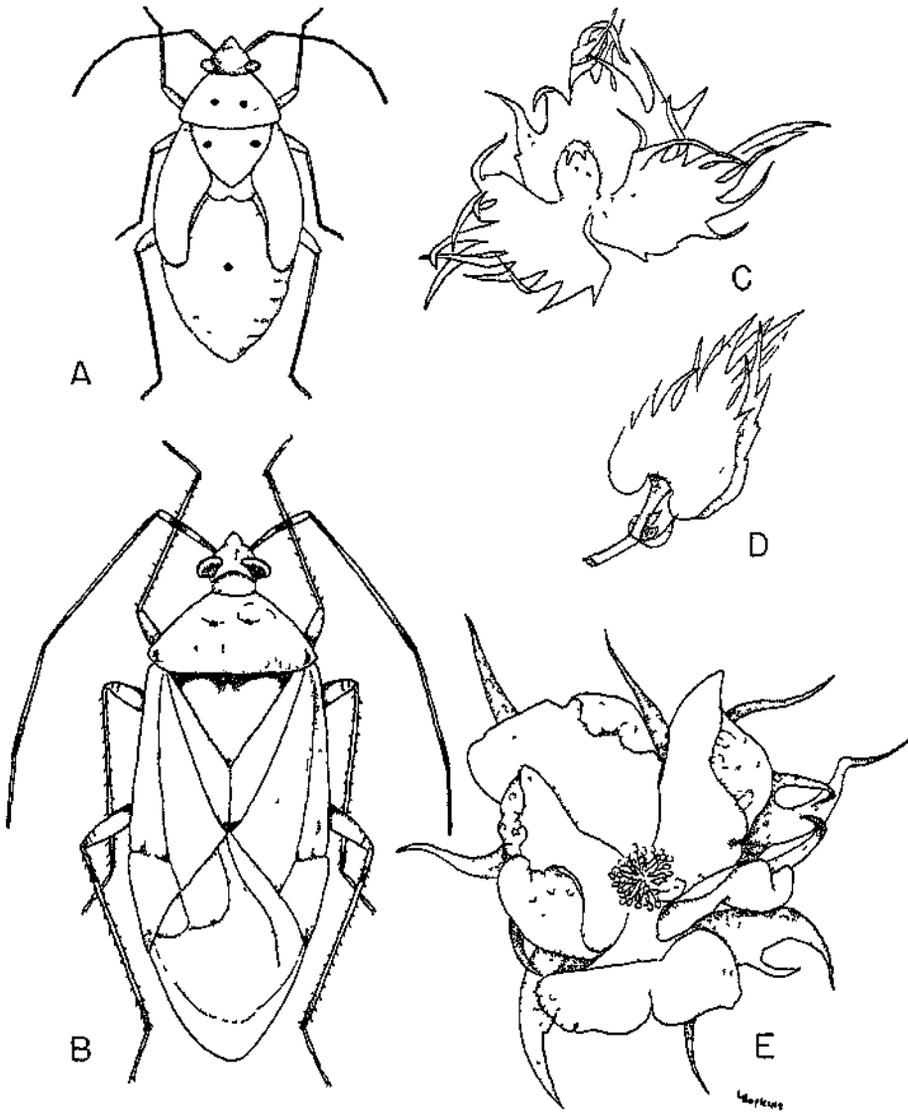
During the early part of the day, black fleahoppers may be found on the lower parts of the plant where they are difficult to catch with the conventional sweep net. After 11 a.m. both adults and nymphs can be readily seen feeding and resting on the upper surfaces of the young terminal leaves, which are more succulent than the older leaves on the lower portions of the plant.

Drying desert vegetation is the source of infestations in such areas as Coolidge and Safford. Alfalfa is another important source of infestations. When this crop is cut, black fleahoppers migrate to adjacent fields of young cotton.

LYGUS BUGS

Lygus are the most harmful of the true bugs on cotton. Of the three common Arizona species, *Lygus hesperus* Knight constitutes about 95 per cent of the total population, with *Lygus elisus* Van Duzee and *Lygus lineolaris* (P. de B.) making up the remainder.

The adults are oval, approximately one-fourth inch long, and about one-half as broad. They range from straw-green to rather dark brown, with a conspicuous lighter diamond between the "shoulders." All have relatively long antennae and legs. The posterior halves of the wings are bent downward.



Lygus. A—Nymph; B—Adult; C—Square, punctured and flared; D—Normal square; E—Damaged blossom showing typical warty and deformed petals.

Hesperus is green, often infused with red or brown just behind the middle. *Elisus* is always pale green. *Lineolaris*, the darkest species, is variegated brown throughout. Sometimes it is marked with small red spots on the wings at the middle of the outer edges.

These insects are swift of foot and can quickly take to flight. In Arizona, lygus bugs breed continuously throughout the year on alfalfa and other hosts. They are found in cotton from the time the squares begin to appear.

Their eggs are laid in the plant tissues and, after hatching, the nymphs molt five times before maturity. During July and August it takes approximately three to four weeks for a generation to develop.

In order to feed, these insects insert their long needle-like mouth parts into the squares, flowers, and young bolls. Feeding punctures cause warty growths on the flower petals and brown

spots on the pistils and stamens. Similar warts occur within bolls.

Extensive feeding causes "flared" squares and flowers with the eventual dropping of these forms as well as injured small bolls. Injured bolls that fail to drop may later open abnormally. The lint is inferior and clings to the warty carpels, making picking more difficult. Seeds that are not totally destroyed contain less oil and germinate poorly.

Serious infestations show a number of characteristic signs: (1) increased flaring of the squares, (2) abnormal dropping of the squares and small bolls, (3) warty, deformed flowers, (4) circular, shiny spots of excrement on the squares, stems, and flowers, (5) adult and immature lygus bugs on or around the fruiting structures during the cooler hours of the day.

Lygus bugs are extremely fond of alfalfa and develop large populations in that crop. When the hay is cut, these bugs move into adjacent cotton fields to become established.

STINK BUGS

Stink bugs are shield-shaped, relatively flattened insects, about two-thirds as broad as long. The nymphs are oval, wingless, often variable in color, and may not closely resemble the adults. Most give off a heavy, offensive odor, especially when disturbed.

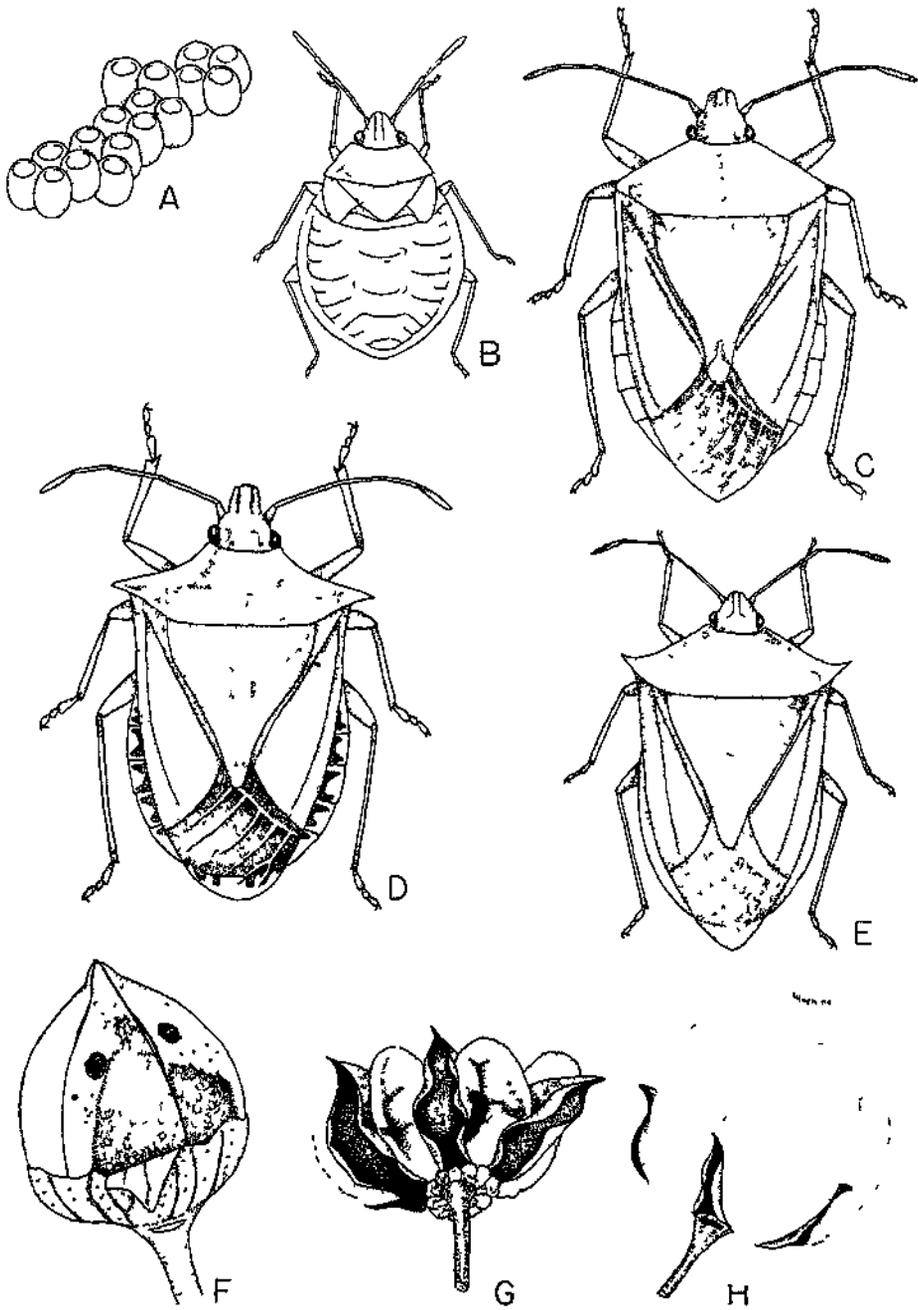
Four species of stink bugs are commonly found in Arizona cotton fields. The most important are the Say stink bug and the so-called "brown cotton bug." Other common species include the improperly named "red-shouldered stink bug" (few have red shoulders),

