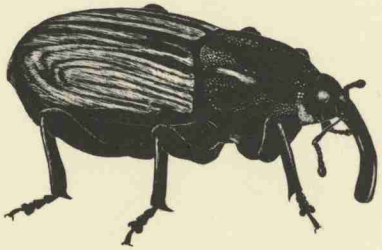
# *INSECT and related PESTS of FIELD CROPS*



*Some important, common and potential pests in North Carolina.*

# *INSECT and related PESTS of FIELD CROPS*

*Some important, common and potential pests in North Carolina.*

Edited by
Thomas N. Hunt, American Cyanamid Company
Formerly Extension Entomologist
North Carolina Agricultural Extension Service

James R. Baker
Extension Entomologist
North Carolina Agricultural Extension Service

Written by
Cathy Cameron Carter, North Carolina Agricultural Extension Service
Thomas N. Hunt, North Carolina Agricultural Extension Service
Daniel L. Kline, United States Department of Agriculture, Gainesville, Fla.
T.E. Reagan, Louisiana State University
W.P. Barney, Diamond Shamrock Corporation

With the Collaboration of
David L. Stephan, North Carolina Agricultural Extension Service

This publication was partially funded by American Cyanamid Co., Wayne, N.J.

Published by
THE NORTH CAROLINA AGRICULTURAL EXTENSION SERVICE



5-82-5M

AG-271

Copies may be obtained from:
Department of Agricultural Communications,
North Carolina State University
Raleigh, North Carolina 27650

Price: $6.00

# PREFACE

To compile a manual of all real and potential pests of North Carolina's seven major field crops would be an endless and impractical task of little subsequent value. Therefore, this volume is restricted to common and/or important arthropod pests of field crops. Insects, or their relatives, which rarely cause damage and are seldom seen are not included here. Such a criterion excludes pests such as the corn blotch leafminer, although populations of this pest did flare unexpectedly and cause some problems in 1974. Overall, however, this manual is designed primarily to cover pests encountered on a yearly basis. Should new pest problems arise and persist, additions to the manual may be issued.

The illustrations of many artists appear throughout this publication. The following artists are especially noted:

Susan Van Gieson (Figures 1 J; 2; 5 E; 7 C; 8; 11 B; 12 A; 14 A,B; 17 A,B; 20 B; 28 A; 31 A,B; 35; 39; 44; 45; 46; 47 B; 48; 49; 52; 54; 55 A; 56 A; 57; 59; 60; 61 A; 62 A; 65 A; 67; 68; 71 A; 74; 77 A; 79; 82 A; 83 E; 84 C; 85 B; 88 B; 92; 95 C; 99 D (redrawn from USDA); 103; 104 A,C,E; 106; 108 E; 109 F; 110 B, C; 112 F,G; 114; 115; 116 B; 117; 121 B; 127 E; 129 A; 133 C to E; 135; 136 B,C; 137; 141 A; 148 E; 150; 151 B; 152; 155; 159 E; 164; 165 B,C; 170 C,E; 174 C; 175 B; 177; 179 D,G; 181 A; 186 A; 189; 191 F; 192 B,D; 193 F,J,K,L; 197 B; 199; 202 C),

Ponglerd Kooaroon (Figures 4 B,D; 13 A; 19 A; 28 B; 40; 42; 50; 55 B; 56 B; 62 B; 63 A; 64 B,C; 71 B; 76 A,B; 77 B to D; 83 F; 84 A; 85 C; 86 C,F; 87 E; 88 A,D; 93 D; 94 B,D; 96 B; 100 B,E; 101 C,F; 116 A; 120; 122 B; 123 B,F; 124 A,B; 126 D; 127 F; 134 B,D,E, H,L; 140 A; 141 B to D; 143 C, F; 145 B,D; 148 B,D; 151 A; 154 A,B; 159 F; 168 B; 169 E; 175 C; 176 C,F; 178; 182 A; 185 C; 187 A; 193 A to D,M; 196 A,B; 197 C; 201 D; 203 B,D; 204 B,D,G), and

James R. Baker (Figures 1 D,G; 3; 6; 9; 10 A,B; 26; 31 C,D; 38; 41; 47 A; 51; 58; 72 B; 78; 82 B,D; 85 A; 90; 97; 104 B; 109 A to E; 110 A,D; 112 D; 113; 132; 136 A; 142; 147; 163 D; 165 A; 170 D; 172; 175 A; 190; 191 A to E; 192 A,D; 197 A).

Other artists include Mei-Jung Lin and L.L. Deitz (Figures 1 N; 5 A; 13 B; 14 D; 25 B; 131 H; 144 H; 163 A,C; 167; 169 D; 173 B; 179 C; 196 C,F; 201 E), Shuling Tung (Figures 12 B; 70 C; 102 D; 121 E; 139 D), and Judy Stewart (Figures 65 B,C; 96 A; 100 C; 148 F,G; 204 E,F).

Figure credits also go to the Arizona Agricultural Experiment Station (Figures 1 M; 24; 107 F; 109 I,J; 110 E; 111 F to H; 112 H; 179 H to J), Arkansas Agricultural Experiment Station (Figures 14 C; 18 C; 169 A to C; 171 A to J), Florida Agricultural Experiment Station (Figure 170 F), Illinois Agricultural Experiment Station (Figures 5 D; 10 C; 66; 81; 84 B,D; 134 C; 168 A; 173 A; 193 E,G; 194 A to C), South Carolina Agricultural Experiment Station (Figures 15, 82 E), South Carolina Agricultural Extension Service (Fig. 4 A; 163 E; 166; 176 A,B,D,E), South Dakota Agricultural Experiment Station (Figure 4 E), United States Department of Agriculture (Figures 1 A to C,E,F,H,I,K,L,P; 4 C; 5 B,C; 7 A,B; 10 D; 11 A; 16; 18 B; 19 B; 20 A; 21 to 23; 25 A; 27; 29; 30; 33; 34; 36; 37; 43; 53; 61 B; 63 B; 64 A,D; 69; 70 A,B; 72 A,C; 73; 75; 76 C,D; 80; 82 C; 83 A to D,G,H; 84; 86 A,B,D,E; 87 A to D; 88 C; 89; 91; 93 A to C,E; 94 A,C,E; 95 A,B,D; 98; 99 A to C; 100 A,D; 101 A,B,D,E, 102 A to C; 104 D; 105; 107 A to E; 108 A to D; 109 G,H; 111 A to E; 112 A to C,E; 118; 119; 121 A,C,D; 122 A; 123 A,C to E; 124 C,D; 125; 126 A to C,E; 127 A to D,G,H; 128; 130; 131 A to G; 133 A,B; 134 A,F,G, I to K; 138; 139 A to C; 140 B; 143 A,B,D,E; 144 A to G; 145 A,C; 146; 148 A,C; 149; 153; 154 C,D; 156 to 158; 159 A to D, G,H; 160 to 162; 163 B; 165 D; 168 C; 170 A,B,G; 171 K,L; 174 A,B,D, to F; 179 A,B,E,F; 180; 181 B,C; 182 B; 183; 184; 185 A,B; 186 B; 187 B; 188; 191 G to K; 193 H,I; 195; 196 D,E; 198; 200; 201 A to C; 202 A,B; 203 A,C; 204 A,C), and Washington Agricultural Experiment Station (Figure 1 0).

The patience of Ms. Lela Conrad, Mrs. Susan Boykin, Ms. Vicki Grantham, Mrs. Carmen Sasser, and Mrs. Teresa Snell as they prepared the typewritten copy of the manuscript is heartily appreciated. T. G. Floore helped prepare rough drafts of a portion of the manuscript. Special thanks is extended to NCSU Extension Entomology and Crop Science staff members whose informational resources and reviewing services have proved invaluable. Reviews by the entomology departments of the University of Georgia and Auburn University are gratefully acknowledged. Also of value was the assistance of the North Carolina Crop Reporting Service which provided 1980 estimates of field crop acreages. Without the partial support provided by the Office of Pesticide Programs, Environmental Protection Agency, Contract #68-01-2903, this manual would not have been possible.

Cathy Cameron Carter
Thomas N. Hunt

# Table of Contents

# *INSECT and related PESTS of FIELD CROPS*

## Introduction

In 1980, about 2 million hectares (approximately 4.85 million acres) of agronomic crops were planted in North Carolina. Every year potential yield is reduced 5 to 15 percent by insects and their relatives. To help minimize losses, producers should have: 1) an awareness of the insects which attack crops in their locality, and 2) a knowledge of pertinent pest biology to ensure the proper implementation of control practices. To fill these needs, this manual has been designed to present basic information necessary in insect pest identification and pest management decisions.

Accurate identification is important to insect control and essential for application of insect pest management concepts. Scouting methods, equipment selection and application timing all depend upon correct pest identification. To aid in this process, two types of keys are presented in this volume: 1) a general key to adults of economically important insect families and related pests, and 2) field keys to the insect pests of each major crop based on the morphology and damage of the injurious life stages. In addition to the keys, a color plate section and illustrations in individual insect notes are also presented.

Crop advisors or managers will commonly encounter insects that have not been included in this volume. These will include insects of little or no economic significance and beneficial species. Variability in size, color and habits can also lead to confusion concerning the identity of a suspected pest. For these reasons, not all insects detected by fieldmen can be identified by using this book. In these cases, a specialist should be consulted.

### PEST CONTROL

This volume does not provide complete control recommendations. Cultural control suggestions and some currently recognized threshold levels are given where applicable. Since chemical recommendations quickly become obsolete, the reader is referred to the current *North Carolina Agricultural Chemicals Manual* for this type of information.

**Chemical Control**—Although the use of pesticide application schedules is an integral part of the production of crops such as cotton, this type of control strategy is not feasible for most agronomic crops. Unlike high-unit-value crops such as cotton, fruits, or ornamentals, the economics of field crop production often does not justify the preventive use of expensive control chemicals. In these cases, cultural and other controls are of paramount importance in utilizing pesticides efficiently.

Non-chemical control tactics tend to be slow in action and primarily preventive in nature. Once an infestation is in full swing they usually are of little use. On the other hand, cultural practices, the use of resistant varieties, and other methods often prevent or substantially reduce the need for chemical control later in the season. When appropriate, these control measures are also discussed in the control section for each pest in the main body of the text.

**Cultural Control**—Practices such as the use of recommended planting dates, thorough weed control, and proper fertilization lead to the production of a healthy and vigorous crop better able to withstand insect injury. Early or late planting dates can be used with some crops and against some pests to avoid a pest's peak reproductive period. A combination of row spacing and planting date also has potential as a preventive control tactic for insects. Crop rotation, another cultural practice, has been used since prehistoric times as an efficient means of disrupting the development of most host-specific insects.



The insect-controlling properties of various tillage operations have long been realized. Such practices can be effective in one of several ways: 1) by directly destroying or disrupting soil-inhabiting insects, 2) by exposing such insects to unfavorable environmental elements, 3) by burying favorite weedy hosts or surface crop debris, or 4) by making an area unattractive to egg-laying adults. A notable exception to the above generalization concerns the lesser cornstalk borer. This caterpillar is primarily saprophytic under minimum or no-till conditions, but tends to be a crop pest in tilled fields. In most cases, however, tillage helps prevent damaging populations of soil-inhabiting insect pests.

Resistant crop varieties can also prevent economic insect injury in several ways. Some varieties avoid insect injury by lacking characteristics which particular insects prefer, e.g. smoothness or hairiness, a pleasing taste, a distinctive odor, a particular growth habit, etc. Another factor of resistance is the ability to tolerate insect feeding without accompanying yield reduction. Last of all, a resistant plant may possess some biochemical or morphological character which allows it to recover from incurred insect damage.

**Natural and Biological Control**—Although individual growers rarely have the opportunity or the resources to manipulate meteorological or biological factors for insect

control purposes, understanding these factors can facilitate more informed control decisions. For this reason, the general effects of temperature, humidity, rainfall, and drought on the pest population are discussed in the insect notes along with general control practices. Likewise, major predators, parasities, and diseases of many pests are listed. In cases where parasite or disease relationships should be considered before initiating control practices, the telltale signs of such occurrences are explained. As a result, the extent to which these natural and/or biological factors are alleviating or promoting a pest situation can be taken into account when control decisions must be made.

**Cooperative Control Efforts**—Pest control strategies involving the manipulation of parasites and predators most often, but not always, involve the coordinated efforts of government officials and the growers in a particular area. The USDA Animal and Plant Health Inspection Service (APHIS) parasitoid release program for control of the cereal leaf beetle is one such project. Some cooperative control efforts, such as the boll weevil eradication program, do not involve biological control agents.

**Pest Management**—The tools of insect pest management are not new, but the strategy behind the movement is. The methods so far mentioned, in addition to various forms of chemical control, have been in use for at least several hundred years. The new pest management strategy, however, involves consideration and coordination of many of the above tactics to minimize the use of pesticides.

The pest management approach attempts to maintain pest populations below an economically damaging threshold by using a combination of available control tactics. Insect pest management systems usually rely heavily upon variety selection, planting date, optimum crop tolerance, promotion of beneficial organisms, scouting and other insect monitoring, thresholds utilization and judicial pesticide use. This manual may be of help in the area of scouting. In a pest management system, scouting consists of field sampling. Scouts must know the pests involved and recognize their damage. Thresholds cited for many pests in this manual have not been documented by exhaustive research. These thresholds are best estimates for taking control measures.

## SUMMARY

The high cost of labor, equipment, credit, and land, plus the need to maximize yields to feed and clothe the expanding world population, has forced crop producers into monoculture. This form of production is most conducive to the buildup of insect pests. Frequently, natural controls are not capable of maintaining insect pest populations below established economic threshold levels. Therefore, cultural and chemical controls must be used on the damaging population to obtain acceptable yields. Before appropriate control decisions can be made, however, a crop manager must have a fundamental understanding of the pest or pest complex and its relationship to the crop. These are the primary concerns to which this volume is addressed.

## Keying Important Orders and Families

Because insects are divided into families and orders primarily on the basis of their adult characteristics, immature forms are not described in the following key. As a general rule, adult insects differ from immatures by possessing all the following characteristics:

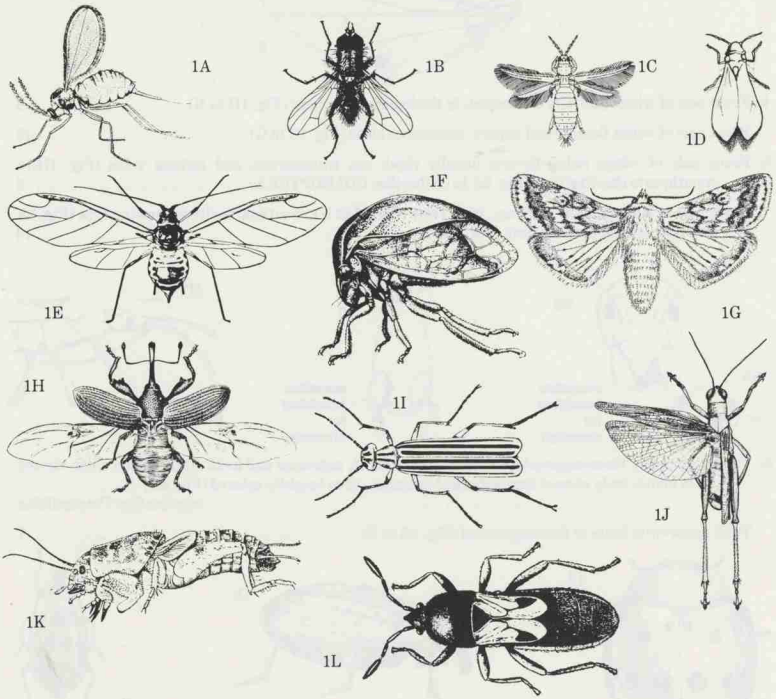
1) three distinct body segments (head, thorax, abdomen),
2) one or two pairs of wings (rarely no wings),
3) three pairs of legs and
4) one pair of antennae.

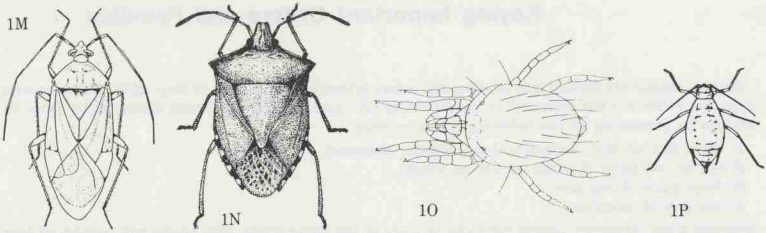
Although some immature insects have one or more of the above traits, only adults will possess all four. Mites (although not insects, included in the following key) will not fit the above criteria. To identify insect nymphs or larvae, it is best to proceed through the field identification keys located at the beginning of each crop section, or the Key to Caterpillars (p. 16).

### KEY TO ADULTS

1. Winged (Fig. 1A to N) ..... 2

   Wingless (Fig. 1 O,P) ..... 26



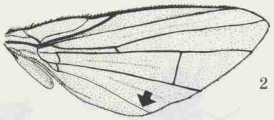



2. One pair of wings (Fig. 1A,B) (flies: DIPTERA) ..... 3

   Two pairs of wings, first pair often modified and covering the second (Fig. 1C to N) ..... 4

3. Long, many-segmented antennae; legs also long (Fig. 1A) ..... midges: Cecidomyiidae

   Short, three-segmented antennae; anal wing vein reaches wing margin (Fig. 2); body usually longer than 3 mm (Fig. 1B) .....root maggot flies: Anthomyiidae

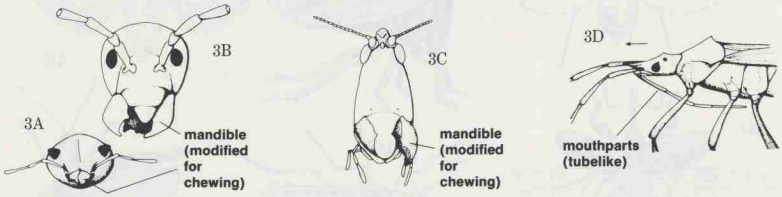



4. Front pair of wings partially or completely thickened or leathery (Fig. 1H to N) ..... 5

   Front pair of wings flexible and papery, sometimes clear (Fig. 1C to G) ..... 18

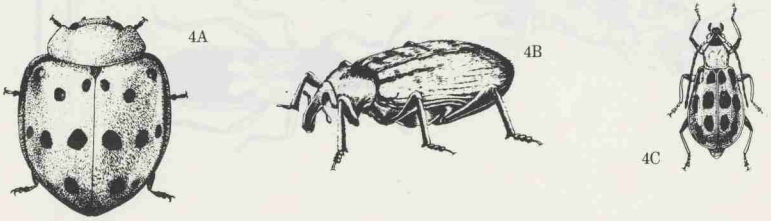
5. Front pair of wings (wing covers) usually rigid, not transparent, and lacking veins (Fig. 1H,I); mouthparts chewing type (Fig. 3A to C) (beetles: COLEOPTERA) ..... 6

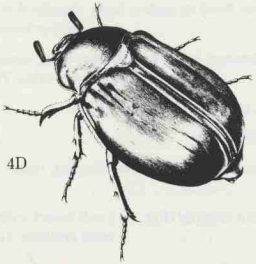
   Front pair of wings usually leathery, with veins (Fig. 1J to N); mouthparts either chewing type (Fig. 3A to C) or piercing-sucking beak (Fig. 3D) ..... 13



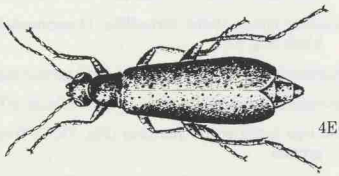

6. Tarsi apparently three-segmented; antennae very short; antennae and head often hidden when viewed from above; body almost hemispherical in shape, often brightly colored (Fig. 4A) ..... ..... lady beetles: Coccinellidae

   Tarsi apparently four- or five-segmented (Fig. 4B to E) ..... 7





4D



4E

7. All tarsi appear four-segmented (Fig. 4B,C) ..... 8

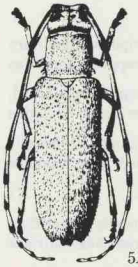
   Not as above ..... 10

8. Head with a well-developed, elongated snout; elbowed antennae located about middle of snout; body size and shape variable (Figs. 1H, 4B) ..... weevils, billbugs: Curculionidae

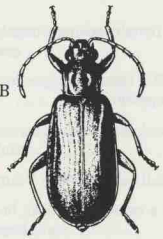
   Not as above ..... 9

9. Long antennae at least one-half the length of the body; elongate body with parallel sides; body length 3 to 75 mm, but usually over 12 mm (Fig. 5A) ..... long-horned beetles: Cerambycidae

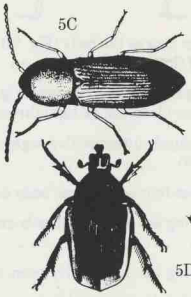
   Antennae usually less than one-half the length of the body; body usually less than 12 mm long; shape and coloration variable (Figs. 4C, 5B) ..... leaf beetles, flea beetles: Chrysomelidae



5A

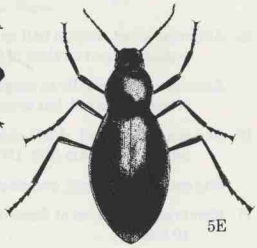


5B



5C

5D



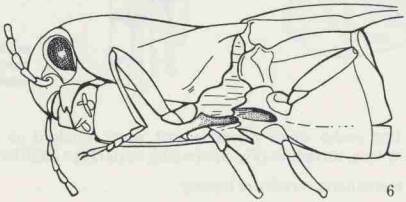
5E

10. Tarsal formula 5-5-5 (Fig. 4D) ..... 11

    Tarsal formula 5-5-4 (Fig. 4E) ..... 12

11. Robust-bodied beetle; oval-elongate in shape and usually over 10 mm long; short 8- or 11-segmented antennae with plate-like segments at the tip which may form a compact ball (Figs. 4D, 5D) ..... June beetles, May beetles: Scarabaeidae

    Elongate beetle 35 mm or less in length, usually 12 to 30 mm long; antennae appear serrated (Fig. 5C); mechanism present by which beetle can right itself when placed on its back by snapping two body segments together thereby propelling itself into the air (Fig. 6) ..... click beetles: Elateridae



6

12. Pronotum, or front part of thorax, narrower than either head or elytra; body usually 3 to 30 mm long; antennae thread-like (Fig. 4E) ..... blister beetles: Meloidae

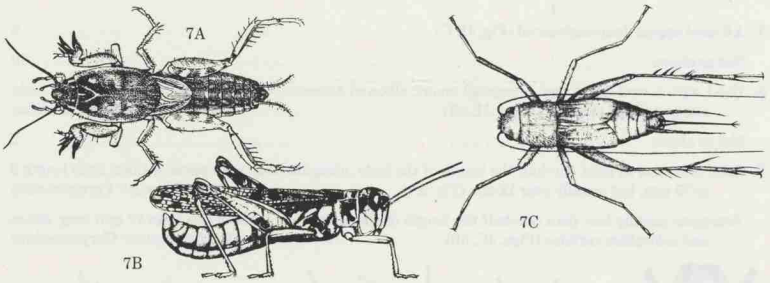
Pronotum not as above; threadlike, 11-segmented antennae; body 2 to 35 mm long, usually brown or black (Fig. 5E). ..... darkling beetles: Tenebrionidae

13. Mouthparts chewing type (Fig. 3A to C) (grasshoppers, crickets: ORTHOPTERA) ..... 14

Mouthparts extended into tube (Fig. 3D) (bugs: HEMIPTERA) ..... 16

14. Hind legs modified for jumping (Fig. 7B,C); front legs not modified for digging; insect found above ground ..... 15

Hind legs not as above; front legs shovellike, modified for digging (Fig. 7A); soil insect with beady eyes ..... mole crickets: Gryllotalpidae




15. Antennae short, seldom half as long as the body (Fig. 7B); female lacking elongate ovipositor; auditory organs present on sides of first abdominal segment ..... grasshoppers: Acrididae

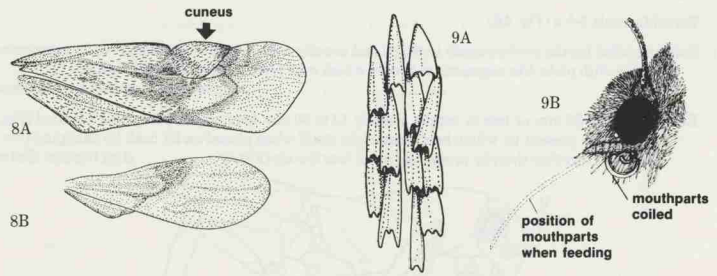
Antennae long, usually as long as the body or longer (Fig. 7C); female's ovipositor elongate, cylindrical, or needle-shaped, but never bladelike; all tarsi three-segmented ..... crickets: Gryllidae

16. Bug generally broad, shield-shaped; antennae five-segmented; large triangular scutellum; body usually longer than 7 mm (Fig. 1N) ..... stink bugs: Pentatomidae

Bug not shield-shaped; antennae four-segmented; body usually shorter than 7 mm ..... 17

17. Membranous portion of forewing has two closed cells and a cuneus (Fig. 8A); body rarely longer than 10 mm ..... plant bugs, lygus bugs: Miridae

Membranous portion of forewing has four to five open, non-parallel veins (Fig. 8B); body usually less than 13 mm long ..... seedbugs, chinch bugs: Lygaeidae

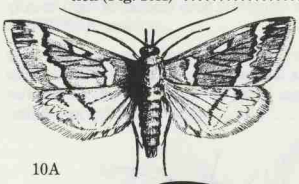



18. Wings covered with tiny scales which resemble dust when smudged on one's finger (Fig. 9A); mouthparts usually long, threadlike (Fig. 9B) (moths, butterflies: LEPIDOPTERA) ..... 19

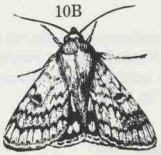
Wings without scales; mouthparts variable or lacking ..... 21

19. Wingspan of 25 mm or more ..... 20

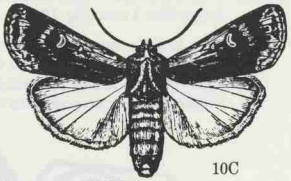
Wingspan 20 mm or less; labial palps large and distinctive, forming a fairly straight snoutlike projection (Fig. 10A) ..... flour moths, grass moths: Pyralidae



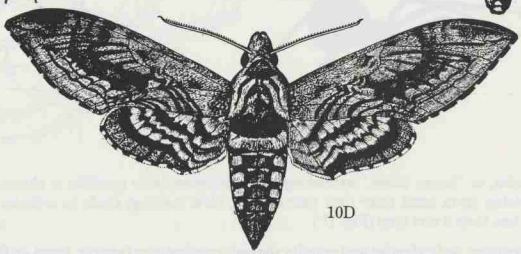
10A



10B



10C



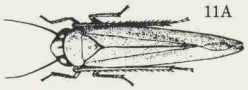
10D

20. Wingspan of 25 to 50 mm; robust-bodied moths, dull in color; threadlike antennae (Fig. 10B,C) ..... cutworm moths: Noctuidae

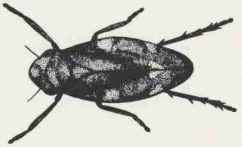
Wingspan larger than 50 mm, more in range of 10 cm; large body tapering anteriorly and posteriorly; hummingbird-like feeding habits (Fig. 10D) ..... sphinx moths: Sphingidae

21. Jumping insects; antennae short and bristlelike; piercing-sucking beak from head near first pair legs (Figs. 1F, 11A,B) (HEMIPTERA) ..... 22

Flying insect, may also run or flutter when disturbed; antennae filiform and threadlike; insect soft-bodied and less than 5 mm long (Fig. 1C to E) ..... 24



11A



11B

22. Large pronotum covers head and extends back over the abdomen (Fig. 1F) ..... treehoppers: Membracidae

Pronotum not as above ..... 23

23. Hind tibiae with one or more rows of small spines (Fig. 11A); bug usually associated with chlorosis of many types of plants ..... leafhoppers: Cicadellidae

Hind tibiae with one or two stout spines and usually series or circle of spines at apex (Fig. 11B); may be found in areas infested with spittle-producing nymphs; ..... spittlebugs: Cercopidae

24. Body with pair of cornicles, or "honey tubes," protruding from abdomen (Fig. 1E,P); slow-moving insect usually found in colonies (HEMIPTERA) ..... aphids: Aphididae

Body without cornicles ..... 25

25. White insect (up to 2 mm) which resembles a tiny moth; often found on underside of plant leaves; flutters when disturbed, often flying in a spiral (Fig. 1D) (HEMIPTERA) ..... whiteflies: Aleyrodidae

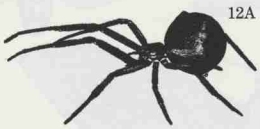
Yellow, orange, brown, or black insect (up to 2 mm) which is slender and spindle-shaped with narrow, fringed wings (Fig. 1C); often found in buds of flowers, foliage, even corms; runs or flies when disturbed ..... thrips: THYSANOPTERA

26. Four pairs of legs; only two major body segments ..... 27

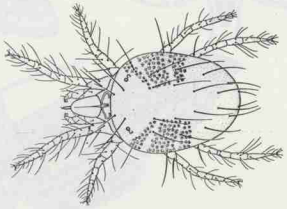
Three pairs of legs ..... 28

27. Abdomen connected to cephalothorax by a narrow, petiolelike structure; body (including legs) usually larger than 1 mm (Fig. 12A) ..... spiders: ARANEIDA

Abdomen broadly connected to cephalothorax, no constriction between these two body segments; body minute in size, usually about 0.5 mm long, but rarely as long as 1 mm (mites: ACARINA). The following characters are visible only under a microscope: Setae on tarsus 1 erect; no anterior tubercule on the propodosoma (Fig. 12B) ..... spider mites: Tetranychidae.



12A



12B

28. Pair of cornicles, or "honey tubes," extending from abdomen; body pearlike in shape; piercing-sucking beak arising from head near first pair of legs; slow moving; feeds in colonies on foliage; body usually less than 3 mm long (Fig. 1P) ..... aphids: Aphididae

No pair of cornicles; body slender and spindle shaped; rasping mouthparts; feeds on flowers, foliage, or corms; usually orange, black, or brown; body less than 2 mm long ..... common thrips: Thripidae

# Important Orders and Families of Agricultural Pests

Over one million insect species inhabit the world. In spite of this impressive diversity, far less than 0.1 percent of these species pose a threat to agronomic crops in North Carolina. Consequently, these economically important species fall into a limited number of orders and families.

The majority of these orders and families are described in the following pages. However, because this publication is designed to help identify crop *pests*, many insects found in the field will not fit the descriptions below. Descriptions and keys including harmless and beneficial insects as well as pests would be very informative but also tediously long and minutely detailed. Although the following information is general, it does give an overall perspective of the types of insect and mite pests most likely to be encountered.

## GENERAL DESCRIPTION OF ORDERS AND FAMILIES

### COLEOPTERA (beetles, weevils)

Beetles undergo complete metamorphosis; that is, they pass through four life stages—egg, larva, pupa, adult—during development. The larval stage is often a grub, wireworm, or stem borer. Adults have chewing mouthparts, a uniformly leathery or rigid, veinless pair of forewings, and a membranous pair of hind wings.

**Cerambycidae (long-horned beetles).** These beetles are generally elongate and cylindrical in shape, and often brightly colored. Their distinctive antennae extend over one-half the length of the body, sometimes even surpassing the body length. Adults typically feed on flowers; the larvae often bore into stems of herbaceous plants or trees. The soybean stem borer is practically the only agronomic pest in this family, although some species are a threat to fruit and ornamental trees.

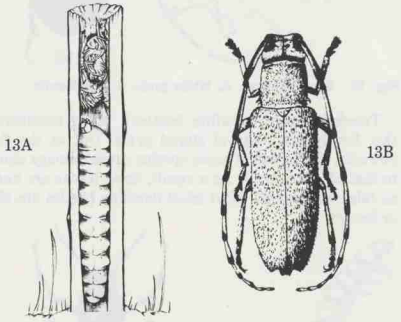



**Fig. 13 Cerambycidae—Soybean stem borer. A, Larva. B, Adult.**

**Chrysomelidae (leaf beetles).** Oval to oval-elongate in shape, chrysomelid beetles are usually less than 13 mm long. Their color and shape is so variable, however, that they may be difficult to identify consistently. Since both the larval and adult chrysomelids are phytophagous, a large number of economically significant species occur in this family. Adults feed on flowers and foliage; many larval forms attack plant roots. This family encompasses the corn rootworms, cereal leaf beetle, bean leaf beetle, and flea beetles.

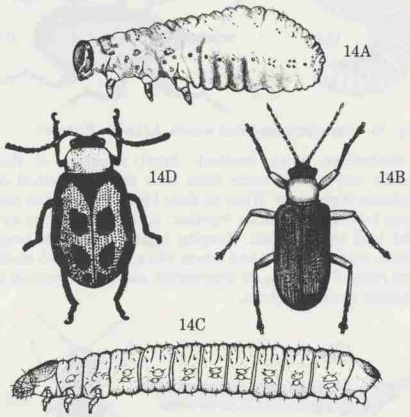
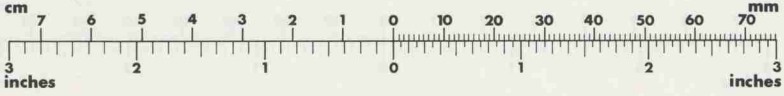



**Fig. 14 Chrysomelidae. A-B, Cereal leaf beetle larva and adult. C-D, Bean leaf beetle larva and adult.**

**Coccinellidae (lady beetles).** Characteristically, lady beetles have round or oval, strongly convex bodies with bright contrasting colors. Many beneficial predatory species, in addition to a limited number of phytophagous species, make up this family. The Mexican bean beetle, whose adult and larva both consume crop foliage, is one of the more damaging members of this family.

**Curculionidae (snout beetles, weevils, billbugs).** The largest of the beetle families, Curculionidae is comprised almost entirely of plant feeders. They are easily recognized by their noticeably elongated snout. Although the snout appears noselike, the beetles' mouthparts are located at its tip and the elbowed antennae are borne on its midsection.





When disturbed, weevils and billbugs often tuck in their legs and antennae and fall to the ground where they resemble dirt clods. The boll weevil may well be the most infamous member of this family.

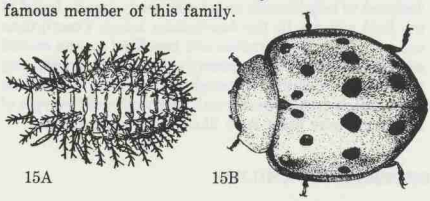



**Fig. 15 Coccinellidae—Mexican bean beetle. A, Larva. B, Adult.**

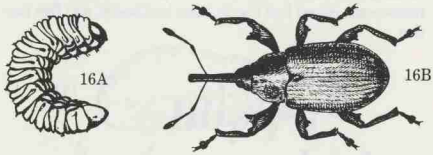



**Fig. 16 Curculionidae—Boll weevil. A, Larva. B, Adult.**

**Elateridae (click beetles).** Adult members of this family derive their name from their peculiar method of righting themselves. When on their back, these beetles can snap two body segments together, spring up into the air, and land on their feet. Ranging from 3 to 45 mm long, adults inhabit flowers and leaves while larvae attack seeds and roots. The larvae, or wireworms, cause more economic damage than the adults.

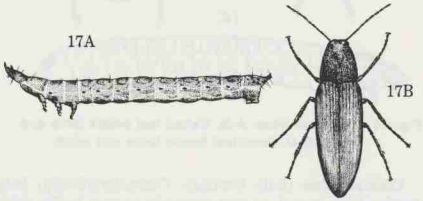



**Fig. 17 Elateridae. A, Wireworm. B, Click beetle.**

**Meloidae (blister beetles).** These narrow, elongate beetles are common, but relatively innocuous, foliage and flower feeders. The adults produce cantharidin in quantities which may cause blisters to form on sensitive human skin. The larvae of many species are beneficial in that they feed on grasshopper eggs. Several blister beetle species are occasionally pests of soybeans.

**Scarabaeidae (scarab beetles).** Like the coccinellids, scarab beetles are oval or elongate and convex. Scarabs, however, are larger with heavier bodies. Some members feed on decaying organic matter while others prefer living plants. Both larvae and adults cause plant damage. Commonly known as white grubs, the larvae often abound among the roots of grasses. Adults of plant-feeding species are primarily attracted to ornamental and fruit trees as well as shrubs and flowers. A notable exception is the Japanese beetle which sporadically damages corn and soybeans.

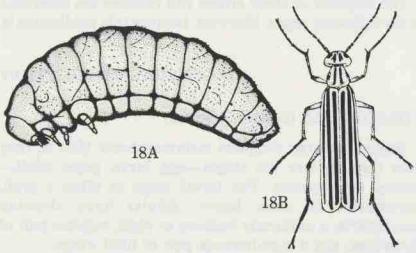



**Fig. 18 Meloidae. A, Blister beetle larva. B, Threestriped blister beetle.**

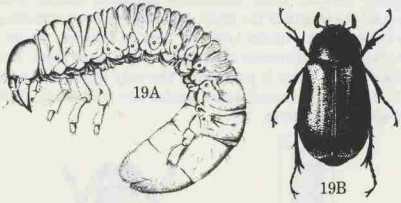



**Fig. 19 Scarabaeidae. A, White grub. B, May beetle.**

**Tenebrionidae (darkling beetles).** Many members of this family are pests of stored grain. Out in the field, however, the larvae of some species cause damage similar to that of wireworms. As a result, these larvae are known as false wireworms. Most adult darkling beetles are black or brown.

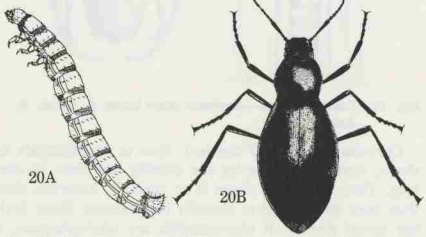
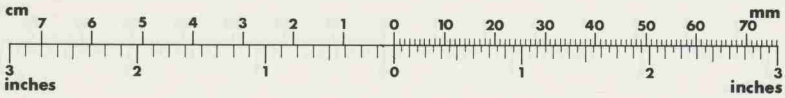



**Fig. 20 Tenebrionidae. A, False wireworm. B, Darkling beetle.**





## DIPTERA (flies)

Like beetles, flies also undergo complete metamorphosis. The larvae, however, are commonly referred to as maggots. The fact that flies have only a single pair of wings distinguishes them from most other flying insects. A pair of small knoblike appendages, known as halters, is all that remains of what may have been a hind pair of wings. Adults have either piercing-sucking or sponging mouthparts, but larvae are endowed with chewing or rasping mouthparts.

**Anthomyiidae (root maggot flies).** In this family, the larva is the injurious life stage. Although most larvae are root- and seed-destroying maggots, some are leafminers. The seedcorn maggot is a common pest belonging to this family. To distinguish the adults from similar flies, wing venation must be closely examined (see couplet 3 of Key to Adults).

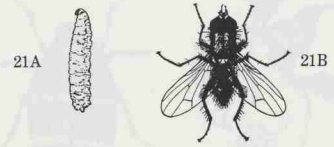



**Fig. 21 Anthomyiidae—Seedcorn maggot. A, Larva. B, Adult.**

**Cecidomyiidae (midges).** Although most injurious members of this family are gall formers, the agronomic pest species do not cause this type of damage. The adult midges are innocuous, gnatlike insects; the larvae feed in seedheads or between the leaf sheath and stem. Adults can often be identified by their long legs and antennae. The Hessian fly and the sorghum midge are notorious members of this family.

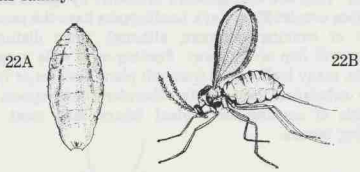



**Fig. 22 Cecidomyiidae—Sorghum midge. A, Larva. B, Adult.**

## HEMIPTERA/suborder HETEROPTERA (true bugs)

True bugs undergo simple metamorphosis developing through only three life stages: egg, nymph, and adult. They feed by means of piercing-sucking mouthparts (a stylet-like beak) which originate at the front of the head. A triangular area, known as the scutellum, is evident on the middle area of the thorax. True bugs have two pairs of wings or none. If wings are present, the front pair is partially thickened or leathery, the second pair membranous.

**Lygaeidae (seed bugs, chinch bugs).** There is great variability among the members of this family. Some are phytophagous, others predaceous. Wing venation (as described in the Key) distinguishes members of this family from other Heteropteran families. The chinch bug is its best known member.

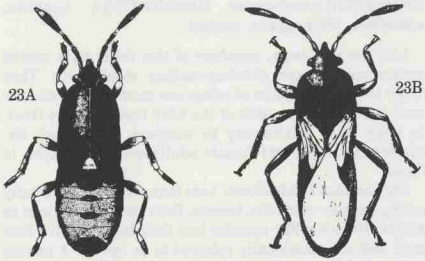



**Fig. 23 Lygaeidae—Chinch bug. A, Nymph. B, Adult.**

**Miridae (plant bugs, lygus bugs).** Although referred to as plant bugs, some mirid bugs are predaceous. True to the family name, however, most members do extract sap from plants. Like lygaeid bugs, wing characteristics also distinguish mirids from other bug families. The tarnished plant bug and the suckfly belong to this family.

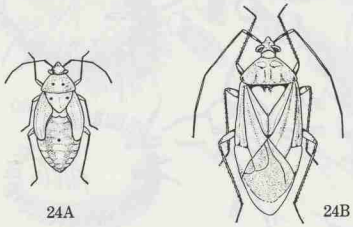



**Fig. 24 Miridae—Plant bug. A, Nymph. B, Adult.**

**Pentatomidae (stink bugs).** Stink bugs receive their name as a result of the disagreeable odor they are capable of producing. Their family name Pentatomidae refers to their five-segmented antennae. Although both these features are useful identifying characteristics, these bugs are more quickly recognized by their shieldlike shape. As with the previous two families, both predaceous and phytophagous insects belong to this family. However, most species, including the green, brown, and Southern green stink bugs, damage seed crops, particularly soybeans.

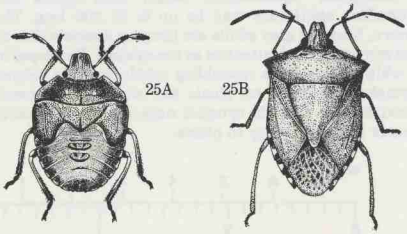



**Fig. 25 Pentatomiidae—Brown stink bug. A, Nymph. B, Adult.**

**HEMIPTERA/suborder HOMOPTERA (aphids, whiteflies, leafhoppers, scales).**

Like the true bugs, members of this order have simple metamorphosis and piercing-sucking mouthparts. They differ in that both pairs of wings are membranous and the beak arises from the back of the head instead of the front. In some cases, adults may be wingless. Under such circumstances, male and female adults are often unlike in form.

**Aleyrodidae (whiteflies).** Less than 3 mm long, whitefly adults are tiny moth-like insects. Both sexes have wings as adults. The scale-like nymphs lose their legs after the first molt and are occasionally referred to as larvae. A resting stage, known as the pupa, precedes adult emergence. Whiteflies regain their legs as adults. These insects do undergo gradual or simple metamorphosis even though names assigned to the various life stages are analogous to those of complete metamorphosis.

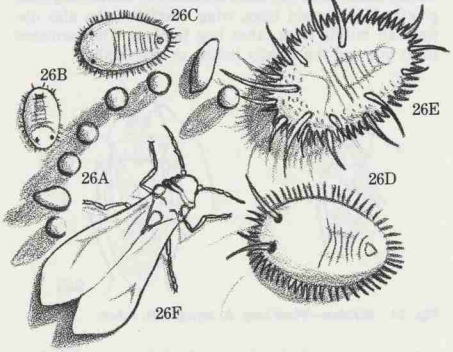



**Fig. 26 Aleyrodidae—Whitefly life stages. A, Eggs. B-D, Nymphs. E, Pupa. F, Adult.**

**Aphididae (aphids).** Another family of tiny insects, the Aphididae contains winged and wingless forms. But whether winged or not, all aphids are basically pear-shaped with long antennae and a pair of tailpipe-like structures known as cornicles. Color varies greatly among species. Wingless adult females produce young without mating and, therefore, large populations often develop rapidly. All aphids, both adults and nymphs, extract plant sap.

**Cercopidae (spittlebugs).** Larger than aphids and whiteflies, spittlebugs may be up to 13 mm long. The brown, black, or gray adults are jumping insects which do not attract as much attention as the nymphs. Enveloped in a white, frothy mass resembling spittle, brightly colored nymphs suck sap from plants and sometimes transmit plant diseases. Only the nymphal stage of this insect family causes economic injury to plants.

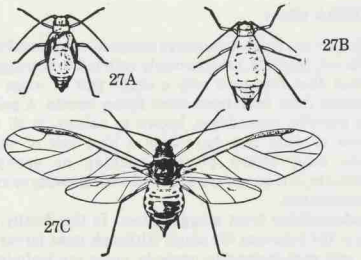



**Fig. 27 Aphididae—Green peach aphid. A, Nymph. B, Wingless adult. C, Winged adult.**

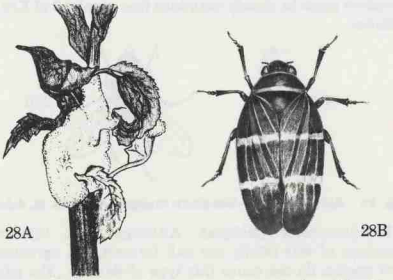



**Fig. 28 Cercopidae—Spittlebug. A, Nymphs in spittle. B, Adult.**

**Cicadellidae (leafhoppers).** Leafhoppers are fairly similar in size and appearance to the above spittlebug family. They are distinguished primarily by spines on the legs (see couplet 23 in Key). Leafhoppers have the peculiar habit of running sideways, although when disturbed, adults will hop or fly away. Feeding on a wide range of plants, many leafhoppers transmit plant diseases or inject toxic substances into plants. Therefore, leafhoppers are capable of causing more plant injury than most sap-sucking insects.

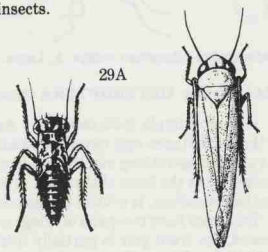
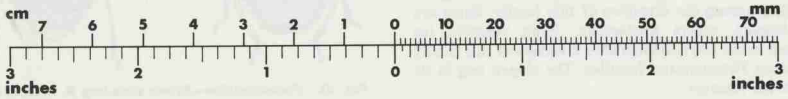



**Fig. 29 Cicadellidae—Potato leafhopper. A, Nymph. B, Adult.**



**Membracidae (treehoppers).** Treehoppers are 10 to 12 mm long, and characteristically appear horned or "humpbacked" because of their enlarged pronotum. Unlike spittlebugs and leafhoppers, treehoppers cause damage primarily by inserting eggs into plants rather than by extracting plant juices. The threecornered alfalfa hopper is one of the few treehoppers that damages agronomic crops.

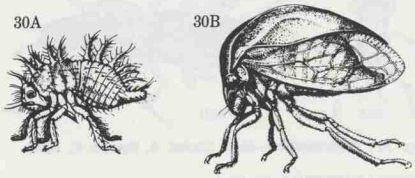



**Fig. 30 Membracidae—Threecornered alfalfa hopper. A, Nymph. B, Adult.**

## LEPIDOPTERA (moths, butterflies)

Butterflies and moths undergo complete metamorphosis: egg, larva, pupa, and adult. The larvae, commonly known as caterpillars, have chewing mouthparts. Adults have long, coiled, threadlike mouthparts which are used for siphoning nectar. Their two pairs of membranous wings are covered with minute scales which rub off easily. Within this order, the larva is the economically damaging life stage.

**Noctuidae (cutworm moths).** The Noctuidae is a large family of much economic importance to agriculture. Among the larvae of this family are the well known armyworms, cutworms, bollworms, and loopers, to mention a few. Primarily foliage feeders, many species also consume stems and grains or bore into stalks, ears, or bolls. The heavy-bodied moths are usually drab in color and have wingspans in excess of 20 mm.

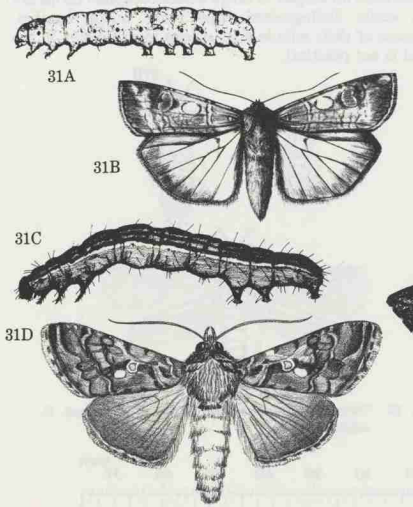



**Fig. 31 Noctuidae. A-B, Variegated cutworm larva and adult. C-D, Cabbage looper larva and adult.**

**Pyralidae (snout and grass moths).** True to their name, the small, delicate moths of this family have a prominent snout (labial palps) and are commonly found in grassy areas. The larvae vary from stalk borers to foliage feeders. Among the agriculturally destructive members of the family are the sod webworms, the lesser cornstalk borer, and the European corn borer.

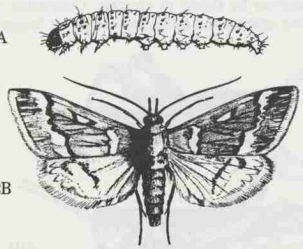



**Fig. 32 Pyralidae—European corn borer. A, Larva. B, Moth.**

**Sphingidae (sphinx moths).** These medium- to large-bodied moths resemble hummingbirds in their hovering feeding habit. The larvae of sphinx moths almost always have a spinelike projection on their eighth abdominal segment and, therefore, are commonly known as hornworms. These voracious foliage feeders are a threat to many solanaceous crops.



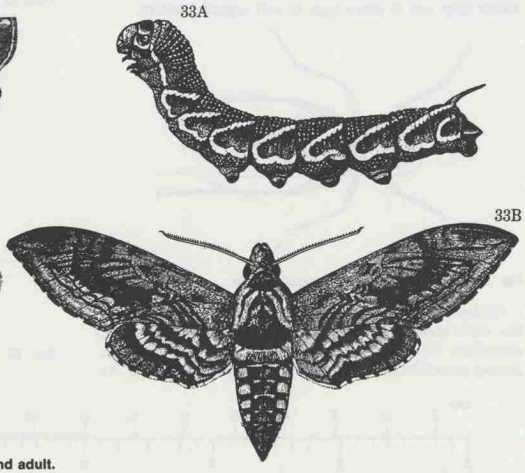



**Fig. 33 Sphingidae—Tomato hornworm. A, Larva. B, Moth.**

## ORTHOPTERA (grasshoppers and crickets)

Grasshoppers and crickets develop gradually, the young bearing much resemblance to the adults. All life stages have chewing mouthparts. Most adults have two pairs of wings: the first thickened and leathery, the second membranous. This order contains a limited number of agricultural pests.

**Acrididae (short-horned grasshoppers).** This family is among the most destructive of all Orthoptera. Concentrating particularly on grassy plants, nymphs and adults are voracious foliage feeders. Although equipped with characteristically enlarged "jumping legs," some grasshoppers also migrate by flying in swarms. Coloration varies widely among species and antennae are never longer than the body.

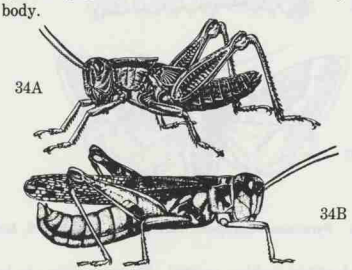



**Fig. 34 Acrididae—Grasshopper. A, Nymph. B, Adult.**

**Gryllidae (crickets).** Crickets generally are not considered serious economic pests. Some species, however, can damage pastures significantly by consuming large quantities of grass. Easily overlooked, members of this group are usually brown or black, with antennae at least as long as their body. Female adults have a needlelike ovipositor which they use to place eggs in soft organic matter.



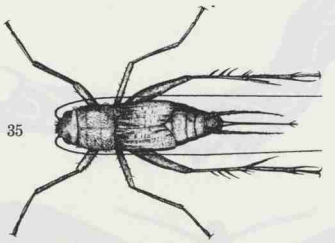



**Fig. 35 Gryllidae—Striped ground cricket.**

**Gryllotalpidae (mole crickets).** Mole crickets are among the most striking and unique of all insects. Their stout, shovellike forelegs and large, beady eyes give them an almost crawfishlike appearance. Although they feed on the roots of grasses, they do not usually directly damage field crops. As these insects tunnel through the soil, they destroy roots and cause the soil to dry out. As a result, crops on infested soils wilt from lack of water.

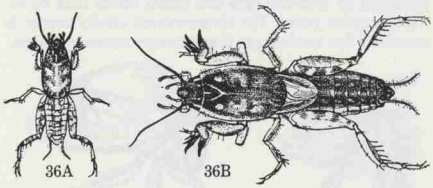



**Fig. 36 Gryllotalpidae—Mole cricket. A, Nymph. B, Adult.**

## THYSANOPTERA (thrips)

Rarely as large as 5 mm, North American thrips are minute insects. Primarily phytophagous, they rasp plant tissues and feed on the released juices. Metamorphosis in thrips is usually considered simple or gradual, although in some ways resembling complete metamorphosis. The first two wingless instars are known as larvae. During the next one or two instars (depending on the species) as wings become apparent, thrips are called prepupae. A pupal resting stage precedes adult emergence. Adults are generally characterized by having two pairs of slender wings with hairlike fringe. Wingless adults do exist, but occur primarily during the winter.

**Thripidae (common thrips).** The largest thrips family, Thripidae, also contains the highest number of economically important thrips species. Bulbs, leaves, and flowers are all subject to thrips attack. Common thrips are not easily distinguished from other thrips families. Because of their minute size, species identification in the field is not practical.

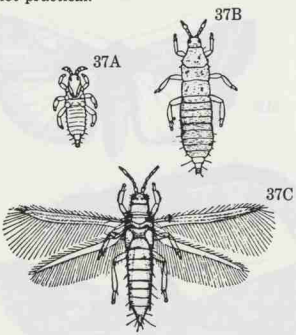
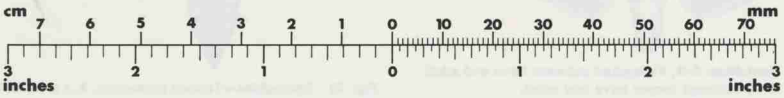



**Fig. 37 Thripidae—Onion thrips. A, Larva. B, Nymph. C, Adult.**



## ACARINA (mites)

Mites are very tiny arthropods closely related to insects. Some are barely visible with the naked eye; others are microscopic. Their size and frequent similarity in shape and color make it difficult to distinguish between species. Not all mites found on field crops cause damage to plants. Some are predaceous and help control the harmful mite species. In this respect it is useful to know which species are present. In most states, the agricultural extension service offers a pest identification service or reference to one. In North Carolina, the majority of agronomic mite pests fall into the family Tetranychidae in the suborder Prostigmata.

**Tetranychidae (spider mites).** This mite family contains a large number of pest species. The twospotted spider mite, carmine spider mite, and Banks grass mite are among the most common. Some members of this family spin silken webs over plant foliage.

38

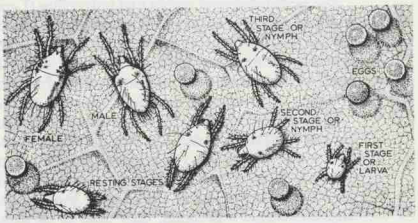
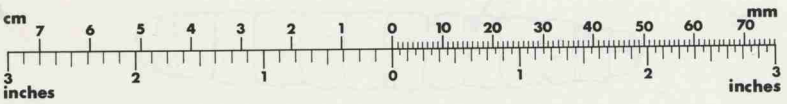



**Fig. 38 Life stages of twospotted spider mite.**

15



# Keying Caterpillars Found in Field Crops

The larval stages of moths and butterflies (Lepidoptera) are called caterpillars. Larvae of the sawflies, a group of wasps, are also called caterpillars, but none are known to be pests of field crops in North Carolina. Larvae of other insects are called maggots, grubs, worms, or just larvae. Lepidopterous larvae may be separated from other kinds of larvae in the following key. There is no convenient way to key out the relatively few species of pest caterpillars from the much larger number of nonpest species except by the presence or absence of significant damage to the crops on which they occur.

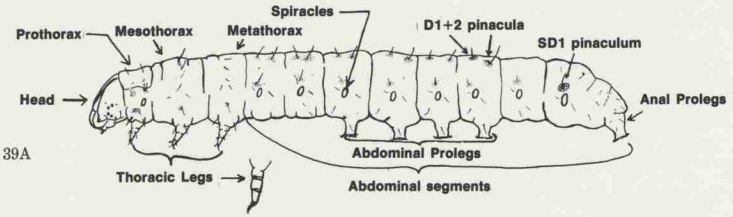
This key will separate the more common pests in North Carolina. If a caterpillar is not numerous or does not cause significant damage, it is not likely to be in this key. If, after examining several specimens, caterpillars will not key out, you may want to send them to a taxonomist for identification. In many cases, caterpillars feeding only on weeds in or around the field need not be identified. However, any large population of defoliating caterpillars or stalk borers should be observed regularly until their development is complete. If they do become a problem, they need to be identified so that a control tactic can be selected.

Certain terms and diagnostic features of caterpillar anatomy must be learned to use this key. These terms and features are labeled on illustrations accompanying the key or defined in the glossary at the end of this text. It is often impossible to identify caterpillars on the basis of color alone because of variability within species and similarity between them. The most reliable characteristics may be too difficult to see with a hand lens or on a live, squirming specimen. Therefore, this key relies upon body features, behavior, hosts and injury symptoms as well as color and pattern. To use this key most effectively, you need a 10x hand lens and a pocket knife.

