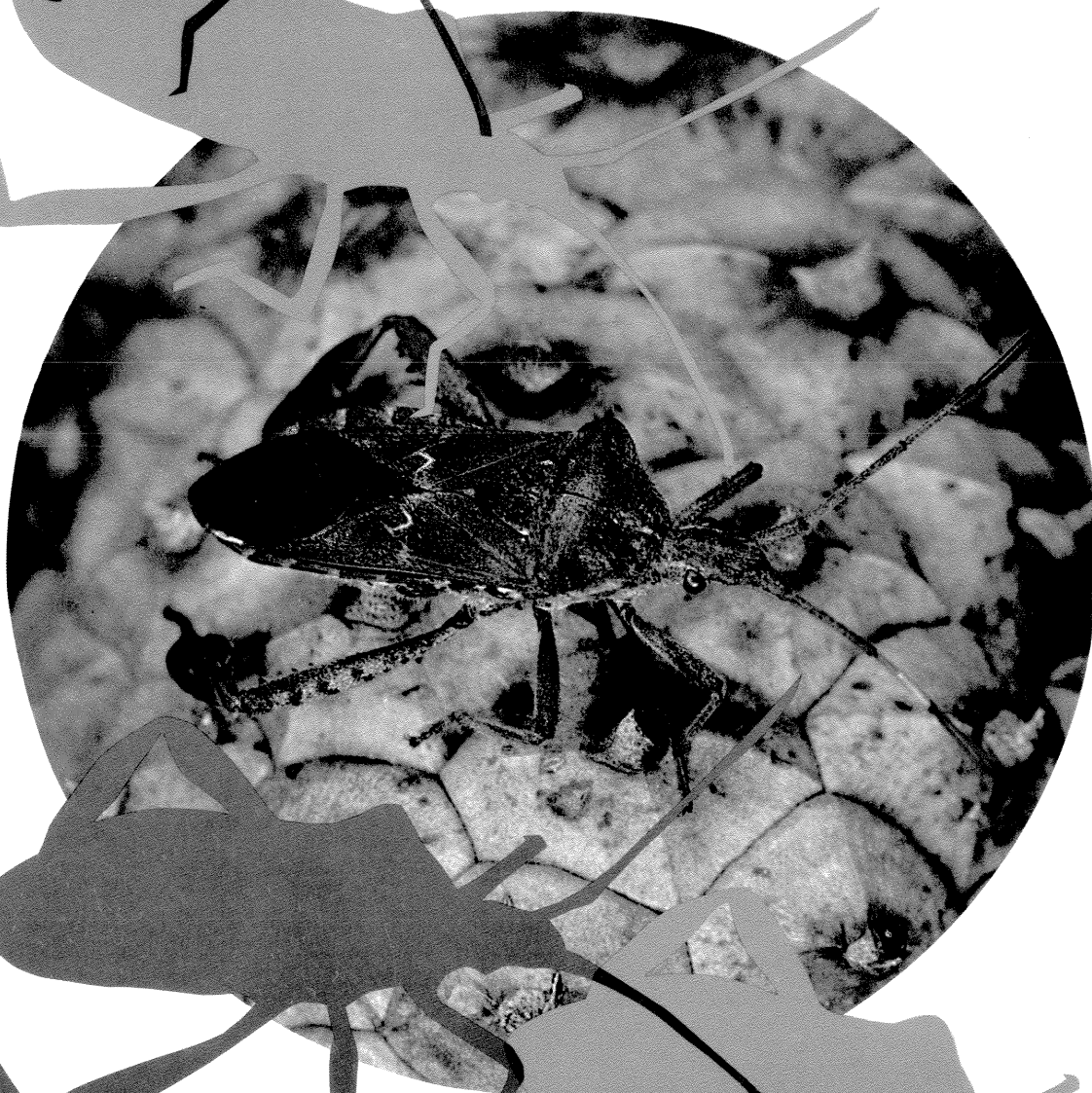


seed and cone insects of southern pines



General Technical Report SE-8
Revised 1980
USDA—Forest Service
Southeastern Forest Experiment Station
Asheville, North Carolina
and
Southeastern Area, State & Private Forestry
Atlanta, Georgia

INSECT OCCURRENCE ON HOST PINES

Flower and Conelet Damaging Insects – p. 4

INSECT	HOST PINES						
	Longleaf	Shortleaf	Loblolly	Slash	Virginia	Eastern White	Table Mountain
Nantucket pine tip moth	No	Yes	Yes	No	Yes	No	No
Slash pine flower thrips	No	No	No	Yes	No	No	No
Pine conelet looper	No	Yes	Yes	Yes	?	No	No
Virginia pine sawfly	No	Yes	Yes	No	Yes	No	No
May beetles	?	?	Yes	?	?	?	?
Pine catkin sawflies	Yes	Yes	Yes	Yes	Yes	Yes	?
Leaffooted pine seed bug	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Southern cone gall midge	?	?	?	Yes	?	?	?
Cone feeding midges	Yes	Yes	Yes	Yes	Yes	?	?
South coastal coneworm	Yes	No	Yes	Yes	No	No	No
Loblolly pine coneworm	Yes	Yes	Yes	Yes	Yes	No	?
Southern pine coneworm	Yes	Yes	Yes	Yes	Yes	No	No
Blister coneworm	Yes	Yes	Yes	Yes	?	No	?

Cone Damaging Insects – p. 13

INSECT	HOST PINES						
	Longleaf	Shortleaf	Loblolly	Slash	Virginia	Eastern White	Table Mountain
Southern pine coneworm	Yes	Yes	Yes	Yes	Yes	No	No
South coastal coneworm	Yes	No	Yes	Yes	No	No	No
Webbing coneworm	No	Yes	Yes	No	Yes	?	?
Blister coneworm	Yes	Yes	Yes	Yes	?	No	?
Mountain pine coneworm	No	?	Yes	No	?	No	Yes
Loblolly pine coneworm	Yes	Yes	Yes	Yes	Yes	No	?
Shortleaf pine cone borer	No	Yes	Yes	No	?	No	?
White pine cone borer	No	No	No	No	Yes	Yes	No
White pine cone beetle	No	No	No	No	?	Yes	No
Cone feeding midges	Yes	Yes	Yes	Yes	Yes	?	?

Seed Damaging Insects – p. 31

INSECT	HOST PINES						
	Longleaf	Shortleaf	Loblolly	Slash	Virginia	Eastern White	Table Mountain
Longleaf pine seedworm	Yes	No	Yes	Yes	No	No	No
Slash pine seedworm	Uncommon	No	Uncommon	Yes	No	No	No
Eastern pine seedworm	No	Yes	Yes	No	Yes	No	No
Leaffooted pine seed bug	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shieldbacked pine seed bug	Yes	Yes	Yes	Yes	Yes	Yes	?
Seed chalcid	No	No	No	No	No	Yes	No

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SEED AND CONE INSECTS OF SOUTHERN PINES

by

Bernard H. Ebel,¹ Thomas H. Flavell,² Loyd E. Drake,³
Harry O. Yates III,¹ and Gary L. DeBarr¹

This booklet is a guide to insects that limit seed production by the major pine species native to the Southern United States. It is intended for use primarily by foresters and tree improvement workers. Major emphasis in this guide is on insects of longleaf, shortleaf, loblolly, and slash pines. Available information is also provided on other species, including eastern white, Virginia, and Table Mountain pine, Pitch, pond, spruce, and sand pines are excluded for lack of pertinent data. Research in recent years has demonstrated that insects are a major factor limiting the production of both cone crops and viable seeds. Before the orchard manager can consider control, however, he must know what insects are causing the damage. This guide is designed for such identification, with emphasis on the use of damage specimens.

To most effectively use this guide, samples of the insect damage should be collected, then identified by direct comparison with illustrations provided and by keying of damaged material. Where it is feasible, the user may wish to collect or rear insects from the damaged host material. This procedure may be needed to positively identify the species of insect pest. To this end, photographs, descriptions, and keys to various insect forms are included. Illustrations and descriptions of adults are also useful in the identification of specimens captured in light traps or by other means. The guide groups damage into three categories – flower and conelet damage, cone damage, and seed damage.⁴ Each category makes up a separate section of this booklet, and each section begins with a damage identification key. In most instances, the user should begin to identify his insect problem by referring to one of these three keys on the pages indicated:

Flower and Conelet Damage – page 5
Cone Damage – page 15
Seed Damage – page 33

These keys lead to a concise summary of the biology, damage, and importance of each insect species. These summaries represent the consensus of the authors on information gleaned both from the literature and personal knowledge. Hence, no attempt is made to cite the authority of each statement. However, references are listed by number in parentheses following each species name. These numbers refer to the selected references at the end of the guide.

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⁴These reproductive structures are defined in the glossary on page 41.

Distribution maps are included for all insect species, providing at a glance each insect's expected southern distribution. Knowledge of some distributions is incomplete. Accordingly, the range maps should be used as general rather than absolute guides.

Insect species and their pine hosts are tabulated for each of the three damage categories (inside front cover). Insect-host relationships are based upon our present knowledge. In some instances, insect-host associations are uncertain; these are designated by a question mark.

A summary of insect damage periods (inside back cover) shows when each insect species is likely to cause damage. It is a further aid in specific identification.

Illustrations and a key to the larvae of cone boring caterpillars are included because of the importance of this group, the similarity of the damage they inflict on the host, and the likelihood of the larvae being present in the damaged host material collected. A glossary at the end of this guide defines certain technical terms which might be unfamiliar to the user, and a host list provides scientific names of the host species.

In identifying the insect causing damage, the reader should make use of as much information as possible. He should use the range maps, the summary of insect occurrence by host pines, the summary of insect damage periods, keys, and color photographs. In most instances, the attacking insect may be narrowed down to one or two species using only the colored photographs. Individual descriptions of the insects and their damage should confirm identification in nearly all cases.



FLOWER AND CONELET DAMAGE

This category includes insects that feed primarily on the male and female flowers and developing conelets of pines. Insects that feed on flowers or conelets but which also commonly damage cones and seeds are discussed in other sections. These insects are, however, included in the key to flower and conelet damage.

Flower and conelet losses often are overlooked because the flowers and conelets are small and the insects feeding upon them may be minute or inconspicuous.

INSECT OCCURRENCE ON HOST PINES

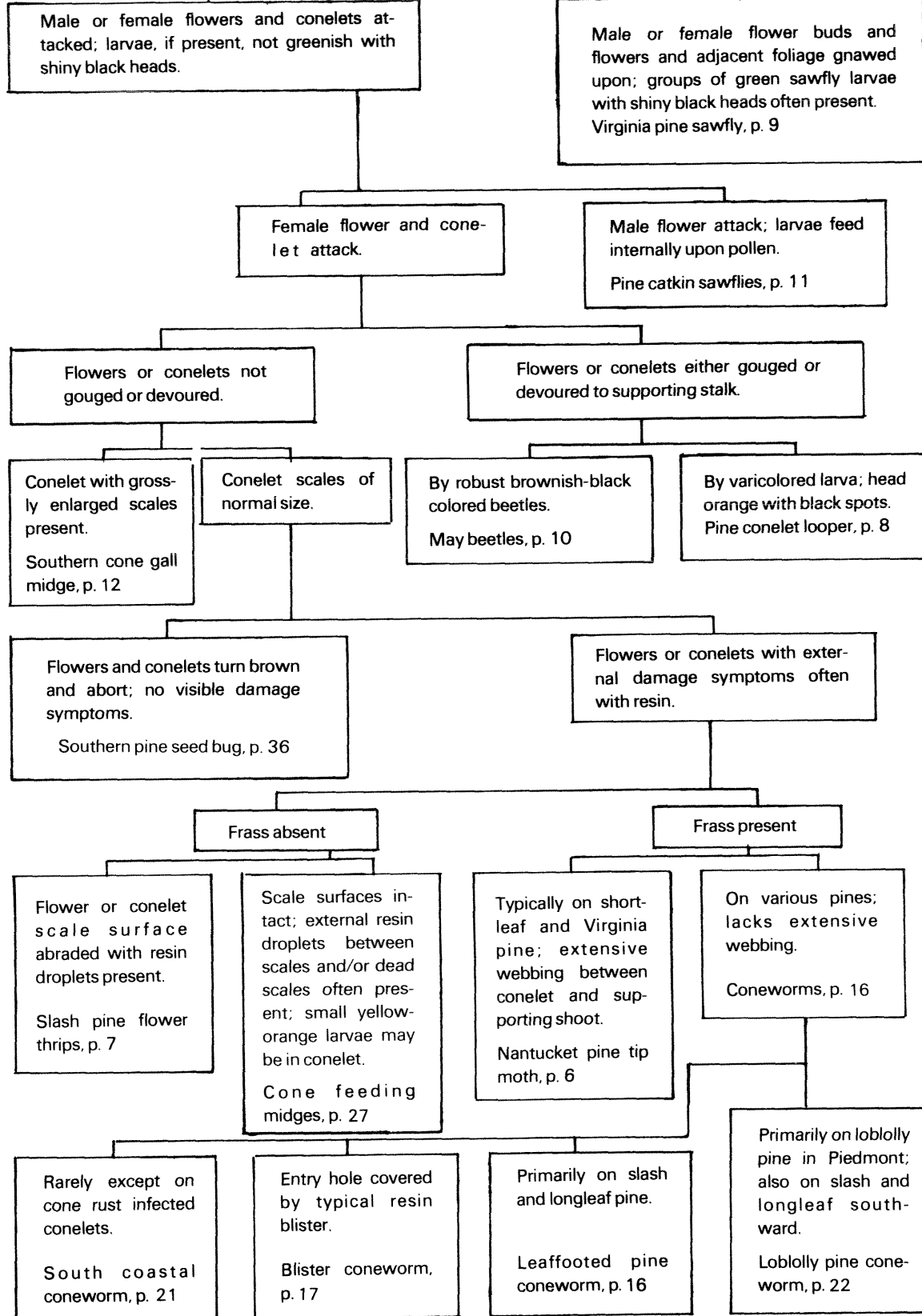
FLOWER AND CONELET DAMAGE

INSECT	HOST PINES						
	Longleaf	Shortleaf	Loblolly	Slash	Virginia	Eastern White	Table Mountain
Nantucket pine tip moth	No	Yes	Yes	No	Yes	No	No
Slash pine flower thrips	No	No	No	Yes	No	No	No
Pine conelet looper	No	Yes	Yes	Yes	?	No	No
Virginia pine sawfly	No	Yes	Yes	No	Yes	No	No
May beetles	?	?	Yes	?	?	?	?
Pine catkin sawflies	Yes	Yes	Yes	Yes	Yes	Yes	?
Leaffooted pine seed bug	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Southern cone gall midge	?	?	?	Yes	?	?	?
Cone feeding midges	Yes	Yes	Yes	Yes	Yes	?	?
South coastal coneworm	Yes	No	Yes	Yes	No	No	No
Loblolly pine coneworm	Yes	Yes	Yes	Yes	Yes	No	?
Southern pine coneworm	Yes	Yes	Yes	Yes	Yes	No	No
Blister coneworm	Yes	Yes	Yes	Yes	?	No	?

