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: Gilbert T. Bottger, William Kauffman (deceased) and Louis W. Sheets of the Cotton Insects Section, Entomology Research Branch, U. S. Department of Agriculture; J. N. Roney and Leon Moore, Extension Entomologists; George D. Butler, Jr., Donald M. Tuttle, and Floyd G. Werner, staff entomologists of the College of Agriculture, The University of Arizona.

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 38).

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INDEX

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 It has been assembled from scattered and usually fragmentary published sources and from previously unpublished notes and field observations of entomologists familiar with cotton insects in Arizona.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-26, "Protect the Cotton Plant from Insect Injury," 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

Plant Part	*Injury*	*Pest*	*Pages*
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	24
		ants	15
	of seedlings gouged at or above ground	darkling beetles	45
		crickets	51
	deeply punctured	cicadas	33
Cotyledons (seed leaves)	deformed; plants stunted	APHIDS	33
		thrips	15
	ragged, eaten	beet armyworm	16
		cabbage looper	20
		crickets	51
Leaves	LEAVES ESSENTIALLY ENTIRE, OCCASIONALLY TORN cupped and torn, seedlings stunted	thrips	15
	deformed, covered with honeydew	APHIDS	33
		mealybugs	35
	deformed, covered with honeydew, with waxy scales on lower surfaces	whiteflies	35
	deformed, scarred; plants whip-like	cotton fleahopper	36
		black fleahoppers	37
	discolored, yellow to red or brown above, usually webbed beneath	SPIDER MITES	52
	Webbed together, chewed beneath webbing	webworms	25
	rolled and webbed; terminals chewed	omnivorous leaf roller	25
	irregularly mined, often with many small "windows"	cotton leaf perforator	22
	with long, twisting mines	leaf miners	49

Plant Part	Injury	Pest	Pages
Leaves	LEAVES SKELETONIZED, SOMETIMES WITH "SHOT" HOLES OR "WINDOWS"		
	skeletonized or with small "windows"	cotton leaf perforator	22
	with "shot holes," skeletonized, occasionally ragged	cucumber beetles	45
		Colaspis beetles	44
	with upper or lower surfaces skeletonized	various young caterpillars (feeding in groups):	
		beet armyworm	16
		fall armyworm	17
		yellow-striped armyworm	32
		cotton leafworm	21
		salt-marsh caterpillar	30
Leaves	LEAVES RAGGED OR TOTALLY CONSUMED		
	ragged; plants occasionally defoliated	various older caterpillars:	
		beet armyworm	16
		yellow-striped armyworm	32
		cabbage looper	20
		cotton leafworm	21
		cutworms	24
		salt-marsh caterpillar	30
		white-lined sphinx caterpillar	32
		grasshoppers	52
		crickets	51
Squares	punctured, disfigured, flared, eventually dropped	STINK BUS	40
	punctured, disfigured, flared, with shiny excrement spots, eventually dropped	LYGUS BUGS and relatives	38
	with holes, hollowed out, eventually dropped	BOLLWORM	18
		beet armyworm	16
		cotton square borer	23
		yellow-striped armyworm (rarely)	32
	with bracts rolled and webbed, bracts and squares chewed	omnivorous leaf roller	25

Plant Part	Injury	Pest	Pages
Flowers	punctured, disfigured	STINK BUGS	40
	"warty," disfigured, flared, with shiny excrement spots	LYGUS BUGS and relatives	38
	with holes, eaten out	BOLLWORM	18
		beet armyworm	16
		cotton square borer	23
		yellow striped armyworm (rarely)	32
	with petals rosetted	PINK BOLLWORM	27
	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	18
		beet armyworm	16
		cotton square borer	23
		yellow-striped armyworm (occasionally)	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 or large bolls	PINK BOLLWORM	27
	with small and large holes in carpels, holes thru lint between locks, weevil pupae or adults within hollow cells in lint	boll weevil	47
	honeydew on lint	APHIDS	33
		whiteflies	35
		mealybugs	35

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.

			Pages
Laid in groups or clusters	White to cream, round, variously sculptured; usually on underside of leaves and near top of plant	salt-marsh caterpillar	30
	Pearly white to gray, with purplish bands and definite ridges, clusters indiscriminately placed	cutworms	24
	Pale green covered with velvety hair	beet armyworm	16
	Pale blue-green, flat, overlapping, on upper surfaces of leaves	omnivorous leaf roller	25
	Nearly transparent, overlapping, on underside of leaves	webworms	25
	Mostly white to gray, like little barrels	STINK BUGS	40
	Orange, cigar-shaped, standing on end	*lady beetles*	59
Laid singly	Greenish to red, oval, ridged like a peanut, at bases of bolls and on inside of bracts	PINK BOLLWORM	27
	Whitish-green, flattened "domes," depressed on top, covered with small hexagonal depressions, on foliage	cotton square borer	23
	Blue-green to dirty white, flattened "saucers," ribbed, usually on underside of leaves	cotton leafworm	21
	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	BOLLWORM	18
	White, shallow inverted "cups," never with brownish band, shorter than width at base, on foliage	cabbage looper	20
	White to green, on silken stalks, mostly single but occasionally in groups, on foliage	*green lacewings*	55

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, smoth, fat, "greasy;" curl up when distrubed; usually feed at night	cutworms	24
Exposed on foliage	Pale yellow to black with white stripes and rak spots on back and head; falsc legs on 6th segment not fully developed	salt-marsh caterpillar	30
	Black with yellow and brown stripes	yellow-striped armyworm	32
	Very hairy	cotton leafworm	21
	Yellowish to green, tubular, only two pairs of legs under middle of body, moves with looping gait	cabbage looper	20
	Large, pale green to black, with white lines on body and yellow horn at rear	white-lined sphinx caterpillar	32
	Greenish with faint lighter stripe, 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 (¼ 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	25
	Dark green to pale green with black spots on each segment; in loose, webbed shelter	webworms	25
Within leaf mines	Minnute (one-sixteenth inch), white	young cotton leaf perforators	22

Feeding on or in bolls	Velvety-green, slug-shaped	cotton square borer	23
	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	32
	Black with yellow and brown stripes; rarely enters bolls		
	Pink on back and sides, lighter beneath, relatively stubby, bolls with short mines (no noticeable entrance holes)	PINK BOLLWORM	27
	Small (¼ inch long when mature), dull amber-green with gray-black spots and lighter bumps over body, occassionally bore into tips of bolls and chew outside of carpels	cotton leaf perforator	22

III. OTHER LARVAE

Legless	White to cream, ¼ inch long, in soil and on seed or underground parts of seedling (maggot)	seed corn maggot	50
		leaf miner fly	49
	Usually pale green, ⅛-⅛ inch long, found near aphids (maggots)	*syrphid flies*	60
	White to cream, about ¼ inch long, in bolls	boll weevils	47
With legs	Tan to yellow, up to one inch long, in soil	wireworms	48
	Black with orange and (or) white marks, about ¼ 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 (aphid lions)*	55

IV. PUPAL SHELTERS

Portions of leaves or bracts rolled and tightly webbed	omnivorous leaf roller	25
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	*green lacewings*	55

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

Pages

Larger than ¼ inch

- Shield-shaped, ¼ - ½ inch long ..... STINK BUGS 40
- **Oval-shaped**
  - 3/16 inch long, straw-green to dark brown, rear half of wings bent downward ..... LYGUS BUGS (adults) 38
  - ⅜ inch long, dark brown or black, reddish triangle behind head with two dark spots, outer wing margins orange to red, (resembles large lygus bug) ..... superb plant bug 43
  - ⅛ - ⅜ inch long, oval to round, wingless various colors ..... STINK BUG (nymphs) 40
- **Slender, forelegs held as in prayer**
  - ½ inch long, green and wine or brown, legs long and thin, neck narrow, spines prominent ..... *assassin bugs* 56
  - ⅜ inch long, gray to buff, almost cigar-shaped, spines not conspicious ..... *nabids* 57

⅛ inch or smaller

- Pale green with black specks over body, about ⅛ inch long; resemble small lygus bugs ..... fleahoppers 36
- Same as above, but black ..... black fleahoppers 37
- Buff to dark brown or black, ⅛ inch long or smaller, with dark protruding eyes and a silvery triangle where wings cross on back ..... *big-eyed bugs* (adults) 57
- Shiny gray to brown or black, wingless with protruding dark eyes ..... *big-eyed bugs* (nymphs) 57
- Black with three silver-white areas on back, tiny (1/16 inch long) ..... *minute pirate bugs* (adults) 58
- Amber to orange, wingless, 1/16 inch long or smaller ..... *minute pirate bugs* (nymphs) 58
- 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, ⅛ inch long, covered with powdery wax. Seldom moves	mealybugs	35
		Oval to round, scale-like, bordered with white, flaxy filaments	whiteflies (nymphs)	35
		Like tiny white moths	whiteflies (adults)	35
	Body naked	Almost globular, most with less obvious wavy covering, 1/16 inch long, six legs, slow-moving, associated with honeydew	APHIDS	33
		Round, green to reddish, almost invisible to the naked eye, eight legs, active	SPIDER MITES	52
Slender, not in colonies		Usually greenish-wedge-shaped 1/16 to 3/16 inch long, wings held roof-like over body	various leafhoppers	36
		Usually yellow to straw-colored, 1/25 inch long, two pairs of fringed wings held flat over back, move actively	thrips (adults)	15
		Yellow to straw colored, wingless, similar in habit to adult thrips	thrips (immature)	15
¼ inch or larger		Rust to dark brown with buff margin on wing covers, robust, 1 to 1½ inches long	desert June beetles	46
			Texas June beetles	46
Less than ¼ inch		Rust, with sparse golden hairs, prominent snout, ¼ inch long	boll weevils	47
		Yellow to buff, with fine longitudinal ridges on wing covers, ¼ inch long	Colaspis beetles	44
		Dull brown to black, robust, ¼ inch or longer, hidden during day	darkling beetles	45

Green with black spots, or yellow to cream with black stripes, ¼ inch long	cucumber beetles	45
Orange or pink with black spots, circular to oval, ¼ inch long	*lady beetles*	59
Usually orange with two longitudinal, metallic blue bands on wing covers, 3/16 to ¼ inch long	*striped collops beetles*	60
Black, slender with darker bands across wing covers, horn-like process	fruit bud beetle	49
projecting forward over head, 3/16 inch long	notoxus beetles	49

VIII. GRASSHOPPERS AND CRICKETS (LARGE LEATHERY INSECTS, ACTIVE JUMPERS)

Wings held roof-like over body, short antennae	grasshoppers	52
Wings held flat over body, long antennae	crickets	51

IX. OTHER CLEAR-WINGED INSECTS

Body slender, pale green or brown, with large, net-veined wings held roof-like over the back, about ½ inch long	*lacewings*	55
Bee-like flies, usually brightly marked with yellow and black or white and black	*syrphid flies*	60
With only two clear wings, many sizes and colors	various flies	61
With four clear wings, many sizes and colors	*various bees and wasps*	61