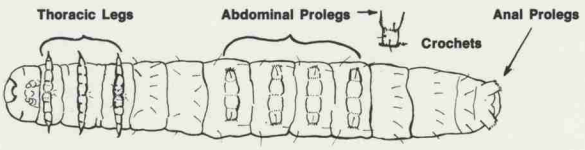
## KEY TO CATERPILLARS

1. Larva with three pairs of thoracic legs, each leg bearing a short sharp claw; one to four pairs of abdominal prolegs and one pair of anal prolegs, each proleg bearing many crochets (except sad-

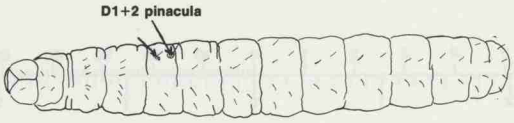
dleback caterpillar, see couplet 2) (Fig. 39A,B,C) ..... 2




39A




39B




39C

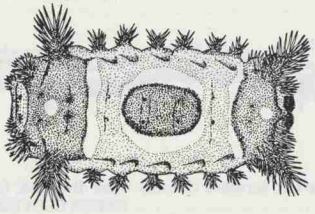
Larva with or without thoracic legs, abdominal prolegs usually absent; if abdominal prolegs present (sawflies), then there are five to seven pairs and they lack crochets (Fig. 40) ....OTHER INSECTS

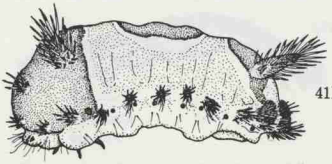
40

2. Larva lacking prolegs but has a pair of fleshy, spine-covered lobes at each end of body; back green and purple with a central spot (Fig. 41A,B) .....SADDLEBACK CATERPILLAR

Has distinct prolegs; coloration different ..... 3

41A



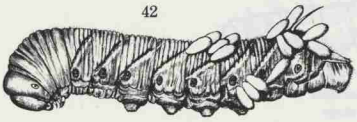


41B

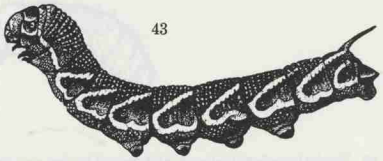
3. Larva with single, curved horn (Figs. 42, 43) sometimes to 89 mm (about 3½ inches) long ..... 4

Larva without horn; usually less than 51 mm (about 2 inches) long ..... 5

42



43



4. Horn reddish; a single, diagonal, pale line on side of each abdominal segment (Fig. 42) .....
.....TOBACCO HORNWORM

Horn bluish or greenish; two pale lines on side of each abdominal segment, forming a V-shaped mark (Fig. 43) .....TOMATO HORNWORM

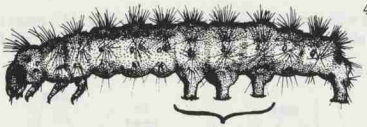
5. Larva distinctly fuzzy, with long hairs ..... 6

Larva apparently hairless, with 12 or fewer fine hairs per side of each body segment ..... 7

6. Has three pairs of abdominal prolegs; body small, 13 mm (½ inch) or less in length; in sorghum heads (Fig. 44) .....SORGHUM WEBWORM

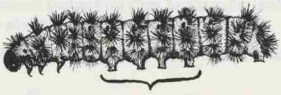
Has four pairs of abdominal prolegs; body larger, to 39 mm (1½ inches) or more (Fig. 45) .....
.....SALTMARSH CATERPILLAR

44



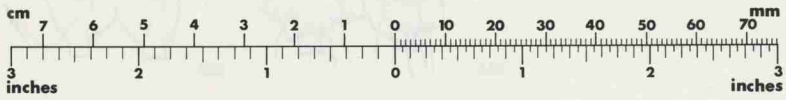
Abdominal Prolegs

45

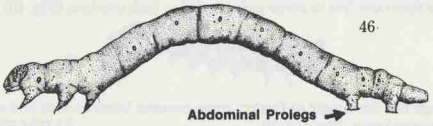


Abdominal Prolegs

7. Has one pair of abdominal prolegs (Fig. 46) ..... INCHWORMS (SPANWORMS, GEOMETERS)



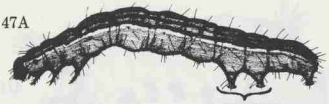
Has two or more pairs of abdominal prolegs ..... 8



46

8. Has two pairs of abdominal prolegs (Fig. 47A,B) .....CABBAGE LOOPER and SOYBEAN LOOPER

Has three or more pairs of abdominal prolegs ..... 9

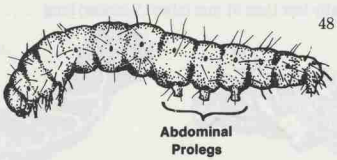


47A


47B

9. Has three pairs of abdominal prolegs; uniformly green, thrashes violently when disturbed; found on soybeans and other legumes (Fig. 48) ..... GREEN CLOVERWORM

Has four pairs of abdominal prolegs ..... 10

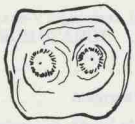


48



10. Hooks (crochets) on each abdominal proleg arranged in a circle (Fig. 49A) ..... 11

Hooks of each abdominal proleg arranged in a straight or curved row (Fig. 49B) ..... 14


49A


49B

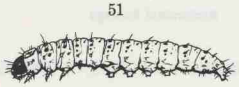

50

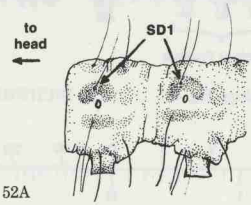
11. Body color greenish with reddish or brownish striping and cross banding; body 13 mm (½ inch) or less in length (Fig. 50); larva usually in silk tube in soil, tube attached to plant ..... LESSER CORNSTALK BORER

Not as above ..... 12

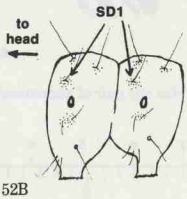
12. Dorsal pinacula of each abdominal segment with centers paler than margins (Fig. 51); mass of frass and silk dangling from entrance hole in stalk ..... EUROPEAN CORN BORER

Dorsal pinacula uniformly colored; frass not as above ..... 13


51



52A



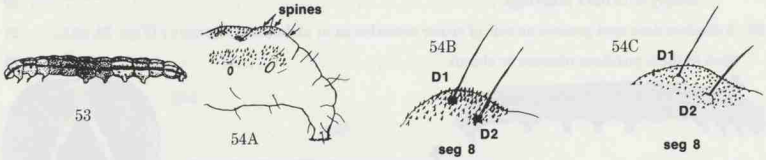
52B

13. Larva in soil on roots; body 19 mm (¾ inch) long or less; SD1 pinaculum on each abdominal segment large, partly surrounding spiracle (Fig. 52A) .....CORN ROOT WEBWORM

Larva in stalk; body up to 32 mm (1¼ inches) long; SD1 pinaculum small (Fig. 52B) ..... ..... SOUTHERN CORNSTALK BORER

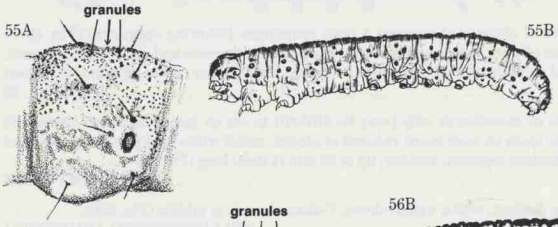
14. Body longitudinally striped black and white; abdominal segments one to four uniformly blackish (except a middorsal line); head orange with black stripe on side; in stalks (Fig. 53) ... STALK BORER

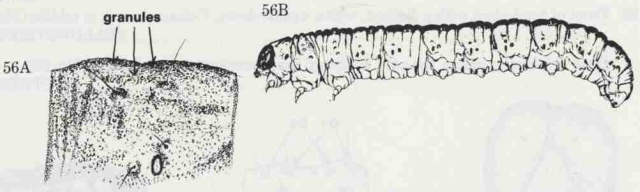
Not as above .....15




15. Skin bearing many small, sharp, hairlike spines (Fig. 54 A to C) .....16

Skin either smooth or bearing pebbly or low, conical granules (Fig. 55A,B; Fig. 56A,B) .....17




16. Spines relatively longer and extending onto pinacula D1 and D2 on abdominal segment 8 (Fig. 54B) ... .....TOBACCO BUDWORM

Spines shorter, surrounding but not occurring on pinacula D1 and D2 of abdominal segment 8 (Fig. 54C) .....CORN EARWORM, TOMATO FRUITWORM, COTTON BOLLWORM

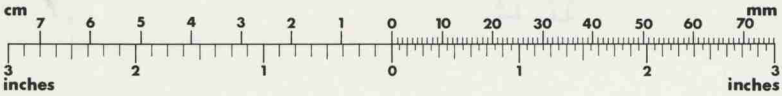
17. Skin bearing pebbly or conical irregular granules (Figs. 55A, 56A) .....18

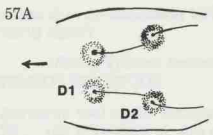
Skin smooth .....19

18. Many skin granules elevated as blunt cones that are as high as wide (Fig. 55A, B) ..... ..... GRANULATE CUTWORM

All granules low, like rounded pebbles (Fig. 56A, B) .....BLACK CUTWORM

19. Head and body hairs (setae) long, dark and conspicuous, with setae D1 and D2 of each abdominal segment longer than the distance between their bases (Fig. 57A); head without dark markings (Fig. 57B); thrashes violently when disturbed; rarely seen before mid-August ..... ..... VELVETBEAN CATERPILLAR



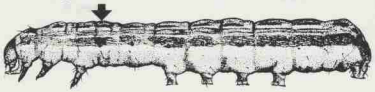


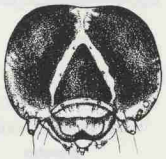


Setae shorter , less conspicuous, setae D1 and D2 shorter than the distance between their bases; head usually with dark markings ..... 20

20. A distinct dark spot present on side of either mesothorax or abdominal segment 1 (Figs. 58, 59A) ... 21

Spot in these positions obscure or absent. ..... 23

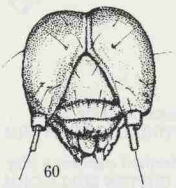

21. Dark spot present on side of abdominal segment 1 (and sometimes following segments) (Fig. 59A); usually bearing a pair of dark, triangular spots on back of each thoracic and abdominal segment; no white spot behind spiracle on each abdominal segment; body larger, up to 39 mm (1½ inches) long ..... 22

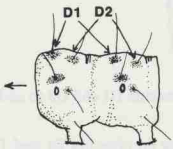
Dark spot present on side of mesothorax only [may be difficult to see on larvae less than 13 mm (½ inch) long], triangular spots on back much reduced or absent; small white spot present just behind spiracle on each abdominal segment; smaller, up to 25 mm (1 inch) long (Fig. 58) ..... BEET ARMYWORM

22. Front of head black with a distinct, white, upside-down, V-shaped mark in middle (Fig. 59B). ..... YELLOWSTRIPED ARMYWORM

20

Head uniformly orange, the pale, V-shaped mark present but not distinct (Fig. 60) ..... SOUTHERN ARMYWORM

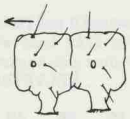




23. Pinacula D1 and D2 distinct, forming two pairs of dark spots on each abdominal segment (Fig. 61A); head slightly flattened in front; body of uniform diameter throughout; usually occurs midsummer to fall, attacking many crops (Fig. 61B) ..... FALL ARMYWORM

Pinacula D1 and D2 absent (Fig. 62A); head more rounded, appearing slightly swollen; body widest at middle, tapering toward each end; usually occurs spring to early summer, attacking grasses and grains (Fig. 62B). ..... ARMYWORM




## General References


Blatchley, W.S. 1910. An illustrated descriptive catalogue of the Coleoptera or beetles known to occur in Indiana. Nature Publ. Co., Indianapolis, Ind. 1386 pp.

Brimley, C.S. 1938. The insects of North Carolina. North Carolina Dep. Agr., Raleigh, N.C. 560 pp.

Crumb, S.E. 1956. The larvae of the Phalaenidae. U.S. Dep. Agr. Tech. Bull. 1135. 356 pp.

Dietrich, H. 1945. The Elateridae of New York state. New York Agr. Exp. Sta. (Cornell) Mem. 269. 79 pp.

Dillon, E.S. and L.S. Dillon. 1961. A manual of common beetles of eastern North America. Row, Peterson & Co., Evanston, Ill. 884 pp.

Edwards, J.G. 1949. Coleoptera or beetles east of the Great Plains. Edwards Brothers, Inc., Ann Arbor, Mich. 181 pp.

Essig, E.O. 1958. Insects and mites of western North America. Macmillan Co., New York. 1050 pp.

Forbes, W.T.M. 1954. Lepidoptera of New York and neighboring states, part III: Noctuidae. New York Agr. Exp. Sta. (Cornell) Mem. 329. 433 pp.

Gates, D.E. and L.L. Peters. 1962. Insects in Kansas. Jean M. Neibarger, Topeka, Kansas. 307 pp.

Hawkins, J.H. 1936. The bionomics and control of wireworms in Maine. Maine Agr. Exp. Sta. Bull. 381. 146 pp.

Hering, E.M. 1951. Biology of the leaf miners. Dr. W. Junk B.V. Publ., The Hague. 420 pp.

Jeppson, L.R., H.H. Keifer, and E.W. Baker. 1975. Mites injurious to economic plants. Univ. of California Press, Berkeley. 614 pp.

Jewett, H.H. 1946. Identification of some larval Elateridae found in Kentucky. Kentucky Agr. Exp. Sta. Bull. 489. 40 pp.

Metcalf, C.L., W.P. Flint, and R.L. Metcalf. 1962. Destructive and useful insects—their habits and control. McGraw-Hill Book Co., New York. 1087 pp.

Peairs, L.M. and R.H. Davidson. 1966. Insect pests of farm, garden, and orchard. John Wiley & Sons, Inc., New York. 675 pp.

Peterson, A. 1962. Larvae of insects, part I: Lepidoptera and plant-infesting Hymenoptera, 4th ed. Edwards Brothers, Inc., Ann Arbor, Mich. 315 pp.

Peterson, A. 1960. Larvae of insects, part II: Coleoptera, Diptera, Neuroptera, Siphonaptera, Mecoptera, Trichoptera, 4th ed. Edwards Brothers, Inc., Ann Arbor, Mich. 416 pp.

Pfadt, R.E. 1971. Fundamentals of applied entomology. Macmillan Publ. Co., New York. 693 pp.

Spencer, K.A. 1973. Agromyzidae (Diptera) of economic importance. Dr. W. Junk B.V. Publ., The Hague. 418 pp.

Swan, L.A. and C.S. Papp. 1972. The common insects of North America. Harper & Row, New York. 750 pp.

Thomas, C.A. 1940. The biology and control of wireworms: review of the literature. Pennsylvania Agr. Exp. Sta. Bull. 392. 90 pp.

Thomas, C.A. 1941. The Elateridae of Pennsylvania. New York Entomol. Soc. J. 49: 233-63.

Tietz, H.M. 1951. The Lepidoptera of Pennsylvania. Pennsylvania Agr. Exp. Sta. Manual. 194 pp.

Tietz, H.M. 1972. An index to the described life histories, early stages, and hosts of the Macrolepidoptera of the continental United States and Canada, 2 vols. Allyn Museum of Entomology, Sarasota, Fla. 1041 pp.

Torre-Bueno, J.R. de la. 1973. A glossary of entomology. New York Entomol. Soc., New York. 336 + 36 pp.

U.S., Department of Agriculture. 1952. Insects, Yearbook of Agriculture, 780 pp.

Van Dyke, E.C. 1932. Miscellaneous studies in the Elateridae and related families of Coleoptera. Proc. California Acad. Sci. 20:291-465.

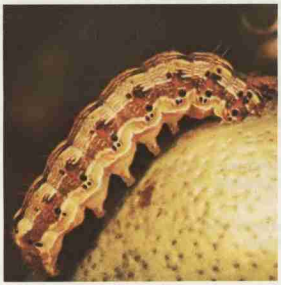
Westcott, C. 1964. The gardener's bug book. Doubleday & Co., Inc., Garden City, N.Y. 625 pp.

## PLATE 1

A. Corn earworm damaging ear.

B. Corn earworm and damage to soybean pods.

C. Corn earworm feeding on sorghum.



D. Bollworm attacking boll.

E. Typical bollworm damage.

F. Bollworm moth.

G. Bollworm egg.

H. Tobacco budworm in bud.

I. Tobacco budworm moth.

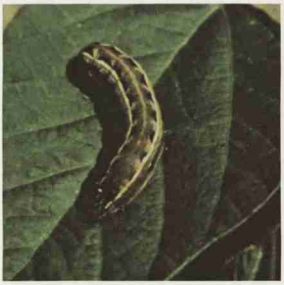
## PLATE 2

A. Armyworms feeding in corn whorl.

B. Fall armyworm on leaf.

C. Fall armyworm and exit hole.

D. Beet armyworm.



E. Yellowstriped armyworm.

F. Sorghum webworm.



G. Soybean looper and moth.

H. Diseased looper.

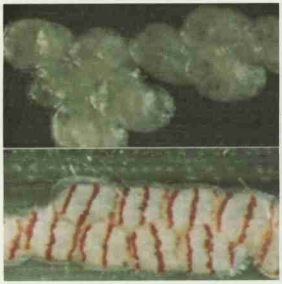
I. Black cutworm with severed seedling.

## PLATE 3

A. Velvetbean caterpillar.

B. Green cloverworm.

C. Tobacco hornworm.



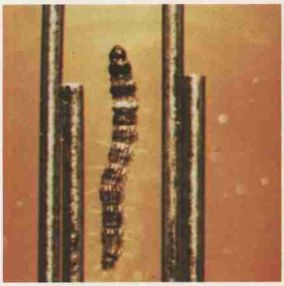
D. Southern cornstalk borer eggs newly laid (above), just prior to hatch (below).

E. Southern cornstalk borer-summer form.

F. Stalk borer.

G. European corn borer eggs/newly hatched larvae.

H. European corn borer-damage to stalk.



I. Lesser cornstalk borer.

## PLATE 4

A. Southern corn billbug.

B. Billbug damage to corn.

C. Billbug larva.

D. White grub.

E. Green June beetle grub.

F. Wireworm.



G. Cereal leaf beetle.

H. Cereal leaf beetle larva covered with fecal matter.

I. Southern corn rootworm in corn seedling.

## PLATE 5

A. Soybean stem borer adult.

B. Soybean stem borer larva and damage.

C. Japanese beetle damage to soybean.

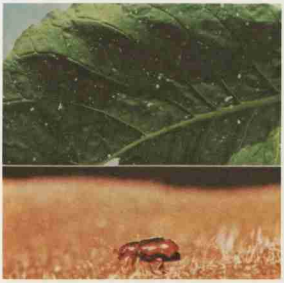
D. Bean leaf beetle damage to soybean.

E. Southern corn rootworm adult.

F. Mexican bean beetle adult, larva, and damage.

G. Sugarcane beetle.

H. Margined blister beetle.



I. Tobacco flea beetle damage and adult.

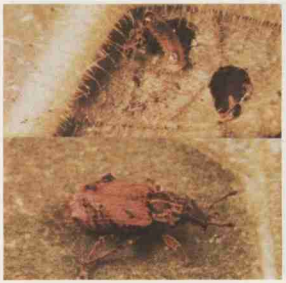
## PLATE 6

A. Boll weevil.

B. Boll weevil punctures.

C. Boll weevil larva and pupa.

D. Alfalfa weevil larva and adult.



E. Vegetable weevil larva and adult.

F. Sorghum midges in spider web.

G. Grasshopper and damage.

H. Corn field damaged by grasshoppers.

I. Corn flea beetle on seedling.

## PLATE 7

A. Corn root aphids.

B. Cotton aphid damage.

C. Green peach aphids.

D. Thrips injury to seedling cotton.

E. Twospotted spider mite damage to cotton.

F. Spider mites on corn.

G. Leafhopper damage to peanuts—"hopper burn".

H. Stink bug nymph (left) and adult (right).

I. Threecornered alfalfa hopper and damage to stem.

# Pests of Corn/Sorghum

In 1980, corn was planted on 708,502 hectares (1,750,000 acres) of North Carolina farm land concentrated in the Coastal Plain, but also scattered throughout the Piedmont and Mountains. Grain sorghum accounted for an additional 46,559 hectares (115,000 acres) in the Piedmont and south central counties of this state. The corn and sorghum planted on this extensive acreage are subject to infestation by a diverse array of insect or related pests.

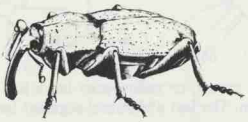
Although these two crops are unlike in many respects, (e.g. sorghum being much more drought tolerant than corn), they have many pests in common. When present, many of these pests go unnoticed because they are hidden within the soil, stalk, ear, seedhead, or whorl. Few corn and sorghum pests feed on exposed sites where they can be easily detected and controlled before damage occurs. As a result, much attention needs to be focused on early recognition of both pests and their injury so control measures may be employed at the most appropriate time.

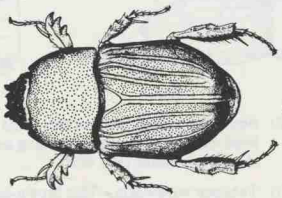
## KEY TO PESTS OF CORN AND SORGHUM

A. Insects that feed on seed, roots, lower stems, or surface debris.

1. **Beetles**—These chewing insects have hard, shell-like forewings (wing covers or elytra) which meet in a straight line down the middle of the back (Fig. 63A,B). They may or may not be able to fly.

63A





63B

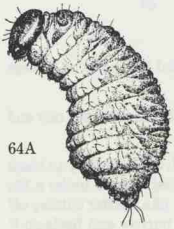
a. **Billbugs**—These black, gray, or brown snout beetles are 10 to 16 mm long (Fig. 63A). They pierce young seedlings near the ground with their "beak," causing stunting, tip dieback, and often death of corn seedlings. Plants which survive display yellow streaks, suckering, and rows of holes transverse across the blades ..... p. 58



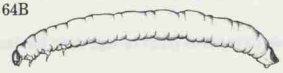
b. **Sugarcane beetle**—This black, hardshelled, dome-shaped beetle (Fig. 63B) is about 13 mm long. As it feeds below the ground line on the lower stalks of corn seedlings, a large ragged hole is left in the stalk. Damage is most common in corn following sod ..... p. 65

2. **Beetle larvae**—These larvae are either legless or have three pairs of short legs near the head (Fig. 64A to D).

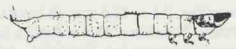
64A



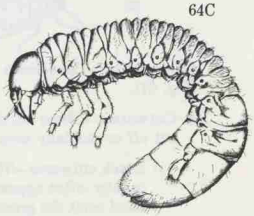
64B

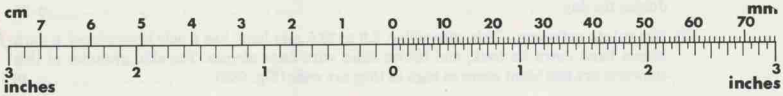


64D



64C






* See also "Key to Caterpillars" on page 16.

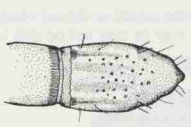
a. **Billbug larvae**—Several species of these cream-colored, brown-headed, legless grubs (Fig. 64A) tunnel in the basal area of the stalk, dwarfing and often killing plants. Billbug larvae range from 2 to 15 mm long ..... p. 58

b. **Southern corn rootworm**—This wrinkled, yellowish-white larva (Fig. 64B) has three pairs of short legs and measures 15 to 16 mm long when mature. The last segment of the body has a brown, dorsal shield ..... p. 59

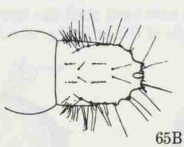
c. **White grubs**—These C-shaped, brown-headed grubs (Fig. 64C) may be as long as 45 mm, and have three pairs of legs and a slightly enlarged abdomen. They feed heavily on roots of grass crops, stunting and sometimes killing plants. ..... p. 68

d. **Wireworms**—Injury by these slender, short-legged larvae (Fig. 64D) produces stunting, tip dieback, and chlorotic blades. Taproots of recently infested plants usually display an irregular feeding hole with jelly-like plant secretions. Damage to germinating corn is common. Larvae of most species are cream to copper in color.

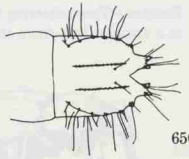
i) ***Melanotus communis***—This pale yellow to reddish-tan wireworm is 21 to 25 mm long, and its last abdominal segment has blunt scalloped edges (Fig. 65A). This pest usually feeds on the roots of seedlings. Older infested plants are stunted and may not tassle ..... p. 52



65A



65B



65C

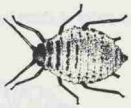
ii) **Southern potato wireworm**—This white, cream, or yellow-gray larva has a red-orange head capsule and may be as long as 17 mm. The last abdominal segment terminates in a closed, oval notch (Fig. 65B) ..... p. 62

iii) **Tobacco wireworm**—This brown-headed, white, yellowish or cream-colored wireworm, 14 to 19 mm long when mature, is characterized by a V-shaped notch in its last abdominal segment (Fig. 65C) ..... p. 67



3. **Corn root aphid**—This typically wingless, pale green to blue-green aphid (Fig. 66) has a black head and black or reddish eyes. Some females are gray and pink with a white, powdery coating. Length varies from 0.3 mm for small nymphs to 2.0 mm for mature adults. Usually associated with anthills in corn fields, this aphid feeds on the roots causing the foliage to develop a yellowish to reddish tinge ..... p. 41

66



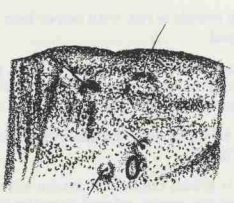
67

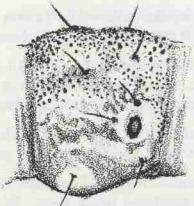
4. **Caterpillars**—These moth larvae have three pairs of legs near the head and five pairs of prolegs (Fig. 67).

a. **Cutworms**—These fat, darkly colored caterpillars burrow in soil and debris during the day and cut off or partially sever seedlings near the soil line at night.

i) **Black cutworm**—This caterpillar, 3.5 to 45.5 mm in length, varies from light gray to black in color, often appearing greasy. The skin of this cutworm is granulated (as seen under a 10x hand lens), the granules resembling rounded, flattened pebbles (Fig. 68A). After cutting off a seedling, this cutworm commonly pulls it into the entrance of its burrow and feeds on it during the day ..... p. 36

ii) **Granulate cutworm**—This caterpillar, 2.0 to 38.5 mm long, has a pale brown head, a dark brown band down its back, and brown sides with faint stripes. The skin granules of this cutworm are like blunt cones as high as they are wide (Fig. 68B) ..... p. 46


68A

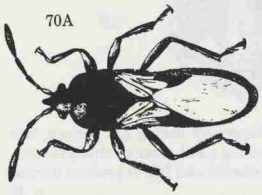

68B

b. **Lesser cornstalk borer**—This larva may be found feeding on leaves or roots but eventually tunnels into the plant's stem usually at or near the soil line. A silken, soil-covered tube is often connected to the plant stem at the entrance hole. This small, slender, bluish-green caterpillar has brown bands around each body segment and measures about 19 mm long when mature.....p. 48

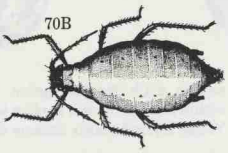
c. **Southern cornstalk borer**—This larva, which reaches a length of 25 mm, is creamy yellow during the winter and white with black spots in the summer. Although it feeds in the whorl early in its development, it later causes severe taproot and lower stalk injury by tunneling within the plant .....p. 61

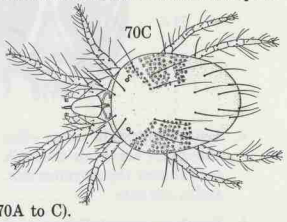
d. **Webworms**—When mature, these pinkish-white, yellow, or light-brown worms are 6 to 19 mm long with thick bodies, coarse hairs, and paired dorsal and lateral spots on each segment. They feed on the roots of seedlings, and bore into the stalk near the soil line. Such stalk damage causes the plant to be deformed and the newly emerged leaves to be ragged and distorted. Fine silken strands entangled with plant debris are usually present near the entrance hole... p. 54, 57

5. **Seedcorn maggot**—This tiny, legless, white to yellow maggot (Fig. 69) is 5 to 7 mm long, tunnels in seeds and the tender root tissue of seedlings. Many injured seeds do not germinate and those which do produce weak, spindly seedlings which rarely survive .....p. 53


70A


69


70B

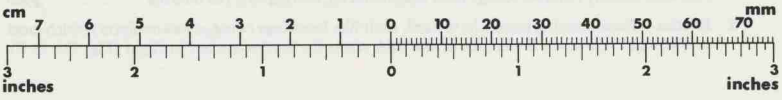

70C

B. Small pests that extract juices from foliage and stems (Fig. 70A to C).

1. **Chinch bug**—This black bug, up to 4 mm long, has opaque wings, each marked with a black triangle (Fig. 70A). Feeding anywhere from the roots to the upper leaves, adults and smaller, wingless, red and black nymphs cause dwarfing, lodging, and yield reduction. Seedlings may wilt and die during severe infestations .....p. 134

2. **Corn leaf aphid**—Up to 2 mm long, the wingless form of this pear-shaped insect (Fig. 70B) is pale bluish green with a dark area around the base of the cornicles. Its body often seems to have a powdery coating. The insects feed in groups of 5 to over 2000. Tassels, leaves, and silks on which this aphid feeds become black with mold. Leaf deformation, yellowing, and cast aphid skins often are associated with heavy infestations .....p. 40

3. **Spider mites**—Several species of these eight-legged (larvae six-legged), almost microscopic pests (Fig. 70C), congregate and feed on the underside of leaves and spin webs on the foliage. A silver speckling of the leaves, especially during dry periods, is associated with these pests. In North Carolina, they are usually a problem on corn rather than sorghum. Severe infestations resemble drought stress since damage progresses from the bottom of the plant up.



a. **Carmine spider mite**—The 0.4 mm long, oval female is red, with two or four dark, dorsal spots; the male is smaller and slightly diamond shaped. .....p. 63

b. **Twospotted spider mite**—The 0.4 mm long, oval female is yellow to dark green, with two or four dark, dorsal spots; the male is smaller and diamond shaped. Webbing is initiated near the midribs of the host plant and gradually envelopes the plant as the population increases .....p. 63

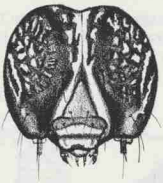
C. Caterpillars that bore into the whorl, stalk, or ear. All larvae described in this section have three pairs of legs near the head and five pairs of prolegs (Fig. 67).

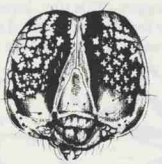
1. **Corn earworm**—When fully grown, this larva is green, reddish, or brown with pale, longitudinal stripes and scattered black spots. Early instars are cream colored or yellowish green with few markings. Larval instars vary from 1.5 to 44 mm in length and have five pairs of prolegs. As injured leaves unfurl, they display ragged holes and soggy, brown frass. This worm also feeds on the tip kernels of the ear. Round emergence holes are sometimes evident in the shuck .....p. 37

2. **European corn borer**—This cream to light-pink caterpillar with a reddish-brown to black head reaches a length of 25.5 mm. Its boring into the stalk weakens the plant and causes tassel and stalk breakage, ear dropping, and small ears. Light tan frass entangled with silk, tunneled midribs, and pin holes in the leaves indicate the presence of this pest .....p. 42

3. **Fall armyworm**—This green, brown, or black worm reaches a length of up to 40 mm and often has a pale, but distinct, inverted "Y" on its head capsule (Fig. 71A). It has a black, longitudinal stripe down each side of its body and a yellowish-gray stripe down its back. It feeds in the whorl causing injury similar to that of the corn earworm. It also attacks ears near the shank and when mature may bore into the stalks. Unlike the corn earworm, it rarely occurs in North Carolina before July .....p. 44

71A





71B



4. **Lesser cornstalk borer**—See section A.4.b. for description. Especially during dry periods, this caterpillar bores into the stalk within 5 cm of the soil surface leaving a soil-covered, silken tube attached near the entrance site. Young injured plants become distorted and fail to produce normal stalks and ears .....p. 48

5. **Southern cornstalk borer**—See section A.4.c. for description. During early stages of development this larva feeds in the whorl, causing emerging leaves to have rows of irregular holes and sometimes damaging the growing point. Later it tunnels into the stalk causing severe taproot and lower stalk injury .....p. 61

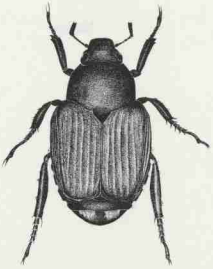
6. **Stalk borer**—This caterpillar may be solid white, light purple, or cream colored with a dark brown band around the middle and brown or purple longitudinal stripes. Reaching a length of 31.8 mm, it may enter the stalk at ground level and sever leaves as it moves upward or it may climb the plant and enter through the bud and tightly coiled leaves. Tassels are usually destroyed and the upper plant deformed. This insect is most common in no-till or weedy fields .....p. 64

D. Chewing insects that feed exposed on foliage or silks.

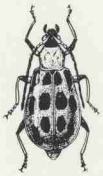
1. **Armyworm**—This smooth-skinned, 30- to 35-mm long caterpillar is basically yellowish or greenish brown with three dark, longitudinal stripes and five pairs of prolegs (Fig. 67). The tan or greenish-brown head capsule has markings like those of the fall armyworm, but on the armyworm, these markings are lighter or less intense (Fig. 71B). Feeding primarily at night and spending the days under ground litter, this insect may damage both tender and mature foliage. In corn, this insect characteristically removes foliage from the ground up, leaving only the midribs .....p. 35

2. **Beetles**—These chewing insects have hard, shell-like forewings (wing covers or elytra) which meet in a straight line down the middle of the back when the beetles are not in flight (Fig. 72A to C).

72A



72B



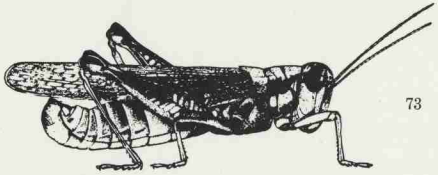
72C

a. **Corn flea beetle**—This oval, 1.3- to 2.5-mm long insect (Fig. 72A) is about the size and shape of a #5 shotgun pellet. It chews the foliage of seedlings, leaving small round holes and bleached-out spots or stripes. Basically black, this beetle is tinged with bronze or bluish green and usually jumps very actively .....p. 39

b. **Japanese beetle**—This shiny, metallic green, 13-mm long beetle has coppery brown wing covers (Fig. 72B). It feeds on the silks of corn and in very severe infestations may reduce pollination and kernel formation, although yield reduction has not been documented in North Carolina.p. 47

c. **Spotted cucumber beetle**—About 6-mm long, this elongate, yellowish-green beetle has black legs, antennae, and head as well as 12 black spots on its back (Fig. 72C). It feeds on most above ground plant parts but causes greatest damage when it severs newly emerged, unpollinated silks. As a result, ears of corn are sparsely filled .....p. 59

3. **Grasshoppers**—Adults of various grasshopper species (Fig. 73), varying from 3.8 to 4.4 cm in length, feed from the outer edges of leaves inward. Stalks, ears, and silks may also be attacked if infestation is severe .....p. 104



73



E. Insects that feed in the heads of sorghum.

1. **Caterpillars**—These soft-bodied, moth larvae have three pairs of legs near the head and either four (Fig. 74) or five (Fig. 67) pairs of fleshy prolegs.

74

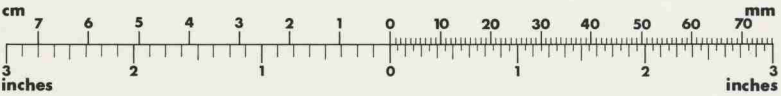
75

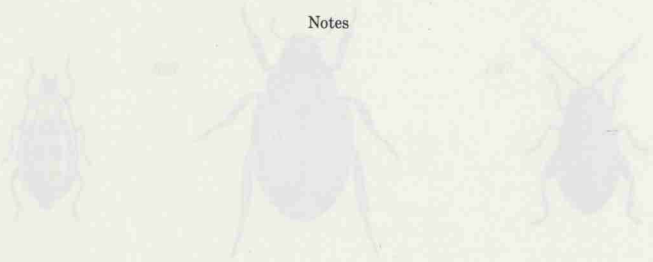
a. **Corn earworm**—See section C.1. of this key for larval description. This caterpillar bores deep into the sorghum seed head, feeding on seed contents and flower stems. It is usually no longer than 45 mm .....p. 37

b. **Fall armyworm**—See section C.3. of this key for description.

c. **Sorghum webworm**—Feeding on grain, this hairy larva is green with four reddish-tan stripes and reaches a length of 14 mm. It has four pairs of prolegs, three pairs of abdominal prolegs and one pair of anal prolegs (Fig. 74). It webs flowers and seeds together .....p. 57

2. **Sorghum midge maggot**—This tiny maggot (Fig. 75), no longer than 2 mm and pink to orange in color, feeds inside sorghum kernels. The orange adult is similar to a mosquito .....p. 55





## CORN/SORGHUM INSECT NOTES

### DESCRIPTION

**Adult**—The true armyworm moth has grayish-brown forewings, each with a white spot near the center, and grayish-white hind wings. The wingspan averages 38.5 mm.

**Egg**—The minute, greenish-white egg is globular in shape.

**Larva**—The young armyworm is pale green. The mature larva is basically yellowish or brownish green with a tan or greenish-brown head mottled with dark brown. The smooth, practically hairless body is marked with three longitudinal dark stripes, one along each side and one down the back. A full grown armyworm is 30 to 35 mm long.

**Pupa**—The reddish-brown, 13-mm-long pupa darkens gradually until it is almost black.

### BIOLOGY

**Distribution**—True armyworms occur throughout the United States east of the Rocky Mountains. In North Carolina, they are particularly abundant in the Piedmont and Coastal Plain regions. During daylight hours, larvae prefer to remain under litter on the ground.

**Host Plants**—Although true armyworms strongly prefer grasses and cereals, they have occasionally been reported to infest various vegetables, fruits, legumes, and weeds, especially when they are on the march. Most commonly, however, they are pests of corn, sorghum, timothy, small grains, flax, millet, and some wild grasses.

**Damage**—Preferring to feed at night, armyworms devour succulent foliage. By feeding on leaves and occasionally stems, they can severely damage seedling stands. In corn, armyworms characteristically feed on the lower leaves and progress toward the top of the plant. Leaves of seedlings are completely eaten, but the midribs are left on mature plants. Because they feed at night, the worms may inflict much injury before they are detected. Once having exhausted their food supply, the worms migrate as an "army" to new host plants. Fields adjacent to or harboring lush grass are most commonly attacked, particularly no-till corn planted into a small grain cover crop.

**Life History**—True armyworms overwinter as partly grown larvae. Early in the spring, larvae resume feeding at night, usually on grasses and small grains. First generation adults appear in May or June depending upon climatic conditions. Moths mate soon after emergence and feed on nectar for 7 to 10 days. Females then deposit up to 2000 eggs in small clusters or rows on the leaf sheaths of grasses. About 6 to 10 days later, larvae emerge. After feeding for 3 or 4 weeks, they drop to the ground and pupate in earthen cells 5 to 7.5 cm deep within the soil. Moths emerge about 2 to 4 weeks later. True armyworms complete five or more generations per year in North Carolina.

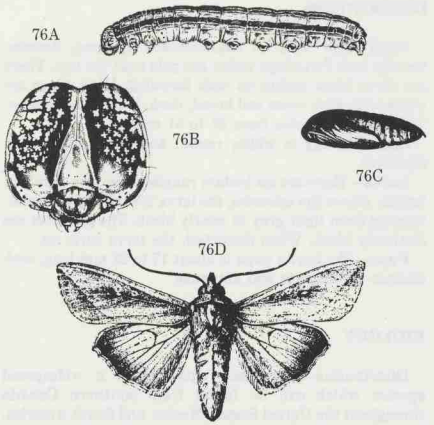


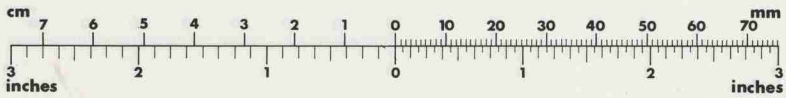

**Fig. 76 Armyworm. A, Larva. B, Larval head capsule. C, Pupa. D, Adult.**

### CONTROL

Parasites, various diseases, insect predators, and birds usually keep armyworms under control except after cold, wet springs. When practical, cultural methods, such as disking large areas, can help reduce future armyworm populations by exposing the pupae to natural enemies and hot weather. However, since armyworm moths are strong fliers, most areas will be subject to constant reinfestation.

Because armyworms feed exposed, are active during their larval stages, and are susceptible to several insecticides, they are easily controlled when buildup occurs. Controls are warranted when defoliation by armyworms averages 20 percent. For specific control information, consult the current *North Carolina Agricultural Chemicals Manual.*






* *Pseudaletia unipuncta* (Haworth), Noctuidae, LEPIDOPTERA

## CORN/SORGHUM
## Black Cutworm*

### DESCRIPTION

**Adult**—The moth is characterized by long, narrow, usually dark forewings which are pale near the tips. There are three black dashes on each forewing. Hind wings are white with dark veins and broad, dark, indefinite margins. The wingspan varies from 38 to 51 mm.

**Egg**—The egg is white, round, and about 0.5 mm in diameter.

**Larva**—There are six instars ranging from 4 to 46 mm in length. Above the spiracles, the larva is basically one color, varying from light gray to nearly black. The spiracles are distinctly black. When disturbed, the larva curls up.

**Pupa**—The brown pupa is about 17 to 22 mm long, with distinct mouthparts and antennae.

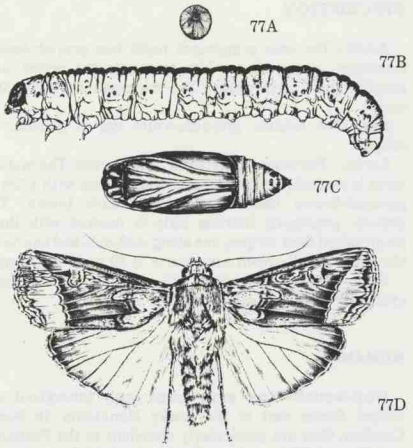



**Fig. 77 Black cutworm. A, Egg. B, Larva. C, Pupa. D, Adult.**

### BIOLOGY

**Distribution**—The black cutworm is a widespread species which can be found from southern Canada throughout the United States, Mexico, and South America. Each year in North Carolina, infested fields occur from the coast to the Tennessee state line. The threat of an infestation appears to be greatest in no-till or weedy corn fields, especially in poorly drained areas.

**Host Plants**—The black cutworm feeds on a wide range of field and garden crops. Corn and tobacco are two of its preferred crops. Other known hosts include asparagus, bean, beet, cabbage, castor bean, cotton, grape, lettuce, peanut, pepper, potato, radish, spinach, squash, strawberry and tomato.



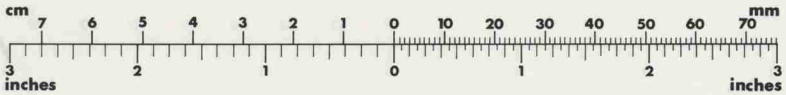
**Damage**—Black cutworms are among the most destructive of all cutworms. The larvae sever plants from roots near the soil line; usually no other feeding damage is present. Many larvae move from plant to plant on successive nights, while some stay to feed on the roots and underground stems of cut plants.

**Life History**—Little is known about the biology of this pest in North Carolina, but in Tennessee there are four broods annually. Moths of the first or overwintering brood emerge between the middle of March and the first of May. They mature about the middle of May. Second brood moths emerge from the latter part of May to the middle of July. Third brood moths emerge between the middle of July and the last of August. Fourth brood moths make their appearance near the first of September and continue to emerge into December; they produce the overwintering generation. A similar seasonal history probably occurs in North Carolina, where the majority of this pest population overwinters as pupae, though a few overwinter as larvae.

Between 5 and 11 days after emergence, each female begins to deposit about 1300 eggs in clusters of 1 to 30. Most eggs are laid on low, densely growing plants like chickweed, curly dock, and mustard; corn and soybeans are among the least attractive oviposition hosts. The egg stage lasts 3 to 16 days, depending upon the temperature. These cutworms prefer moist soil where they are usually found in tunnels 8 to 10 cm beneath the surface. The destructive larval stage varies in duration from 3 weeks (or slightly more) in July to over 4 weeks in September. The July-to-August pupal stage lasts about 2 weeks for early pupae; later ones require as much as 8 or 9 weeks.

### CONTROL

Damage from these cutworms often can be avoided by not planting corn on newly broken sod or on land which was grassy or weedy the previous summer. Other important components in cutworm control are rapid seedling growth, scouting, and properly applied insecticides. Treatment should begin when 5 percent or more of the optimum stand of seedlings has been cut. All fields should be examined before the corn is 8 cm (3 inches) tall. For specific control information, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Agrotis ipsilon* (Hufnagel, Noctuidae), LEPIDOPTERA

## DESCRIPTION

**Adult**—The moth has a wingspan of 25.5 to 38.5 mm. The forewings of the male are usually a light yellowish olive; those of the female are yellowish brown to pinkish brown. Each forewing has a dark spot near the center. The hind wings are white with a broad, dark brown, outer marginal band and, usually, a narrow, brown, intermarginal band.

**Egg**—The dome-shaped egg is white when first deposited but develops a reddish-brown band before hatching. Each egg is approximately half the size of a pinhead (about 0.55 mm high and 0.57 mm wide).

**Larva**—When fully grown, this moderately hairy larva is pale-striped, black-spotted and predominantly yellowish green, brown or reddish brown with a tan to orange head. When disturbed, it curls up tightly, remaining motionless for a few seconds. Early instars are yellowish white or yellowish green, often with orange and brown longitudinal stripes. Length ranges from 1.5 to 44 mm depending upon the instar, or developmental stage.

**Pupa**—The pupa is about 31.5 mm long and 6.0 mm wide. Initially a shiny reddish brown, it becomes dark brown before the adult emerges.

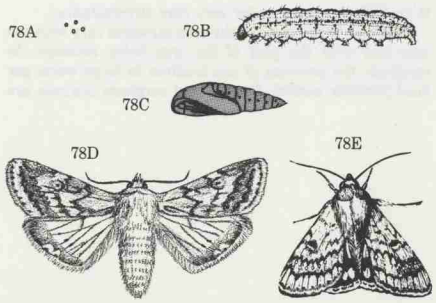



**Fig. 78 Corn earworm. A, Eggs. B, Larva. C, Pupa. D-E, Adults.**

## BIOLOGY

**Distribution**—This insect is found throughout most of the Western Hemisphere. Annually it is among the most destructive insect pests in the southern United States and has been found as far north as Saskatchewan. It has recently been introduced into the Hawaiian Islands.

**Host Plants**—The corn earworm infests over 100 plants, but corn is the preferred host. In the South it occurs on at least 17 cultivated plants: alfalfa, bean, chrysanthemum, corn, cotton, geranium, gladiolus, okra, peanut, pea, sorghum, soybean, strawberry, sweet pepper, sweet potato, tobacco, and tomato. The earworm is also found occasionally on wild hosts such as toadflax.

**Damage**—Although the corn earworm prefers the fruiting stage of the host, it will also attack the foliage. During May and June, first-generation larvae feed in the tightly coiled blades of corn. As a result, numerous ragged holes appear when the blades unfurl. Wet, tan to brown excrement lodges in the whorl and blade axils. This condition is often referred to as "shatter worm" injury.

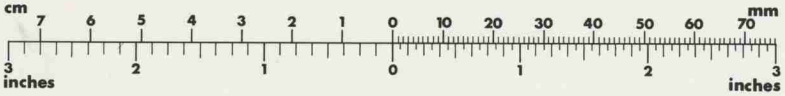
Since the eggs beginning the second generation are laid on corn silks, larval damage is confined largely to the developing kernels in the ear tip area. Round holes (approximately 5 mm in diameter) through the shuck are usually emergence rather than entrance holes. Third-generation damage may occur on very late corn, but larvae of this generation develop primarily on sorghum, soybeans, peanuts, and cotton, depending upon location. On sorghum, the earworm is generally found entwined in the seedhead feeding on seeds and flower stems.

**Life History**—In North Carolina, corn earworms overwinter as "resting" (diapausing) pupae in the soil at a depth of more than 5 cm. Adults emerge in early May, mate, and seek suitable oviposition (egg-laying) sites. A high percentage of first-generation eggs are laid on seedling corn when it is available. However, once field corn begins silking, most eggs are deposited on the silks. Later in the season, as corn silks dry up, oviposition again occurs on a variety of hosts, including sorghum. The eggs are deposited singly, each female laying from 450 to 3,000. Within 2 to 5 days, the larvae emerge and begin feeding. This insect is cannibalistic; therefore, rarely does more than one larva develop from an ear or whorl. Larvae feed for 2 to 4 weeks during which time they develop through five or six instars. They then burrow in the soil to pupate. At least four generations occur each year in North Carolina.



## CONTROL

Plant high quality, certified corn seed of varieties noted for their "husk-tightness." Such varieties help prevent the entry of earworms by the silks. An early planting, which allows the corn to silk before earworm populations peak, also reduces the extent of earworm damage. The expense of chemically controlling this pest in field corn and sorghum




* *Heliothis zea* (Boddie), Noctuidae, LEPIDOPTERA

is prohibitive except under very rare circumstances.

Economic thresholds for the corn earworm vary with the crop and with the part of the crop being attacked. In sorghum, the presence of one medium to large worm per head justifies control. In corn and sorghum controls are warranted when 80 percent of the whorls are infested with one earworm or when 40 percent of the whorls have two or more earworms. For further control information, consult the current *North Carolina Agricultural Chemicals Manual.*

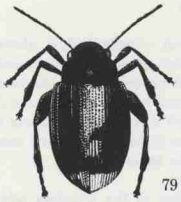
## DESCRIPTION

**Adult**—This oval, black beetle is tinged with bronze or bluish green, has yellow markings on its legs, and is 1.3 to 2.5 mm long. The basal segment of each antenna is orange.

**Egg**—Each white egg is about 0.35 mm long and pointed at one end. It gradually darkens before hatching.

**Larva**—The white, slender, cylindrical grub has a brown head and tiny legs. It may be 3.2 to 8.5 mm long when full grown.

**Pupa**—The white, soft-bodied pupa resembles the adult in size and somewhat in shape and gradually darkens as it matures.



79

**Fig. 79 Corn flea beetle.**

## BIOLOGY

**Distribution**—The corn flea beetle occurs in most areas east of the Rocky Mountains. It infests corn all across North Carolina but appears to create more concern in the Piedmont counties.

**Host Plants**—Although the corn flea beetle is a general feeder, most hosts are grasses. However, sugar beets are periodically infested in other states.

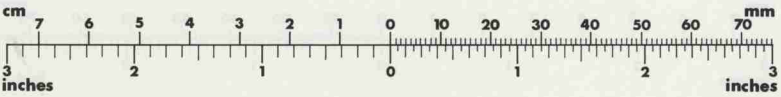
**Damage**—Corn flea beetles attack foliage, leaving small round holes and bleached out spots or stripes; the larvae feed on the roots of grasses. However, the direct loss caused by these injuries is relatively insignificant. The overwintering beetles which carry bacterial wilt of corn (Stewart's disease) are primarily responsible for any economic damage. These beetles are usually most troublesome after a mild winter followed by a cold spring. Under such conditions, high numbers of beetles survive the winter and attack the slowly growing corn over a prolonged period. Growth is retarded and leaves may wilt. Early maturing varieties in the middle and southern states are most seriously affected.

**Life History**—Adults generally overwinter in litter and trash around fields. Mortality tends to be high during harsh winters. In early spring, the beetles move to weeds and then to corn seedlings. Eggs are scattered on the soil beneath host plants. In about 10 days, the larvae emerge and begin feeding on and tunneling in underground stems, roots, or tubers. They feed for 3 to 4 weeks and develop through three instars before pupating in the soil. In 7 to 10 days, a new generation of adults emerges. Three or more generations are completed each year.

## CONTROL

Damaging corn flea beetle infestations can be prevented by plowing under crop residue and maintaining good weed control to eliminate overwintering sites. The use of wilt resistant hybrids also lessens the chances of excessive loss due to bacterial wilt. For specific control information, consult current North Carolina State Agricultural Extension Service recommendations.






* *Chaetocnema pulicaria* Melsheimer, Chrysomelidae, COLEOPTERA

## CORN/SORGHUM
## Corn Leaf Aphid*

### DESCRIPTION

**Adult**—The oval, wingless adult, about 2.0 mm long, is usually pale bluish green with black antennae, legs, and cornicles, and a dark area around the base of the cornicles. The head is marked with two longitudinal dark bands, and the abdomen with a row of black spots on each side. The body often seems to have a powdery coating. The winged form is about the same size.

**Egg**—Unknown.

**Nymph**—Similar to the wingless adult, the nymph is smaller and has no wings.

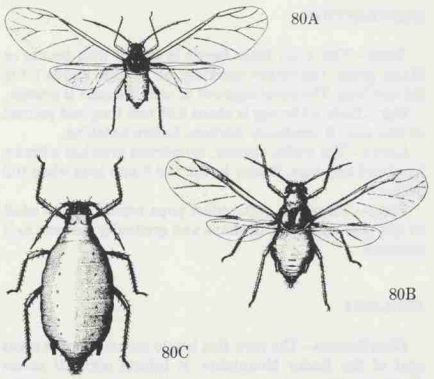



**Fig. 80 Corn leaf aphid. A, Adult male. B, Adult female - winged. C, Adult female - wingless.**

### BIOLOGY

**Distribution**—The range of the corn leaf aphid extends throughout the tropical and temperate regions of the world. In the continental United States, it occurs in all areas except the Rocky Mountain region.

**Host Plants**—Rarely a problem in the northern states, the corn leaf aphid shows a preference for barley, sorghum, and corn, in that order. It also infests millet, broomcorn, sugarcane, Sudan grass, and many other wild and cultivated grasses.

**Damage**—Feeding by colonies of these aphids causes mottling and discoloration of the leaves. Heavily infested leaves turn red or yellow, shrivel, and die. The important damage usually occurs during and after flowering. At this time the aphid population peaks and feeds on corn tassels and silks. In sorghum, the developing heads of grain become infested. Areas fed upon become covered with sweet, sticky honeydew secretions. Black mold grows on the honeydew and may result in poor corn pollination, interference with photosynthesis and, in severe cases, reduced grain development. Entomologists have speculated that the honeydew attracts corn earworm moths and therefore, induces heavy earworm egg deposition.

**Life History**—Little is known about the biology of this pest in North Carolina. Since the relationship between corn and this aphid is not well understood, it has been difficult to estimate damage and to determine thresholds. This aphid generally is not considered a serious threat.

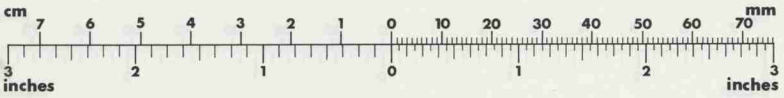
Corn leaf aphid adults overwinter each year in southern states, including North Carolina. On warm winter days, the females actively continue to feed and reproduce on winter grain crops or other grasses. The first spring adults are winged females which fly in search of suitable host plants, sometimes migrating far northward. Shortly thereafter, they give birth to live nymphs which usually develop into wingless females. Under favorable conditions, more winged females develop and migrate. Males are rarely found but females continue to reproduce without mating. No egg stage is known. Reproduction slows down in winter and summer and is most rapid during cool weather. Therefore, corn leaf aphids tend to be a problem on winter grains in spring and on late-planted corn in fall. The number of generations per year varies from 9 in Illinois to 50 in southern Texas.

### CONTROL

Early planting and other cultural practices which hasten maturity will help prevent corn leaf aphid infestations which are usually restricted to late-planted corn and sorghum. This insect rarely requires control in North Carolina on sorghum or corn. In the northern states control is usually unnecessary because populations build up so late in the season. During summers in the southern and southwestern states, however, the corn leaf aphid is controlled both by extreme heat and by the insect's natural enemies.

Research in Kansas indicates that corn leaf aphid infestations of 800 to 1500 aphids per sorghum plant do not substantially reduce yield unless the aphids feed in the whorl. Much lower populations feeding on silks, tassels, and developing grain, however, may inflict significant injury. Should damaging populations develop, consult the current *North Carolina Agricultural Chemicals Manual.*






* *Rhopalosiphum maidis* (Fitch), Aphididae, HEMIPTERA

## DESCRIPTION

**Adult**—This typically wingless, blue-green aphid has a black head and black or reddish-brown eyes. The female in the egg-laying period has a gray body with a pink abdomen and a white, powdery coating. The various adult forms range from 1.5 to 2.0 mm long.

**Egg**—The dark green, oval-elongate egg is less than 1 mm long.

**Nymph**—The pale green nymph has red eyes, resembles the adult in shape, and measures from 0.3 to 2.0 mm in length.

## BIOLOGY

**Distribution**—Although generally distributed, the corn root aphid is most prevalent throughout the corn- and cotton-growing areas east of the Rocky mountains. It is considered a problem in Ohio, Kentucky, North Carolina, Tennessee, Virginia, and West Virginia, particularly under minimum and no-tillage cropping systems.

**Host Plants**—Corn, cotton, and smartweed roots seem to be the most common hosts of the corn root aphid. Other hosts include broomcorn, crabgrass, dock, foxtail, knotweed, mustard, pigweed, plantain, purslane, ragweed, sorghum, sorrel, squash, and wheat roots.

**Damage**—The corn root aphid pierces roots with its needle-like mouthparts and extracts sap. As a result of aphids' feeding, the foliage soon develops a characteristic yellowish to reddish tinge. Heavily infested seedlings become stunted, rarely growing taller than 25 cm (10 inches). In addition to these symptoms, infested fields are likely to harbor many anthills; however, the presence of anthills does not necessarily imply infestation by the corn root aphid.

**Life History**—Throughout their life cycle, corn root aphids are highly dependent upon ants, especially cornfield ants. In most areas, the aphids overwinter as eggs deep within the ant nest. In late March or April, ants carry newly hatched nymphs to the roots of corn or weeds, particularly dock and smartweed. If corn seedlings are available, aphids are transferred to them either from the over-wintering nest or from weeds. Later the ants feed on the aphids' honeydew secretions. First-generation aphid nymphs feed on roots for 2 to 3 weeks before developing into wingless female adults. By-passing the egg-laying stage, these mature aphids soon give birth to 40 or 50 live nymphs. As summer approaches and temperatures increase, nymphs may mature in as few as 8 days. After several generations, winged female aphids often appear and fly to nearby fields, especially corn or cotton. After landing on anthills, they are carried to the roots by ants. Here the aphids continue to feed and reproduce as before until the approach of cold weather. In the fall, wingless male and female forms develop, mate, and are responsible for the production of overwintering eggs. These eggs are protected from the cold by the ants which carry them deep into their nests. The number of annual aphid generations varies greatly with latitude and environmental conditions. In no-till corn, 10 to 22 generations per year are possible.

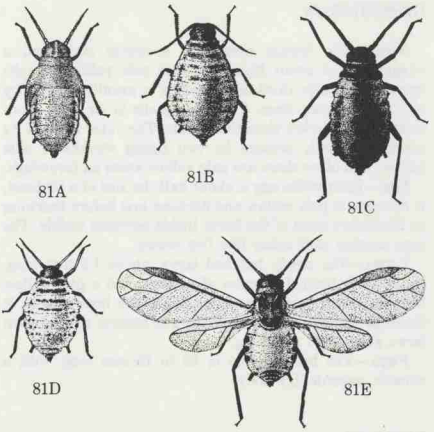
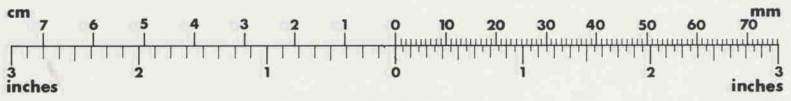



**Fig. 81 Corn root aphid. A, Last instar nymph. B, Egg-laying adult female. C, Adult male. D-E, Parthenogenetic females.**

## CONTROL

Corn root aphid infestations can be prevented by a variety of cultural practices. Control of weedy hosts in spring eliminates breeding and feeding sites for a large segment of the first aphid generations. Proper cultural practices throughout the growing season stimulate rapid corn growth and greatly reduce early season stunting by aphids. Deep tillage at least every other year weakens ant colonies and thereby decreases the chances that overwintering aphid eggs will survive. Finally, and most importantly, crop rotation prevents the buildup of large ant and aphid populations in any one field. For further control information, consult current North Carolina State Agricultural Extension Service recommendations.






* *Anuraphis maidiradicis* (Forbes), Aphididae, HEMIPTERA

## CORN/SORGHUM
### European Corn Borer*

### DESCRIPTION

**Adult**—The female moth has a robust body and a wingspread of about 25.5 mm. It is pale yellow to light brown. The outer third of the wings is usually crossed by two dark, zigzag lines. The male moth is smaller, more slender, and darker than the female. The outer third of its wings is usually crossed by two zigzag streaks of pale yellow, and often there are pale yellow areas on forewings.

**Egg**—Each white egg is about half the size of a pinhead. It changes to pale yellow and darkens just before hatching as the brown head of the borer inside becomes visible. The eggs overlay each other like fish scales.

**Larva**—The newly hatched larva, about 1.5 mm long, has a black head, five pairs of prolegs, and a pale yellow body bearing several rows of small black or brown spots. It develops through five or six instars to become a full-grown larva about 25.5 mm long.

**Pupa**—The brown pupa is 13 to 15 mm long with a smooth, capsule-like body.

### BIOLOGY

**Distribution**—Within the United States, this pest is found in all the major corn-producing states of the Plains, Midwest, and South. In North Carolina, the highest numbers occur in the Coastal Plain where 75 percent of the stalks in some fields have been attacked. However, 40 percent lodging due to borers has been observed where harvesting was delayed in the Piedmont.



**Host Plants**—The European corn borer has been found on more than 200 host plants, but corn is a preferred host. In addition to corn, crops likely to suffer primary economic damage include barley, beans, millet, oats, Irish potatoes, and sorghum.

**Damage**—Although a prevalent insect pest of sorghum, the European corn borer is less damaging than pests which attack the grain portion of the plant. In corn, however, this borer is a serious pest. Both corn and sorghum are attacked in approximately the same manner.

Initial feeding occurs on the leaf surface, generally in the whorl. Later the larvae bore down midribs of leaves into stalks. Frass and silk, near entrance holes, are evidence of their presence. Primary damage to conducting tissue may result in a reduction of starch and sugar reaching the grain. Serious tunneling damage by subsequent generations may weaken plants so extensively that tassel and stalk breakage, ear dropping, and small ears may occur.

**Life History**—Mature larvae overwinter inside tunnels in stubble, stalks, ears, or other protective plant material.

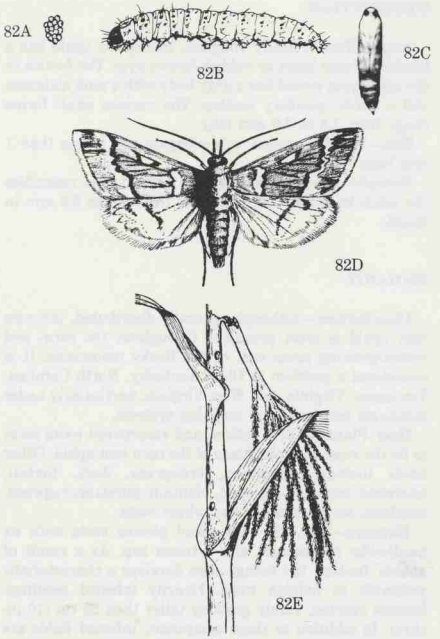
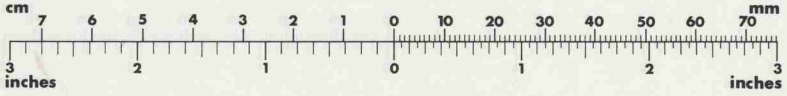



**Fig. 82 European corn borer. A, Eggs. B, Larva. C, Pupa. D, Adult. E, Broken tassel, usually first sign of European corn borer infestation.**

They pupate in the spring. During late spring, the adult moths emerge and mate. Each female lays 500 to 600 eggs in small masses of 15 to 20 on the underside of leaves. Eggs hatch in 3 to 12 days, depending upon the temperature. The young larvae usually begin feeding on the leaf surface and, as they mature, begin boring in the midribs of the leaves. During the 4th instar, stalk- or ear-boring commences and continues until pupation. In Florence, South Carolina, the European corn borer completes four generations per year and may do so in parts of North Carolina too. If this is the case, eggs of the second generation are laid in mid- to late June, those of the third generation in late July, and those of the fourth generation in September. This last generation is not a problem on corn.




* *Ostrinia nubilalis* (Hubner), Pyralidae, LEPIDOPTERA

## CONTROL

Many natural parasites of this corn borer, mainly flies and wasps which have been introduced from Europe, exist in corn-growing areas. Other biological control agents such as ladybird beetles, predaceous mites, and downy woodpeckers have also been responsible for some borer reduction. The bacterium *Bacillus thuringiensis*, however, shows most promise for borer control.