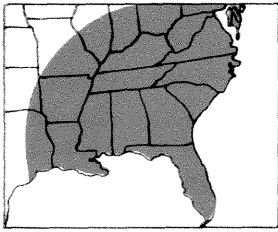
INSECT DAMAGE PERIODS

INSECT	FEEDING PERIOD											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Nantucket pine tip moth												
Slash pine flower thrips												
Pine conelet looper												
Virginia pine sawfly												
May beetles												
Pine catkin sawflies												
Leaffooted pine seed bug												
Southern cone gall midge												
Cone feeding midges												
South coastal coneworm												
Loblolly pine coneworm												
Southern pine coneworm												
Blister coneworm												

FLOWER AND CONELET DAMAGE KEY



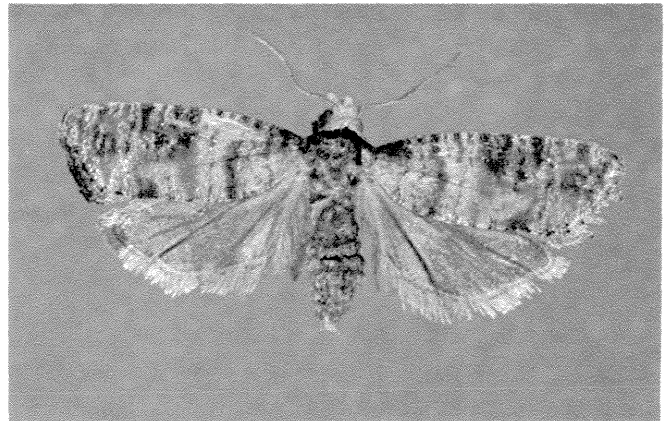
Nantucket pine tip moth, *Rhyacionia frustrana* (Comstock) (2, 48, 51)



BIOLOGY. – Moths emerge from overwintering pupae and lay their eggs on conelets or shoots in the early spring. There are two to five generations per year, depending on latitude. Larvae injure shoots and buds, but those of the first generation cause significant conelet mortality by feeding directly in and on the flowers and conelets. Minor conelet attack may also occur during the last generation in the fall.

INSECT IDENTIFICATION. – Larval coloration varies with age. Young larvae are cream colored, while mature larvae range from light-brown to orange. Head capsule and thoracic shield are black. In contrast to young coneworm larvae, tip moth larvae have no dark spots on setal bases.

Moth with forewing marked with irregular brick-red and coffee-colored patches separated by a background of gray scales.



Adult. (5X)

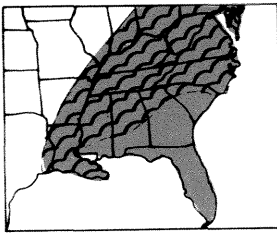
DAMAGE IDENTIFICATION. – A newly hatched Nantucket pine tip moth larva often bores into and destroys one or two conelets. Minute frass on the conelet surface is the first sign of larval boring. Later, a small quantity of resin often accumulates around or over the lesion. When older, the larva migrates to the supporting shoot or another conelet, laying down a loose network of webbing between the shoot and the adjacent injured conelet. A larva may also enter another shoot, killing it and any conelets it bears.



Shortleaf pine conelets killed by larvae. (1X)

IMPORTANCE. – Tip moths severely damage shoots in young pine plantations up to 3 meters tall (primarily loblolly, shortleaf, and Virginia pines) and often reduce the survival of outplanted grafted stock during seed orchard establishment. In older orchards, tip moths infest shoots during the summer and fall, destroying buds containing embryonic flower primordia and thereby reducing flower production the following year. Direct attacks on shortleaf pine conelets often cause losses of 30 percent or more.

Slash pine flower thrips, *Gnaphothrips fuscus* (Morgan) (13, 18, 19)



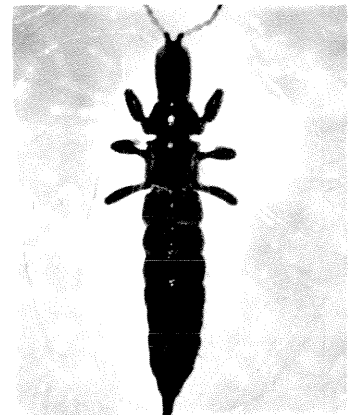
BIOLOGY. – Knowledge of the life history of the slash pine flower thrips is incomplete. It is likely that this thrips occurs throughout the Eastern United States (see wavy area of distribution map). Injury to conelets, however, appears to be restricted to slash pine (see unlined red area of distribution map).

The slash pine flower thrips damages or kills female buds and flowers during a limited period from January through mid-February. The minute insects hide among the bracts or scales and are seldom visible. Pollinated flowers quickly become leathery enough to resist additional thrips feeding, but the more severely damaged conelets continue to abort. This thrips has also been noted on succulent new shoots of slash and loblolly pines during the summer.

INSECT IDENTIFICATION. – The adults are comparatively large thrips, about 2 mm long, and very dark-brown to black. They can be either winged or wingless.

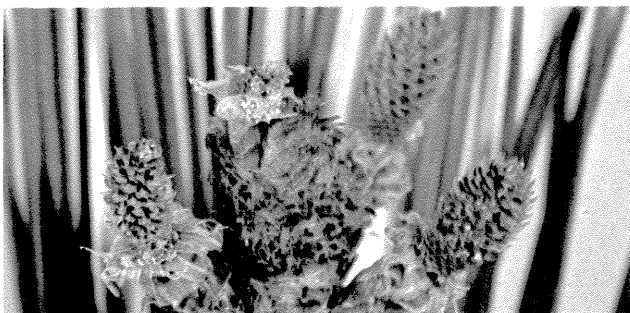
DAMAGE IDENTIFICATION. – Damaged female flower buds have resin flowing from wounds at the tips and between the crevices formed by abutting vegetative buds. Severely damaged buds often abort.

Once the buds open, the thrips scrape the tender scales and bracts of the female flowers, leaving tiny, barely visible abrasions marked by beads of resin. Individual scales and bracts are often destroyed, and if damage is severe the flower shrivels and dies. Female flowers sustaining sublethal damage develop into mature cones the following year, but these cones are crooked and gnarled, with areas of sunken, deformed scales.

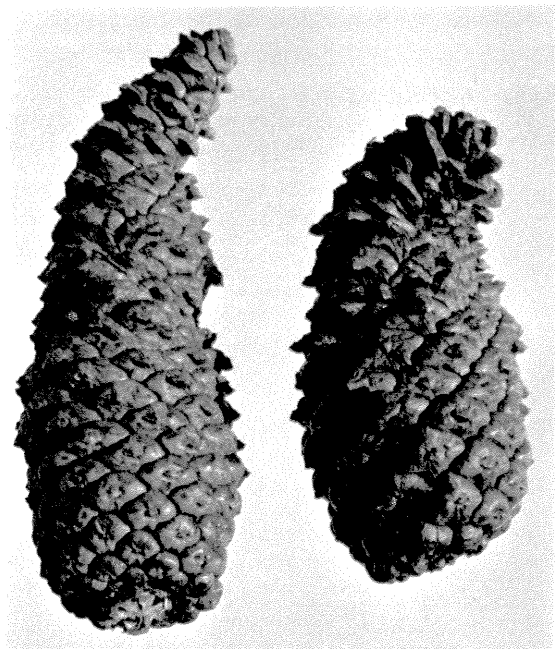


Adult (25X)

IMPORTANCE. – While the slash pine flower thrips damages and destroys female flowers only on slash pine, it is often very destructive in seed orchards of this species. Flower mortality as high as 45 percent has been recorded. In addition, both total and filled seed yields from cones that develop from flowers sustaining sublethal damage are often reduced by more than 50 percent.

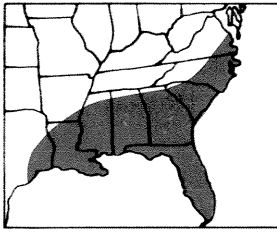


Damage to conelets. (1X)



Damage on developed cones. (1X)

Pine conelet looper, *Nepytia semiclusaria* (Walker) (11, 25)

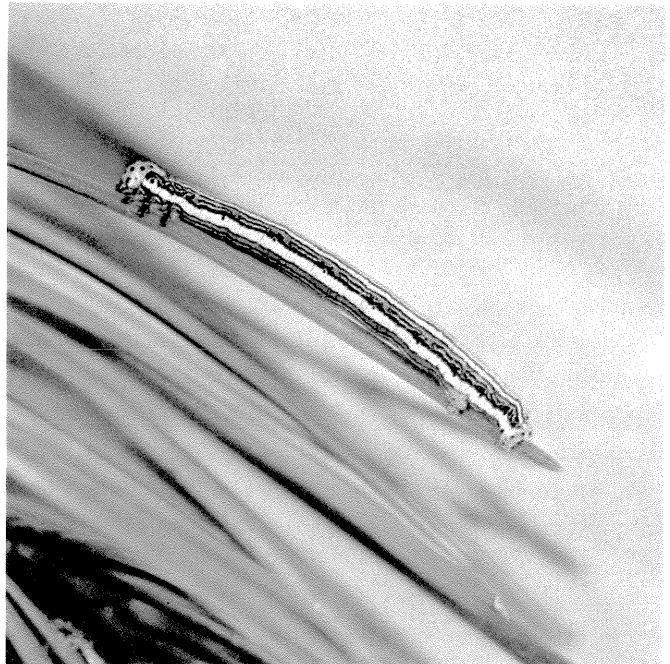


BIOLOGY. – The pine conelet looper has a single generation per year. It overwinters as an egg, presumably under bark scales. In early spring the eggs hatch and the larvae feed on the female flowers of slash, loblolly, and shortleaf pines. On slash pine the larvae soon migrate to new needles, but on loblolly and shortleaf pines they continue to feed to maturity on the young conelets. Larvae often retreat into the foliage when not feeding. Pupation occurs in a flimsy web shelter among the needles, and adults emerge during the early summer (June in the Georgia Piedmont).

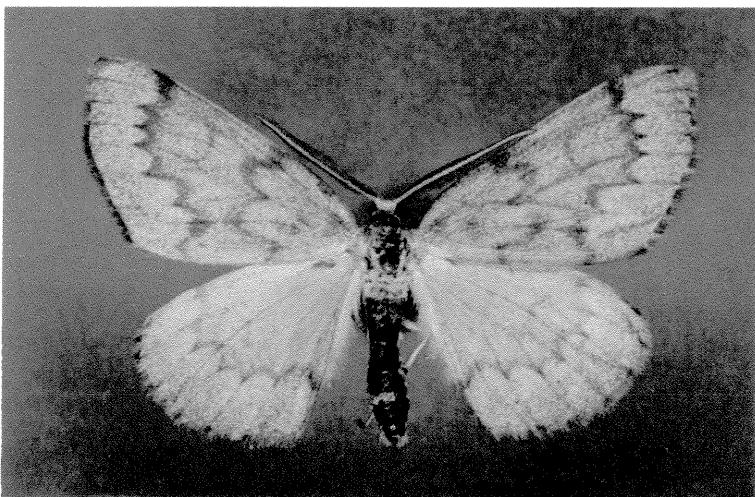
INSECT IDENTIFICATION. – The mature larva of this looper is about 2.5 to 3.0 cm long, with an obvious brick-red dorsal stripe flanked by yellow stripes separated by a number of thin black and white lines. The orange head is marked with black spots. The moth is grayish-tan. Forewings are marked with two dark scalloped bands running front to back.

DAMAGE IDENTIFICATION. – Flowers or conelets injured by this looper are either gouged or completely devoured to the supporting stalk.

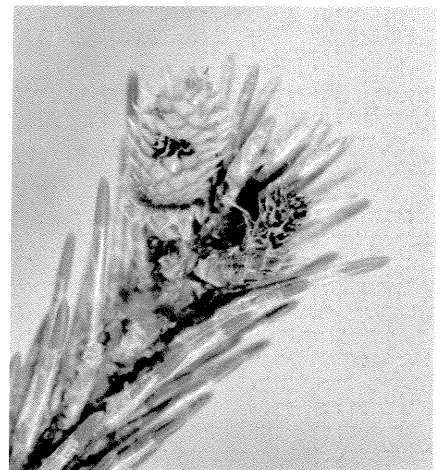
IMPORTANCE. – This insect is usually of minor importance but occasionally becomes epidemic and causes noticeable flower or conelet damage. Defoliation has been reported on sand pine.



Larva. (2X)

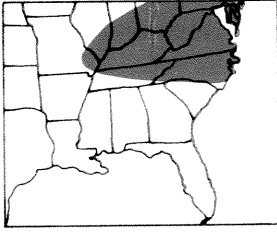


Adult. (3X)



Killed shortleaf pine conelets. (1X)

Virginia pine sawfly, *Neodiprion pratti pratti* (Dyar) (1, 3, 11)



BIOLOGY. – The Virginia pine sawfly is the only sawfly known to damage pine strobili. There is one generation a year. Winter is spent in the egg stage. In the early spring, eggs hatch and the larvae feed in groups on the previous year's needles. Small larvae also devour buds, flowers, and the tender bark of twigs. Full-grown larvae drop to the ground and pupate in the soil. Adults emerge in late fall and deposit eggs in slits along the needles.

INSECT IDENTIFICATION. – Newly hatched larvae are pale green with shiny black head capsules. Full-grown larvae are spotted or marked with longitudinal black stripes. They are from 16 to 23 mm long. Adults are seldom seen.

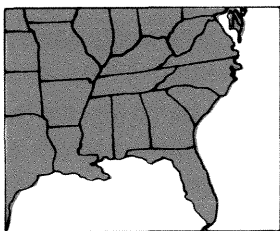
DAMAGE IDENTIFICATION. – Large portions of unopened flower buds or flowers are eaten away; obvious foliage feeding leaves tufts of needle bases.

IMPORTANCE. – From 3 to over 9 percent of the shortleaf pine flower crop has been destroyed when sawfly populations were low. Much greater mortality of female flowers can probably be expected during sawfly epidemics.

Killed shortleaf pine flower buds and larvae (bottom). (3X)



May beetles, *Phyllophaga* spp. (1, 11, 36)



BIOLOGY. – Adults, commonly called May or June beetles, feed nocturnally on the foliage of various pines and hardwoods. One species, *P. micans* (Knoch), however, has been reported as damaging conelets of loblolly pine. Eggs are laid in small groups in the soil at depths of 7 to 18 cm. The larvae, commonly called white grubs, are root feeders. After feeding for 1 to 3 years, they pupate and emerge as adults in the spring or summer.

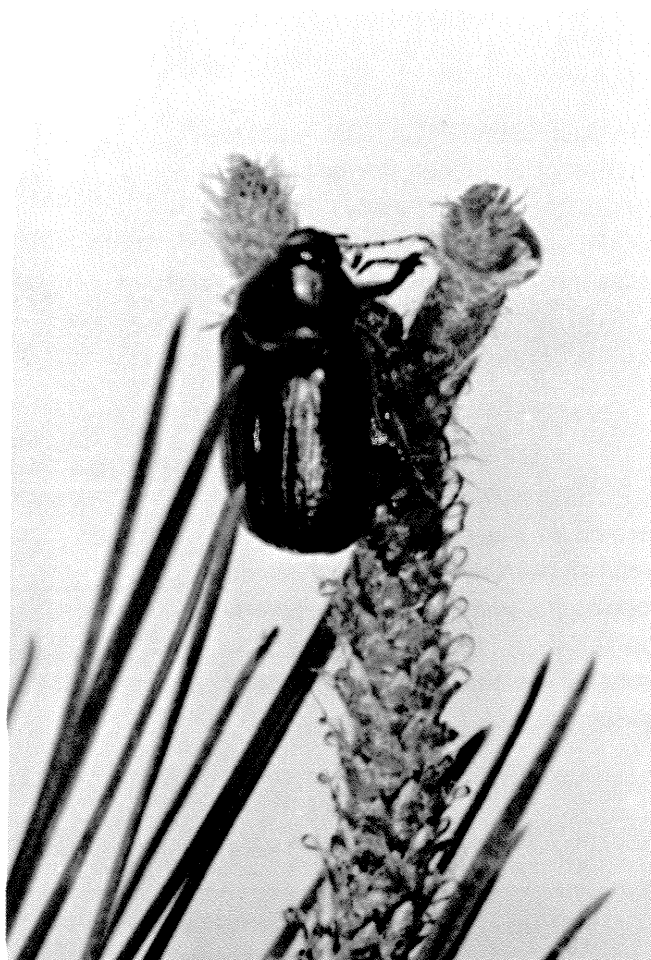
INSECT IDENTIFICATION. –

Adults are robust beetles 15 to 17 mm long. Wing covers are dull brownish-black.