Harmful Insects

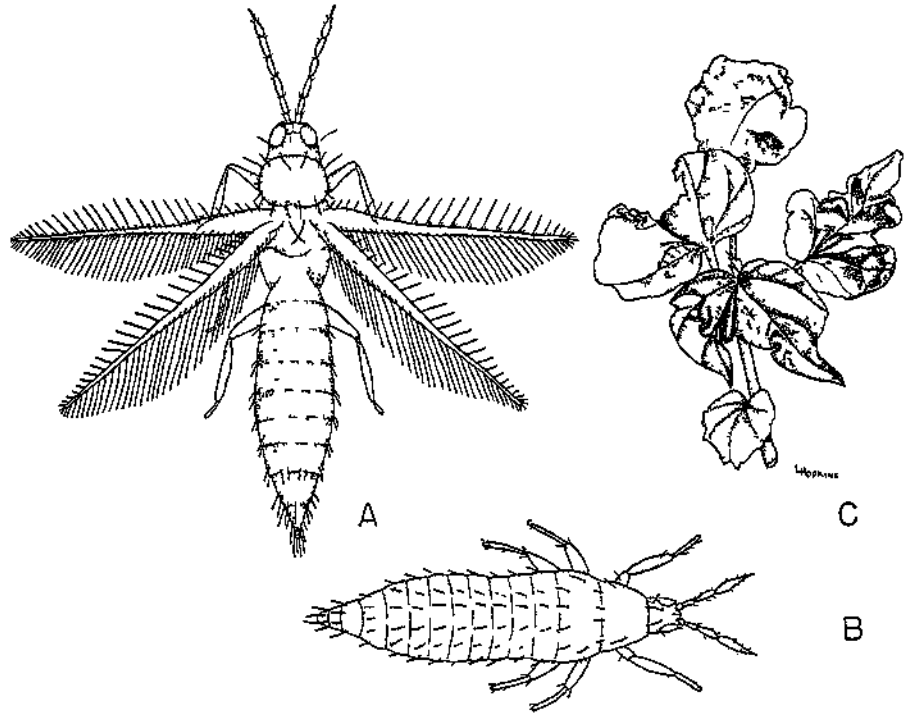
THRIPS

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 cultivated 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 cotton leaves and consume the escaping juices. Injured areas do not grow



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

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."

Thrips 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.

Long staple cotton is very susceptible to injury because the thrips feed only on the growing point and not also on leaves as in short staple cotton. Such feeding causes smaller and deformed long staple plants and, depending on early thrips populations, may cause squaring to be delayed a week or more.

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.

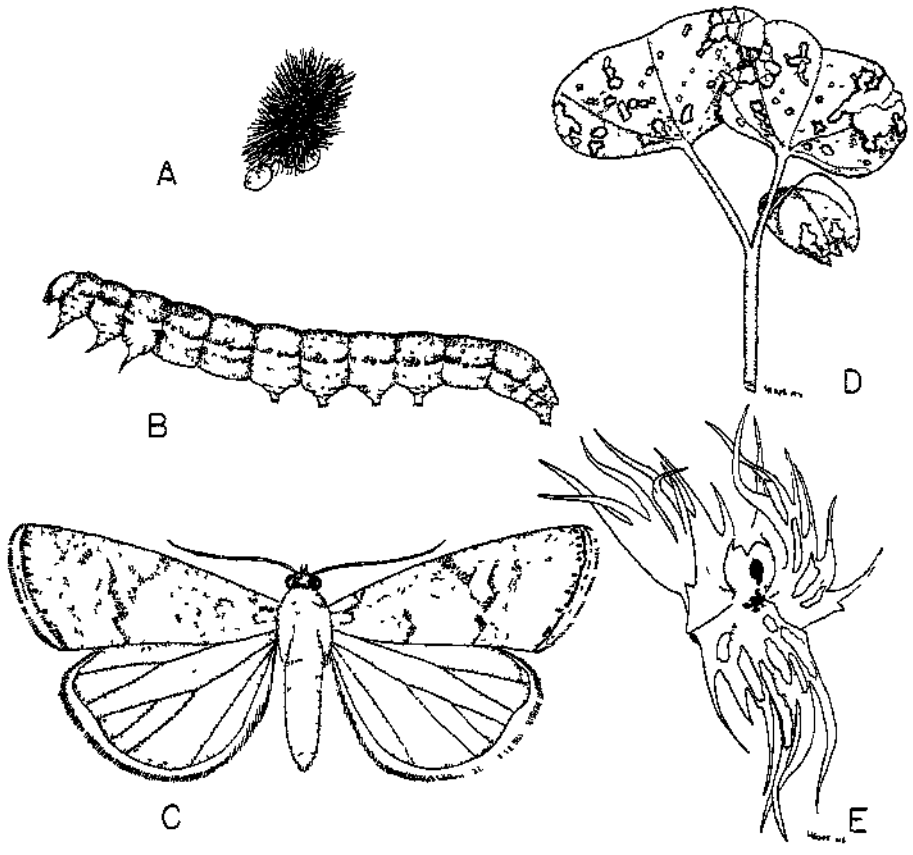
The moths are about three-fourths inch long with a wing span of one to one and one-fourths inches. They are dusky, mottled gray with distanct lighter markings on the fore wings.

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,



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.

causing a die-back to a short distnce below the entrance holes. During periods of heavy infestations egg masses may be laid on both the lower and upper leaf surfaces.

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 conspicious black dots, each of which bears a single hair. As the larva grows, these dots become less conspicious.

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 burrows 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.

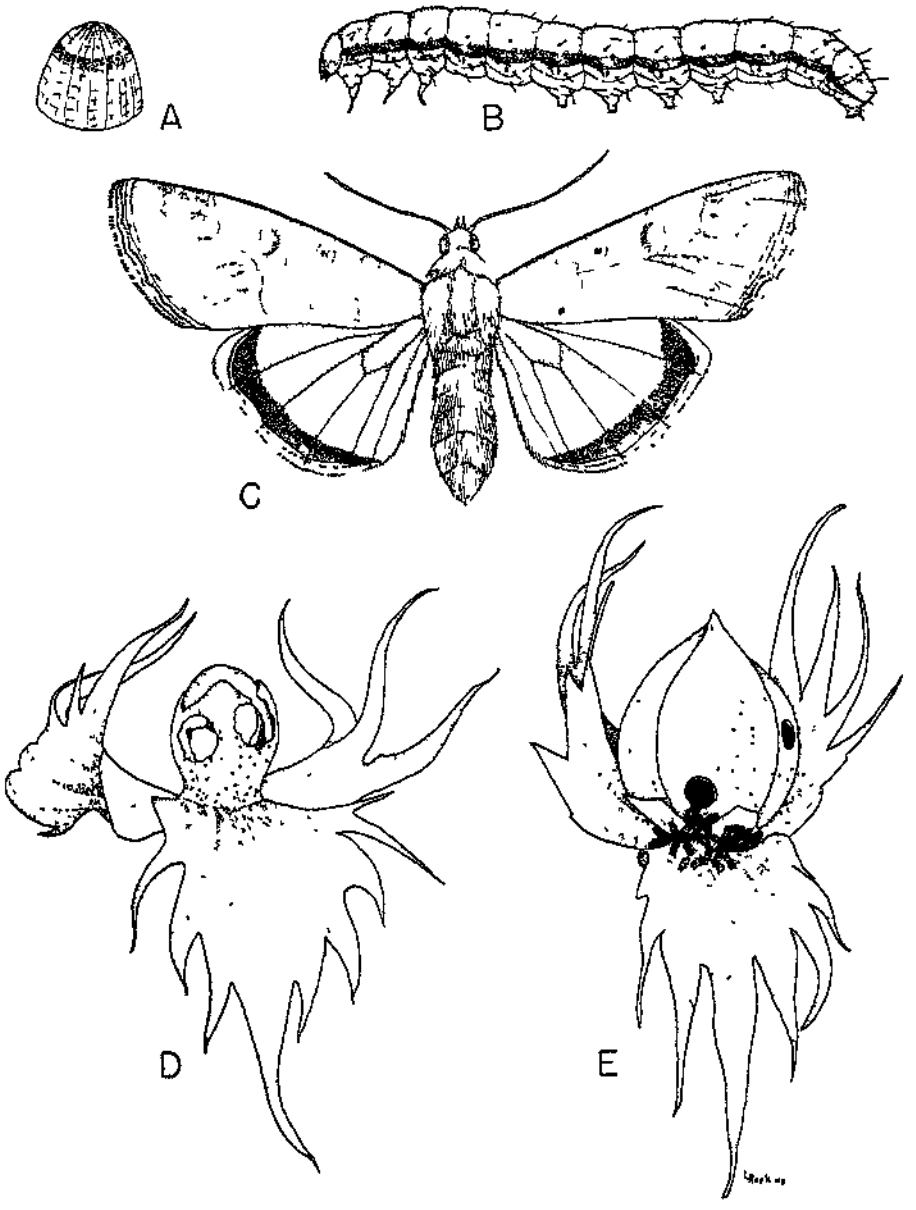
The moth has a wing span of one and one-half inches. The fore wings are buff to tan, marked with irregular dark lines and spots. A rather large, dark crescent near the center of each forewing helps to identify the species. The hind wings are light gray with a dark band at the trailing edges. These moths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

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 occassionally rag the foliage and bore into the stems.



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

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 bollworms 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.

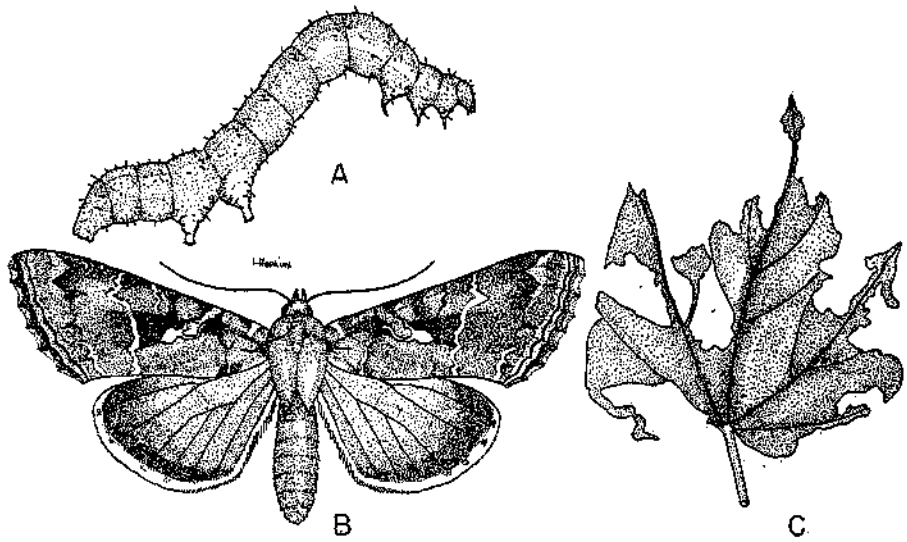
CABBAGE LOOPER

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 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.