The most effective cultural method of control has been stalk destruction. This is accomplished by cutting corn for silage; disking; using stalk cutters, shredders, and flailers; and clean fall plowing. If all stalks and other debris in corn fields is completely plowed under in the fall, few borers will survive the winter. However, a neighborhood effort is necessary since the adults are strong fliers.

In North Carolina, crop destruction, resistant varieties, and early harvest provide the most logical control. In former years, insecticides as a first line defense proved ineffective in this state, but recent research indicates that chemical control of first-generation larvae may now be practical. However, thresholds have not yet been established in North Carolina. For further control information, consult the current *North Carolina Agricultural Chemicals Manual.*

## CORN/SORGHUM
### Fall Armyworm*

### DESCRIPTION

**Adult**—The moth has a wingspan of about 38.5 mm. The hind wings are grayish white; the front wings are dark gray, mottled with lighter and darker splotches. Each forewing has a noticeable whitish spot near the extreme tip.

**Egg**—Minute, light gray eggs are laid in clusters and covered with grayish, fuzzy scales from the body of the female moth. The eggs become very dark just before hatching.

**Larva**—About 30 to 40 mm long, the full-grown larva varies in color from light tan or green to nearly black. Along each side of its body is a longitudinal, pitch-colored stripe, and down the back is a wider yellowish-gray stripe. Unlike the true armyworm, the head of the fall armyworm is often marked with a pale, but distinct, inverted "Y."

**Pupa**—The pupa, approximately 13 mm long, is originally reddish brown and darkens to black as it matures.

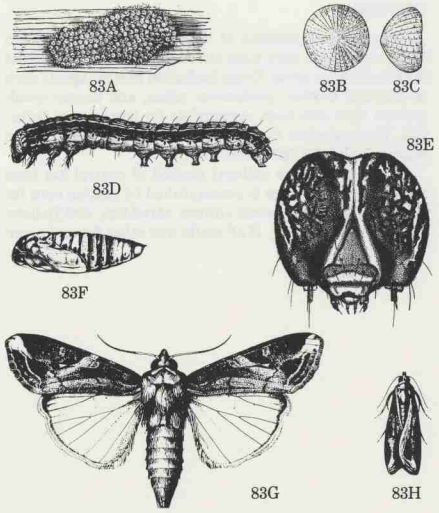



**Fig. 83 Fall armyworm. A, Egg mass. B, Egg (top). C, Egg (side). D, Larva. E, Larval head capsule. F, Pupa. G-H, Adults.**

### BIOLOGY

**Distribution**—The fall armyworm is a continuous resident of the Gulf states, the tropics of North, Central and South America and some of the West Indies. Each year it migrates as far northward as Montana, Michigan and New Hampshire. In the southeastern states, it occurs annually on late corn and reaches epidemic populations in sorghum about once in 3 years. Fall armyworms annually attack late corn and sorghum in the North Carolina Coastal Plain and Piedmont.

**Host Plants**—Corn, sorghum, and other plants of the grass family are the preferred foods, but the fall armyworm also attacks alfalfa, bean, peanut, potato, sweet potato, turnip, spinach, tomato, cabbage, cucumber, cotton, tobacco, all grain crops, and clover.

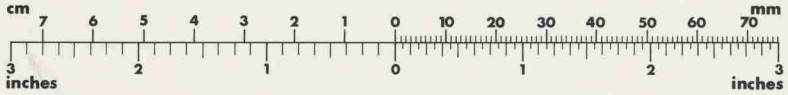
**Damage**—In North Carolina, the fall armyworm can be a serious pest of corn in July and August. Light populations occur annually; however, heavy populations (one or more larvae per plant) occasionally occur and can be very difficult to control.

The most frequent damage by the fall armyworm is to the whorl of late pretassel corn or sorghum. Several larvae may feed throughout the tightly coiled blades. This feeding results in numerous ragged holes when the blades unfurl and may prevent infested plants from producing normal ears or seed heads. As with the corn earworm, wet, tan excrement can be found lodged in the remaining blades and blade axils.

In addition to defoliation, damage to corn may occur in three other ways. First, larvae feed on the undeveloped tassels of young plants. Secondly, immature ears are attacked. Last of all, large larvae may bore into stalks.

**Life History**—This insect overwinters in Florida and along the Gulf Coast in several life stages, but usually as pupae. Egg-laying moths usually appear in North Carolina about the middle of July. Each female lays about 1,000 eggs in masses of 50 to several hundred. Two to ten days later, the small larvae emerge, feed gregariously on the remains of the egg mass, and then scatter in search of food. They are usually unnoticed until they are 25.5 to 38.5 mm long, by which time, if abundant, they have consumed so much foliage that they create alarm. Unlike the nocturnal true armyworms, fall armyworms feed any time of the day or night, but are most active early in the morning or late in the evening. When abundant, these caterpillars may eat all the available food and then crawl in great armies to adjoining fields. After feeding for 2 or 3 weeks, the larvae dig about 20 mm into the ground to pupate. Within 2 weeks, a






* *Spodoptera frugiperda* (J.E. Smith), Noctuidae, LEPIDOPTERA

new swarm of moths emerges, usually flying several miles before laying eggs. Several generations occur each year in North Carolina.

## CONTROL

During favorable seasons, a number of parasitic enemies keep fall armyworm larvae down to moderate numbers. Cold, wet springs seem to reduce the effectiveness of these parasites and a population explosion often results. Early planting is the most effective cultural control method in the South.

When 80 percent of the plants in a field of corn or sorghum have at least one fall armyworm feeding in the whorl, control is justified. If there are two or more caterpillars per plant, controls should be initiated when 40 percent of the corn plants or 50 percent of the sorghum plants are infested. For further control information, consult the current *North Carolina Agricultural Chemicals Manual.*

## CORN/SORGHUM
## Granulate Cutworm*

### DESCRIPTION

**Adult**—Both the thorax and forewings of the granulate cutworm moth are yellowish brown. The thoracic collar is dark with a distinct black line, and the abdomen is gray. The hind wings are pure white, though the veins and a slight border may be smoky gray-brown with a blackish tinge. The wings span from 38.0 to 44.5 mm.

**Egg**—The egg is almost hemispherical with the lower surface smooth and flat or slightly convex. When first laid, the egg is yellowish white, but it becomes darker before hatching. The egg is 0.63 to 0.75 mm across.

**Larva**—The head of this caterpillar is pale brown; the body is dark brown to gray with pale longitudinal stripes. The skin surface is covered with small, black, conical granules which can be seen with a 10x hand lens. The six larval stages range from 2 to 38 mm in length.

**Pupa**—The pupa is about 16 to 20 mm long.

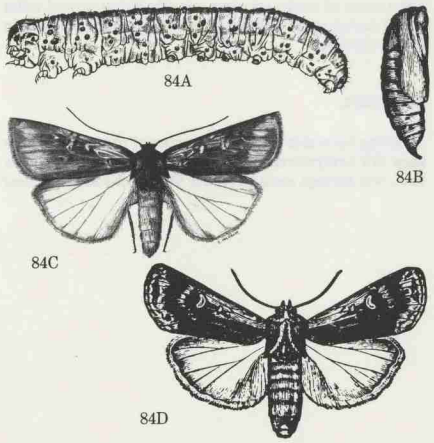



**Fig. 84 Granulate cutworm. A, Larva. B, Pupa. C-D, Adults.**

### BIOLOGY

**Distribution**—Though it occurs from Massachusetts and New York to California, the granulate cutworm probably does not breed regularly in its northern limit. It is abundant in the southern United States and occurs as far south as the Bahama Islands, Cuba, Puerto Rico, Central America and South America.

**Host Plants**—Granulate cutworms have been observed feeding on over 61 hosts of economic importance. In addition to corn, these worms also feed on the foliage of young cotton seedlings, threaten tobacco plant beds in North Carolina, and apparently are becoming a primary pest of peanuts in Georgia. Other hosts include alfalfa, bean, beet, Brussels sprouts, cabbage, cauliflower, clover, dandelion, eggplant, grass, pepper, pea, plantain, potato, sweet potato, tomato, turnip, and wheat.

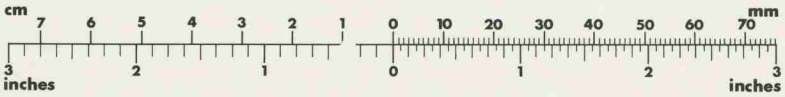
**Damage**—The granulate cutworm causes its most serious damage by cutting off small plants near the ground. If the plant is too large to be severed at ground level, the larva climbs the plant and feeds on the foliage.

**Life History**—No life history study has been made in North Carolina, though rather extensive research has been conducted in Louisiana. In North Carolina, granulate cutworms are believed to overwinter as larvae or pupae. In the spring, moths emerge and lay eggs. Each female deposits an average of 325 eggs which hatch 3 to 5 days later. The larvae develop through six instars in about 4 weeks during July and August and in 5 to 7 weeks during August and September. These caterpillars feed at night, retreating during the day into the soil or under trash near the plants upon which they fed the previous night. Mature larvae burrow 5 to 15 cm below the soil surface and pupate. The pupal stage lasts 2 weeks (or slightly longer) in July, August, and the first part of September. Larvae which pupate after mid-September overwinter in the pupal stage. There are five to six generations per year in Louisiana and probably two to three in North Carolina.

### CONTROL

Crop rotation is a commonly used method for controlling this pest on a large scale. Chemical controls include poison baits or directed insecticides when needed, and pre-plant insecticides in areas with a high cutworm incidence. Treatment should begin when 5 percent or more of the optimum stand of seedlings has been cut. For specific control information, consult the current *North Carolina Agricultural Chemicals Manual.*






* *Feltia subterranea* (Fabricius), Noctuidae, LEPIDOPTERA

## DESCRIPTION

**Adult**—This shiny, metallic green beetle has coppery brown wing covers and is approximately 13 mm long.

**Egg**—The white or cream colored egg is spherical and about 1.5 mm in diameter when first laid. By the time it hatches, the egg has doubled its original size.

**Larva**—The grayish-white, slightly curled grub has a dark brown head and measures about 26 mm long when mature. It can be distinguished from other white grubs by two rows of spines which form a "V" on the underside of its last abdominal segment.

**Pupa**—The cream colored pupa, approximately 13 mm long and 6 mm wide, gradually turns light brown and finally develops a metallic green cast.

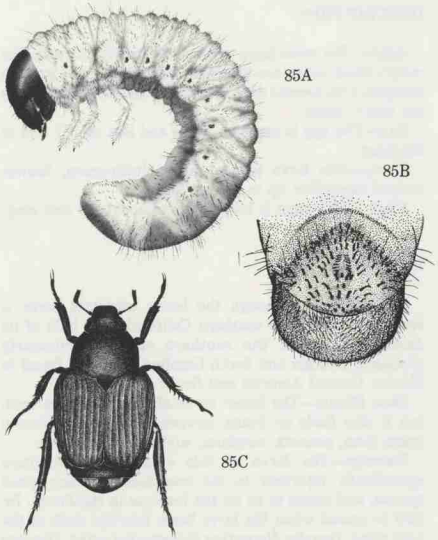



**Fig. 85 Japanese beetle. A, Larva. B, Larval setal pattern. C, Adult.**

## BIOLOGY

**Distribution**—First reported in North America in 1916, the Japanese beetle now occurs in over 20 states from southern Maine southward into Georgia and westward into Kentucky, Illinois, Michigan, and Missouri. They occur statewide in North Carolina with heaviest infestations in the central Piedmont and mountains.

**Host Plants**—Adult Japanese beetles infest over 275 different plants, including corn. Shade and fruit trees, ornamental shrubs, small fruits, garden crops, weeds, and field crops are often damaged also. The grubs are serious pests of lawns, other grasses, and nursery stock.

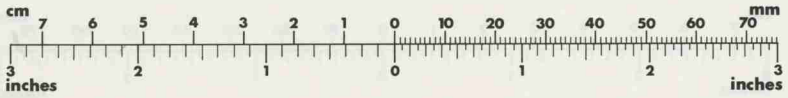
**Damage**—Gregarious in nature, Japanese beetle adults are often found feeding in masses on a few plants, leaving others nearby uninfested. On most hosts, leaves are skeletonized and the mature fruit is damaged. However, injury to corn may occur when the beetles feed very heavily on the silks and ear tips thereby reducing pollination and predisposing the ear to other insects and fungi. However, heavy feeding does not necessarily influence pollination and adult injury of this magnitude is rare. In localized spots, larval injury to developing root systems can severely reduce corn stands.

**Life History**—The grubs overwinter in cells within 13 cm of the soil surface. In the spring, they move upward, almost to ground level, where they complete feeding and pupate. The three larval instars complete development in about 140 days. Adults emerge as early as mid-May in eastern North Carolina and as late as July in New England. Throughout the summer, they attack the fruit and foliage of many plants, including the silks of corn. In North Carolina, peak emergence occurs during July. Soon after emerging, females deposit 40 to 60 eggs in small batches 5 to 8 cm deep in the ground. Under extremely dry conditions, many eggs and larvae perish. However, during warm wet summers, populations thrive and eggs hatch about 2 weeks after deposition. The newly emerged larvae feed until cold weather forces them into hibernation. Only one generation occurs each year.



## CONTROL

"Milky" spore disease and several parasites often attack beetle grubs and thereby keep Japanese beetle adult populations below economically damaging levels. Field tests in Virginia have shown that much Japanese beetle damage can be avoided by planting corn so that it silks before July 20 or after August 1. In field crop situations where insecticides are applied to control other insect pests, Japanese beetles are rarely a problem. Some plants in border rows may appear heavily infested due to the tendency of these beetles to congregate. Should high populations develop, consult the North Carolina State Agricultural Extension Service for current control recommendations.




* *Popillia japonica* Newman, Scarabaeidae, COLEOPTERA

## CORN/SORGHUM
### Lesser Cornstalk Borer*

### DESCRIPTION

**Adult**—The moth has a wingspan of nearly 25.5 mm. The male's front wings are brownish yellow and have grayish margins with several dark spots. The female's front wings are nearly black.

**Egg**—The egg is greenish white and less than 1 mm in diameter.

**Larva**—The larva is a slender, bluish-green, brown-striped caterpillar up to 19 mm long.

**Pupa** —The pupa is brownish and about 8.5 mm long.

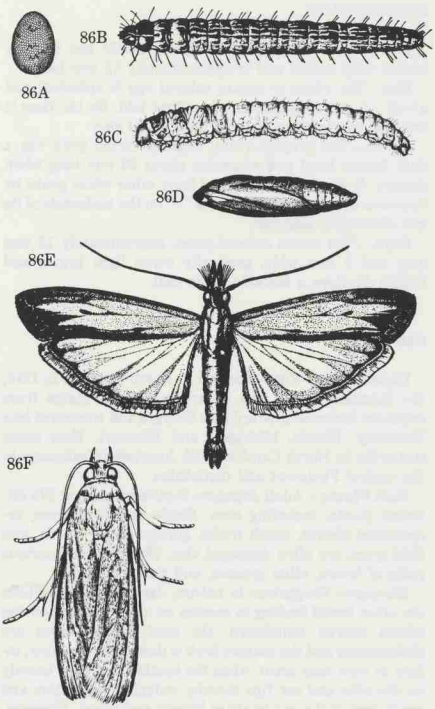



**Fig. 86 Lesser cornstalk borer. A, Egg. B-C, Larvae. D, Pupa. E, Adult. F, Adult at rest.**

### BIOLOGY

**Distribution**—Although the lesser cornstalk borer is found from Maine to southern California, the bulk of its damage occurs in the southern states, particularly Alabama, Georgia and South Carolina. It is also found in Mexico, Central America and South America.

**Host Plants**—The lesser cornstalk borer prefers corn, but it also feeds on beans, cowpeas, crabgrass, Johnson grass, peas, peanuts, sorghum, soybeans, and wheat.

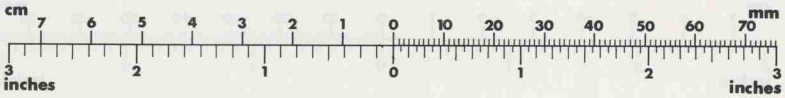
**Damage**—The larva of this small moth has been sporadically injurious to the seedlings of many plant species, and seems to be on the increase in the South. Injury is caused when the larva bores into the stalk of the host plant, thereby disrupting the growing point. Damage can be slight, or it can kill the plant. Damage is most prevalent during drought conditions in crops grown on sandy soils.



**Life History**—These borers hibernate as larvae or pupae. In North Carolina, they usually overwinter as larvae which develop into pupae before spring. The moths emerge early in the spring and lay their eggs on the host's leaves or stems. The eggs hatch in about a week. The larvae feed first on the leaves or roots. Later they construct underground silken tubes or burrows from which they bore into plants near the ground line. They become fully grown in 2 to 3 weeks, leave their burrows, and spin silken cocoons under trash on the surface of the ground. In these cocoons, they change to pupae from which moths emerge in 2 to 3 weeks. Two generations are known to occur in most southern states.

### CONTROL

Cultural practices, such as clean cultivation and weed destruction along fence rows, have long been recommended for lesser cornstalk borer control. Recent research findings in Georgia, however, indicate that cultivation promotes, rather than retards, injury by this insect. The fact that damage by the lesser cornstalk borer is rare under no-tillage cropping systems has been attributed to increased




* *Elasmopalpus lignosellus* (Zeller), Pyralidae, LEPIDOPTERA

soil moisture and the presence of decaying organic matter. Under conventional cropping systems, the cultural practice of late fall plowing may still be of some benefit since it kills overwintering life stages. For more specific control information, consult current North Carolina State Agricultural Extension Service recommendations.

## CORN/SORGHUM
### Maize Billbug*

### DESCRIPTION

**Adult**—The robust adult is a shiny black weevil when clean; in the field, however, it is often so covered with dirt that it resembles a small clod. It ranges from 10 to 14 mm long and is often found attached upside down to seedling cornstalks near the ground line.

**Egg**—The cream colored, kidney-shaped egg is about 3 mm long and 1 mm in diameter.

**Larva**—The larva is cream colored and legless, with a distinct reddish-brown head capsule. It varies from 5 to 15 mm in length.

**Pupa**—The pupa is cream colored to reddish black, depending upon its age, and ranges in length from 15 to 20 mm. Some adult features—legs, antennae, and beak —are apparent.

### BIOLOGY

**Distribution**—The maize billbug first attracted attention during the late 1800's in the corn fields of Alabama, South Carolina, and Kansas. Although this species has been found as far north as Michigan, it is a more serious pest in the southern states. In North Carolina, this billbug occurs over the entire Coastal Plain. Close field observations and a recent survey indicate that the heaviest infestations occur in the western Coastal Plain counties bounded on the north by Wilson, Johnston and Wake counties. Surveys for billbug detection should be directed toward border rows and volunteer clumps.

**Host Plant**—Corn is the preferred host of maize billbugs. However, these insects have been collected from sorghum, cattails, and many species of wild grasses, reeds, rushes, and sedges.



**Damage**—The maize billbug is one of two billbug species which annually damage corn in the Coastal Plain of North Carolina. Although it causes similar damage, the other species, *S. callosus*, is apparently more abundant and difficult to control in both North and South Carolina. The adult billbug pierces corn seedling stalks with its beak, damaging the tender inner tissue. This injury often causes stunting or death of seedlings. Stunted plants usually produce excessive suckering and become deformed and nonproductive. Plants which survive attack are marked by rows of holes across the blades. In addition to adult attack, maturing larvae tunnel in the basal area of the stalk. Extensive damage is generally restricted to non-rotated corn fields or areas adjacent to the previous year's corn.

**Life History**—During April and May, the overwintering adults, which rarely fly, emerge from litter in the field, ditches or hedgerows. After feeding and mating, females lay about 200 eggs. Eggs are deposited in holes chewed out by females in the basal area of host plants. The tiny, legless larvae hatch from the eggs in 4 to 15 days and feed for several weeks in and around the taproot. Although several larvae have been observed in the taproot area of a single corn plant, there is usually only one larva per infested stalk. Larval development is complete in 40 to 50 days, and pupation occurs in cells in or near the excavated taproot. After a 2-week pupal stage in August or September, the

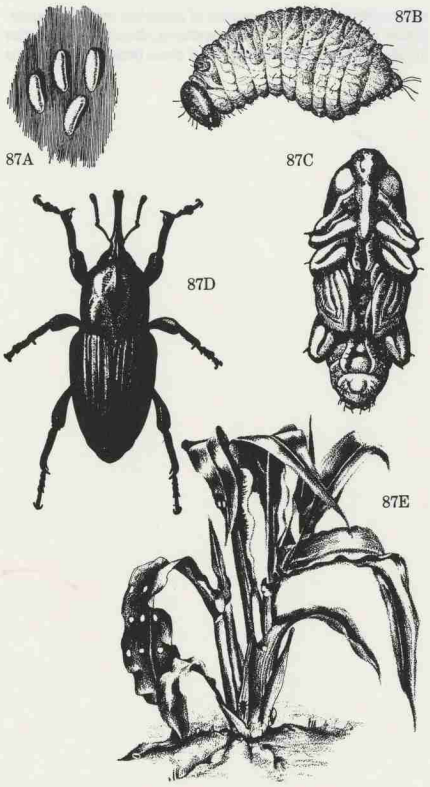
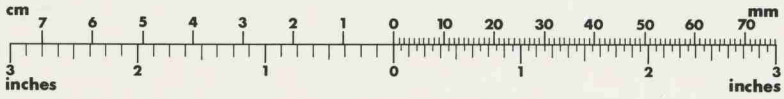



**Fig. 87 Maize billbug. A, Eggs. B, Larva. C, Pupa. D, Adult. E, Adult injury to foliage.**




* *Sphenophorus maidis* Chittenden, Curculionidae, COLEOPTERA

adults emerge from pupal skins and either remain within pupal cells or exit and feed before entering hibernation. Only one complete generation occurs each year.

## CONTROL

Rotation is the cheapest and most effective method of control. After overwintering , the adults crawl to the corn; therefore, rotating the corn approximately 0.4 kilometer (¼ mile) from its previous location will provide effective control. A 5 percent loss of an optimum stand is recognized as an economic threshold in North Carolina. For additional control information, consult the current *North Carolina Agricultural Chemicals Manual.*

Notes

## CORN/SORGHUM
### *Melanotus communis**

### DESCRIPTION

**Adult**—*Melanotus communis* is a hard, smooth-bodied, reddish-brown to black click beetle about 13 mm long.

**Egg**—The white, glistening egg is oval to spherical in shape and 0.33 mm long.

**Larva**—This short-legged wireworm has a pale yellow to reddish-brown body and a brown, flattened head. When mature, it ranges from 21 to 25 mm in length.

**Pupa**—The white, soft-bodied pupa has no protective covering and is approximately the same size and shape as the adult.

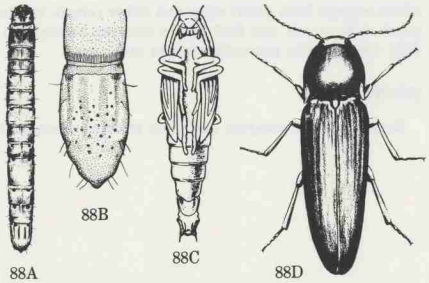



**Fig. 88** ***Melanotus communis.*** **A, Larva. B, Last larval segment. C, Pupa. D, Adult.**

### BIOLOGY

**Distribution**—*Melanotus communis* wireworms can be found throughout the United States, but are most abundant in the midwestern and southeastern states. They tend to be common in newly planted sod or no-till planted corn.

**Host Plants**—The wireworm, *M. communis*, feeds on the roots of many grasses including corn and many small grain crops. It may also attack the roots, seeds, and tubers of many flower and vegetable crops, especially potatoes. This species has been known to infest tobacco.

**Damage**—The most significant wireworm damage occurs to germinating seeds and seedling plants. Wireworms feed on the seed and often leave only the empty hull (pericarp). Roots are snipped off as they emerge and often rot. Corn seedlings 5 to 20 cm high are damaged when wireworms tunnel in or feed superficially upon the underground stem and taproot area of plants. Recent injury of this kind may be characterized by the presence of rot and jelly-like plant secretions. Above-ground symptoms include yellowing and wilting or death of terminal shoots. *Melanotus communis* does more damage during cold, wet springs, especially in fields which have been grassy or weedy for the previous year or more.

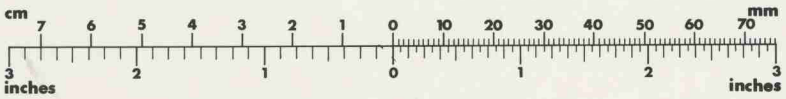
**Life History**—This wireworm species has a six-year life cycle. In June of the first year, adults deposit eggs singly among the roots of grasses. First instar larvae emerge in July and begin feeding on roots. The first year, larvae continue to develop throughout the summer and overwinter in the ground as second instars. Most of these immatures remain in the larval stage for 5 years although life cycles as short as 3 years have been reported. In late July or August of the sixth year, mature larvae construct oval cells 15 to 30 cm deep in the soil and pupate. *Melanotus communis* beetles emerge about 18 days later and feed on pollen before hibernating in protected areas. They become active and deposit eggs the following May or June.

### CONTROL

Cultural methods of controlling wireworms include summer plowing of fallow fields and crop rotation. Plowing to a depth of 23 cm (9 inches) around the first of August will dry out the soil and break up the insects' cell-like chambers, killing large numbers of pupae and adults. Legumes are more tolerant to feeding by these pests and are therefore excellent crops with which to rotate corn. Rotating corn with small grains and planting crops in well-drained soils are additional control measures effective against *Melanotus communis*.

For specific chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*






* (no common name), *Melanotus communis* Gyllenhal, Elateridae, COLEOPTERA

## DESCRIPTION

**Adult**—This gray, black-legged fly has scattered bristles on its body and is approximately 5 mm long.

**Egg**—Each white, elongate egg has a rough surface and is about 1 mm in length.

**Larva**—This 12-segmented, white to yellow maggot is 5 to 7 mm long when mature. It is legless and tough skinned with a sharply pointed head and a rounded tail.

**Pupa**—The last larval skin hardens to form a puparium (about 5 mm long) in which the pupa develops. The ivory puparium gradually turns reddish brown as the pupa matures.

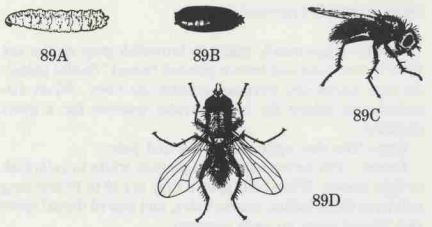



**Fig. 89 Seedcorn maggot. A, Larva. B, Puparium. C-D, Adults.**

## BIOLOGY

**Distribution**—The seedcorn maggot was not identified in North America until 1855 when it was discovered in New York. Common throughout the temperate zones of the world, it has now been identified in all arable portions of North America from southern Canada into Mexico. Although widespread in the United States, it has not been found at altitudes in excess of 1.4 km (4500 ft) above sea level.

**Host Plants**—Although it feeds primarily on decaying organic matter, the seedcorn maggot infests the germinating seeds and roots of over 47 living plants. Beans, soybeans, and peas are the most seriously damaged hosts. To a lesser extent, crucifers, cereals, potato seed pieces, cucurbits, corn, tobacco, onions, pepper, buckwheat, and alfalfa are also injured by this pest.

**Damage**—This insect is usually a problem during cold, wet seasons and in highly organic soils. Seedcorn maggots feed on the seed contents often leaving only empty shells and thereby causing seed death or poor germination. The seedlings which do emerge are tall and spindly with few leaves. They rarely mature and, even then, maturity is late and seed quality poor. Occasionally seedcorn maggots tunnel in these seedling stems. Either type of feeding allows the entry of disease-causing organisms.

**Life History**—In North Carolina, all stages of the seedcorn maggot can be found throughout the winter. Further north, however, the insects overwinter in the soil as pupae. The adult flies emerge from puparia at night or early in the morning and push themselves up to the soil surface. For a variable length of time, adults feed on nectar and honeydew. At the end of this period, each fertilized female begins laying an average of 270 eggs, singly or in small clusters. Moist, freshly disturbed soil, fields with decaying seed or crop remnants, and/or organically fertilized soils are all attractive to ovipositing female flies.

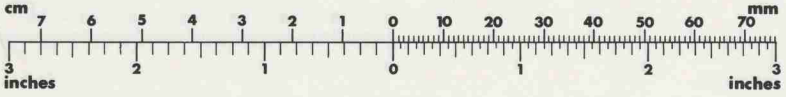
Eggs hatch in 1 to 9 days depending on the temperature. The newly hatched larvae tunnel in seeds or other decaying vegetable matter. Maggots remain active at temperatures as low as 4.4°C (40°F). They develop through three larval stages. After feeding for 1 to 3 weeks, the larvae pupate as deep as 18 cm in the soil. Pupation may last 7 to 26 days or all winter.

## CONTROL

For control of seedcorn maggots in field or vegetable crops, shallow planting in a well-prepared seedbed, sufficiently late so that quick seed germination is ensured, is one means of preventing injury. A field where manure is heavy or where a cover crop is turned under should be plowed early in the fall, if possible; it will be less attractive to the egg-laying flies the following spring. Prompt resetting or replanting of damaged crops will usually give a good stand.

Combination fungicide-insecticide seed treatments or soil-applied insecticides can be used to prevent seedcorn maggot damage. For further control information, consult current North Carolina State Agricultural Extension Service recommendations.






* *Hylemya platura* (Meigan), Anthomyiidae, DIPTERA

## CORN/SORGHUM
### Sod Webworms*

DESCRIPTION (several species)

**Adult**—These small, white to brownish-gray moths are 13 to 19 mm long and have a pointed "snout" (labial palps). At rest, wings are wrapped around the body. When disturbed, the moths fly in an erratic manner for a short distance.

**Egg**—The tiny eggs are oblong and pale.

**Larva**—The larvae vary from pinkish white to yellowish to light brown. When fully grown they are 16 to 19 mm long and have thick bodies, coarse hairs, and paired dorsal spots and lateral spots on each segment.

**Pupa**—The reddish-brown pupae are about 13 mm long.

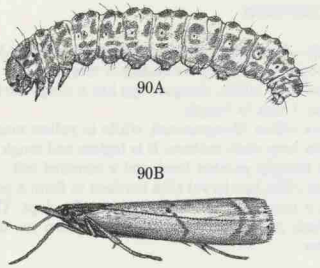



**Fig. 90 Sod webworm. A, Larva. B, Adult.**

### BIOLOGY

**Distribution**—Many species of webworms, all native to America, periodically infest corn throughout the United States and Canada. Damage by these pests, however, is most prevalent in a central band of states from North Carolina and Massachusetts westward into Iowa.

**Host Plants**—Webworms primarily infest the roots of many grasses causing problems in lawns, golf courses, and pastures. They are usually a threat to field crops such as corn and tobacco only when these crops follow sod. Some species overwinter near the roots of weeds such as stickweed, plantain, and fleabane.

**Damage**—Webworms attack the roots of seedling corn plants. The larvae feed on the stalk at or below the soil surface. As the leaves emerge, they are ragged, distorted, and almost perpendicular to the stem. When webworm damage is heavy, the whole plant may be curled or twisted and the growing point killed. Careful examination around the base of an infested plant will reveal scarred or damaged tissue on one side of the stem plus at least one hole extending into the center of the plant. Fine silken strands intermingled with bits of plant material or soil pellet cocoons are usually present.

**Life History**—Webworms overwinter within silk-lined tubes in the soil. Early in the spring, they emerge and feed at night on roots of grasses, weeds, and cultivated plants. In southern states, larvae have usually completed feeding by June 1, whereas in Ohio and Indiana feeding may continue until July 1. When mature, the larvae pupate within a silk-lined cocoon made up of soil particles and leaf blades interwoven with silk. Moths emerge 10 days to 2 weeks later, push their way to the soil surface, and mate soon afterwards. For the few days that they live, female moths fly at dusk and drop eggs over grassy areas. Eggs hatch in approximately 7 days. Depending on geographic location and the particular webworm species, these pests complete one to three generations each year.

### CONTROL

Cultural methods are very important in controlling webworms in corn. If possible, avoid planting corn in fields which were in pasture or sod the year before. Where this is impossible, plow the grassy field under in mid-summer or early fall the year before planting corn. This cultivation will help deter egg deposition and destroy many overwintering larvae. The next year, plant high quality, certified seed at the proper time, fertilize the crop well to give it a good start, and use a granular, labeled, soil insecticide. Varieties particularly susceptible to the European corn borer are also easily damaged by webworms.

For further control information, consult current North Carolina State Agricultural Extension Service recommendations.




* *Crambus* spp., Pyralidae, LEPIDOPTERA

## DESCRIPTION

**Adult**—The sorghum midge is an orange fly, the male measuring approximately 1.3 mm in length and the female 1.6 mm.

**Egg**—Each white, cylindrical egg, 0.3 by 0.6 mm, is attached to the host spikelet by a slender, tapering stalk.

**Larva**—The newly hatched larva is colorless. As it feeds on the developing grain, it gradually becomes pale pink to a deeper pink, then orange, and finally a darker orange or red-orange. The full-grown larva, 1.5 to 2.0 mm long, is slightly flattened and spindle-shaped, tapering to a point at the head.

**Pupa**—At first, the pupa is uniformly dark orange, but after a few hours the head, antennae, legs and thorax darken until they become black. Only the abdomen retains the orange color.

## BIOLOGY

**Distribution**—The sorghum midge occurs in nearly all areas of the world where sorghum is grown. In the United States, it occurs from Virginia to Florida and as far west as Texas. It is an important full-season pest in Texas and a threat to late-planted sorghum in southeastern states such as North Carolina. Areas where sorghum has been grown for several years and where Johnson grass is prevalent are typically infested.

**Host Plants**—Johnson grass and grain sorghum are the primary host plants of the sorghum midge. Although the midge has been reported on and reared from 14 other grasses, these hosts generally are not considered suitable for normal midge development.

**Damage**—Larvae of the sorghum midge feed on the ovary thereby preventing normal seed development. Infested heads appear blighted or blasted and produce small, malformed grain.

**Life History**—Sorghum midges overwinter as larvae in aborted sorghum spikelets. They spin cocoons inside the spikelets where they may remain in a resting stage, resistant to cold and dessication for as long as 2 or 3 years. Under favorable conditions, however, pupation and emergence take place the following spring at about the time Johnson grass begins to bloom. After mating, each female then deposits 30 to 120 eggs, singly, in the flowering spikelets of this grass. The eggs hatch 42 to 60 hours later, depending upon the temperature. The first two generations of the sorghum midge can be found on Johnson grass, after which a migration occurs to the flowering sorghum spikelets. Under normal summer temperatures, the complete life cycle requires 14 to 16 days. Under warm (26°C), humid conditions, at least nine generations per year are possible in North Carolina.

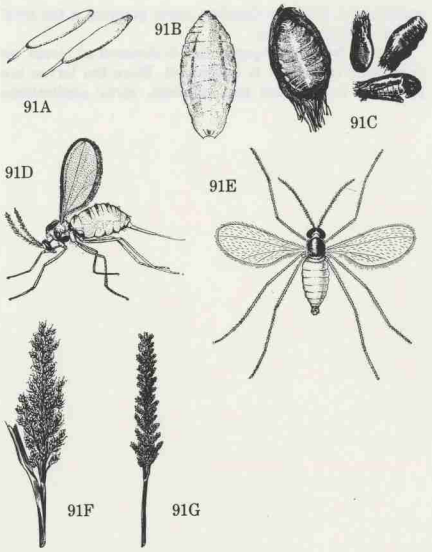
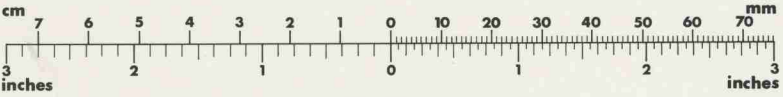



**Fig. 91 Sorghum midge. A, Eggs. B, Larva. C, Pupae in cocoons. D, Adult female. E, Adult male. F, Normal sorghum head. G, Damaged sorghum head.**



## CONTROL

Several cultural practices have been recommended for control of the sorghum midge. These include preventing Johnson grass or other hosts from producing heads in and around sorghum fields before the crop blooms, planting at the time of year best suited for the variety selected, and destroying crop residues which may contain overwintering larvae. If early- and late-maturing varieties are to be grown in close proximity, some benefit may be derived by placing fields so that prevailing winds blow toward the




* *Contarinia sorghicola* (Coquillett), Cecidomyiidae, DIPTERA

earlier field. In North Carolina, early planting is the most logical control practice.

When a large adult population is detected at bloom, an insecticide treatment is warranted. Since the larvae are protected in the seed and spikelets, spray applications should be directed toward the ovipositing females which are particularly abundant for several days after the sorghum head emerges. For specific information concerning insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*

## DESCRIPTION

**Adult**—This small, whitish moth has a wingspan of 12 to 16 mm. The wing pattern is poorly defined and variable.

**Egg**—The egg, 0.5 by 0.3 mm, is round to oval and slightly flattened. It is white with a pale green-yellow tinge when laid, but changes to straw yellow over a 2-day period. As it matures the color darkens to deep yellow or brown.

**Larva**—The newly hatched, pale green caterpillar averages 0.7 mm in length. Later instars, still green to tan in color, are thickly covered with spines and hairs, bear four red-to-brown longitudinal stripes on their back and have four pairs of fleshy prolegs. The caterpillar is sluggish and has a maximum length of 9 to 14 mm.

**Pupa**—The lower surface of the pupa is generally light yellow to brown in color, while the upper side is reddish brown. Length ranges from 6.0 to 9.5 mm.

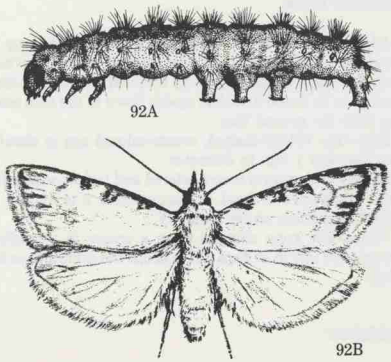



**Fig. 92 Sorghum webworm. A, Larva. B, Adult.**

## BIOLOGY

**Distribution**—The sorghum webworm is a major pest of grain sorghum in Central and North America. In North America, the range of the sorghum webworm extends north to Illinois and Nebraska and south to Panama and Puerto Rico. It is most damaging in areas where the annual precipitation averages 76 cm or more. In North Carolina, damage occurs statewide where sorghum is grown.

**Host Plants**—Although grain sorghums with compact seed heads seem to be their preferred food source, sorghum webworms will also feed on sweet sorghum, Sudan grass, Johnson grass, corn, rye and timothy.

**Damage**—On sorghum, the caterpillars feed only on the ripening grain, consuming the contents of individual kernels and leaving the outside hull intact. Losses in individual fields may be as high as 30 to 80 percent; however, extensive damage rarely occurs during seasons characterized by prolonged spells of hot, dry weather.

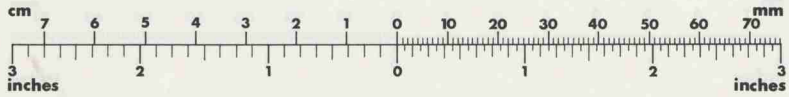
**Life History**—Sorghum webworms average four generations per year in North Carolina. Webworms spin cocoons and overwinter in the larval stage behind the appressed leaves of the host plant stalk sheath. The overwintering caterpillars begin to pupate when mean daily temperatures reach 14° to 15°C (57° to 59°F). The pupal period may last 5 to 9 days. The adults are nocturnal and live 10 to 20 days during which time the females deposit an average of 88 eggs singly on protected areas of the flowering parts or seeds of the host plant. The population grows slowly up to the middle of the season after which these insects increase rapidly. The larvae usually develop through five instars in 13 days. Twenty-four days lapse from the egg stage to the emergence of adult moths.

## CONTROL

Cultural control practices include the destruction of crop residues to destroy overwintering larvae, and early planting to escape the late-season buildup in webworm populations. Warm, dry weather also effectively deters damaging infestations.

An infestation of three larvae per sorghum head is currently recognized as a threshold in North Carolina. For up-to-date insecticide recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*






* *Celama sorghiella* (Riley), Noctuidae, LEPIDOPTERA

## CORN/SORGHUM
### Southern Corn Billbug*

### DESCRIPTION

**Adult**—The weevil is robust and generally ash gray or brownish in color. It is usually covered with soil which gives it the appearance of a small dirt clod. The 12-mm-long weevil can be found attached upside down to the corn seedling near the ground line.

**Egg**—The kidney-shaped, cream-colored egg is about 3 mm long and 1 mm in diameter.

**Larva**—The grub is cream colored and legless with a distinct reddish-brown head. It ranges from 2 to 12 mm in length, depending on its maturity.

**Pupa**—The pupa changes from a cream to a reddish-brown color in 7 to 10 days and is about the same size as the adult.

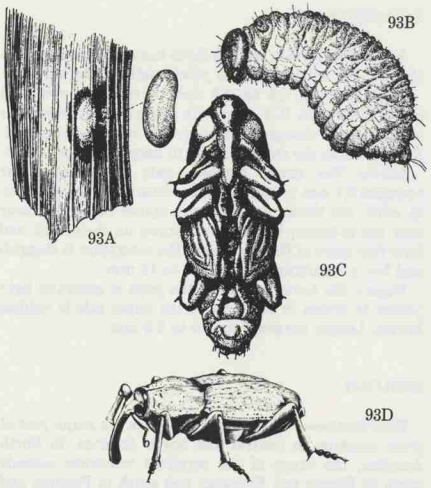



**Fig. 93 Southern corn billbug. A, Egg. B, Larva. C, Pupa. D, Adult.**

### BIOLOGY

**Distribution**—Southern corn billbug damage is most apparent in the Coastal Plain of the Carolinas and Georgia. However, this pest damages corn over the entire Coastal Plain of the southern states and up the Mississippi River valley into the Midwest. Surveys for billbug detection should be directed toward border rows and volunteer clumps of corn.

**Host Plants**—The southern corn billbug appears to prefer corn, but also attacks sorghum and several species of sedges, particularly nutsedge.

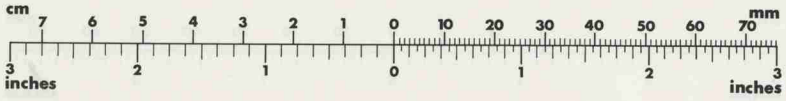
**Damage**—Adults feed on the tender inner tissue of seedling corn. During feeding their beaks pierce through the outer leaf sheath into developing tissues causing dieback of terminal blades, rows of tranverse holes on the blades and excessive suckering in plants which survive. In addition to adult attack, larvae develop in and around the underground portion of the stalk. Extensive damage is generally restricted to nonrotated cornfields or to areas adjacent to the previous year's corn.

**Life History**—The overwintering adults, which rarely fly, emerge during April and May from litter in fields, ditches and hedgerows. Each female feeds, mates and lays about 200 eggs, usually at night. They are laid in holes chewed out by the female in the basal area of the host plant. In 4 to 15 days, tiny legless, grublike larvae hatch, migrate down the outside of root crowns, and feed in roots and lower stalks. There is usually only one larva per cornstalk though as many as five have been known to attack the same stalk. The larvae develop in 40 to 70 days and pupate in or around the excavated taproot. Most pupae occur from July to September. Adults develop in 7 to 10 days and either remain within pupal cells or emerge to feed before hibernation. There is only one generation per year.



### CONTROL

Rotation is the cheapest and most effective method of control. After overwintering, the adults crawl to corn; therefore, effective control can be achieved by rotating the crop approximately 0.4 kilometer (¼ mile) from its previous location. A 5-percent loss of an optimum stand is recognized as an economic threshold for adult billbugs in North Carolina. For further control information, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Sphenophorus callosus* (Olivier), Curculionidae, COLEOPTERA

## DESCRIPTION

**Adult**—The adult beetle is about 6 mm long with a bright yellowish-green body. The head, legs, and antennae are black, and twelve black spots are present on the wings.

**Egg**—The egg is dull yellow, oval, and about 0.6 mm long (the size of a pinhead).

**Larva**—The fully grown larva is 15 to 16 mm long with a yellowish-white, somewhat wrinkled body. It has six tiny brownish legs.

**Pupa**—White to yellow in color, the pupa is about 6 mm long.

## BIOLOGY

**Distribution**—The southern corn rootworm is widely distributed, occurring in most areas east of the Rocky Mountains, in southern Canada, and in Mexico. It is most abundant and destructive in the southern states.

**Host Plants**—Southern corn rootworm larvae infest the roots of many grass crops and weeds as well as those of peanuts, alfalfa, and occasionally cucurbits. They are most damaging to corn and peanuts. The beetles are general feeders on at least 280 plant species, including most cultivated crops. They prefer broadleaved hosts, especially cucurbits, and are particularly attracted to flowers.

**Damage**—The southern corn rootworm prefers moist soil and is most injurious to corn during cold, wet springs. Corn is most likely to be injured if it is under no-till culture, in a continuous rotation, or following turned-under winter legumes. Both the adults and larvae damage corn, but the larvae are more destructive.

Larvae cause corn injury in the spring. They chew out round holes (0.75 mm in diameter) through the growing points, killing the terminal blades. Stands may be reduced 50 to 90 percent or more. Extensive feeding on the roots may occur late in the season. Plants with severe root damage lodge during wind and rain storms, often causing the stalks to "goose neck" and making harvest more difficult. In addition to direct injury, rootworms transmit bacterial wilt disease from infected plants to healthy plants and make wounds that allow the entry of rot organisms.

Although the larvae cause most of the injury to corn, the adults feed upon every part of the plant above ground. Most damaging is their feeding on newly emerging, unpollinated silks causing sparsely filled ears. The beetles also carry the bacterial wilt organism, but plants are more often inoculated by contaminated larvae.

**Life History**—The beetles overwinter in any kind of vegetative cover, though they prefer the bases of plants that have not been killed by frost. In southern states, the adults first become active about the middle of March and lay eggs from late April to early June. Eggs are laid singly, each female producing as many as 500. They hatch in 7 to 10 days, depending on the temperature. The larvae feed for 2 to 4 weeks before pupating. First-generation adults emerge from late June to early July in the southern states. A complete life cycle requires from 6 to 9 weeks.

In the southern states, including North Carolina, there are two, and sometimes three, generations per year. In areas where there are multiple generations, the larvae of first-generation eggs are found on the roots of corn from late spring until mid-summer. Second-generation adults are found from September to November. These adults assemble on clover and alfalfa upon which they feed until winter. They may come out to feed during warm periods in January and February.

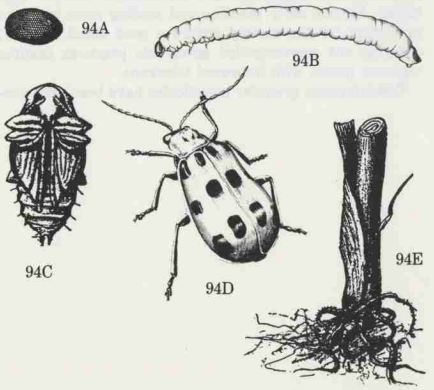
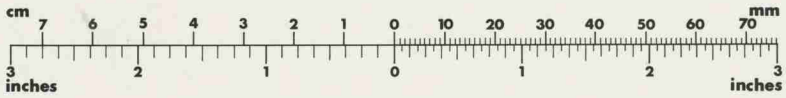



**Fig. 94 Southern corn rootworm. A, Egg. B, Larva. C, Pupa. D, Adult. E, Rootworm injury.**

## CONTROL

Both cultural and chemical methods are used to control rootworms. In the South, the following cultural practices reduce the southern corn rootworm population. First, early plowing and/or discing at least 30 days before planting






* *Diabrotica undecimpunctata howardi* Barber, Chrysomelidae, COLEOPTERA

corn removes vegetation and discourages further egg-laying. Second, early planting and seeding rates near the maximum for the variety ensure a good stand. Finally, carrying out recommended agronomic practices ensures vigorous plants with improved tolerance.

Preemergence granular insecticides have been very successful in the control of southern corn rootworms. In North Carolina corn or sorghum crops, it is not currently economically feasible to control the larvae by spraying the adults. For further control information, consult the current *North Carolina Agricultural Chemicals Manual.*

## DESCRIPTION

**Adult**—The adult is a straw-colored or dull white moth with a wingspan of 15 to 40 mm (females larger than males). The forewings are slightly darker than the hind wings.

**Egg**—The flat, elliptical egg, approximately 1.3 mm by 0.8 mm, is creamy white when laid but later develops an orange hue due to the presence of three transverse, orange-red lines.

**Larva**—The full grown larva is approximately 25 mm long. The winter form is creamy yellow with a dark brown head. The summer form is milky white and covered with black spots, each bearing a short, dark bristle.

**Pupa**—About 22 mm long, the pupa is the same color as the larva when first formed but later changes to a reddish brown.

## BIOLOGY

**Distribution**—The southern cornstalk borer occurs from Alabama and northern Florida to Ohio and Maryland. A 1974 survey in North Carolina revealed that infestations rarely occur in the mountain counties.

**Host Plants**—The southern cornstalk borer attacks corn, grain sorghum, sugarcane, broomcorn, and Johnson grass.

**Damage**—Young caterpillars feed within the plant whorl. As the leaves unfold, rows of irregular holes may appear. Larvae also tunnel in the midribs of leaves, and sometimes destroy growing points within leaf whorls. As larvae grow larger they tunnel into stalks. Tunnelling may be extensive in the lower portion of the stalk, primarily just above the soil line and into the taproot. This damage may be very destructive because of reduced nutrient and water uptake. Often the southern cornstalk borer is not noticed until severe stalk damage has occurred.

**Life History**—Southern cornstalk borers overwinter as larvae within cavities in corn taproots. In March or April, they change into pupae. Approximately 10 days later, moths emerge, mate, and begin laying eggs at night, usually on the underside of lower leaves. The flat eggs are laid either singly or in small clusters of 2 to 25 overlapping one another like shingles When the eggs hatch 7 to 10 days later, larvae move into the whorl of the plant, feeding on the leaves and spinning a silken thread behind them. Third- or fourth-instar larvae move down the stalks and eventually tunnel inside not far above the ground. In the summer, southern cornstalk borers live from 20 to 35 days and develop through seven instars. Mature larvae seal off the tunnels with frass and form cells in which to pupate. Summer pupation occurs in the above-ground stalk; pupation of the hibernating generation occurs in the base of the stalk or in large roots. Southern cornstalk borers have two generations per year.

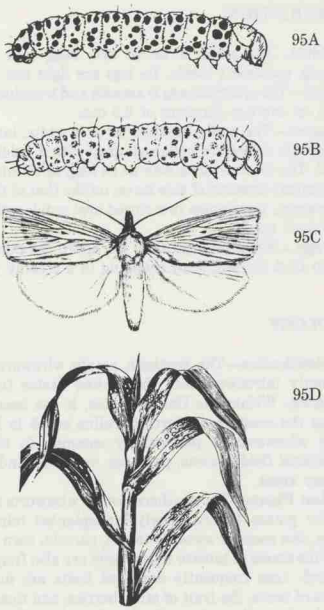
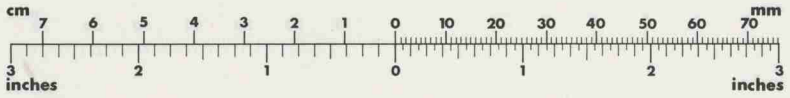



**Fig. 95 Southern cornstalk borer. A, Summer larva. B, Winter larva. C, Adult. D, Damage to leaves.**

## CONTROL

Disc fields in the fall to reduce overwintering populations. Southern cornstalk borers cannot survive the winter in uprooted exposed stalks. Two years of successive corn crops on the same land usually enhance cornstalk borer populations; therefore, crop rotation is recommended. For specific information on insecticides and rates, consult current North Carolina State Agricultural Extension Service recommendations.




* *Diatraea crambidoides* (Grote), Pyralidae, LEPIDOPTERA

## CORN/SORGHUM
### Southern Potato Wireworm*

### DESCRIPTION

**Adult**—The adult, 6 to 8.5 mm long, is a brownish, oblong, pubescent beetle. Its legs are light tan.

**Egg**—The spherical egg is smooth and translucent white, with an average diameter of 0.5 mm.

**Larva**—The newly hatched larva is white, later becoming cream colored or yellowish gray with a reddish orange head. The mature larva may be as long as 17 mm. The last abdominal segment of this larva, unlike that of the tobacco wireworm, terminates in a closed oval notch rather than a V-shaped notch.

**Pupa**—Slightly larger than the adult, the pupa is white when first formed, soon changing to a creamy yellow.

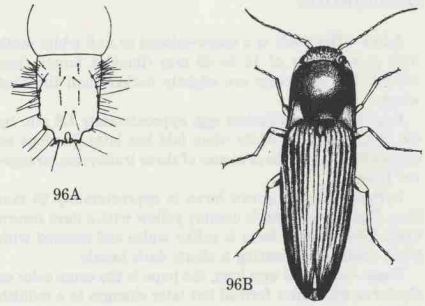



**Fig. 96 Southern potato wireworm. A, Last abdominal segment of larva. B, Adult.**

### BIOLOGY

**Distribution**—The southern potato wireworm was apparently introduced into the United States from South America. Within the United States, it has been reported along the coast from North Carolina south to Louisiana. This wireworm is particularly common in the soil of cultivated fields, lawns, pastures, orchards, and weedy or grassy areas.

**Host Plants**—The southern potato wireworm appears to prefer potato tubers. Newly transplanted tobacco seedlings, the roots of sweet potatoes, carrots, corn seedlings, and the stems of tomato transplants are also frequently attacked. Less frequently damaged hosts are melons, the roots of beets, the fruit of strawberries, and tomatoes that touch the soil surface. Seeds of various small grains, grasses, and sorghums are damaged.

**Damage**—Damage from this insect is most severe in nonrotated or minimum-till corn fields of the South. These wireworms threaten the establishment of vigorous stands of field corn by feeding on germinating seeds and the roots of corn seedlings. Above ground, symptoms appear as tip dieback. Later symptoms include yellow streaking in leaves of older plants or severe wilting. Underground symptoms include tunnels in the root crown, a jelly-like exudation from injured corn stems, and root pruning. In severe infestations, tunneling in the roots of larger plants has been observed.

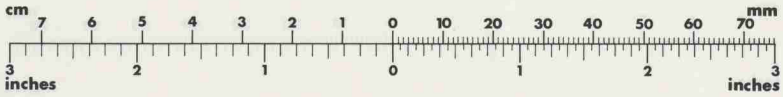
**Life History**—Although adults are found in fields throughout the year in some areas of South Carolina, southern potato wireworms are believed to overwinter as larvae in North Carolina. Their biology, however, has not been studied in this state. Adults from overwintering larvae begin to appear in large numbers during May, reaching their peak abundance in June. Each first generation female lays an average of 36 eggs. The larvae which emerge comprise the "short-cycle" brood and require 42 to 109 days to mature. Adults of this "short-cycle" brood are abundant in late August and in September. They mate and lay eggs of the "long-cycle" brood, or overwintering generation, which requires 239 to 318 days for development from egg to adulthood. There are two generations annually.



### CONTROL

No insect parasites or predators of this wireworm are known. Three disease-causing agents—a fungus, a protozoan, and a parasitic nematode—have been isolated , but their usefulness in the control of this wireworm has not been determined.

Rotation to nonhost crops such as soybeans should be the first defense. At planting, in-furrow applications of granular insecticides have been used successfully to control this pest in corn fields, but use is limited by expense and by variability in wireworm populations. A problem has been this wireworm's development of resistance to some chlorinated hydrocarbon and organophosphate insecticides. For up-to-date control information, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Conoderus falli* Lane, Elateridae, COLEOPTERA

## DESCRIPTION (two species)

**Adult**—Carmine and twospotted spider mites are differentiated on the basis of live summer female forms. Carmine spider mite females are red; twospotted spider mite females are yellowish to dark green. Oval and about 0.4 mm long, females of both species have two or four dark, dorsal spots. Smaller than the females, males of these two species have slightly pointed abdomens. Adults of both species have eight legs.

**Egg**—The eggs are spherical, and white to transparent when first laid. Just before hatching, they become straw colored and average 0.14 mm in diameter.

**Larva**—Not much bigger than eggs, the six-legged larvae are colorless except for carmine eye spots.

**Nymphs**—The two, eight-legged nymphal instars are difficult to distinguish. Both instars are oval, pale green to deep green, sometimes spotted, and slightly smaller than adults.

## BIOLOGY

**Distribution**—The twospotted spider mite is cosmopolitan. The carmine spider mite has been reported in scattered areas throughout the world and is probably also a cosmopolitan species. In the North Carolina Coastal Plain, the twospotted spider mite causes more damage to corn and sorghum than the carmine spider mite.

**Host Plants**—In view of recent taxonomic revisions which establish the carmine spider mite as a species separate from the twospotted spider mite, it is difficult to separate the host ranges of these two mites. Before the change, the twospotted spider mite (*Tetranychus urticae* and *T. cinnabarinus*) was recorded on over 180 host plants, including 100 cultivated species. Violets, chickweed, pokeweed, wild mustard, and blackberry are probably common hosts of both species from which infestations spread to nearby crops. Although these two species have been reported to infest grain sorghums since the early 1970's, forage sorghums appear to be resistant.

**Damage**—Feeding on corn and sorghum usually occurs on the undersides of leaves, where spider mites pierce the epidermis and extract sap. Lightly infested leaves have a stippled appearance; heavily infested leaves turn completely pale and dry up. The entire plant may die. The undersurfaces of the leaves usually have silken webs over which the mites crawl. A heavily infested plant, however, may have webs all over it, including the grain heads or ears. A rapid increase in spider mite populations is closely

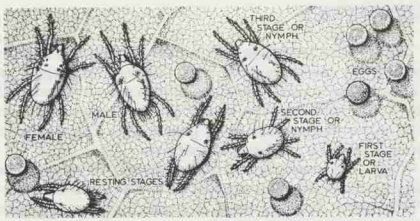



**Fig. 97 Twospotted spider mite life stages.**

associated with drought conditions and symptoms are very similar from a distance.

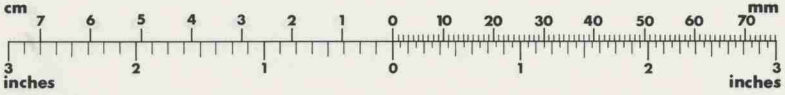
**Life History**—As a general rule, these spider mites overwinter as fertilized females resistant to low temperatures. In mild winters, they may continue to feed and lay eggs. In summer, many generations (7 or more) develop; the number of eggs laid depends largely on temperature. Within 1 to 3 weeks, eggs hatch into six-legged larvae which develop into eight-legged nymphs. There are two nymphal stages. After the larval and each nymphal stage, a resting stage occurs.

Adults mate soon after emerging from the last resting stage. In warm weather, the females soon begin laying approximately 100 eggs each. Development is rapid in hot, dry weather. A generation requires 1 to 3 weeks to mature.

## CONTROL

One form of cultural control is the destruction of weeds around fields in the fall or early spring. This practice eliminates much of the overwintering mite population. However, avoid destroying weeds or clearing fence rows adjacent to cultivated fields during the growing season. This practice forces mites to migrate into field crops. Two other cultural controls, trap crops and clean turn rows, also help reduce infestations.

Control measures, such as acaricide applications, resistant host plants, or sprinkler irrigation, are most effective in giving short-term relief of mite infestations. The need for chemical spider mite control on North Carolina corn and sorghum is rare, perhaps due to a fungal disease of the mites. For further control information, consult current North Carolina State Agricultural Extension Service recommendations.




* Carmine spider mite, *Tetranychus cinnabarinus* (Boisduval);
Twospotted spider mite, *Tetranychus urticae* Koch, Tetranychidae, PROSTIGMATA

## CORN/SORGHUM
### Stalk Borer*

### DESCRIPTION

**Adult**—The forewings of this moth are basically reddish or grayish brown marked with distinct white spots or obscure smoky areas. The outer third is paler and bordered by a thin white line. The hind wings are grayish brown on the upper surface and fawn gray below. The wingspan ranges from 25 to 40 mm in diameter.

**Egg**—The longitudinally ribbed egg may be spherical or slightly flattened and measures 0.4 to 0.6 mm in diameter. White when first deposited, it gradually turns brownish gray or amber before hatching.

**Larva**—Basically brown, the early larval instars have a dark brown band around the middle and brown or purple longitudinal stripes on all but the first four segments. The mature larva is solid white or light purple and may reach a length of 31.8 mm.

**Pupa**—About 16 to 22 mm in length, the light brown pupa gradually darkens as it matures.

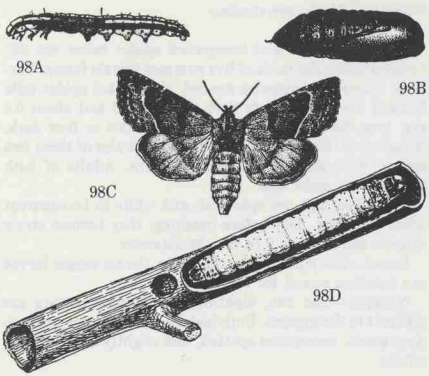



**Fig. 98 Stalk borer. A, Larva. B, Pupa. C, Adult. D, Larva and entrance hole in stem.**

### BIOLOGY

**Distribution**—The stalk borer occurs in all areas east of the Rocky Mountains from southern Canada to the Gulf of Mexico. Highest populations are associated with fields and fence rows with large-stemmed weeds. Economically significant infestations are most common in the Piedmont, particularly in no-till plantings.