DAMAGE IDENTIFICATION. –

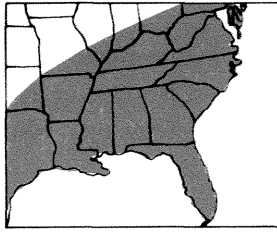
Adult May beetle feeding often leaves only the conelet stalk intact. This injury is indistinguishable from that caused by the pine conelet looper.

IMPORTANCE. – The impact of these insects on southern pine conelet crops is unknown. Damage has only been reported from central Louisiana. While only one species is recorded as causing this damage, other May beetles with similar biologies and habits may also damage conelets.



Adult feeding on loblolly pine flowers. (3X)

Pine catkin sawflies, *Xyela* spp. (4, 22, 30)

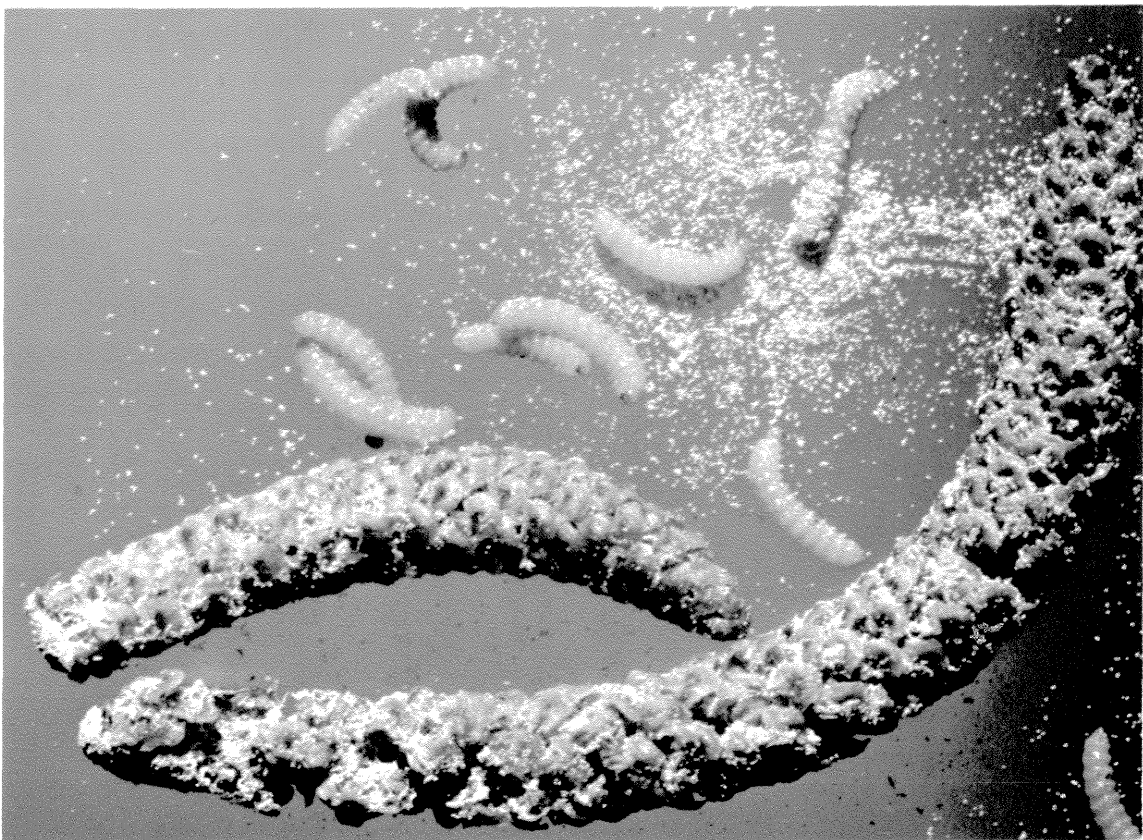


BIOLOGY. – The pine catkin sawflies have one generation per year. Adults emerge from pupae in the soil (December-February in northern Florida) and lay their eggs in male flower (catkin) buds of pines. The larvae feed within the male flowers on pollen. Larval development is synchronized with maturation of male flowers, and the larvae drop to the ground during pollen shed, remain dormant in the soil until winter, then pupate. Pine catkin sawfly species include *Xyela bakeri* Konow, *X. minor* Norton, *X. obscura* (Strobl), and probably *X. dodgei* Greenbaum.

INSECT IDENTIFICATION. – The larvae are commonly observed in pollen extracted for pine breeding work. They are small white grubs 3 to 5 mm long. The adults are about 3 mm long but are seldom seen.

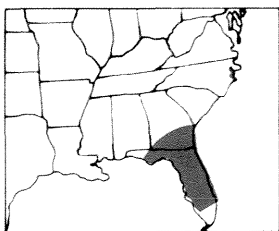
DAMAGE IDENTIFICATION. – Infested male flowers are often distorted and bear small white spots of dried resin on the surface.

IMPORTANCE. – Larval damage undoubtedly reduces the amount of viable pollen; however, this loss is usually tolerable. Effect on viability of stored pollen has not yet been studied.



Larvae emerging from drying pine catkins. (4X)

Southern cone gall midge, *Cecidomyia bisetosa* Gagné (32)

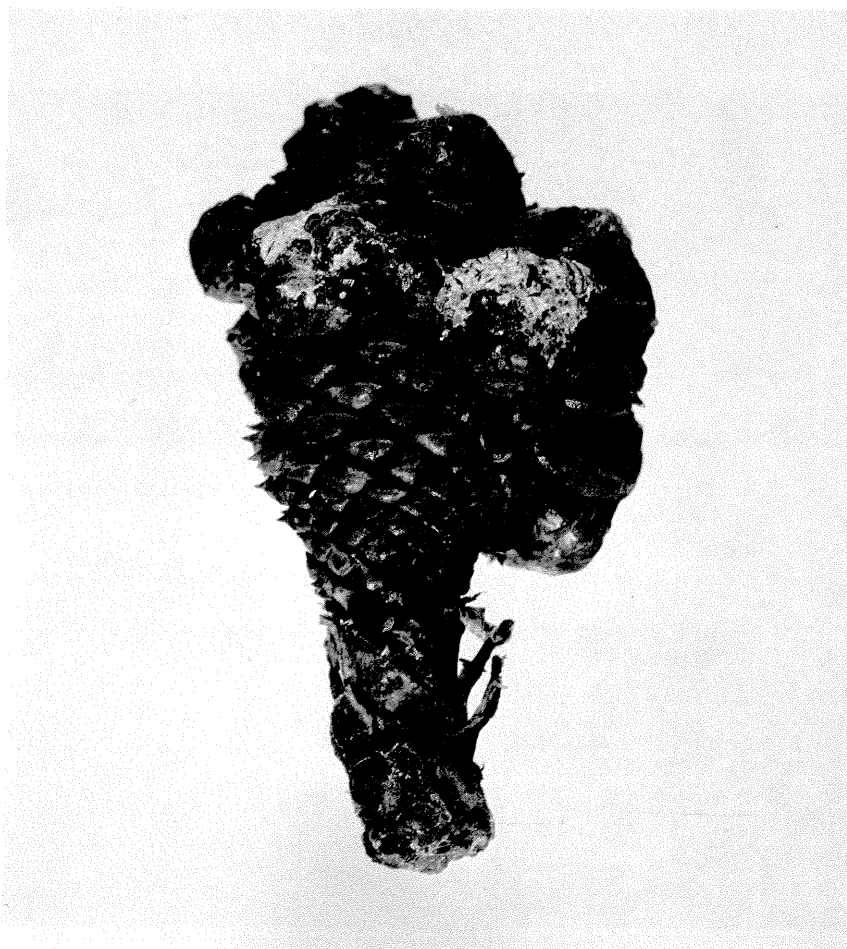


BIOLOGY. – Adults emerge in late January from hypertrophied (swollen) conelets. Eggs apparently are laid between new flower scales, and larvae develop slowly in the scales during the year of conelet growth. Infested conelet scales hypertrophy in response to larval presence. Mature larvae overwinter in conelet.

INSECT IDENTIFICATION. – Mature larvae are pale reddish-orange, about 3 mm long. Adults are delicate mosquito-like flies.

DAMAGE IDENTIFICATION. – Infested conelets show grossly enlarged scales; sometimes nearly all scales are involved. Larvae are more or less embedded in the affected scales. Heavily infested conelets die following insect emergence; lightly damaged conelets may continue to develop into deformed cones.

IMPORTANCE. – This insect was only recently found and described from northeastern Florida. In the area of infestation, damage varied from tree to tree with as high as 32 percent of the conelets infested.



Slash pine conelet damage by the southern cone gall midge. (2½X)

CONE DAMAGE

Several kinds of larvae feed by tunneling into and within cones. Characteristically, pellets of frass (excrement) are deposited within or on the cone, often mingled with obvious strands of silken webbing. Attacked cones are easily noticed because all or parts of the cones turn brown. Such cone-damaging insects belong to two moth families, the Pyralidae (*Dioryctria* spp.) and the Olethreutidae (*Eucosma* spp.), and one beetle family, the Scolytidae (*Conophthorus* spp.). Several genera of midge flies in the family Cecidomyiidae also kill or damage cones by less obvious internal feeding.

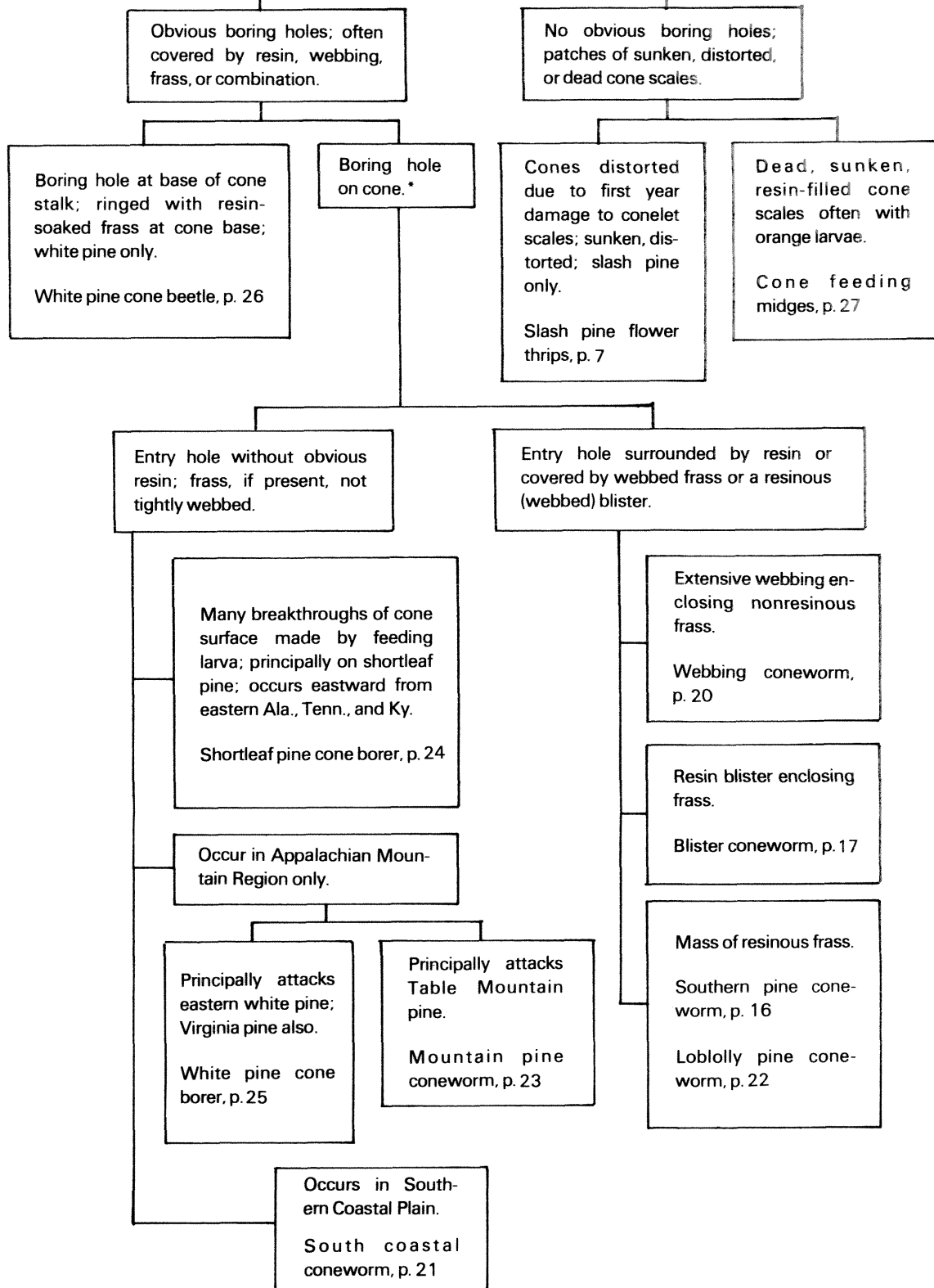
INSECT OCCURRENCE ON HOST PINES

INSECT	HOST PINES						
	Longleaf	Shortleaf	Loblolly	Slash	Virginia	Eastern White	Table Mountain
Southern pine coneworm	Yes	Yes	Yes	Yes	Yes	No	No
South coastal coneworm	Yes	No	Yes	Yes	No	No	No
Webbing coneworm	No	Yes	Yes	No	Yes	?	?
Blister coneworm	Yes	Yes	Yes	Yes	?	No	?
Mountain pine coneworm	No	?	Yes	No	?	No	Yes
Loblolly pine coneworm	Yes	Yes	Yes	Yes	Yes	No	?
Shortleaf pine cone borer	No	Yes	Yes	No	?	No	?
White pine cone borer	No	No	No	No	Yes	Yes	No
White pine cone beetle	No	No	No	No	?	Yes	No
Cone feeding midges	Yes	Yes	Yes	Yes	Yes	?	?

INSECT DAMAGE PERIODS

INSECT	FEEDING PERIOD											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Southern pine coneworm												
South coastal coneworm												
Webbing coneworm												
Blister coneworm												
Mountain pine coneworm												
Loblolly pine coneworm												
Shortleaf pine cone borer												
White pine cone borer												
White pine cone beetle												
Cone feeding midges												

CONE DAMAGE KEY

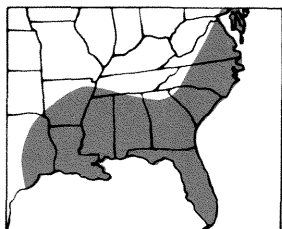


* For additional help in identifying these borers, see Key and drawings of cone boring caterpillars on page 28 and plates of larvae (page 29) and moths (page 30).

Pine Coneworms (*Dioryctria* spp.)

Damage consists of larval tunnels or partly to totally excavated areas within the infested cones. Some coneworms also feed in buds, shoots, flowers, and conelets. Six coneworm species are known to damage southern pines.