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

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.

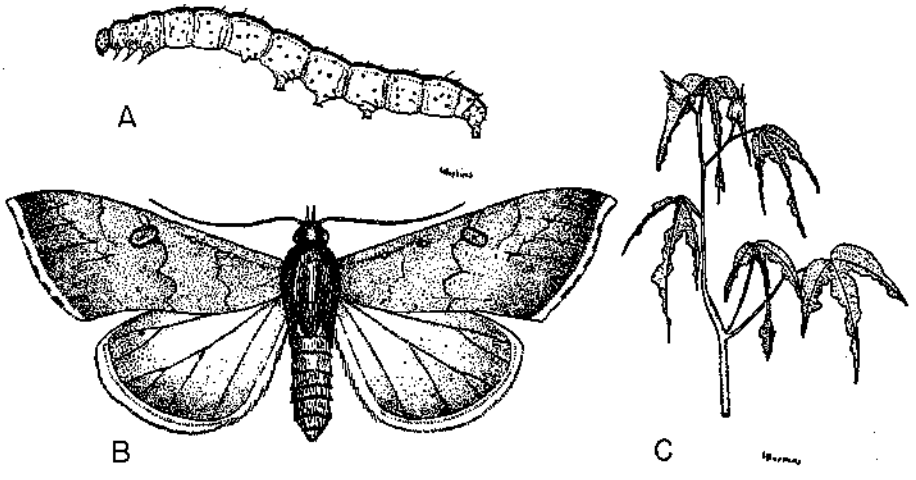
COTTON LEAFWORM

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 injurious populations rarely develop, and harmful infestations have not been reported since 1944. The cotton leaf-worm 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



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

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.

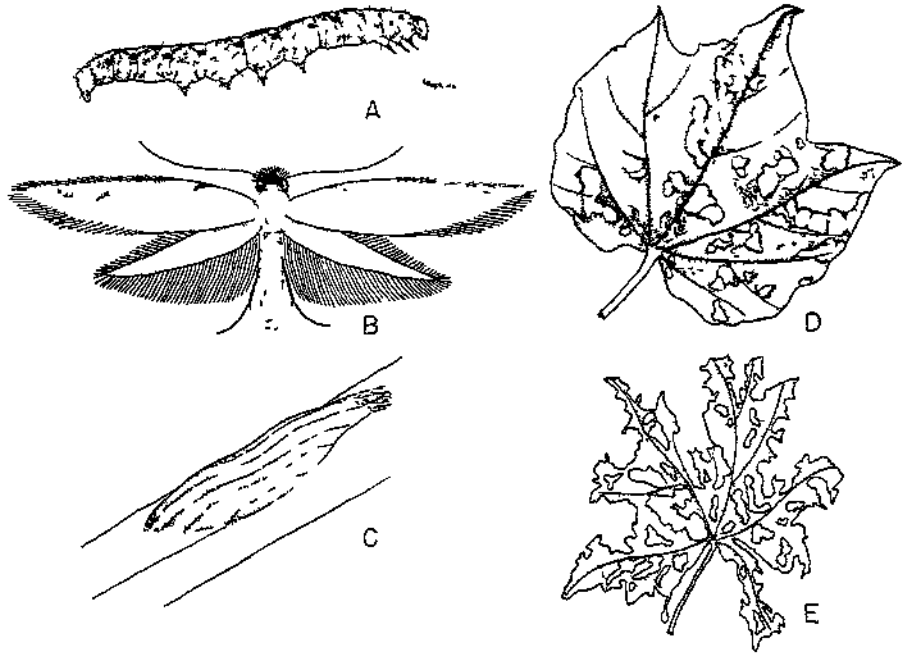
The small, white, newly hatched caterpillars make irregular mines in the foliage. After molting once, they leave the mines to feed externally. During the second molt they are protected within a white, U-shaped, silken covering. This is frequently referred to as the "horseshoe stage."

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 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 feeding 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



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.

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.)

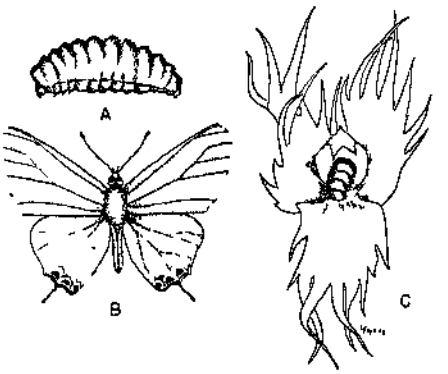
The cotton square borer has a wide range of hosts throughout the United States and is generally considered to be of minor importance on cotton. The adult is a small, bluish butterfly with a wing span of about an inch.

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 bolls 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.

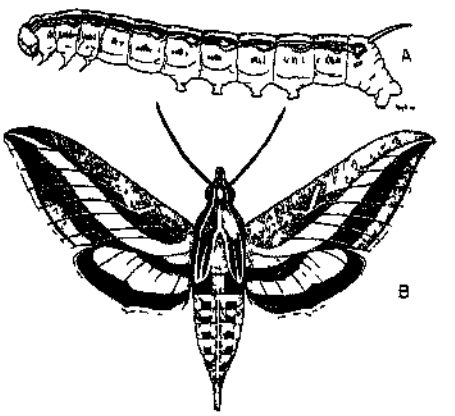
Occasionally cutworms are locally abundant and cause serious damage in restricted areas. Cutworms are often abundant on cotton that follows alfalfa.

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.

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.



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

WEBWORMS

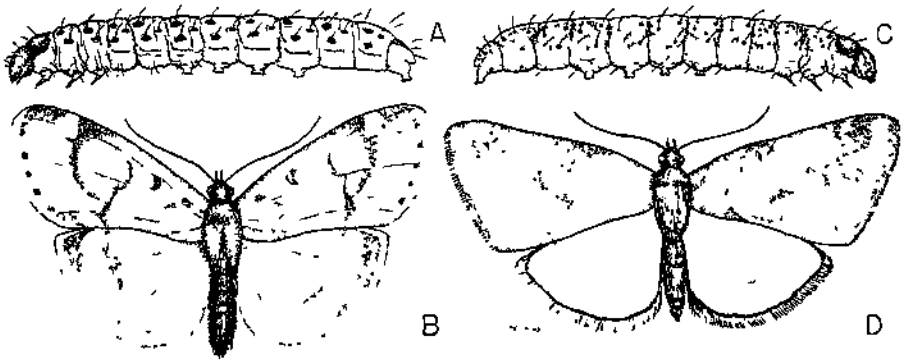
The garden webworm, *Loxostege similalis* (Guen.), and the sugar beet webworm, *Loxostege sticticalis* (L.), have a wide range of weed hosts and attack many crops in the Southwest. They are not major pests of cotton but injurious populations are occasionally found, particularly in weedy and poorly managed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



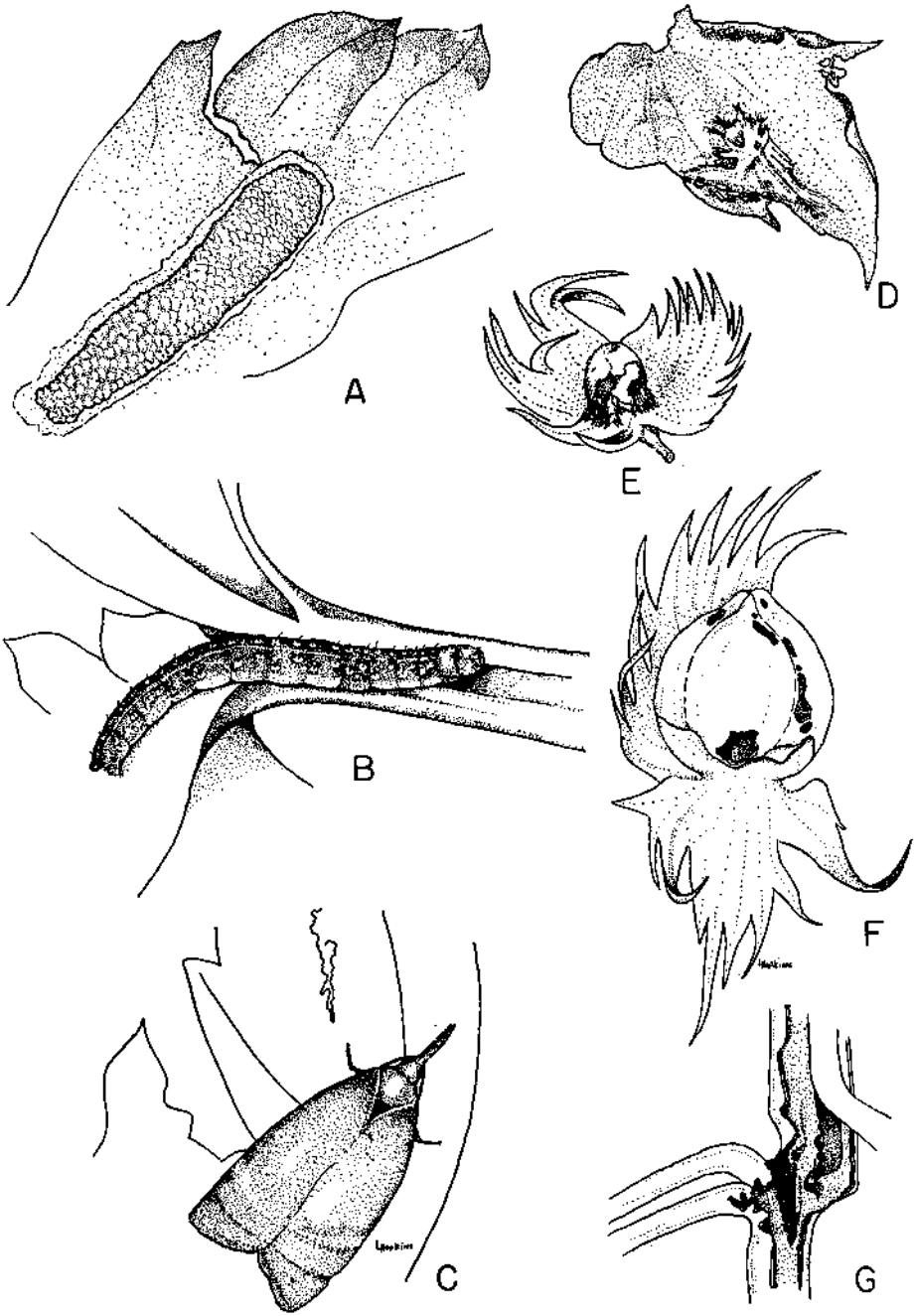
Webworms. A—Garden webworm, mature larva; B—Garden webworm, adult; C—Sugar beet webworm, mature larva; D—Sugar beet webworm, adult.

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



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.

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 characteristic 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 omnivorious 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.