and the conchuela. The following characters will aid in the field recognition of these species:

1. Large stink bugs (one-half inch or longer):

a. Say stink bug. *Chlorochroa savi* Stal, in Arizona is usually dark green with three prominent light spots in the triangular area between the wings. Light green forms are also seen in the summer. And, in the fall, olive to reddish-brown forms occur.

This is the most generally harmful of our species, particularly in Graham



Stink bugs. A—Say stink bug egg cluster; B—Say stink bug nymph; C—Say stink bug adult; D—The brown cotton bug; E—The red-shouldered plant bug; F—A maturing boll infected with boll rot introduced by feeding stink bugs; G—An abnormal open boll with hardened dry locks caused by stink bug feeding during boll development; H—A normal open boll.

and Cochise counties, but may also develop tremendous and destructive localized infestations on cotton in other counties of central and southern Arizona.

b. The so-called "brown cotton bug," *Euschistus impictiventris* (Stal.) is light brown above and yellow to yellow-green on the underside. Its "shoulders" are sharply pointed laterally. This species is predominant in cotton grown at lower elevations and has caused particularly serious damage in Yuma and Maricopa counties.

c. The conchuela, *Chlorochroa ligata* (Say), is slightly larger than either of the above named stink bugs. It is dark brown with a narrow border of red around the body except for the head. The triangular area between the wings is usually tipped with red.

This species is occasionally found in southeastern Arizona but seldom causes serious damage. In New Mexico and Texas the conchuela is more abundant and harmful.

3. **Small stink bugs**
(seven-sixteenths inch or shorter):

a. The so-called "red-shouldered stink bug", *Thyanta pallido-virens spinosa* Ruckes, is variable in color, ranging from light green to tan. Few individuals have the "red shoulders" that provide the popular name, although there is often a pale longitudinal stripe extending backward across the pronotal shield behind the head.

This is the most generally harmful of the smaller stink bugs. It is distributed throughout the state but is most abundant in the Salt River Valley.

Specific life histories for all species are not known; however, they follow

a similar general pattern. Females lay clusters of small, barrel-shaped eggs on the stems and leaves of host plants. The young bugs molt approximately five times before maturing. When conditions are favorable, this takes two to four weeks.

The life span during summer is about two months, but overwintering adults may survive for six months or more. Stink bugs are particularly attracted to wild grasses, grains, alfalfa, and various weeds. Fortunately, cotton is attacked only when more preferred host plants are absent or in an unattractive condition. These bugs are seldom found in cotton fields before the first bolls are set, and usually do not reproduce on cotton plants.

Stink bugs are particularly injurious because of their habit of attacking many bolls in all stages of growth. They feed by inserting their long beaks into the bolls and extracting juices from developing tissues and young seeds. Small injured bolls fall from the plant but larger bolls remain.

Rough, warty, cellular growths form at the puncture sites on the inner surfaces of the carpels. In addition, seeds are shriveled and fibers are stained. Feeding injuries may eventually cause hardened, dry locks which cannot be harvested.

Small reddish-brown spots on the carpels are external evidence of stink bug feeding. Boll rot fungi are often introduced by the feeding bugs.

Certain cultural practices will help to reduce the numbers of invading bugs. It is advisable to destroy the preferred hosts of stink bugs, as well as grain stubble, in the early winter and spring before the cotton bolls begin to develop. Invasions of the "brown cotton bug" from alfalfa continue throughout the cotton-growing season.

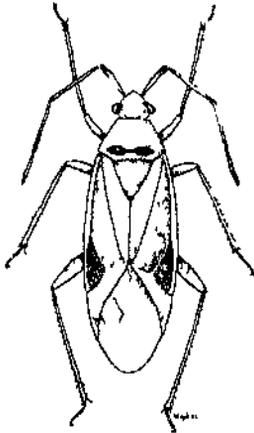
MISCELLANEOUS PLANT BUGS OCCASIONALLY FOUND ON COTTON

Superb Plant Bug

The superb plant bug *Adelphocoris superbus* (Uhler) is a common pest of cotton and alfalfa in the south-eastern counties of Arizona. Although infestations are not usually of major importance, serious combined injury may result when lygus bugs are also present.

The adults are about three-eighths inch long and are dark brown to black with orange to red outer wing margins. There are two black markings in the reddish triangular area behind the head. Superficially they resemble lygus bugs. The nymphs are usually green marked with red.

Like lygus bugs, these insects puncture the squares, flowers and bolls. Because they are slightly larger, each feeding puncture may be more severe and larger bolls may be attacked.



Superb plant bug.

Little is known of their life history. Eggs are laid in the stems of the host plants. The winter may be passed in the adult stage or in the egg. There are probably three or more generations a year in Arizona. This pest is most often found in association with lygus bugs and is incorporated into the same sweep count evaluations when control measures are being considered.

Several closely related species of pyrrhocorid plant bugs have been recorded from Arizona. The adults are mostly oval and approximately one-half inch long. They are black with a narrow orange margin around most of the body. Often there are fine orange specks over the back. The nymphs are oval to circular, brilliant metallic blue, often with a conspicuous red spot anteriorly on the abdomen. These bugs have been known to feed upon squares and bolls, but have always been of minor importance.

Leaf-Footed Bug

The leaf-footed bug, *Leptoglossus zonatus* (Dallas), and its relatives are large, usually brown, with conspicuous leaf-like enlargements on the hind legs. *Zonatus*, the most common species, has two yellow spots in the triangular area behind the head, and an irregular yellow band across the middle of the back. It is a general feeder, and although rarely found on cotton, it sometimes attacks squares and bolls.

Spotted Milkweed Bug

The spotted milkweed bug, *Oncopeltus fasciatus* (Dallas), is about one-half inch long. It is bright orange or red with three black areas on the back and black spots on the underside.

Common Milkweed Bug

The common milkweed bug, *Lygaeus reclinatus* Say, is very similar to the spotted milkweed bug. The head, the triangle at the shoulders, the legs, and the spots on the abdomen are velvety gray-black. The abdomen and spots on the back are bright red. The black wings have white margins and two characteristic white spots near the middle. These bugs are common in the Southwest. Their primary host is milkweed, but they are found on a wide range of plants. They are presumed to rarely feed upon the squares and bolls, although injury has never been noticeable.