**Host Plants**—Stalk borers tunnel in almost any large-stemmed plant. Their host range encompasses at least 44 families and 176 species of plants. Some cultivated crops subject to infestation include corn, cotton, potato, tomato, alfalfa, rye, barley, pepper, spinach, beet, and sugarbeet. Although many weedy plants are infested, giant ragweed is preferred.

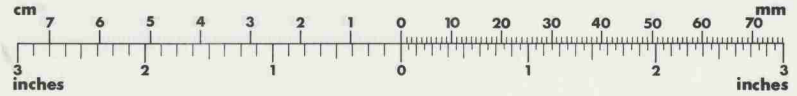


**Damage**—Stalk borers migrating from an earlier host infest corn seedlings 6 to 60 cm (2 to 24 inches) high, causing two types of injury. Larvae that enter the plant through the lower stalk tunnel upwards, severing the leaves from below. In this case, infested stalks are hollow and apparently healthy green leaves wilt and die. Other larvae climb plants, enter from the top, and feed on buds and rolled leaves. As they unfurl, the new leaves display ragged holes which increase in size as the leaves develop. Both forms of injury result in destruction of tassels, production of suckers and deformation of the upper plant. Soon after borers enter the seedlings, the stems often break. Frass is usually evident around the base of more mature infested plants. Once past the "whorl" stage, however, corn is somewhat resistant to the stalk borer and recovers more readily from damage. Damage is sporadic but most commonly associated with the border rows of conventionally planted corn and with no-till plantings.

**Life History**—Stalk borers overwinter as eggs on weedy plants. In May, the newly emerged larvae feed as leafminers on broadleaf plants or as stem borers on grasses. On all hosts, larvae eventually bore into the stem and feed until they kill or outgrow their host. When this occurs, they emerge at night and tunnel into new plants, including seedling corn. Developing through 7 to 16 instars, stalk borers mature in their second host. Late in July, the borers emerge, construct individual cells in the soil, and begin a 4-week pupal period. Stalk borer moths emerge in late summer and deposit eggs singly or in masses between the leaf sheath and stems where they remain until the following spring. One generation occurs each year.

### CONTROL

Stalk borers cannot be controlled once they have entered the plant; therefore, control measures should concentrate on prevention. Destruction of weeds in fields and along fence rows results in the elimination of many primary hosts from which the borers infest corn. Where applicable, systemic insecticides may be effective when applied in areas of highest potential damage. For specific control information, consult current North Carolina State Agricultural Extension Service recommendations.




* *Papaipema nebris* (Guenée), Noctuidae, LEPIDOPTERA

## DESCRIPTION

**Adult**—This black, hard-shelled beetle is dome-shaped and faintly ribbed, has strong legs with coarse spines, and is about 13 mm long.

**Egg**—When first deposited, the smooth, white egg is oval and about the size of a pinhead. Before it hatches, it gradually enlarges until it is spherical and about twice its original size.

**Larva**—Ranging from 4.8 to 31.8 mm in length, the dirty white grub has a brick red head, pale brown legs, and a dark abdomen.

**Pupa**—The pupa is about 19 mm long and changes from white to pale brown as it matures.

## BIOLOGY

**Distribution**—The sugarcane beetle has been a problem on corn in all southern states except Oklahoma, Kentucky, and Florida. Even in these states, however, some damage is periodically reported. This beetle is also a pest of rice and sugarcane in Louisiana, Texas, and Arkansas. Damage in North Carolina occurs statewide but most frequently in the Piedmont counties.

**Host Plants**—Although the sugarcane beetle is primarily a problem on corn, sugarcane, and rice, it also infests cotton, strawberry, rose, and wild grasses.

**Damage**—The grubs feed on the roots of grasses; however, the adult beetles are responsible for damage to field crops. Feeding below the soil surface, the beetles chew into the outer walls of lower stalks leaving large ragged holes. Seedlings suffer the most damage and are often killed when the beetles destroy the growing point. Corn plants one meter (3 feet) or taller usually recover from sugarcane beetle injury. Damage occurs most frequently when corn is planted into a sod field or adjoining such a field. Damage occurs primarily from April 15 to June 15 in Gulf Coast states and from late April to late June in Virginia and North Carolina.

**Life History**—Adult beetles hibernate during the winter in the soil of well-drained sod land. Although they may become active on warm days in late fall or winter, they normally do not resume continual activity until late March or early April. After mating in the soil, females each deposit clusters of three or four eggs in earthen cells. Approximately 2 weeks later, larvae emerge and begin feeding on decaying vegetable matter. After 2 or 3 months, the mature larvae enter a 2-week pupal period. Emerging in August and September, the new generation of adults feeds for a short time before entering hibernation. One generation occurs each year.

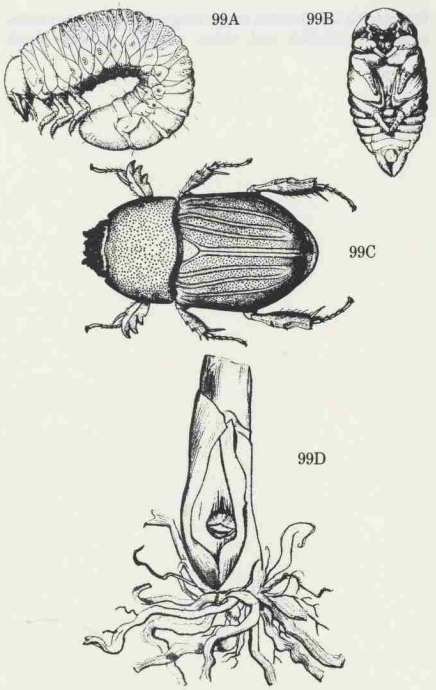



**Fig. 99 Sugarcane beetle. A, Larva. B, Pupa. C, Adult. D, Damage to stem.**

## CONTROL

Cultural practices are useful in controlling sugarcane beetles. Since most problems occur where corn is planted after or near sod, avoid growing corn or sorghum in these fields where possible. If planting corn in a former sod field cannot be avoided, use high quality certified seed, early planting, and proper fertilization. These practices will increase the vigor of the crop so the plants will grow rapidly and become more resistant to the beetles.

Sugarcane beetles can also be controlled chemically. Insecticides should be recommended when corn or sorghum is planted for a sod field established for 3 or more years.




* *Euetheola rugiceps* (LeConte), Scarabaeidae, COLEOPTERA

For specific information concerning cultural recommendations, insecticides and rates, consult current North Carolina State Agricultural Extension Service recommendations.

## DESCRIPTION

**Adult**—The adult, called a click beetle, is oblong and about 8.5 mm in length, though the size varies considerably. It has a distinct and characteristic pattern of light and dark brown markings on the thorax and elytra.

**Egg**—The newly laid egg is spherical, white and about 0.5 mm in diameter.

**Larva**—The newly hatched larva is white and approximately 1.5 mm long. The mature larva reaches a length of 14 to 19 mm. Its last abdominal segment terminates in a V-shaped notch.

**Pupa**—The brown pupa is slightly larger than the adult; it occurs in the soil near the food source.

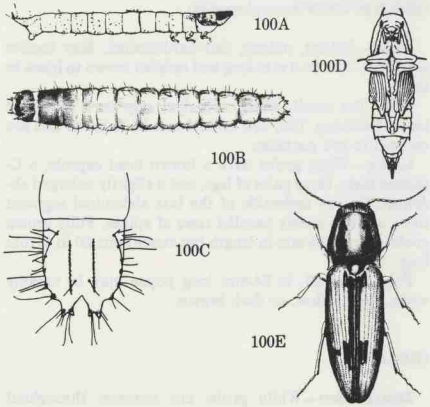



**Fig. 100 Tobacco wireworm. A-B, Larvae. C, Last larval segment. D, Pupa. E, Adult.**

## BIOLOGY

**Distribution**—The tobacco wireworm is common in the southeastern states. In North Carolina it occurs throughout most of the Coastal Plain and Piedmont. It is much more prevalent in areas where tobacco or corn are the main crops than in areas planted chiefly with truck crops. Grassy and weedy fields are characteristically infested.

**Host Plants**—The tobacco wireworm apparently prefers tobacco, but it feeds on a variety of other plants including corn, potatoes, and various truck crops.

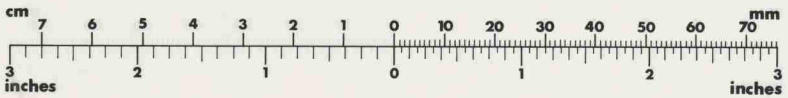
**Damage**—The tobacco wireworm is one of several species of wireworms which reduce field corn stands in North Carolina. Problems with this insect result primarily from continual planting of corn in the same field. Larval feeding on newly planted corn seeds causes poor germination and stunted, spindly, chlorotic plants which often die or are nonproductive. The typical above ground symptom is a distinct yellow streaking of the terminal blades. Wireworm damage consists of one or more ragged holes on the underground stem and extensive root pruning in older seedlings.

**Life History**—The eggs (240 per female) are laid singly on, or slightly beneath, the soil surface in the summer. Larvae hatch and feed on the roots of corn or other plants. The winter is passed in the larval stage. When corn is planted the following spring, these wireworms feed on the germinating seeds and young seedlings. Pupation then occurs in the soil, and adults emerge during early summer. There is only one generation per year. The average life cycle requires about 348 days in North Carolina, as follows: egg, 10 days; larva, 315 days; pupa, 10 days; and preoviposition period, 13 days.

## CONTROL

Because infestations occur erratically, controls are still only speculative. Crop rotation is an effective management tool for control and should be practiced where possible. Granular insecticides have proven beneficial on highly susceptible fields. For specific control information, consult the current *North Carolina Agricultural Chemicals Manual.*






* *Conoderus vespertinus* (Fabricius), Elateridae, COLEOPTERA

## CORN/SORGHUM
### White Grubs*

**DESCRIPTION** (several species)

**Adult**—Robust, oblong, and hard-shelled, May beetles are about 19 to 25.5 mm long and reddish brown to black in color.

**Egg**—The small, white, spherical eggs turn dark just before hatching. They are 1.5 to 3 mm in diameter and are encased in soil particles.

**Larva**—White grubs have a brown head capsule, a C-shaped body, three pairs of legs, and a slightly enlarged abdomen. On the underside of the last abdominal segment there are two nearly parallel rows of spines. Fully grown grubs average 35 mm in length but range from 20 to 45 mm long.

**Pupa**—The 20- to 24-mm long pupae may be creamy white, pale yellow, or dark brown.

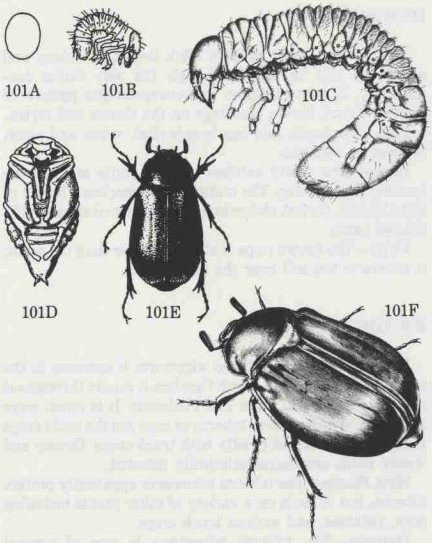



**Fig. 101 White grubs. A, Egg. B-C, Grubs. D, Pupa. E-F, Adults.**

**BIOLOGY**

**Distribution**—White grubs are common throughout North America, although species distribution varies greatly.

**Host Plants**—White grubs feed on the roots of corn, timothy, Kentucky bluegrass, sorghum, soybean, strawberry, potato, barley, oat, wheat, rye, bean, turnip, and to a lesser degree, other cultivated crops. They also infest various pasture grasses, lawns, and nursery plantings. The adults, which are strongly attracted to fragrant flowers and ripe fruits, feed on the foliage of forest, shade and fruit trees.

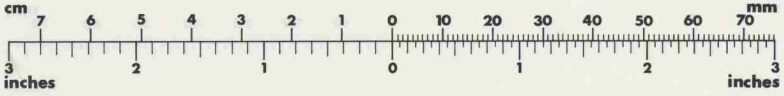


**Damage**—Damage by white grubs is usually most severe when corn is planted following sod. In this case, root feeding can be so severe that plants may grow no taller than 30 to 60 cm (1 or 2 feet). If the root system is badly damaged, injured plants will eventually die and can be easily pulled from the ground. Even light infestations usually result in increased lodging and reduce yield.

White grubs are sensitive to differences in soil moisture and texture. Since these factors are not uniform throughout any given field, a white grub infestation, likewise, is not uniform. Therefore, within the same field, some areas may be completely destroyed while others are undamaged.

**Life History**—In spring, overwintering May beetles emerge from the ground at dusk, feed on the leaves of trees, and mate during the night. At dawn, they return to the ground, where the females lay 15 to 20 eggs in earthen cells several centimeters below the surface. Most May beetles lay eggs in grassy sod. Eggs hatch 3 to 4 weeks later. The young grubs feed on plant roots throughout the summer; in the fall, they burrow below the frost line (to a depth of 1.5 meters) and hibernate. The following spring, they return near the soil surface to feed and grow. In fall, the grubs again migrate downward to overwinter. The third spring, they move upward to feed on plant roots. By late spring, they are completely grown. These large grubs form earthen cells and pupate. In late summer, adults emerge from the pupal stage, but they do not leave the ground. These beetles overwinter, emerging the next spring to feed and mate.

The usual length of time for one complete generation (adult to adult) is 2 to 4 years depending upon latitude. Generations, however, are staggered so that grubs and beetles are present every year. Grubs are usually most numerous and damaging the second season following a large beetle flight.




* *Phyllophaga* spp., Scarabaeidae, COLEOPTERA

## CONTROL

White grubs are among the most destructive soil insects in North America. True white grubs may be easily confused with several other grubs infesting corn roots. However, the damage inflicted and the control methods employed are identical for most white grubs and their close relatives.**

The cultural practices of late-spring and early-fall plowing or discing provide control in areas where predaceous birds occur (e.g. the Atlantic Coastal Plain). Crop rotation, however, is the most effective cultural control method. Deep-rooted legumes, like alfalfa and clovers, are excellent crops with which to rotate corn or small grains, especially following years of unusually heavy May beetle flights. For specific control information consult current North Carolina State Agricultural Extension Service recommendations.

---

**In the strictest sense only species of *Phyllophaga* are white grubs. Other similar larvae of the insect family Scarabaeidae are often referred to as "white grubs" also. These include larvae of the Japanese beetle, *Popillia japonica* Newman; the green June beetle, *Cotinis nitida* (Linnaeus); and annual white grubs, *Cyclocephala* spp.

## CORN/SORGHUM
## References


### GENERAL

Alabama, Agricultural Experiment Station. 1934. Control of corn insects and diseases. Leafl. 9. 8 pp.

American Phytopathological Society. 1973. Bacterial leaf blight, pp. 8-10. *In* A compendium of corn diseases, St. Paul, Minn., 64 pp.

Daniels, N.E. and L.D. Chedester. 1975. Insect and mite control in corn. Progress Rep. Texas Agr. Exp. Sta. PR-3328C. 8 pp.

Dicke, F.F. 1976. The most important corn insects, pp. 501-90. *In* Corn and corn improvement, ed. F.F. Sprague. Amer. Soc. Agron. Inc., Madison, Wis. 774 pp.

Doering, G.W. and N.M. Randolph. 1960. Field methods to determine the infestation of the sorghum webworm (*Celama sorghiella* Riley) (Lepidoptera: Noctuidae) and damage by the sorghum midge (*Contarinia sorghicola* Coquillett) (Diptera: Cecidomyiidae) in grain sorghum. J. Econ. Entomol. 53: 749-50.

Gibson, K.E., M.C. Lane, W.C. Cook, and E.W. Jones. 1958. Effect of some crop rotations on wireworm populations in irrigated lands. U.S. Dep. Agr. Tech. Bull. 1172. 19 pp.

Green, H.B., H.N. Pitre, L.M. Gourley, and J.P. Roth. 1975. Management and production practices for control of insect pests in grain sorghum. Mississippi Agr. Forest. Exp. Sta. Bull. 817. 8 pp.

Hyslop, J.A. 1915. Wireworms attacking cereal and forage crops. U.S. Dep. Agr. Dep. Bull. 156. 34 pp.

Janes, M.J. 1975. Corn earworm and fall armyworm: comparative larval populations and insecticidal control on sweet corn in Florida. J. Econ. Entomol. 68: 657-58.

Jordan, C.R. 1965. Control of billbugs on corn. Georgia Agr. Ext. Service Entomol. Leafl. 18. 4 pp.

Leach, J.G. 1952. Insects, bacteria, and fungi, pp. 191-6. *In* Insects. U.S. Dep. Agr. 1952 Yearbook of Agr. 780 pp.

Rand, F.V. and L.C. Cash. 1924. Further evidence of insect dissemination of bacterial wilt of corn. Sci. 59: 67-9.

Raney, H.G. 1973. Grain sorghum insects. Kentucky Agr. Coop. Ext. Service Entomol. Pub. 20. 2 pp.

Robert, A.L. 1967. Bacterial wilt and Stewarts leaf blight of corn. U.S. Dep. Agr. Farmers' Bull. 2092. 12 pp.

Tate, H.D. and O.S. Bare. 1946. Corn rootworms. Nebraska Agr. Exp. Sta. Bull. 381. 12 pp.

Thomas, C.A. 1940. The biology and control of wireworms: a review of the literature. Pennsylvania Agr. Exp. Sta. Bull. 392. 90 pp.

U.S., Department of Agriculture. 1958. Cutworms in the garden: how to control them. Home and Garden Bull. 29. 4 pp.

U.S., Department of Agriculture. 1961. The armyworm and the fall armyworm—how to control them. Leafl. 494. 8 pp.

Walkden, H.H. 1950. Cutworms, armyworms, and related species attacking cereal and forage crops in the Central Great Plains. U.S. Dep. Agr. Circ. 849. 52 pp.

Walton, W.R. and J.J. Davis. 1916. Cutworms and their control in corn and other cereal crops. U.S. Dep. Agr. Farmers' Bull. 739. 3 pp.

Whelan, D.B. 1935. A key to Nebraska cutworms and armyworms that attack corn. Nebraska Agr. Exp. Sta. Res. Bull. 81. 27 pp.

Young, W.R. 1970. Sorghum insects, pp. 235-7. *In* Sorghum production and utilization, ed. J.S. Wall and W.M. Ross. Avi Publ. Co., Inc. Westport, Conn. 702 pp.

Young, W.R. and G.L. Teetes. 1977. Sorghum entomology. Annu. Rev. Entomol. 22: 193-218.

### ARMYWORM

Walton, W.R. and C.M. Packard. 1951. The armyworm and its control. U.S. Dep. Agr. Farmers' Bull. 1850. 10 pp.

### BLACK CUTWORM

Busching, M.K. and F.T. Turpin. 1976. Oviposition preferences of black cutworm moths among various crop plants, weeds, and plant debris. J. Econ. Entomol. 69: 587-90.

Harris, C.R., J.H. Mazurek, and G.V. White. 1962. The life history of the black cutworm, *Agrotis ipsilon* (Hufnagel), under controlled conditions. Can. Entomol. 94: 1183-7.

Rings, R.W., F.J. Arnold, A.J. Keaster, and G.J. Musick. 1974. A worldwide, annotated bibliography of the black cutworm, *Agrotis ipsilon* (Hufnagel). Ohio Agr. Res. and Development Center Res. Circ. 198. 106 pp.

### CORN EARWORM

Barber, G.W. 1936. The corn earworm in southeastern Georgia. Georgia Agr. Exp. Sta. Bull. 192. 18 pp.

Blanchard, R.A. and W.A. Douglas. 1953. The corn earworm as an enemy of field corn in the eastern United States. U.S. Dep. Agr. Farmers' Bull. 1651. 15 pp.

Buckley, B.R. and C.C. Burkhardt. 1962. Corn earworm damage and loss in grain sorghum. J. Econ. Entomol. 55: 435-9.

Buckley, B.R. and C.C. Burkhardt. 1963. Notes on the biology and behavior of *Heliothis zea* (Boddie) on grain sorghum. Kansas Entomol. Soc. J. 36: 127-32.

Burkhardt, C.C. 1957. Corn earworm control in grain sorghum. J. Econ. Entomol. 50: 539-41.

Caron, R.E. and J.R. Bradley, Jr. 1978. *Heliothis zea* (Boddie): biotic factors affecting egg and larval survival on field corn in North Carolina. Georgia Entomol. Soc. J. 13: 295-304.

Ditman, L.P. and E.N. Cory. 1931. The corn earworm—biology and control. Maryland Agr. Exp. Sta. Bull. 328: 443-82.

Henderson, C.F., H.G. Kinzer, and J.H. Hatchett. 1965. Effectiveness of insecticides against the corn earworm in sorghum heads. J. Econ. Entomol. 58: 207-9.

Isley, D. 1935. Relation of hosts to abundance of the cotton bollworm. Arkansas Agr. Exp. Sta. Bull. 320. 30 pp.

Johnson, M.W., R.E. Stinner, and R.L. Rabb. 1975. Ovipositional response of *Heliothis zea* (Boddie) to its major hosts in North Carolina. Environmental Entomol. 4: 291-7.

Kirk, V.M. 1959. Control of the corn earworm in grain sorghum heads. J. Econ. Entomol. 52: 338-9.

Slosser, J.E., J.R. Phillips, G.A. Herzog, and C.R. Reynolds. 1975. Overwinter survival and spring emergence of the bollworm *(Heliothis zea)* in Arkansas. Environmental Entomol. 4: 1015-24.

Snow, J.W. and W.W. Copeland. 1971. Distribution and abundance of the corn earworm in the United States. U.S. Dep. Agr. Coop. Econ. Insect Rep. 21: 71-6.

York, A. 1974. Corn earworm control. Indiana (Purdue Univ.) Coop. Ext. Service Pub. E 31. 2 pp.

### CORN LEAF APHID

Cartier, J.J. 1957. On the biology of the corn leaf aphid. J. Econ. Entomol. 50: 110-2.

Everly, R.T. 1960. Loss in corn yield associated with the abundance of the corn leaf aphid, *Rhopalosiphum maidis*, in Indiana. J. Econ. Entomol. 53: 924-32.

Pathak, M.D. and R.H. Painter. 1958. Effect of the feeding of the four biotypes of corn leaf aphid, *Rhopalosiphum maidis* (Fitch), on susceptible White Martin sorghum and Spartin barley plants. Kansas Entomol. Soc. J. 31: 93-100.

Walter, E.V. 1940. Differential susceptibility of corn hybrids to *Aphis maidis*. J. Econ. Entomol. 33: 623-8.

Wilde, G. and C.J. Ohiagu. 1976. Relation of corn leaf aphid to sorghum yields. J. Econ. Entomol. 69: 195-7.

Wildermuth, V.L. and E.V. Walter. 1932. Biology and control of the corn leaf aphid with special reference to the southwestern states. U.S. Dep. Agr. Tech. Bull. 306. 22 pp.

### CORN ROOT APHID

Davis, J.J. 1909. Biological studies on three species of Aphididae. U.S. Dep. Agr. Bur. Entomol. Tech. Ser. 12, part VIII: 121-68.

Davis, J.J. 1949. The corn root aphid and methods of controlling it. U.S. Dep. Agr. Farmers' Bull. 891. 7 pp.

### EUROPEAN CORN BORER

Chiang, H.C. 1964. Overwintering corn borer, *Ostrinia nubilalis*, larvae in storage cribs. J. Econ. Entomol. 57: 666-9.

Dicke, F.F., R.E. Atkins, and G.R. Pesho. 1963. Resistance of sorghum varieties and hybrids to the European corn borer (*Ostrinia nubilalis* Hbn). Iowa State J. Sci. 37: 247-57.

Durant, J.A. 1969. Seasonal history of the European corn borer at Florence, South Carolina. J. Econ. Entomol. 62: 1071-5.

Painter, R.H. and D.E. Weibel. 1951. European corn borer damage to grain sorghum. J. Econ. Entomol. 44: 796-8.

Sparks, A.N. and J.R. Young. 1971. European corn borer activity in Georgia. Georgia Entomol. Soc. J. 6: 211-5.

U.S., Department of Agriculture. 1967. The European corn borer: how to control it. Farmers' Bull. 2190. 14 pp.

Wedderburn, R.N., J.D. Munson, and J.L. Wedberg. 1973. Field trials to control the European corn borer with insecticides. J. Econ. Entomol. 66: 253-4.

### FALL ARMYWORM

Bass, M.H. 1978. Fall armyworm: evaluation of insecticides for control. Alabama (Auburn Univ.) Agr. Exp. Sta. Leafl. 93. 7 pp.

Harrell, E.A., J.R. Young, and W.W. Hare. 1977. Insect (*Spodoptera frugiperda*) control on late planted sweet corn. J. Econ. Entomol. 70: 129-31.

Henderson, C.F., H.G. Kinzer, and E.G. Thompson. 1966. Growth and yield of grain sorghum infested in the whorl with fall armyworm. J. Econ. Entomol. 59: 1001-3.

Luginbill, P. 1928. The fall armyworm. U.S. Dep. Agr. Tech. Bull. 34. 92 pp.

### GRANULATE CUTWORM

Cline, L.D. and D.H. Habeck. 1977. Reproductive biology of the granulate cutworm. J. Georgia Entomol. Soc. 12: 34-41.

Jones, T.H. 1918. Miscellaneous truck crop insects in Louisiana. II.—the granulated cutworm, an important enemy of vegetable crops in Louisiana. U.S. Dep. Agr. Dep. Bull. 703: 7-14.

Snow, J.W. and P.S. Callahan. 1968. Biological and morphological studies of the granulate cutworm, *Feltia subterranea* (F.), in Georgia and Louisiana. Georgia Agr. Exp. Sta. Res. Bull. 42. 23 pp.

### JAPANESE BEETLE

Britton, W.E. and J.P. Johnson. 1938. The Japanese beetle in Connecticut. Connecticut Agr. Exp. Sta. (New Haven) Bull. 411. 31 pp.

Fleming, W.E. 1963. The Japanese beetle: how to control it. U.S. Dep. Agr. Farmers' Bull. 2151. 16 pp.

Fleming, W.E. 1970. The Japanese beetle in the United States. U.S. Dep. Agr. Agr. Handbook 236. 30 pp.

Hadley, C.H. and I.M. Hawley. 1934. General information about the Japanese beetle in the United States. U.S. Dep. Agr. Circ. 332. 23 pp.

Hawley, I.M. and F.W. Metzger. 1940. Feeding habits of the adult Japanese beetle. U.S. Dep. Agr. Circ. 547. 32 pp.

Ladd, T.L. 1976. Controlling the Japanese beetle. U.S. Dep. Agr. Home and Garden Bull. 159. 15 pp.

### LESSER CORNSTALK BORER

All, J.N. and R.N. Gallaher. 1977. Detrimental impact of no-tillage corn cropping systems involving insecticides, hybrids, and irrigation on lesser cornstalk borer infestations. J. Econ. Entomol. 70: 361-5.

Dupree, M. 1964. Insecticidal and cultural control of the lesser cornstalk borer. Georgia Agr. Exp. Sta. Mimeograph Ser. N. S. 197. 21 pp.

Dupree, M. 1965. Observations on the life history of the lesser cornstalk borer. J. Econ. Entomol. 58: 1156-7.

Leuck, D.B. 1966. Biology of the lesser cornstalk borer *(Elasmopalpus lignosellus)* in south Georgia. J. Econ. Entomol. 59: 797-801.

Luginbill, P. and G.G. Ainslie. 1917. The lesser cornstalk borer. U.S. Dep. Agr. Bull. 539. 27 pp.

### MAIZE BILLBUG

Kelly, E.O.G. 1911. The maize billbug (*Sphenophorus maidis* Chittn.). U.S. Dep. Agr., Bur. Entomol., Bull. 95, Part II: 11-22.

### *MELANOTUS COMMUNIS*

Fenton, F.A. 1926. Observations on the biology of *Melanotus communis* and *Melanotus pilosus*. J. Econ. Entomol. 19: 502-4.

### SEEDCORN MAGGOT

Miller, L.A. and R.J. McClanahan. 1960. Life-history of the seedcorn maggot, *Hylemya cilicrura* (Rond.) and of *H. liturata* (Mg.) (Diptera: Anthomyiidae) in southwestern Ontario. Can. Entomol. 92: 210-21.

Reid, W.J., Jr. 1940. Biology of the seed-corn maggot in the Coastal Plain of the South Atlantic States. U.S. Dep. Agr. Tech. Bull. 723. 44 pp.

Vea, E.V. and C.J. Eckenrode. 1976. Resistance to seedcorn maggot in snap bean. Environmental Entomol. 5: 735-7.

### SORGHUM MIDGE

Doering, G.W. and N.M. Randolph. 1963. Habits and control of the sorghum midge, *Contarinia sorghicola*, on grain sorghum, J. Econ. Entomol. 56: 454-9.

Harding, J.A. 1965. Ecological and biological factors concerning the sorghum midge during 1964. Texas Agr. Exp. Sta. Misc. Pub. 773. 10 pp.

Pitre, H.N., J.P. Roth, and L.M. Gourley. 1975. The sorghum midge in Mississippi. Mississippi Agr. Forest. Exp. Sta. Bull. 836. 13 pp.

Walter, E.V. 1941. The biology and control of the sorghum midge. U.S. Dep. Agr. Tech. Bull. 778. 27 pp.

Walter, E.V. 1953. The sorghum midge with suggestions for control. U.S. Dep. Agr. Farmers' Bull. 1566. 6 pp.

### SORGHUM WEBWORM

Haseman, L. 1933. The sorghum worm in Missouri. Missouri Agr. Exp. Sta. Bull. 320. 8 pp.

Henderson, C.F., J.H. Hatchett, and H.G. Kinzer. 1963. Effectiveness of insecticides against the sorghum webworm in sorghum heads. J. Econ. Entomol. 56: 483-4.



Kinzer, H.G. and C.F. Henderson. 1967. Effect of sorghum webworm on yield of grain sorghum in Oklahoma. J. Econ. Entomol. 60: 118-21.

Reinhard, H.J. 1938. The sorghum webworm (*Celama sorghiella* Riley). Texas Agr. Exp. Sta. Bull. 559. 35 pp.

### SOUTHERN CORN BILLBUG

Durant, J.A. 1975. Southern corn billbug (Coleoptera: Curculionidae) control on corn in South Carolina. Georgia Entomol. Soc. J. 10: 287-91.

### SOUTHERN CORN ROOTWORM

Arant, F.S. 1929. Biology and control of the southern corn rootworm. Alabama (Auburn Univ.) Agr. Exp. Sta. Bull. 230. 46 pp.

Arant, F.S. 1934. Time of turning legumes and planting corn to avoid injury from the southern corn rootworm. Alabama (Auburn Univ.) Agr. Exp. Sta. Circ. 65. 10 pp.

Isley, D. 1929. The southern corn rootworm. Arkansas Agr. Exp. Sta. Bull. 232. 31 pp.

Luginbill, P. 1940. The southern corn rootworm and farm practices to control it. U.S. Dep. Agr. Farmers' Bull. 950. 10 pp.

Sweetman, H.L. 1926. Results of life history studies of *Diabrotica 12-punctata* Fabr. (Chrysomelidae, Coleoptera). J. Econ. Entomol. 19: 484-90.

U.S., Department of Agriculture. 1961. The southern corn rootworm—how to control it. Leafl. 391. 8 pp.

### SOUTHERN CORNSTALK BORER

U.S., Department of Agriculture. 1954. The southern cornstalk borer. Leaflet 363. 5 pp.

### SOUTHERN POTATO WIREWORM

Day, A., F.P. Cuthbert, Jr., and W.J. Reid, Jr. 1971. The southern potato wireworm, its biology and economic importance in coastal South Carolina. U.S. Dep. Agr. Tech. Bull. 1443. 33 pp.

Day, A. and H. Crosby. 1972. Further field evaluation of insecticides for control of southern potato wireworms. J. Econ. Entomol. 65: 1164-5.

Norris, D.M. 1957. Bionomics of the southern potato wireworm, *Conoderus falli* Lane. 1. life history in Florida. Florida State Hort. Soc. Proc. 70: 109-11.

Reid, W.J., Jr. and F.P. Cuthbert, Jr. 1956. Resistance of the southern potato wireworm to insecticides. J. Econ. Entomol. 49: 879-80.

### SPIDER MITES

Boudreaux, H.H. 1963. Biological aspects of some phytophagous mites. Annu. Rev. Entomol. 8: 137-54.

Cagle, L.R. 1949. Life history of the twospotted spider mite. Virginia Agr. Exp. Sta. Tech. Bull. 113. 31 pp.

Hazan, A., U. Gerson, and A.S. Tahori. 1974. Life history and life tables of carmine spider mite. Acarologia 15: 414-40.

Huffaker, C.B., M. van de Vrie, and J.A. McMurtry. 1969. The ecology of tetranychid mites and their control. Annu. Rev. Entomol. 14: 125-74.

Tuttle, D.M. and E.W. Baker. 1968. Spider mites of the southwestern United States and a revision of the family Tetranychidae. Univ. Arizona Press, Tucson, Ariz. 143 pp.

Vrie, M. van de, J.A. McMurtry, and C.B. Huffaker. 1972. Ecology of tetranychid mites and their natural enemies: a review. III. biology, ecology, and pest status, and host-plant relations of tetranychids. Hilgardia 41: 343-432.

### STALK BORER

Decker, G.C. 1931. The biology of the stalk borer *Papaipema nebris* (Gn.). Iowa State Agr. Exp. Sta. Res. Bull. 143: 292-351.

Hamilton, C.C. 1935. The stalk borer (*Papaipema nebris* Gn.). New Jersey Agr. Exp. Sta. Circ. 342. 4 pp.

### SUGARCANE BEETLE

Douglas, W.A. 1942. Rice-field insects. U.S. Dep. Agr. Circ. 632. 32 pp.

Ingram, J.W., E.K. Bynum, R. Mathes, W.E. Haley, and L.G. Charpentier. 1951. Pests of sugarcane and their control. U.S. Dep. Agr. Circ. 878. 38 pp.

U.S., Department of Agriculture. 1963. Controlling the sugarcane beetle on corn in the southern states. Leafl. 520. 5 pp.

### TOBACCO WIREWORM

Rabb, R.L. 1963. Biology of *Conoderus vespertinus* in the Piedmont section of North Carolina (Coleoptera: Elateridae). Ann. Entomol. Soc. Amer. 56: 669-76.

WEBWORMS

Ainslie, G.G. 1922. Webworms injurious to cereal and forage crops and their control. U.S. Dep. Agr. Farmers' Bull. 1258. 16 pp.

Dominick, C.B. 1960. Control of the corn root webworm. J. Econ. Entomol. 53: 670-2.

WHITE GRUBS

Boving, A.G. 1942. A classification of larvae and adults of the genus *Phyllophaga*. Entomol. Soc. Washington Mem. 2. 96 pp.

Hayes, W.P. 1925. A comparative study of the history of certain phytophagous scarabaeid beetles. Kansas Agr. Exp. Sta. Tech. Bull. 16. 146 pp.

Luginbill, P. and H.R. Painter. 1953. May beetles of the United States and Canada. U.S. Dep. Agr. Tech. Bull. 1060. 102 pp.

Ritcher, P.O. 1940. Kentucky white grubs. Kentucky Agr. Exp. Sta. Bull. 401. 157 pp.

U.S., Department of Agriculture. 1959. Control of common white grubs in cereal and forage crops. Farmers' Bull. 1798. 14 pp.

# PESTS OF COTTON

In 1980, cotton was planted on 25,506 hectares (63,000 acres) of North Carolina farm land. Cleveland county, the Scotland-Robeson counties area, and the Northampton-Halifax-Edgecombe counties area produce 90 percent of the cotton in North Carolina. Insects are an important factor in cotton production here but only the bollworm and the boll weevil are considered limiting. A pest management approach of varying degrees of sophistication has been applied for insect control in all cotton-producing areas of our state.

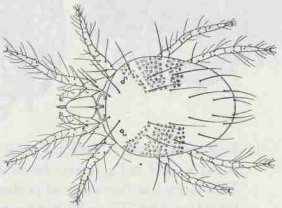
## KEY TO PESTS OF COTTON

A. Insect and mite pests which pierce or rasp plant tissue to extract sap (Fig. 102A to D).

102A

102B

102C



102D

1. **Aphids**—Usually feeding in colonies, these yellow, green, or black, pear-shaped insects (Fig. 102A) may be as long as 2 mm and may or may not have wings. Infested leaves curl and pucker; heavily infested seedlings become stunted and die. A black mold, which grows on the sticky, sugary "honeydew" that aphids excrete, is often evidence of aphid infestation.

   a. **Cotton aphid**—This aphid is usually yellow in the summer and pale or dark green in cooler seasons ..... p. 79

   b. **Cowpea aphid**—The adult of this species is black with white appendages. The nymph is pale gray with a powdery coating ..... p. 79

2. **Tarnished plant bug**—Approximately 6.4 mm long, this oval-shaped, brown lygus bug (Fig. 102B) has long legs, long antennae, and a white triangle between its "shoulders." It extracts sap from terminals, squares, flowers, and bolls, causing young fruiting forms to be shed. Infested flowers and bolls may open prematurely ..... p. 85

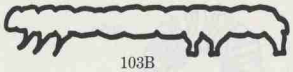
3. **Thrips**—Several species of these yellow, orange, brown, or black rasping insects (Fig. 102C) attack seedling cotton. Foliage infested by these tiny, fringed-wing insects becomes distorted and curls upward; terminal buds are sometimes killed ..... p. 87

4. **Twospotted spider mite**—The almost microscopic, eight-legged, adult female mite is yellowish (Fig. 102D) to dark green with two or four dark spots on its back. The immature mite may have six or 8 legs. Feeding on the underside of the leaf, this mite extracts sap, causing the upper leaf surface to have a whitish or bronze cast. Severe infestations can result in defoliation and loss of plant vigor. Silken webs are common on the underside of infested leaves, particularly along the large leaf veins ..... p. 89

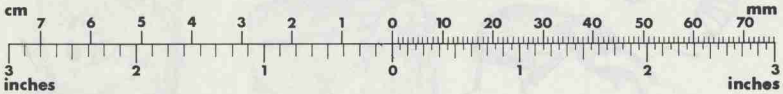
B. Caterpillars that chew or mine the foliage or sever seedling stems.

1. **Armyworms**—These smooth-skinned, variously colored caterpillars have five pairs of prolegs (Fig. 103A), are occasionally problem foliage pests, and may be difficult to control chemically.

103A



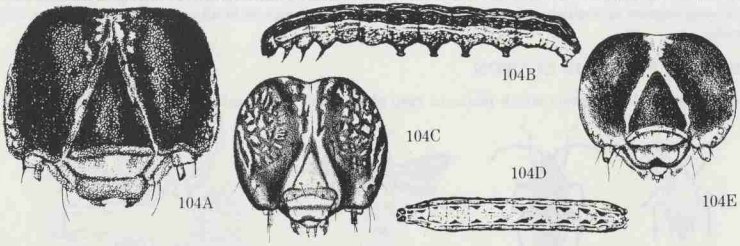
103B






* See also "A Key to Caterpillars" on page 16.

a. **Beet armyworm**—This dark-headed (Fig. 104A), green or black larva sometimes has 3 longitudinal, light stripes and usually attains a length of 25 to 30 mm. A small black spot occurs on each side of the second segment behind the head (Fig. 104B). This larva normally skeletonizes foliage but at times feeds on squares, blooms, and bolls causing economic loss to cotton ..... p. 150




b. **Fall armyworm**—Although this green, brown, or black caterpillar primarily attacks blooms, squares, and bolls, it also feeds on the foliage, occasionally tops plants, and bores into stems. This larva has five pairs of prolegs, reaches a maximum length of 40 mm, and often has a distinct inverted "Y" on its head capsule (Fig. 104C). It has a black, longitudinal stripe down each side of its body and a yellowish-gray stripe down its back. ..... p. 103

c. **Yellowstriped armyworm**—Reaching a length of up to 45 mm, the smooth-skinned, pale gray to jet black caterpillar has a yellowish-orange stripe along each side and a pair of black, triangular spots on the back of most segments (Fig. 104D). Like the fall armyworm, this larva often has a pale, but distinct, inverted "Y" on its head capsule (Fig. 104E). This insect rarely reaches damaging levels on cotton but is most injurious to seedlings ..... p. 90

2. **Cabbage looper**—Reaching a length of about 40 mm, this green caterpillar has three pairs of prolegs (Fig. 103B) and several longitudinal, white stripes. Its body tapers from rear to front. Its feeding leaves ragged holes in the foliage ..... p. 84

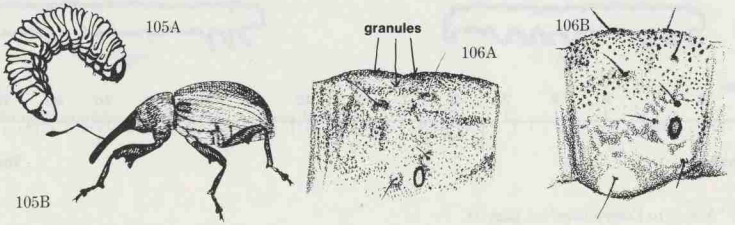


3. **Cutworms**—These fat caterpillars reach a length of 40 or 45 mm and have five pairs of prolegs (Fig. 103A). They display a variety of feeding habits and curl up when disturbed. They sever seedling stems and occasionally feed on leaves.

a. **Black cutworm**—The skin of this light gray to black cutworm is granulated, the granules resembling rounded, flattened pebbles (Fig. 106A). The caterpillar cuts seedlings off at the soil line during the night. It commonly pulls the cut stem of a seedling into the entrance of its burrow and feeds on it during the day ..... p. 119

b. **Granulate cutworm**—This cutworm has a pale brown head, a dark brown band down its back and brown sides with faint stripes. The skin granules of this cutworm are like blunt cones as high as they are wide (Fig. 106B). The caterpillar also severs seedlings near the soil line at night ..... p. 46

c. **Variegated cutworm**—Although primarily damaging to seedling stems, this species is a climbing cutworm and may feed on foliage. Its smooth-skinned body is pale gray to dark brown with a row of orange or yellow spots down the middle of its back. A black spot and a yellow spot occur on the eighth abdominal segment ..... p. 110



C. Insects that feed in squares or bolls.

1. **Boll weevil larva**—The white-bodied, brownheaded, legless grub (Fig. 105A), up to 13 mm long, feeds within squares or small bolls, destroying the contents ..... p. 80

2. **Boll weevil adult**—About 8.5 mm long, the reddish-brown or gray adult weevil (Fig. 105B) has a distinctive characteristic: a double-toothed spur on the inner surface of each front leg. The female punctures squares and young bolls to lay eggs. These nipple-like egg punctures are about 1 mm in diameter. Egg-punctured squares flare and fall to the ground where larval development is completed ..... p. 80

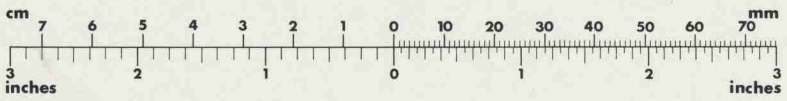
3. **Caterpillars**—These moth larvae have three pairs of short legs near the head and five pairs of prolegs (Fig. 103A).

   a. **Bollworm complex**—When fully grown, these larvae are green, reddish, or brown with pale, longitudinal stripes and scattered, black spots. Early instars are cream colored or yellowish green with few markings. Larval instars vary from 1.5 to 44 mm in length and have five pairs of prolegs. The contents of squares or bolls may be completely consumed by bollworms. Cotton lint development is reduced and rot organisms may gain entrance into the bolls that are only partially damaged ..... p. 82

   b. **Fall armyworm**—See section B.1.b. of this key for description. This caterpillar may bore into stems and bolls like the bollworm, but typically enters the boll at the tip or at the base next to the stem ..... p. 103

   c. **Yellowstriped armyworm**—See section B.1.c. of this key for description. This larva occasionally bores into squares or bolls but is rarely an economic problem ..... p. 90





## COTTON INSECT NOTES

**COTTON**
**Aphids***

### DESCRIPTION (two species)

**Adult**—Several species of aphids attack cotton but the cotton aphid and the cowpea aphid are most common. Adult aphids are about 2 mm long and may be winged or wingless. The cotton aphid is pale to dark green in cool seasons and yellow in hot, dry summers. The adult cowpea aphid is shiny black with white appendages.

**Nymph**—Cotton aphid nymphs are smaller than but similar in shape and color to the wingless adults. Cowpea aphid nymphs are pale green to gray with a powdery coating.

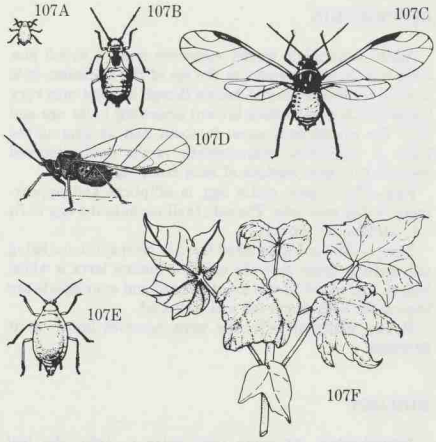



**Fig. 107 Cotton aphid. A-B, Nymphs. C-E, Adults. F, Damage.**

### BIOLOGY

**Distribution**—Generally distributed throughout temperate, subtropic, and tropic zones, the cotton aphid occurs in all cotton-producing areas of North Carolina. The cowpea aphid has been reported in at least 28 scattered states and in 3 Canadian provinces.

**Host plants**—The cotton aphid infests cotton, okra, hibiscus, cowpea, citrus, cucurbits, strawberry, bean, spinach, tomato, clover, asparagus, catalpa, violet, hydrangea, begonia, ground ivy, gardenia, and several weeds. Host plants of the cowpea aphid include alfalfa, apple, carrot, cotton, cowpea, dandelion, dock, goldenrod, kidney bean, lambsquarters, lettuce, lima bean, pinto bean, peanut, pepperweed, pigweed, red clover, shepherds purse, vetch, wheat, white sweet clover, and yellow sweet clover.

**Damage**—In spite of the fact that many aphids infest cotton, these insects are only secondary pests. Congregating on lower leaf surfaces and on terminal buds, aphids extract plant sap. If weather is cool during the spring, populations of natural enemies will be slow in building up and heavy infestations of aphids may result. When this occurs, leaves begin to curl and pucker; seedling plants become stunted and may die. Most aphid damage is of this type. If honeydew resulting from late season aphid infestations falls onto open cotton, it can act as a growing medium for sooty mold. Cotton stained by this black fungus is reduced in quality and brings a low price for the grower.

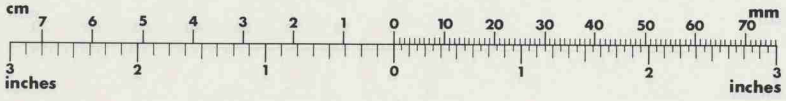
**Life History**—Little information is available on the biology of the cowpea aphid although the life history of the cotton aphid is well known. Cotton aphids overwinter as adults in the cotton belt, and as eggs in cooler climates. In the cotton belt, winged adults hibernate in soil or field debris. During warm periods, they fly to weedy hosts, and continue their life cycle until cool weather forces them back into hibernation. In spring, winged females fly to suitable host plants and give birth to living young. In the cotton belt, all progeny generally develop into wingless females. Whenever crowding occurs or food becomes scarce, winged adults develop and fly to new host plants. Male and female adults occur in northern states.

Females produce an average of 84 nymphs. Under favorable conditions, a nymph will mature within 4 or 5 days and begin producing its own progeny. In the South, reproduction may continue all winter so that as many as 57 generations may be produced each year.

### CONTROL

Aphid populations on cotton are generally of no economic concern in North Carolina due to naturally occurring controls and insecticides directed at other cotton pests. Should early or late season populations build up, consult the current *North Carolina Agricultural Chemicals Manual.*






* Cotton aphid, *Aphis gossypii* Glover; Cowpea aphid, *Aphis craccivora* (Koch), Aphididae, HEMIPTERA

## COTTON
## Boll Weevil*

### DESCRIPTION

**Adult**—The adult weevil measures from 3 to 8.5 mm from the tip of the snout to the tip of the abdomen. It is usually reddish or grayish brown though its color may vary (yellowish brown to dark brown) according to its age and size. The conspicuous snout is about half as long as the body. A distinctive characteristic is the double-toothed spur on the inner surface of each front leg.

**Egg**—The pearly white egg is elliptical and approximately 0.85 mm long. The soft shell permits the egg to fit into almost any cavity.

**Larva**—The newly hatched larva is inconspicuous, being only slightly larger than the egg. The mature larva is white, legless, and about 13 mm long. Its head and mouthparts are brown; its body is curved and wrinkled.

**Pupa**—White at first, the pupa becomes brown as it develops.

### BIOLOGY

**Distribution**—At some time prior to 1894, the boll weevil spread into the United States from Mexico. It now occurs throughout the cotton belt east of the high plains of Texas and may now be found in some areas of Arizona.

**Host Plants**—In North Carolina, cotton is practically the only host plant of the boll weevil.

**Damage**—The annual loss to boll weevils in North Carolina has reached $7.5 million but varies greatly depending upon winter temperatures and their effect upon population levels. Injury is caused by both adults and larvae. Although adult females prefer squares, they oviposit into both squares and young bolls and seal the holes with excrement. Egg punctures become small, nipple-like protuberances. Larvae (developing within the cavities) then feed within the squares, causing the bracts to open or "flare," the color to fade to a yellowish green, and the plant to shed the infested squares. Limited feeding on the squares and bolls by adults usually does not result in shedding, but cotton fiber is sometimes ruined. Boll-rotting fungi may enter through egg and feeding punctures.

**Life History**—Boll weevils overwinter as diapausing adults sheltered under leaf litter, in woods, in weeds and along fence rows and ditch banks surrounding cotton fields. These adults begin to emerge as early as February in southerly areas and continue through early July, with peak emergence during late May and early June. In early spring the weevils feed primarily on terminals of cotton seedlings, but egg-laying does not occur until squares are present.

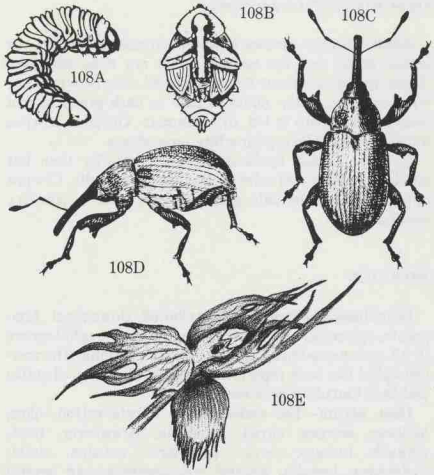



**Fig. 108 Boll weevil. A, Larva. B, Pupa. C-D, Adults. E, Damage.**

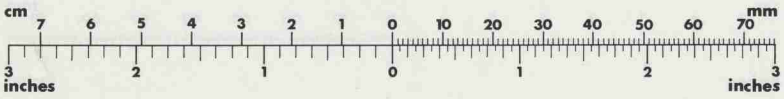
Adult females make a small cavity in each square into which they deposit a single egg. First generation females lay an average of 200 eggs while late summer generations may average only 5 eggs per female. Eggs usually hatch in 2 to 4 days depending upon the temperature.

After the larvae begin to feed, the infested squares yellow, flare, and drop from the plant in about 3 days. Depending upon the temperature and nutritional value of their food, larvae complete their development in 7 to 12 days and then transform into pupae within the squares. This stage lasts from 3½ to 8½ days. Newly formed adults remain in squares 1½ to 2½ days before chewing their way out. Because of the prolonged emergence of overwintering adults, distinct generations are difficult to recognize; however, in North Carolina, there are usually 4 generations per year.

### CONTROL

Satisfactory control depends upon a combination of cultural and chemical methods. Recommended cultural






* *Anthonomous grandis grandis* Boheman, Curculionidae, COLEOPTERA

practices include (1) early planting; (2) stimulating rapid growth by thorough preparation of the seed bed, by adequate fertilization and by recommended weed control practices; and (3) selection of early maturing varieties specifically adapted to local areas. The main objective of these practices is to hasten the development of cotton plants and set a crop before weevils become abundant. The application of a chemical defoliant toward the end of the season speeds up harvesting and allows crop residue to be destroyed as early as possible. As a result, potentially diapausing weevils are left without a food source.

Insecticidal controls include in-season and diapause applications. Regular in-season applications are used to control weevils during the major period of fruit set and boll maturity; these applications should be based on weekly weevil counts and damage. Initial insecticide applications are made when 10 percent of the squares are punctured. Insecticide applications are frequently used to reduce the diapausing (overwintering) weevil population. This practice delays the need for in-season insecticides the following year. When warranted, treatments should start at the onset of diapause and continue until fields no longer afford the boll weevil food and breeding sites. For further control information, consult the current *North Carolina Agricultural Chemicals Manual.*

## COTTON
## Bollworm Complex*

**DESCRIPTION** (two species)

**Adult**—The moths of this "complex" have a wingspan of 25.5 to 38.5 mm. The forewings of the bollworm are usually light yellowish olive with a dark spot near the center. Those of the budworm are olive or brownish olive with three slanted lines across each one. The hind wings of both species are white with a broad, dark brown or brownish-gray border along the outer wing. The hairs of the head and thorax are the same color as the forewings, the abdomen being somewhat paler.

**Egg**—The small, dome-shaped eggs are white when first deposited, but develop reddish-brown bands before hatching.

**Larva**—These moderately hairy larvae may be cream-colored (first instar), pale green (second or later instars), rose (late instars), or brown (late instars). As they mature, they develop pale longitudinal stripes and scattered black spots (chalazae). From hatch to maturity, they vary from 1.5 to 44 mm in length.

**Pupa**—The pupae are about 31.5 mm long and 6 mm wide. Initially, a shiny reddish brown, they become dark brown near the time of adult emergence.

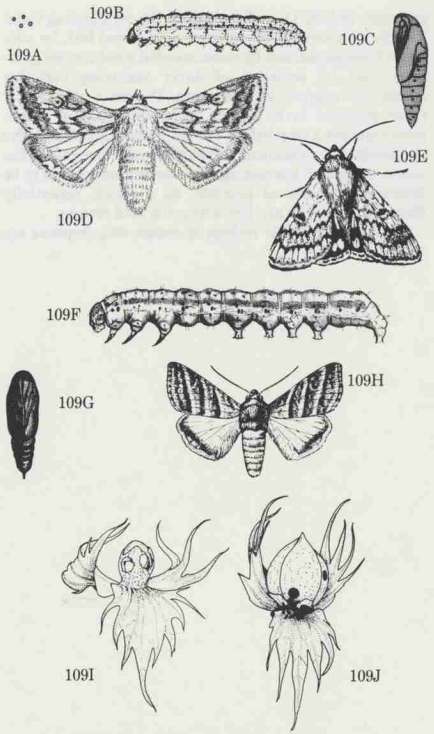



**Fig. 109 Bollworm complex. A-E, Bollworm eggs, larva, pupa, and adults. F-H, Tobacco budworm larva, pupa and adult. I-J, Bollworm complex damage to cotton.**

## BIOLOGY

**Distribution**—Both species of bollworms are found throughout most of the Western Hemisphere. They are of considerable economic importance in the southern United States, and occur northward into Canada. *H. zea* has recently been introduced into the Hawaiian Islands. Though found statewide in North Carolina, bollworms usually maintain higher populations in the Coastal Plain.



**Host Plants**—*H. zea* occurs on at least 14 cultivated plants: alfalfa, bean, corn, cotton, okra, peanut, pea, sorghum, soybean, strawberry, sweet pepper, sweet potato, tobacco, and tomato. It is also found occasionally on such wild hosts as toadflax. Although corn is the preferred host, this pest is very destructive to cotton.

The major agronomic hosts of the tobacco budworm are tobacco and cotton, the former being the preferred host. Budworms have been collected from soybeans but economic loss has not been documented. Species of deergrass (*Rhexia* spp.) are the most common wild hosts, but toadflax, beggarweed, groundcherry, geranium, and ageratum are also commonly infested.

**Damage**—Bollworms (*Heliothis zea*) and tobacco budworms (*H. virescens*) comprise the "bollworm complex" on cotton. Damage by third-generation larvae usually causes the greatest economic loss; however, second-generation bollworms may reach threshold levels. First instars feed on the epidermis of tender plant terminals. Later instars, however, move into squares, blooms, buds, and bolls. They not only feed superficially but also burrow into young bolls and squares, often hollowing them and facilitating the introduction of pathogens. Each of these larvae is capable of destroying several fruiting forms; therefore, low populations can cause economic damage.

**Life History**—In North Carolina, bollworms overwinter


* Bollworm, *Heliothis zea* (Boddie);
Tobacco budworm, *Heliothis virescens* (Fabricius), Noctuidae, LEPIDOPTERA

as pupae in the soil at a depth of 5 to 10 cm (2 to 4 inches). Diapausing pupae occur in August or September. Adult moths emerge from late April to mid-May to mate and lay eggs (oviposit). Each female lays an average of 1,000 eggs, which usually hatch within 2 to 5 days.

In spring and early summer when the overwintering generation moths emerge, no single species of plant is abundant or desirable enough to receive the majority of eggs. Therefore, eggs and larvae occur in moderate numbers on corn (in the whorl), tobacco, cotton, and various weedy hosts. When the many acres of field corn start silking, almost 100 percent of the *H. zea* eggs are deposited on corn; the same is true concerning flowering tobacco and *H. virescens* eggs. Later in the season when corn silks dry up, third-generation bollworm moths oviposit on a variety of hosts: cotton, soybeans, peanuts, and others. Therefore, most of the *H. zea* population on cotton occurs in August and early September. Tobacco budworm moths, however, continue to prefer tobacco for oviposition, only sporadically laying eggs on cotton. Therefore, cotton is not normally attacked as readily by the tobacco budworm as it is by the bollworm in North Carolina.

On cotton, larvae of the "bollworm complex" require 17 to 25 days to feed and mature. They then pupate in the soil for about 16 days. A new generation of moths emerges from the pupae, mates, and lays eggs. Up to four generations occur each year in North Carolina.

## CONTROL

Judicious early use of insecticides permits an adequate build-up of beneficial insects which helps control second-generation bollworms. Thresholds for cotton bollworm control vary throughout the Cotton Belt. Five percent square damage by third-generation bollworms usually justifies the initiation of insecticidal control. Occasionally spraying to control second-generation bollworms is warranted in the southern North Carolina counties. Normally, however, this practice is discouraged for the following reasons: (1) early applications of organophosphorous insecticides tend to delay maturity, (2) cotton plants can compensate, to a large extent, for second-generation bollworm damage, and (3) early insecticide applications often put the cotton producer on an expensive, "treadmill" type spray program.

Insecticide applications are most effective when the bollworms are very small. For specific information concerning insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*

## COTTON
## Cabbage Looper*

### DESCRIPTION

**Adult**—The cabbage looper moth has a wingspan of about 38 mm. Near the center of each brownish-gray forewing is a silver, figure 8 design; the lighter colored hind wings have dark margins.

**Egg**—The round, greenish-white egg is slightly smaller than a pinhead.

**Larva**—This green larva tapers from the rear to the head and has 3 pairs of prolegs. Several white stripes run the length of the body. When fully grown, the caterpillar is about 40 mm long and is less noticeably striped. It moves in a characteristic "looping" motion.

**Pupa**—The green to brown pupa is approximately 19 mm long and encased in a loosely woven, silk cocoon. Cocoons occur on vegetation or in the soil litter.

### BIOLOGY

**Distribution**—Native to North America, the cabbage looper is common from southern Canada into Mexico. In the United States, this caterpillar is primarily a problem in the South. Damaging infestations in cotton usually occur after early insecticide applications.

**Host Plants**—The cabbage looper infests a large range of plants. Some cultivated hosts include: crucifers, cotton, potato, spinach, soybean, lettuce, celery, parsley, tomato, chrysanthemum, geranium, and carnation.

**Damage**—During their 2- to 4-week lifespan cabbage loopers are voracious foliage feeders. Ragged holes in cotton foliage may be indicative of their presence.



**Life History**—Cabbage loopers overwinter as pupae attached to host plant foliage which has fallen to the ground. The inconspicuous night-flying moths emerge in the spring and females soon begin depositing 275 to 350 eggs, singly, on the upper and lower surfaces of leaves. About 3 days later (up to 10 days under adverse conditions), young loopers hatch from the eggs and begin feeding. The caterpillars consume foliage voraciously for 2 to 4 weeks before spinning cocoons and pupating. Within 2 weeks the next generation of moths emerges. In North Carolina, five to six generations may occur each year, primarily on crucifers.