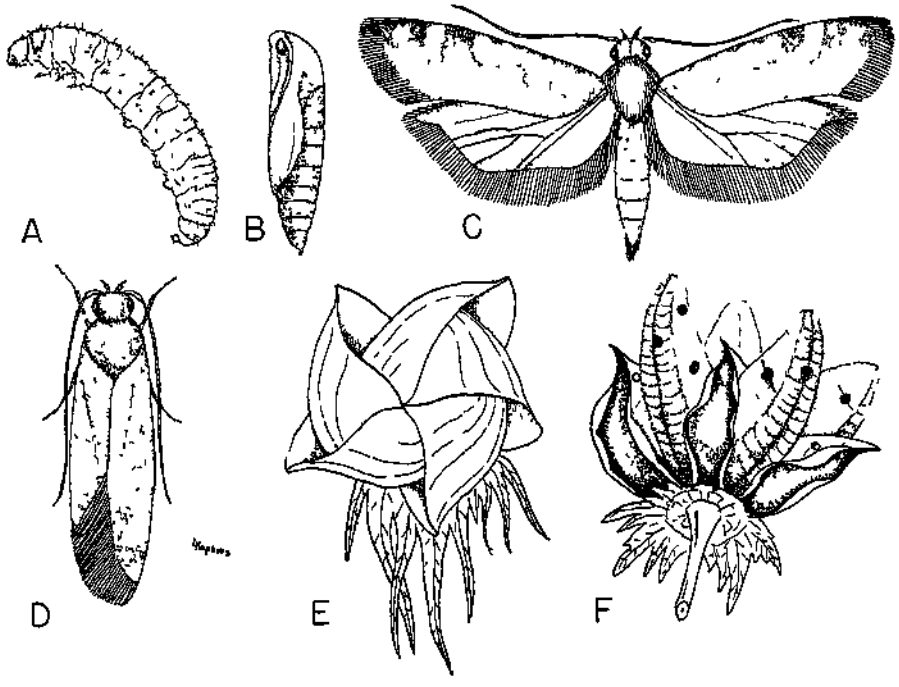
Investigations in southern California indicate that the most practical means to evaluate omnivorous leaf roller populations in cotton is the time-search-basis method. All the living larvae found anywhere on the plants during a given period of time are counted. If living larvae are found at an average 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.

PINK BOLLWORM

Pectinophora gossypiella (Saunders)

The pink bollworm has been continuously observed in Arizona since the winter of 1926-27, when it was first found in Cochise, Graham, and Greenlee Counties. It has also been found in Pima (1927), Maricopa (1929), Pinal (1929), and Santa Cruz (1937) Counties. Until recently, infestations have usually been light and more threatening than actually damaging.

Infestations in Graham County began to increase in 1955, although serious economic damage did not appear until 1963 and 1964, when heaviest losses occurred in late maturing, long staple cotton. "Eradication" campaigns were conducted in Maricopa County in 1930-31, 1940-42, 1947, and 1959-1962. The last campaign followed the discovery, in 1958, of widespread infestations in Maricopa and Pinal



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.

Counties, with highest pink bollworm population in fields grown from "stub" cotton. Although this last eradication effort appeared, by early 1963, to have been successful, heavy infestations again appeared in 1964, with some cases of serious economic loss.

By late 1964, it was concluded that infestations in Maricopa and Pinal Counties were so widespread and so intense that further publicly financed eradication efforts were not justified. By its recent activities the pink bollworm has shown that it can seriously reduce yields both in fields of planted cotton and of stub cotton in Arizona.

The adult is a small, mottled, grayish-brown moth, 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 moths emerge from pupae sheltered within bolls, or within cocoons in the soil. The first spring generation emerges in Arizona over a period extending from March to August, carying with the season and the area. Over a 6-year period in Graham County an overage of 50 percent of the moths had emerged by the end of May, with 90 percent average emergence by June 20. The 50- and 90 percent emergence dates are earlier in Maricopa County, usually by a week or more. The peak of spring moth emergence usually coincides with the

appearance of the first cotton squares.

The oval, greenish to red eggs are laid preferably in sheltered areas such as the bases of the bolls or the insides of the flower bracts but may also be laid elsewhere on the cotton plant. Moths emerging before the first squares appear lay few eggs and are said to have emerged "suicidally". Immediately upon hatching, the young caterpillars search for food. Without food they die within 24 hours. It is estimated that 90 percent of the newly hatched young die before feeding.

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. Although larvae prefer to attack nearly mature bolls, they will also feed upon squares and flowers. In the summer the larvae pupate when full grown and a generation may be comlpeted in three to four weeks. Five to six generations a year are possible.

Beginning in late September and October some full-grown larvae, instead of pupating, enter a stage of inactivity, or diapause, which continues through the winter. Larvae infesting earlier maturing, short staple cotton varieties enter diapause sooner than those infesting later maturing, long staple cotton varieties. The diapausing larvae spend the winter in seeds in bolls or as free individuals in cocoons in the soil. In eastern Arizona at least 50 percent of the larvae spend the winter in the latter manner in the soil. Some diapausing larvae may remain inactive for as long as two years before pupating. Pupation of overwintering larvae occurs in the spring and is immediately followed by moth emergence.

Cotton squares and younger fruiting structures injured by pink bollworms usually drop from the plant. The larvae damage maturing bolls by feeding within the seeds and by cutting and tunneling through the developing lint. Lint from infested bolls is short, discolored, and of low grade. Oil content and germination of infested seeds are reduced.

Pink bollworm infestations can be detected by a number of signs: (1) Caterpillars in squares web the tips of the developing flower petals together. When these squares bloom, *the flowers are rosetted* (See diagram "E", page 28). This is particularly evident in fields of short staple cotton during the first week of blooming. (2) Pink bollworm infestations may be detected by the presence of very small tunnels in the carpels of cut bolls. (3) Larvae make clean-cut, round holes as they move between locks or leave the bolls. (4) Late in the season larvae often web two seeds together, producing characteristic *double seeds*, within which the winter may be spent.

The pink bollworm is difficult to control with insecticides because much of the larval development takes place within the boll, beyond the reach of conventional toxicants. Insecticides, particularly formulations of carbaryl (Sevin) have been employed, usually in series of repeated treatments, against larvae in eradication campaigns.

For individual growers cultural practices, directed mainly toward the overwintering larvae, are of great importance. Such practices include avoidance of stub cotton, early harvesting, prompt disposal of stalks by shredding, followed by deep plowing, and winter irrigation to aid decomposition of plant residues. Growing a crop of winter barley following a cotton crop is an effective method of destroying overwintering pink bollworms.

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 female 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. Then they 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.

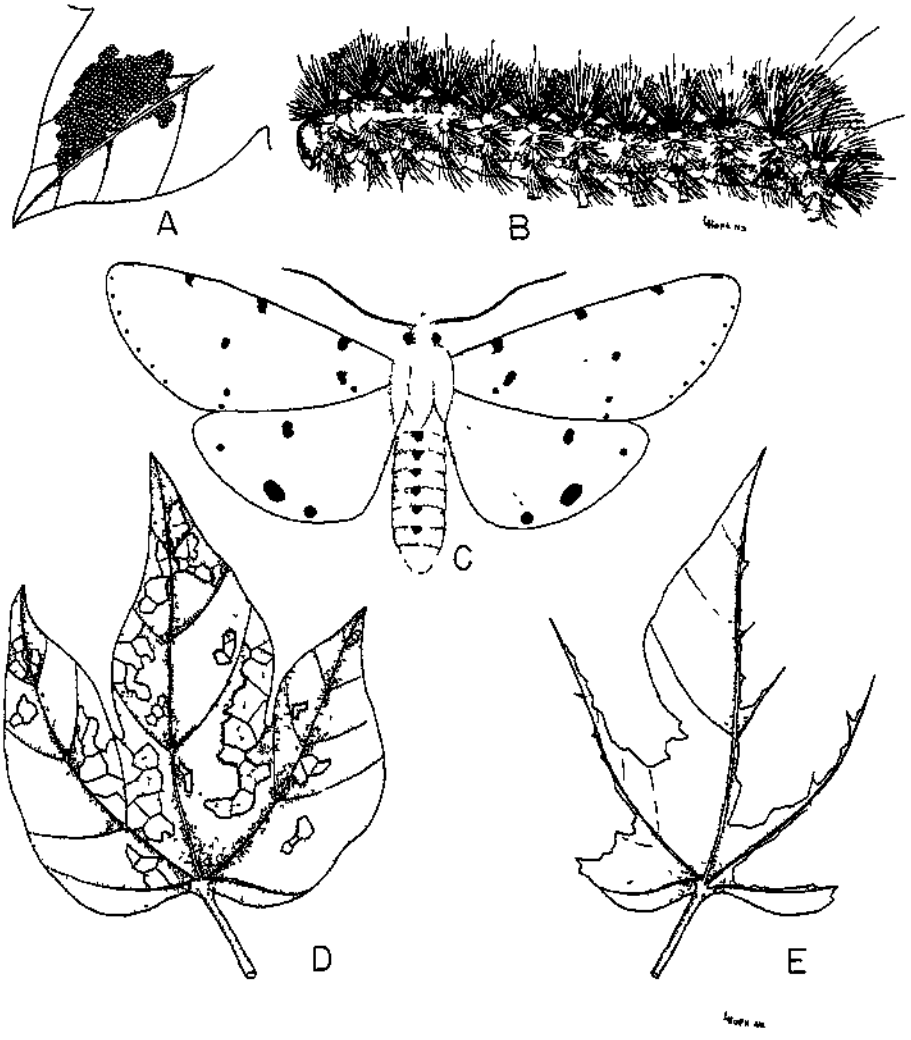
Young larvae, feeding gregariously on the lower surfaces of the leaves, leave the leaf veins and upper surfaces intact. Damaged leaves then have the appearance of fancy lace work. Older larvae, feeding independently, eat through the leaves and consequently rag the foliage.

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 deceased yields because the small bolls are exposed to the sunlight and open prematurely. Late infestations, occuring 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.

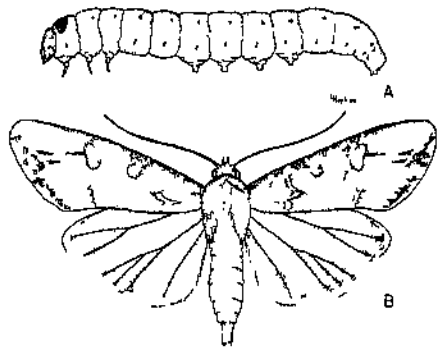
WHITE-LINED SPHINX MOTH

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 longtitudinal 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.

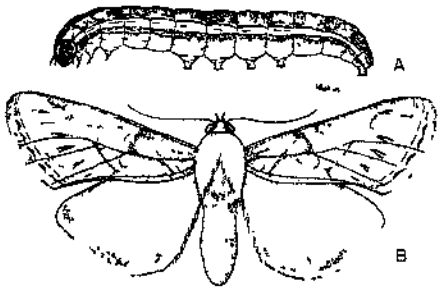


White-lined sphinx moth. A—Mature larva; B—Adult.