Western Plant Bug

Creontiades femoralis Van Duzee, locally known as the western plant bug, is about one-fourth inch long and slightly more than one-sixteenth inch broad. It is reddish brown with long antennae and legs. Before World War II, it frequently caused deformed plants and reduced yields.

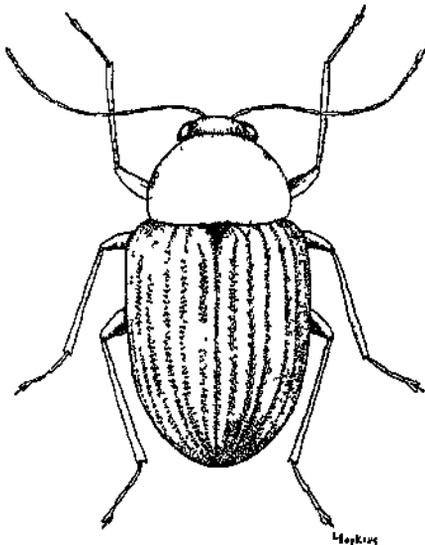
Cotton Stainer

Dysdercus albidiventris Stal, a cotton stainer, is about three-eighths inch long, and black with red markings on the head. The leathery portion of the forewings is yellowish with two large black spots near the middle. Before organic insecticides were used extensively this insect and closely related species caused serious damage.

COLASPIS BEETLES

Colaspis beetles, mainly *Colaspis flavida* Say, attack a wide variety of

plants, and occasionally become abundant on cotton, particularly in southeastern Arizona. They are mid-season pests and rarely cause significant injury except in weedy fields.



Colaspis beetle.

These beetles are three-eighths to one-fourth inch long and about half as broad. They are buff in color and have conspicuous, rather threadlike antennae. A series of narrow, punctuate grooves and alternating ridges traverses the length of the wing covers, causing them to appear longitudinally striped.

Colaspis beetles feed upon the bracts, flowers, and leaves of cotton plants, showing a preference for the bracts. Individual beetles riddle or "shot hole" these structures, while large populations cause more obvious ragging. Short, black, threadlike droppings of excrement are often associated with colaspis beetle damage.

CUCUMBER BEETLES

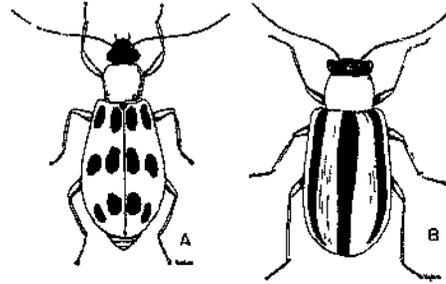
Diabrotica and *Acalymma* spp.

Spotted cucumber beetles are approximately one-fourth inch long and half as broad. They have pale yellow or black bodies and bright green wing covers with about a dozen prominent black spots.

The larvae feed in the soil on the roots of various plants. The adults feed on foliage and either riddle or rag the leaves.

Striped cucumber beetles are similar in general appearance but have yellow to cream wing covers with four longitudinal black stripes. The area behind their black heads is red to orange in color. Striped cucumber beetles are occasionally seen in cotton flowers.

Cucumber beetles are minor cotton pests but may rarely cause localized damage in Arizona cotton fields.



Cucumber beetles. A—A spotted cucumber beetle; B—A striped cucumber beetle.

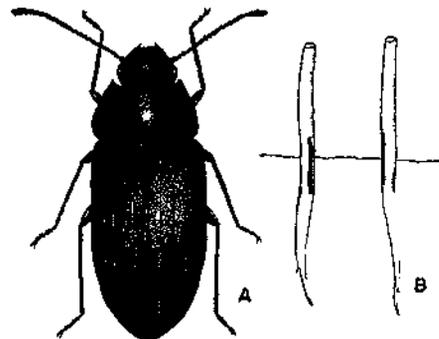
DARKLING BEETLES

Blapstinus spp.
Ulus crassus (Lec.)

Darkling beetles are frequently destructive to seedling cotton. Most infestations are the result of previous population increases in other favored host crops.

Darkling beetle infestations build up in such crops as alfalfa and pastures on sandy soils. When these crops are plowed under both the immature and adult beetles feed on the organic plant matter. When cotton follows in the rotation, the adult darkling beetles feed on the succulent seedlings.

These beetles are dark brown to nearly black in color, range from one-fourth to one-third of an inch in



A—Typical darkling beetle; B—Seedling stalks, with cotyledons removed, showing darkling beetle injury at ground level.

length, and are approximately a third as broad as long. In cotton fields, darkling beetles can be found by digging approximately an inch and a half deep

about injured seedlings. Darkling beetles are nocturnal in habits and can be found only in the soil during the day.

JUNE BEETLES

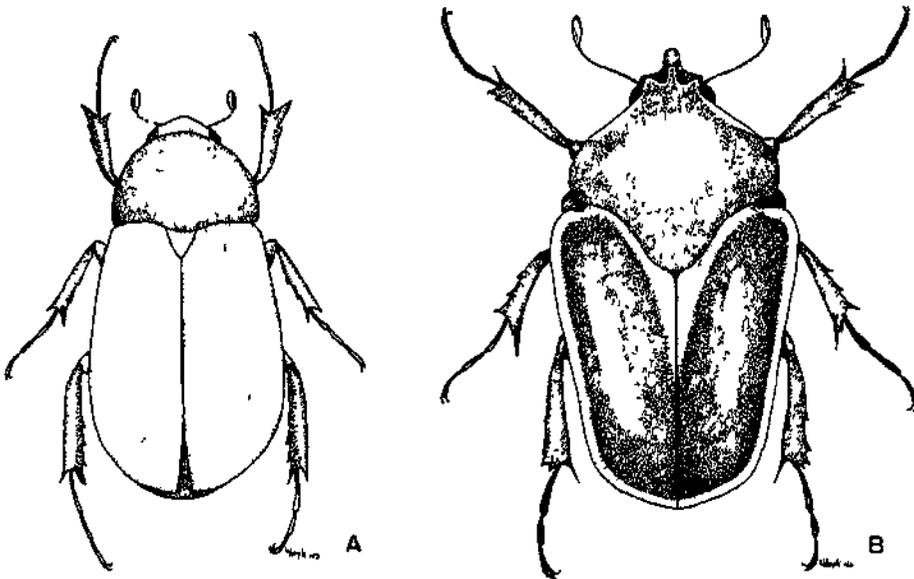
The desert June beetle, *Cyclocephala dimidiata* Burm, is a relatively common general feeder in the southwestern states. It is about one-half inch long and half as broad, with a reddish-brown to black body and light buff wing covers.

The grub, or larva, lives in the soil. The adult is most active in the evening and at night, but is occasionally seen earlier in the day feeding in cotton flowers. The desert June beetle has never been numerous enough in cotton to cause significant damage.

The Texas June beetle, *Cotinis texana* Casey, is about one inch long and

measures approximately five-eighths inch across the "shoulders" where it is broadest. It is a robust, metallic green species, usually with an irregular buff margin on the wing cover. The larva develops in moist organic litter in places like corals and feed lots.

The Texas June beetle is very destructive to ripening fruit of all kinds throughout southern Arizona, and is occasionally found within the cups of cotton blossoms. However, this beetle has never been sufficiently abundant in cotton flowers to cause alarm.



June beetles. A—The desert June beetle; B—The Texas June beetle.

BOLL WEEVIL

Anthonomus grandis Boh.

The boll weevil is the primary pest of cotton in southeastern United States and in parts of its original home, Mexico. Thus far in the United States it has not become established west of Texas.