Southern pine coneworm, *Dioryctria amatella* (Hulst) (7, 8, 20, 21, 24, 27, 29, 33, 40, 42, 43, 52, 53)⁵



BIOLOGY. – The southern pine coneworm has several generations per year with much overlapping of life stages. Male and female pine flowers, galls caused by fusiform rust (*Cronartium fusiforme* Hedg. & Hunt ex. Cum. ex. Cum.), injured tree stems, and cones may be infested. On slash and longleaf pines, early-season infestations tend to occur in flowers and shoots, in cones infected by southern cone rust (*Cronartium strobilinum* (Arth.) Hedg. & Hahn), and in fusiform rust galls. These larvae, except in gall infestations, often move on to com-

plete development in cones. Fusiform rust galls sustain larvae through pupation. Second and subsequent generations of larvae develop primarily in cones. Early-season infestations of loblolly pine seem to be in fusiform rust galls, but succeeding generations infest the cones of loblolly and associated pines. Pupation occurs within the infested material. Larvae, usually first instars, overwinter.

INSECT IDENTIFICATION. – Mature larvae of the southern pine coneworm are somewhat variable in color, but tend toward dark purplish-brown above and nearly white beneath, with greenish tints especially in prepupal larvae. Dark elevated areas bearing setae and black beadlike patterns of small depressions are obvious on abdominal segments.

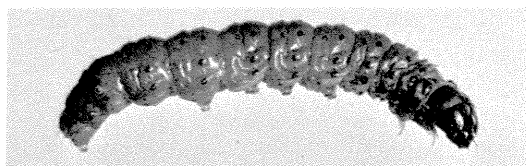
Adults are dark brown, often appearing nearly black, with contrasting distinct white markings.



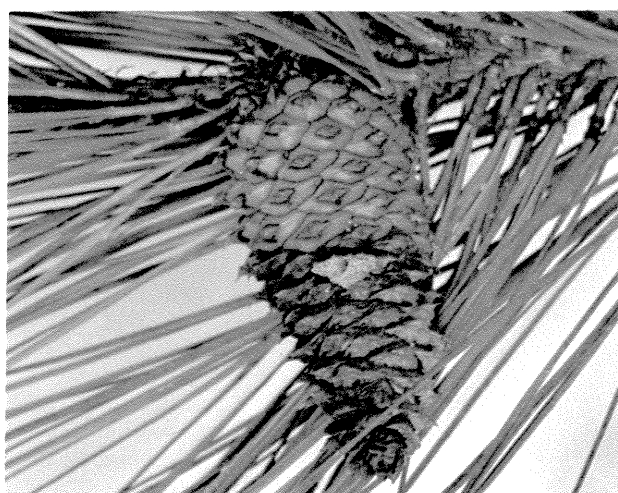
Adult (2X)

DAMAGE IDENTIFICATION. – A mixture of resin and frass is usually present on the surface of infested material, but resin may be scant or absent from maturing cones.

IMPORTANCE. – This coneworm is prevalent throughout the Southeast and is consistently one of the most serious pests of pine cones.



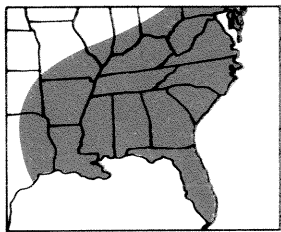
Larva. (2½X)



Damage to loblolly pine cone. (½X)

⁵*Dioryctria taedae* Schaber & Wood, a similar species reported from loblolly pine in Maryland, is reported to occur sparingly in the Southeast. It differs from *D. amatella* in having grayish, much less contrasting crosslines on the forewings. It has been confused with *D. yatesi* Mutuura & Munroe, which has similar wing coloration.

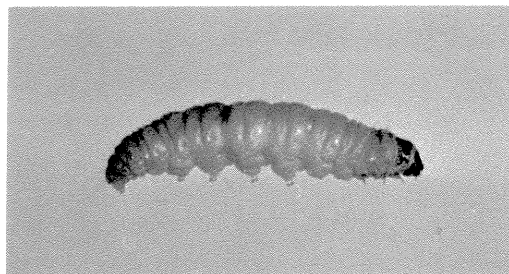
Blister coneworm, *Dioryctria clarioralis* (Walker) (21, 27, 33, 42, 43, 52, 53)



BIOLOGY. – The blister coneworm has three distinct generations per year in the Middle to Deep South. Flowers, buds, and shoots, as well as conelets and young cones, are attacked. Mature larvae migrate from the infested material to pupate on twigs in thin cocoons covered with bits of shoot scales.

INSECT IDENTIFICATION. – Mature blister coneworm larvae are easily recognized by their brownish-orange color, which is often tinged with gray above and is paler beneath. Beadlike patterns of small pits are only moderately obvious on abdominal segments.

The moth is also distinctive; each forewing has a wide dark brownish-black band near the wing base. The remainder of this wing is shaded in tones of brown to black with grayish-white crosslines and markings.



Larva. (2X)

DAMAGE IDENTIFICATION. – Infested material has a very typical silk and resin blister, filled with frass, covering the entry hole. Infested buds or conelets are usually completely hollowed out.



Adult. (2½X)

IMPORTANCE. – The blister coneworm seems of lesser importance than most coneworm species. It often occurs on longleaf pine but feeds in buds and shoots as well as conelets. This feeding pattern tends to minimize losses of conelets.



Damage to shortleaf pine cones. (1X)



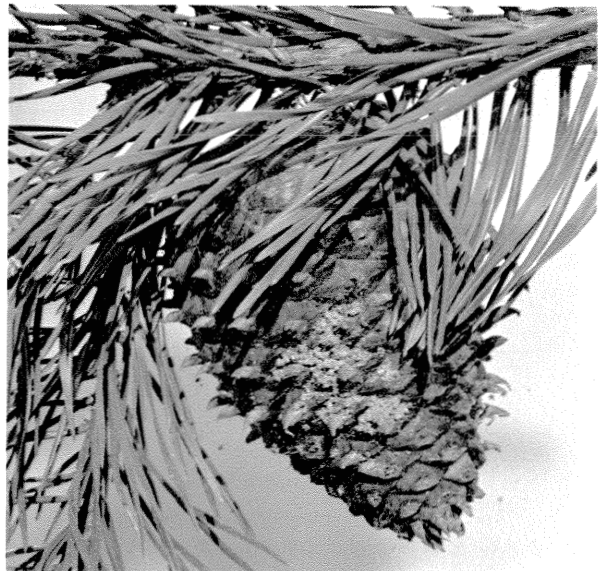
a ($\frac{1}{2}X$)



b (1X)



e (1X)

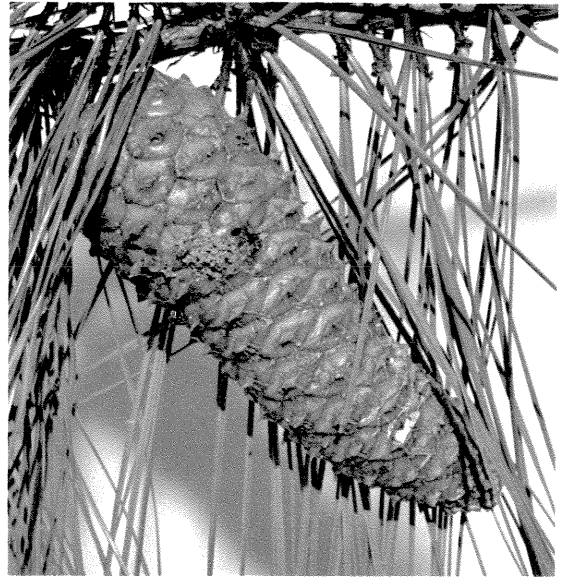


f ($\frac{3}{4}X$)

Coneworm damage: (a) southern pine coneworm damage to loblolly pine cone; (b) blister coneworm damage to shortleaf pine cones; (c) webbing coneworm damage to loblolly pine cones; (d) south coastal coneworm damage to loblolly pine cone; (e) loblolly pine coneworm damage to loblolly pine cone; (f) mountain pine coneworm damage to Table Mountain pine cone; (g) loblolly pine coneworm damage to loblolly pine conelet; (h) shortleaf pine cone borer damage to shortleaf pine cones; (i) white pine cone borer damage to eastern white pine cones.



c (1X)



d (1X)



g (1½X)

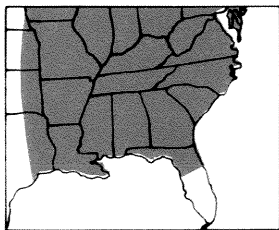


i (1X)



h (1X)

Webbing coneworm, *Dioryctria disclusa* Heinrich (27, 33, 35, 42, 43, 52, 53)

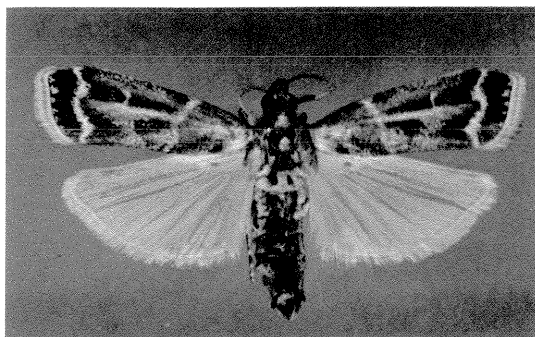


BIOLOGY. – The webbing coneworm has a single generation per year. Moths emerge in late spring and early summer in the Georgia Piedmont, and lay eggs. These hatch but the young larvae diapause until the following spring. Presumably, young larvae infest male flowers. Cones are infested early in the growing season, when older larvae are found to be present. Mature larvae pupate in the host cone behind a network of silken threads across the larval hole.

INSECT IDENTIFICATION. – Larvae of the webbing coneworm are grayish-buff above, paling beneath. Seta-bearing elevations are pale, while the dark beadlike patterns of pits are moderately noticeable (as in the blister coneworm).

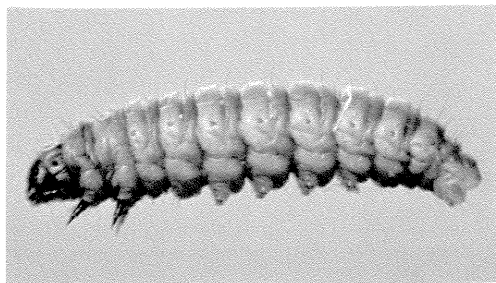
Moths have striking yellow to orange-colored forewings, with sharp white crossbands and markings.

DAMAGE IDENTIFICATION. – Infested cones have a characteristic mass of heavily webbed frass, similar to that produced by the pine webworm (*Tetralopha robustella* Zeller) over the larval entry hole. Internally, the infested cones are nearly-to-completely hollowed out and often contain much silken material.



Adult. (2½X)

IMPORTANCE. – The webbing coneworm is occasionally abundant, causing moderate losses of Virginia and loblolly pine cones in the South.

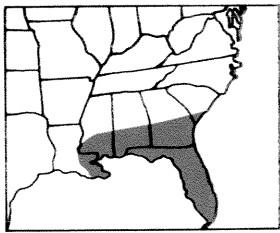


Larva. (3X)



Damage to loblolly pine cone. (1X)

South coastal coneworm, *Dioryctria ebeli* Mutuura & Munroe⁶ (21, 41, 53)



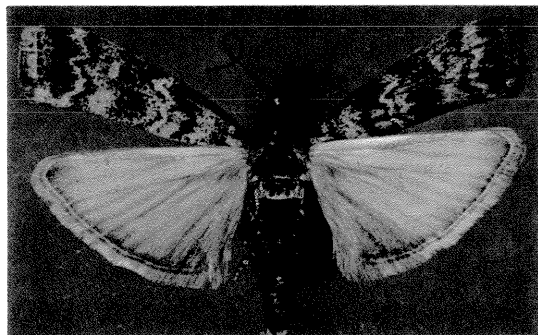
BIOLOGY. – The south coastal coneworm has repeated generations per year, possibly as many as six in Florida. Spring infestations occur in conelets infected by southern cone rust. During the summer and early fall, cones are infested. An overwintering infestation occurs in fusiform rust galls and infrequently in shoot material.

INSECT IDENTIFICATION. – Larvae of the south coastal coneworm are reddish-purple above, paling beneath, and with greenish tints especially in fully mature larvae. Abdominal seta-bearing elevations are brown, not conspicuous; pit patterns are pale, inconspicuous.

The forewings of the moths have white crossbands and markings which blend into the gray background. A pair of pale-yellow spots occurs about midway along the hind margin of the forewing. Raised tufts of scales, characteristic of many coneworm species, are lacking in this species as well as in the webbing coneworm.

DAMAGE IDENTIFICATION. – Infested cones generally have only frass pushed to the surface through entry holes. The south coastal coneworm is frequently a secondary invader of previously damaged cones, such as those infested by the southern pine coneworm. Internally, the damage is a maze of galleries.

IMPORTANCE. – The rather limited distribution of this species, its spring association with diseased conelets, plus a tendency to secondarily infest damaged cones, suggest that it be considered of less importance than the southern pine coneworm. However, it appears to become more prevalent in maturing cones where it obviously causes primary destruction.



Adult. (3½X)



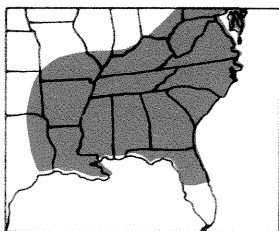
Larva. (3X)



Damage to loblolly pine cone. (1X)

⁶This has appeared in the literature as *D. abietella* (D. & S.) and *D. abietivorella* (Grote) in previous reports from the Southeastern United States.

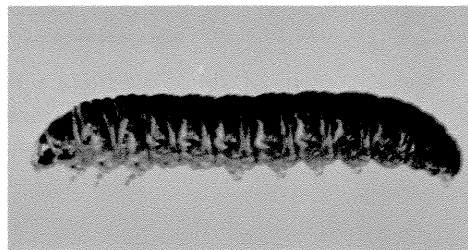
Loblolly pine coneworm, *Dioryctria merkeli* Mutuura & Munroe⁷ (9, 24, 27, 41, 52)



BIOLOGY. – The loblolly pine coneworm has one generation per year. Young larvae overwinter, then infest flowers and shoots. Some larvae complete development in shoots in slash and longleaf pines; others migrate into cones. In loblolly, shortleaf, and Virginia pines, most, if not all, larvae finish feeding in the cones. The mature larvae remain inactive over the summer, and pupation and adult emergence occur from August to October.

INSECT IDENTIFICATION. – Mature larvae of the loblolly pine coneworm resemble the southern pine coneworm but are dark bluish-black above and blue-green beneath.

The moths are also similar to those of the southern pine coneworm, but the base color of the forewing tends more toward a medium brown with irregular patches of rust-brown. The crossbanding and other pale markings are grayish, subtly blending into medium brown.



Larva. (2X)

DAMAGE IDENTIFICATION. – Damage to flowers, shoots, and cones by the loblolly pine coneworm resembles closely that of the southern pine coneworm. Spring and early summer cone infestations on loblolly, shortleaf, and Virginia pines may be attributed to the loblolly pine coneworm, but damage by the two species cannot be separated on slash and longleaf pines.

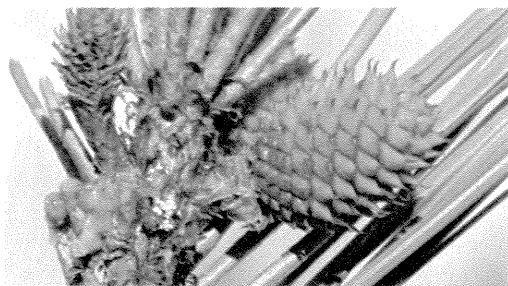


Adult. (2X)

IMPORTANCE. – Shoot attacks followed by cone infestations are common, particularly on loblolly pine. On this species, the loblolly pine coneworm seems to approach the southern pine coneworm in importance.