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.



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

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 in-

vasion of nearly mature caterpillars.

Harvesting nearby alfalfa fields containing large larvae 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.

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

Aphsi 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

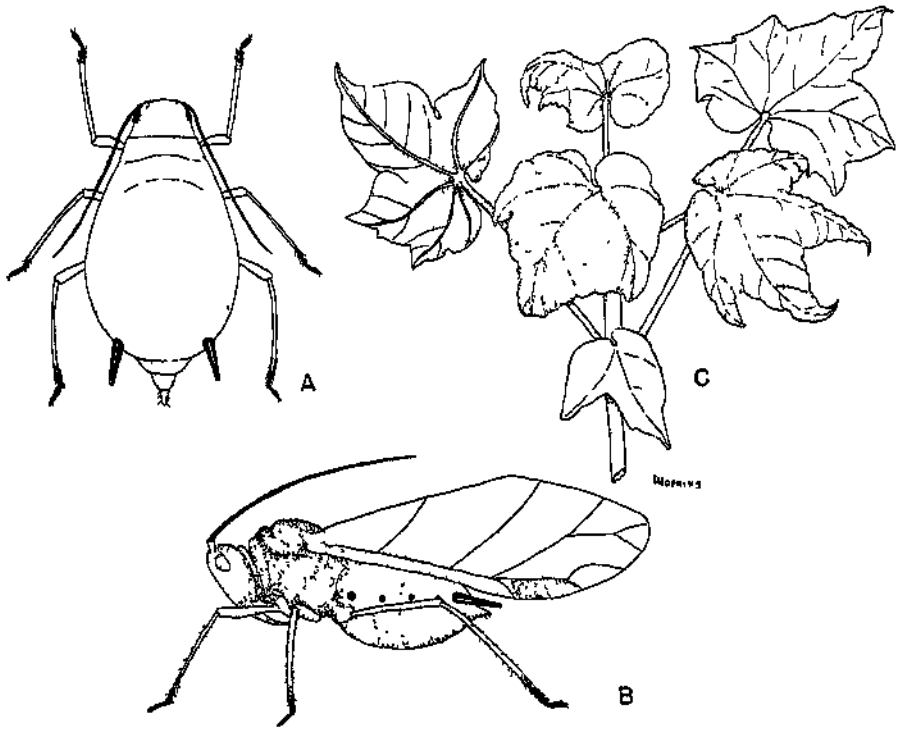
or even kill seedling plants. The first injury symptom is a distorted, inverted, cupping of leaves.

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 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.



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

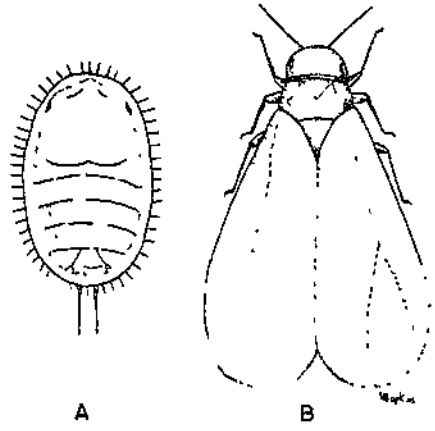
WHITEFLIES

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.

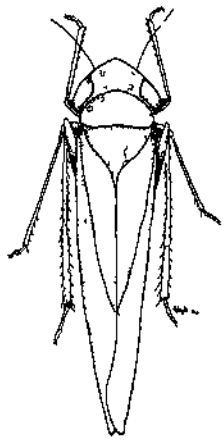
LEAFHOPPERS

Empoasca spp. and others

Leafhoppers are frequently found on cotton throughout Arizona, but only in Yuma county do 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.

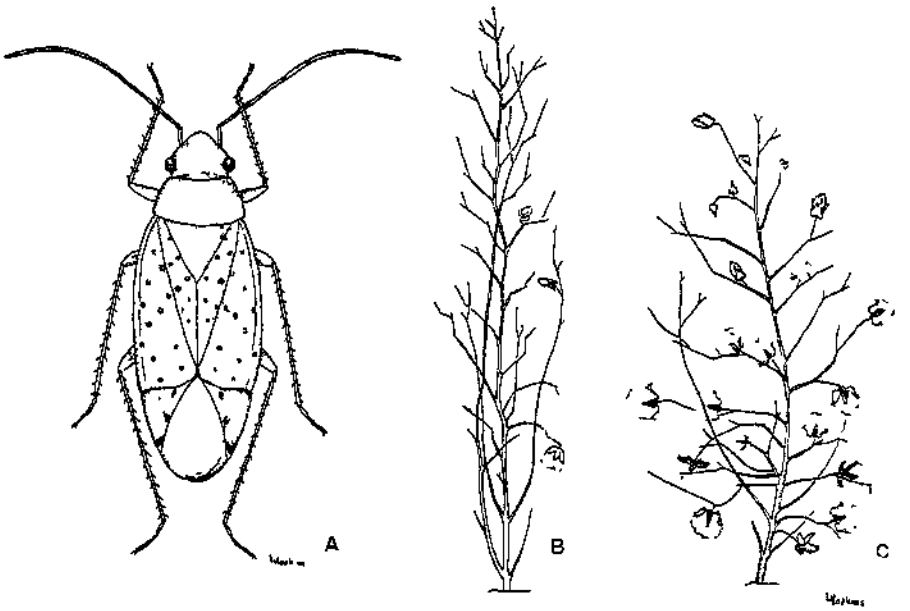
The adults are about one-eighth inch long, a third as broad, and look like small lygus bugs. They are light green with fine black speckling over the body. The older nymphs resemble adults, but lack wings. Newly-hatched nymphs are very small, white and elongated, with slender legs.

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



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

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

BLACK FLEAHOPPERS

Spanogonicus albofasciatus (Reut.)
Rhinacloa forticornis (Reut.)

Black fleahoppers are frequently found in large numbers on cotton during the early part of the growing season. Recent research has shown that a few black fleahoppers feeding during a prolonged cold spring can seriously injure seedling plants. This feeding causes stunting and may produce plants with forked stems. Such injury also delays square setting and may depress final yields. Heavy populations, (5 or more per plant) have killed young cotton plants during cool weather. If the spring weather is warm and the young cotton plants are growing vigorously, black fleahoppers usually cause little or no damage. These insects do not cause significant injury to plants in the five-leaf or older stages of growth. In recent laboratory tests, black fleahoppers have shown some activity as predators of certain insect pests of cotton. These tests have not yet been adequately verified under field conditions.

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.

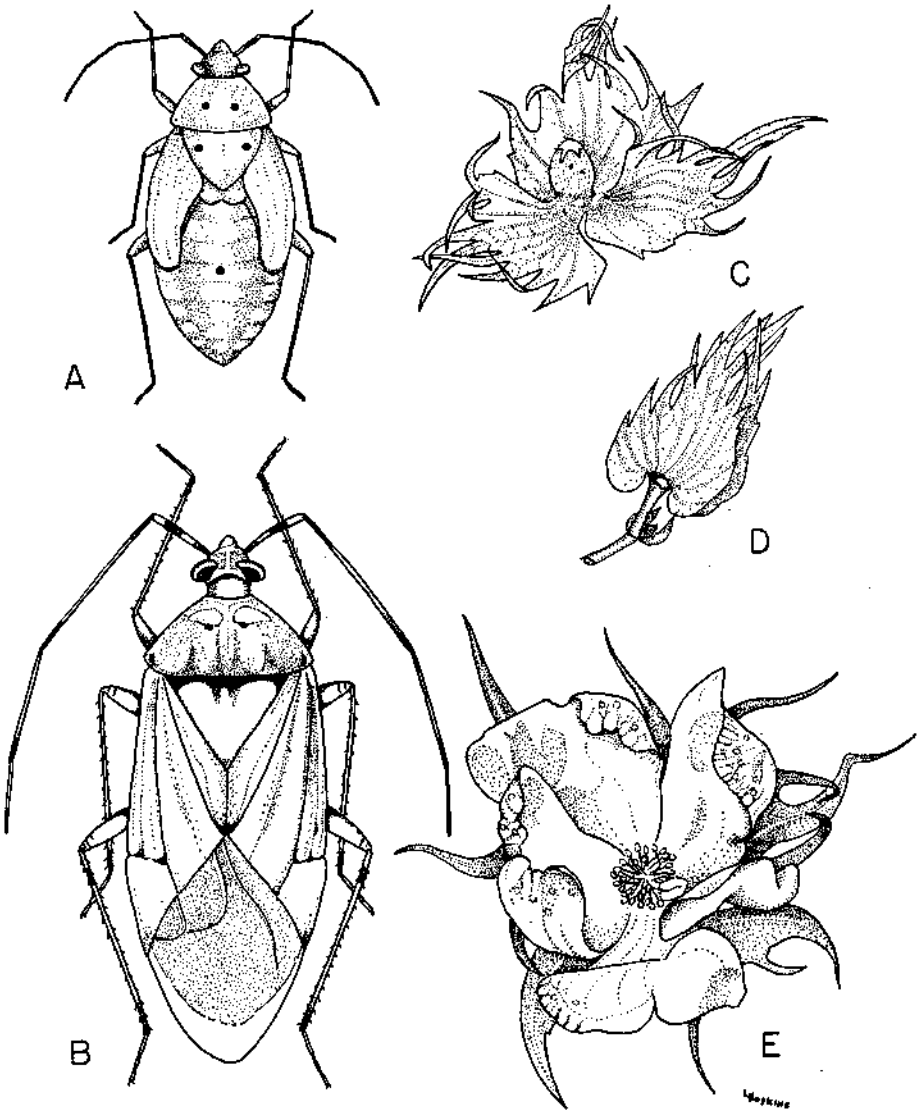
Drying desert vegetation is the source of infestations in such areas as Coolidge and Safford. Alfalfa is another important source of infestations. When this crop is cut, black fleahoppers migrate to adjacent fields of young cotton.

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.

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. Eggs are laid in the plant tissues and, after hatching, the nymphs molt fives times before maturity. During July and August it takes approximately three to four weeks for a generation to develop. 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. When abundant, lygus bugs may be very destructive to presquaring cotton. Only the growing tips of



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

such plants are attacked. Prolonged feeding causes unusually tall plants and abnormal branching of the main stem. This early injury does not become evident until approximately 3 weeks after the damage has been done but may later be reflected in delayed fruiting, delayed maturing, and potential yield reductions. Extensive feeding on fruiting cotton causes the "flaring" and shedding of injured squares, blossoms, and small bolls. Injured bolls that fail to drop may later open abnormally. The lint of such bolls is of inferior quality and clings to the warty carpels, making picking more difficult. Seeds not totally destroyed contain less oil and germinate poorly.

Serious infestations of lygus bugs in mid-season or late cotton 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 sayi* 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 and Cochise counties, but may also develop tremendous and destructive localized infestations on cotton in other counties of central and southern Arizona.