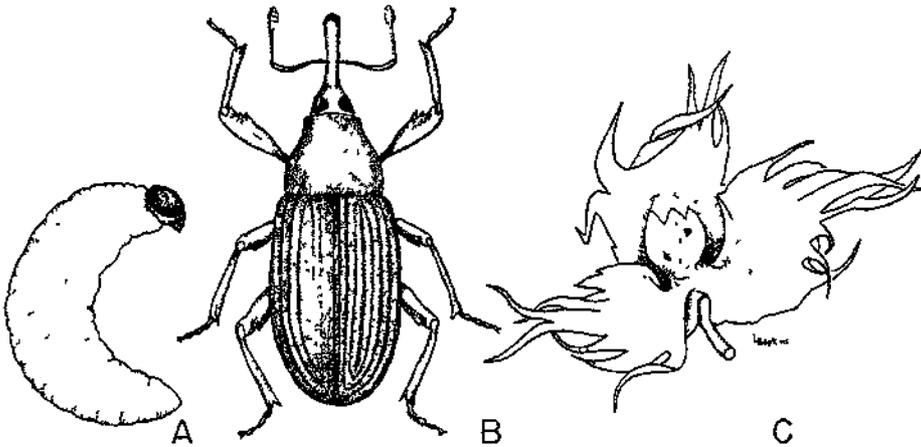
The adult weevil is a rust-brown beetle about one-fourth inch long and half as broad, and is usually sparsely covered with silver gray hairs. Like most weevils, it has a prominent snout. The soft, wrinkled larva is white with a darker head and is slightly less than three-eighths inch long when full grown.

The boll weevil makes its appear-

ance early in the year; the first individuals emerge as early as February. In spite of its name it prefers squares to bolls.

There are several generations a year. As a result, the boll weevil is very injurious. When cold weather approaches, most of the adult weevils disperse to hibernate until the following spring. However, many remain in the fields throughout the winter.

Many entomologists believe that uncultivated, arid deserts have prevented a natural spread of the cotton boll weevil into New Mexico, Arizona, and California.



Boll weevil. A—Mature larva; B—Adult; C—Square with dark spots at oviposition sites.

THURBERIA WEEVIL

Anthonomus grandis thurberiae Pierce

The thurberia weevil, a close relative of the boll weevil, is restricted to southeastern Arizona and Mexico at

higher elevations. Before commercial cotton was grown, it survived on wild cotton in the mountain canyons

throughout its range.

The thurberia weevil still shows a preference for its wild cotton host, but has occasionally been found attacking bolls of long and short staple cotton in Arizona in November. Superficially, the thurberia weevil appears to be identical to the boll weevil of south-eastern United States.

Overwintering adults usually do not emerge until July or August of the following year. Then they mate and deposit their eggs. Unlike the boll weevil, the thurberia weevil prefers to lay its eggs in the bolls.

The female drills a small hole in the boll and places an egg in it. After laying, she seals the hole with a mixture of excrement and a cement-like secretion. The presence of eggs and

larvae in the bolls causes cell proliferations, or warty growths, on the insides of the carpels. The larvae feed on the proliferating cells, the developing lint, and the young seeds.

Pupation occurs within oval cells constructed in the lint. After pupation, the adult weevils gnaw out of the bolls. Due to the late emergence of overwintering adults, and because of the cooler climate at high elevations, thurberia weevils have only one or two generations each year. Occasionally, a partial third generation may occur.

Overwintering thurberia weevils are reduced when thurberia plants near cotton fields are eliminated and stalks and field trash are destroyed after picking.

WIREWORMS

Although wireworms are seldom pests of Arizona cotton, they occasionally kill or retard seedlings in light, sandy soils. These pests are actually click beetle larvae (family *Elateridae*), and are called wireworms because of their rather shiny, tough body covering and slender, cylindrical shape.

Their heads are rust brown in color and their bodies are cream to tawny-white. Adults of the common species are dull rust-brown, flattened, bullet-shaped beetles which range from one-fourth to one-half inch in length. When turned on their backs, these beetles make jerking motions accompanied by a clicking sound when at-

tempting to right themselves. Unlike their larvae, the adult beetles are not pests of cotton.

Wireworms inhabit moist sandy soil where they feed upon the roots of numerous plants. Although they are not specifically attracted to cotton plants, infestations may become serious where soil conditions are right and young plants are available. Many species require a year or more to mature but, because generations overlap, a new brood is started each year.

Where infestations are serious, a good rotation program and fallowing aid in the control of wireworms .

NON-INJURIOUS BEETLES COMMON ON COTTON IN ARIZONA

Fruit Bud Beetle

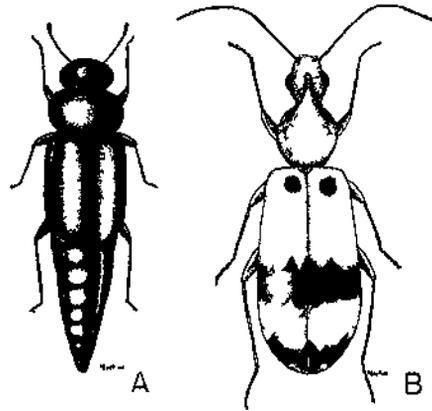
The fruit bud beetle, *Conotelus mexicanus* Murray, is occasionally abundant in Arizona cotton fields where it congregates in the flowers. These slender, black beetles are approximately three-sixteenths inch long, and have short wing covers which expose much of their cone-shaped abdomens. Fruit bud beetles feed upon pollen in the flowers but do not harm the cotton plants.

Notoxus Beetles

Notoxus beetles are very often numerous in cotton fields. Two species *Notoxus calcaratus* Horn and *N. nuperus* Horn are most frequently encountered. Both are about three-sixteenths inch long and one-third as broad, and are light rusty brown with darker bands across the wing covers. The part of the body behind the "neck" projects forward in a horn-like process above the head, which seems to hang loosely beneath.

Notoxus beetles have never been

known to cause injury to the cotton plants. They feed upon secretions of the nectar glands at the bases of the bracts and on the undersides of the leaves.



Non-injurious beetles found on cotton plants. A—Fruit bud beetle; B—Notoxus beetle.

LEAF MINER

Liriomyza sp.

Leaf miners attack a wide variety of crops in this state and have been particularly abundant on melons and alfalfa.

Although these insects have been steadily increasing in importance in Arizona they are pests of cotton only when plants have become stunted through lack of water. Irrigation and fertilization to promote vigorous plant

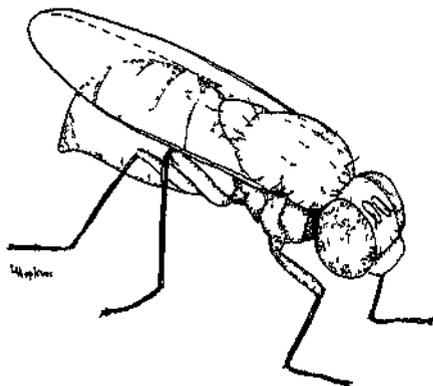
growth are the best methods of control.

The immature leaf miner is a cream to yellowish colored maggot approximately one-eighth inch long. The adult is a minute black fly marked with yellow on its under side, on its face, and on the small triangle between the wings.

The female lays her eggs on the leaves of the host plant. After hatching,

the maggot eats its way beneath the surface of the leaf. Continued feeding results in a twisting tunnel which increases in size with the growth of the maggot. Full grown maggots normally pupate in the mines. A generation requires an average of three weeks to develop under favorable conditions.

Rapid plant growth and a high percentage of parasitism normally hold leaf miner populations in check.

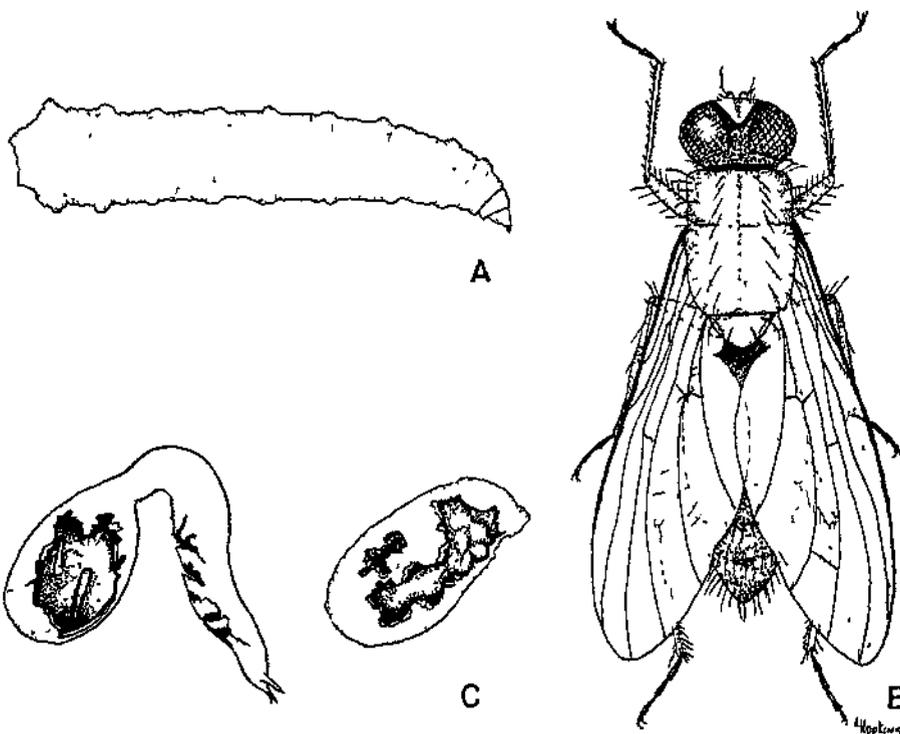


Leaf miner fly adult.