### CONTROL

In cotton, cabbage looper populations usually remain low due to a viral disease. Whenever the dead, darkened loopers are found hanging by their hind legs from cotton leaves, controls are usually unnecessary. When damaging infestations do develop, the loopers are usually fairly large and difficult to control. Due to the relative inefficacy of most insecticides now on the market, chemical control should be used only as a last resort. For further information, consult the current *North Carolina Agricultural Chemicals Manual.*

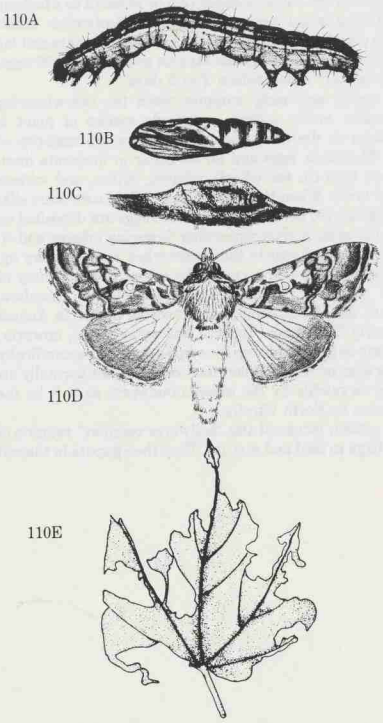
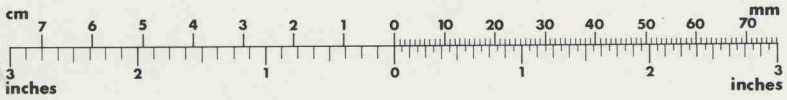



**Fig. 110 Cabbage looper. A, Larva. B, Pupa. C, Cocoon. D, Adult. E, Damage.**




* *Trichoplusia ni* (Hübner), Noctuidae, LEPIDOPTERA

## DESCRIPTION

**Adult**—Like most lygus bugs, the tarnished plant bug is oval in shape and has a characteristic white triangle between the "shoulders." Its legs and antennae are relatively long. The adult may be one of several shades of brown and is approximately 6.4 mm long.

**Egg**—The tiny, elongate egg is slightly curved.

**Nymph**—The wingless nymph is yellow-green in color with several black spots on its back. Length varies from 1.5 mm to slightly less than adult size. The fourth instar nymph has wing pads.

## BIOLOGY

**Distribution**—Tarnished plant bugs are generally distributed. Since warm, dry climates are most conducive to the buildup of lygus bug infestations, tarnished plant bugs pose a limited threat in North Carolina. In states further south and southwest, economic injury occurs annually.

**Host Plants**—Tarnished plant bugs infest over 50 economic plants including many field, forage, fruit, and vegetable crops. Also, weeds such as butterweed, fleabane, goldenrod, aster, vetch, dock, and dogfennel commonly harbor these insects in southern states.

**Damage**—Shiny, circular spots of excrement on various plant parts indicate the presence of tarnished plant bugs. These bugs pierce the terminal growth, squares, flowers and bolls with their needle-like mouthparts and extract plant juices. The most conspicuous result is the appearance of warty growths on flower petals and inside the bolls. The more economically important damage, however, is not as noticeable. Injured pinhead squares and terminals drop from the plant. The anthers of larger squares may turn black resulting in poor pollination and reduced boll set. Larger bolls, opening prematurely, expose lint which becomes discolored, clings inside the warty boll, and is difficult to harvest. Finally, cotton seed harvested from heavily infested fields germinates poorly.

Indirect losses due to this pest greatly enhance its economic importance. Early season chemical treatments eliminate predators and parasites, sometimes resulting in a resurgence of other economically important pests, particularly bollworms.

**Life History**—In the more southern areas of the Cotton Belt, tarnished plant bugs may remain active year round. In North Carolina, however, adults hibernate in plant debris and resume activity in the spring. At this time females insert eggs into succulent host plant tissue with

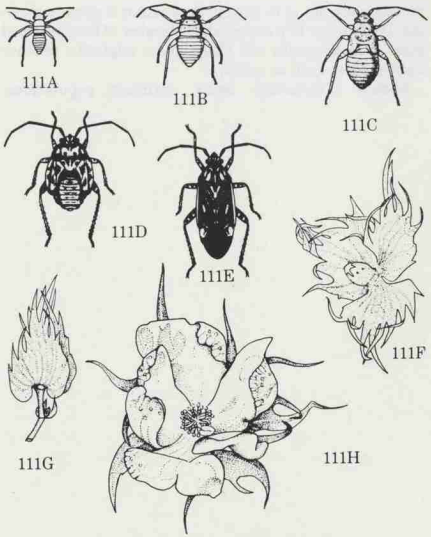


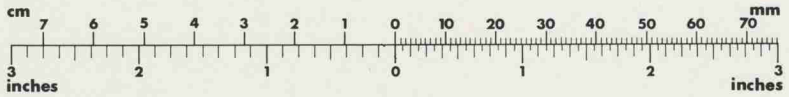

**Fig. 111 Tarnished plant bug. A-D, Nymphs. E, Adult. F, Flared square. G, Normal square. H, Warty blossom.**

their sword-like ovipositor. Eggs hatch 1½ to 3 weeks later. The nymphs develop through five instars over a 3 week period as they feed on plant sap. Mature nymphs molt and emerge as adults. The first few generations develop on preferred hosts such as small grains, alfalfa, wild grasses, vetch, dock, and fleabane. As hay is cut or as other plants dry out, tarnished plant bugs migrate in large numbers to succulent cotton. During the summer, the life cycle from egg hatch to adult emergence is completed in 4 weeks. The number of generations produced each year depends upon geographic location and weather conditions.

## CONTROL

To reduce chances of tarnished plant bug infestation, avoid planting cotton adjacent to preferred host plants, maintain good weed control practices, and plow under crop residue to destroy overwintering sites. However, these






* *Lygus lineolaris* (Palisot de Beauvois), Miridae, HEMIPTERA

practices are not to be started once cotton is already growing. Destruction of a considerable number of infested weed hosts or small grains will likely induce migration to other nearby hosts such as cotton.

Should infestations occur, estimate populations. Chemical control is recommended in some southeastern states when 15 or more tarnished plant bugs are found per 100 terminals. For specific information on insecticides and rates, consult current North Carolina State Agricultural Extension Service recommendations.

## DESCRIPTION (several species)

**Adult**—Thrips which are pests of cotton are yellow, brown, or black insects usually less than 2 mm in length. Most adults have two pairs of narrow wings fringed with long hairs although some species lack wings in the winter.

**Egg**—Eggs are usually white, bean-shaped, and approximately 0.2 mm long.

**Larva**—The wingless larvae are usually white or yellow and approximately 0.25 mm long. There are two larval instars.

**Prepupa** and **Pupa**—Pupal stages resemble larvae in shape and color. Prepupa have short wing pads and pupae have long wing pads. Pupae usually remain motionless unless disturbed.

## BIOLOGY

**Distribution**—Most species of thrips occur throughout the entire United States Cotton Belt. However, tobacco thrips occur primarily in the eastern United States as far west as Texas and Oklahoma.

**Host Plants**—The respective host range of each thrips species found on cotton is too extensive to list here. Most field, vegetable, flower, and orchard crops are attacked by at least one thrips species. Several trees and weedy plants are commonly infested also.

**Damage**—Thrips cause most damage to seedling cotton. They rasp tender leaves and terminal buds with their sharp mouthparts and feed on the escaping juices. Leaves may turn brown on the edges, develop a silvery color, or may become distorted and curl upward. This damage may be confused with aphid injury (aphids cause leaves to curl downward). Light thrips infestations tend to delay plant growth and retard maturity. Heavy infestations may kill terminal buds or even entire plants. Damaged terminal buds result in abnormal branching patterns.

The duration and intensity of thrips infestations vary greatly according to season and geographic location. Once cotton plants are 4 to 6 weeks old, they usually outgrow thrips damage and begin to recover. In most areas, plants recover and suffer no yield loss. However, if late infestations persist, plant maturity may be delayed with resulting yield loss.

**Life History**—In North Carolina, thrips overwinter as hibernating adults in sheltered areas, as larvae on plants, or as pupae in the soil. They resume development in the spring. Winged adult thrips emerge and fly in search of suitable host plants. Depending on the particular species, each female may produce 10 to 100 eggs which she inserts singly into tender plant tissue. About 4 days later, eggs hatch. The larvae usually feed for approximately 6 days before pupating in the soil. Approximately 4 days later, new adults emerge which soon feed and lay eggs. Although the winged adults are weak fliers, they are capable of flying from plant to plant and may be carried long distances by wind. Most thrips species complete five or more generations per year in North Carolina.

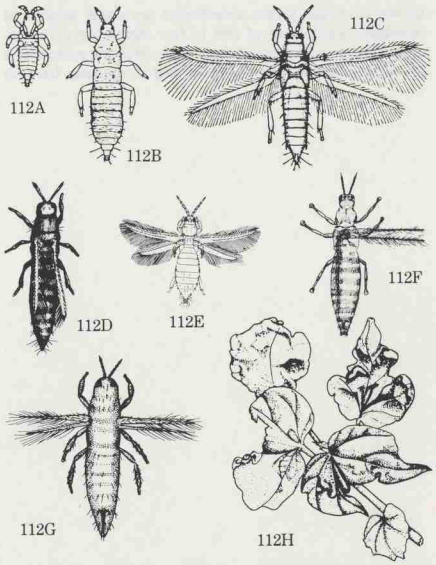
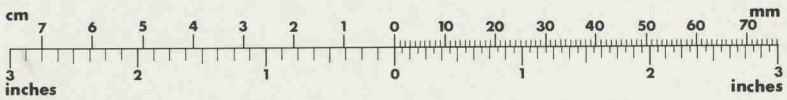



**Fig. 112 Thrips. A-C, Onion thrips larvae and adult. D, Flower thrips. E, Tobacco thrips. F, Soybean thrips. G, *Frankliniella exigua*. H, Damage.**



## CONTROL

Since North Carolina has an early frost date in comparison with other Cotton Belt states, severe thrips infestations may warrant control. In areas where thrips are




* Onion thrips, *Thrips tabaci* Lindeman; Flower thrips, *Frankliniella tritici* (Fitch); Tobacco thrips, *Frankliniella fusca* (Hinds); No common name, *Frankliniella exigua* Hood; Soybean thrips, *Sericothrips variabilis* (Beach), Thripidae, THYSANOPTERA

known to reduce yields, insecticides are either applied at threshold populations of one to five thrips per plant, especially during the first 30 days of the growing season, or a granular systemic insectide is utilized at planting. Later in the season, control is rarely necessary. For more specific control information, consult the current *North Carolina Agricultural Chemicals Manual.*

## DESCRIPTION

**Adult**—The adult mite has eight legs. Oval and about 0.4 mm long, the female is yellowish to dark green with two or four black, dorsal spots. Slightly smaller than the female, the male has a more pointed abdomen.

**Egg**—The egg is spherical, minute, and transparent when first laid. Just before hatching, it becomes straw colored or yellowish green.

**Larva**—The six-legged larva, not much bigger than the egg, is colorless except for carmine eyes.

**Nymph**—There are two nymphal stages which are difficult to distinguish. Both are pale green, oval, and eight-legged. The pair of dark spots are visible at this point of development.

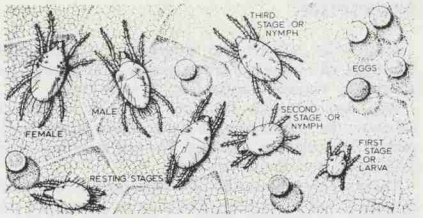
## BIOLOGY

**Distribution**—Twospotted spider mites are widely distributed throughout the world and the United States. In North Carolina, they are pests throughout the Coastal Plain area on cotton, peanuts, and corn.

**Host Plants**—Twospotted spider mites have been found on over 180 host plants including at least 100 cultivated species. Violets, chickweed, pokeweed, wild mustard, and blackberry are common hosts from which infestations spread to crops nearby.

**Damage**—The spider mite is a frequent minor pest in cotton fields near sources of infestation (brush, weeds, clover, and peanuts, for example). Yield reduction is greater when infestations develop in the early squaring stage than in late stages of plant growth. Feeding usually occurs on the underside of the leaf, where the mites pierce the epidermis and extract the sap. Infested foliage soon assumes a whitish or bronze appearance. Lightly infested leaves have pale blotches or spots showing through the leaf; heavily infested leaves turn completely pale and dry up, or their edges turn reddish brown. The entire plant may die. The undersurfaces of the leaves usually have silken webs over which the mites crawl, though a heavily infested plant may have webs all over it. Close examination reveals adult mites on the leaves.

**Life History**—Twospotted spider mites overwinter as females resistant to low temperatures. In mild winters, they may continue to feed and lay eggs. During summer, many generations may develop; the number of eggs laid depends largely upon temperature. In 3 to 19 days, eggs hatch into six-legged larvae, which develop into eight-legged nymphs. There are two nymphal stages: protonymphs and deutonymphs. After the larval and each nymphal stage, there is a resting stage. In warm weather, the females soon begin laying eggs; each female produces up to 19 eggs per day and up to 100 eggs in total. Development is rapid in hot, dry weather. One generation may mature in as few as 5 days or as many as 20.




113

**Fig. 113 Twospotted spider mite life stages.**

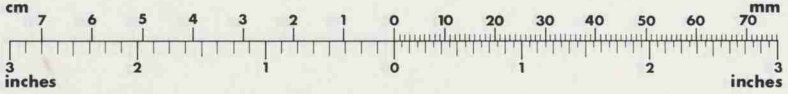
## CONTROL

One form of cultural control is the destruction of weeds around the field in fall or early spring. This practice reduces the overwintering population. The maintenance of clean turn rows also reduces infestation. The destruction of weeds or the clearing of fence rows during the growing season forces mites to migrate into field crops. Therefore, these practices should be avoided.

89

Spider mites are distributed over a field in two ways: (1) migration of females from a heavily infested area to a lightly infested one, and (2) natural or mechanical transportation of mites (by wind, mammals, and man or his machinery) from an infested area to an uninfested one. Man often spreads the mite inadvertently by walking from an infested area to an uninfested area, carrying mites on his pants legs. Therefore, known "hot spots" should be investigated last.

Several available miticides provide effective chemical control. Since recommended miticides do not act as ovicides, a second application is often advised 5 to 7 days after the first. Currently recommended miticides are given in the *North Carolina Agricultural Chemicals Manual.*




*Tetranychus urticae* Koch, Tetranychidae, PROSTIGMATA

## COTTON
## Yellowstriped Armyworm*

### DESCRIPTION

**Adult**—The yellowstriped armyworm moth has dark forewings with white and brown markings, and white hind wings. The wingspan ranges from 32 to 38 mm.

**Egg**—Approximately 0.5 mm long and 0.4 mm in diameter, the ribbed, greenish egg gradually becomes pale pink or brown before hatching. The egg mass is covered with scales from the moth's body.

**Larva**—This smooth-skinned, pale gray to jet black caterpillar has a yellowish-orange stripe along each side and a pair of black, triangular spots on the back of most segments. The sixth larval instar may be as long as 45 mm.

**Pupa**—The brownish pupa is about 18 mm long and 5.5 mm wide.

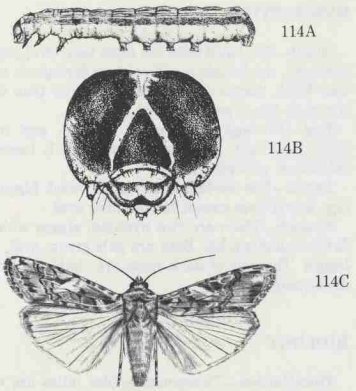



**Fig. 114 Yellowstriped armyworm. A, Larva. B, Larval head capsule. C, Adult.**

### BIOLOGY

**Distribution**—The yellowstriped armyworm occurs from New York southward into Mexico, westward to the Rocky Mountains, and in some areas of California and the West Indies. In this country, however, it is most common and most injurious in the southern states. The distribution in North Carolina is statewide.

**Host Plants**—The yellowstriped armyworm is a general feeder. Some of its hosts include alfalfa, bean, beet, cabbage, clover, corn, cotton, cucumber, grape, grass, jimsonweed, morning glory, onion, pea, peach, peanut, sweet potato, tobacco, tomato, turnip, wheat, watermelon, and wild onion.

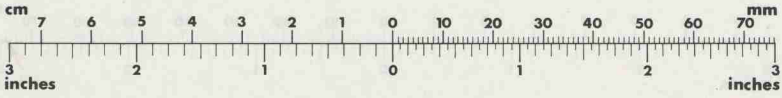


**Damage**—This foliage-feeding caterpillar is sporadically injurious to young stands of field crops. Larvae are annually observed in cotton, peanut, and soybean fields and occasionally damage cotton squares and bolls. However, most of its injury consists of defoliating young plants.

**Life History**—Yellowstriped armyworms overwinter as pupae in the soil. In the southern states, moth emergence begins in early April and continues into May. After mating, the females deposit egg masses on foliage, trees, or buildings. Approximately 6 days later, the eggs hatch and the newly emerged larvae begin feeding. Although these caterpillars emerge by late spring in the South, they may not appear before July in northern and midwestern states. Over a 3-week period, the larvae feed during the day on tender foliage. Mature sixth instars burrow into the soil and change into pupae. Two weeks later, the second generation of moths emerges. In southern states, including North Carolina, three to four generations occur each year.

### CONTROL

Yellowstriped armyworms are difficult to control with insecticides. Early detection is important in maintaining populations below economic injury levels. For specific control measures, consult current North Carolina State Agricultural Extension Service recommendations.




*Spodoptera ornithogalli* (Guenée), Noctuidae, LEPIDOPTERA

GENERAL

Boyer, W.P., J.G. Burleigh, and M.L. Wall. 1977. Larval characters for separating bollworm and tobacco budworm. Ann. Entomol. Soc. Amer. 70: 5-6.

Bradley, J.R., J. Bacheler, and G. Toomey. 1978. Production guide, cotton insect pest management. North Carolina Agr. Ext. Service Pub. CPG 7. 4 pp.

Folsom, J.W. 1932. Insect enemies of the cotton plant. U.S. Dep. Agr. Farmers' Bull. 1688. 29 pp.

Gaines, J.C. 1959. Cotton insects. Texas Agr. Ext. Service Bull. B-933. 16 pp.

Gilliland, F.R., Jr. 1973. A pest management system for cotton insect suppression. Alabama (Auburn Univ.) Agr. Exp. Sta. Progress Rep. Ser. 105. 6 pp.

Kinzer, R.E., L.A. Bariola, L. Ridgway, and S.L. Jones. 1976. Systemic insecticides and a nuclear polyhedrosis virus for control of the bollworm and tobacco budworm on cotton. J. Econ. Entomol. 69: 697-701.

Little, V.A. and D.F. Martin. 1942. Cotton insects of the United States. Burgess Publ. Co., Minneapolis, Minn. 130 pp.

Lukefahr, M.J. 1960. Effects of nectariless cottons on populations of three lepidopterous insects. J. Econ. Entomol. 53: 242-4.

Lukefahr, M.J. 1977. Varietal resistance to cotton insects. Proc. Beltwide Cotton Prod. Res. Conf.: 236-7.

Lukefahr, M.J., J.E. Houghtaling, and D.G. Cruhm. 1975. Suppression of *Heliothis* spp. with cottons containing combinations of resistant characters. J. Econ. Entomol. 68: 743-6.

Reynolds, H.T., P.L. Adkisson, and R.F. Smith. 1975. Cotton insect pest management, pp. 379-444. *In* Introduction to insect pest management, ed. R.L. Metcalf and W.H. Luckmann. John Wiley and Sons, New York. 587 pp.

Sartor, C., D. Young, J. Hamer, and H.C. Mitchell. 1976. Cotton scouting manual. Mississippi Coop. Ext. Service. Pub. 988. 20 pp.

Smith, G.L. 1942. California cotton insects. California Agr. Exp. Sta. Bull. 660. 50 pp.

Telford, A.D. and L. Hopkins. 1957. Arizona cotton insects. Arizona Agr. Exp. Sta. Bull. 286. 61 pp.

Telford, A.D., G.P. Wene, and L.A. Carruth. 1962. Descriptions and habits of Arizona cotton insects. Arizona Agr. Ext. Service Bull. A-23. 62 pp.

Tynes, J.S. 1976. Cotton insect pest management—1976. Louisiana Coop. Ext. Service Pub. 1829. 4 pp.

U.S., Department of Agriculture. 1972. Twenty-fifth Ann. Conf. Rep. on Cotton Insect Research and Control. Agr. Res. Service. 92 pp.

U.S., Department of Agriculture. 1977. Thirtieth Ann. Conf. Rep. on Cotton Insect Research and Control. Agr. Res. Service. 92 pp.

U.S., Department of Agriculture. 1978. Thirty-first Ann. Conf. Rep. on Cotton Insect Research and Control. Agr. Res. Service. 75 pp.

BOLL WEEVIL

Cross, W.H. 1973. Biology, control, and eradication of the boll weevil. Annu. Rev. Entomol. 18: 17-46.

Fenton, F.A. 1929. Biology of the cotton boll weevil at Florence, S. C. U.S. Dep. Agr. Tech. Bull. 112. 76 pp.

U.S., Department of Agriculture. 1969. The boll weevil . . . how to control it. Farmers' Bull. 2147. 12 pp.

BOLLWORM COMPLEX

Lincoln, C. 1973. Bollworm outbreaks on cotton in Arkansas: 1962-1970. Arkansas Agr. Exp. Sta. Mimeograph Service. 211. 18 pp.

Neunzig, H.H. 1969. The biology of the tobacco budworm and the corn earworm in North Carolina. North Carolina Agr. Exp. Sta. Tech. Bull. 196. 76 pp.

Slosser, J.E., J.R. Philips, G.A. Herzog, and C.R. Reynolds. 1975. Overwinter survival and spring emergence of the bollworm in Arkansas. Environmental Entomol. 4: 1015-24.

Stadelbacher, E.A. and T.R. Pfrimmer. 1972. Winter survival of the bollworm at Stoneville, Mississippi. J. Econ. Entomol. 65: 1030-4.

Sterling, W.L., *et al.* 1979. Economic threshold and sampling of *Heliothis* species on cotton, corn, soybeans and other host plants. Regional Res. Proj. S-59, Southern Coop. Ser. Bull. 231. 159 pp.

York, A. 1974. Corn earworm control. Indiana (Purdue Univ.) Coop. Ext. Service Pub. E 31. 2 pp.

CABBAGE LOOPER

Elsey, K.D. and R.L. Rabb. 1970. Analysis of the seasonal mortality of the cabbage looper in North Carolina. Ann. Entomol. Soc. Amer. 63: 1597-604.

McEwen, F.L. and G.E.R. Hervey. 1960. Mass rearing of the cabbage looper, *Trichoplusia ni*, with notes on its biology in the laboratory. Ann. Entomol. Soc. Amer. 53: 229-34.

Shorey, H.H., L.A. Andres, and R.L. Hale, Jr. 1962. The biology of *Trichoplusia ni* (Lepidoptera: Noctuidae) I. Life history and behavior. Ann. Entomol. Soc. Amer. 55: 591-7.

COTTON APHID

Isley, D. 1946. The cotton aphid. Arkansas Agr. Exp. Sta. Bull. 462. 29 pp.

U.S., Department of Agriculture. 1960. The cotton aphid: how to control it. Leafl. 467. 8 pp.

TARNISHED PLANT BUG

Isley, D. 1927. The cotton hopper and associated leaf-bugs attacking cotton. Arkansas Agr. Ext. Service Circ. 231. 8 pp.

Kelton, L.A. 1975. The Lygus bugs of North America. Entomol. Soc. Can. Mem. 95. 101 pp.

Pack, T.M. and P. Tugwell. 1976. Clouded and tarnished plant bugs on cotton: a comparison of injury symptoms and damage on fruit parts. Arkansas Agr. Exp. Sta. Rep. Ser. 226. 17 pp.

Sevacherian, V. and V.M. Stern. 1974. Host plant preferences of Lygus bugs in alfalfa-interplanted cotton fields. Environmental Entomol. 3: 761-6.

Tugwell, N.P. 1969. Plant bugs in northeast Arkansas. Arkansas Farm Res. 18(6): 10.

Tugwell, P., S.C. Young, Jr., B.A. Dumas, and J.R. Phillips. 1976. Plant bugs in cotton: importance of infestation time, types of

cotton injury, and significance of wild hosts near cotton. Arkansas Agr. Exp. Sta. Service Rep. Ser. 227. 24 pp.

U.S., Department of Agriculture. 1969. Lygus bugs on cotton . . . how to control them. Leafl. 503. 8 pp.

### THRIPS

Dunnam, E.W. and J.C. Clark. 1937. Thrips damage to cotton. J. Econ. Entomol. 30: 855-7.

Eddy, C.O. and E.M. Livingstone. 1931. *Frankliniella fusca* Hinds (thrips) on seedling cotton. South Carolina Agr. Exp. Sta. Bull. 271. 23 pp.

Eddy, C.O. and W.H. Clarke. 1930. The onion thrips on seedling cotton, with a season's record of parthenogenetic development. J. Econ. Entomol. 23: 704-8.

Eyer, J.R. and J.T. Medler. 1941. Control of thrips on seedling cotton. J. Econ. Entomol. 34: 726-7.

Newsom, L.D., J.S. Roussel, and C.E. Smith. 1953. The tobacco thrips: its seasonal history and status as a cotton pest. Louisiana Agr. Exp. Sta. Bull. 474. 36 pp.

U.S., Department of Agriculture. 1962. Thrips on cotton—how to control them. Leafl. 516. 8 pp.

Watts, J.G. 1936. A study of the biology of the flower thrips *Frankliniella tritici* (Fitch) with special reference to cotton. South Carolina Agr. Exp. Sta. Bull. 306. 46 pp.

Watts, J.G. 1937. Species of thrips found on cotton in South Carolina. J. Econ. Entomol. 30: 857-60.

### TWOSPOTTED SPIDER MITE

Baker, E.W. and A.E. Pritchard. 1953. A guide to the spider mites of cotton. Hilgardia 22: 203-34.

Canerday, T.D., T.F. Watson, and F.S. Arant. 1962. Biology and control of spider mites on cotton in Alabama. Alabama (Auburn Univ.) Agr. Exp. Sta. Leafl. 68. 4 pp.

Laing, J.E. 1969. Life history and life table of *Tetranychus urticae* Koch. Acarologia 11: 32-42.

Schuster, M.F. 1975. Relative twospotted spider mite damage to cultivars of *Gossypium* sp. J. Econ. Entomol. 68: 171-2.

Schuster, M.F., F.G. Maxwell, J.N. Jenkins, E.T. Cherry, W.L. Parrott, and D.G. Holder. 1973. Resistance to twospotted spider mite in cotton. Mississippi Agr. Forest. Exp. Sta. Bull. 802. 25 pp.

Schuster, M.F. and F.G. Maxwell. 1976. Resistance to twospotted spider mite in cotton. Mississippi Agr. Forest. Exp. Sta. Bull. 821. 13 pp.

U.S., Department of Agriculture. 1968. Spider mites on cotton Leafl. 502. 4 pp.

Vrie, M. van de, J.A. McMurtry, and C.B. Huffaker. 1972. Ecology of tetranychid mites and their natural enemies: a review. III. Biology, ecology, and pest status, and host-plant relations of tetranychids. Hilgardia 41: 343-432.

### YELLOWSTRIPED ARMYWORM

Crumb, S.E. 1927. The army worms. Brooklyn Entomol. Soc. Bull. 22: 41-55.

Walkden, H.H. 1950. Cutworms, armyworms, and related species attacking cereal and forage crops in the Central Great Plains. U.S. Dep. Agr. Circ. 849. 52 pp.

Whelan, D.B. 1935. A key to the Nebraska cutworms and armyworms that attack corn. Nebraska Agr. Exp. Sta. Res. Bull. 81. 27 pp.

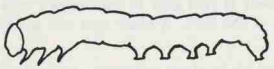
# PESTS OF FORAGES AND PASTURE

Based on 1980 estimates, North Carolina forages and pasture comprise a total of over 900,000 hectares (about 2,222,000 acres). This acreage includes not only improved and unimproved pasture but also legume and grass hay crops. Since many different kinds of plants fall into the category of forages, it is not surprising that the insect pests attacking these crops are just as numerous and varied. Several hundred species are associated with alfalfa alone. Fortunately, only a few of these are economically important. The alfalfa weevil remains the primary pest problem of alfalfa, while white grubs are the corresponding threat to grass forages. Although the number of serious pests is few, their chemical control poses the problem of insecticide residues.

## Key to Pests of Forages and Pasture

A. Chewing insects that feed above ground

1. **Caterpillars**—All moth larvae described in this section have three pairs of legs near the head and five pairs of prolegs (Fig. 115).



115

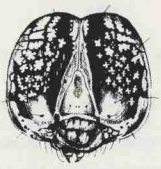
a. **Armyworms**—Usually 30 to 40 mm long when fully grown, these smooth-skinned caterpillars are voracious foliage feeders.

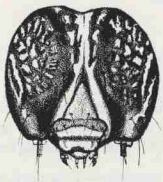
i. **Armyworm** (true)—The larva is basically yellowish or greenish brown with three dark, longitudinal stripes and is 30 to 35 mm long when fully grown. The head capsule has markings like those of the fall armyworm, but they are lighter or less intense (Fig. 116A). Feeding primarily at night, the armyworm often does much damage to the tender, succulent foliage of seedling grasses. During the day, this caterpillar usually hides among debris on the soil surface .....p. 99

ii. **Fall armyworm**—The green, brown, or black larva may be as long as 40 mm and has a dark head capsule usually marked with a pale, but distinct, inverted "Y" (Fig. 116B). It has a black, longitudinal stripe down each side of its body and a yellowish-gray stripe down its back. As its name implies damage is most prevalent in lush grass crops during late summer and fall .....p. 103



116A

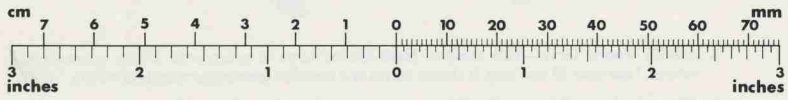




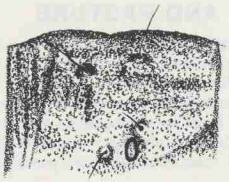
116B

b. **Cutworms**—These fat worms may be as long as 45 mm and curl up when disturbed. Depending upon their stage of development, cutworms may sever seedlings at the soil line or feed on foliage.

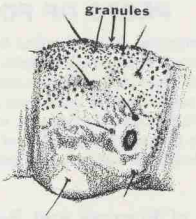
i. **Black cutworm**—This caterpillar varies from light gray to black in color, often appearing greasy. The skin of this cutworm is granulated (as seen under a 10X hand lens), the granules resembling rounded, flattened pebbles (Fig. 117A). It burrows in soil and debris during the day and, when mature, cuts or partially severs seedlings near the soil line at night. When immature, the larva feeds primarily on foliage .....p. 119




* See also "Key to Caterpillars" on page 16.



117A



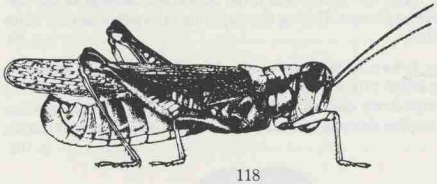

117B

ii. **Granulate cutworm**—This caterpillar has a pale brown head, a dark brown band down its back, and brown sides with faint stripes. The skin granules of this cutworm are like blunt cones as high as they are wide (Fig. 117B) ..... p. 46

iii. **Variegated cutworm**—This climbing cutworm feeds on foliage, buds, and fruit. Its smooth-skinned body is pale gray to dark brown with a row of yellow or orange spots down the middle of the back. A black spot and a yellow spot occur on the eighth abdominal segment ..... p. 110

c. **Sod webworms**—Several kinds of sod webworm caterpillars consume leaves and tender new growth. Basically greenish with black spots, they are 16 to 19 mm long when mature. Silky webbing near the soil line is often found in association with these foliage-feeding caterpillars ..... p. 54

2. **Grasshoppers**—Full grown grasshoppers (Fig. 118) are 19 to 33 mm long. They consume foliage as well as sever stalks ..... p. 104



118

119A

119B

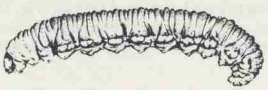


3. **Weevils**—A few species of small, dark, snout beetles (Fig. 119A to B) feed on the foliage of legume forage and pasture crops.

a. **Alfalfa weevil**—The dark brown, gray-mottled weevil, less than 6 mm long, has a darker stripe down its back more than half the length of the body. Its snout is at least twice as long as it is wide (Fig. 119A). This pest shreds leaves and destroys growing alfalfa terminals ..... p. 97

b. **Clover root curculio**—This dark-colored weevil, 3 to 5 mm long, has a short, stocky snout about as long as it is wide (Fig. 119B). The curculio makes small, crescent-shaped notches in the leaves of alfalfa and clover. Small plants may be defoliated as soon as they emerge from the ground ..... p. 102

4. **Weevil larvae**—These soft-bodied, legless larvae (Fig. 120) feed on leaves.

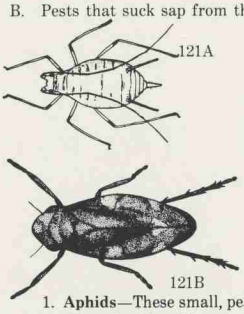


120

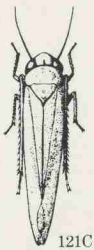
a. **Alfalfa weevil larva**—This slender, black-headed larva is green with white, longitudinal stripes. Less than 10 mm long, it shreds leaves and destroys growing terminals of alfalfa .. p. 97

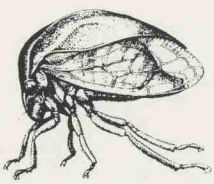
b. **Clover leaf weevil larva**—Reaching a mature length of 12 to 13 mm, this stocky, greenish or yellowish larva has a white or pink line down the center of its back and a dark line along each side. Leaves of infested plants become full of small holes and irregular patches ..... p. 100

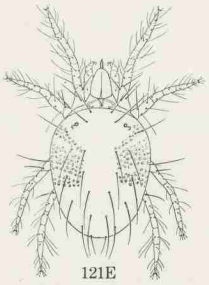
B. Pests that suck sap from the plant (Fig. 121A to E).


121A

121B


121C


121D


121E

1. **Aphids**—These small, pear-shaped, winged or wingless insects (Fig. 121A) congregate primarily on the underside of leaves. They extract sap, causing the foliage to turn yellow, and then excrete a sweet, sticky, substance known as "honeydew." Black sooty mold grows on the surface of this excretion.

   a. **Cowpea aphid**—The adult of this species is black with white appendages and grows to 2 mm long. The nymph is pale gray with a powdery coating .....p. 79

   b. **Pea aphid**—This pale green aphid may be as long as 4 mm and has long, slender cornicles ...p. 107

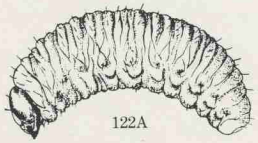
2. **Meadow spittlebug**—Both the gray, brown, or spotted, 6-mm-long adult (Fig. 121B) and the orange, yellow, or pale green nymph extract plant sap. Hosts do not turn yellow, but may wilt, become stunted, develop a terminal rosette, and produce a lower yield. Nymphs are surrounded by white, frothy masses resembling spittle ..... p. 106

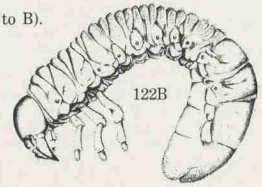
3. **Potato leafhopper**—This 3-mm-long insect (Fig. 121C) is yellowish to pale green with yellow to dark green spots, which can be observed under magnification. It pierces and extracts sap from leaf veins, causing yellowing of leaves, loss of vigor, or death of the plant .....p. 108

4. **Threecornered alfalfa hopper**—The straw-colored nymph (about 4.6 mm long) and the green adult (6.0 to 6.5 mm long) are both wedge-shaped, the front of the body being widest (Fig. 121D). Their feeding and egg-laying activities on the lower stem may cause stem breakage and lodging .....p. 164

5. **Twospotted spider mite**—This almost microscopic, eight-legged (larva six-legged) pest (Fig. 121E) feeds on the underside of leaves, often "spinning" a network of silken webs on which to travel and deposit eggs. Damage is indicated by a white cast to the leaves when viewed from a distance. This mite is identified by the adult female which is yellowish to dark green with two or four dark, dorsal spots .....p. 125

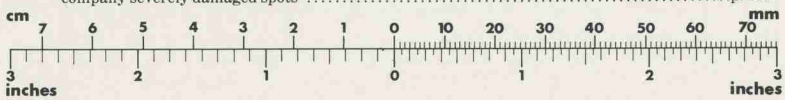
C. Insects that attack plants underground (Fig. 122A to B).

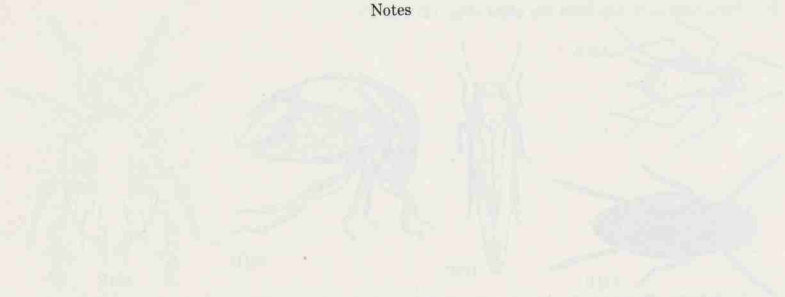

122A


122B

1. **Clover root curculio grub**—Roots are scored and girdled near the crown by a fleshy, legless, grayish-white grub measuring about 5 mm long when fully grown (Fig. 122A) .....p. 102

2. **White grubs**—These C-shaped, six-legged grubs (Fig. 122B) are 5 to 48 mm long. They eat or sever roots, thereby causing reduced plant growth or death, especially during drought. Small localized areas of unhealthy plants are often indicative of a white grub infestation. Fluffy soil may also accompany severely damaged spots .....p. 111





## FORAGES AND PASTURE INSECT NOTES

### Alfalfa Weevil*

### DESCRIPTION

**Adult**—Usually 5 to 6 mm long, alfalfa weevil adults vary widely in color and marking. The newly emerged weevil is light brown with a distinct, dark line down the center of its back. After a few days, it becomes entirely dark brown or black.

**Egg**—The egg is small, oval, and pale yellow when laid. It darkens before hatching. The surface, although appearing smooth, is sculptured.

**Larva**—There are three or four larval instars. The young larva is legless, cream colored or yellowish green and about 0.75 mm long. As it matures, it becomes green and has a black head. The mature larva has a distinct, white stripe down the center of its back and a faint, white line along each side. The entire body is wrinkled and about 9.5 mm long when mature.

**Pupa**—About the size of the mature larva, the newly formed pupa is yellowish green, but later changes to light brown. Its loosely constructed, white, silken cocoon usually contains leaf fragments.

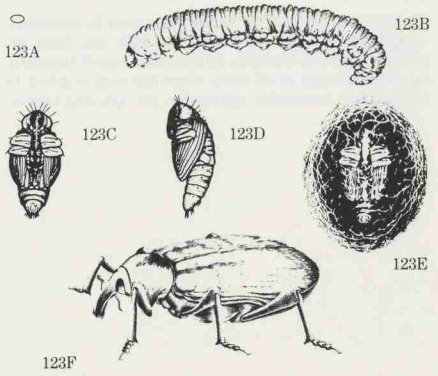



**Fig. 123 Alfalfa weevil. A, Egg. B, Larva. C-D, Pupae. E, Pupa in cocoon. F, Adult.**

### BIOLOGY

**Distribution**—Although this weevil now occurs throughout the 48 contiguous states, 2 different strains are believed to exist. The eastern strain occurs as far west as Kansas, the western strain as far east as Nebraska, North Dakota, and South Dakota. In North Carolina, heaviest infestations parallel the alfalfa-producing areas in the northern Piedmont and mountains.

**Host Plants**—In addition to alfalfa, host plants include white clover, red clover, bur clover, yellow sweet clover, white sweet clover, and a few other clovers. However, alfalfa is the preferred host and economic damage to other crops is very rare.

**Damage**—Larvae do the most damage, although adult alfalfa weevils are also injurious. Early season feeding in leaf buds and terminal growing areas may seriously retard normal plant growth. As the larvae grow, they feed on leaves, and eventually skeletonize them. The larvae can easily be seen curled around stems or leaves. As feeding persists, an infested field takes on a distinct grayish appearance.

Adult weevils notch main stems, side shoots, and leaf stems. They often sever the latter two from the plant. They also feed on the leaves, causing ragged and torn leaf margins. Females puncture the stem during oviposition. Feeding damage by both adults and larvae greatly reduces the quality and yield of the first cutting of hay, and may reduce the quality of subsequent cuttings.

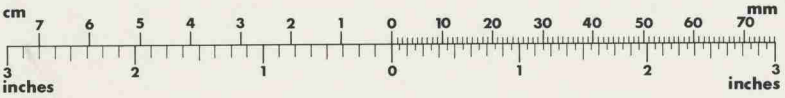
**Life History**—Alfalfa weevils overwinter as adults, larvae, or even eggs. In spring, adults resume feeding and egg-laying activities; viable eggs hatch; and larvae begin feeding on new leaves. Small clusters of spring eggs are usually deposited in cavities of dead alfalfa stems and hatch within a couple of weeks. The larvae feed for 3 to 4 weeks, usually causing much damage in April and May. Mature larvae spin cocoons around themselves and pupate either on alfalfa leaves or among soil debris. Adult weevils emerge from the cocoons 8 to 16 days later. Alfalfa weevils estivate throughout most of the summer and resume activity in the fall. The weevils have been known to deposit eggs as early as mid-August and as late as November in the North Carolina Piedmont. Only one generation is completed each year.



### CONTROL

Cultural control of alfalfa weevils includes the following: (1) cutting newly seeded alfalfa at one-tenth bloom; (2) cutting established, second year alfalfa at full bud for the first harvest in spring and at one-tenth bloom for succeeding cuts; and (3) removing plants as hay or allowing the field to be grazed after a freeze to reduce overwintering egg populations.

Parasite release programs by governmental agencies have established effective alfalfa weevil parasite populations in most alfalfa-growing areas. In some states, an




* *Hypera postica* (Gyllenhal), Curculionidae, COLEOPTERA

economic threshold of 25 larvae per sweep is commonly recognized, although no such threshold has been established in North Carolina. In this state, weevil damage is consistent enough in all areas where the crop is grown to warrant one insecticide application per growing season.

Research at N.C. State University indicates that application at a predetermined date prescribed for each area is the most efficient approach to alfalfa weevil control. For specific chemical recommendations see the current *North Carolina Agricultural Chemicals Manual.*

## DESCRIPTION

**Adult**—The adult moth is pale brown to grayish brown with a wingspan of about 38.5 mm. In the center of each forewing is a characteristic white spot.

**Egg**—The minute egg is greenish white and globular.

**Larva**—The young larva is pale green. The full-grown larva is basically yellow to brownish green with 3 longitudinal, dark stripes. A mature armyworm may be 30 to 35 mm long.

**Pupa**—The pupa, reddish brown at first, gradually darkens until it is almost black.

## BIOLOGY

**Distribution**—Widely distributed, the armyworm inhabits most regions of the world. In North Carolina, it is particularly abundant in the Piedmont and Coastal Plain regions. During bright daylight hours, larvae prefer to remain under litter on the ground.

**Host Plants**—The armyworm infests weedy grasses, such as crabgrass and fall panicum, as well as most grass crops, especially corn, millet, bluegrass, and small grains. Under stress of hunger, however, it will eat broadleaved plants, such as alfalfa, clover, bean, and pea, as well as a number of fruit, vegetable, and weedy plants.

**Damage**—Armyworms, apparently native to North America, vary greatly in abundance and destructiveness from year to year. They are particularly attracted to lush new growth of grass crops. After consuming all the tender, young foliage, they may devour the remainder of the host plant or move on to more succulent hosts.

**Life History**—In North Carolina, armyworms overwinter as partly grown larvae. Early in the spring they resume feeding on lush stands of grass and small grains. The larval stages prefer to hide during the day and feed at night. Migration of many larvae ("armies") from infested areas to nearby, more succulent grasses is an increasing threat as small grain matures (see Small Grain Armyworm Note).

First generation adults appear in May or June and mate. After feeding primarily on nectar for 7 to 10 days, the females lay eggs at night on succulent grasses and grain crops. An individual female may deposit as many as 2,000 eggs (in clusters of 25 to 134). Six to ten days later, second generation larvae emerge and feed for about 3 weeks. They then pupate in earthen cells 5 to 7.5 cm deep in the soil. Moths emerge about 4 weeks later. There are five or more generations per year in North Carolina. However, generations which develop after early July are usually kept below economic threshold by natural controls.

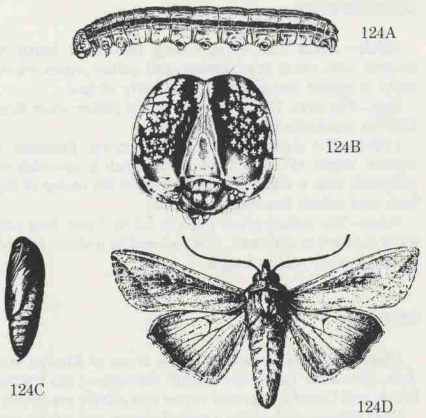


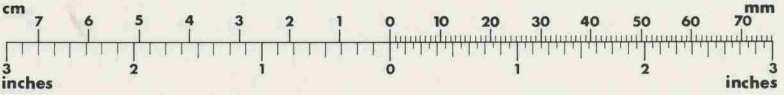

**Fig. 124 Armyworm. A, Larva. B, Larval head capsule. C, Pupa. D, Adult.**

## CONTROL

Parasites, various diseases, insect predators, and birds often keep the armyworm under control. The effectiveness of these natural control agents, however, is reduced during cool, wet springs and during growing seasons that follow years of drought.

The presence of five medium to large armyworms per 929 $cm^2$ (1 $ft^2$) is recognized as a threshold in North Carolina. For specific chemical control information, consult the current *North Carolina Agricultural Chemicals Manual.*






* *Pseudaletia unipuncta* (Haworth), Noctuidae, LEPIDOPTERA

## FORAGES AND PASTURE
### Clover Leaf Weevil*

### DESCRIPTION

**Adult**—About 5 to 10 mm long, this snout beetle is covered with small gray, brown, and yellow scales which make it appear mottled and indistinctly striped.

**Egg**—The oval, 1-mm-long egg is pale yellow when first laid but gradually darkens to black.

**Larva**—The young, legless larva is green. Reaching a mature length of 12 to 13 mm, the grub is greenish or yellowish with a white or pink line down the center of the back and a dark line along each side.

**Pupa**—The yellow-green pupa is 5.5 to 7 mm long and has a dark green abdomen. It is enclosed by a straw colored cocoon 9 to 10 mm in length.

### BIOLOGY

**Distribution**—Common in many areas of Europe and Asia, the clover leaf weevil occurs throughout the United States and Canada wherever clover and alfalfa are grown.

**Host Plants**—Primarily a pest of clovers and alfalfa, the clover leaf weevil occasionally infests snap bean, timothy, wheat, corn, Jerusalem artichoke, and goldenrod.

**Damage**—Clover leaf weevil larvae begin feeding on plants early in the spring. Infested plants become ragged as the grubs chew out small holes and irregular patches from leaves. Damage is most severe during late, cool, dry springs. During wet or humid weather, many larvae are killed by a fungal disease.

**Life History**—The larvae spend the winter in the soil near the crowns of plants and emerge early in the spring, climb the plant, and feed on foliage. Full grown in April or May, the larvae spin cocoons on leaves, in soil, or among debris and pupate for 11 days. From May to July, the nocturnal weevils emerge and feed only a short time before becoming inactive. In September and throughout the fall, beetles resume activity and deposit eggs on leaves, in hollow spaces of old stems, and in cavities gnawed out of young stems. Most eggs hatch in the fall, but a few eggs overwinter. Beetles which fail to lay eggs in the fall, deposit them the next spring. In Indiana and areas of similar latitude only one generation occurs each year. Under milder weather conditions two annual generations are possible.



### CONTROL

The following cultural conditions are favorable for crop growth and enhance the development of the fungus that attacks the larvae: 1) favorable fertility conditions, 2) rotation of clover or alfalfa regularly with grass crops, 3)

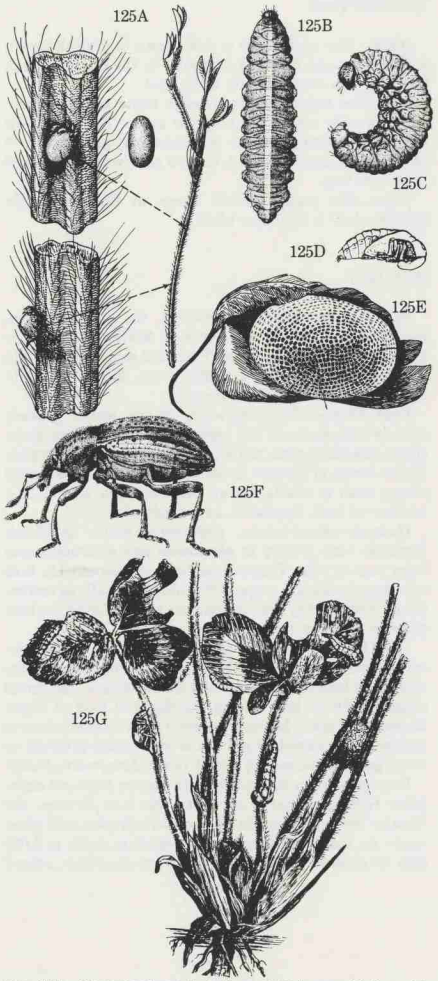
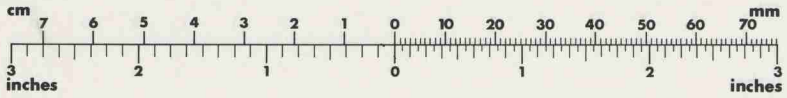



**Fig. 125** Clover leaf weevil. A, Eggs. B-C, Larvae. D, Pupa. E, Cocoon. F, Adult. G, Plant injured by larvae and adults.




* *Hypera punctata* (Fabricius), Curculionidae, COLEOPTERA

favorable humus level which promotes moisture retention. Chemical control of this pest is seldom practical or necessary. In case of a particularly damaging infestation, consult current North Carolina State Agricultural Extension Service recommendations for specific information concerning insecticides and rates.

## FORAGES AND PASTURE
### Clover Root Curculio*

### DESCRIPTION

**Adult**—The adult weevil (3 to 5 mm long) is shiny black or dark brown on top and ash gray on the underside. Small coppery or grayish scales on the back form three distinct stripes. The wing covers are deeply etched with parallel lines and minute spots; the beak is short, curved, and thick.

**Egg**—The tiny egg is ellipsoid or nearly round. Slightly yellow when laid, it turns dusky black in about 3 days.

**Larva**—The legless, fleshy grub is grayish white with a light brown head. It is about 5 mm long when fully grown.

**Pupa**—The small pupa is curled in an oval cell 13 to 25.5 mm below the soil surface.

### BIOLOGY

**Distribution**—The clover root curculio is found throughout the United States and southern Canada.

**Host Plants**—The clover root curculio larva feeds on many clovers (white, red, sweet, alsike), alfalfa, Kentucky bluegrass, soybeans, cowpeas, and other legumes.

**Damage**—The beetles feed by cutting small notches in the margins of the leaves; they also consume leaf buds. The grubs, however, feed on the roots of legumes, causing more serious injury than the leaf feeding adults. Nodules and small roots are entirely eaten; larger roots are severed; the taproots are tunneled. Plants weakened in this manner are very susceptible to death during dry weather conditions. Although usually of little importance, the grubs have been known to destroy 60 to 80 percent of the plants in young stands of alfalfa.



**Life History**—Clover root curculios pass the winter as adults, young larvae or eggs. In spring, the grubs feed on small roots, nodules, or root crowns. In late March or early April, they mature and pupate for 17 to 22 days. Adults, which seldom fly, emerge in May or June and feed on leaves and stems for 4 to 6 weeks. During hot summer days, the beetles become active feeders again and mate. Although some females lay about 500 eggs in the crowns of the plants during October or November, most females do not lay their eggs at this time. Instead, they hibernate in field debris and lay their eggs the following spring. These eggs hatch in about 30 days. Some eggs laid in the fall hatch quickly; the young grubs feed for a short time and then hibernate. Other eggs do not hatch until the following spring, 150 to 200 days after being laid. A complete life cycle requires one year.

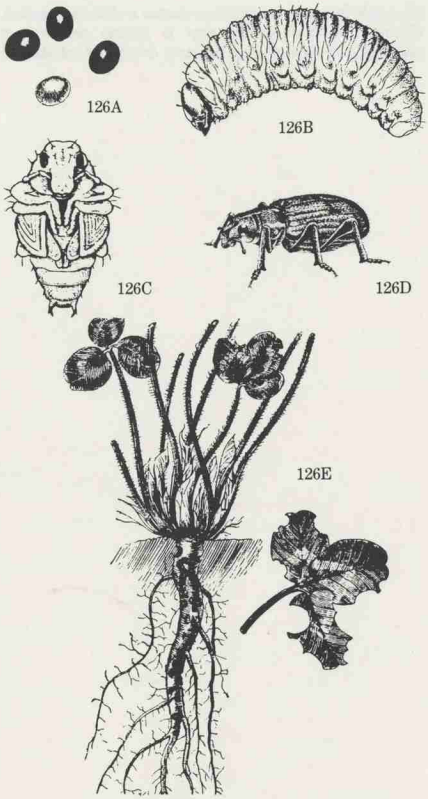
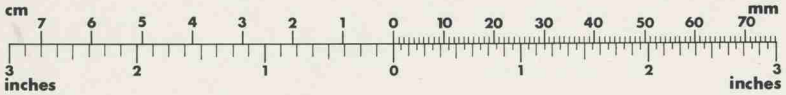



**Fig. 126 Clover root curculio. A, Eggs. B, Larva. C, Pupa. D, Adult. E, Damage.**

### CONTROL

Cultural controls are most often employed. Rotating crops and planting infested fields with a grass or cultivated crop are effective control measures. Where possible, plowing during late fall or early spring has proven beneficial; early fall plowing, however, simply drives the beetles into another host field.

In North Carolina, chemical control is usually not warranted. Under some circumstances, however, insecticidal treatment may be necessary. For specific control information, consult current North Carolina State Agricultural Extension Service recommendations.




**Sitona hispidula* (Fabricius), Curculionidae, COLEOPTERA

## DESCRIPTION

**Adult**—The moth has a wingspan of about 38.5 mm. The hind wings are white; the front wings are dark gray, mottled with lighter and darker splotches. Each forewing has a noticeable whitish spot near the extreme tip.

**Egg**—Minute, light eggs are laid in clusters of approximately 200 and are covered with grayish, fuzzy scales from the body of the female moth. The eggs become very dark just before hatching.

**Larva**—The fully grown, green, brown, or black larva is 30 to 40 mm long and has a dark brown to black head capsule usually marked with a pale, but distinct, inverted "Y." Along each side of its body is a longitudinal, black stripe, and along the middle of its back is a wider yellowish-gray stripe.

**Pupa**—The pupa, approximately 13 mm long, is originally reddish brown and darkens to black as it matures.

## BIOLOGY

**Distribution**—The fall armyworm is a continuous resident of the Gulf states, the tropics of North, Central, and South America, and some of the West Indies. Each year moths may migrate as far northward as Montana, Michigan, and New Hampshire, but usually attain significant populations only in the southeastern states.

**Host Plants**—Corn, sorghum, coastal Bermuda, fescue, and other plants of the grass family are preferred foods. However, the fall armyworm may attack alfalfa, bean, peanut, potato, soybean, sweet potato, turnip, spinach, tomato, cabbage, cucumber, cotton, tobacco, all grain crops, and clover.

**Damage**—Larvae, often migrating in large armies, are potential pasture pests in late summer and fall. Consuming all above ground plant parts, they are capable of killing or severely retarding the growth of pasture crops. In any case, these caterpillars inevitably lower the forage-producing capacity of a pasture. Even though an important pest of pastures, these larvae are more common on late-planted corn or sorghum (See Corn/Sorghum Fall Armyworm Note).

**Life History**—Fall armyworms overwinter in several life stages in the tropics, but usually as pupae in the Gulf Coast region of this country. Moths usually migrate into North Carolina during June and early July. New moths may continue to appear until November. Each female lays about 1,000 eggs in masses of 50 to several hundred. Two to 10 days later, the small larvae emerge, feed in clusters on the remains of the egg mass, and then scatter in search of food. Unlike the nocturnal true armyworms, fall armyworms feed any time of the day or night, but are most active early in the morning or late in the evening. When abundant, these caterpillars eat all the food at hand and then crawl in great armies to adjoining fields. After feeding for 2 or 3 weeks, the larvae dig about 20 mm into the ground to pupate. Within 2 weeks, a new swarm of moths emerges, usually flying several miles before laying eggs. Three to four generations occur each year in North Carolina.

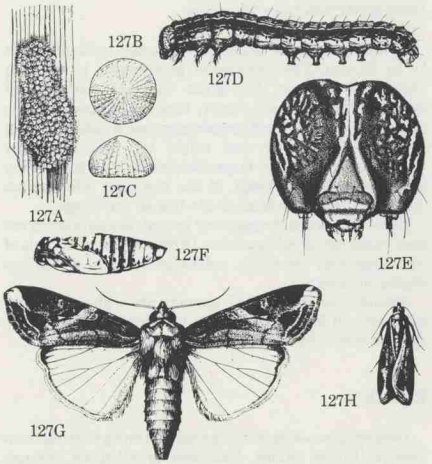


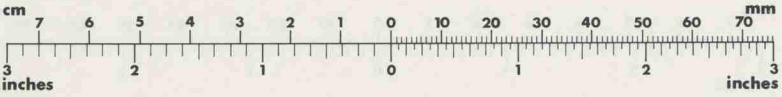

**Fig. 127 Fall armyworm. A, Egg mass. B, Egg (top). C, Egg (side). D, Larva. E, Larval head capsule. F, Pupa. G-H, Adults.**

## CONTROL

During favorable seasons, a number of parasitic enemies and diseases keep fall armyworm larvae down to moderate numbers. Cold, wet springs seem to reduce the effectiveness of these parasites and allow large fall armyworm populations to develop. However, high moisture during summer favors the spread of insect pathogens.

The fall armyworm is more difficult to chemically control than the true armyworm but the threshold is the same. The presence of 5 medium to large fall armyworms per 929 $cm^2$ (1 $ft^2$) justifies initiation of control measures. For specific recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*






**Spodoptera frugiperda* (J.E. Smith), Noctuidae, LEPIDOPTERA

## DESCRIPTION (several species)

**Adult**—Full-grown grasshoppers range in length from 19 to 38 mm. The differential grasshopper is basically brownish yellow or olive green with contrasting black markings. On the hind femur, these markings resemble chevrons. The redlegged grasshopper has a reddish-brown back, a yellow belly, and bright red hind legs. The twostriped grasshopper is greenish yellow with contrasting black or brown markings. It has two light color stripes which run from the head to the tips of the wings.

**Egg**—Grasshopper eggs occur in oval, elongate or curved pods made out of soil particles. Often the size of kernels of rice, eggs may be white, yellow green, tan, or various shades of brown.

**Nymph**—Newly hatched nymphs are white. However, after several hours of exposure to sunlight, they assume the distinctive colors and markings of adults.

## BIOLOGY

**Distribution**—Grasshoppers occur throughout the continental United States. Extensive grasshopper damage, however, is confined primarily to subhumid, semiarid areas of the country from Montana and Minnesota southward into New Mexico and Texas. The differential grasshopper is most injurious in the Great Plains, upper Mississippi Valley, and southern states. The redlegged grasshopper prefers areas of low, moist soil. The twostriped grasshopper is common throughout North America.



**Host Plants**—The grasshoppers which damage crops are general feeders. They have been known to cause losses in small grains, corn, alfalfa, soybeans, cotton, clover, grasses, and flax. The redlegged grasshopper displays a preference for alfalfa.

**Damage**—Although approximately 600 species of grasshoppers occur in the United States, the differential, twostriped, and redlegged grasshoppers are among the most troublesome species in forages. The differential and redlegged species are sporadically of economic concern in North Carolina forages, but the problem is not an annual concern. As a group, grasshoppers cause more damage to alfalfa than any other insect in the Midwest. Each year, they destroy at least 80 million dollars worth of forage crops in this country. An infestation of 7 or 8 adult grasshoppers per square meter (approximately 1 $yd^2$) consumes as much forage on a 4-hectare (about 10 acres) lot as one cow. Damage is most severe when hot, dry weather slows the growth of the forage crop thereby preventing a rapid recovery.

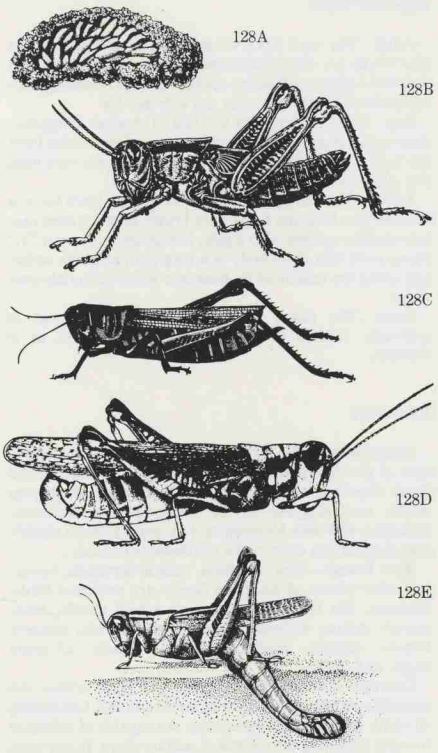
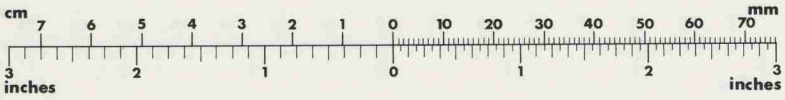



**Fig. 128 Grasshoppers. A-C, Differential grasshopper egg, nymph, and adult. D, Redlegged grasshopper adult. E, Twostriped grasshopper adult laying eggs.**

**Life History**—The grasshopper species covered in this text overwinter as eggs in the soil. Eggs hatch throughout April, May and June as soil temperatures rise and spring rains begin. The first nymph to leave the egg pod makes a tunnel from the pod to the soil surface through which the succeeding nymphs emerge. Nymphs feed and grow for 35 to 50 days, molting five or six times during this period.