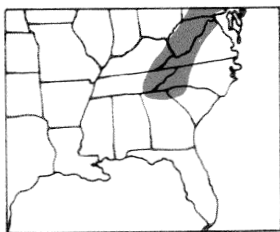
Damage to loblolly pine cone. (1X)



Damage to loblolly pine conelet. (1½X)

⁷This has appeared in the literature as *D. zimmermani* (Grote) in previous reports from the Southeastern United States.

Mountain pine coneworm, *Dicryctria yatesi* Mutuura & Munroe (41)



BIOLOGY. – Little is known about the mountain pine coneworm, which was only recently recognized as a new species. It is known only from Table Mountain pine cones. Pupation occurs in the infested cones, and the moths emerge in late summer and early fall (August-September). The complete life cycle is unknown.

INSECT IDENTIFICATION. – Larvae of the mountain pine coneworm resemble those of the southern pine coneworm but are off-white to pale green, usually tinted light purplish-pink on the upper surfaces.

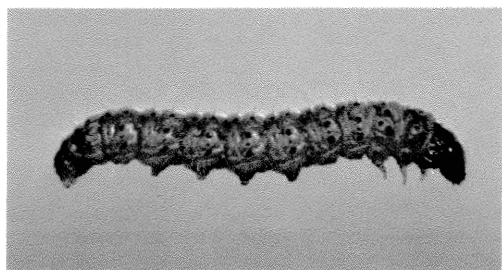
Moths are variable in color. Forewings are slate gray to mixed gray and brown with white crossbands and diffuse markings somewhat similar to those of the south coastal coneworm. Raised tufts of strongly reflexed scales on the forewings of this coneworm separate it from the south coastal coneworm. Hind wings are pale tan, shaded gray at the margins.



Adult (2½X)

DAMAGE IDENTIFICATION. – Maturing larvae infesting Table Mountain pine cones produce noticeable breaks in the cone surface in addition to the entry holes. Frass accumulations, lightly webbed, are often piled up on the upper cone surfaces and lodged between cones.

IMPORTANCE. – This insect is apparently prevalent only on Table Mountain pine, and occasionally occurs locally in destructive abundance.



Larva (2½X)

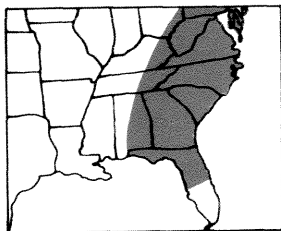


Damage to Table Mountain pine cone. (1X)

Pine Cone Borers (*Eucosma* spp.)

Damage is similar to that of *Dioryctria* spp., but the riddled cones tend to be packed with a mixture of chewings and frass with no obvious tunnel system.

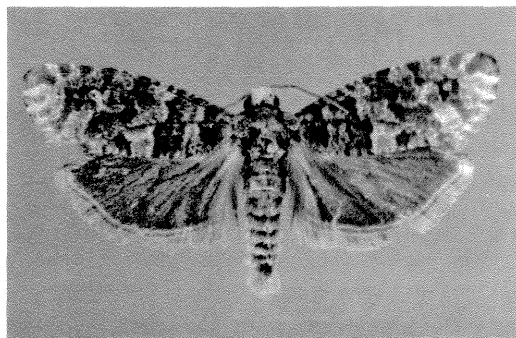
Shortleaf pine cone borer, *Eucosma cocana* Kearfott (6, 24, 26, 27, 44)



BIOLOGY. – The shortleaf pine cone borer has a single generation each year. Moths emerge from overwintered pupae in the soil and lay small overlapping groups of eggs under the scales of cone stalks in the spring (April-May). Young larvae feed in groups in immature cones, then disperse, tending to become more solitary in subsequently infested cones. Dispersal tends to be within a major branch system so that infested (or killed) cones within the tree crown are noticeably grouped. When mature (June-July), the larvae drop from the cones and pupate in the soil until the following spring.

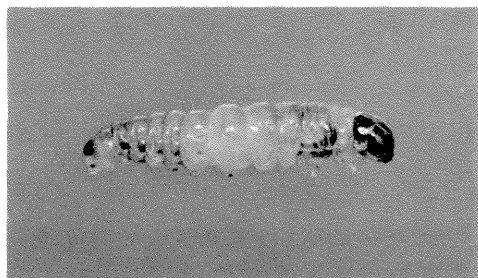
INSECT IDENTIFICATION. – Larvae are light pink-purple with brown heads. Moths are mottled in orange-brown and silver.

DAMAGE IDENTIFICATION. – The first cones infested in the spring are usually peppered by small exit holes created by dispersing larvae. Subsequently attacked cones have oval entry-exit holes (2x3 mm) near the cone base together with small holes scattered along the cone surface where larvae break through the cone surface while feeding. Fine chewings and frass can be present on the surface of infested cones. The cone interior is riddled and packed with frass and chewings.



Adult (3X)

IMPORTANCE. – This insect commonly infests shortleaf pine cones. Extent of damage is comparable to that of cone-worms. On loblolly pine it occurs less frequently and is generally of minor importance.

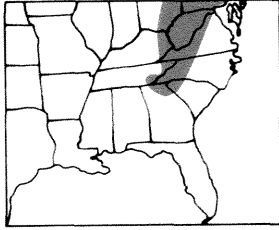


Larva. (3X)



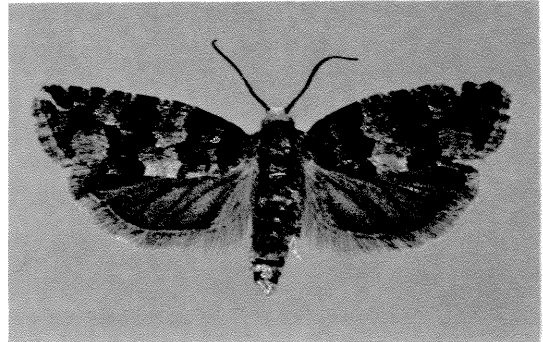
Damage to shortleaf pine cones. (1X)

White pine cone borer, *Eucosma tocullionana* Heinrich (1, 32, 44)



BIOLOGY. – Knowledge of the biology of the white pine cone borer is incomplete. The first signs of damage appear in late spring, and pupation and adult emergence occur in middle to late summer. The attack pattern is similar to that of the shortleaf pine cone borer, particularly in cones of Virginia pine.

INSECT IDENTIFICATION. – Larvae of the white pine cone borer are similar in size to the shortleaf pine cone borer but are greenish-brown and do not have a distinct dark patch (anal shield) on the top of the last abdominal segment. The moths have distinct patches of alternating rich-brown and light-tan scales on the forewings.

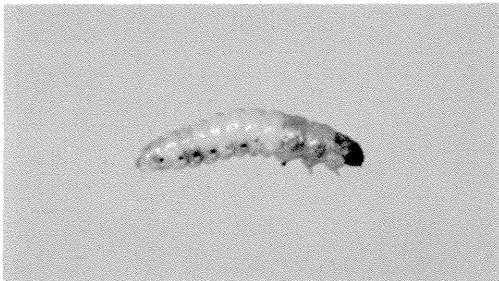


Adult. (4X)

DAMAGE IDENTIFICATION. – Eastern white pine cones are peppered with many small holes and covered with patches of extruded frass. Virginia pine cones attacked by either the white pine cone borer or shortleaf pine cone borer are indistinguishable.



Damage to eastern white pine cones. (1X)

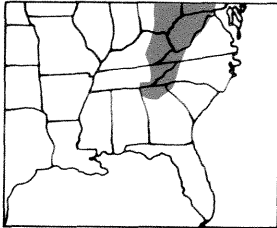


Larva. (3X)

Pine Cone Beetles (*Conophthorus* spp.)

Members of this genus are the only beetles that attack healthy living cones in the South. Two other beetle genera, *Ernobius* and *Pityophthorus*, often implicated in causing pine conelet and cone losses, are secondary invaders of dead and dying conelets and cones.

White pine cone beetle, *Conophthorus coniperda* (Schwarz) (1, 32)

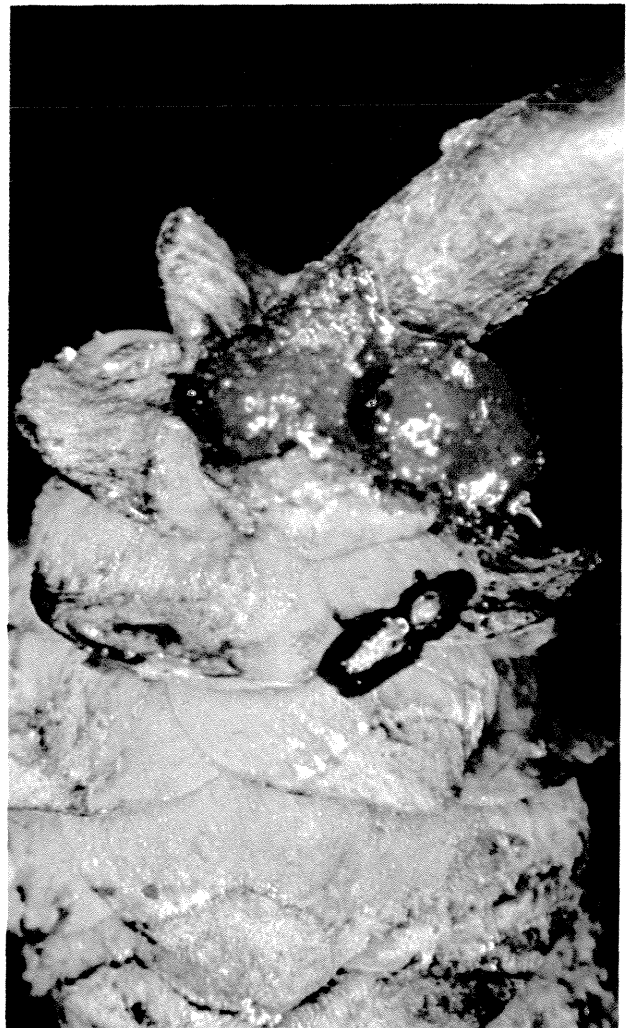


BIOLOGY. – Adults emerge in the early spring. Over a period of about 30 days, each female attacks several cones, laying eggs in some or all of them. The female beetle constructs a gallery down the cone axis, laying her eggs in from 1 to 24 niches cut into the gallery walls. The larvae feed on both seed and cone tissues. When cones are scarce, conelets are attacked but no eggs are laid in them. There is one generation per year, and the new adults overwinter in the infested cones.

INSECT IDENTIFICATION. – Adult beetles are about 3 to 4 mm long, shiny black, and covered with moderately long erect hairs. The head is directed downward and may not be visible from above. Larvae are creamy-white, legless, and somewhat C-shaped.

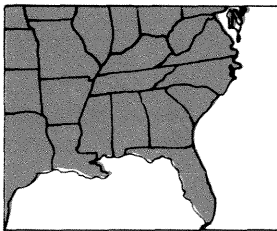
DAMAGE IDENTIFICATION. – The beetles always attack the base of the cone where it joins the stalk, usually on the underside. The entrance hole is surrounded by a characteristic doughnut-shaped mass of resin-soaked light-brown frass. Attacked cones soon wither and die. Infested cones feel spongy, and the interior tissues are completely destroyed as larvae near the completion of their development.

IMPORTANCE. – In the South, the white pine cone beetle is a serious problem in eastern white pine seed production areas, and its occurrence is increasing in seed orchards. Damage to eastern white pine cone crops in the New England States has been particularly devastating.



Attack of eastern white pine cone. (5X)

Cone Feeding Midges, (*Cecidomyiidae*) (7, 20, 24, 27)



Several species of midges (small flies) in the family Cecidomyiidae (Diptera) have been identified as cone pests.

BIOLOGY. – Very little information is available on the biology of cone feeding midges attacking the southern pines. Both conelets and cones are attacked, but damage seems to be more common on cones. The larvae feed in groups on both the seed and cone tissues.

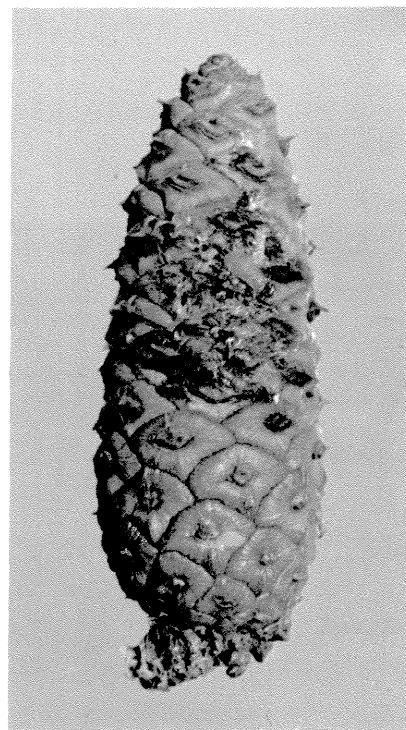
INSECT IDENTIFICATION. – The larvae are 2 to 3 mm long, tapered, and variable in color from near-white to orange. Adults are very small and mosquito-like, with long delicate legs and antennae (2 mm long). Several insect genera have been identified, but the relative importance of the individual species is uncertain.



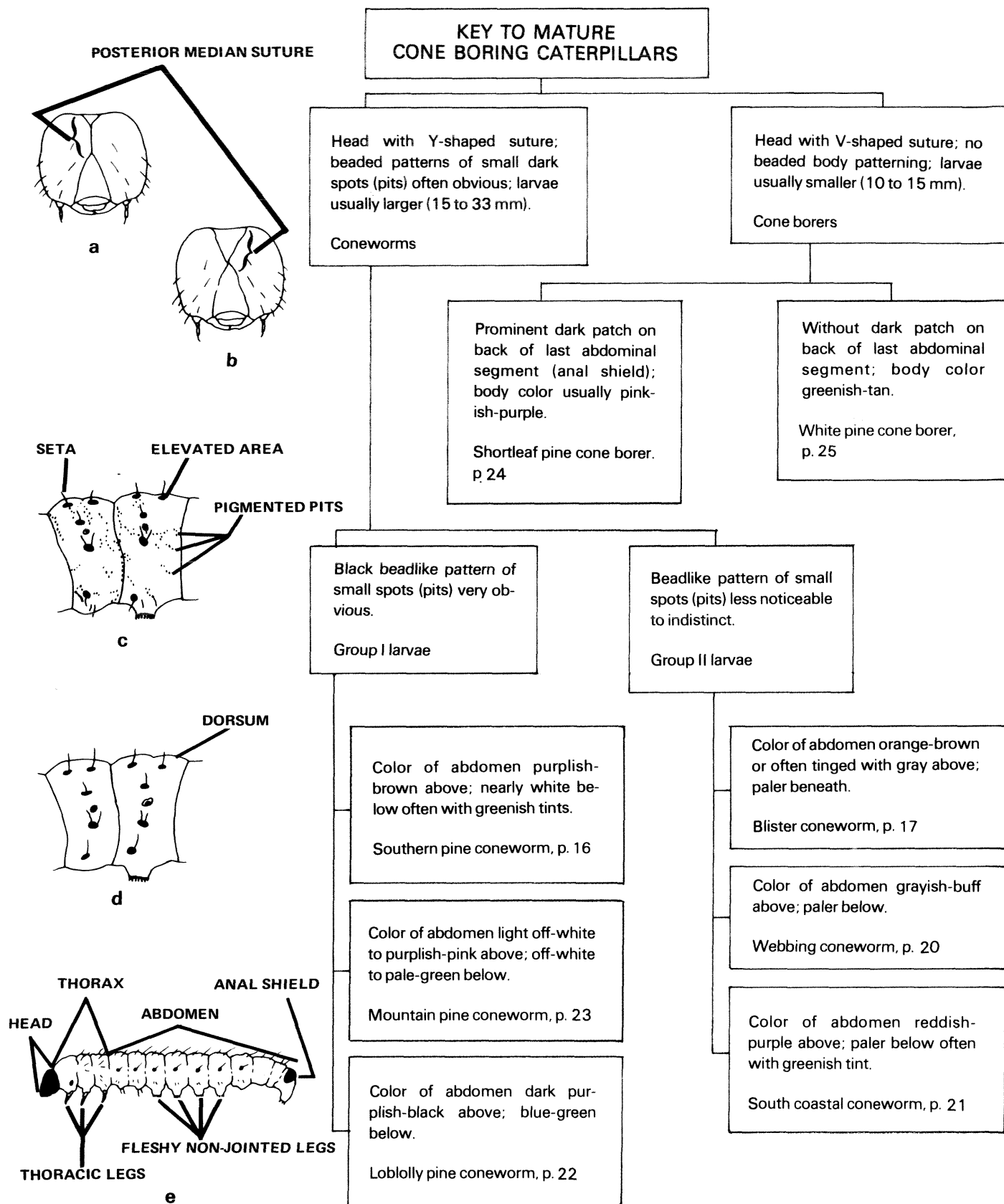
Pine cone scales removed to expose cone feeding midge larvae and pupae. (2X)

DAMAGE IDENTIFICATION. – Cone feeding midge larvae feed between the cone scales and cause resinosis and withering of the scales. Internally, infested cones have areas of dead resin-soaked tissue between the scales, which are notably free of any boring frass. Externally, cone feeding midge attack is indicated by brown sunken areas on the cone surface, often accompanied by some resinosis. This damage often causes distortion and a decrease in size of cones.