SEED-CORN MAGGOT

Hylemya cilicrura (Rondani)

The seed-corn maggot is a pest of many crops and is occasionally injurious to cotton. The adults are small gray flies less



Seed-corn maggot. A—Mature larva; B—Adult; C—Injured germinating seed.

than one-fourth inch long. The white legless larvae, or maggots, attain a length of one-fourth inch before pupating.

They inhabit the soil, usually where there is abundant organic matter. The maggots attack planted seed and very young seedlings, thereby reducing ger-

mination and sometimes killing young plants.

In Arizona, serious seed-corn maggot infestations occasionally occur. Plant injury is relatively rare when the soil is warm enough to cause rapid germination and quick seedling growth.

ANTS

In Arizona, ants usually are most injurious in cotton grown on newly cleared land or in fields that follow alfalfa and grains.

The red harvester ant, *Pogonomyrmex* sp., is rarely a pest of seedling cotton. It is about one-fourth inch long, conspicuous, and active. The nests are identified by a bare mound of earth. This ant habitually clears

away all plant growth within several feet of the nest mound. Several colonies in a field can cause considerable seedling loss.

The dark brown leaf-cutting ant, *Acromyrmex versicolor* (Perg), has been reported to cut off stems and foliage of seedlings, usually along a single row, to supply its less conspicuous nests. It is seldom troublesome.

COMMON FIELD CRICKET

Gryllus assimilis F.

The field cricket is very common throughout the United States. Occasionally, when conditions are favorable for large outbreaks, crickets may become particularly injurious to cotton plants.

In Arizona, crickets are usually early-season pests. They hide during the day in weedy ditches, grassy areas and cracks in the ground, and come out to feed at night.

They frequently gouge the stems of young cotton plants but, like grasshoppers, they will feed on all parts of the plant and, when sufficiently numerous, can strip the plants to the ground. Cricket infestations on cotton have been reported from Yuma county more frequently than from other areas of the state.

(See drawing on next page). 

GRASSHOPPERS

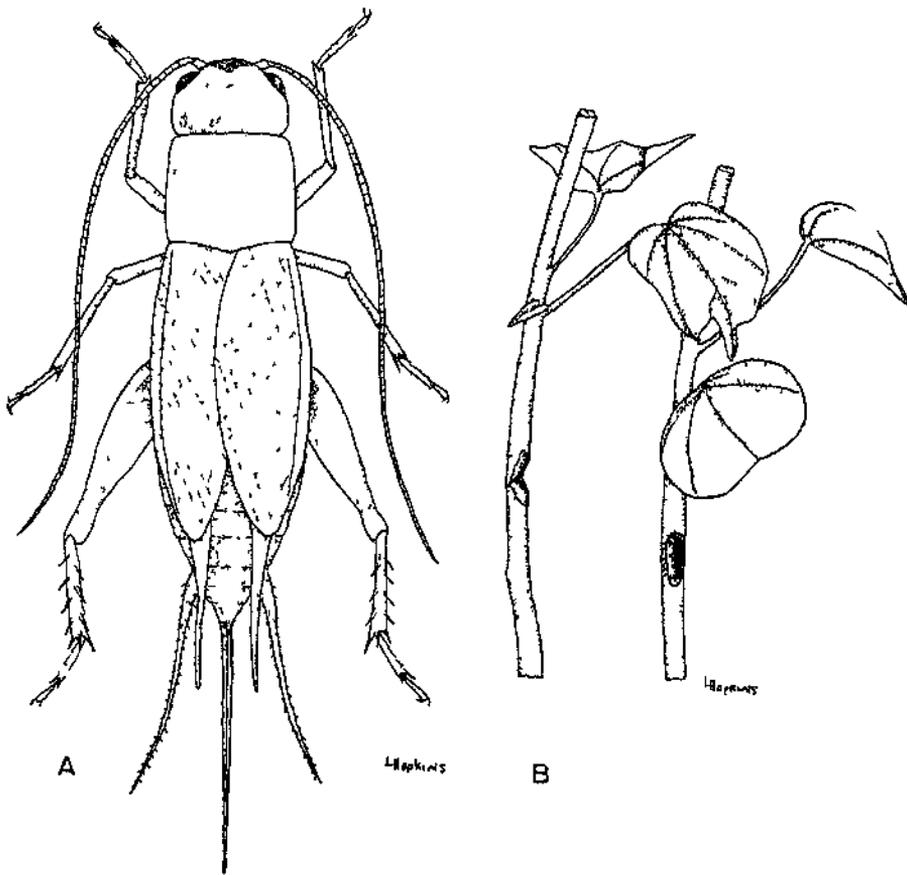
Many species of grasshoppers are potential pests of cotton in Arizona. When weeds and grasses become undesirable food sources or when alfalfa fields are cut, grasshoppers move onto the nearest attractive growth. Under these conditions, grasshoppers can rapidly defoliate the marginal rows of a cotton field.

Some of the commonest species encountered on cotton in Arizona are:

1. The differential grasshopper, *Melanoplus differentialis* (Thos.)

2. The migratory grasshopper, *Melanoplus sanguinipes defectus* Scudd.

3. The desert grasshopper, *Trimetropis pallidipennis* (Burm.)



Common field cricket. A—Adult; B—Stems of young cotton plants gouged by field crickets.

4. The bird locusts, *Schistocerca* spp.

5. The lubber grasshopper, *Brachystola magna* (Gir.)

The differential grasshopper, the

desert grasshopper, the migratory grasshopper, and the bird locusts make up the major portion of the grasshoppers that attack cultivated crops in southern Arizona.

SPIDER MITES

Spider mites are close relatives of insects and injure cotton by sucking plant juices. They are difficult to see and identify without magnification.

Females lay eggs which are often protected by webbing on the under sides of the leaves. Newly laid eggs are spherical, clear, and colorless, but become opaque as they develop.

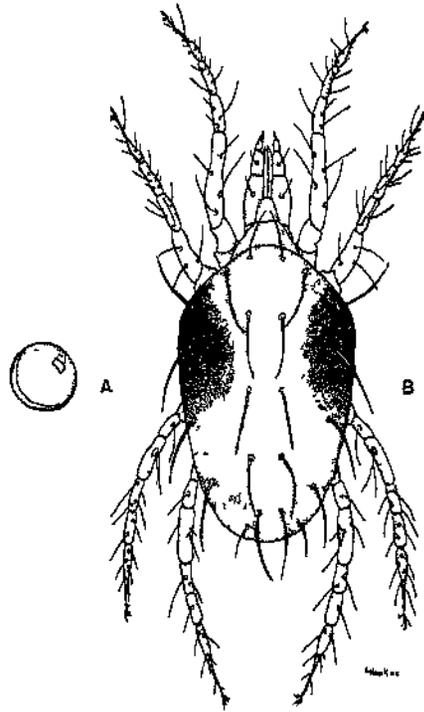
Newly hatched "larvae" have only six legs but otherwise resemble the adults. The two later immature stages (nymphs) possess eight legs. Most species require a week or less to develop during the summer and, in cool climates, overwinter as eggs or non-feeding females. In warmer areas they reproduce at a slower rate during the winter on various host plants.