*Differential grasshopper, *Melanoplus differentialis* (Thomas); Redlegged grasshopper, *Melanoplus femurrubrum* (De Geer); Twostriped grasshopper, *Melanoplus bivittatus* (Say), Acrididae, ORTHOPTERA

Development proceeds most rapidly when the weather is warm and not too wet.

Mature grasshoppers mate and continue feeding on crop plants. About 2 weeks later, females begin to deposit clusters of eggs in the soil. During this process, a glue-like secretion cements soil particles around the egg mass, forming a protective "pod." Each pod may contain 25 to 150 eggs, depending on the species of grasshopper. Grasshoppers which deposit masses containing few eggs usually lay more pods to compensate. Ideally each female may produce 300 eggs. Swarms of grasshoppers usually adopt a specific area as their breeding ground and lay all eggs in that vicinity. Most economically important grasshopper species complete only one generation each year. Redlegged grasshoppers, however, have at least two annual generations and often a partial third in Florida.

## CONTROL

Although grasshopper populations occur annually in North Carolina forages, infestations are not usually large enough to warrant control. Populations of 5 medium to large grasshoppers or 8 small grasshoppers per 929 $cm^2$ (1 $ft^2$) are necessary before control is advised on pasture crops. Should populations become threatening, chemical recommendations are available in the *North Carolina Agricultural Chemicals Manual.*

## FORAGES AND PASTURE
### Meadow Spittlebug*

### DESCRIPTION

**Adult**—The variably colored, leafhopperlike adult is about 6 mm long. Most commonly tan to brown, it also may be gray or mottled.

**Egg**—The white, oblong egg is about 1 mm long and becomes light brown just before hatching.

**Nymph**—The wingless nymph resembles the adult in shape but is slightly smaller. The first instar is orange; instars two through four are yellow; the last nymphal instar is pale green.

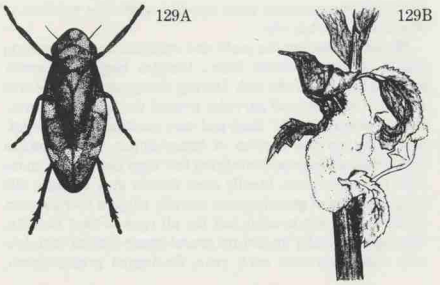



**Fig. 129A, Meadow spittlebug adult. B, Spittle mass.**

### BIOLOGY

**Distribution**—The meadow spittlebug is widely distributed throughout Europe and North America. In the United States, it can be found along the Pacific Coast and from Louisiana to Minnesota eastward. Particularly a problem in humid regions, this pest causes extensive economic damage to legumes in the northeastern and north central states but rarely in North Carolina.

**Host Plants**—This general feeder infests over 400 species of plants. It is particularly injurious to alfalfa, red clover, wheat, oats, corn, and strawberries.

**Damage**—Nymphs and adults extract plant juices through their needle-like mouthparts. Unlike most sap-sucking insects, however, they do not cause the foliage to turn yellow. Most plants wilt and become stunted. On alfalfa, a rosetting of the terminal plant growth often occurs. A severe infestation (100 bugs/plant) of meadow spittlebugs may drastically reduce seed yields and lower hay production 25 to 50 percent. The hay that is harvested often is too wet to cure. Such an infestation is most likely to result after an unusually dry spring.



**Life History**—Meadow spittlebugs overwinter as egg masses between the leaf sheath and the stem. Located 8 to 15 cm above the ground, these masses of up to 30 eggs hatch from late March in North Carolina to early June in Maine. The nymphs seek sheltered, humid areas of plants. Once they begin feeding, the nymphs exude a white, frothy spittle mass which protects them from natural enemies and dessication. The nymphs feed for a month or longer, depending on temperature, and finally develop into adults in late May or June. During the summer, adults feed on the crop upon which they developed. As the foliage dries out, adults migrate to new hosts. In late August or early September, females each begin to deposit 18 to 51 eggs on succulent plant tissue. Each mass consists of a row of 2 to 20 eggs lying side by side and glued together with a frothy cement. Meadow spittlebugs produce only one generation each year.

### CONTROL

Meadow spittlebug infestations cannot be controlled the year they occur. Heavily infested fields (50 to 100 spittle masses/plant) should be sprayed in September to kill adults and thereby reduce the nymph population the following spring. A follow-up spray in the spring should be directed toward the young, unprotected nymphs. For specific information concerning timing, insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*


*Philaenus spumarius* (Linnaeus), Cercopidae, HEMIPTERA

## DESCRIPTION

**Adult**—The long-legged pea aphid adult is light to deep green with reddish eyes. It has a body length of 2.0 to 4.0 mm and in North Carolina, most adults are wingless. The cornicles (a pair of tailpipelike structures projecting from the abdomen) of this aphid are characteristically long and slender.

**Egg**—Approximately 0.85 mm long, the light green egg turns a shiny black before hatching. Eggs are very rare in North Carolina.

**Nymph**—The immature aphid is smaller than, but similar to, the larger wingless adult. It requires four molts to reach the adult stage.

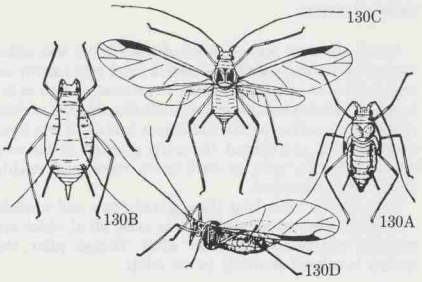



**Fig. 130 Pea aphid. A, Nymph. B-D, Adults.**

## BIOLOGY

**Distribution**—The pea aphid is found throughout the United States and Canada wherever peas and alfalfa are grown.

**Host Plants**—Pea aphids infest garden and field peas, sweet peas, sweet clover, alfalfa, and some leguminous weeds. Vetch and crimson clover are important overwintering hosts.

**Damage**—Pea aphids extract sap from the terminal leaves and stem of the host plant. Their feeding can result in deformation, wilting, or death of the host depending upon the infestation level. Plants that survive heavy infestations are short and bunchy with more lightly colored tops than those of healthy plants. Wilted plants appear as brownish spots in the field. Moreover, plants are often coated with shiny honeydew secreted by the aphids, and cast skins may give the leaves and ground a whitish appearance. These aphids also transmit the pea enation mosaic and the yellow bean mosaic viruses. The first of these viruses, the pea enation mosaic, has been a problem in New York but has not been reported in North Carolina.

**Life History**—In North Carolina, wingless, female pea aphids continue to feed and breed throughout the winter months. In spring, feeding activity increases. At this time, some winged aphids develop and migrate, usually to peas. Most of the progeny of these winged females develop into wingless females. Whenever overcrowding occurs, more winged aphids appear, migrate to different areas, and establish new colonies.

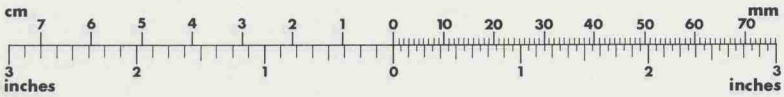
Each adult female gives birth to 6 to 8 nymphs each day until she has produced about 100 offspring. Nymphs mature into adults in 10 to 14 days. Since generations overlap and reproduction continues all year, the number of annual generations is difficult to determine. The pea aphid thrives best and reproduces most quickly at temperatures around 65°F (18°C) and humidities near 80 percent.

## CONTROL

When the aphids infest alfalfa or clover, proper timing of cutting (during the early-bloom stage) reduces the aphid population by exposing it to the direct sun. In addition, proper and effective crop management results in a vigorous stand which resists aphid attack. Predators and parasites usually control this pest, to some extent, and resistant varieties are available.

A series of economic thresholds based on the height of the plant and the number of aphids per stem are helpful to determining when chemical control is necessary. They are as follows: 40 to 50 aphids per 25 cm (10 inch) or shorter stem; 70 to 80 aphids per 25 to 38 cm (10 to 15 inch) stem; 100 aphids per 50 cm (20 inch) stem. For specific insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*






**Acyrthosiphon pisum* (Harris), Aphididae, HEMIPTERA

## FORAGES AND PASTURE
### Potato Leafhopper*

### DESCRIPTION

**Adult**—Because many species of leafhoppers look alike, entomologists studying these insects must rely heavily on examination of internal genitalia structures, as well as external morphological characters, to distinguish the various species. The mature potato leafhopper is about 3 mm long, wedge-shaped, and winged. Generally greenish, it has very small, yellowish, pale, or dark green spots, and readily jumps when disturbed.

**Egg**—About 1 mm long, the egg is elongate and whitish.

**Nymph**—Several nymphal stages exist, all of which are wingless and smaller than the adult. Though paler, the nymph is colored similarly to the adult.

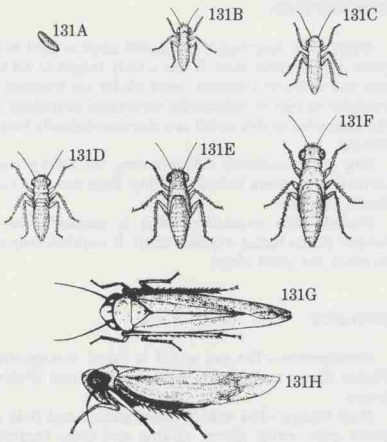



**Fig. 131 Potato leafhopper. A, Egg. B-F, Nymphs. G-H, Adults.**

### BIOLOGY

**Distribution**—During the summer, potato leafhoppers are found from the Atlantic coast to the Rocky Mountains. They are absent throughout most of the winter which they spend in the Gulf States. Northeastern and midwestern states suffer the greatest forage loss from this pest due to the concentration of alfalfa and clover in these areas. In North Carolina, these leafhoppers are widely distributed during the growing season on peanuts, hay and pasture crops.

**Host Plants**—This leafhopper feeds on more than 100 cultivated and wild plants, including bean, potato, alfalfa, soybean, and peanut. In North Carolina, peanuts are more seriously affected by this pest than are forage and pasture crops.

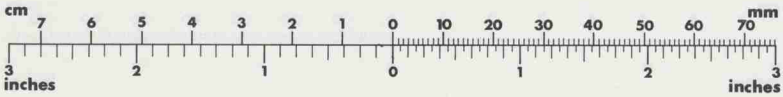


**Damage**—Nationwide, the potato leafhopper is a very injurious pest of forages, particularly alfalfa and clover. Both nymphs and adults feed on the undersides of the leaves. By extracting the sap, they cause stunting and leaf curl, as well as the condition called "hopperburn." This disease is caused by the injection of a toxic substance. It is characterized by a yellowing of the tissue at the tip and around the leaf margin which increases until the leaf dies. Symptoms are sometimes confused with drought stress.

**Life History**—Potato leafhoppers winter in the Gulf States and migrate northward in spring. They arrive in North Carolina in early summer. After mating, eggs are laid inside the veins on the underside of leaves. A female leafhopper lives about a month, producing one to six eggs daily. Eggs hatch in about 10 days, and the nymphs mature in about 2 weeks. Mating occurs approximately 48 hours after maturation. Three or four generations are produced each year in North Carolina.

### CONTROL

When populations become severe, insecticides are the only practical method of leafhopper control. For specific control information, consult the current *North Carolina Agricultural Chemicals Manual.*




**Empoasca fabae* (Harris), Cicadellidae, HEMIPTERA

## DESCRIPTION (several species)

**Adult**—The webworm moth is about 13 mm to 19 mm long, with a wingspread of 25.5 mm. It is pale brown with a distinct snout-like projection on the head. The forewings are brown or dull ash gray and have a whitish streak from the base to the margin; the hind wings are brownish. The wings are folded close to the body at rest, giving the moth a very streamlined appearance.

**Egg**—The tiny egg is pale and oblong.

**Larva**—The apparently legless larva is pinkish white, yellowish, or light brown. When full-grown, it is 16 to 19 mm long. Its thick body is marked by coarse hairs and paired dorsal and lateral spots on each segment. The head is yellowish brown, brown, or black.

**Pupa**—The pupa is reddish brown, immobile, and about 13 mm long.

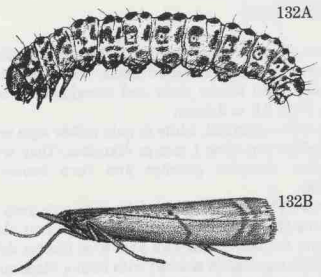



**Fig. 132 Sod webworm. A, Larva. B, Adult.**

## BIOLOGY

**Distribution**—Webworms are found throughout the United States. Six or seven species commonly occur east of the Rockies in lawns, pastures and wild grasses.

**Host Plants**—Sod webworms feed on corn, tobacco, bluegrass, timothy, pasture and field grasses, some clovers, and lawn and golf course grasses.

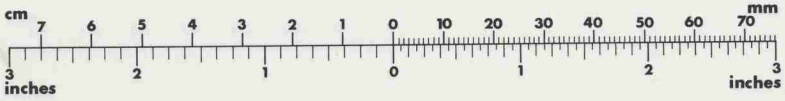
**Damage**—Sod webworms cause two kinds of damage: that done to cultivated crops (such as corn and tobacco); and that occurring in pastures, lawns, grassland, meadows, and golf courses. In corn, the larvae feed just underground on the stem, often nearly severing it. This type of damage usually occurs in the spring when plants are small and most vulnerable to stem damage (See Corn/Sorghum Sod Webworm Note). In grasses, they either cut off the blades at ground level and pull them into the tunnels, or they skeletonize the plants, causing characteristic brown spots in normally green lawns. The latter type of injury is more common in the summer. Several other insects, such as cutworms, wireworms, and billbugs, are often credited with webworm damage in turf.

**Life History**—Webworms pass the winter in silk-lined nests several centimeters deep in the soil. Usually, they overwinter among the roots of weeds or grasses. In spring, the larvae become active and feed at night on the upper root systems, stems, and blades of grass. They also construct protective silken nests in which they feed and mature. About June first, larvae construct cocoons of silk, plant debris, and soil particles, and pupate within them. In a week or two, the adult moths emerge from the cocoons, move up the silken tunnels, and mate. The moths, which are weak, erratic fliers, live only a few days and feed on dew. They are most active at dusk, resting during the day near the ground in grass. The eggs, indiscriminately dropped over the grass, hatch in a week or 10 days. The young larvae then feed and start construction of the silken tunnels, which are reinforced with dirt and grass. There are one to three generations per year, depending upon the species.



## CONTROL

Early fall plowing of sod land to be cultivated the following spring reduces the webworm population. If three or four webworms are found per 225 $cm^2$ (a 6 inch square or 36 square inches) of sod, chemical treatment is recommended. For chemical control recommendations, consult current North Carolina State Agricultural Extension Service recommendations.




*Crambus spp., Pyralidae, LEPIDOPTERA

## FORAGES AND PASTURE
### Variegated Cutworm*

### DESCRIPTION

**Adult**—The forewings of this moth are basically yellow or brown with pale mottled designs, while the hind wings are white with brown veins and margins. The wingspan varies from 3.8 to 5.0 cm.

**Egg**—The spherical, white or pale yellow eggs are ribbed and slightly less than 1 mm in diameter. They are laid in irregular, elongate patches and turn brown before hatching.

**Larva**—The smooth-skinned larva is pale gray or light brown mottled with dark brown. The first four abdominal segments (at least) bear two yellow or orange dots while the eighth segment is marked with both a black spot and a yellow spot. The mature larva may be as long as 40 mm and curls into a C-shaped ball when disturbed.

**Pupa**—The reddish-brown pupa is 15 to 20 mm long.

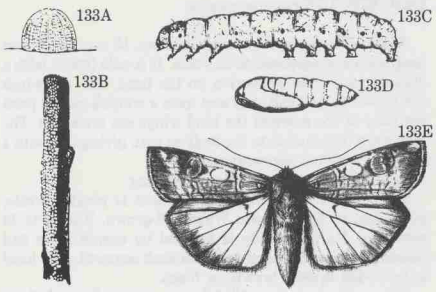



**Fig. 133 Variegated cutworm. A, Egg. B, Egg mass. C, Larva. D, Pupa. E, Adult.**

### BIOLOGY

**Distribution**—The range of the variegated cutworm spans most of North America including Canada and Alaska and extends into South America. It is also found in Europe and the Mediterranean area. Although it is of most importance in the Pacific Northwest and some northeastern states, this cutworm is an occasional pest in North Carolina, especially in areas with sandy or sandy loam soils.

**Host Plants**—The variegated cutworm feeds on a variety of garden crops, trees, vines, grasses, field crops, ornamentals, and greenhouse plants. Of the forage crops, it prefers alfalfa and sweet clover.

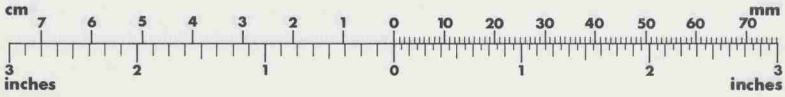
**Damage**—Beginning in early spring and continuing throughout the summer, variegated cutworms climb host plants and devour foliage, buds, and fruit. Damaging infestations, however, are sporadic. Because the variegated cutworm is one of the few cutworm species that climbs the plant to feed, its presence is usually more striking than that of subterranean cutworms. Late larval instars, however, do burrow in the soil and cut off plants at or near the soil surface.

**Life History**—Variegated cutworms overwinter as pupae with a high percent mortality occurring during this life stage. Female moths emerging from surviving pupae compensate by laying over 2000 eggs during their short life span. Clusters of 60 or more eggs are deposited on stems or leaves of low-growing plants as well as on fences and buildings. During the summer, eggs usually hatch in 5 days. The active larvae feed at night and on cloudy days for about 3½ weeks before burrowing into the soil to pupate. The nonoverwintering pupal stage lasts 2 weeks to a month before second generation moths emerge. Requiring 48 days to complete a life cycle, variegated cutworms produce two to four generations each year depending on weather conditions and latitude.

### CONTROL

Cultural controls are difficult to employ for pasture crops since plowing and rotation are not easily accommodated. In forages, however, deep tillage late in the fall destroys many overwintering pupae. Since certain insecticides pose residue problems, consult current North Carolina State Agricultural Extension Service recommendations for specific information on insecticides, rates, formulations, and waiting periods.






*Peridroma saucia* (Hübner), Noctuidae, LEPIDOPTERA

## DESCRIPTION (several species)

**Adult**—The May beetle is about 19 to 25.5 mm long, and shiny reddish brown to black in color. It is robust, oblong, and hardshelled. The June beetle is dull velvety green on top, brownish yellow on the sides, and shiny green and orange yellow underneath.

**Egg**—The egg is a dull, pearly white when laid, but it turns dark just before hatching. Oval to spherical shaped, it is 1.5 to 3 mm in diameter and encased in a cell of soil particles.

**Larva** (Grub)—Young May beetle grubs are creamy white and about 5 mm long. Fully grown grubs range from 20 to 45 mm long depending upon the species. They are C-shaped and creamy white, with distinct brown heads. Except for scattered hairs and six distinct forelegs, the body is shiny and smooth. Two rows of hairs on the underside of the last segment distinguish white grubs from similar grubs. Green June beetle larvae are about 48 mm long when fully grown and have the curious habit of crawling on their backs.

**Pupa**—Approximately the same size as the adult, the pupae may be creamy white, pale yellow, or dark brown.

## BIOLOGY

**Distribution**—More than 200 species of white grubs are found throughout North America. Common species include May beetles and green June beetles. May beetles are most injurious throughout the North Central states and into New England. During summer, they are often seen flying around lights at night. In North Carolina, green June beetles are most commonly reported in the Piedmont and mountain areas, maybe because forage and pasture acreage is concentrated in these areas. Populations of most grub species tend to be highest in older plantings of sod, or in soils high in decomposing organic matter.

**Host Plants**—White grubs feed on the roots of corn, timothy, lespedeza, Kentucky bluegrass, sorghum, soybean, strawberry, potato, barley, oat, wheat, rye, bean, turnip, and other cultivated crops. They also infest various pasture grasses, lawns, and nursery plantings. In addition, green June beetle grubs occasionally infest alfalfa and may be a major pest of Ladino clover. They also feed on decaying organic matter in the soil.

May beetles and June beetles feed on the foliage of forest and shade trees. They are strongly attracted to fragrant flowers and ripe fruits.

**Damage**—White grubs are among the most destructive soil insects in North America. They destroy root systems by their feeding and tunneling activities. When numerous, the larvae can cause severe mechanical plant damage by uprooting plants during movement. Under these conditions

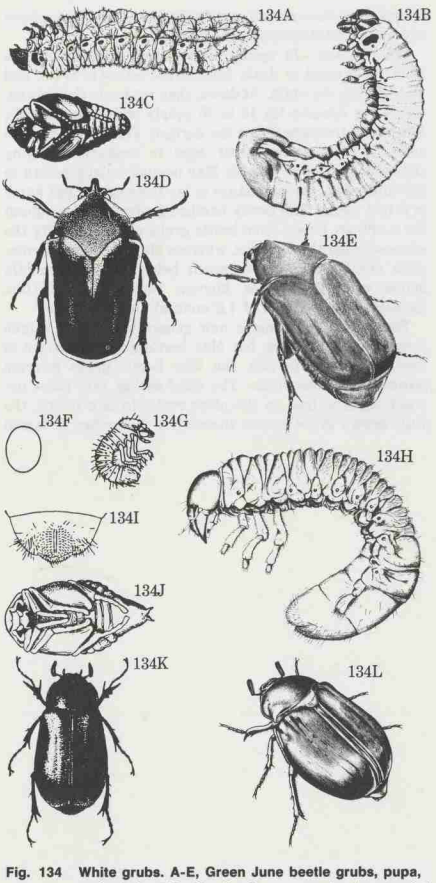
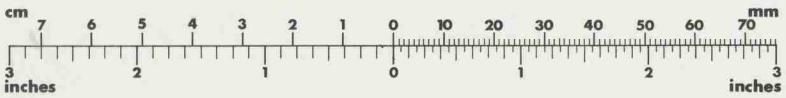



**Fig. 134 White grubs. A-E, Green June beetle grubs, pupa, and adults. F-L, May beetle egg, grubs, larval setal pattern, pupa, and adults.**






*Larvae of the green June beetle, *Cotinis nitida* (Linnaeus) and the May beetle, *Phyllophaga* spp., Scarabaeidae, COLEOPTERA

the soil may become soft and fluffy due to grub movement and stolon establishment is affected.

**Life History**—In spring, overwintering adults emerge from the ground at dusk, feed on the leaves of trees, and mate during the night. At dawn, they return to the ground, where the females lay 15 to 20 pearly white eggs in cells several centimeters below the surface. Female green June beetles prefer to lay their eggs in manure, decaying vegetable matter or humus; May beetles usually return to the cultivated crop or pasture to lay their eggs. Eggs hatch in 3 to 4 weeks. The newly hatched grubs feed throughout the summer. Green June beetle grubs reach maturity the same summer they emerge, whereas May beetle grubs complete only ⅓ their development before fall. In the fall, grubs of both species burrow below the frostline (sometimes to a depth of 1.5 meters) and hibernate.

The following spring, a new generation of green June beetle adults emerges, but May beetle grubs resurface to feed and grow. In fall, the May beetle grubs migrate downward to overwinter. The third spring, they move upward again to feed on the plant roots. In late spring, the fully grown grubs encase themselves in earthen cells and pupate. In late summer, adults emerge from pupal cases, but they do not leave the ground. These beetles overwinter, emerging the next spring to feed and mate.

Green June beetles complete one generation each year. May beetles produce one generation approximately every 3 years. In spite of the length of this life cycle, generations overlap so that both beetles and grubs are present every year.

## CONTROL

The cultural control practice of late-spring and early-fall plowing provides control in areas where predaceous birds occur (Coastal Plain primarily). Crop rotation is the most effective control method. Susceptible crops should be rotated with resistant or less susceptible crops (e.g., oats, rye, clovers, orchard grass, or alfalfa). In areas where green June beetle grubs are the primary problem species, avoid planting small-seeded legumes or grasses immediately after plowing under large amounts of vegetative matter.

For current control recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*

GENERAL

App, B.A. and G.R. Manglitz. 1972. Insects and related pests, pp. 527-54. *In* Alfalfa science and technology, ed. C.H. Hanson. Amer. Soc. Agron. Inc., Madison, Wis. 812 pp.

Armbrust, E.J. and G.G. Gyrisco. 1975. Forage crops insect pest management, pp. 445-70. *In* Introduction to insect pest management, ed. R.L. Metcalf and W.H. Luckmann. John Wiley and Sons, New York. 587 pp.

Gyrisco, G.G. 1958. Forage insects and their control. Annu. Rev. Entomol. 3: 421-48.

Heath, M.E., D.S. Metcalfe, and R.F. Barnes. 1973. Forages, the science of grassland agriculture, 3rd ed. The Iowa State Univ. Press, Ames, Iowa. 755 pp.

Osborn, H. 1939. Meadow and pasture insects. The Educators' Press, Columbus, Ohio. 288 pp.

Packard, C.M. 1952. Cereal and forage insects, pp. 581-95. *In* Insects. U.S. Dep. Agr. 1952 Yearbook Agr. 780 pp.

Painter, R.H., H.R. Bryson, and D.A. Wilbur. 1954. Insects that attack wheat in Kansas. Kansas State Univ. Agr. Exp. Sta. Bull. 367. 47 pp.

Quinton, R.J. 1956. The forage insect problem. Connecticut Agr. Exp. Sta. (New Haven) Circ. 197. 14 pp.

Randolph, N.M. and C.F. Garner. 1961. Insects attacking forage crops. Texas Agr. Ext. Service Bull. B-975. 26 pp.

U.S., Department of Agriculture. 1976. Report of the 25th alfalfa improvement conference. ARS-NC-52. 87 pp.

Vance, A.M. and B.A. App. 1971. Lawn insects: how to control them. U.S. Dep. Agr. Home and Garden Bull. 53. 23 pp.

Whelan, D.B. 1935. A key to Nebraska cutworms and armyworms that attack corn. Nebraska Agr. Exp. Sta. Res. Bull. 81. 27 pp.

ALFALFA WEEVIL

App, B.A. 1959. Studies on the control of alfalfa weevil larvae in the East. J. Econ. Entomol. 52: 663-6.

Campbell, W.V., T.G. Bowery, and K.G. Jester. 1961. Seasonal history and control of the alfalfa weevil in North Carolina. J. Econ. Entomol. 54: 743-7.

Campbell, W.V., T.H. Busbice, J.M. Falter, and J.W. Glover. 1975. Alfalfa weevil and its management in North Carolina. North Carolina Agr. Exp. Sta. Tech. Bull. 234. 37 pp.

DuBose, W.P. and M.H. Farrier. 1959. Alfalfa weevils in North Carolina. Res. and Farming 17(4): 7.

Hamlin, J.C., W.C. McDuffie, and F.V. Lieberman. 1949. Alfalfa weevil distribution and crop damage in the United States. U.S. Dep. Agr. Circ. 815. 21 pp.

Wilson, M.C. and E.J. Armbrust. 1970. Approach to integrated control of the alfalfa weevil. J. Econ. Entomol. 63: 554-7.

ARMYWORM

Walton, W.R. and C.M. Packard. 1951. The armyworm and its control. U.S. Dep. Agr. Farmers' Bull. 1850. 10 pp.

CLOVER LEAF WEEVIL

Tower, D.G. and F.A. Fenton. 1920. Clover-leaf weevil. U.S. Dep. Agr. Dep. Bull. 922. 18 pp.

U.S., Department of Agriculture. 1956. The clover leaf weevil and its control. Farmers' Bull. 1484. 6 pp.

CLOVER ROOT CURCULIO

Bigger, J.H. 1930. Notes on the life history of the clover root curculio, *Sitona hispidula* Fab., in central Illinois. J. Econ. Entomol. 23: 334-42.

Jewett, H.H. 1934. The clover root curculio. Kentucky Agr. Exp. Sta. Circ. 42: 13-23.

Morrison, W.P., B.C. Pass, M.P. Nichols, and E.J. Armbrust. 1974. A bibliography of the *Sitona* species (Coleoptera: Curculionidae). Illinois Natur. Hist. Surv. Biol. Notes 88. 24 pp.

Phillips, W.G. and L.P. Ditman. 1962. Studies on biology and economic importance of the clover root curculio *Sitonia hispidula* (Fab.) in Maryland. Maryland Agr. Exp. Sta. Bull. A-121. 21 pp.

Underhill, G.W., E.C. Turner, Jr., and R.G. Henderson. 1955. Control of the clover root curculio on alfalfa with notes on life history and habits. J. Econ. Entomol. 48: 184-7.

Webster, F.M. 1915. Alfalfa attacked by the clover root curculio. U.S. Dep. Agr. Farmers' Bull. 649. 8 pp.

FALL ARMYWORM

Bass, M.H. 1978. Fall armyworm: evaluation of insecticides for control. Alabama (Auburn Univ.) Agr. Exp. Sta. Leafl. 93. 7 pp.

Luginbill, P. 1928. The fall armyworm. U.S. Dep. Agr. Tech. Bull. 34. 92 pp.

GRASSHOPPERS

Parker, J.R. and R.V. Connin. 1964. Grasshoppers: their habits and damage. U.S. Dep. Agr. Information Bull. 287. 28 pp.

U.S., Department of Agriculture. 1977. Grasshopper control. Farmers' Bull. 2193. 10 pp.

MEADOW SPITTLEBUG

U.S., Department of Agriculture. 1968. The meadow spittlebug: how to control it on legumes. Leafl. 514. 4 pp.

Weaver, C.R. and D.R. King. 1954. Meadow spittlebug. Ohio Agr. Exp. Sta. Res. Bull. 741. 99 pp.

PEA APHID

Davis, J.J. 1915. The pea aphid with relation to forage crops. U.S. Dep. Agr. Bull. 276. 67 pp.

U.S., Department of Agriculture. 1967. The pea aphid on alfalfa: how to control it. Leafl. 529. 3 pp.

POTATO LEAFHOPPER

Edwards, C.R. 1974. Potato leafhopper control on alfalfa. Indiana (Purdue Univ.) Coop. Ext. Service Pub. E 36. 3 pp.

Medler, J.T. 1957. Migration of the potato leafhopper, a report on a cooperative study. J. Econ. Entomol. 50: 493-7.

Roof, M.E., E. Horber, and E.L. Sorenson. 1976. Evaluating alfalfa cuttings for resistance to the potato leafhopper. Environmental Entomol. 5: 295-301.

U.S., Department of Agriculture. 1963. The potato leafhopper on alfalfa: how to control it. Leafl. 521. 6 pp.

SOD WEBWORMS

Ainslie, G.G. 1922. Webworms injurious to cereal and forage crops and their control. U.S. Dep. Agr. Farmers' Bull. 1258. 16 pp.

VARIEGATED CUTWORM

Wadley, F.M. 1921. Life history of the variegated cutworm. J. Econ. Entomol. 14: 272-7.

Rings, R.W., B.A. Johnson, and F.J. Arnold. 1976. A worldwide, annotated bibliography of the variegated cutworm, *Peridroma saucia* Hübner. Ohio Agr. Res. and Development Center Res. Circ. 219. 126 pp.

WHITE GRUBS

Böving, A.G. 1942. A classification of larvae and adults of the genus *Phyllophaga*. Entomol. Soc. Washington Mem. 2. 96 pp.

Ritcher, P.O. 1940. Kentucky white grubs. Kentucky Agr. Exp. Sta. Bull. 401. 157 pp.

U.S. Department of Agriculture. 1959. Control of common white grubs in cereal and forage crops. Farmers' Bull. 1798. 14 pp.

Notes

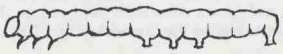
# PESTS OF PEANUTS

In 1980, peanuts were planted on 68,016 hectares (168,000 acres) of North Carolina farm land. Since all parts of the peanut plant are attacked by an array of pests, peanut farmers must be constantly on the lookout for insect and mite problems. It is impossible to predict what problems a grower will encounter in a given year due to variation in cultural practices, weather conditions and other factors. The following pests, however, are most likely to be encountered in North Carolina though perhaps not in every field every year.

## Key to Peanut Pests

A. Chewing insects that consume above-ground plant parts

1. **Caterpillars**—These soft-bodied, moth larvae have three pairs of legs near the head and four or five pairs of prolegs (Fig. 135A and B).

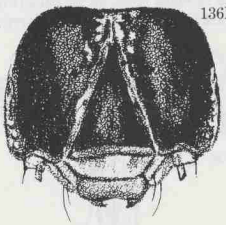

135A

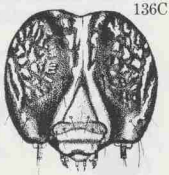

135B

a. **Armyworms**—These variously colored caterpillars have five pairs of prolegs (Fig. 135B), are occasionally foliage pests, and are difficult to chemically control.

i. **Beet armyworm**—Dark-headed (Fig. 136B) and green or black, this larva sometimes has three longitudinal, light stripes and usually grows about 25 to 30 mm long. A small, black spot, located above the second leg behind the head (arrow), occurs on each side of the body (Fig. 136A). Heavily infested plants may be skeletonized. Young larvae often web leaves together ..... p. 150


136A


136B

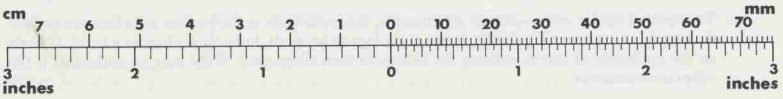

136C

ii. **Fall armyworm**—Green, brown, or black, this caterpillar reaches a maximum length of 30 to 40 mm and often has a distinct, inverted "Y" on its head. A darker, curved marking occurs on each side of the "Y" (Fig. 136C). The worms sometimes appear in large numbers in August and September ..... p. 137

b. **Corn earworm**—When fully grown, this larva is green, reddish, or brown with pale longitudinal stripes and scattered, black spots. Early instars are fuzzy, cream colored or yellowish green with few markings. Larval instars vary from 1.5 to 44 mm in length and have five pairs of prolegs (Fig. 135B). Earworms feed on leaves, stems, and occasionally pegs ..... p. 120

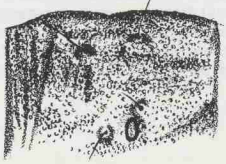
c. **Cutworms**—These chunky, sluggish caterpillars are active primarily at night; they feed on foliage and occasionally pods. They have five pairs of prolegs.

i. **Black cutworm**—Varying from light gray to black in color and often appearing greasy, this caterpillar grows from 3.5 to 46 mm in length. The skin of this cutworm is granulated, the granules resembling rounded, flattened pebbles (Fig. 137A) ..... p. 119

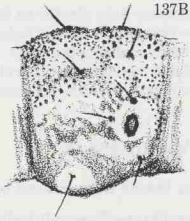



*See also "Key to Caterpillars" on page 16.

137A



137B



ii. **Granulate cutworm**—Growing from 2 to 38 mm long, this caterpillar has a pale brown head, a dark brown band down its back, and brown sides with faint stripes. The skin granules of this cutworm are like blunt cones as high as they are wide (Fig. 137B) ....p. 46

d. **Green cloverworm**—This pale caterpillar, 15 to 30.5 mm in length, is distinguished from all other caterpillar pests of peanuts by the presence of only four pairs of prolegs (Fig. 135A).p. 156

e. **Velvetbean caterpillar**—This pale green to black caterpillar has a light stripe along both sides of its body. It has five pairs of prolegs (Fig. 135B), varies from 2.5 to 48 mm long, and wiggles rapidly when disturbed. During September or early October, this caterpillar may attack both terminal buds and foliage .....p. 165

2. **Spotted cucumber beetle**—About 6 mm long, this yellowish-green beetle has black legs, antennae, and head as well as 12 black spots on its back (Fig. 138). The beetle feeds on unopened leaflets. As leaflets open, they are riddled with oblong or irregularly shaped holes .....p. 123

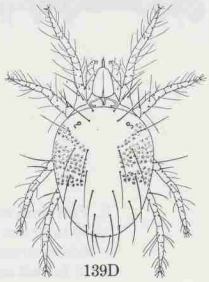


138

139A

139B

139C



139D

B. Piercing-sucking pests which feed on above-ground plant parts (Fig. 139A to D).

1. **Cowpea aphid**—This small, pear-shaped insect (Fig. 139A) is no longer than 2 mm. The adult of this species is black with white appendages. The nymph is pale gray with a powdery coating. This insect feeds in colonies on the underside of leaves, causing the foliage to turn yellow and also excretes a sweet, sticky substance known as "honeydew." Black sooty mold often grows on the surface of this excretion .....p. 79

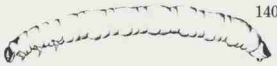
2. **Potato leafhopper**—This tiny, 3 mm long, yellowish- to pale-green insect (Fig. 139B) has yellow or dark green spots which can be observed under magnification. It feeds on the underside of leaves, causing a yellowing from the leaf tip back (hopperburn) .....p. 122

3. **Tobacco thrips**—Slender, yellowish brown, and about 1 mm long, this tiny insect (Fig. 139C) rasps leaves and causes them to pucker and lose color .....p. 124

4. **Twospotted spider mite**—Almost microscopic, this yellowish- to dark-green mite has two or four dark spots on its back (Fig. 139D). It has eight legs as an adult, but only six legs as a larva. It feeds on the underside of leaves, causing the foliage to turn silver-gray. Webs may be noticeable if the mites are numerous .....p. 125

C. Insects that feed below ground

1. **Beetle larvae**—These larvae have three pairs of short legs near their head (Fig. 140).


140A


140B

a. **Southern corn rootworm**—About 15 to 16 mm long when fully grown, this beetle larva (Fig. 140A) is yellowish white with a wrinkled body. It has a hardened, brown shield over its last abdominal segment. Most injurious in heavy, poorly drained soils or following winter cover crops, this pest bores into young pods or attacks pegs before pods develop ..... p. 123

b. **Wireworms**—Ranging from a few millimeters in length to 24 mm when fully grown, several species of these slender larvae (Fig. 140B) feed within the underground plant parts of the peanut. Infested plants become yellow and less productive ..... p. 126

2. **Lesser cornstalk borer**—Slender, bluish green, and brown-striped, this caterpillar has brown rings around its body. It is about 19 mm long when fully grown. It may feed externally or tunnel into underground plant parts. Developing nuts are often hollowed out ..... p. 121

## PEANUT INSECT NOTES

### DESCRIPTION

**Adult**—This moth has long, narrow, usually dark forewings, which are pale near the tips. There are three black dashes on each forewing. The hind wings are white with dark veins and broad, dark, indefinite margins, and the wingspan is 38 to 51 mm.

**Egg**—The egg is white, round, and about 0.5 mm in diameter.

**Larva**—The six instars range from 3.5 to 45.5 mm in length. Above the spiracles (tiny breathing holes along the sides), the larva is uniformly one color, varying from light gray to nearly black. The spiracles are distinctly black. When disturbed, the larva curls into a C-shaped ball.

**Pupa**—The brown pupa is about 17 to 22 mm long, with distinct mouthparts and antennae.

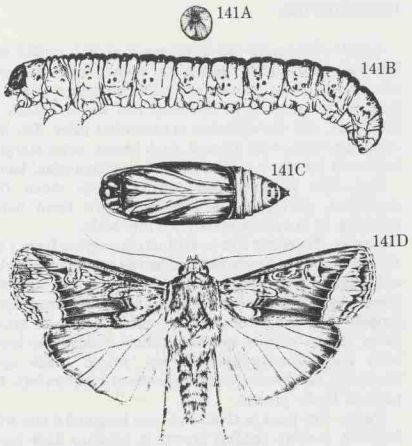



**Fig. 141 Black cutworm. A, Egg. B, Larva. C, Pupa. D, Adult.**

### BIOLOGY

**Distribution**—Widespread throughout North America and Europe, the black cutworm is found in all North Carolina counties. The threat of an infestation appears to be greatest in insecticide free, no-till corn fields. Peanuts, however, are damaged annually in all major production areas of our state.

**Host Plants**—The black cutworm feeds on a wide range of field and garden crops. Corn and tobacco are two of its most preferred crops. Other known hosts include asparagus, bean, beet, cabbage, castor bean, cotton, grape, lettuce, peanut, pepper, potato, radish, spinach, squash, strawberry, and tomato.

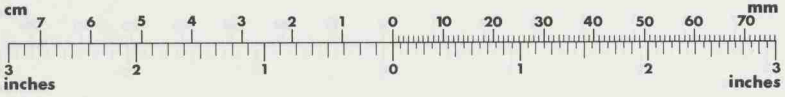
**Damage**—Several kinds of cutworms may damage peanuts under certain conditions in North Carolina, but the black cutworm is one of the most important. Its biology and damage are typical of cutworms in general. During the day these large dark caterpillars hide under trash, in cracks, or below the soil surface where they feed on pegs or pods. At night they feed on the stems and foliage and often move from plant to plant.

**Life History**—Little is known about the biology of this pest in North Carolina, but in Tennessee there are four broods between March and December. Moths of the first brood emerge between the middle of March and the first of May, shortly after which they mate. Oviposition begins 5 to 11 days after emergence. Typically, clusters of up to 30 eggs are deposited on low, densely growing plants like curly dock and mustard. The egg stage lasts 3 to 16 days, depending upon the temperature. The caterpillars develop through 6 instars in about 3 to 4 weeks. The pupal stage lasts from 2 to 3 weeks during the summer; after September, pupae may require 8 or 9 weeks to develop. Overwintering in North Carolina occurs in the pupal stage though a few black cutworms overwinter as larvae.



### CONTROL

Cutworms are often difficult to control. However, insecticides applied when thresholds occur have been effective in controlling these insects on peanuts. For specific insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*




**Agrotis ipsilon* (Hufnagel), Noctuidae, LEPIDOPTERA

## PEANUTS
### Corn Earworm*

### DESCRIPTION

**Adult**—This moth has a wingspan of 25.5 to 38.5 mm. The forewings of the males are usually light yellowish olive; those of the females are yellowish brown to pinkish brown. The covering of the head and thorax match the forewings, and the abdomen is somewhat paler. The hind wings are white with a broad, dark brown, outer marginal band and usually a narrow, brown, intermarginal band.

**Egg**—The dome-shaped egg is white when first deposited, developing a reddish brown band before hatching. It is approximately 0.5 mm wide.

**Larva**—There are five to six instars varying from 1.5 to 44 mm in length. Newly hatched larvae are yellowish white with dark head capsules. Second instars are yellowish green and frequently have orange and brown, longitudinal stripes; their head capsules are reddish brown or brown. Later instars may be greenish yellow, reddish, or brown with pale, longitudinal stripes, raised black spots (chalazae), and brown to orange heads. All instars have five pairs of fleshy prolegs.

**Pupa**—The pupa is about 31.5 mm long and 6 mm wide. Initially, a shiny reddish brown, it becomes dark brown when adult emergence approaches.

### BIOLOGY

**Distribution**—The corn earworm is found throughout most of the Western Hemisphere. Frequently encountered in the southern United States, it has been found as far north as Saskatchewan and has been recently introduced into the Hawaiian Islands. In North Carolina, it occurs in virtually every corn field sometime during the growing season.

**Host Plants**—The corn earworm is found on over 100 host plants, but corn is the preferred host. In North Carolina, it occurs on at least 14 cultivated plants (alfalfa, bean, corn, cotton, okra, peanut, pea, sorghum, soybean, strawberry, sweet pepper, sweet potato, tobacco and tomato). This insect is also found occasionally on wild hosts such as toadflax.

**Damage**—The corn earworm is one of several caterpillar pests of peanuts. Damage is largely restricted to the foliage

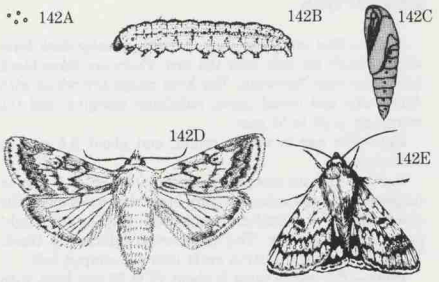



**Fig. 142 Corn earworm. A, Eggs. B, Larva. C, Pupa. D-E, Adults.**

although they will occasionally feed on pegs and pods. Infestations generally occur from mid-August to October.

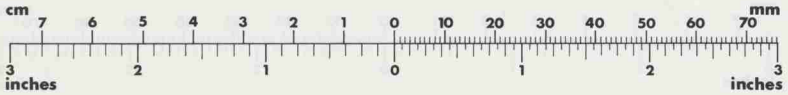
**Life History**—In North Carolina, the corn earworm overwinters as a "resting" (diapausing) pupa in the soil at a depth of more than 50 mm. Adults emerge in early May, mate, and seek suitable host plants where the females deposit their eggs singly. Each female may lay from 450 to 3,000 eggs which usually hatch within 3 days.

In spring, because no single host is both abundant and in a stage attractive enough to receive a majority of eggs, moderate numbers of larvae occur on several hosts. When field corn starts silking, most of the eggs are deposited on corn. Later in the season, when corn silks dry, this pest lays eggs on a variety of hosts such as cotton, soybeans, certain vegetables and peanuts. The corn earworm usually does not appear in peanut fields in large numbers until after both corn and cotton begin to mature. Up to four generations occur each year in North Carolina, but the third generation is of most significance to peanuts.

### CONTROL

For control recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*






*Heliothis zea* (Boddie), Noctuidae, LEPIDOPTERA

## DESCRIPTION

**Adult**—The lesser cornstalk borer moth has a wingspan of nearly 26 mm. The male's front wings are brownish yellow and have grayish margins with several dark spots. The female's front wings are nearly black.

**Egg**—The egg is greenish white and less than 0.5 mm in diameter.

**Larva**—About 19 mm long, the larva is a slender, bluish-green, brown-striped caterpillar with brown rings around its body. This insect thrashes wildly when disturbed or prodded.

**Pupa**—The pupa is brownish and about 8.5 mm long.

## BIOLOGY

**Distribution**—Although the lesser cornstalk borer is found from Maine to southern California, the bulk of its damage occurs in the more southern states. It is also found in Mexico, Central America, and South America. This insect is a major pest of peanuts in Texas, Oklahoma, Georgia, and Alabama.

**Host Plants**—The lesser cornstalk borer prefers corn, but it also feeds on bean, cowpea, peanut, pea, crabgrass, Johnson grass, sorghum, and wheat.

**Damage**—Under moist soil conditions, lesser cornstalk borers tend to be saprophytic. In tilled soils which tend to be drier, the borers often become a problem on crop plants. The larvae feed on and tunnel into lower stems, roots, pods, and pegs. Pegs are severed and developing nuts hollowed out. As a result of such injury, plant growth is retarded and yield is reduced. Feeding by high numbers of lesser cornstalk borers may cause plants to wilt and die.

**Life History**—Lesser cornstalk borers can hibernate as larvae or pupae. However, they usually overwinter as larvae which develop into pupae before spring. The moths emerge early in the spring and lay their eggs on the leaves or stems of host plants. The eggs hatch in about a week. Feeding first on roots and leaves, the larvae later construct underground silken tubes or burrows near the ground line from which they bore into plants. They become fully grown in 2 to 3 weeks, leave their burrows, and spin silken cocoons under trash on the surface of the ground. In these cocoons, they change to pupae, from which moths emerge in 2 to 3 weeks. Normally, two generations occur each year.

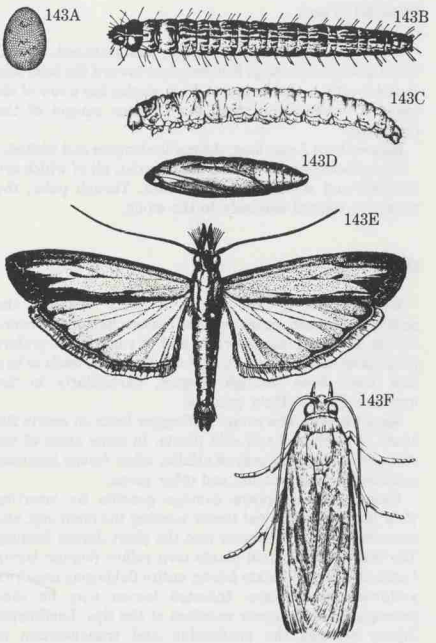
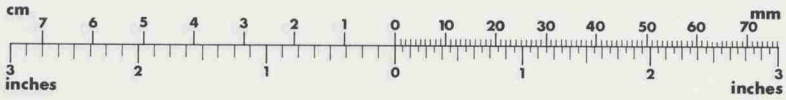



**Fig. 143 Lesser cornstalk borer. A, Egg. B-C, Larvae. D, Pupa. E-F, Adults.**

## CONTROL

Late fall plowing is of some benefit since it kills overwintering life stages. For specific chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*




**Elasmopalpus lignosellus* (Zeller), Pyralidae, LEPIDOPTERA

## PEANUTS
### Potato Leafhopper*

### DESCRIPTION

**Adult**—The adult is a pale green, wedge-shaped, winged insect about 3 mm long. It is broadest toward the head and tapers evenly to the wing tips. This species has a row of six rounded, white spots along the anterior margin of the prothorax.

**Egg**—About 1 mm long, the egg is elongate and whitish.

**Nymph**—Several nymphal stages exist, all of which are wingless and smaller than the adult. Though paler, the nymph is colored similarly to the adult.

### BIOLOGY

**Distribution**—A pest native to North America, the potato leafhopper occurs over the eastern half of this country as far west as Colorado and Wyoming. It prefers peanuts on sandy soils and, in North Carolina, tends to be a pest from June through August, particularly in the northern Coastal Plain counties.

**Host Plants**—The potato leafhopper feeds on nearly 200 kinds of cultivated and wild plants. In some areas of the state, it is a serious pest of alfalfa, other forage legumes, potatoes, beans, peanuts, and other crops.

**Damage**—Leafhoppers damage peanuts by inserting their beaks into the leaf tissue, sucking the plant sap, and secreting a toxic substance into the plant during feeding. The leaf tips of injured plants turn yellow (hopper burn). Later, if infestations are heavy, entire fields may acquire a yellowish appearance. Infested leaves may be shed prematurely and appear scorched at the tips. Leafhopper injury reduces the production and translocation of photosynthetic materials to the developing pods, thus lowering yields.



**Life History**—The potato leafhopper overwinters in the Gulf States and migrates northward in the spring. In North Carolina, these pests are usually found on the underside of peanut leaves by June. Young (nymphs) are not found in abundance on peanuts until the first or second week of July. Peak numbers of leafhoppers occur in peanut fields during early August and usually begin declining by mid- to late August. However, in exceptional years, heavy infestations may be present through September.

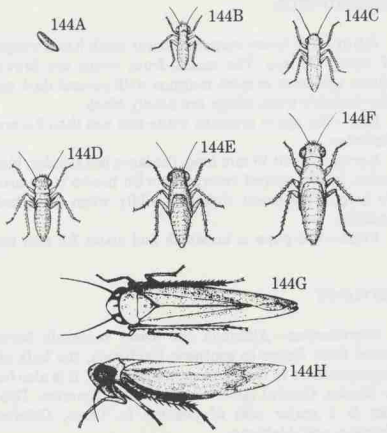
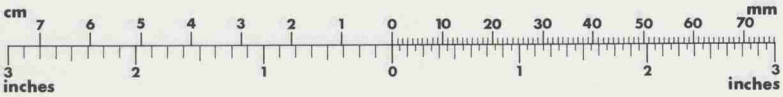



**Fig. 144 Potato leafhopper. A, Egg. B-F, Nymphs. G-H, Adults.**

Three to ten days after mating, the females use their sharp ovipositors to thrust eggs into the main veins or petioles of the leaves. An average of two or three eggs are laid daily, and the females live a month or more. The eggs hatch in about 10 days. Nymphs become fully grown in about 2 weeks. Nymphs usually develop on the leaves where they hatch, molting five times before they become adults. Several overlapping generations (two to four) occur each year.

### CONTROL

The use of systemic insecticides at planting is usually adequate to control this pest. For specific insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*




**Empoasca fabae* (Harris), Cicadellidae, HEMIPTERA

## DESCRIPTION

**Adult**—The adult beetle, about 6 mm long, has a bright yellowish-green body with black legs, antennae and head. Twelve black spots are found on the wings.

**Egg**—The egg is dull yellow, oval and about the size of a pinhead (0.6 mm).

**Larva**—The mature larva is 15 to 16 mm long with a yellowish-white, somewhat wrinkled body. It has six tiny, brownish legs and a brown plate on top of its last abdominal segment.

**Pupa**—About 6 mm long, the pupa is white to yellow.

## BIOLOGY

**Distribution**—The southern corn rootworm is widely distributed throughout most areas east of the Rocky Mountains, in southern Canada, and in Mexico. It is most abundant and destructive in its southern range. In North Carolina, growers in the northern Coastal Plain, where soils are heavy, express more concern than producers in other areas of the state.

**Host Plants**—Southern corn rootworms have been found on more than 200 plants including common weeds, grasses, and cultivated crops. This insect is prevalent on corn and peanut, but it also attacks cucumber, squash, bean and other vegetables, melon, wheat, rice, millet, rye, oat, and alfalfa.

**Damage**—The southern corn rootworm is the most serious insect attacking the roots and pods of peanuts in the southeastern Coastal Plain. This pest is most injurious to peanuts grown in heavy, poorly drained soil. It is frequently destructive to peanuts following a winter cover crop, such as vetch or crimson clover. More damage occurs in fields where peanut foliage is heavy than in those where foliage is light.

The larvae bore into the pods of the peanuts and feed on the kernels. They prefer young pods but will often attack the tips of the shoots or pegs and kill them before the pods develop. Occasionally, when pods are scarce, they attack stems. Fungi and bacteria may enter injured pods and cause decay.

Adults, known as spotted cucumber beetles, feed on the unopened leaves. After the damaged leaflets open, oblong to slightly irregular holes appear. Although not as injurious as the larvae, the beetles are sometimes minor pests.

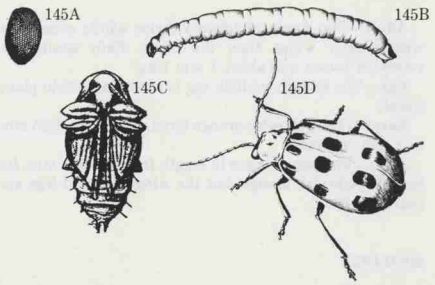



**Fig. 145 Southern corn rootworm. A, Egg. B, Larva. C, Pupa. D, Adult.**

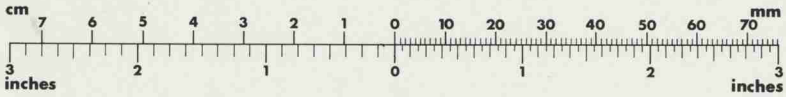
**Life History**—The adults overwinter in and around the bases of plants or other protected places. Adults become active about the middle of March, and their eggs are laid from late April to early June. The eggs are laid singly, each female laying as many as 500. They hatch in 7 to 10 days, depending upon the temperature. Larvae feed, become fully grown in 2 to 4 weeks, and pupate. First-generation adults emerge 1 to 2 weeks after pupation (late June or early July). A complete life cycle requires from 6 to 9 weeks. This insect has two, and sometimes three generations per year.

A few adults can usually be found on peanuts in late June, although heavy infestations do not occur until the third or fourth week in July. The greatest adult populations are usually found during late July and early August, when second-generation egg laying occurs. In late fall, these last adults assemble on weeds, alfalfa, or clover where they spend the winter.



## CONTROL

Crop rotation, resistant varieties, and the use of soil insecticides aid in controlling this pest. For specific insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*




**Diabrotica undecimpunctata howardi* Barber, Chrysomelidae, COLEOPTERA

## PEANUTS
## Tobacco Thrips*

### DESCRIPTION

**Adult**—Two forms of tobacco thrips adults occur, one with shorter wings than the other. Both adults are yellowish brown and about 1 mm long.

**Egg**—The minute, whitish egg is concealed within plant tissue.

**Larva**—The yellowish orange larva varies from 0.25 mm to 1 mm in length.

**Pupa**—The pupa ranges in length from 0.6 to 1 mm. Its body is yellowish orange, but the wing pads and legs are pearly white.


**Fig. 146 Adult tobacco thrips.**

### BIOLOGY

**Distribution**—Tobacco thrips are distributed throughout the United States and are found in all North Carolina counties.

**Host Plants**—Tobacco thrips attack bean, cocklebur, cotton, crabgrass, dewberry, Irish potato, oat, peanut, pea, tobacco, tomato, and many other plants.

**Damage**—Several species of thrips damage peanut leaves, but the tobacco thrips is the principal, damaging species in North Carolina. Flower thrips, *F. tritici* (Fitch), sometimes feed on the flowers but do no economic damage. Thrips are most damaging to young peanut plants. As the upper surfaces of developing leaflets unfold, they appear scarred and even deformed. Farmers often refer to these damaged leaves as "possum-eared." Damage is usually minor but, with heavy insect infestations in combination with other stresses, stunting occurs during early development and the damaged peanuts recover slowly.



**Life History**—In North Carolina, tobacco thrips probably over-winter as adult females under ground litter or in other protected places. In the spring, adult thrips migrate to peanuts from small grain crops, grasses, and weeds. Each female deposits 50 to 60 eggs in the tissue of the foliage. They hatch in about 7 days. Apparently, unfertilized eggs produce males and fertilized eggs produce only females. Larvae (two stages) feed for 5 to 6 days before pupating either on the plant or in the soil. In 3 to 4 days, the adults emerge and begin feeding. Total development time from egg to adult is about 16 days. Five overlapping generations per year have been reported in South Carolina, and a similar number probably occurs in North Carolina.

### CONTROL

Heavy rainfall is one of the most effective natural controls on tobacco thrips, although predaceous insects are also of some value. Chemical control of this pest is not difficult. In the Southeast, thrips are controlled throughout the season by systemic insecticides applied at planting. For specific insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*

* *Frankliniella fusca* (Hinds), Thripidae, THYSANOPTERA

## DESCRIPTION

**Adult**—The eight-legged adult is almost microscopic, being only 0.4 mm long. Green or straw-colored, the female usually has two or four black, dorsal spots. The male is slightly smaller than the female and has a more pointed abdomen.

**Egg**—The minute egg is shiny white and concealed under webbing. It becomes straw-colored or pale green a few hours after it is deposited.

**Larva**—The six-legged larva, not much larger than the egg, is colorless with distinct carmine eyes.

**Nymph**—The eight-legged nymph is smaller than but similar to the adult.

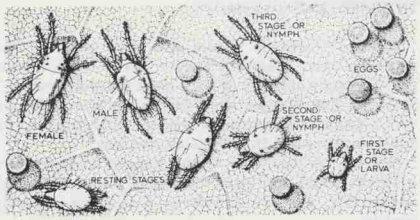



**Fig. 147 Twospotted spider mite life stages.**

## BIOLOGY

**Distribution**—Twospotted spider mites are widely distributed throughout the United States and the rest of the world. The northern Coastal Plain is the most heavily infested area of North Carolina.

**Host Plants**—Twospotted spider mites have been found on over 180 host plants including over 100 cultivated species. Violets, chickweed, pokeweed, wild mustard, and blackberry are common weeds from which infestations develop on crops nearby.

**Damage**—Spider mites cause extensive damage to peanut foliage in North Carolina, particularly in the northern Coastal Plain. Yields are often drastically reduced in many fields, especially during periods of hot, dry weather. Initially, leaves appear gray with webbing on the lower surface. As damage progresses, extreme webbing and a burned appearance become very noticeable.

**Life History**—In North Carolina, twospotted spider mites overwinter as adults on field border vegetation (usually weeds). In mild weather, they continue to feed and lay eggs, though development in the winter is much slower than in the summer. In spring, adults initially infest peanuts near the edges of fields and lay eggs. From these eggs hatch larvae which soon develop into nymphs. After each larval and nymphal stage, there are resting stages. The new adults mate soon after emerging from the last resting stage. In warm weather, the females soon begin laying eggs; each female produces up to 19 eggs per day (up to 100 eggs in all). Each generation requires 5 to 20 days to mature depending upon environmental conditions. Development is most rapid during hot, dry weather.

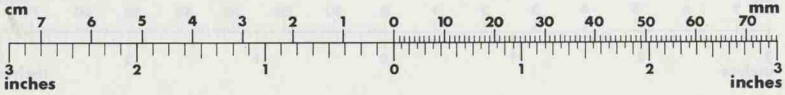
## CONTROL

There are several preventive practices that growers should follow in areas with a past history of spider mite infestations.

1. Growers should choose fungicides that do not contribute to mite build-up. (Certain fungicides apparently kill fungi that are pathogenic to spider mites.)
2. Avoid the use of fungicide-insecticide mixtures (especially with carbaryl) unless the insecticide is definitely needed for insect control.
3. Keep field margins and turn rows clear of grass and weeds throughout the growing season. If weeds are present, do not destroy them during the growing season. This will intensify the mites' migration from their overwintering sites to the peanuts.
4. As much as possible, avoid moving workers and equipment from infested areas to noninfested areas.

If mites build up in a field, miticides will be necessary to control the population. For specific miticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*






**Tetranychus urticae* Koch, Tetranychidae, PROSTIGMATA

## PEANUTS
### Wireworms*

**DESCRIPTION** (two species)

**Adult**—Wireworm adults are click beetles. The yellowish-brown tobacco wireworm beetle has a characteristic pattern of brown or black markings and measures 7 to 11 mm long. The *Conoderus lividus* beetle is dull brown with a grayish pubescence, yellow legs, and reddish-brown antennae. It ranges from 11 to 17 mm long.