IMPORTANCE. – Accurate estimates of the impact of cone feeding midges on cone production are not available. Casual observations, however, indicate that the incidence of damage is usually low.

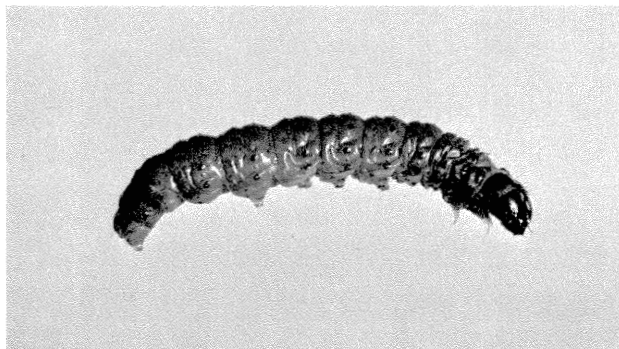


Loblolly pine cone damage by cone feeding midges. (1X)

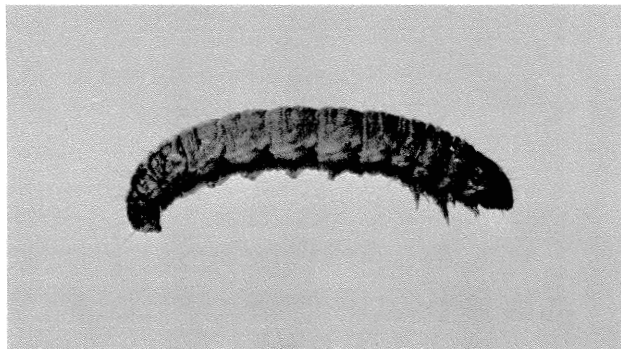


Coneworm and cone borer larvae: (a) dorsal view of coneworm larva head, Y-shaped suture; (b) dorsal view of cone borer larva head, V-shaped suture; (c) lateral view of two abdominal segments of Group I coneworm larvae; (d) lateral view of two abdominal segments of Group II coneworm larvae; (e) lateral view of generalized larva.

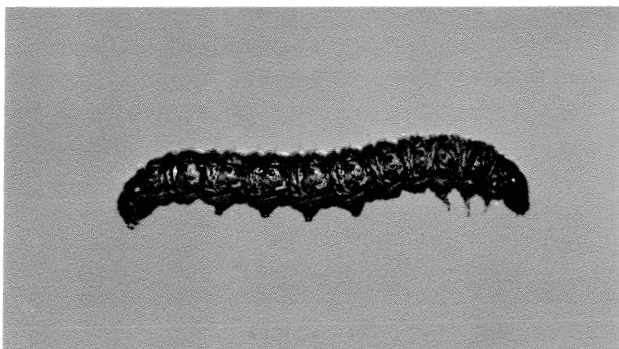
a



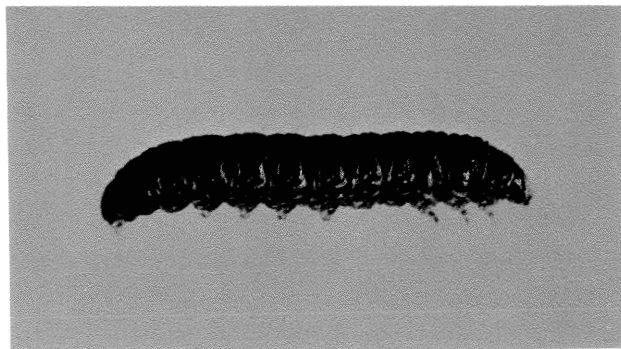
b



c



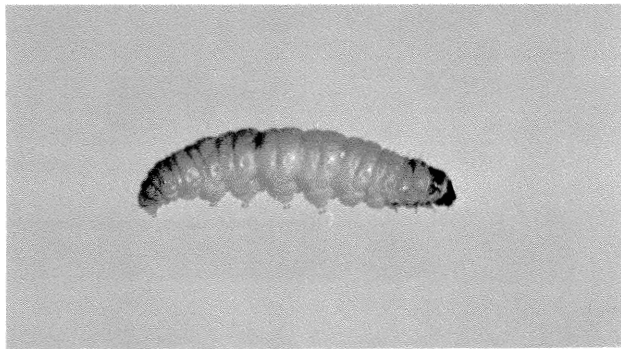
d



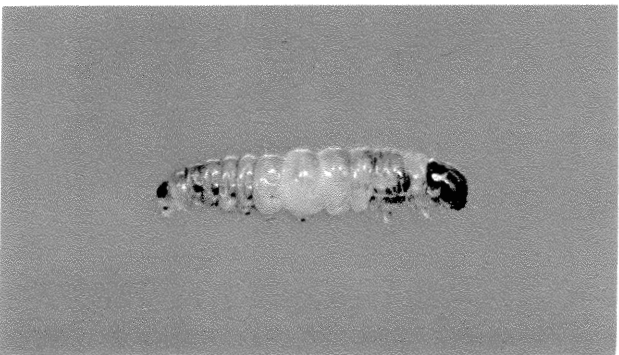
e



f



g

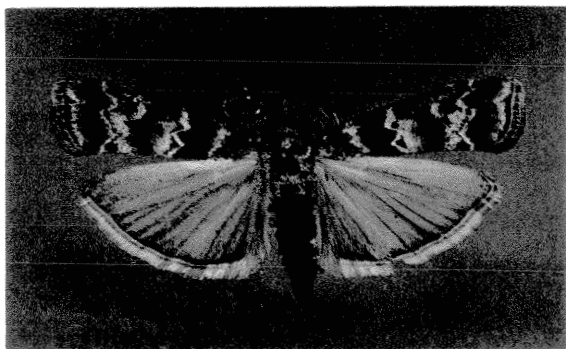


h

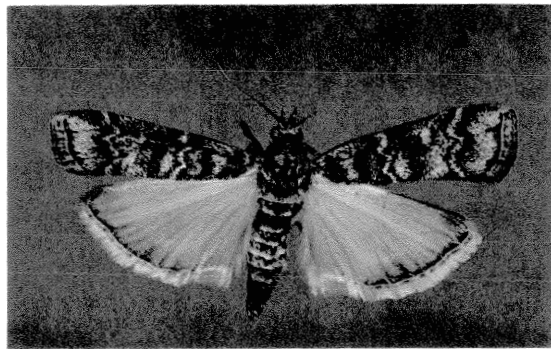


Cone boring caterpillars: (a) southern pine coneworm; (b) south coastal coneworm; (c) mountain pine coneworm; (d) loblolly pine coneworm; (e) webbing coneworm; (f) blister coneworm; (g) shortleaf pine cone borer; (h) white pine cone borer. (2-3X)

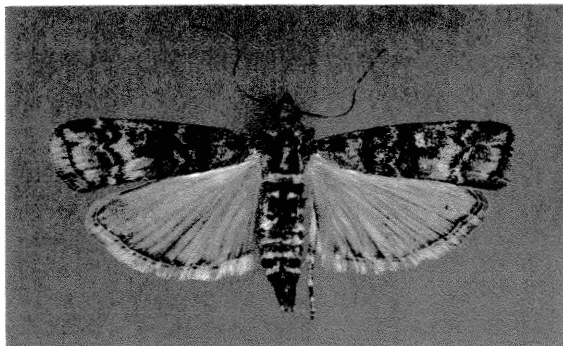
a
30 mm



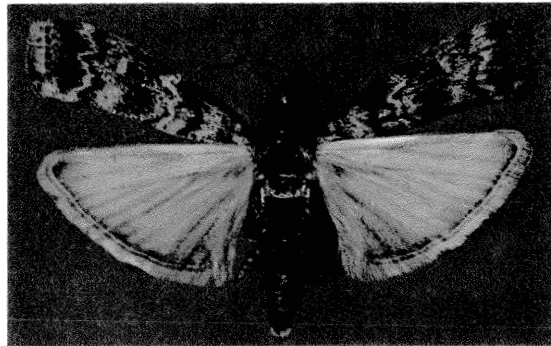
b
26 mm



c
28 mm



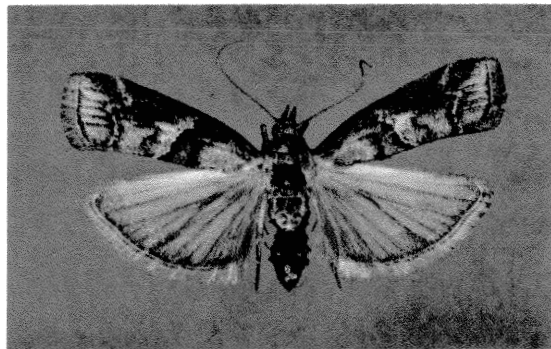
d
20 mm



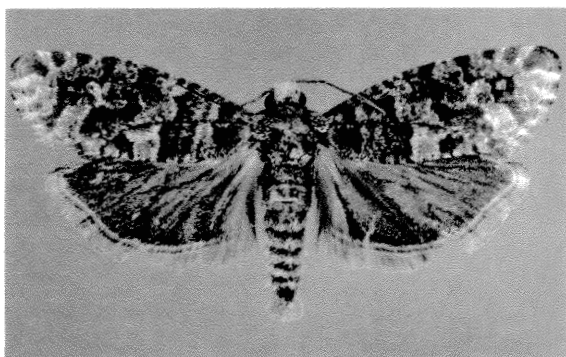
e
27 mm



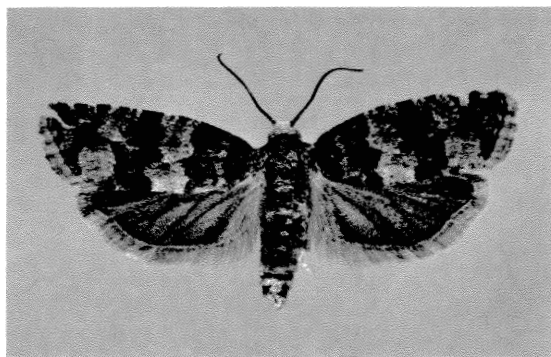
f
25 mm



g
18 mm



h
16 mm



Cone boring caterpillar adults: (a) southern pine coneworm; (b) mountain pine coneworm; (c) loblolly pine coneworm; (d) south coastal coneworm; (e) webbing coneworm; (f) blister coneworm; (g) shortleaf pine cone borer; (h) white pine cone borer. (Actual wingspan indicated.)

SEED DAMAGE

This group includes insects that feed upon developing seeds in the conelets and cones of pines. Outwardly, cones containing seeds damaged by seed bugs or infested by seed chalcids and seedworms appear healthy, even when extensive internal seed loss has occurred.

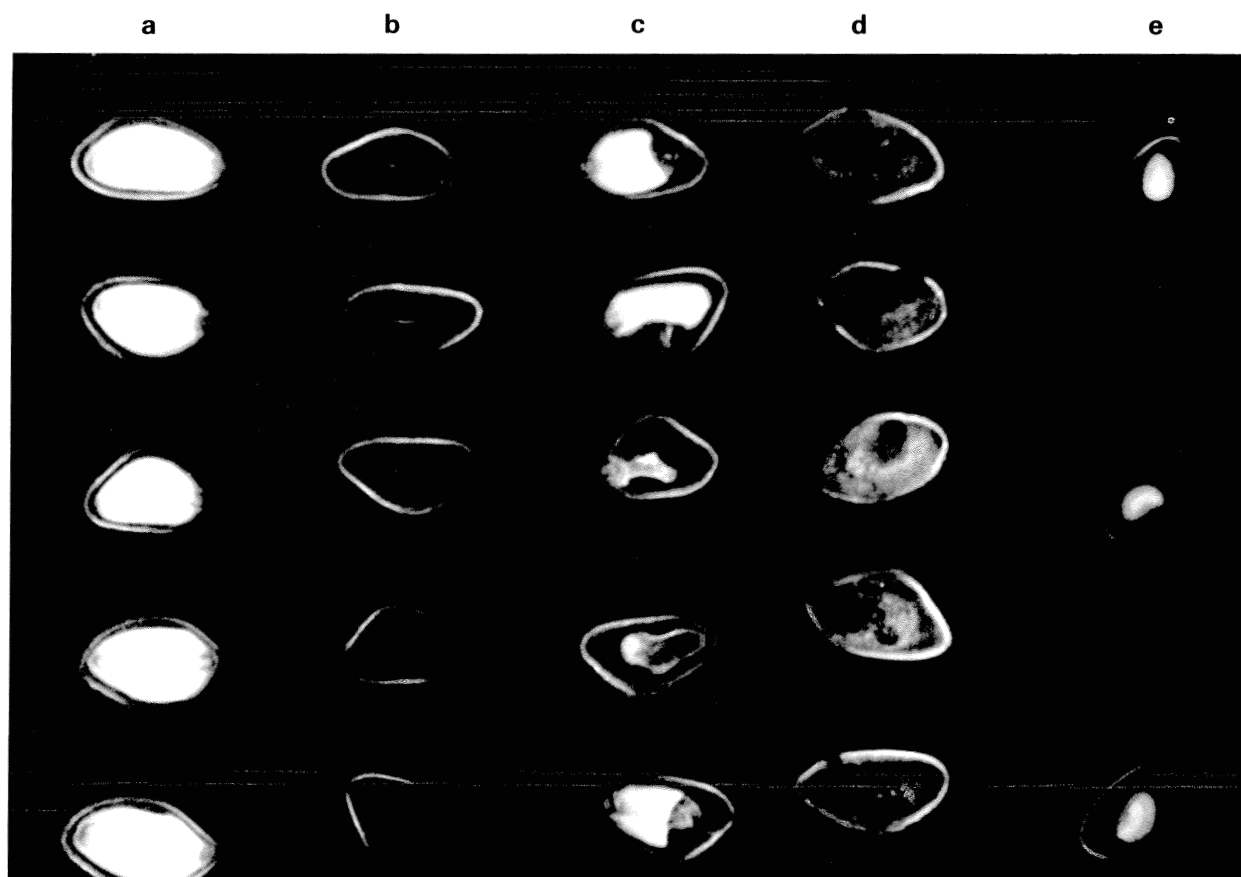
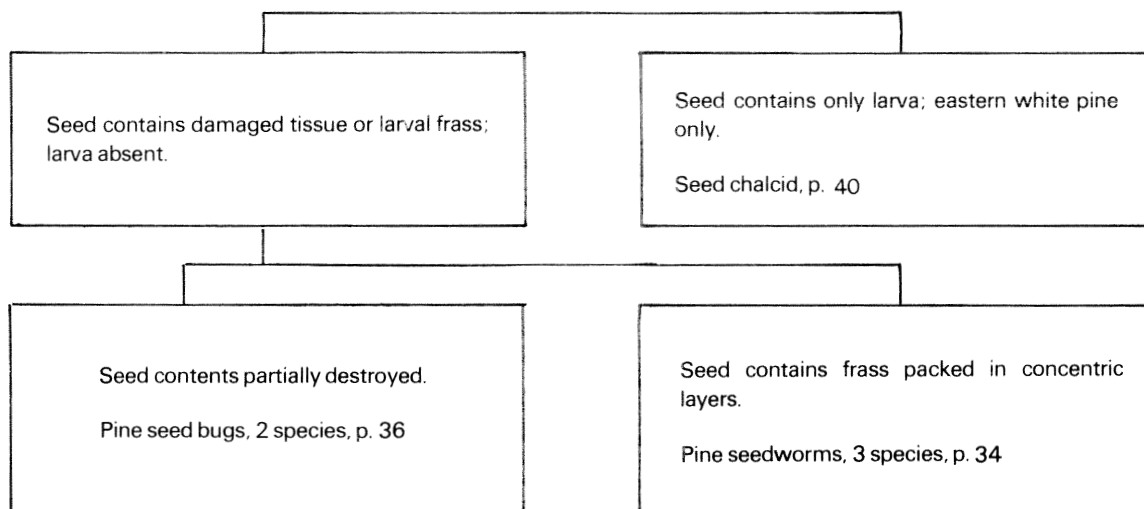
INSECT OCCURRENCE ON HOST PINES