The five spider mites recorded from cotton in Arizona are, in order of importance:

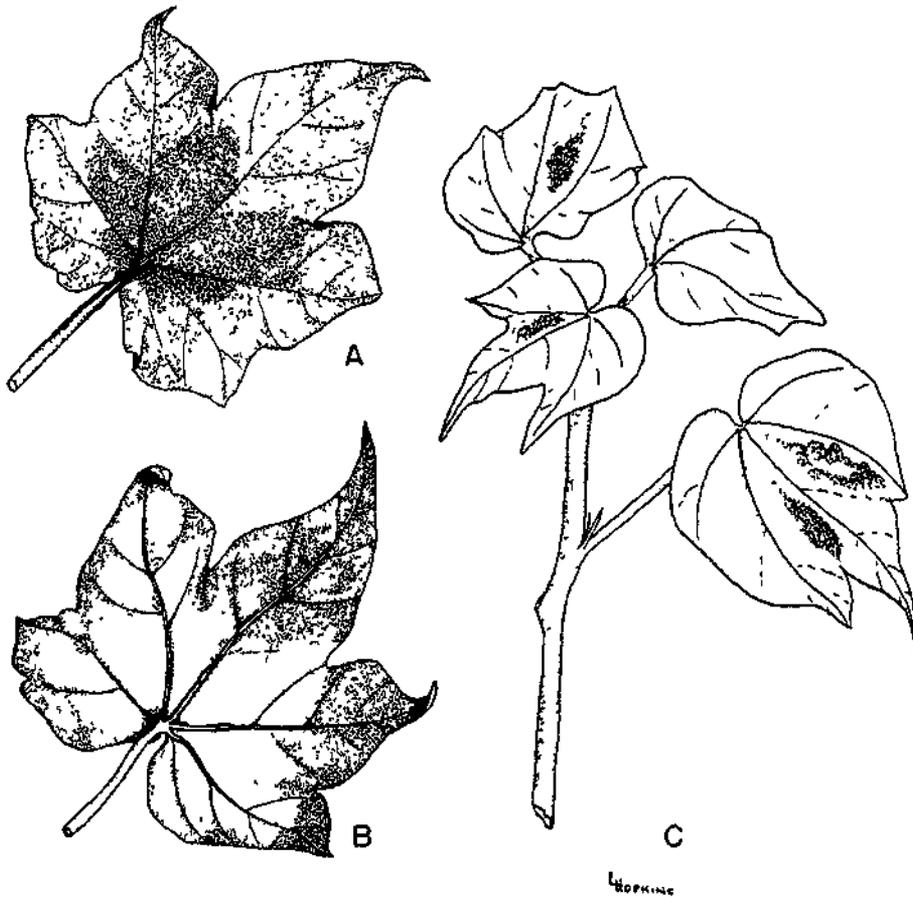
1. The two-spotted spider mite, *Tetranychus cinnabarinus* (Boisduval).
2. The Atlantic spider mite, *Tetranychus atlanticus* (McGregor).
3. The desert spider mite, *Tetranychus desertorum* (Banks).
4. The tumid spider mite, *Tetranychus tumidus* (Banks)

5. The brown wheat mite, *Petrobia latens* (Muller).

The two-spotted spider mite is the most serious mite pest of Arizona cotton. A recent evaluation of the two-spotted complex suggests that most, or all, of these are *Tetranychus cinnabarinus*.



Two-spotted spider mite. A—Egg; B—Adult.



Spider mite damage. A—Leaf injury by the two-spotted spider mite; surface view; B—Leaf injury by the two-spotted spider mite, under side; C—Leaf injury by the Atlantic spider mite, surface view. Note the restricted red "islands".

Typically, this mite is greenish or reddish with a large dark spot on each side near the shoulder of the body. Winter and spring females are green and the basic color of summer females is reddish. The eggs are often reddish. This mite closely resembles the Atlantic spider mite; however, the characteristic damage caused by its colonies distinguishes it in the field.

Two spotted spider mite colonies spread between the major veins of the cotton leaves and cause a general yellowing of the infested areas. A red

coloration on the upper surfaces of the leaves may develop slowly. This reddening is not usually as restricted nor as vivid as that caused by the Atlantic spider mite.

Webbing spun by adults on the under sides of the leaves is usually brown, but may occasionally be whitish. The lower leaves of the plant are not necessarily the first to be attacked. Feeding injuries cause eventual but rarely rapid shedding of leaves. On cotton, two-spotted spider mites may be intimately associated with Atlantic

spider mites, and species identification by field damage is difficult.

The Atlantic spider mite is a pest primarily in the western states, especially California and occasionally southwestern Arizona. This mite is typically straw-colored to greenish, with a dark spot on each side at "shoulder" level.

Pure colonies of the Atlantic spider mite are usually localized and do not spread rapidly along the leaf veins. Their feeding quickly produces red islands on the upper surfaces of the infested leaves. This red blotching is particularly evident on young plants early in the season.

Webbing on the undersides of the leaves is brown. The bottom leaves of the plant are attacked first and severe infestations will cause rapid defoliation.

The desert spider mite is recorded from most of the cotton-growing areas of the state. Although it is a serious pest in Texas, it has caused only occasional damage in Arizona. The pucture vine appears to be a favorite host plant.

The colonies are generally distributed over the leaves and throughout the plant. The upper leaf surfaces take on a mottled yellow appearance. Webbing on the under sides of the leaves is characteristically white.

The tumid spider mite was first recorded at Safford in September of

1950, but, as yet, has not become a serious pest in Arizona. In the field, the tumid spider mite cannot be distinguished from the desert spider mite or the carmine form of the two-spotted spider mite.

The brown wheat mite only rarely infests Arizona cotton. Grasses and grain crops are its preferred hosts. When preferred hosts become dry or are harvested, the mites move to the nearest suitable plants, which may include cotton. Infestations are sporadic and disappear with hot, dry weather.

Brown wheat mites are metallic brown or greenish with yellow legs. The fore legs of the females are noticeably elongated. Unlike the other species mentioned here, these mites are not web spinners. Infestations are recognized by a yellowing and speckling of the leaves.

Spider mites are found on cotton in small numbers every year during the early part of the growing season. Parasites and predators usually prevent these low infestations from building up to destructive levels. The improper choice of insecticides for early season insect control will produce spider mite populations capable of increasing to destructive levels within a short time.

Light infestations of spider mites early in the season may advantageously serve to build up infestations of *Orius*, an effective general predator of various cotton pests, including particularly the bollworm.

Beneficial Insects Associated With Cotton in Arizona

Many predatory and parasitic insects are directly helpful to Arizona cotton growers. These beneficial insects can frequently hold or reduce populations of harmful insects to levels

that do not require chemical control.

An efficient economical control program should incorporate the advantages of beneficial insects and of insecticides. Indiscriminate use of insecticides will

often intensify the damage of destructive insects by destroying beneficial parasites and predators.

It is important that the grower familiarize himself with the insects that are working for him. He should be

able to distinguish them from harmful insects and should know when he is receiving this cost-free control. For these reasons the major beneficial insects found in Arizona's cotton are presented here.

LACEWINGS

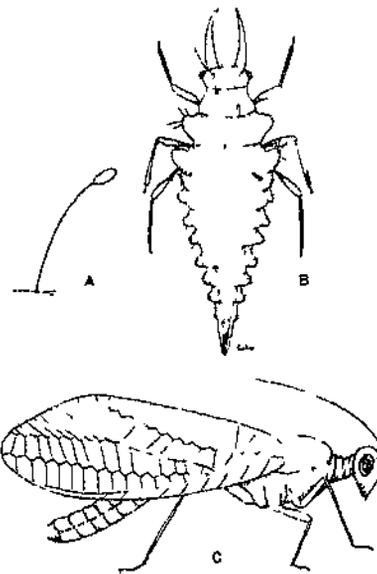
Lacewing larvae are very effective in destroying bollworm eggs and small bollworm larvae. They are abundant during the latter part of August and during September. They have aided greatly in keeping bollworms below destructive levels, particularly during seasons when the rainfall and humidity have been low.

Green lacewing larvae, *Chrysopa* spp., are called aphid lions because they ferociously attack aphids, mites, and other soft-bodied insects. Mature aphid lions are three-eighths to one-half inch long, flat, elongated and tapered at both ends. They somewhat resemble miniature alligators and are cream to yellow, mottled with red or brown.