**Egg**—Newly laid eggs of the tobacco wireworm are spherical, white, and about 0.5 mm in diameter. Though undescribed, eggs of *Conoderus lividus* are probably similar.

**Larva**—Newly hatched larvae of the tobacco wireworm are white and approximately 1.5 mm long. Tobacco wireworms become cream colored and average 13 mm long when they mature. Full grown larvae of the species *C. lividus* average 24 mm. Both species have a tan to brown, V-shaped notch in their last abdominal segment.

**Pupa**—The brown pupae are slightly larger than adults. They occur in the soil near the food source.

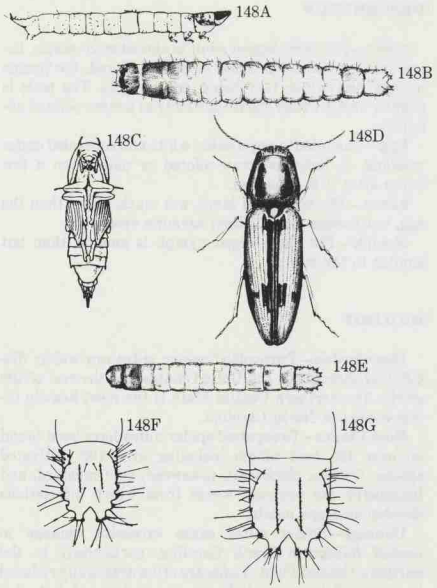



**Fig. 148 Wireworms. A-D, Tobacco wireworm larvae, pupa, and adult. E-F, *Conoderus lividus* larva and last abdominal segment. G, Last abdominal segment of tobacco wireworm.**

### BIOLOGY

**Distribution**—The tobacco wireworm is widely scattered throughout the southern and eastern states whereas *C. lividus* is most commonly found in southern and central states. Both species are common throughout the Coastal Plain and Piedmont regions of the southeastern states. The tobacco wireworm is particularly damaging to peanuts in areas where corn or tobacco have been planted extensively or where peanuts follow sod.



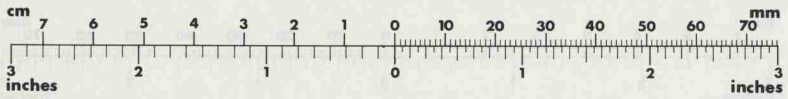
**Host Plants**—Although tobacco wireworm larvae prefer tobacco, they also attack corn, cotton, potato, bean, peanut, and various truck crops. The adult beetles commonly feed on the weed mullein. *Conoderus lividus* larvae are most frequently found in bluegrass sod or in fields which were in sod the previous year. *C. lividus* beetles, on the other hand, are commonly found on trees and shrubs, especially walnut and hickory.

**Damage**—Wireworm larvae damage peanuts by feeding in the seed, roots, underground stem and pods of the plant. Ragged holes are apparent in infested roots and stems. The above ground symptoms may include poor germination, chlorotic plants, and low productivity.

**Life History**—Since little is known concerning the life cycle of *C. lividus*, the following life history is based on the tobacco wireworm. About 240 eggs per female are laid singly on or slightly beneath the soil surface in summer. Larvae hatch and feed on the roots of tobacco, corn, or other plants. The larvae overwinter 5 to 9 cm below the soil surface. If crop hosts are planted the following spring, these wireworms feed on the germinating seeds and young seedlings. Pupation then occurs in the soil, and adults emerge during early summer. There is only one generation per year. The average life cycle requires about 348 days, as follows: egg, 10 days; larva, 315 days; pupa, 10 days; and preoviposition period, 13 days.

### CONTROL

Wireworms are an occasional, but manageable, problem on North Carolina peanuts. The problem can be largely avoided by not planting peanuts on land that has been in




*tobacco wireworm, *Conoderus vespertinus* (Fabricius); (no common name), *Conoderus lividus* (De Geer), Elateridae, COLEOPTERA

sod the previous year. Rotations that do not include corn or tobacco can also be effective. For persistent problems, several insecticides are available which can be applied at planting. For information concerning specific insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*

## PEANUTS
## References


### GENERAL

Bass, M.H. and F.S. Arant. 1973. Insect pests, pp. 383-428. *In* Peanuts—culture and uses; a symposium, ed. A.J. St. Angelo. Amer. Peanut Res. and Educ. Assn., Inc., Stillwater, Okla. 684 pp.

Dillon, E.S. and L.S. Dillon. 1972. A manual of common beetles of eastern North America, Vol. I. Dover Publ., New York. 434 pp.

Feakin, S.D. 1973. Pest control in groundnuts, PANS manual no. 2. Centre for Overseas Pest Res., London. 197 pp.

French, J.C. 1975. Peanut insect control. Georgia Coop. Ext. Service Circ. 543. 2 pp.

Jaques, H.E. 1951. How to know the beetles. Wm. C. Brown Co., Publ., Dubuque, Iowa. 372 pp.

Metcalf, C.L., W.P. Flint, and R.L. Metcalf. 1962. Destructive and useful insects, their habits and control. McGraw-Hill Book Co., New York. 1087 pp.

Pettit, R.H. 1924. Common pests of field and garden crops. Michigan Agr. Exp. Sta. Spec. Bull. 132. 60 pp.

Robertson, R.L. 1977. Control of insects on peanuts. Peanut Farmer 13(4): 16-17, 20-21.

Westcott, C. 1964. The gardener's bug book. Doubleday & Co., Inc., Garden City, New York. 625 pp.

### BLACK CUTWORM

Busching, M.K. and F.T. Turpin. 1976. Oviposition preferences of black cutworm moths among various crop plants, weeds, and plant debris. J. Econ. Entomol. 69: 587-90.

Harris, C.R., J.H. Mazurek, and G.V. White. 1962. The life history of the black cutworm, *Agrotis ipsilon* (Hugnagel), under controlled conditions. Can. Entomol. 94: 1183-7.

Rings, R.W., F.J. Arnold, A.J. Keaster, and G.J. Musick. 1974. A worldwide, annotated bibliography of the black cutworm, *Agrotis ipsilon* (Hufnagel). Ohio Agr. Res. and Development Center Res. Circ. 198. 106 pp.

### CORN EARWORM

Sears, D.E. and J.W. Smith, Jr. 1975. A natural mortality table for the corn earworm on peanuts. Progress Rep. Texas Agr. Exp. Sta. Coll. Sta. PR-3344. 4 pp.

Slosser, J.E., F.R. Phillips, G.A. Herzog, and C.R. Reynolds. 1975. Overwinter survival and spring emergence of the bollworm in Arkansas. Environmental Entomol. 4: 1015-24.

York, A. 1974. Corn earworm control. Indiana (Purdue Univ.) Coop. Ext. Service Pub. E 31. 2 pp.

### LESSER CORNSTALK BORER

French, J.C. and L.W. Morgan. 1972. The damage and control of the lesser cornstalk borer, *Elasmopalpus lignosellus* (Zeller) on peanuts. J. Amer. Peanut Res. and Educ. Assn. 4: 41-2.

Harding, J.A. 1960. Control of the lesser cornstalk borer attacking peanuts. J. Econ. Entomol. 53: 664-7.

### POTATO LEAFHOPPER

Campbell, W.V., D.A. Emery, and J.C. Wynne. 1976. Resistance of peanuts to the potato leafhopper. Peanut Sci. 3: 40-3.

DeLong, D.M. 1938. Biological studies on the leafhopper *Empoasca fabae* as a bean pest. U.S. Dep. Agr. Tech. Bull. 618. 60 pp.

Medler, J.T. 1957. Migration of the potato leafhopper—a report on a cooperative study. J. Econ. Entomol. 50: 493-7.

### SOUTHERN CORN ROOTWORM

Fronk, W.D. 1950. Cultural and biological control of the southern corn rootworm in peanuts. J. Econ. Entomol. 43: 22-4.

Isley, D. 1929. The southern corn rootworm. Arkansas Agr. Exp. Sta. Bull. 232. 31 pp.

### TOBACCO THRIPS

Beckham, C.M., R.J. Beshear, and H.H. Tippins. 1971. Some winter host plants of thrips. Georgia Agr. Exp. Sta. Res. Bull. 86. 13 pp.

Eddy, C.O. and E.M. Livingstone. 1931. *Frankliniella fusca* Hinds on seedling cotton. South Carolina Agr. Exp. Sta. Bull. 271. 23 pp.

Newsom, L.D., J.S. Roussel, and C.E. Smith. 1953. The tobacco thrips, its seasonal history and status as a cotton pest. Louisiana Agr. Exp. Sta. Tech. Bull. 474. 36 pp.

### TWOSPOTTED SPIDER MITE

Cagle, L.R. 1949. Life history of the two-spotted spider mite. Virginia Agr. Exp. Sta. Tech. Bull. 113. 31 pp.

Laing, D.E. 1969. Life history and life table of *Tetranychus urticae* Koch. Acarologia 11: 32-42.

Vrie, M. van de, J.A. McMurtry, and C.B. Huffaker. 1972. Ecology of tetranychid mites and their natural enemies: A review. III. Biology, ecology, and pest status, and host-plant relations of tetranychids. Hilgardia 41: 343-432.

### WIREWORMS

Conradi, A.F. and H.C. Eagerton. 1914. The spotted click beetle, *Monocrepidius vespertinus* (Fabricius). South Carolina Agr. Exp. Sta. Bull. 179. 8 pp.

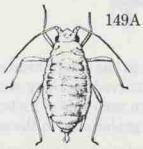
Jewett, H.H. 1939. Four wireworms found in bluegrass sod. Kentucky Agr. Exp. Sta. Bull. 392: 107-18.

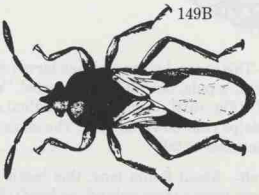
# PESTS OF SMALL GRAINS

The production of small grains in North Carolina is concentrated in the Piedmont and Coastal Plain counties. Approximately 212,550 hectares (525,000 acres) of rye, oats, wheat, and barley were planted for grain in 1980, wheat being most prevalent. In addition, some small grains are utilized as cover crops. Acreage and production, however, are erratic and respond quickly to variations in weather, pest populations, and economic conditions.

## Key to Pests of Small Grains

A. Insects and mites that pierce tissues to extract sap (Fig. 149A to C).


149A


149B


149C

1. **Aphids**—These winged or wingless, pear-shaped insects (Fig. 149A) are usually less than 3 mm long and feed in colonies. They are basically green, yellow, or pink and have a pair of appendages on the abdomen known as cornicles. The extent of damage caused by these aphids varies, but nearly all aphids cause some discoloration or mottling of the foliage.

   a. **Corn leaf aphid**—Up to 2 mm in length, this pale bluish-green insect has a dark area around the base of its cornicles and a fine, powdery film over its body. This aphid causes a yellow mottling of the foliage .....p. 135

   b. **English grain aphid**—Up to 2.5 mm long, this aphid is usually pale green (though sometimes yellow or pink) with a dark blotch on its back. The insect feeds on the foliage but causes more damage when it feeds on ripening kernels, causing them to shrivel .....p. 136

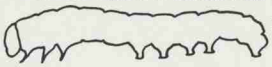
   c. **Greenbug**—Up to 2 mm long, the wingless form of the greenbug has a pale yellow to bluish-green abdomen with darker green, longitudinal streaks. The head, which is often a pale, strawlike color, is lighter than the rest of the body. As it feeds on the foliage, this aphid causes red spots which gradually enlarge. Eventually leaf tips turn brown. Circular areas of yellow plants with dead plants in the center, known as "greenbug spots," may continue to enlarge. p. 140

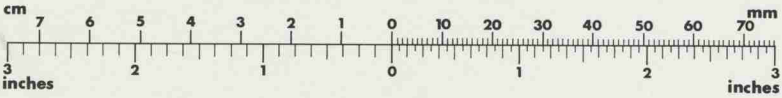
2. **Chinch bug**—This 4 mm-long, black bug has opaque wings, each marked with a black triangle (Fig. 149B). Feeding anywhere from the roots to the upper leaves, the smaller, wingless, red and black nymphs cause dwarfing, lodging, and yield reduction. Young plants may wilt and die .....p. 134

3. **Hessian fly maggot**—This 2 mm-long, white to tan, legless larva (Fig. 149C) feeds along with other maggots behind the leaf sheath where the leaf joins the stem. Leaves become thickened and weakened stems may break when the grain heads .....p. 142

B. Chewing insects that feed above ground

1. **Armyworms**—Reaching a maximum length of 30 to 40 mm, these smooth-skinned caterpillars are voracious foliage feeders. They have 5 pairs of prolegs (Fig. 150).

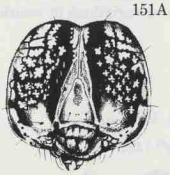

150



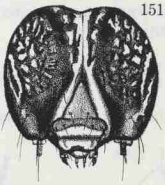

*See also "Key to Caterpillars" on page 16.

a. **Armyworm**—This pale green to brownish-green caterpillar is 30 to 35 mm long when fully grown and has three dark longitudinal stripes. Its head capsule has markings like those of the fall armyworm but they are lighter or less intense (Fig. 151A). The armyworm tends to snip off heads of grain in addition to feeding on the leaves, but is usually found in the soil litter during sunny days ..... p. 131

151A



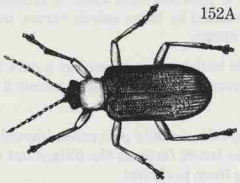
151B



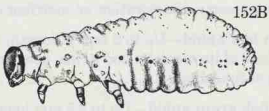
b. **Fall armyworm**—This green, brown, or black larva (up to 40 mm long) has a dark head capsule usually marked with a pale, but distinct, inverted "Y." A darker, curved marking occurs on each side of the "Y" (Fig. 151B). A black, longitudinal strip runs down each side of its body and a yellowish-gray stripe runs down its back. The larva attacks small grains only in the seedling stage during late summer or fall ..... p. 137

2. **Cereal leaf beetle adult**—About 6 mm long, this beetle has a blue-black body, brownish-yellow legs, and a reddish-brown thorax (area behind the head) (Fig. 152A). The beetle chews leaves, leaving longitudinal holes between the veins ..... p. 132

152A



152B

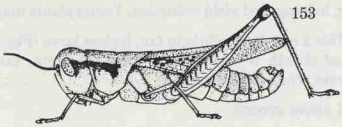




3. **Cereal leaf beetle larva**—About 6 mm long when fully grown, this soft-bodied, yellow larva is usually coated with black, fecal material (Fig. 152B). It has three pairs of legs near its head. The larva feeds between the leaf veins on surface leaf tissue, leaving longitudinal gray or white patches instead of holes. Infested fields may have an overall whitish cast ..... p. 132

4. **Grasshoppers**—Many species of variously colored grasshoppers (Fig. 153), ranging in length from 19 to 38 mm, feed on leaves and stems of small grains, eventually causing the heads to fall to the ground ..... p. 138

153



## SMALL GRAINS INSECT NOTES

### DESCRIPTION

**Adult**—The adult moth is pale brown to grayish brown with a wingspan of about 38 mm. In the center of each forewing is a characteristic white spot.

**Egg**—The minute egg is greenish white and globular.

**Larva**—The young larva is pale green. The full-grown larva, 30 to 35 mm long, has a yellow to brownish-green body with three dark, longitudinal stripes.

**Pupa**—The pupa, reddish brown at first, gradually darkens until it is almost black.

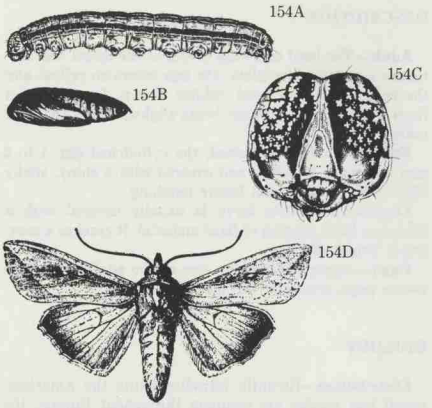



**Fig. 154 Armyworm. A, Larva. B, Larval head capsule. C, Pupa. D. Adult.**

### BIOLOGY

**Distribution**—Widely distributed, the armyworm inhabits most regions of the world. In North Carolina, it is particularly abundant in the Piedmont and Coastal Plain regions. During bright daylight hours, larvae usually remain under litter on the ground.

**Host Plants**—The armyworm infests all grass crops, especially corn, millet, bluegrass, crabgrass, fall panicum, and small grains. Under stress of hunger it will eat some broadleaved plants.

**Damage**—Armyworms, apparently native to North America, vary greatly in abundance and destructiveness from year to year. They are most destructive to small grains when wet weather has caused lush growth in the fields. Armyworms eat succulent leaves first. As the foliage is consumed, they move to other parts of the plant. In headed small grains, the caterpillars may feed on awns and tender kernels, frequently cutting through the stem immediately below the head. Farmers often notice snipped off heads and leaf feeding in combination. Damage to small grains most commonly occurs in the eastern Coastal Plain of our state.

**Life History**—In North Carolina, armyworms overwinter as partly grown larvae. Early in the spring they resume feeding on lush stands of grass and small grains. The larval stages hide during the day and feed at night. Migration of many larvae ("armies") from infested to adjacent small grain, corn, or other grass crops becomes a threat as small grains mature.

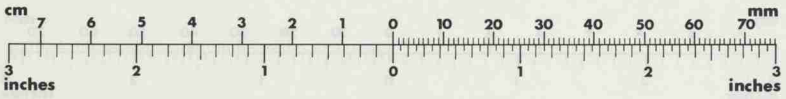
First generation adults appear in May or June and mate. After feeding on sweet substances for 7 to 10 days, the females lay eggs at night on succulent grasses and grain crops. An individual female may deposit as many as 2,000 eggs (in clusters of 25 to 134). Six to ten days later, second generation larvae emerge and feed for about 3 weeks. They then drop to the ground and pupate in earthen cells 5 to 7.5 cm in the soil. Moths emerge about 4 weeks later. There are five or more generations per year in North Carolina. However, generations which develop after early July are usually not an economic threat due to the natural controls.



### CONTROL

Parasites, various diseases, insect predators, and birds usually keep the armyworm under control in small grains. The effectiveness of these natural control agents, however, is reduced during cool, wet springs and during growing seasons that follow years of drought.

Shallow plowing, shortly after larvae have entered the soil to pupate, destroys many larvae and pupae. The presence of six caterpillars 13 mm (0.5 inch) long or longer per 929 $cm^2$ (1 $ft^2$) justifies chemical control, except when grain is near maturity. At that time, the threshold changes to 12 armyworms per 929 $cm^2$ (1 $ft^2$). For futher control information consult the current *North Carolina Agricultural Chemicals Manual.*




*Pseudaletia unipuncta* (Haworth), Noctuidae, LEPIDOPTERA

## SMALL GRAINS
## Cereal Leaf Beetle*

### DESCRIPTION

**Adult**—The head and wing covers of the cereal leaf beetle are a metallic blue-black, the legs brownish yellow, and the area behind the head reddish brown. Length varies from 5 to 6 mm, the female being slightly larger than the male.

**Egg**—When first deposited, the cylindrical egg, 1 to 2 mm in length, is yellow and covered with a shiny, sticky film. It turns black just before hatching.

**Larva**—The yellow larva is usually covered with a brown or black coating of fecal material. It reaches a maximum length of 6 mm.

**Pupa**—Approximately the size of the adult beetle, the yellow pupa gradually becomes blue-black.

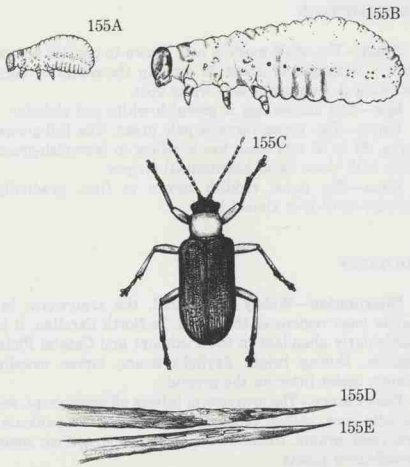



**Fig. 155 Cereal leaf beetle. A-B, Larvae. C, Adult. D, Larval feeding injury. E, Adult feeding injury.**

### BIOLOGY

**Distribution**—Recently introduced into the Americas, cereal leaf beetles are common throughout Europe, the British Isles, North Africa, the Middle East, and parts of Siberia. In the United States, they have been found from eastern Wisconsin, Iowa, and Missouri eastward into New Hampshire, Massachusetts, Connecticut, and New Jersey and southward into Tennessee and North Carolina. Detection in North Carolina was made in 1977 and, at this writing, infestations were restricted to the tier of counties along the Virginia line.

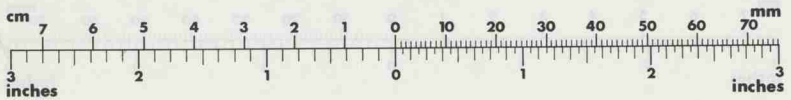
**Host Plants**—Cereal leaf beetles are not known to feed or breed on broadleaved plants. They often infest late-planted winter grains, but are most damaging to spring-planted oats. The beetles also feed on many wild and cultivated grasses including corn, sorghum, timothy, orchard grass, ryegrass, reed canarygrass, quackgrass, bluegrass, fescue, millet, rice, brome, wild oats, mouse barley, and foxtail grass.



**Damage**—Larvae and adults both are voracious feeders. They prefer seedling plants or new growth on older plants. The larvae consume one to ten times their weight each day. Since larvae eat so much and rarely move from plant to plant, their damage is more noticeable than that of adults. Seedlings in the one-leaf stage are often killed by a single larva per plant. Both larvae and adults feed between the leaf veins. Adults, however, chew completely through the leaf while larvae feed superficially. The tips of damaged leaves turn white, giving infested fields an overall whitish appearance.

**Life History**—Adult cereal leaf beetles overwinter in field debris, soil and bark crevices, crowns of grasses, and similar sheltered places. From early March in North Carolina to early April in Michigan, the first beetles emerge and mate. For the next 6 weeks, the beetles, which are strong fliers, will be active on sunny days. Shortly after mating, each female begins to lay 150 to 400 eggs on the upper leaf surfaces of host grasses, especially oats, wheat and barley. The eggs, which are usually deposited singly near the midvein, hatch 4 to 23 days later. The warmer the temperature, the sooner the eggs hatch. Newly emerged larvae feed voraciously on the host plant for 1½ to 3 weeks. As they feed they develop through four larval instars. Mature fourth instar larvae pupate in earthen cells 3 to 4 cm deep in the soil. Pupation lasts 12 to 25 days.

Throughout June, summer adults emerge, fly and feed, but do not mate. In July, they become less active and hide most of the day, often in corn sheaths. As summer progresses, adults leave corn for more sheltered wooded areas or field margins and remain inactive through December. Adults become active for brief periods if temperatures reach 10°C (50°F) or higher. Extreme temperatures and natural enemies may reduce overwintering beetle populations 40 to 70 percent. Only one generation occurs each year.




*Oulema melanopus* (Linnaeus), Chrysomelidae, COLEOPTERA

## CONTROL

Cereal leaf beetles are controlled by the use of favorable planting dates and release of parasitoids. Fall wheat should be planted immediately after the Hessian fly-free date for each county. Crops planted this early will be more advanced in growth the next spring than late-planted small grains. Therefore, they will be less attractive and, at the same time, more tolerant to the beetles. Cereal leaf beetle infestations on spring-planted wheat cannot be avoided by means of planting date.

The USDA Animal and Plant Health Inspection Service (APHIS) is currently sponsoring parasitoid release programs in many states in which the cereal leaf beetle has been found. As a result, four of five parasitoid species which help control this pest in Europe have become established in this country. These tiny wasps, released at carefully selected sites each year, have been instrumental in keeping cereal leaf beetle populations below economic damage levels. Cereal leaf beetles are chemically controlled only in scattered areas where the parasitoids fail to keep them below damaging levels. For more specific control information, consult North Carolina State Agricultural Extension Service recommendations.

## SMALL GRAINS
### Chinch Bug*

### DESCRIPTION

**Adult**—The adult chinch bug is about 4 mm long and black with opaque wings. The wings may be as long as the body or ⅓ to ½ the length of the body. In either case, each wing bears a distinctive, triangular, black mark.

**Egg**—The egg, approximately 0.84 x 0.30 mm, is flattened at one end which bears three to five minute projections. The egg gradually changes in color from pale yellow to red before hatching.

**Nymph**—The wingless nymph is smaller than but similar in shape to the adult. The head and thorax are brown; the eyes are dark red; and the abdomen is pale yellow or light red with a black tip.

### BIOLOGY

**Distribution**—The chinch bug is found from the east coast into the western plains of Nebraska, Kansas, Oklahoma, and Texas. Specimens have been examined as far north as Maine, Wisconsin, Minnesota, and South Dakota, and as far south as Louisiana and Alabama. Confined primarily to the Midwest, damaging infestations can be associated with above-normal temperatures and below-normal rainfall between March and October in the Southeast.

**Host Plants**—Chinch bugs attack many forage, lawn, and wild grasses. The principal crop plants damaged are spring barley, wheat, corn, sorghum, Sudan grass, rye, timothy, and, to a lesser extent, winter barley and oats.

**Damage**—The chinch bug pierces the plant with its four-jointed beak and sucks out the plant sap. This feeding prevents normal growth and results in dwarfing, lodging, and yield reduction. Severe infestations during early development may cause plants to wilt and die prematurely. Most injury is caused by the six nymphal instars.

**Life History**—Chinch bugs overwinter as adults in various protected areas, particularly among weeds and grasses near fields. Adults emerge in the spring and deposit eggs singly behind the leaf sheath or in the soil at the base of the small grain crop plant. In a few days, the eggs hatch and the nymphs begin feeding on all parts of the host plant from the roots to the uppermost leaves. The nymphs undergo six developmental stages, the last being the adult stage. Two to three generations occur per year, the later generations migrating to corn and sorghum when small grain crops become dry.

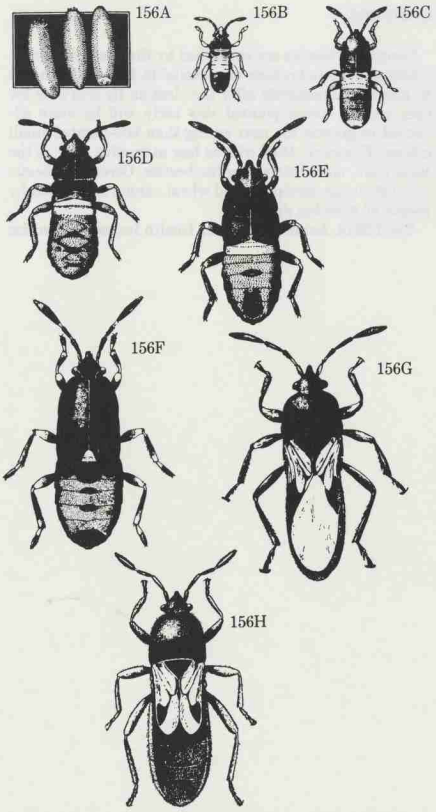


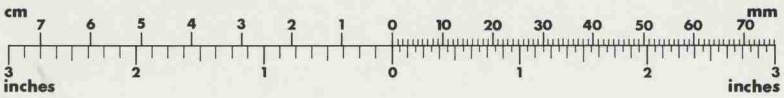

**Fig. 156 Chinch bug. A, Eggs. B-F, Nymphs. G, Long-winged adult. H, Short-winged adult.**

### CONTROL

Since chinch bugs attack only grass crops, crop rotation, especially with legumes, is an effective cultural control practice. Chinch bug feeding is also deterred by a vigorously growing crop. Therefore, cultural practices—timely seeding, ample fertilization, and thorough weed control—help prevent chinch bug damage. Some varieties of corn and sorghum offer resistance to this pest.

If chinch bugs do invade in economic numbers, they must be controlled chemically. For specific control recommendations, consult the North Carolina State Agricultural Extension Service.






*Blissus leucopterus leucopterus* (Say), Lygaeidae, HEMIPTERA

## DESCRIPTION

**Adult**—The wingless adult is oval and about 2.0 mm long. It is usually pale bluish green with black antennae, legs, and cornicles and a dark area at the base of the cornicles. The head is marked with two dark, longitudinal bands, and the abdomen with a row of black spots on each side. The body often seems to have a powdery coating. The winged form is about the same size as the wingless form.

**Egg**—Unknown.

**Nymph**—The nymph is smaller than but similar to the wingless adult.

## BIOLOGY

**Distribution**—The corn leaf aphid is common wherever small grains and corn are grown in the United States and Canada, being especially abundant in the South. Its range extends throughout the tropical and temperate regions of the world. In North Carolina, there appears to be no geographic difference in population.

**Host Plants**—The corn leaf aphid is commonly found on corn, barley, millet, broomcorn, sorghums, Sudan grass, and many other wild and cultivated grasses. It shows a preference for barley and sorghums. Although this aphid has been reported to attack wheat, oats, and rye, economically significant infestations on these crops are uncommon.

**Damage**—The corn leaf aphid causes injury to small grains in the southern United States by the removal of plant sap and the introduction of diseases. Feeding by colonies of this aphid causes mottling and discoloration of the leaves. Infested plants become covered with sweet, sticky honeydew secretions. Sooty mold fungi grow on the honeydew causing reduced grain development and interfering with photosynthesis. These aphids also transmit a mosaic disease of sweet corn and the barley yellow dwarf virus of small grains.

**Life History**—Little is known about the biology of this pest in North Carolina. Apparently it overwinters as an adult and actually does much of its damage during the winter. Ovoviviparous females, both winged and wingless, form the bulk of the population. Males are rarely found, and no eggs have ever been seen. This suggests that the aphid can reproduce parthenogenetically. The female aphids are found in large clusters on the leaves, where they feed and reproduce. Reproduction slows down in winter and summer and is most rapid during cool weather. Therefore, corn leaf aphids tend to be a problem on winter grains in fall, on warm winter days, and in spring. The number of generations per year varies from 9 in Illinois to 50 in southern Texas.

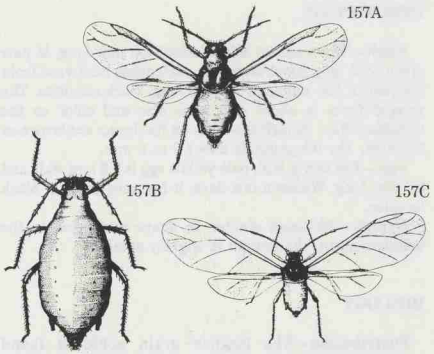
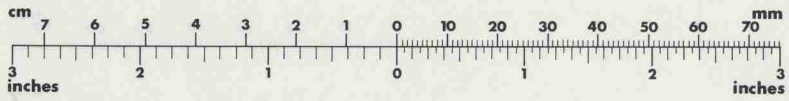



**Fig. 157 Corn leaf aphid. A, Adult male. B-C, Adult females.**

## CONTROL

Resistant varieties, early planting and proper growing conditions reduce this insect's impact. Pasturing infested winter barley is recommended to free the crop of this pest. In North Carolina, 25 aphids per head of grain or 100 foliar-feeding aphids per 30 cm (1 row foot) are recognized as economic thresholds. For further control recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*






*Rhopalosiphum maidis* (Fitch), Aphididae, HEMOPTERA (Homoptera)

## SMALL GRAINS
### English Grain Aphid*

### DESCRIPTION

**Adult**—The wingless adult, about 2.5 mm long, is pale green with long, black antennae. Extending backward from the rear of the abdomen are two long, black cornicles. The winged form is about the same size and color as the wingless adult, though the lobes on its thorax are brown or blackish. The wingspan is about 6 to 9 mm.

**Egg**—The newly laid, pale yellow egg is 0.3 mm wide and 0.7 mm long. Within a few days, it becomes green or black in color.

**Nymph**—Although similar in shape and color to the wingless adult, the nymph is slightly smaller.

### BIOLOGY

**Distribution**—The English grain aphid is found throughout the United States and southern Canada wherever small grains are grown. In North Carolina, they are widespread throughout the state, commonly occurring where grain is grown in mixed or pure populations.

**Host Plants**—English grain aphids feed on all small grains and many wild cultivated grasses. They have been found in small numbers on corn but are not important pests of this crop.

**Damage**—The English grain aphid is one of the most common and destructive aphids attacking the foliage and heads of wheat and other small grains. Colonies of this aphid feed upon the leaves until the grain begins to head; they then collect on the heads among the ripening kernels. When sufficiently large populations develop, their feeding shrivels the growing kernels. Extensive early spring feeding can kill grain plants. This aphid species is also a known vector of the barley yellow dwarf virus disease of small grains in the eastern United States.



**Life History**—These insects overwinter as eggs, late instar nymphs, or adults. The overwintering forms are all females, which in the spring give birth to live young. These progeny mature into wingless females which produce live offspring without mating. In early spring, the aphids feed on growing grains. As these plants mature and become less succulent, winged aphids develop and migrate to wild or cultivated grasses, where they spend the summer. In the fall, after the winter grains are planted, the aphids return to the grains or gather in large numbers in clumps of volunteer grain. Males appear during the fall or early winter and mate with the females, which then lay eggs on the grains where they have been feeding. Each female lays only about eight eggs. As many as 17 generations occur each year.

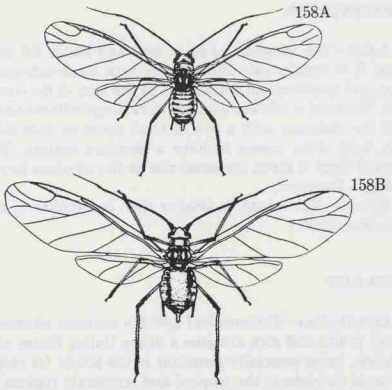
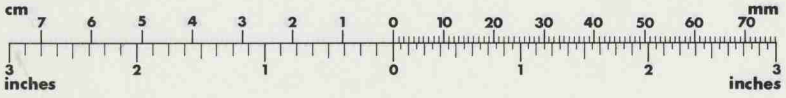



**Fig. 158 English grain aphid. Adult male. B, Adult female.**

### CONTROL

Normally these aphids are held in check by their natural enemies, which include parasites, predators, and fungal diseases. Grains are usually injured when the parasites have been destroyed and the aphids are allowed to multiply unchecked. Because an outbreak is often preceded by several dry seasons, it has been speculated, but not scientifically proven, that such seasons hinder the development of fungal diseases.

Properly managed fields are more vigorous and far less susceptible to injury from this pest. When populations of aphids reach 25 per head of grain or 100 foliar-feeding aphids per 30 cm (1 row foot), chemical control is warranted. For current control recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*




**Macrosiphum avenae* (Fabricius), Aphididae, HEMIPTERA

## DESCRIPTION

**Adult**—The adult moth has a wingspan of about 38.5 mm. The hind wings are white; the front wings are dark gray, mottled with lighter and darker splotched. Each forewing has a noticeable whitish spot near the extreme tip.

**Egg**—Minute, white eggs are laid in clusters and are covered with grayish, fuzzy scales from the body of the female moth. The eggs become very dark just before hatching.

**Larva**—The full-grown, green, brown, or black larva is about 30 to 40 mm long and has a dark head capsule usually marked with a pale, but distinct, inverted "Y." Along each side of its body is a longitudinal, black stripe, and along the middle of its back is a wider, yellowish-gray stripe with four black dots on each segment.

**Pupa**—The pupa, approximately 13 mm long, is originally reddish brown and darkens to black as it matures.

## BIOLOGY

**Distribution**—The fall armyworm is a continuous resident of the Gulf states, the tropics of North, Central, and South America, and some of the West Indies. Each year it migrates as far northward as Montana, Michigan, and New Hampshire, but usually attains significant populations only in the southeastern states.

**Host Plants**—Corn, sorghum, coastal Bermuda and other plants of the grass family are preferred foods. However, the fall armyworm may attack alfalfa, bean, peanut, potato, soybean, sweet potato, turnip, spinach, tomato, cabbage, cucumber, cotton, tobacco, all grain crops, and clover.

**Damage**—In the southern Plains states just east of the Rockies and in the deep South, fall armyworms occasionally damage mature stands of grain as well as early, fall-seeded grain crops. However, in North Carolina, damage is restricted to late summer and fall plantings of small grains. During severe infestations, foliage can be completely removed, so that replanting is sometimes necessary.

**Life History**—Fall armyworms overwinter in tropical areas in several life stages, but usually as pupae. Moths appear in North Carolina during late June. Under favorable temperature conditions, new moths may continue to appear until early November. Each female lays about 1,000 eggs in masses of 50 to several hundred. Two to ten days later, the small larvae emerge, feed gregariously on the

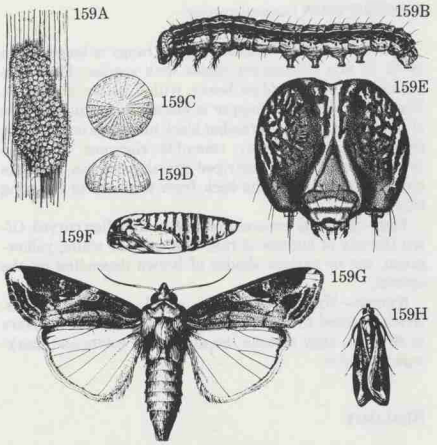



**Fig. 159 Fall armyworm. A, Egg mass. B, Egg (top). C, Egg (side). D, Larva. E, Larval head capsule. F, Pupa. G-H, Adults.**

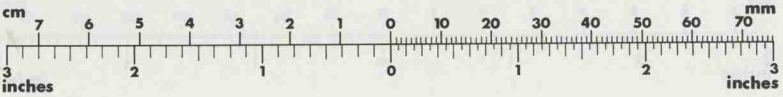
remains of the egg mass, and then scatter in search of food. Unlike nocturnal true armyworms, fall armyworms feed any time of the day or night, but are most active early in the morning or late in the evening. When abundant, these caterpillars eat all the food at hand and then crawl in great armies to adjoining fields. After feeding for 2 or 3 weeks, the larvae dig about 20 mm into the ground to pupate. Within 2 weeks, a new moth flight occurs. The moths usually fly several miles before laying eggs. Several generations occur each year in North Carolina.



## CONTROL

During favorable seasons, a number of parasitic enemies keep fall armyworm larvae down to moderate numbers. Cold, wet springs seem to reduce the effectiveness of these parasites and allow large fall armyworm populations to develop. Should an infestation occur late in the summer, delay fall planting as long as practical.

The fall armyworm is more difficult to control chemically than the true armyworm. For specific control information, consult the current *North Carolina Agricultural Chemicals Manual.*




**Svodoptera frugiperda* (J.E. Smith), Noctuidae, LEPIDOPTERA

## SMALL GRAINS
### Grasshoppers*

**DESCRIPTION** (several species)

**Adult**—Fully grown grasshoppers range in length from 19 to 38 mm. Coloration varies with species. Redlegged grasshoppers are reddish brown with a yellow underside. The differential grasshopper is basically brownish yellow or olive green with contrasting black markings on the hindlegs which distinctively resemble chevrons. Greenish yellow in color, the twostriped grasshopper has two pale stripes running down its back from the head to the wing tips.

**Egg**—Egg pods are oval to elongate and often curved. Often the size of kernels of rice, eggs may be white, yellow-green, tan or various shades of brown depending on the species.

**Nymph**—Nymphs resemble small, wingless adults. Newly hatched nymphs are white; however, after exposure to sunlight, they assume the distinctive colors and markings of adults.

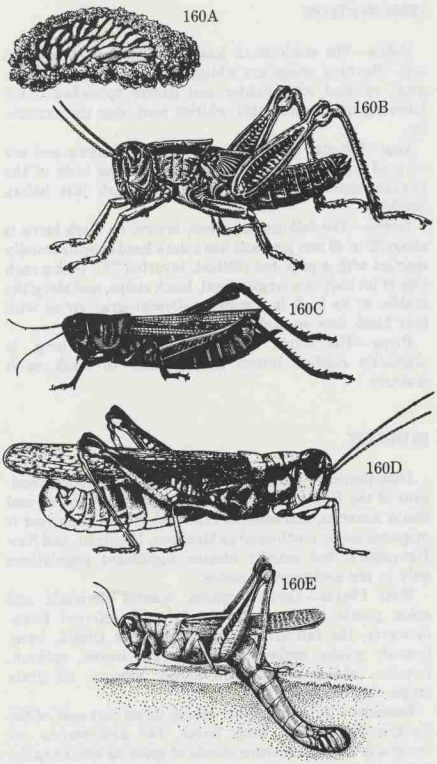



**Fig. 160 Grasshoppers. A-C, Differential grasshopper eggs, nymph, and adult. D, Redlegged grasshopper. E, Twostriped grasshopper laying eggs.**

**BIOLOGY**

**Distribution**—Grasshoppers occur throughout the continental United States. Extensive grasshopper damage to crops, however, is fairly restricted to subhumid, semiarid areas which receive 25.4 to 76.2 cm (about 10 to 30 inches) of rain annually. Such an area includes the states from Montana and Minnesota, southward into New Mexico and Texas. Although common in North Carolina, grasshoppers seldom pose a severe threat to crops in this state.

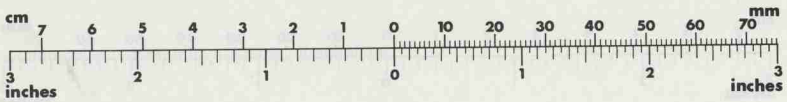


**Host Plants**—These three species of grasshoppers are general feeders which attack many kinds of plants. They are known to cause losses in small grains, corn, alfalfa, soybeans, cotton, clover, grasses, and tobacco.

**Damage**—Although approximately 600 species of grasshoppers occur in the United States, the 3 species covered in this note are the damaging species most likely to be found in North Carolina. Grasshoppers rarely damage the commercially valuable parts of crop plants. They occasionally cause injury to small grains by feeding on stems, causing heads of grain to be snipped off. The most common damage in North Carolina occurs to forages and around the margins of corn and tobacco fields.

**Life History**—Economically important grasshoppers overwinter as eggs in the soil. Eggs hatch throughout April, May and June as soil temperatures rise and spring rains begin. The first nymph to hatch out of the egg pod leaves a tunnel from the pod to the soil surface, making emergence easier for the nymphs which follow. Nymphs feed and grow for 35 to 50 days, molting five or six times during this period. Development proceeds most rapidly when the weather is warm and not too wet.

Two weeks after mating, females begin to deposit clusters of eggs in the soil. During the process, a glue-like secretion cements soil particles around the egg mass forming a protective "pod." Each pod may contain 15 to 150 eggs depending on the species of grasshopper which laid them.




*Differential grasshopper, *Melanoplus differentialis* (Thomas); Twostriped grasshopper, *Melanoplus bivittatus* (Say); Redlegged grasshopper, *Melanoplus femurrubrum* (De Geer), Acrididae, ORTHOPTERA

Under optimum conditions, each female produces 300 eggs. Generally, agriculturally important grasshoppers produce only one generation per year. Redlegged grasshoppers, however, have two generations per year plus a partial third in Florida.

## CONTROL

Several cultural practices help prevent the buildup of high grasshopper populations. Spring or fall tillage destroys many overwintering eggs either by burying them deeply or by exposing them to the sun and air to dry. Where practical, fall plowing has the added advantage of making soil unsuitable to further egg-laying. In North Carolina, grasshopper populations in small grains are seldom large enough to warrant chemical control. When such populations occasionally occur, consult current North Carolina State Agricultural Extension Service recommendations.

## SMALL GRAINS
### Greenbug*

### DESCRIPTION

**Adult**—There are four types of greenbug adults: winged and wingless females which bear live progeny, winged egg-laying females, and winged males. Wingless females, the most commonly seen forms, are about 2 mm long and pale yellow to bluish green with a dark green stripe down the back. Winged females are about the same color but are slightly smaller. Males have wings and are very rarely seen.

**Egg**—The kidney-shaped eggs, about 0.8 mm long, are pale yellow when first deposited but turn black before hatching.

**Nymph**—The pale green nymphs are wingless and smaller than adults.

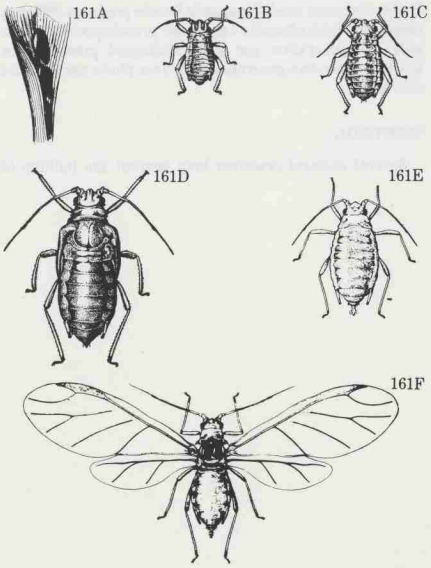



**Fig. 161 Greenbug. A, Eggs. B-D, Nymphs. E-F, Adults.**

### BIOLOGY

**Distribution**—Greenbugs are found throughout the United States and in most areas of the world. In this country, they are particularly damaging in the central states from Texas into North Dakota and Minnesota. Although greenbugs occur in North Carolina, damaging infestations are rare.

**Host Plants**—The greenbug is a particularly serious pest of wheat, barley, oats, and rye. Corn, sorghum, rice, forage grasses, Johnson grass, and western wheat grass may also be infested.

**Damage**—Greenbugs pierce plants with their needle-like mouthparts, secrete toxic substances which kill living tissue, and then extract the released juices. In the winter and early spring, this type of feeding produces "greenbug spots" which are usually circular areas of yellow plants in the field with brown, dead plants in the center. These spots grow as greenbugs feed and continue to move to new plants on the outer edges of the circle. Later in spring, heads of grain may be stunted as greenbugs feed inside the upper leaf sheath.

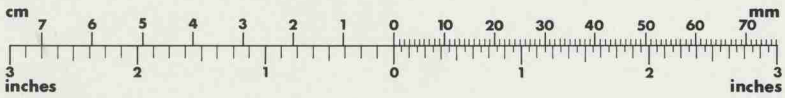
Greenbugs are likely to transmit virus diseases to crops at any time of the year. Occasionally, in the Plains states, fields may be invaded by swarms of migrating greenbugs. In this case, "greenbug spots" are not formed; all plants are killed at the same time. Light to moderate infestations may reduce yields significantly without destroying the whole field.

**Life History**—The greenbug is actually an aphid which causes some damage each year to small grains in the central and southeastern states. In the past century, 32 serious outbreaks have occurred. These outbreaks seem to have been favored by a cool, rainy summer followed by a mild winter and a cool, dry spring. There are now three different strains, or biotypes, of the greenbug in this country. Barley is the only small grain for which resistant commercial varieties have been developed.

The greenbug cannot survive winters in the northern states and Canada. Some adults overwinter in the central states; however, overwintering populations are highest in the southern states where wingless females survive and continue to reproduce throughout the winter. Of the four types of greenbug adults, wingless females are most common. When conditions are favorable they each produce three or four live progeny every day for about 25 days. Adult males, winged females, and eggs are rare, but occur sporadically in the North Central states. Most nymphs become wingless females in 6 to 30 days.

When adverse weather or poor nutritional conditions exist, winged adults develop and migrate to more favorable areas. As early as March or April, some winged female adults migrate northward in air currents to the central






*Schizaphis graminum* (Rondani), Aphididae, HEMIPTERA

states. When small grain in the central states matures in May, greenbugs will migrate further northward. In late summer and fall, greenbugs return south. Therefore states such as Texas experience greenbug infestations in early spring and again in late fall and winter. In such areas there may be 20 or more generations per year.

## CONTROL

In areas where the greenbug is a chronic problem, several cultural practices help reduce infestations. First of all, it is especially important in the southern states to destroy volunteer grain to prevent greenbug populations from growing rapidly and moving northward. Secondly, all practices which stimulate the growth of the plant such as fertilization, seedbed preparation, and use of certified, recommended varieties, help the crop resist greenbug injury. Last of all, avoid continuous planting of small grains. Rotate with legumes or corn, but avoid rotations with grain sorghum which is now susceptible to the greenbug.

Early in spring, when crop plants are small and few natural enemies are present, greenbugs may require chemical control. In North Carolina, 25 aphids per head of grain or 100 foliar or 100 foliar-feeding aphids per 30 cm (1 row foot) are recognized as economic thresholds. Later in the season, natural enemies are usually abundant enough to control infestations without the use of insecticides.

For specific control information, consult the current *North Carolina Agricultural Chemicals Manual.*

## SMALL GRAINS
### Hessian Fly*

### DESCRIPTION

**Adult**—The adult Hessian fly is a small, dark, long-legged, two-winged insect which resembles a mosquito. The female fly, about 4 mm long, has a distinct reddish tinge. The brown or black male is 2.5 to 3.5 mm long and bears two pairs of abdominal claspers.

**Egg**—The thin, cylindrical egg is 0.4 to 0.5 mm long. Although uniformly glossy red when laid, it gradually becomes deeper red at one end and opaque white at the other.

**Larva**—The newly hatched maggot is red for 4 or 5 days after which it turns white. As the larva matures, a translucent green stripe appears down the middle of its back. The full grown maggot is 3.5 to 5.5 mm long and about 1 mm wide.

**Pupa**—The brown-headed pupa is basically white with a reddish tinge. The puparium or "flaxseed" within which the pupa is found is spindle-shaped, red to dark brown, and 2.5 to 6.2 mm in length.

### BIOLOGY

**Distribution**—The Hessian fly was introduced into North America from Europe in the 1700s. In the United States, it can be found from Nebraska to the Atlantic, from Maine into the Piedmont areas of North Carolina, South Carolina, and Georgia, and in isolated areas west of the Rockies. In the past 20 years severe losses have been reported in Nebraska, Kansas, and Indiana.



**Host Plants**—Although wheat is the principle host plant, Hessian flies may also be found on rye, barley, and some wild grasses.

**Damage**—In the midwest, Hessian flies are one of the most destructive pests of wheat. The maggots burrow between the leaf sheath and the stem and extract juices from the plant. Fall-infested wheat usually dies during the winter. Spring-infested wheat produces grain but usually lodges before harvest. Economic infestations are uncommon in North Carolina largely due to proper planting date selection.

**Life History**—Typically, Hessian flies complete two generations per year, a spring brood and a fall brood, although as many as six generations a year have been reported. The pupae overwinter within puparia, the hardened skins of the last instar larvae. These puparia, known as the "flaxseed" stage, are located just below the surface near the crown of the plant. In spring (from March in Georgia and South Carolina to May in Michigan) the flies emerge from the flaxseed stage, deposit eggs on wheat, and

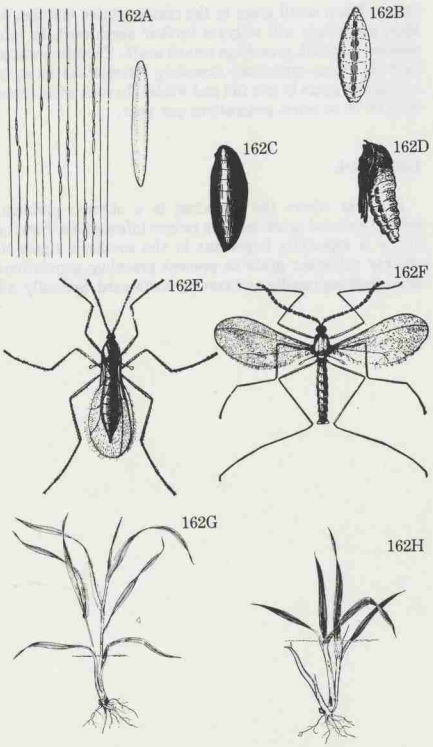
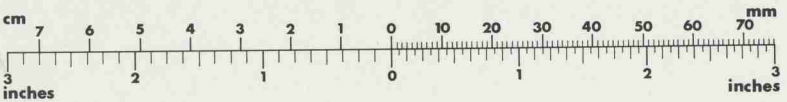



**Fig. 162 Hessian fly. A, Eggs. B, Larva. C, Puparium. D, Pupa. E, Adult female. F, Adult male. G, Normal wheat. H, Hessian fly infested wheat.**

die in 2 or 3 days. Maggots hatch from the eggs in 3 to 7 days, crawl down the leaves, and feed at the crown or joints along the stem. The maggots develop through three instars over a 25 to 30 day period, enter the flaxseed stage before harvest, and pass the summer in the stubble. In late August or September, second generation flies emerge and deposit eggs on volunteer wheat or early-sown winter wheat. Of the six or more Hessian fly races (biotypes)




* *Mayetiola destructor* (Say), Cecidomyiidas, DIPTERA

known to exist, two or more are likely to occur in any area where wheat is grown.

## CONTROL

The Hessian fly can be successfully managed with cultural and biological control methods. The state agricultural extension service will provide the names of wheat varieties resistant to the particular races of the Hessian fly which occur in any localized area as well as the "fly free" date. Wheat planted after this date should escape infestation. Always plant high quality, certified seed.

In areas of annual infestation, it may be beneficial to rotate crops so that wheat is not grown on the same land two years in succession. This practice reduces Hessian fly populations as well as those of other insects attacking small grain crops. For further control information, consult the current *North Carolina Agricultural Chemicals Manual.*

## SMALL GRAINS
## References


### GENERAL

Dahms, R.G. 1967. Insects attacking wheats, pp. 411-43. *In* Wheat and wheat improvement, ed. K.S. Quisenberry and L.P. Reitz. Amer. Soc. Agron., Madison, Wis. 560 pp.

Daniels, N.E., H.L. Chada, D. Ashdown, and E.A. Cleveland. 1956. Greenbugs and some other pests of small grains. Texas Agr. Exp. Sta. Bull. 845. 14 pp.

Painter, R.H., H. Bryson, and D.A. Wilbur. 1954. Insects and mites that attack wheat in Kansas. Kansas Agr. Exp. Sta. Bull. 367. 47 pp.

U.S., Department of Agriculture. 1961. The armyworm and fall armyworm: how to control them. Leafl. 494. 8 pp.

Walkden, H.H. 1950. Cutworms, armyworms, and related species attacking cereal and forage crops in the central plains. U.S. Dep. Agr. Circ. 849. 52 pp.

Wilson, H.K. 1955. Grain crops. McGraw-Hill Book Co., New York. 396 pp.

### ARMYWORM

Walton, W.R. and C.M. Packard. 1951. The armyworm and its control. U.S. Dep. Agr. Farmers' Bull. 1850. 10 pp.

### CEREAL LEAF BEETLE

Casagrande, R.A. and D.L. Haynes. 1976. The impact of pubescent wheat on the population dynamics of the cereal leaf beetle. Environmental Entomol. 5: 153-9.

Casagrande, R.A., W.G. Ruesink, and D.L. Haynes. 1977. The behavior and survival of adult cereal leaf beetles. Ann. Entomol. Soc. Amer. 70: 19-30.

Castro, T.R., R.F. Ruppel, and M.S. Gomulinski. 1965. Natural history of the cereal leaf beetle in Michigan. Michigan State Univ. Agr. Exp. Sta. Quart. Bull. 47: 623-53.

Janes, R.L. and R.F. Ruppel. 1964. Cereal leaf beetle control. Michigan State Univ. Agr. Ext. Bull. 443. 4 pp.

Ruppel, R.F. and M.S. Gomulinski. 1968. Insecticide foliage sprays for cereal leaf beetle control. Michigan State Univ. Agr. Exp. Sta. Quart. Bull. 50: 431-9.

U.S., Department of Agriculture. 1974. Watch for the cereal leaf beetle. Pub. PA-550. 4 pp.

Wellso, S.G. 1976. Cereal leaf beetle: feeding and oviposition on winter wheat and spring oats. Environmental Entomol. 5: 487-91.

Wilson, M.C., R.F. Ruppel, and R.E. Treece. 1965. Low volume concentrate sprays applied by aircraft for control of the cereal leaf beetle. J. Econ. Entomol. 58: 11-14.

### CHINCH BUG

Gould, G.E. 1965. Chinch bug control and new insecticides. Proc. Indiana Acad. Sci. 75: 130-6.

Horton, J.R. and A.F. Satterthwait. 1922. The chinch bug and its control. U.S. Dep. Agr. Farmers' Bull. 1223. 35 pp.

Leonard, D.E. 1966. Biosystematics of the "*Leucopterus* complex" of the genus *Blissus* (Heteroptera: Lygaeidae). Connecticut Agr. Exp. Sta. Bull. 677. 47 pp.

Snelling, R.O. and R.G. Dahms. 1937. Resistant varieties of sorghum and corn in relation to chinch bug control in Oklahoma. Oklahoma Agr. Exp. Sta. Bull. 232. 22 pp.

U.S., Department of Agriculture. 1958. Chinch bugs—how to control them. Leafl. 364. 8 pp.

### CORN LEAF APHID

Cartier, J.J. 1957. On the biology of the corn leaf aphid. J. Econ. Entomol. 50: 110-2.

Pathak, M.D. and R.H. Painter. 1958. Effect of the feeding of the four biotypes of corn leaf aphid, *Rhopalosiphum maidis* (Fitch) on susceptible White Martin sorghum and Spartin barley plants. Kansas Entomol. Soc. J. 31: 93-100.

Wildermuth, V.L. and E.V. Walter. 1932. Biology and control of the corn leaf aphid with special reference to the southwestern states. U.S. Dep. Agr. Tech. Bull. 306. 22 pp.

### ENGLISH GRAIN APHID

Pergande, T. 1904. On some of the aphids affecting grains and grasses of the United States, pp. 5-21. *In* Some miscellaneous results of the work of the division of entomology VII. U.S. Dep. Agr. Div. of Entomol. Bull. 44. 99 pp.

Phillips, W.J. 1916. *Macrosiphum granarium,* the English grain aphis. J. Agr. Res. 7: 463-80.

### FALL ARMYWORM

Bass, M.H. 1978. Fall armyworm: evaluation of insecticides for control. Alabama (Auburn Univ.) Agr. Exp. Sta. Leafl. 93. 7 pp.

Luginbill, P. 1928. The fall armyworm. U.S. Dep. Agr. Tech. Bull. 34. 92 pp.

GRASSHOPPERS

Parker, J.R. and R.V. Connin. 1964. Grasshoppers: their habits and damage. U.S. Dep. Agr., Agr. Information Bull. 287. 28 pp.

U.S., Department of Agriculture. 1977. Grasshopper control. Farmers' Bull. 2193. 10 pp.

GREENBUG

Chada, H.L., I.M. Atkins, J.H. Gardenhire, and D.E. Weibel. 1961. Greenbug-resistance studies with small grains. Texas Agr. Exp. Sta. Bull. B-982. 18 pp.

Dahms, R.G., T.H. Johnston, A.M. Schlehuber, and E.A. Wood, Jr. 1955. Reaction of small-grain varieties and hybrids to greenbug attack. Oklahoma Agr. Exp. Sta. Tech. Bull. T-55. 61 pp.

Schaefer, C.A., G.L. Teetes, and E.E. Lathan. 1975. Insecticide resistance in the greenbug in wheat. Texas Agr. Exp. Sta. Coll. Sta. Progress Rep. 3342. 2 pp.

Starks, K.J. and R.L. Burton. 1977. Preventing greenbug outbreaks. U.S. Dep. Agr. Leafl. 309. 11 pp.

Teetes, G.L., E.G. Lopez, and C.A. Schaefer. 1975. Seasonal abundance of the greenbug and its natural enemies in grain sorghum in the Texas high plains. Texas Agr. Exp. Sta. Bull. B-1162. 4 pp.

HESSIAN FLY

Cartwright, W.B. and E.T. Jones. 1953. The Hessian fly and how losses from it can be avoided. U.S. Dep. Agr. Farmers' Bull. 1627. 9 pp.

Gallun, R.L. 1965. The Hessian fly—how to control it. U.S. Dep. Agr. Leafl. 533. 7 pp.

Gallun, R.L. 1975. Genetic resistance to insects in wheat. Nebraska Agr. Exp. Sta. Misc. Pub. 32: 461-70.

Gallun, R.L. and L.P. Reitz. 1971. Wheat cultivars resistant to races of Hessian fly. U.S. Dep. Agr., Agr. Res. Service Production Res. Rep. 134. 16 pp.

Graves, C.R. 1964. Hessian fly resistant wheats for forage and grain production. Tennessee Farm and Home Sci. Progress Rep. 52: 12-4.

Haseman, L. 1941. The Hessian fly. Missouri Agr. Exp. Sta. Circ. 212. 4 pp.

Horton, J.R., E.T. Jones, H.H. Walkden, and G.A. Dean. 1945. Wheat-seeding dates and the Hessian fly in Kansas. Kansas Agr. Exp. Sta. Tech. Bull. 59. 18 pp.

McColloch, J.W. 1923. The Hessian fly in Kansas. Kansas Agr. Exp. Sta. Tech. Bull. 11. 96 pp.

Morrill, W.L. and L.R. Nelson. 1976. Hessian fly control with carbofuran. J. Econ. Entomol. 69: 123-4.

Parkard, C.M. 1928. The Hessian fly in California. U.S. Dep. Agr. Tech. Bull. 81. 26 pp.