INSECT	HOST PINES						
	Longleaf	Shortleaf	Loblolly	Slash	Virginia	Eastern White	Table Mountain
Longleaf pine seedworm	Yes	No	Yes	Yes	No	No	No
Slash pine seedworm	Uncommon	No	Uncommon	Yes	No	No	No
Eastern pine seedworm	No	Yes	Yes	No	Yes	No	No
Leaffooted pine seed bug	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Shieldbacked pine seed bug	Yes	Yes	Yes	Yes	Yes	Yes	?
Seed chalcid	No	No	No	No	No	Yes	No

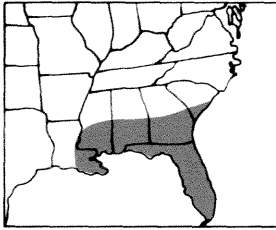
INSECT DAMAGE PERIODS

INSECT	FEEDING PERIOD											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Longleaf pine seedworm												
Slash pine seedworm												
Eastern pine seedworm												
Leaffooted pine seed bug												
Shieldbacked pine seed bug												
Seed chalcid												

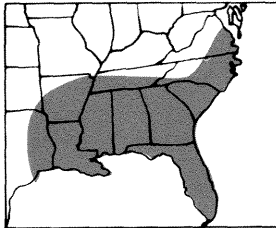
KEY TO RADIOGRAPH OF DAMAGE IN MATURE SEED



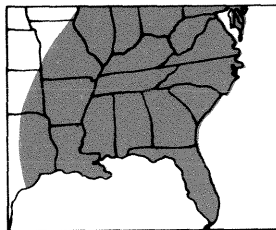
Radiograph of pine seed: (a) sound seed; (b) empty seed; (c) seed bug-damaged seed; (d) seedworm-damaged seed; (e) seed chalcid-damaged seed. (3X)



Slash pine seedworm



Longleaf pine seedworm

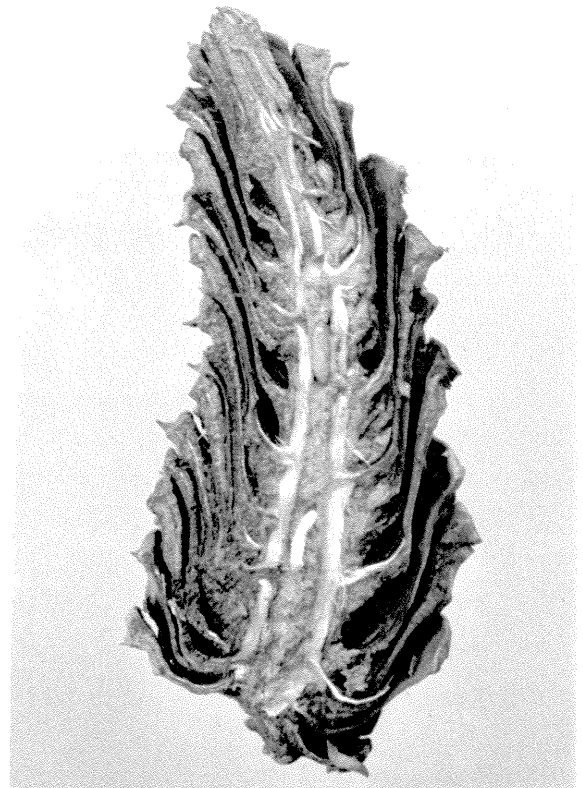


Eastern pine seedworm

SPECIES. – In the South, three species, the slash pine seedworm, *L. anaranjada* Miller; the longleaf pine seedworm, *L. ingens* Heinrich; and the eastern pine seedworm, *L. toreuta* (Grote), are known to destroy seeds of one or more of the major southern pine species. Damage is caused by larval feeding and development within maturing seeds or cones.

BIOLOGY. – The biology of all three species is similar except for the time of adult occurrence. There is only one generation per year. In the spring the adult moths emerge and mate, and the females lay eggs on the cones. The eggs hatch in 3 to 6 days and the young larvae bore into the cones. Each young larva enters a seed and completely consumes the endosperm. The larva then bores its way to another seed, leaving the excrement-filled, hollowed seed behind. Each larva consumes from five to seven seeds during development. In the fall, the mature larva bores to the cone axis where it overwinters. The following spring the seedworm cuts an exit hole through a hollowed seed, neatly webbing the cut "cap" in place. It then pupates within its cone gallery. The pupa wriggles to the exit hole just prior to moth emergence and displaces the "cap." The moth then emerges from seed held between the cone scales of an open cone.

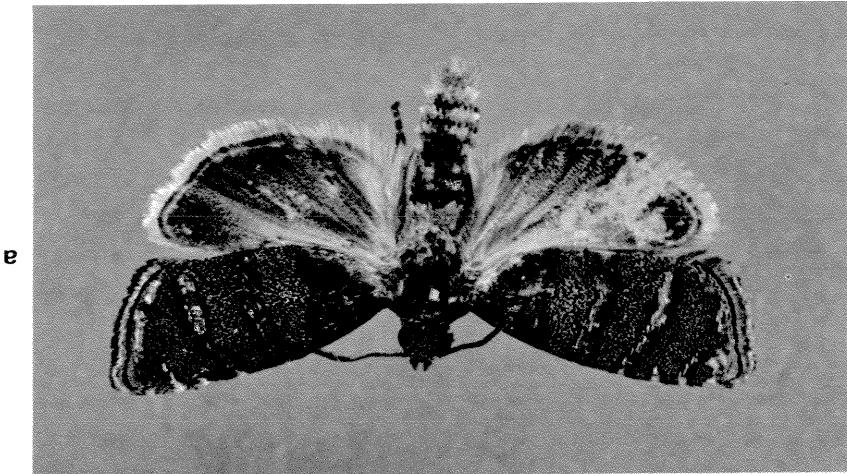
INSECT IDENTIFICATION. – Larvae and pupae of the three species of seedworms are not easily separated. The larvae are whitish with yellowish-brown heads. They are about 1 cm long when mature. The longleaf and eastern pine seedworm moths are almost identical. Both species have dark, slate-gray forewings with several silvery-white crossbars that are typical of the genus. The crossbar of scales on the tip of the forewing of the longleaf pine seedworm parallels and touches the margin of the wingtip. The outer crossbar of scales on the eastern pine seedworm parallels the wingtip margin but does not touch it. Moths of the slash pine seedworm can be easily identified by the orange color of the forewings.



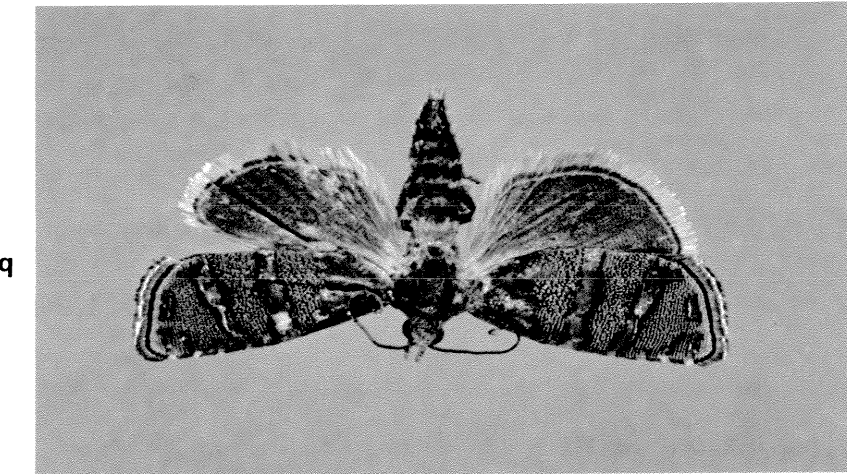
Larva and pupa in axis of loblolly pine cone. (1X)

DAMAGE IDENTIFICATION. – There is no external evidence on cones attacked by seedworms. At cone maturity, most damaged seeds remain firmly stuck in the open cones. Damaged seeds are tightly packed with excrement and have larval emergence holes. They are readily identified on a radiograph. The larval galleries in the cone axis can be exposed by bisecting the mature open cone. Counting these galleries is a convenient method of assessing infestation levels.

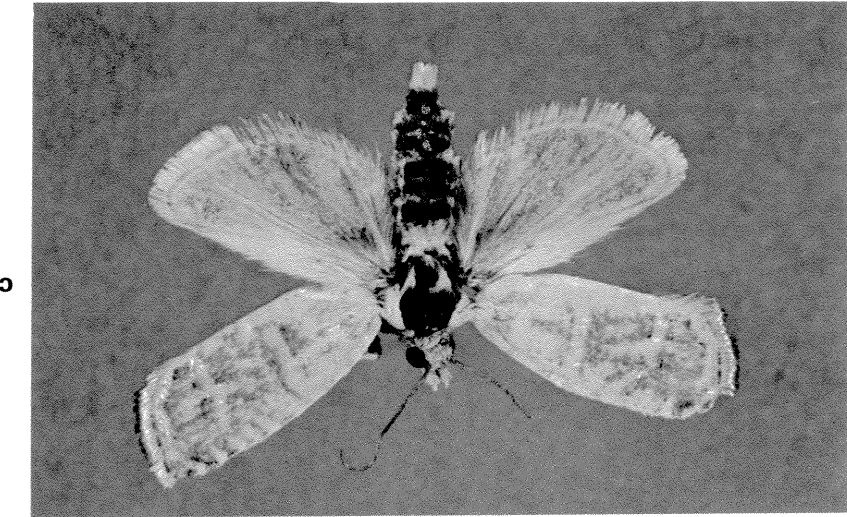
IMPORTANCE. – Seedworm damage varies considerably among host species. Longleaf pine seed losses up to 40 percent have been recorded. Seedworm damage to seed of other pines is generally minor.



(4.5X) 18.5 mm



(6X) 14 mm



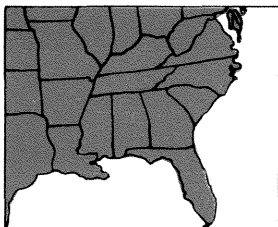
(5X) 15 mm

Adults: (a) longleaf pine seedworm; (b) eastern pine seedworm; (c) slash pine seedworm.

Pine Seed Bugs

Seed bugs are sucking insects that feed upon the developing pine cones. Unlike the boring larvae of the more typical cone and seed insects, seed bugs move freely from one cone cluster to another, puncturing through the cone scales with needlelike mouthparts to extract nutrients from individual seeds. Immature bugs are highly mobile within the tree crown, and adult bugs are strong flyers capable of moving throughout the orchard. Early stages are gregarious, and their concentrated feeding may kill conelets or cones. Later stages become solitary feeders. Two species, the leaffooted pine seed bug, *Leptoglossus corculus* (Say), and the shieldbacked pine seed bug, *Tetyra bipunctata* (H.-S.), commonly occur in seed orchards.

Leaffooted pine seed bug, *Leptoglossus corculus* (Say) (12, 14, 15, 16, 17, 37, 46)



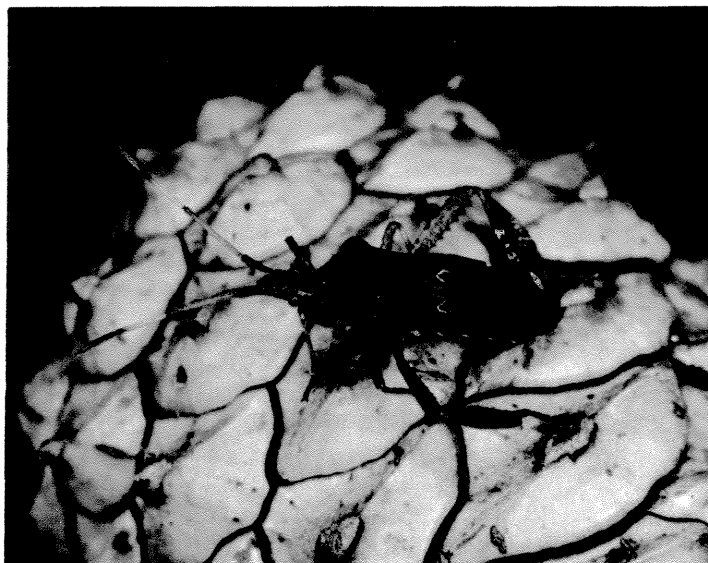
BIOLOGY. – The leaffooted pine seed bug overwinters as an adult. Eggs are laid end to end in neat rows on pine needles. Second-stage nymphs feed on conelets, while older nymphs and adults destroy seed in cones. Nymphs are present from April through October, and adults can be found feeding in the spring, summer, and fall. Several generations are produced each year.

INSECT IDENTIFICATION. – Adults are large, very conspicuous bugs about 2 cm long. The most distinctive characteristic of both late-instar nymphs and adults is the leaflike expansion of the hind legs. Adults are brown with a white zigzag marking across the back. The barrel-shaped eggs are cream colored when laid, turning dark reddish-brown.