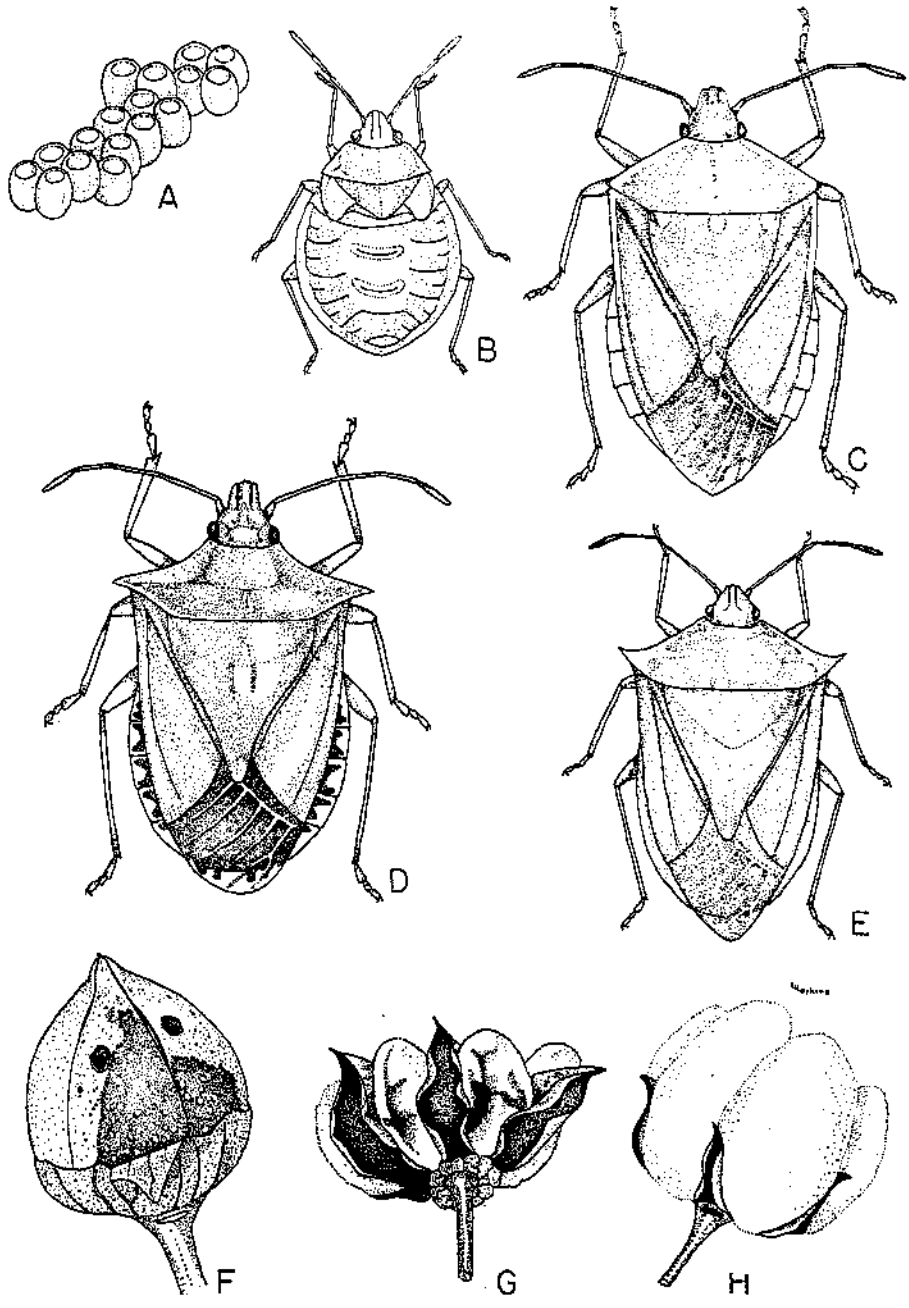
b. The so-called "brown cotton bug," *Euschistus impictiventris* (Stal,) is light brown above and yellow to yellow-green on the underside. Its "shoulders" are sharply pointed laterally. This species is predominant in cotton grown at lower elevations and has caused particularly serious damage in Yuma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

2. 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



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 ball with hardened dry locks caused by stink bug feeding during boll development; H—A normal open boll.

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

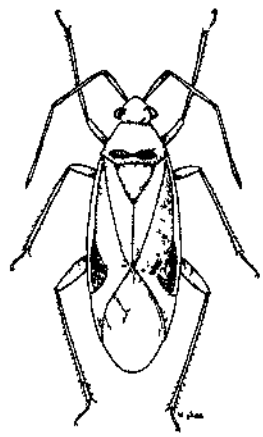
Superb Plant Bug

The superb plant bug *Adelphocoris superbus* (Uhler) is a common pest of cotton and alfalfa in the southeastern 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. Little is known of their life history. Eggs are laid ni 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.



Superb plant bug.

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 reclivatus* 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

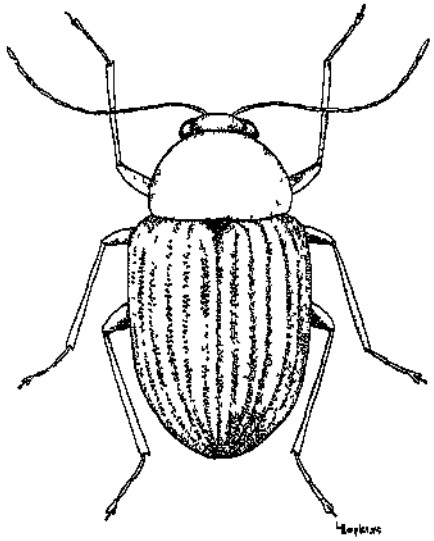
Creontiades femoralis Van Duzee, locally known as the western plant bug, is about one-fourth inch long and slightly more than one-sixteenth inch broad. It is reddish brown with long antennae and legs. Before World War II, it frequently caused deformed plants and reduced yields.

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

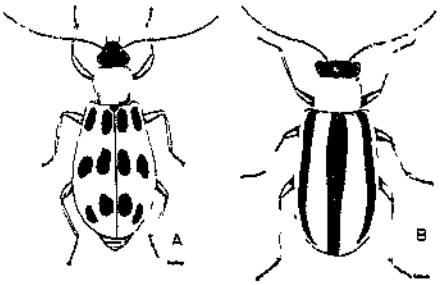
Diabrotica and *Acalymma* spp.

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.

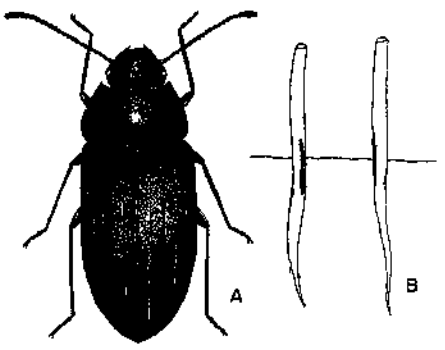


Cucumber beetles. A—A spotted cucumber beetle; B—A cucumber beetle.

DARKLING BEETLES

Blapstinus spp.

Ulus crassus (Lec.)



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

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 length, and are approximately a third as broad as long. In cotton fields, dark-

ling 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.

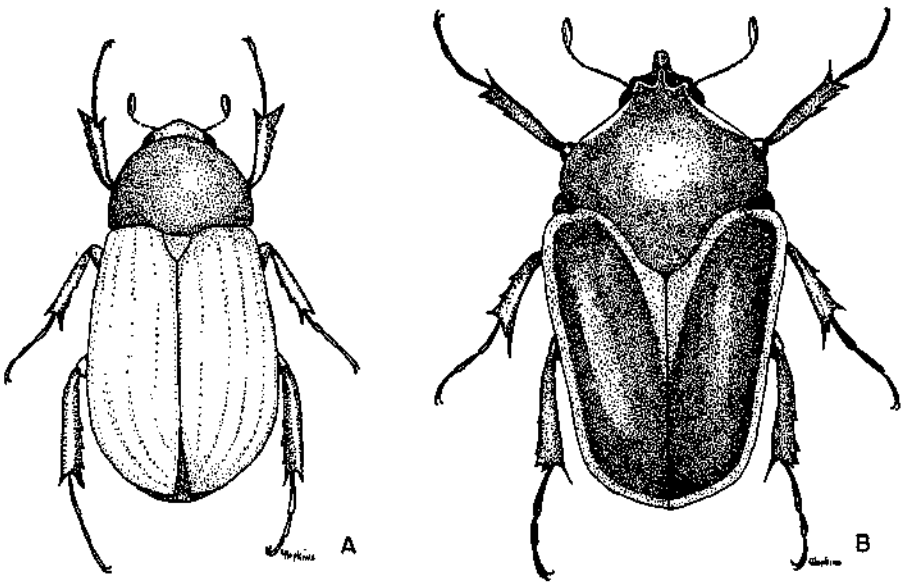
JUNE BEETLES

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 corrals 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 WEEVILS

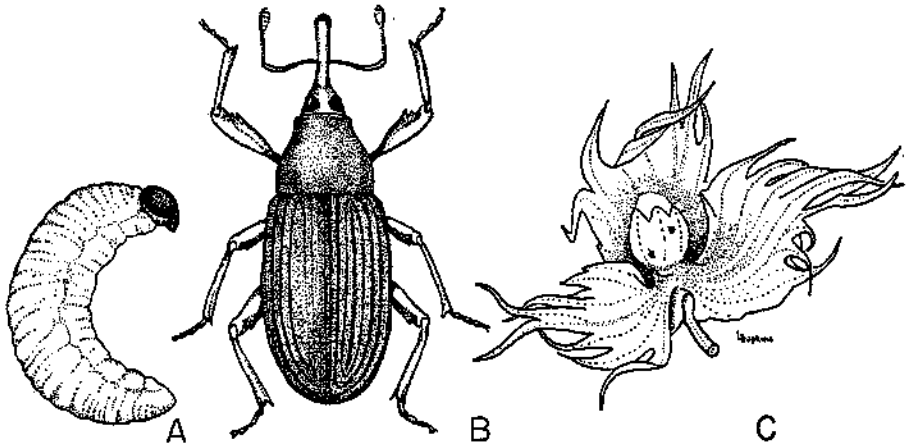
(Subspecies or Varieties of *Anthonomus grandis*)

Cotton in the United States and Mexico is infested by various boll weevils of the species known as *Anthonomus grandis*. These weevils cannot be dependably distinguished by external appearance although they differ in life habits. The distinguishing features are not fully understood and may involve gradations, as well as clear-cut differences.

Adult boll weevils are rust-brown, about one-fourth inch long and half as broad, and are usually sparsely covered with silver-gray hairs. Like most weevils, they have a prominent snout. They can be distinguished from other weevils by obvious spines on the femur of each leg. The wrinkled, legless larva is white with a brown head and is slightly less than three-eighths inch long when full grown.