Their large, conspicuous sickle-shaped jaws are used to puncture their prey. The adults are beautiful, delicate, slender, pale green insects usually one-half to three-fourths inch in length. They are named for their handsome net-veined wings which are held in a roof-like position over the body.

Adults are not known to be predaceous. Eggs of the green lacewings are usually laid singly upon leaves and other plant parts. Each egg is suspended about one-half an inch above the leaf or stem surface by a fine silken stalk.

The brown lacewings, *Hemerobius* spp. and *Symphorobius* spp., are very similar to the green lacewing in habit and appearance. The larvae may be amber or slate color with darker markings. The adults, as the name implies, are dusky brown in color and resemble small, brown, clear-winged moths.



Green lacewing. A—Egg; B—Mature larvae; C—Adult.

ASSASSIN BUGS

The most common assassin bugs found in Arizona cotton are the spined soldier bugs. The commonest species is *Sinea confusa* Caud. *S complexa*

Caud is less abundant.

These insects are about one-half inch long, brown to buff, noticeably spiny and have rather long, slender legs. Like the praying mantis, their fore legs are held in the posture of prayer and are used to capture and hold other insects. They walk about with a slow, clumsy gait and are rather awkward fliers. Spined soldier bugs have been observed to feed on caterpillars and other insect larvae.

Atrachelus cinereus wygodzinskyi Elkins is very similar to the spined soldier bugs but is slightly smaller and darker. It has occasionally been observed in cotton and alfalfa in Arizona.

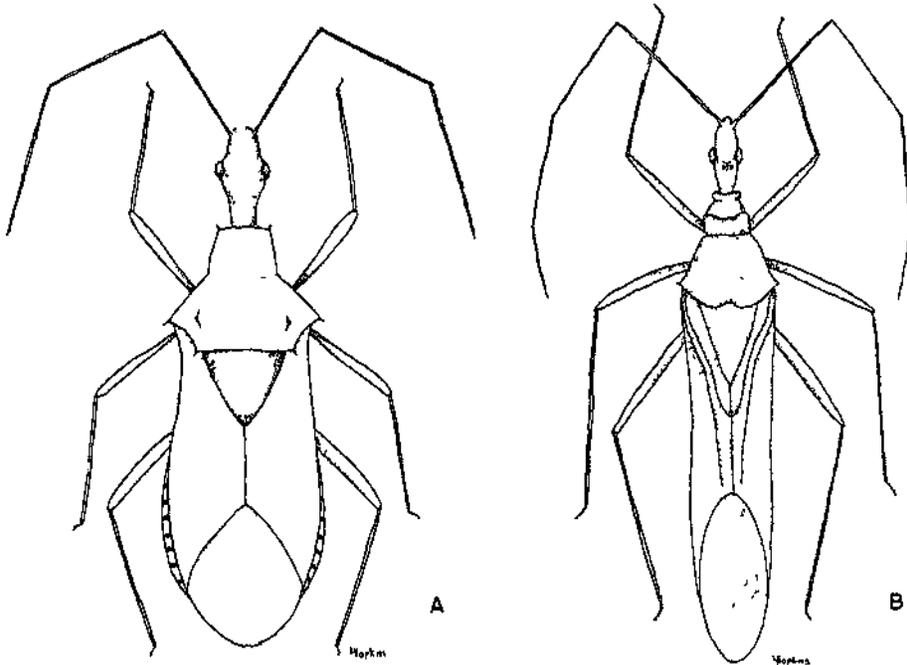
The leafhopper assassin group is second in abundance to the spined soldier bugs. In Arizona cotton fields, *Zelus socius* Uhler and *Zelus renardii* Kolcn are most often seen. They are about one-half inch long and one-eighth inch broad, light brown above

with the basal half of the wings and the top of the abdomen wine red; beneath they are green.

These bugs are more linear and generally less spiny than the spined soldier bugs. Their legs are long and slender with the fore pair held in the characteristic prayer-like attitude. There is a sticky substance covering the fore legs which aids in capturing prey. Quite often small bits of debris adhere to this sticky material.

Immature leafhopper assassins are small, awkward, delicate green insects. The assassin bugs of this group are well known predators of leafhoppers but also attack other harmful cotton insects.

Assassin bugs, as a whole, are effective predators. Although certain species show a preference for particular kinds of prey, in general they are not narrowly restricted to specific insect hosts.



Assassin bugs. A—A spined soldier bug; B—A leafhopper assassin.

NABIDS

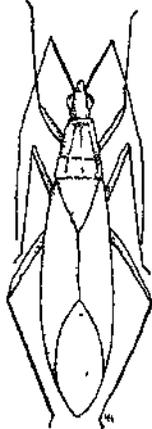
Nabids, or damsel bugs, look and act much like their close relatives, the assassin bugs. The two species in Arizona cotton are difficult to distinguish from one another.

Both are pale gray to tan in color, approximately three-eighths inch long

and one-third as broad. They are less spiny and slightly more robust than the assassin bugs. Their fore legs are also used for capturing prey and are held in the characteristic attitude of prayer.

Nabid alternatus Parshley is the most common species from Tucson east, but also occurs in other areas of southern Arizona. It is grayish tan, usually with oblique dark bands across the fore legs. Three distinct dark lines are found on the area between the head and the wing base. In addition, this area almost always has a fine, variegated dark pattern.

Nabis ferus (Linn.) is the most common species at Yuma and in the Salt River Valley. It is tan and usually does not have the darker markings of *N. alternatus*. These two species have similar habits but each is dominant in a different area. They are predators of aphids, leafhoppers, treehoppers, lygus bugs, and small caterpillars.



Nabid

BIG-EYED BUGS

Geocoris spp.

These small insects are sometimes extremely abundant in cotton fields and on numerous occasions adults and, especially nymphs have been mistaken for lygus bugs by some growers. They are, however, valuable predators and do not injure cotton plants.

Adult big-eyed bugs are about one-eighth inch long and approximately one-half as broad, tan to dark brown or black, and have dark, protruding eyes. The clear portion of the wings forms a silver triangle posteriorly over the back. They are very agile and move rapidly over the plants. Immature big-eyed bugs are brownish green to

gray or black and resemble the adults in shape and habit.

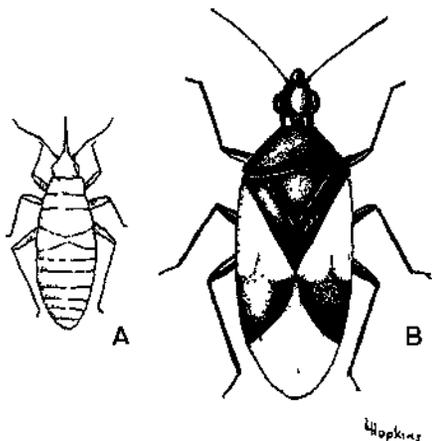
In Arizona, the most common species is *Geocoris punctipes* (Say). It is slightly larger and lighter in color than most of the others.

Geocoris atricolor Montd., *G. carinatus* McAtee and *G. pallens* Stal are all found on cotton in Arizona but it is difficult to distinguish one from another in the field. The big-eyed bugs have been reported to be efficient predators of leafhoppers and spider mites.

(See drawing at right). ➡

MINUTE PIRATE BUGS

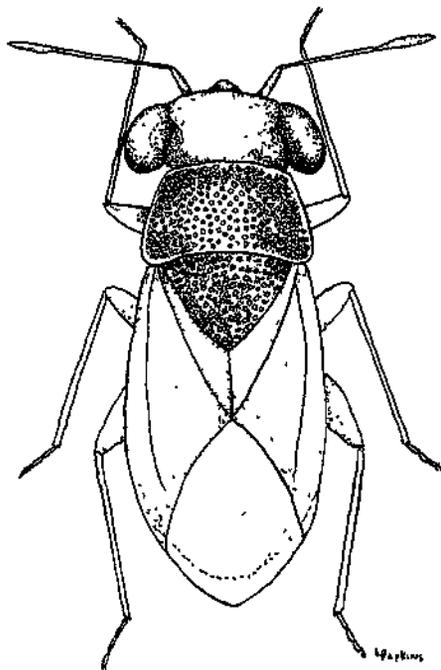
The minute pirate bugs, *Orius* spp. and *Anthocoris* spp., on cotton closely resemble one another. The adults are



Minute pirate bug. A—Nymph; B—Adult.

approximately one-sixteenth inch in length, somewhat oval and flat. They are black with three silvery white spots formed by the transparent parts of the wings folded on the back. The immature bugs are amber in color, wingless, more linear, and rather round.