Egg masses on shortleaf pine needles; first-stage nymph on needle at lower left. (2X)



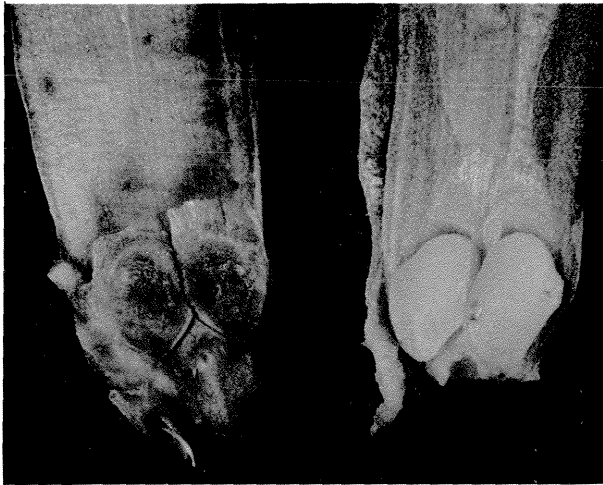
Adult feeding on loblolly pine cone. (2X)



DAMAGE IDENTIFICATION. – Seed bugs feed upon developing seed by inserting their mouthparts between conelet scales or by puncturing cone scales, leaving only a microscopic vestige of their visit. Aborted conelets (or cones) lacking any obvious signs of injury, low yields of seed, high numbers of empty seed, poor seed viability, or mold in germination tests – all these conditions may be the result of feeding by the leaf-footed pine seed bug.

Damage to nearly mature seed can often be identified under magnification. Partial digestion of the seed-coat by the insect saliva produces a fleck on the seed and sometimes the minute hole penetrating the seed-coat can be detected. Seeds damaged late in the growing season can often be identified on radiographs of mature seeds. This technique is valuable for comparing seed bug damage among clones or among treatments in insecticide tests, but it usually provides very conservative estimates of the total impact of the leaf-footed pine seed bug on seed production.

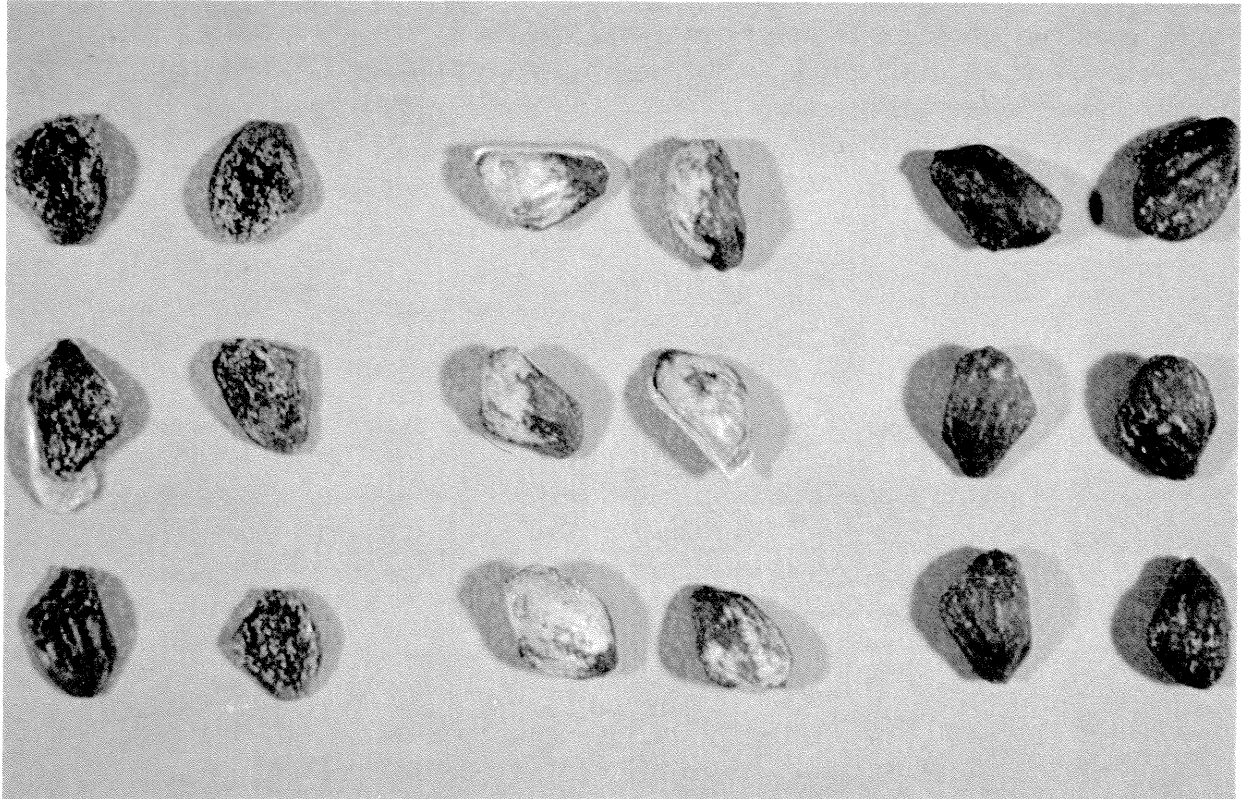
Leaffooted pine seed bug damage (left) to developing seed in immature cone. Undamaged seed on right. (3X)



Shortleaf pine conelet (right) aborted by leaffooted pine seed bug feeding on immature seed. (3X)



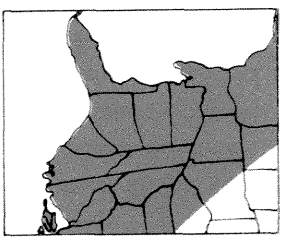
Slash pine seed with two seed bug feeding holes in seed-coat. (10X)



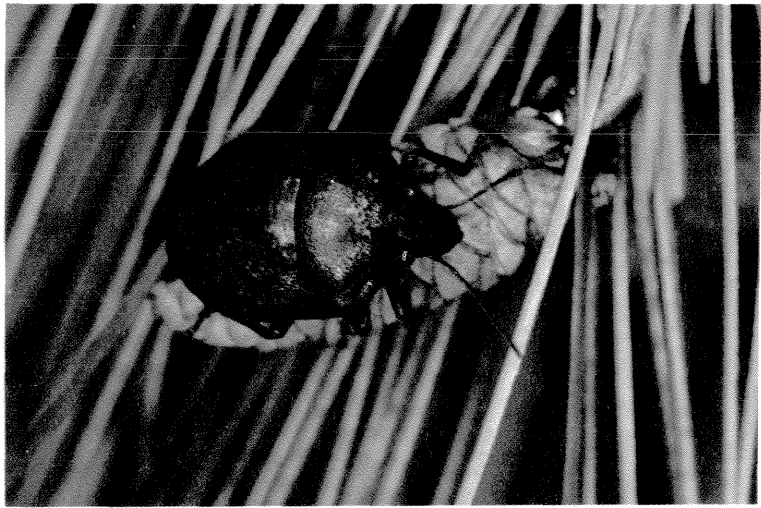
Effects of seed bug feeding vary with the stage of seed development: seed damaged early in the summer are flattened (left); in midsummer damaged seed often have a partially digested seedcoat (center); and seed damaged in the late summer are full size but have internal damage (right). (3X)

IMPORTANCE. – The leaffooted pine seed bug is of major importance throughout the Eastern United States. All species of pines grown in seed orchards in the South are hosts. Since this seed bug is active throughout the growing season, producing multiple generations each year, relatively few seed bugs per tree cause extensive losses by aborting conelets and destroying immature seeds. The leaffooted pine seed bug is not readily observed in orchards until cone harvest, but by then losses may have already occurred at earlier stages of seed development. In seed orchards it is not unusual to double the yields of filled seed per cone by protecting conelets and cones with screen-wire cages or insecticides. In some orchards, increases in yields of filled seed per cone as high as tenfold have occurred.

BIOLOGY. – The shieldbacked pine seed bug overwinters as an adult in the litter. Eggs (8 to 14) are laid in two alternate rows on living pine needles or in a random group on a cone. Older nymphs and adults feed primarily on seed within cones. In the Lake States, the shieldbacked pine seed bug has only one generation per year. This is also apparently true in the South, where overwintered adults are not observed feeding in seed orchards until early summer.



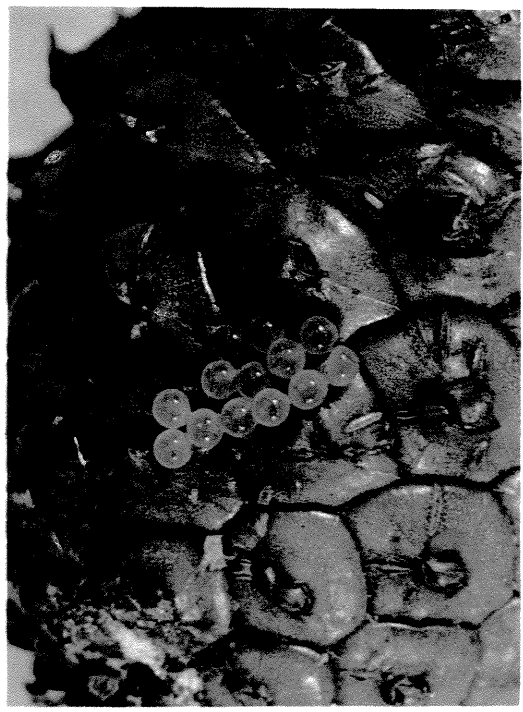
INSECT IDENTIFICATION. – Adults and nymphs have a shieldlike “stinkbug” shape. Their color varies from gray in the early stages to dark reddish-brown with black markings as adults. Adults are about 1.5 cm long. The eggs are small, bright-green spheres about 1.5 mm in diameter.



Adult (3X)

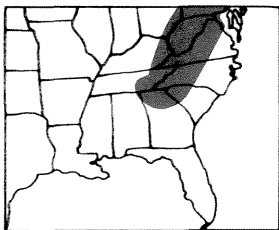
DAMAGE IDENTIFICATION. – Feeding by the nymphs and adults of the shieldbacked pine seed bug is limited to nearly mature seed. Much of this seed damage can be detected by examining mature seeds. These damaged seeds cannot be distinguished either ocularly or radiographically from seeds damaged late in the growing season by the leafrooted pine seed bug.

IMPORTANCE. – The shieldbacked pine seed bug is found throughout the South, and its hosts include all the major pine species. Peak populations of this seed bug coincide with cone harvest, when the bugs are most frequently observed in seed orchards. Since this insect has only one generation each year and feeding is limited to nearly mature seed, the damage potential of the shieldbacked pine seed bug is not nearly as great as that of the leafrooted pine seed bug.



Egg mass on loblolly pine cone. (3X)

Seed Chalcid, *Megastigmus atedius* (Walker) (1, 11, 47)

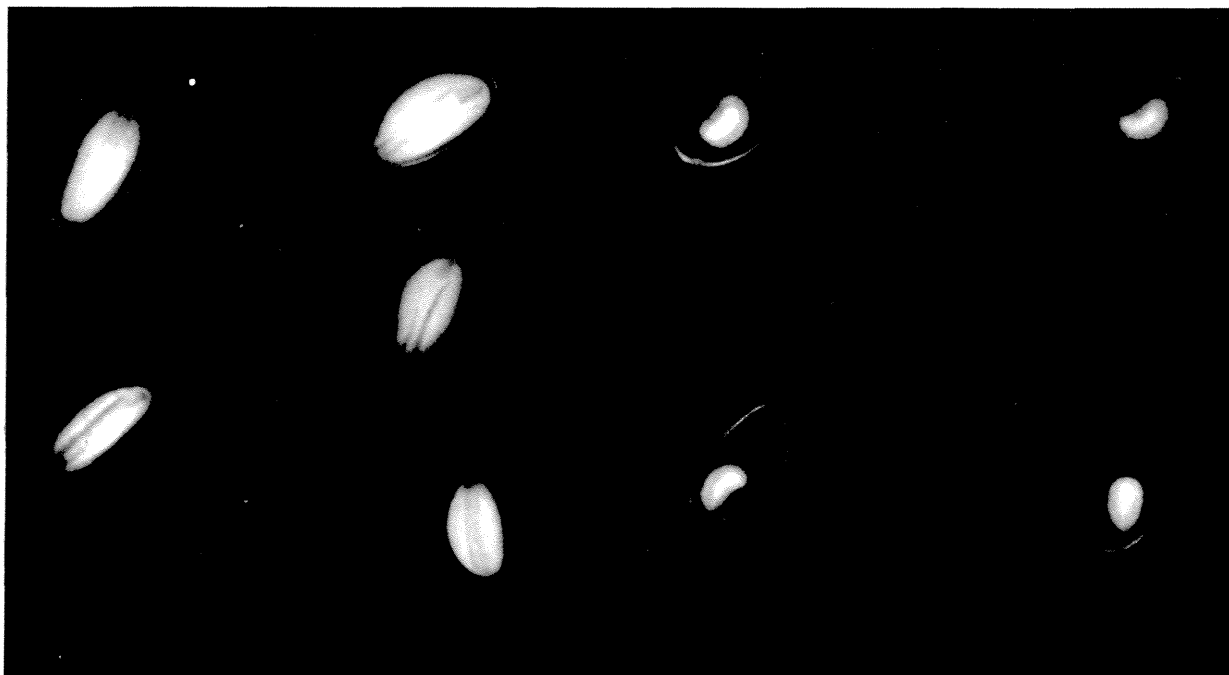


BIOLOGY. – During late spring the female seed chalcid wasp settles on immature cones and inserts her long ovipositor down through the cone scales, depositing eggs directly into the seeds. Each larva feeds for 6 to 8 weeks, consuming the entire contents of a seed. Larvae overwinter in the seed; pupation and adult emergence occur in the spring. Some larvae, however, may remain in a resting condition for up to 3 years. The adult wasp emerges in late May through a hole it bores in the seedcoat.

INSECT IDENTIFICATION. – Adult seed chalcid wasps are only about 3 mm long and are seldom seen. Larvae are white and legless with dark-brown to black mandibles.

DAMAGE IDENTIFICATION. – Infested seeds cannot be distinguished from sound seeds except by dissection or radiography.

IMPORTANCE. – Seed chalcid damage to eastern white pine is believed to be rare, as reports of damage have been infrequent.



Radiograph of eastern white pine seed: five seeds on left, normal; four seeds on right infested with seed chalcid. (3X)

GLOSSARY

ABDOMINAL SEGMENT – a subdivision of the abdomen of a larva delineated by constrictions; no more than one pair of legs per segment.

ANAL SHIELD – a pigmented hard area on the back of last abdominal segment of a larva.

CONE – the female strobilus of pines from the time of appearance of a new conelet crop to maturity (second growing season).

CONELET – the female strobilus of pines from the time of flower scale closure until a new flower crop is pollinated (first growing season).

DIAPAUSE – a condition of suspended animation or arrested development during the life cycle of an insect.

EPIDEMIC – a state of high population of an insect species.

FLOWER – the exposed male and female reproductive structure before or during pollination.

FLOWER BUD – buds which contain either male or female strobili tissues.

FRASS – solid excrement of insects.

RESIN (oleoresin) – sticky substance which exudes from injured pine tissues.

RESINOSIS – plant lesions or surrounding areas infused with resin.

SETA (pl. setae) – slender hairlike structure on insect body; a bristle.

STROBILUS – the reproductive structure of conifers.

Scientific Names of Hosts

Eastern white pine	–	<i>Pinus strobus</i> L.
Loblolly pine	–	<i>Pinus taeda</i> L.
Longleaf pine	–	<i>Pinus palustris</i> Mill.
Pitch pine	–	<i>Pinus rigida</i> Mill.
Sand pine	–	<i>Pinus clausa</i> (Chapm.) Vasey
Shortleaf pine	–	<i>Pinus echinata</i> Mill.
Slash pine	–	<i>Pinus elliottii</i> Engelm. var. <i>elliottii</i>
Spruce pine	–	<i>Pinus glabra</i> Walt.
Table Mountain pine	–	<i>Pinus pungens</i> Lamb.
Virginia pine	–	<i>Pinus virginiana</i> Mill.

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INSECT DAMAGE PERIODS

Flower and Conelet Damaging Insects – p. 4

[illegible]

Cone Damaging Insects – p. 13

[illegible]

Seed Damaging Insects – p. 31

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