The adult weevils make holes in bolls and squares as they feed with their beak-like snout. Females place eggs in some of these holes, which are then covered with a mixture of excrement and a cement-like secretion. The presence of eggs and larvae in bolls, which seem to be preferred over squares for oviposition, causes warty proliferations on the insides of the carpels. The larvae feed on these proliferated cells, and on developing lint and seeds. From one to several larvae may infest a single boll whereas squares usually contain but one larva. Pupation occurs within the bolls or squares. Pupae are at first white, changing to a darker color just prior to emergence.

The eastern boll weevil, *Anthonomus grandis* Boheman, which is now the major insect pest of the eastern cotton belt, originated in Mexico and was just found in the United States in 1892. It is not known to be established west of Texas. The thurberia weevil, *Anthonomus grandis thurberiae* Pierce, was described from Arizona in 1913. It occurs in southern Arizona and northern Mexico in mountain canyons on wild cotton, *Gossypium Thurberi* Todaro. It has occasionally attacked bolls of long and short staple cotton in Arizona during the fall months, particularly in fields bordering desert areas and near wild cotton plants. In recent years, particularly since 1960, cotton growing areas in northern Sonora, Mexico, within from 30 to 100 miles of the Arizona border, have been moderate-



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

ly to severely infested by boll weevils starting early in the season. In 1963 and 1964 boll weevils were found abundantly in Arizona in fall surveys in Santa Cruz, Pima, Pinal, Maricopa, and Yuma counties. Damaging boll weevil infestations, beginning early in the season, were observed in 1964 in a few fields of stubbed cotton in southern Arizona. The possible relation between these recent infestations in Arizona and Sonora and the thurberia weevil is under investigation. Some entomologists refer to the weevil causing summer infestations in cotton in Arizona as the western boll weevil.

The differences in life habits between the eastern boll weevil, the thurberia weevil, the Sonora weevils, and the so-called western boll weevil center around hibernation and overwintering. The eastern boll weevil overwinters as an exposed adult in ground trash in and near cotton fields. This weevil becomes active in the spring, starting when the new cotton plants are small, and passes through a series of several generations a season. The thurberia weevil, on the other hand, overwinters in a cell within the tiny boll of the wild cotton plant and remains imprisoned until this boll is softened and broken by the rains of the following summer. This results in late season infestations, rarely reaching cultivated cotton in noticeable numbers and usually involving but a single generation a year. The weevils recently observed in northern Sonora have overwintered both as free individuals in ground trash and within cells in bolls of cultivated cotton. In Arizona the habits of the western boll weevil are not fully known although exposed adults have been found during the winter. Other adults have been found in cells within cultivated cotton bolls, from which they could readily escape in the spring.

Because of a definite variation in the structure of the spermathecae of the female weevils, visible only by internal dissection, it appears possible to distinguish between adult females of the eastern boll weevil and the thurberia weevil. Some entomologists believe that the weevils from northern Sonora and the so-called western boll weevil may both prove to be specially adapted forms of the thurberia weevil.

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 attempting 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

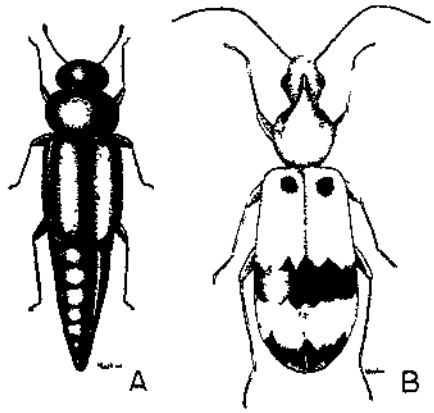
Fruit Bud Beetle

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 Beetle

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.

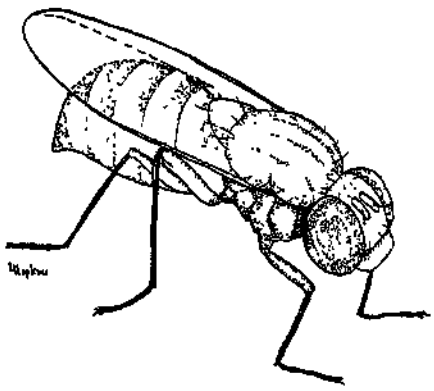
Notoxus beetles have never been known to cause injury to the cotton plants. They feed upon secretions of the nectar glands at the bases of the bracts and on the undersides of the leaves.



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

LEAF MINER

Liriomyza sp.



Leaf miner fly adult.

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 approx-

imately 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 it 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.

SEED-CORN MAGGOT

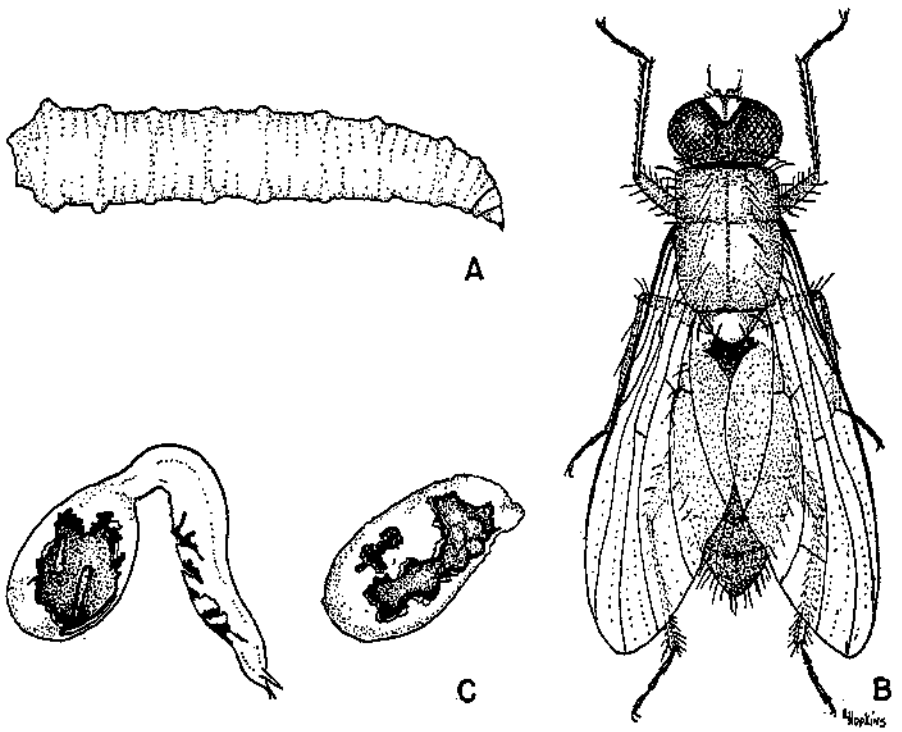
Hylemya cilicrura (Rondani)

The seed-corn maggot is a pest of many crops and is occasionally injurious to cotton.

The adults are small gray flies less 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 germination 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.



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

ANTS

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

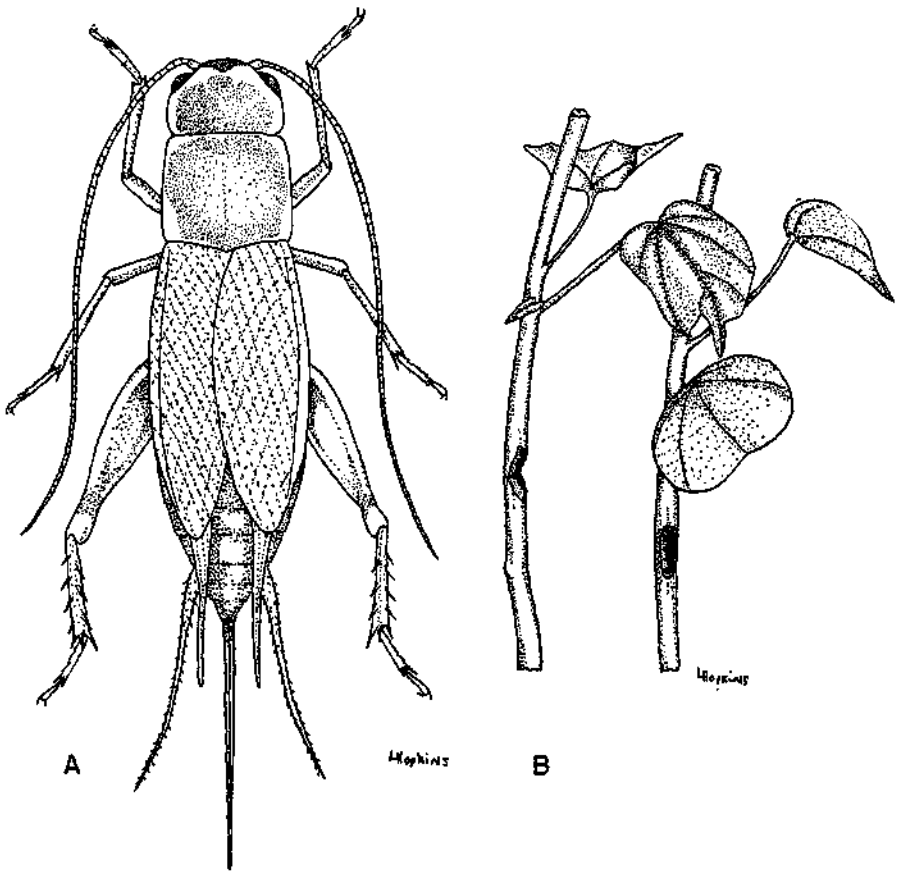
The red harvester ant, *Pogonomyrmex* sp., is rarely a pest of seedling cotton. It is about one-fourth inch long, conspicuous, and active. The nests are identified by a bare mound of earth. This ant habitually clears away all plant growth within several feet of the nest mound. Several colonies in a field 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.



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

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.

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, *Trimerotropis pallidipennis* (Burm.)
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 nonfeeding 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 desertorium* (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.*

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 spitted 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.

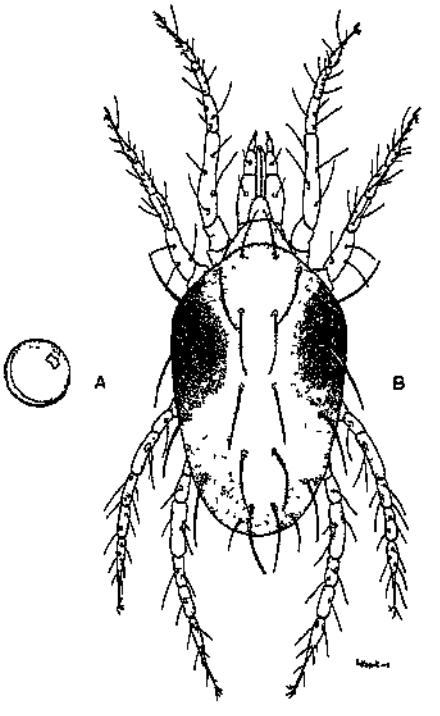
Webbing on the undersides of the leaves is brown. The bottom leaves of the plant are attacked first and severe infestations will cause rapid defoliation.