Both the nymphs and adults of *Orius* are effective predators of all stages of spider mites and of bollworm eggs and young larvae. *Orius* can be found in relatively large numbers throughout the growing season and, as a result, has delayed and sometimes even prevented red spider mites and bollworms from increasing to destructive levels. In addition, *Orius* has been known to destroy thrips, young lygus bugs, aphids, and the eggs of many species of injurious caterpillars.



← Big-eyed bug.

LADY BEETLES

In Arizona, many species of lady beetles are predatory on aphids, mealybugs, scales, and mites. However, there are only a few that regularly feed on cotton insects.

Females deposit their eggs on the cotton plants, usually near a food source for the young. Lady beetle larvae are very different in appearance from the adults, and resemble small, hairy, wrinkled dragons. Most are black, marked with orange and white, but some have a white, waxy covering.

Pupae are attached to the plant and may easily be mistaken for a piece of dirt or a bird dropping. Both the dragon-like larvae and the adults are active predators of aphids, mites, and other soft-bodied cotton pests.

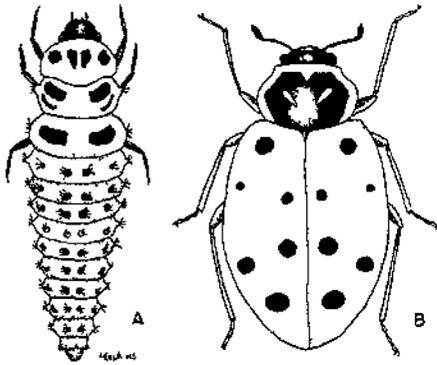
The convergent lady beetle, *Hippodamia convergens* Guer., is the most

common species in cotton throughout the state. It is ovate and approximately one-fourth inch long. The disk behind the head is black with pale margins and two oblique pale lines on each side. The wing covers are orange, usually with 12 small oval black spots.

The orange cigar-shaped eggs are laid standing on end in clusters. The dragon-like larvae are black marked with orange. This species feeds extensively on aphids.

The ash-gray lady beetle, *Olla abdominalis* (Say) is a less common species. The pale orange to buff adult is almost circular in outline and is slightly less than one-fourth inch long. The disk behind the head is spotted with black.

The wing covers have six spots



Convergent lady beetle. A—Mature larva; B—Adult.

across the base near the disk, and four to six larger spots across the middle and one spot at the tip on either side. This beetle has another color form which is black with a red spot on either side of the wing covers near the middle. The larvae resemble those of the convergent lady beetle.

This species is also chiefly a cotton aphid predator.

A third species, the spotted lady beetle, *Coleomegilla maculata* (De G.) is frequently abundant in the Salt River Valley. It has the elliptical outline of the convergent beetle but is less than one-fourth inch long. In the Salt River Valley this beetle is pink above and black beneath. The disk behind the head carries two large black spots and the wing covers are variously marked with black spots.

This beetle also feeds primarily upon aphids.

In addition to these, there are other species which are less frequently seen in cotton fields. Included in this more obscure group are *Cycloneda sanguinea* (L.) and *Hippodamia parenthesis* (Say). *C. sanguinea* is a bright orange species. *H. parenthesis* is a spotted orange with parenthesis-like marking posteriorly on the outer margin of each wing cover.

Small (one-sixteenth to one-eighth inch), usually drab species belonging to the genera *Scymnus* and *Hyperaspis* also deserve mention here. Some are efficient spider mite predators.

SIX-SPOTTED THRIPS

Scolothrips sexmaculatus (Perg.)

Like other members of its group, the six-spotted thrips is hardly visible without magnification. It is approximately one-twenty-fifth inch long, straw-colored and has three dark spots

on each of the fore wings.

This insect will attack other thrips and the young of many small insects. Much of its prey consists of spider mites that attack cotton.

STRIPED COLLOPS

Collops vittatus (Say)

The striped collops beetle is one of the most abundant predators that inhabit Arizona's cotton fields. It is about one-fourth inch long and one-half as broad, basically orange with a longitudinal, indented, metallic blue stripe on each wing cover. There is sometimes a conspicuous blue spot on the orange disk behind the head.

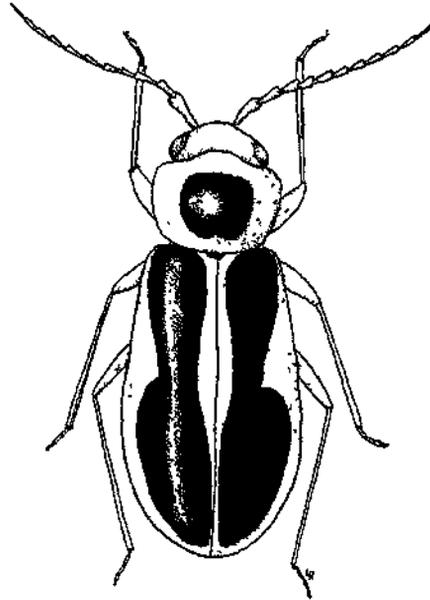
Collops beetles are general predators. They are one of the most effective natural enemies of the salt-marsh caterpillar.

By destroying the caterpillar egg masses, these beetles may delay, and sometimes prevent, serious defoliation by this important cotton pest. These beetles have also been observed to attack various species of caterpillars, fleahoppers, leafhoppers, aphids, and stink bug eggs.

Little is known about the larvae. They live in the soil and are believed to be predaceous.

The striking abundance and wide distribution of the striped collops make it one of our more important beneficial

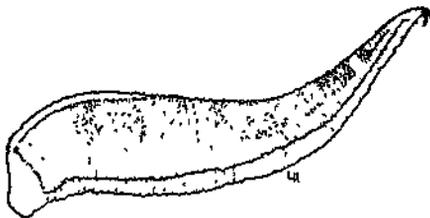
cotton insects. Other variously marked orange-and-blue relatives of the striped collops are also found in cotton fields but are far less numerous.



Striped Collops beetle.

SYRPHID FLIES

Many syrphid fly larvae, or maggots, are abundant and active aphid predators. They range from one-fourth



Typical aphid-feeding syrphid fly maggot.

to one-half inch in length, are legless, soft-bodied, and taper towards the front. Small, dark mouth hooks and the absence of a head capsule distinguish syrphid maggots from harmful caterpillars.

The species most frequently seen in cotton are greenish in color. The adults are similar in structure to houseflies and range from one-fourth to one-half inch in length. Their abdomens are usually flattened beneath and brightly striped above with combinations of yellow, white and black.

They are often called "hover flies" because of their ability to remain stationary in the air while rapidly beating their wings. Syrphid flies are remarkably fast fliers and may dart about with great agility.

Female syrphid flies are attracted to aphid colonies where they deposit their

eggs. The young maggots then hatch in the midst of an abundance of food.

The maggots are effective aphid predators and, once established, may quickly eliminate aphid infestations on cotton. Adult syrphids are not predaceous but are known to feed on nectar, honeydew, and sweet plant secretions.

PARASITIC FLIES AND WASPS

Insect parasitism is one of the factors which keep populations of injurious insects below the destructive level. Many flies and wasps are parasitic on the eggs, young, and adults of insects harmful to cotton. They range from minute wasps which destroy bollworm eggs to large flies whose maggots inter-

nally devour large caterpillars.

Because most parasites are small, and because many do not congregate about cotton plants, they are seldom seen by growers.

The nature and habits of these important insects are not fully understood and are now under investigation.

INSECT POLLINATORS

It has been generally established that the visitation of cotton by insect pollinators can produce an earlier crop. This has been particularly true with the long-staple varieties.

Various domestic and wild bees, wasps, flies, beetles and other insects regularly visit cotton blossoms. They also render their services to other crops.

It is highly important to protect and maintain effective populations of our natural pollinators and domestic honeybees. The application of cotton insecticides without consideration for insect pollinators can seriously reduce yields of other crops such as alfalfa seed and cantaloups, which require insect pollination for maximum production.



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