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 puncture 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



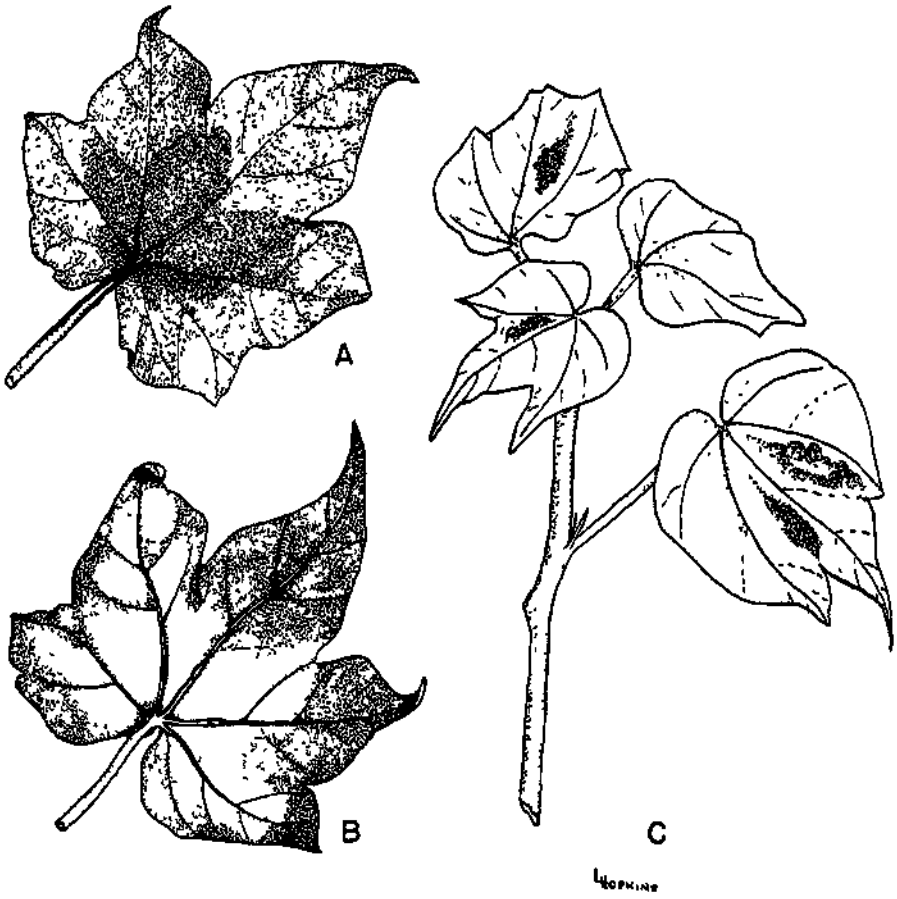
Two-spotted spider mite. A—Egg; B—Adult.

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.



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".

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.

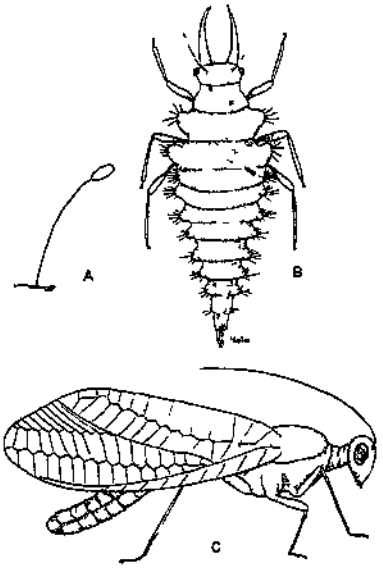
LACEWINGS

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 aphis lions because they ferociously attack aphids, mites, and other soft-bodied insects. Mature aphis 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.



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

The brown lacewings, *Hemerobius* spp. and *Sympherobius* 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.

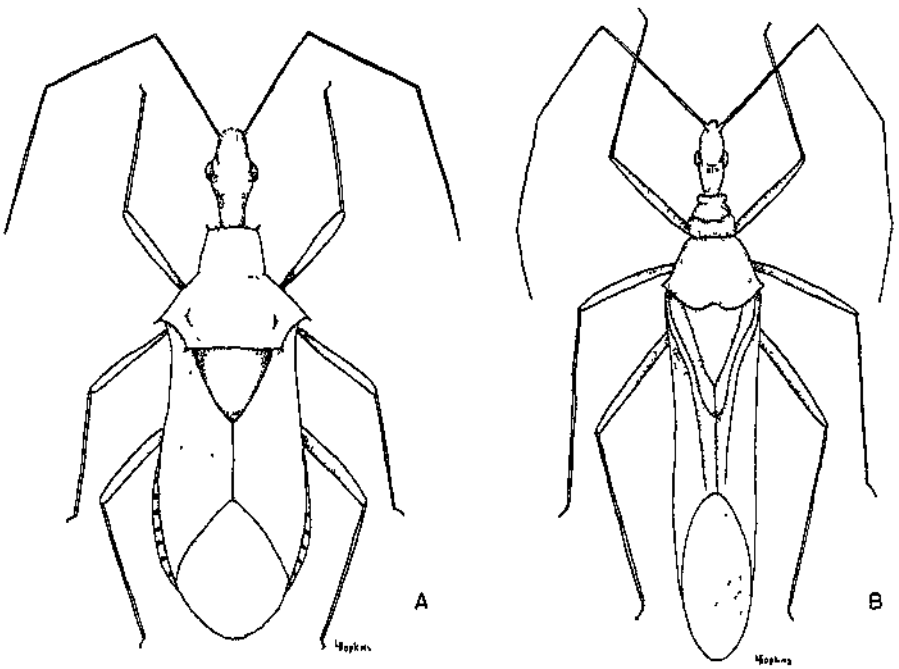
ASSASSIN BUGS

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 caterpillas 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* Kolen 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.



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

These bugs are more linear and generally less spiny than the spined soldier bugs. Their legs are long and slender with the forepair 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.

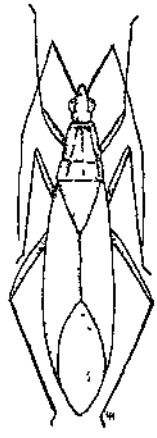
NABIDS

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-eights 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 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, tree hoppers, lygus bugs, and small caterpillars.



Nabid

BIG-EYED BUGS

Geocoris spp.

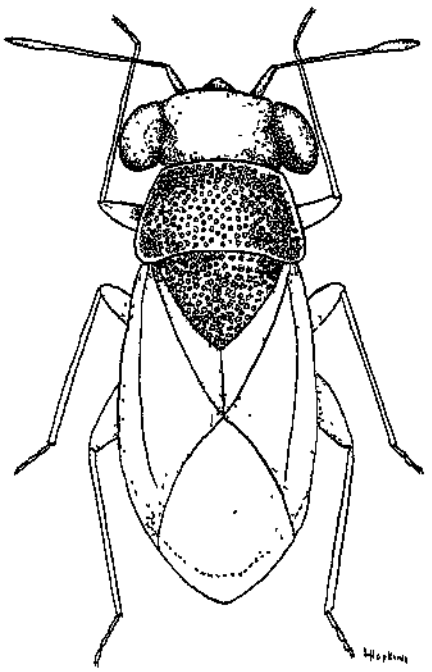
These small insects are sometimes extremely abundant in cotton fields and on numerous occasions adults and, especially nymphs have been mistaken for lygus bugs by some growers. They are, however, valuable predators and do not injure cotton plants.

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.

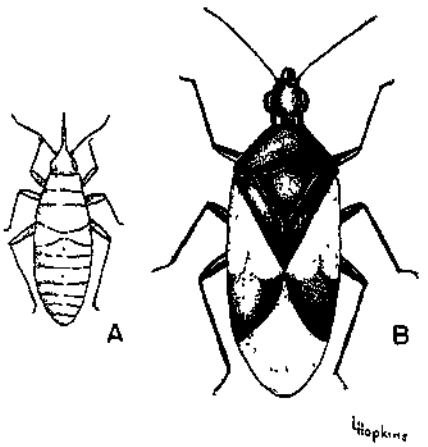
Geocoris atricolor Montd., *G. carinatus* McAtee and *G. pallens* Stal are all found on cotton in Arizona but it is difficult to distinguish one from another in the field. The big-eyed bugs have been reported to be efficient predators of leafhoppers and spider mites.



Big-eyed Bug

MINUTE PIRATE BUGS

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



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.

LADY BEETLES

In Arizona, many species of lady beetles are predatory on aphids, mealy-bugs, 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 canvergent 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, ususually 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 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.

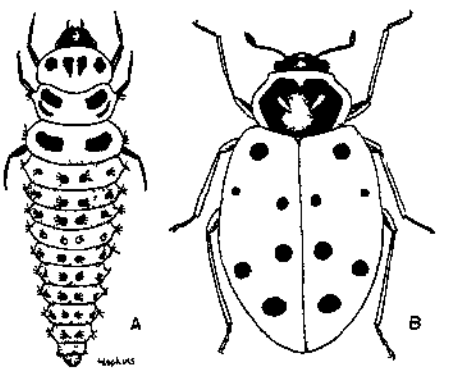
This species is also chiefly a cotton aphid predator.

A third species, the spotted lady beetle, *Coleamogilla 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.



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

SIX-SPOTTED THRIPS

Scolothrips sexmaculatus (Perg.)

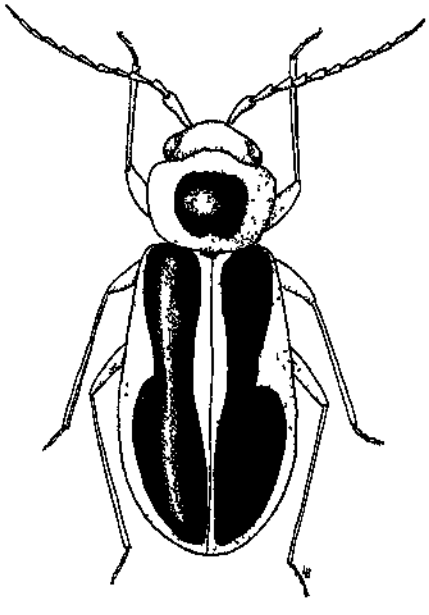
Like other members of its group, the six-spotted thrips is hardly visible without magnification. It is approximately one-twenty-fifth inch long, straw-colored and has three dark spots on each of the fore wings.

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 conspicious blue spot on the orange disk behind the head.



Striped Collops beetle.

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.

SYRPHID FLIES

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

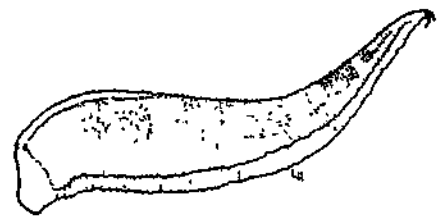
The species most frequently seen in

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.



Typical aphid-feeding syrphid fly maggot.

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 internally 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.

This publication is issued by the Cooperative Extension Service and the Agricultural Experiment Station of The University of Arizona. See your local County Extension Agent for additional information.