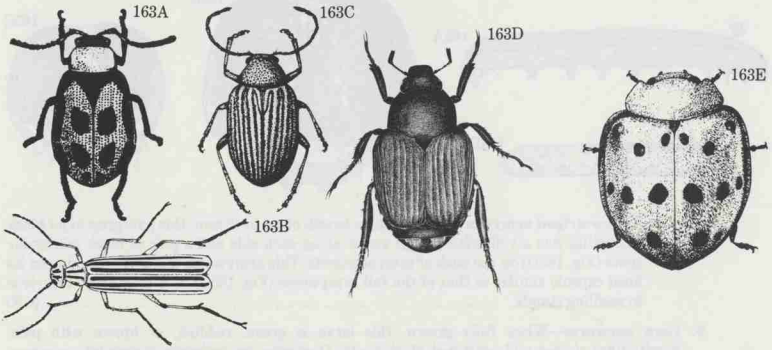
# PESTS OF SOYBEANS

Concentrated in the Coastal Plain and southern Piedmont counties, soybeans were planted in 1980 on 803,644 hectares (1,985,000 acres) of North Carolina farm land. Due to the length of the growing season and the nature of the crop, soybeans have as many insect pests associated with them as any other major crop produced in this country. Insect damage, however, tends to be more of a problem in the southern states due to the longer growing season. Regardless of geographic location, insect infestations in soybeans rarely become economically important until after full bloom.

## Key to Soybean Insect Pests

A. Insects that feed primarily on the foliage

1. **Beetles**—These chewing insects have hard, shell-like forewings (wing covers or elytra) which meet in a straight line down the middle of the back when the beetles are not in flight (Fig. 163A to E).






a. **Bean leaf beetle**—This oval, red to brown and black beetle (Fig. 163A), 5 to 6 mm in length, feeds on the youngest tissue available. It usually, but not always, has three black spots on each wing cover. However, this beetle always has a black head as well as a black, triangular area on the forward margin of its wings. .....p. 149

b. **Blister beetles**—These 12- to 19-mm-long, elongate beetles (Fig. 163B) may be black, gray with black spots, or black and yellow striped. Most species feed heavily on foliage along field margins while some prefer the flowers. .....p. 152

c. **Grape colaspis**—This oval, yellowish-brown beetle is 4 to 5 mm long (Fig. 163C). Its wing covers appear slightly striped. The grape colaspis feeds on foliage, but rarely causes any significant damage. .....p. 155

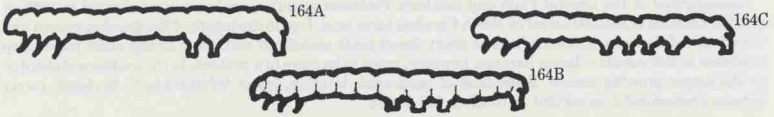
d. **Japanese beetle**—This oval, metallic green and copper colored beetle (Fig. 163D) is about 13 mm long. Many of these beetles typically congregate together and feed on soybean foliage in June or July. .....p. 157

e. **Mexican bean beetle**—This yellow to copper colored beetle (Fig. 163E) is 6.0 to 8.5 mm long and has eight black spots on each wing cover. It feeds on the undersurface of leaves between the veins, leaving a lacy network which eventually turns brown. .....p. 159

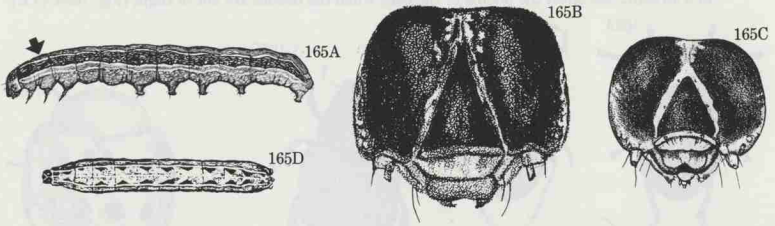
2. **Caterpillars**—These soft-bodied, moth larvae have three pairs of legs near the head and three, four, or five pairs of prolegs (Fig. 164A to C).


*See also "Key to Caterpillars" on page 16.

a. **Armyworms**—These smooth-bodied, variously colored caterpillars have five pairs of prolegs (Fig. 164C), and are occasionally problem foliage pests.




i. **Beet armyworm**—This dark-headed (Fig. 165B), green to black larva sometimes has three longitudinal, light stripes and usually attains a length of about 25 to 30 mm. A small, black spot occurs on each side of the second segment behind the head (Fig. 165A). Leaves often are skeletonized by large larvae and webbed together by young larvae .p. 150




ii. **Yellowstriped armyworm**—Reaching a length of up to 45 mm, this pale gray to jet black caterpillar has a yellowish-orange stripe along each side and a pair of black triangular spots (Fig. 165D) on the back of most segments. This armyworm has a "Y" marking on its head capsule similar to that of the fall armyworm (Fig. 165C). It is primarily injurious to seedling stands. .....p. 90

b. **Corn earworm**—When fully grown, this larva is green, reddish, or brown with pale, longitudinal stripes and scattered black spots. Occurring on soybeans during late summer, early instars are cream-colored or yellowish green with few markings. Larval instars vary from 1.5 to 44 mm in length and have five pairs of prolegs (Fig. 164C). The corn earworm defoliates and damages blooms and pods. .....p. 154

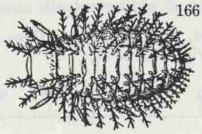


c. **Green cloverworm**—This pale green caterpillar, 1.5 to 30.5 mm in length, is distinguished from all other caterpillar pests of soybeans by the presence of four pairs of prolegs (Fig. 164B). .....p. 156

d. **Soybean looper**—After bloom, this light green caterpillar may cause severe defoliation. The looper has three pairs of prolegs (Fig. 164A), reaches a length of 35 mm, tapers from the rear forward, and walks with a "looping" motion. .....p. 160

e. **Velvetbean caterpillar**—This pale green to black caterpillar has a light stripe along both sides and five pairs of prolegs (Fig. 164C), the last pair resembling a forked tail. It wiggles rapidly when disturbed. Length varies from 2.5 to 48 mm. .....p. 165

3. **Mexican bean beetle larva**—About 8.5 mm long when fully grown, the bright yellow, spiny, soft-bodied larva (Fig. 166) feeds on the undersurface of leaves between veins. This feeding results in a lacy network which eventually turns brown. .....p. 159

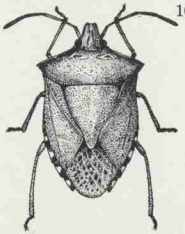



B. Insects that damage pods

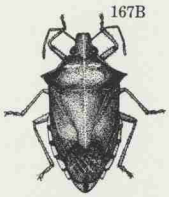
1. **Corn earworm**—See section A.2.b. for description. Unlike the fall armyworm, the corn earworm's head capsule is light brown to chestnut colored and does not have a distinct, inverted "Y." The corn earworm chews into pod tissue and removes the seeds. .....p. 154

2. **Stink bugs**—These shield-shaped bugs (Fig. 167A,B) pierce the pods with their mouthparts leaving sunken, discolored spots on the seed.

167A



167B

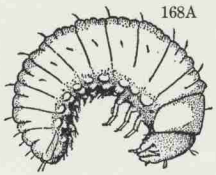


   a. **Brown stink bug**—This dull grayish-yellow bug is 12 to 15 mm long (Fig. 167A). This bug should not be confused with another closely related, brown species, the beneficial, spined soldier bug (Fig. 167B). This mistake can be avoided by strict attention to the shape of the bug. ..... p. 162

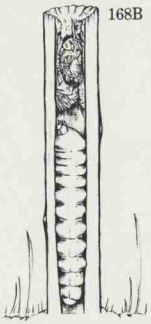
   b. **Green and Southern green stink bugs**—Ranging from 14 to 19 mm long, these two green species are difficult to distinguish from each other in the field. .....p. 162

C. Insects that damage stems or roots (Fig. 168A to C).

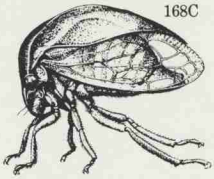
168A



168B



168C

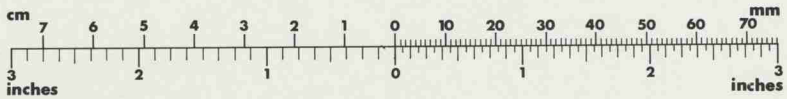


1. **Grape colaspis larva**—This stout, grub-like larva has a dark brown head and a grayish-white or tan body up to 7 mm long (Fig. 168A). It has three pairs of legs near its head and fleshy appendages on its abdomen. Areas of yellow, stunted plants sometimes indicate root damage by this pest. p. 155

2. **Soybean stem borer**—This white, legless larva (Fig. 168B) ranges in length from 1.5 to 15 mm. It bores in the pith of the soybean stem, girdling it from the inside and sometimes causing the plant to lodge at harvesting. .....p. 161

3. **Threecornered alfalfa hopper**—This green wedge-shaped bug (Fig. 168C) is 6.0 to 6.5 mm in length when mature. It girdles the stem by puncturing it with its "beak" to suck sap and by ovipositing within plant tissues. Stems may lodge or break easily before mature. .....p. 164





## SOYBEANS INSECT NOTES

### DESCRIPTION

**Adult**—Though the adult varies greatly in color and markings, it is typically reddish brown to yellowish with black margins and about 5 to 6 mm long. Each wing cover usually, but not always, is marked with three black spots. All bean leaf beetles, however, have a black, triangular-shaped spot on the foreward margin of the wings.

**Egg**—The lemon-shaped egg is orange and about 0.85 mm long.

**Larva**—The larva is basically whitish with both ends colored dark brown. Conspicuously segmented, it has six tiny legs near the head. It grows to a length of about 10 mm.

**Pupa**—The pupa is soft-bodied, white, and about 5 mm long.

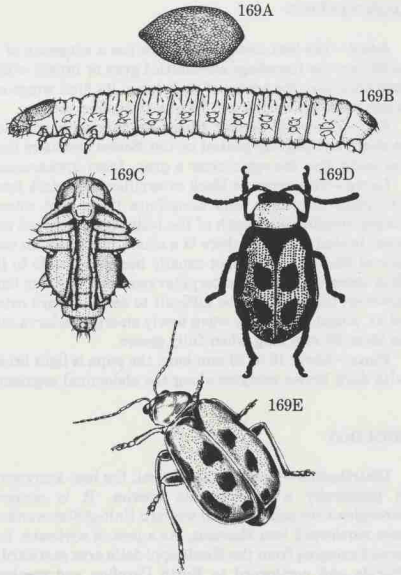



**Fig. 169 Bean leaf beetle. A, Egg. B, Larva. C, Pupa. D-E, Adults.**

### BIOLOGY

**Distribution**—The bean leaf beetle is abundant in the southeastern states particularly in the coastal counties. Its range, however, extends into Canada, New York, Minnesota, Kansas, Texas, and New Mexico. The insect appears to prefer poorly drained clay and organic soils.

**Host Plants**—Hosts of the bean leaf beetle include bean, clover, corn, cowpea, soybean, peanut, and several leguminous weeds.

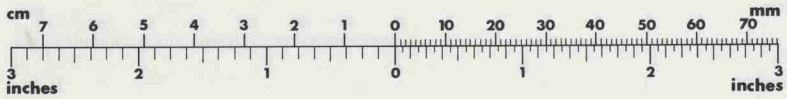
**Damage**—Damage to soybeans appears to be due primarily to the foliar-feeding adults. Bean leaf beetles prefer the youngest plant tissue available; when vegetative growth terminates, they will consume tender pod tissue. Pod damage is usually limited to the outer layers of the pod, the developing seeds being infrequently attacked. In North Carolina, damage is usually greatest in the eastern coastal counties from July through September though some seedling damage may occur on early planted soybeans. In addition to the beetles' direct attack, the adults are also known vectors of the bean pod mottle, cowpea mosaic, and southern bean mosaic viruses.

**Life History**—Adults overwinter in leaf litter or other vegetation, primarily in wooded areas. They become active in April and move to the earliest host plants available. In the southeastern United States, beetles do not usually attack soybeans until early May. They feed voraciously for several days and then mate. Each female lays 175 to 250 eggs in clusters of 12 to 24 in the soil at the plant's base. Eggs hatch in 1 to 3 weeks, depending upon the temperature. The larvae find their way to the base of the stem or roots and feed there for 3 to 6 weeks. Mature larvae form earthern cells within which the pupae form. In southern states, peak periods of adult activity generally occur the last of May, the last of July, the second and third weeks in August, and the second and third weeks of September. Second generation beetles overwinter in North Carolina.



### CONTROL

When defoliation reaches the economic threshold (35 percent foliage loss before bloom or 15 percent foliage loss after bloom), consult the current *North Carolina Agricultural Chemicals Manual.*




* *Cerotoma trifurcata* (Forster), Chrysomelidae, COLEOPTERA

## SOYBEANS
### Beet Armyworm*

### DESCRIPTION

**Adult**—The beet armyworm moth has a wingspan of 25 to 32 mm. Its forewings are mottled gray or brown with a pale spot near the center of each wing. Its hind wings are white with dark veins and have a fringelike border.

**Egg**—The white to pink, ribbed egg is roughly spherical in shape and slightly peaked on top. Scales and hairs from the moth give the egg cluster a gray, fuzzy appearance.

**Larva**—This green or black caterpillar has a dark head, five pairs of prolegs, and sometimes three light colored stripes running the length of the body. On the second segment behind the head, there is a small, black spot on each side of the body. This spot usually becomes visible to the field observer when the caterpillar reaches 7 or 8 mm long; however, the spot may be difficult to see on a dark caterpillar. About 1 mm long when newly emerged, a larva may be 25 to 30 mm long when fully grown.

**Pupa**—About 15 to 20 mm long, the pupa is light brown with dark brown margins along the abdominal segments.

### BIOLOGY

**Distribution**—Native to the Orient, the beet armyworm is practically a cosmopolitan species. It is common throughout the southern and western United States and occurs northward into Montana. As a pest of soybeans, it is most damaging from the Mississippi delta area eastward to Florida and northward to North Carolina and southern Virginia. This insect is a sporadic pest of North Carolina soybeans in both time and space.



**Host Plants**—The beet armyworm infests many weeds, trees, grasses, legumes, truck crops and field crops. It is of economic concern upon cotton, corn, soybean, tobacco, alfalfa, table and sugar beets, pepper, tomato, potato, onion, pea, sunflower and citrus. In addition, plantain, lambsquarters and redroot pigweed are attractive wild hosts.

**Damage**—Early instar beet armyworms most frequently damage the young terminal growth of seedling soybeans. Skeletonization and, often, a profuse silk webbing which gives the plants a shiny appearance are characteristic of this species. Although soybean plants can compensate for much foliage loss before bloom, severe beet armyworm damage will retard plant growth. Later instars do not feed gregariously and the production of webbing is discontinued.

**Life History**—In warm areas, such as Florida and California, the beet armyworm moths may be found year round. In less tropical areas, these insects can survive the winter as pupae in the upper 6 cm of the soil. The extent of the overwintering distribution, however, has not been adequately studied. At any rate, this insect is not believed to overwinter as far north as Kentucky or North Carolina. Most states apparently become infested by migrating moths. In the spring, soon after mating, fertilized females begin laying eggs in clusters of about 80. Approximately 600 eggs per female are deposited over a 3 to 7 day period. Moths die 4 to 10 days after emerging from pupae.

Eggs hatch in 2 to 3 days. The newly emerged larvae spin loose webs around themselves, feed gregariously on the remains of the egg mass, and then attack plant foliage. They eventually scatter to different parts of the plant. After feeding for 1 to 3 weeks, larvae (fifth instars) pupate within loose cocoons composed of soil particles, leaf fragments and trash. About 1 week later moths emerge. The entire life cycle requires 4 to 5 weeks. Several generations occur each year.

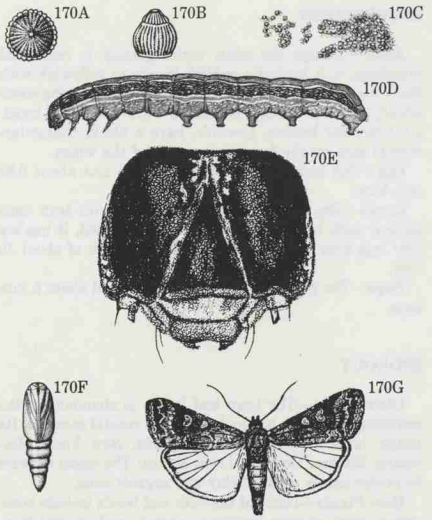
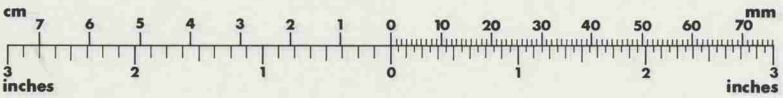



**Fig. 170 Beet armyworm. A, Egg (top). B, Egg (side). C, Egg mass. D, Larva. E, Larval head capsule. F, Pupa. G, Adult.**




* *Spodoptera exigua* (Hubner), Noctuidae, LEPIDOPTERA

## CONTROL

The beet armyworm has few effective parasites, diseases, or predators to lower its population and is resistant to some insecticides. Therefore selection of the proper material and rate is very important when chemical control is considered. When defoliation reaches the economic threshold of 35 percent foliage loss before bloom or 15 percent foliage loss after bloom, consult the current *North Carolina Agricultural Chemicals Manual.*

## SOYBEANS
### Blister Beetle*

**DESCRIPTION** (several species)

**Adult**—Blister beetles are slender insects 12 to 19 mm long. They have prominent heads and may be black, gray with black spots, or black and yellow striped.

**Egg**—The yellow, cylindrical eggs are 1.3 to 1.8 mm long.

**Larva**—Each of the seven larval instars differs in size, shape and color. They can be 2.5 to 13 mm long, slender to plump, and white to yellow or brown. All instars have 3 short pairs of ventral legs and 12 body segments, excluding the head.

**Pupa**—The white, 10 mm-long pupae darken gradually beginning with the eyes.

**BIOLOGY**

**Distribution**—Blister beetles are found throughout the continental United States and the agricultural areas of Canada. Although fairly common in North Carolina, they are not often important pests.

**Host Plants**—Blister beetles have a wide host range. Some economically important agricultural hosts include alfalfa, sweet clover, soybean, potato, tomato, melon, cotton, and eggplant.

**Damage**—Although blister beetles seldom injure soybeans seriously, their presence in spot concentrations is often alarming. Some species of blister beetles feed on the flowers, but most species are strictly foliage feeders. This latter group feeds gregariously, occasionally ragging the foliage and stunting plant growth. Black stringy excrement is associated with severe defoliation. Fortunately, damaged areas rarely exceed 0.1 hectare (0.25 acre) in size and usually occur along field margins.



**Life History**—Blister beetles have an unusual life cycle. They usually overwinter as sixth instar larvae 2.5 to 4 cm deep in the soil. In the spring, resting larvae molt into active, non-feeding larvae which soon pupate. Adult blister beetles begin to emerge in June. Adults can be found well into September but are most abundant in July. During the summer months, they congregate and feed voraciously on foliage or flowers (depending upon the particular species). Two to three weeks after mating, each female deposits up to six egg masses in the soil. These masses may contain 50 to 300 eggs each. Active larvae hatch from the eggs 1½ to 3 weeks later and search for grasshopper egg cases. A few days after locating and feeding on the eggs, the active larvae molt and become fairly inactive. The grubs continue to feed and molt until they are fat, almost legless, fifth instars. These larvae create oval, hibernating chambers in the soil, molt into sixth instars, and overwinter. Development usually continues the following spring but the larvae may remain inactive for as long as 2 years. Sometimes the fifth instar larvae molt directly into the pupal stage, bypassing the last two larval instars. As a general rule, however, blister beetles complete one generation each year.

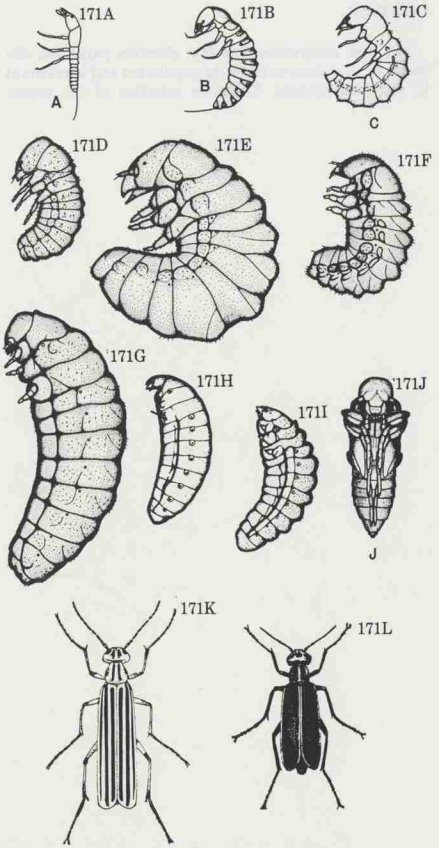
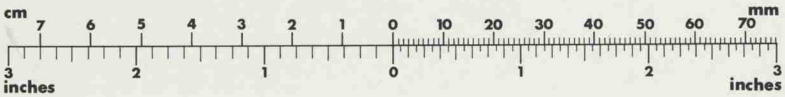



**Fig. 171** **Blister beetles. A-H, Larvae. I, Prepupa. J, Pupa. K, Threestriped blister beetle. L, Margined blister beetle.**




* *Epicauta* spp., Meliodae, COLEOPTERA

## CONTROL

Control of blister beetles in soybeans is seldom necessary. Only when foliage loss exceeds 35 percent prebloom or 15 percent postbloom are controls justified. Spot applications are usually adequate to divert loss. For control recommendations consult the current *North Carolina Agricultural Chemicals Manual.*

## SOYBEANS
### Corn Earworm*

### DESCRIPTION

**Adult**—The corn earworm moth has a wingspan of 25.5 to 38.5 mm and is usually light yellowish olive in color. Each forewing has a dark spot near the center. Eyes are usually light green.

**Egg**—The dome-shaped egg, about 0.5 mm in diameter, is pale white when first laid and develops a reddish brown band before hatching.

**Larva**—The five to six larval instars vary greatly in color. Newly hatched larvae are about 1.5 mm long and yellowish white with dark head capsules. Second instars are yellowish green and frequently have orange and brown longitudinal stripes; their head capsules are reddish brown or brown. Up to 44 mm long, later instars are greenish yellow, reddish or brown with pale, longitudinal stripes, raised black spots (chalazae), and brown to orange heads. All instars have five pairs of fleshy prolegs.

**Pupa**—About 31.4 mm long and 6 mm wide, the pupa is reddish brown to dark brown.

### BIOLOGY

**Distribution**—This insect is found throughout most of the Western Hemisphere. It is a major soybean pest in the southern United States and has been found as far north as Saskatchewan. It has recently been introduced into the Hawaiian Islands. The most severe damage in North Carolina annually occurs in the Coastal Plain area.

**Host Plants**—During late summer, soybeans become one of the corn earworm's primary host crops. In North Carolina, late planted soybeans of maturity group VI and beans of groups VII or VIII are most likely to be moderately or severely damaged by corn earworms. Early maturing beans and beans with closed canopies usually have fewer larvae per unit area. See the corn earworm note (CORN/SORGHUM section) for more details concerning hosts.



**Damage**—Young larvae feed on flowers and tender foliage. Soybean defoliation by corn earworms is a problem typically confined to some areas of the South and, occasionally, the East Coast. This injury normally occurs on late-maturing varieties prior to seed enlargement.

Later in the season, corn earworms prefer to feed on soybean pods, often causing a serious yield loss. During heavy infestations (20 or more large worms per meter of row, or six or more per foot of row), most pods may be destroyed, forcing the larvae to become foliage feeders. Entire 8-hectare fields (roughly 20 acres) have been stripped of pods and foliage during such heavy infestations.

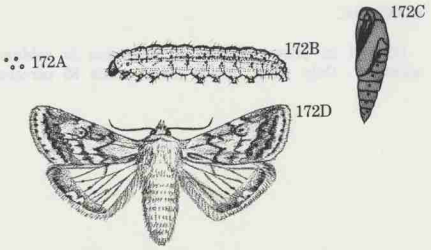
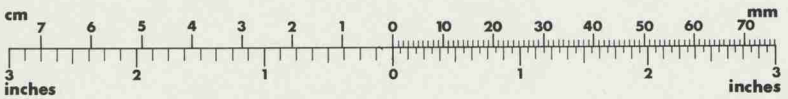



**Fig. 172 Corn earworm. A, Eggs. B, Larva. C, Pupa. D-E, Adults.**

**Life History**—Overwintering and spring development is the same as in the other crops which serve as hosts for this insect (see CORN/SORGHUM section). However, after most corn ears begin to dry (late July), the female earworm moths deposit their eggs on other crops. Soybean, sorghum, peanut and cotton are preferred host crops at this time of year. In soybean fields, earworm eggs are laid largely on tender terminal foliage and near the blooms. Young larvae feed on the developing leaves, flowers, and pods. As the larvae develop, they feed more heavily on the pods. During heavy infestations all pods may be removed, forcing the larvae to complete development on the leaves. Soybean fields which are blooming and have an open foliage canopy during years with heavy moth flights are most likely to have damaging infestations. Apparently, this situation occurs because both egg-laying and larval development are increased under these conditions.

### CONTROL

Not all soybean fields are heavily damaged by corn earworms. Therefore, scouting to determine the extent of the problem should be an integral part of earworm control in soybeans. In most southern states, insecticides are not applied until there are six or seven medium to large earworms per meter of row (two per foot of row). For specific information on insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Heliothis zea* (Boddie), Noctuidae, LEPIDOPTERA

## DESCRIPTION

**Adult**—The oval, yellowish-brown beetle is 4 to 5 mm long. The wing covers appear striped due to the presence of longitudinal rows of shallow indentations.

**Egg**—The smooth, white to yellow egg is about 0.6 by 0.25 mm.

**Larva**—Measuring up to 7 mm long, the grayish-white or tan larva has a dark brown head and prothoracic shield. It is stout and grub-like in form with three pairs of legs near its head and fleshy appendages on the abdominal segments.

**Pupa**—Whitish at first, the 4 mm-long pupa gradually darkens.

## BIOLOGY

**Distribution**—Fairly common in the eastern states, the grape colaspis occurs westward into Arizona and New Mexico and south into northern Alabama. Though prevalent in North Carolina, large populations most frequently occur in poorly drained, organic, or non-rotated fields.

**Host Plants**—The adult beetles are very general foliage feeders and, in most cases, the larvae feed on roots of the same plants. Soybeans and lespedeza seem to be preferred food plants of the adults. Other hosts (of both larvae and adults) include grape, snap bean, red and white clover, strawberry, corn, timothy, okra, beet, and the weeds dock and smartweed.

**Damage**—*Colaspis* beetles consume foliage but rarely do any appreciable damage. When large populations of larvae develop, however, damage much like that done by nematodes occurs. Larvae eat lateral roots and the soft outer tissues of underground stems. This injury becomes evident above ground as areas of yellow, stunted plants develop.

**Life History**—The grape colaspis overwinters in the soil as third through eighth instar larvae. In spring, feeding and development resume. Most larvae pupate within 3 cm (1.5 inches) of the soil surface for a period of 3 to 7 days in June. By late June, most adults have emerged. The beetles mate several times and feed on legumes for 3 to 5 days before eggs are laid. Each female deposits approximately 75 eggs, usually in masses of about 36, near the roots of food plants. In North Carolina, only one generation is completed each year.

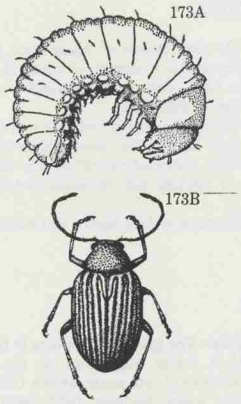
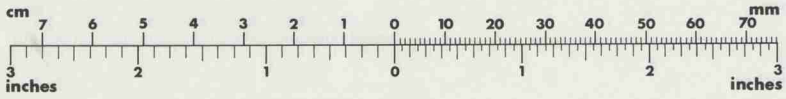



**Fig. 173 Grape colaspis. A, Larva. B, Adult.**

## CONTROL

The grape colaspis is common in North Carolina soybean fields but rarely requires control. Since this pest thrives best on legumes, low populations can be maintained by rotating soybeans with crops like corn. Even though corn is a host plant of the colaspis, it is not a preferred host and, therefore, can still be beneficial in a rotation with soybeans.






* *Colaspis brunnea* (Fabricius), Chrysomelidae, COLEOPTERA

## SOYBEANS
### Green Cloverworm*

### DESCRIPTION

**Adult**—The dark brown or black moth has spotted or mottled wings and a wingspan of about 31.5 mm.

**Egg**—The light green egg is hemispherical, measuring about 0.5 mm in diameter.

**Larva**—Varying in length from 1.5 mm (first instar) to 30.5 mm (sixth instar), the larva is pale green and often with two white, longitudinal stripes on each side. It has four pairs of prolegs and thrashes violently when disturbed.

**Pupa**—The pupa is dark brown and about 13 mm long.

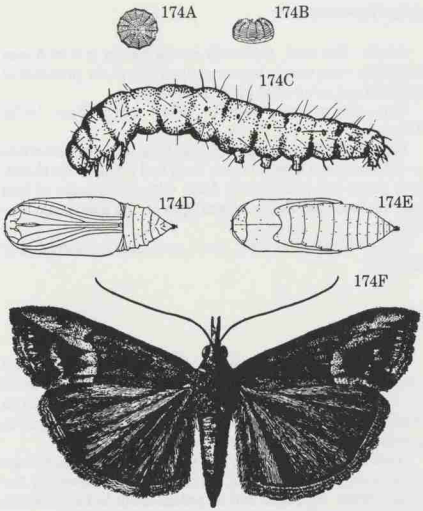



**Fig. 174 Green cloverworm. A-B, Eggs. C, Larva. D-E, Pupae. F, Adult.**

### BIOLOGY

**Distribution**—The green cloverworm is found from the eastern United States westward into the Great Plains states and northward into southeastern Canada. It occurs in practically every soybean field from Illinois and Maryland south at sometime during each growing season.

**Host Plants**—The green cloverworm attacks alfalfa, bean, clover, cowpea, soybean, strawberry, vetch, many common weeds, and other legumes.

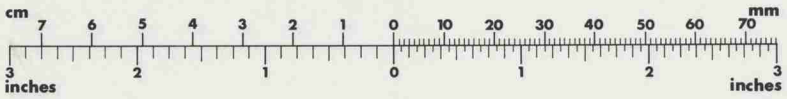
**Damage**—Although common throughout the soybean-growing areas of the eastern United States, the green cloverworm seldom reaches pest status. This caterpillar may defoliate soybean plants and, in some cases, warrants chemical control. Because it attacks early in the season, however, plants usually compensate for foliage loss before pods are set. Many entomologists consider the green cloverworm a valuable food source for beneficial insects and diseases. This reservoir of beneficials often controls pests of more economic importance later in the season.



**Life History**—Green cloverworms overwinter either as pupae or adults. In spring, moths become active about the time clover becomes abundant. After mating, the females lay their eggs singly on the underside of the host plant's leaves. Eggs usually hatch in less than a week. After feeding for about 4 weeks, larvae drop to the ground, burrow into litter or soil, and pupate. The pupal stage lasts about 10 days. Three to four generations per year occur in North Carolina. Larvae appear on soybeans during early July, peak in mid-August, and decline by late September.

### CONTROL

Beneficial insects and diseases usually regulate the green cloverworm population below economic injury levels in most areas where soybeans are grown. When defoliation exceeds the economic threshold (35 percent foliage loss before bloom and 15 percent foliage loss after bloom or during pod fill), chemical control is recommended. For specific control information, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Plathypena scabra* (Fabricius), Noctuidae, LEPIDOPTERA

## DESCRIPTION

**Adult**—Approximately 13 mm long, the Japanese beetle has a metallic green body and coppery wing covers. There are 12 tufts of white hairs bordering the margin of the wing covers.

**Egg**—Each white, translucent egg is almost spherical in shape and approximately 2 mm in diameter.

**Larva**—The white, C-shaped grub has a dark brown head capsule and three pairs of legs. Although it is only 2 mm long when it first hatches, the grub may reach a final length of 32 mm. A V-shaped arrangement of setae on its anal segment distinguishes Japanese beetle grubs from similar species.

**Pupa**—The 13 mm-long, cream to tan colored pupa resembles the adult in appearance except that the appendages are pressed close to the body. It becomes metallic green just before the adult emerges.

## BIOLOGY

**Distribution**—Since 1916, the Japanese beetle has become established from southern New Hampshire and Vermont southward into North Carolina and westward into Ohio and West Virginia. Scattered local populations have been reported in Indiana, Illinois, Tennessee, Kentucky, Michigan, Iowa, Missouri, California, South Carolina, Georgia, Maine, Ontario, and Nova Scotia. Although seldom economically important on soybeans, this beetle has caused severe defoliation in Maryland, Indiana and Illinois.

**Host Plants**—The list of Japanese beetle host plants is seemingly endless. Commonly attacked hosts include: cultivated and wild grapes, raspberry, peach, plum, rose, apple, cherry, corn, soybean, Virginia creeper, hibiscus, marshmallow and Indian mallow, hollyhock, dahlia, zinnia, elm, horsechestnut, linden, lombardy poplar, willow, bracken and sensitive fern, elder, evening primrose, sassafras, and smartweed.

**Damage**—Japanese beetles are voracious foliage and fruit feeders. Feeding in June and July causes little injury to soybeans because the plants can compensate for 35 percent or greater foliage loss. Foliage loss greater than 35 percent may occur in spots 0.4 hectares (1 acre) or less in size. Damaged foliage is characteristically ragged, with only the larger leaf veins intact. Stringy, black excrement is also present.

Japanese beetle injury poses a threat from mid-July until August. After this period, the population naturally declines. The beetles have so many host plants that they rarely confine themselves to soybeans.

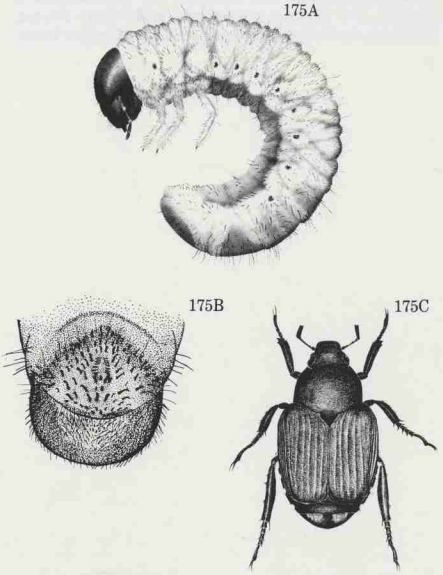
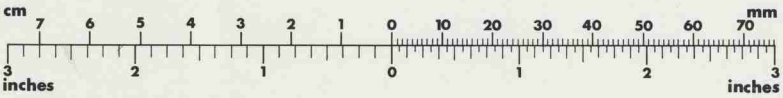



**Fig. 175 Japanese beetle. A, Larva. B, Larval setal pattern. C, Adult.**



**Life History**—Japanese beetle grubs overwinter as third instars within 13 cm of the soil surface. As the soil warms in the spring, the grubs move closer to the surface and feed on fine rootlets. Shortly thereafter, they remain inactive for a 10-day period prior to pupation. After a pupal stage of 8 to 20 days, adults emerge. Emergence usually begins in mid-May in North Carolina and as late as July in Maine. On warm days the beetles fly and often congregate on host plants to feed and mate. In the afternoon, females burrow into loose, moist soil (usually in sod), and deposit one to four eggs. Over her 1.0 to 1.5 month life span, each female produces 40 to 60 eggs. Grubs emerge 2 weeks after egg deposition, feed on rootlets, and remain active until cold weather arrives. In North Carolina, a single generation is produced annually.




* *Popillia japonica* Newman, Scarabaeidae, COLEOPTERA

## CONTROL

Populations of this pest are cyclic. Dry weather, natural enemies, and diseases, particularly milky spore disease, help keep populations below economically damaging levels.

Should defoliation of 35 percent prior to bloom or 15 percent during bloom (or pod fill) occur, control is warranted. Spot applications are usually adequate to divert loss. For further control information, consult the current *North Carolina Agricultural Chemicals Manual.*

## DESCRIPTION

**Adult**—The dome-shaped, copper colored adult varies from 6 to 8.5 mm long. Each wing cover has eight small, black spots that form three rows across the body when the wings are at rest.

**Egg**—The yellow egg is about 1.3 mm long and elliptical in shape.

**Larva**—The yellow larva is about 8.5 mm long and covered with dark, branched spines.

**Pupa**—The yellow or copper colored pupa is about 6 mm long. It moves very little, has fewer spines than the larva, and is most commonly found on the lower half of the soybean plant.

## BIOLOGY

**Distribution**—A native of Mexico, the Mexican bean beetle is now present throughout the United States except in the Pacific Coast states. Damage to soybeans has been most prevalent along the East Coast from Maryland south to Georgia, in southern Indiana, and in some parts of Kentucky. In North Carolina, the Mexican bean beetle occurs on soybeans throughout the growing season.

**Host Plants**—The Mexican bean beetle feeds readily on many varieties of beans (bush, soybean, lima and pole) but may also infest other plants such as alfalfa, clover, cowpea, and kudzu.

**Damage**—On soybeans, larvae and adults feed between the veins on the surface of leaves, leaving a lacy network of the tougher leaf tissues. These remaining tissues die in about 2 days and turn brown. Fields seriously damaged by this beetle often have a brown or "burnt" cast.

**Life History**—Mexican bean beetles overwinter as both mated and unmated adults under litter and other rubbish in hedgerows, ditch banks, and woods. Emergence usually begins in March and increases until April or mid-May in most southeastern and mid-Atlantic states. After a feeding period of 7 to 10 days, females begin to lay groups of 40 to 60 eggs on the underside of leaves. Each female may lay an egg mass every 2 or 3 days, producing an average of 460 eggs. Oviposition by overwintering females lasts about 18 days. In spring, eggs hatch in 10 to 14 days, while in summer they hatch in 5 or 6 days. There are four larval instars

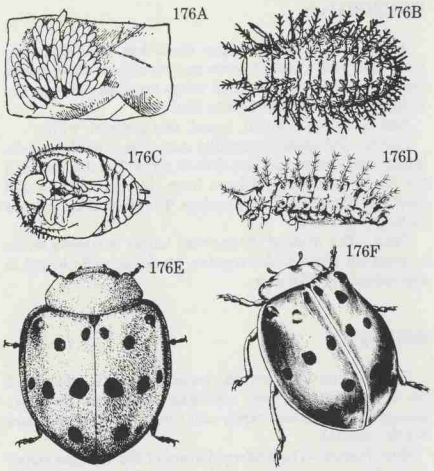


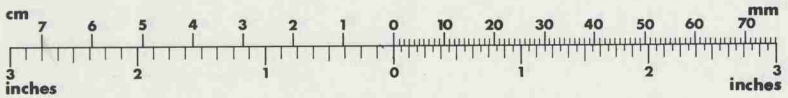

**Fig. 176 Mexican bean beetle. A, Eggs. B-C, Larvae. D, Pupa. E-F, Adults.**

which require about 35 days for development. Mature larvae transform into the pupal stage, which lasts from 7 to 20 days. New females begin laying eggs within 8 to 13 days after emergence. There are three generations per year in North Carolina.



## CONTROL

Several cultural practices aid in Mexican bean beetle control. Crop residue destruction, usually by plowing it under at least 15 cm, destroys all stages of the beetle. Rotation (in large blocks), resistant varieties and good early season growth are very important in the management scheme for this pest. When defoliation exceeds the economic threshold (35 percent foliage loss before bloom and 15 percent foliage loss after bloom), consult the current *North Carolina Agricultural Chemicals Manual.*




* *Epilachna varivestis* Mulsant, Coccinellidae, COLEOPTERA

## SOYBEANS
## Soybean Looper*

### DESCRIPTION

**Adult**—The soybean looper moth has mottled brown forewings with a golden sheen and prominent silver markings near the center. The hind wings are dusky brown. The wingspan ranges from 30.0 to 39.0 mm.

**Egg**—The egg is small, round, and greenish white.

**Larva**—This green caterpillar may or may not have pale, longitudinal stripes and small dark spots. The thick body of the looper gradually narrows from the rear to the small head and has three pairs of prolegs. The sixth instar may be as long as 35 mm.

**Pupa**—The pupa of the soybean looper is creamy white or greenish white with irregular, black spots. Its length is approximately 16.0 mm.

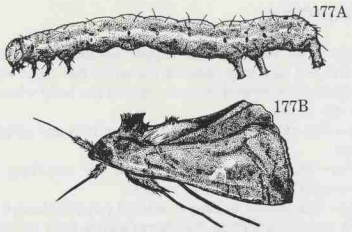



**Fig. 177 Soybean looper. A, Larva. B, Adult.**

### BIOLOGY

**Distribution**—The soybean looper is found in all areas of the United States where soybeans are grown. However, damaging infestations rarely occur north of Tennessee and North Carolina.

**Host Plants**—The preferred hosts of the soybean looper are soybean, sweet potato, and peanut. Other hosts include cotton, tomato, crucifers, pea, tobacco, and cocklebur.

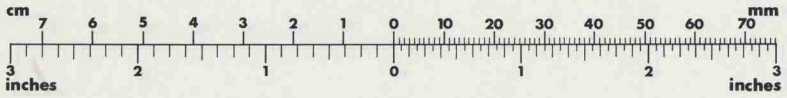
**Damage**—In the Southeast, soybeans are attacked by both cabbage loopers and soybean loopers, but over 90 percent of these are usually soybean loopers. Although loopers infrequently cause pod damage, they are capable of inflicting heavy foliage losses. Defoliation by these pests leaves the plants with a ragged appearance. In North Carolina, damage usually results after a prebloom insecticide application removes most of the looper's natural enemies. Soybean loopers are difficult to control with insecticides.



**Life History**—In North Carolina, soybean loopers have three or four generations a year. They overwinter as pupae within loosely spun cocoons which are usually attached to plant debris. Soon after adults emerge in the spring, each mated female begins laying an average of 640 eggs, singly, on the upper surface of the host plant leaf. The larvae, which emerge approximately 3 days later, pass through six instars in 2 or 3 weeks. The caterpillars then enter a pupal stage which lasts 1 week during the summer. In North Carolina, looper populations reach a peak in August or September.

### CONTROL

Prior to full bloom, chemical control should be employed only if a foliage loss of 35 percent occurs—regardless of the defoliating pest. Fields treated with insecticides prior to bloom have a higher risk of soybean looper infestation than untreated fields. After full bloom, a foliage loss of 15 percent constitutes an economic threshold. For specific control information, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Pseudoplusia includens* (Walker), Noctuidae, LEPIDOPTERA

## DESCRIPTION

**Adult**—The adult is about 15 mm long with a dark gray, elongate body. The antennae are longer than the body and lie parallel to the body when at rest.

**Egg**—The yellow egg is elongate, narrowed at both sides, and about 1.5 mm long.

**Larva**—There are four larval instars varying in length from 1.5 to 15 mm. The larval body is spindle-shaped, creamy white, legless and appears corrugated.

**Pupa**—The pupa, about 15 mm long, is yellowish when first formed but later turns dark brown.

## BIOLOGY

**Distribution**—In North Carolina, the soybean stem borer was first recognized as a pest of soybeans in Beaufort County during 1968; presently it damages soybeans in at least 10 North Carolina counties, primarily the Tidewater counties. It is also considered a pest of soybeans in the following states: Arkansas, Louisiana, Alabama, Missouri, and Tennessee.

**Host Plants**—Known hosts of the soybean stem borer include cocklebur, ragweed, several other weeds, and soybeans.

**Damage**—There is some evidence that a small yield decrease may result from larval feeding within the plant; however, most damage occurs when the immature borer cuts the plant stem from the inside. The insect-induced lodging is most severe on early-planted soybeans, especially in fields where soybeans were grown the previous season and where soybeans are not harvested soon after maturity.

**Life History**—This pest overwinters in North Carolina as mature larvae within tunnels in the stubble of soybeans, ragweed, cocklebur, and other weeds. Pupation occurs in late spring, and adults (beetles) emerge in early summer. About 5 days later the beetles mate. Within 10 to 14 days, the females lay eggs in cavities along leaf petioles which have been chewed out by the beetles. When the eggs hatch, the larvae tunnel through petioles into the stem and feed on pith tissues until cold weather begins. Only one larva will mature in each soybean stem; this is apparently the result of cannibalism.

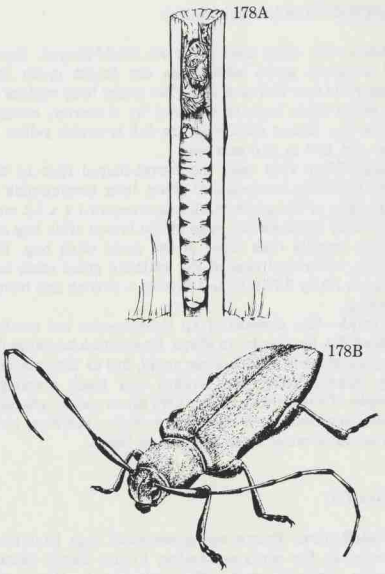
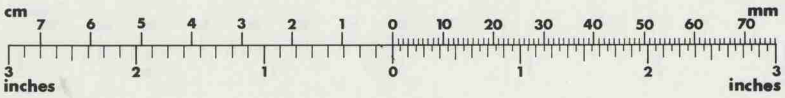



**Fig. 178 Soybean stem borer. A, Larva. B, Adult.**



## CONTROL

This pest is very difficult to control chemically. Deep plowing and rotation are effective. For further information, contact the North Carolina State Agricultural Extension Service.




* *Dectes texanus texanus* LeConte, Cerambycidae, COLEOPTERA

## SOYBEANS
### Stink Bugs*

DESCRIPTION (several species)

**Adult**—All adult stink bugs are shield-shaped. Green and southern green stink bugs are bright green and measure 14.0 to 19.0 mm long. The major body regions of the green stink bug are bordered by a narrow, orange-yellow line. Brown stink bugs are dull brownish yellow in color and 12.0 to 15.0 mm long.

**Egg**—When first laid, the barrel-shaped eggs of the green stink bug are yellow to green, later turning pink to gray. Eggs of the green stink bug measure 1.4 x 1.2 mm. The white, kettle-shaped eggs of the brown stink bug are slightly smaller than those of the green stink bug. The creamy, cylindrical eggs of the southern green stink bug measure 1.0 by 0.75 mm and develop a pinkish hue before hatching.

**Nymph**—The nymphs of all three species are smaller than adults, but similar in shape. Green stink bug numphs are predominantly black when small, but as they mature, they become green with orange and black markings. Nymphs of the brown and southern green species are light green. Southern green stink bug nymphs, however, have two series of white spots along their backs.

BIOLOGY

**Distribution**—Brown and green stink bugs have been reported as far north as Quebec; in the United States, however, they are more often injurious in the South. Although the southern green stink bug occurs outside the United States, in this country it occurs only from Texas to the Atlantic coast and northward to Virginia. It is an important pest in the Gulf Coast states, in North Carolina, however, the green stink bug is the predominant species.



**Host Plants**—Stink bugs feed on over 52 plants, including native and ornamental trees, shrubs, vines, weeds, and many cultivated crops. The preferred hosts are nearly all wild plants. Stink bugs build up on these hosts and move to soybeans late in the season as their preferred foods mature.

**Damage**—Stink bugs inflict mechanical injury to the seed as well as transmit the yeast-spot disease organism. The degree of damage caused by this pest depends to some extent on the developmental stage of the seed when it is pierced by the stink bug's needlelike mouthparts. The younger the seed when damaged, the greater the yield reduction. Although late season infestations may not affect yield, bean oil content and germination will be reduced.

**Life History**—Stink bugs overwinter as adults and become active in spring when temperatures rise above 21°C (about 70°F). Each female deposits up to several hundred eggs, usually in mid or late June. These eggs are laid in

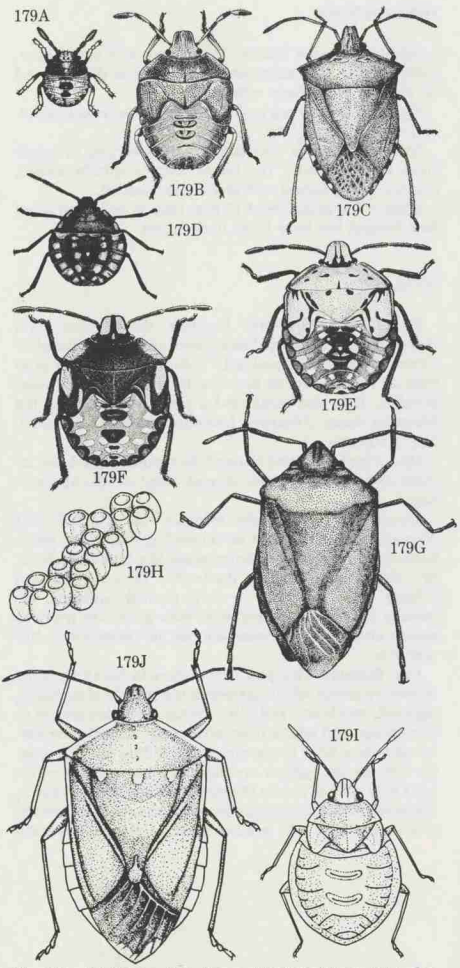
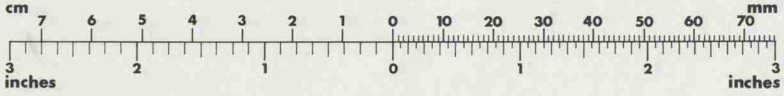



**Fig. 179** Stink bugs. A-C, Brown stink bug 1st and 5th instar nymphs and adult. D-G, Southern green stink bug 1st instar nymph, 5th instars—light and dark forms, and adult. H-J, Green stink bug eggs, nymph, and adult.




* Green stink bug, *Acrosternum hilare* (Say); Brown stink bug, *Euschistus servus* (Say); Southern green stink bug, *Nezara viridula* (Linnaeus), Pentatomidae, HEMIPTERA

clusters (averaging 36 eggs) primarily on leaves and stems but also on pods. Nymphs hatch from these eggs and pass through five instars before becoming adults. Approximately 5 weeks elapse between hatching and adult emergence. Two generations per year occur in Arkansas while only one generation per year has been reported in Virginia. In any case, stink bugs generally reach high population levels in late September or early October. It is then that stink bugs may become a problem on soybeans.

## CONTROL

Stink bugs have some natural enemies, including several common species of birds. As their name implies, stink bugs emit an unpleasant odor and repel many predators. To determine when chemical control is necessary, shake the plants on about 1 meter (3 feet) of row over a muslin cloth and count the number of stink bugs. The economic threshold varies from one stink bug per 0.3 meter (1 ft) of row to one bug per 0.9 meter (3 ft) of row, depending upon state extension service recommendations. In North Carolina, the first threshold value applies. For additional information and current control recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*

## SOYBEANS
### Threecornered Alfalfa Hopper*

### DESCRIPTION

**Adult**—This green, wedge-shaped bug ranges from 6.0 to 6.5 mm in length. The male is slightly smaller than the female and has a red or orange stripe on its "shoulders."

**Egg**—The white, oblong-oval egg is 0.9 to 1.3 mm long. It is slightly larger at one end, that end having a rough surface.

**Nymph**—The straw-colored, wedge-shaped, and heavily spined nymph has white legs, antennae, eyes, and abdomen. The mature nymph is active and about 4.6 mm long.

### BIOLOGY

**Distribution**—Threecornered alfalfa hoppers occur as far north as Canada, but they are an occasional or potential problem only in the southern United States and in northern Mexico. They are prevalent from southern California to North Carolina, usually in early soybean plantings.

**Host Plants**—Threecornered alfalfa hoppers prefer leguminous plants such as alfalfa, soybean, bean, cowpea, and sweet clover. Other plants occasionally infested include tomato, melon, wheat, barley, oat, Bermuda grass, and Johnson grass, as well as some trees and shrubs.

**Damage**—Threecornered alfalfa hoppers girdle stems by their feeding and egg-laying activities. Nymphs and adults weaken the lower stem by piercing it with their needlelike mouthparts and extracting plant juices. As a result, lodging and breaking usually occur weeks after attack. There is some evidence that if damage is randomly scattered and occurs before bloom, in an optimum stand, reduction of at least 25 percent may be necessary to reduce yields. Therefore, these pests rarely cause economic damage.



**Life History**—Threecornered alfalfa hoppers overwinter as eggs in plant tissues or as adults protected by clumps of grasses. Young nymphs from overwintering eggs and overwintered adults begin feeding on weedy plants along field borders in the spring. During May or June, they migrate to soybean seedlings. Females then deposit 30 to 40 eggs, singly, in host plant stems. Nymphs hatch from the eggs 2 to 6 weeks later. They feed for 3 to 10 weeks before fifth instar nymphs molt into adults. On the average, 50 days elapse between egg deposition and adult emergence. The adults are strong flyers and readily migrate to new fields. Although the biology of this pest has not been studied in North Carolina, there are probably at least two generations each year.

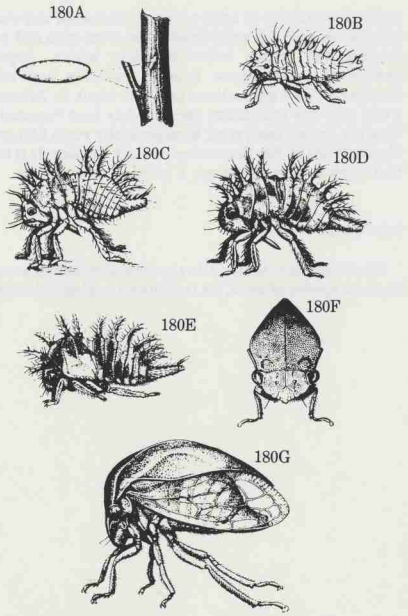
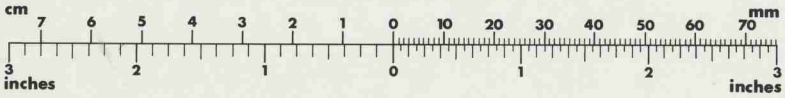



**Fig. 180 Threecornered alfalfa hopper. A, Egg. B-F, Nymphs. G-H, Adults.**

### CONTROL

Damaging infestations of the threecornered alfalfa hopper can be avoided by destroying weedy borders around fields and by seeding a little more heavily. The first practice eliminates overwintering sites from which the bugs will migrate to soybeans. The second practice reduces the importance of the loss of a few plants.

For specific chemical control information, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Spissistilus festinus* (Say), Membracidae, HEMIPTERA

## DESCRIPTION

**Adult**—This moth has a wingspan of 30.0 to 38.0 mm. The forewings are ash gray, light yellowish brown, or dark reddish brown. The hind wings are cinnamon brown with a row of light spots near the margin. When the wings are fully extended, a dark diagonal line extending across both sets of wings is evident.

**Egg**—The white, prominently ribbed egg is flattened on the lower surface and turns pink before hatching. Its diamater is about 2 mm.

**Larva**—The sparsely haired larva, 2.5 to 48.0 mm long, varies in color from green to brown or black. It has a light, dorsal stripe bordered by broad, dark stripes, and a broad, white, longitudinal stripe on each side. The larva has five pairs of prolegs and thrashes vigorously when disturbed.

**Pupa**—The pupa, 18 to 20 mm long, is light green or brown and has 3 pairs of hooked spines at the end of the abdomen.

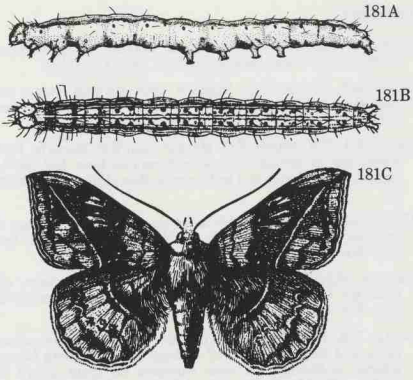



**Fig. 181 Velvetbean caterpillar. A-B, Larvae. C, Adult.**

## BIOLOGY

**Distribution**—The velvetbean caterpillar is a permanent inhabitant of tropical America. It migrates northward into the southeastern United States each year. Overwintering is known to occur in the southern tip of Florida most years. Populations in North Carolina begin developing during late August.

**Host Plants**—Although the soybean is the preferred host, velvetbean caterpillars occasionally feed on kudzu, peanut, and velvetbean. They are occasionally reported on cotton, cowpea, coffeeweed, and black locust.

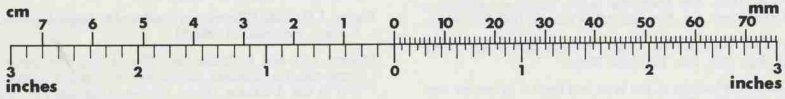
**Damage**—The caterpillars first feed on tender leaves, gradually move to older leaves, and when foliage is removed, attack tender stems, buds, and small bean pods. Eventually, they can completely defoliate the plants. Velvetbean caterpillars are an annual problem June through September in Florida, Georgia, and Alabama. Further west, infestations are usually less severe. Sporadic damage to late-maturing soybeans occurs in North Carolina from late August into October.

**Life History**—The velvetbean caterpillar is the larva of a small night-flying moth which overwinters in the tropics and southern Florida. Adults migrate into the Georgia Piedmont during June or July, laying eggs singly on the underside of soybean foliage. The eggs hatch approximately 3 days later. The first instar larvae feed on the egg capsules. The second to sixth instars attack tender soybean foliage when available. After 3 to 5 weeks of feeding, the larvae pupate either in the soil or in folded leaves on the host. One week later, moths emerge. Several generations of the velvetbean caterpillars occur annually in the South.



## CONTROL

Velvetbean caterpillar populations are usually held in check by natural enemies in North Carolina. If populations reach the economic threshold of 35 percent defoliation prebloom or 15 percent defoliation postbloom, chemical control is necessary. For recommended insecticides and rates, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Anticarsia gemmatalis* Hubner, Noctuidae, LEPIDOPTERA

## SOYBEANS
## References


### GENERAL

Alabama Agricultural Experiment Station. 1971. Soybean production—recent research findings. Bull. 413. 75 pp.

Bickenstaff, C.C. and J.L. Huggans. 1962. Soybean insects and related arthropods in Missouri. Missouri Agr. Exp. Sta. Res. Bull. 803. 51 pp.

Clark, W.J., F.A. Harris, F.G. Maxwell, and E.E. Hartwig. 1972. Resistance of certain soybean cultivars to bean leaf beetle, striped blister beetle, and bollworm. J. Econ. Entomol. 65: 1669-72.

Dietz, L.L., *et. al.* 1976. A guide to the identification and biology of soybean arthropods in North Carolina. North Carolina Agr. Exp. Sta. Tech. Bull. 238. 264 pp.

Godfrey, G.L. (ed.) 1974. Selected literature of soybean entomology. Univ. of Illinois College of Agriculture. International Agr. Pub. INTSOY Ser. 1. 224 pp.

Martin, P.B., P.D. Lingren, and G.L. Greene. 1976. Relative abundance and host preference of cabbage looper, soybean looper, tobacco budworm, and corn earworm on crops grown in northern Florida. Environmental Entomol. 5: 878-82.

Nettles, W.C., C.A. Thomas, and F.H. Smith. 1970. Soybean insects and diseases: how to control. South Carolina (Clemson Univ.) Coop. Ext. Service Circ. 504. 24 pp.

Raney, H.G. 1974. Soybean insects. Kentucky Coop. Ext. Service Pub. ENT-25. 7 pp.

Suber, E.F. and J.C. French. 1974. Soybean insects and their control. Georgia Coop. Ext. Service Leafl. 29. 2 pp.

Turnipseed, S.G. 1972. Management of insect pests of soybeans. Proc. Annu. Tall Timbers Conf. on Ecol. Anim. Control by Habitat Manage., February 24-25, 1972: 182-203.

Turnipseed, S.G. 1973. Insects, pp. 545-72. *In* Soybeans: improvement, production and uses, ed. B.E. Caldwell. Amer. Soc. Agron., Inc., Madison, Wis. 681 pp.

Turnipseed, S.G. and M. Kogan. 1976. Soybean entomology. Annu. Rev. Entomol. 21: 247-82.

Van Duyn, J.W. and T.N. Hunt. 1980. Soybean insect pests field identification guide. North Carolina Agr. Ext. Service. Publication AG-214. 25 pp.

### BEAN LEAF BEETLE

Balsbaugh, E.U. and K.L. Hays. 1972. The leaf beetles of Alabama (Coleoptera: Chrysomelidae). Alabama (Auburn Univ.) Agr. Exp. Sta. Bull. 441. 223 pp.

Boiteau, G., J.R. Bradley, Jr., and J.W. Van Duyn. 1979a. Bean leaf beetle: emergence patterns of adults from overwintering sites. Environmental Entomol. 8: 427-431.

Boiteau, G., J.R. Bradley, Jr., and J. W. Van Duyn. 1979b. Bean leaf beetle: flight and dispersal behavior. Ann. Entomol. Soc. Amer. 72: 298-302.

Boiteau, G., J.R. Bradley, Jr., and J. W. Van Duyn. 1979c. Bean leaf beetle: some seasonal anatomical changes and dormancy. Ann. Entomol. Soc. Amer. 72: 303-7.

Britton, W.E. 1918. The bean leaf beetle *Cerotoma trifurcata* Forst. Connecticut Agr. Exp. Sta. (New Haven) Bull. 211: 327-9.

Eddy, C.O. and W.C. Nettles. 1930. The bean leaf beetle. South Carolina Agr. Exp. Sta. Bull. 265. 25 pp.

Isley, D. 1930. The biology of the bean leaf beetle. Arkansas Agr. Exp. Sta. Bull. 248. 20 pp.

Nichols, M.P., M. Kogan, and G.P. Waldbauer. 1974. The literature of arthropods associated with soybeans III. Bibliography of the bean leaf beetles *Cerotoma trifurcata* (Forster) and *C. ruficornis* (Oliver) (Coleoptera: Chrysomelidae). Illinois Natur. Hist. Surv. Biol. Notes 85. 16 pp.

### BEET ARMYWORM

Atkins, E.L., Jr. 1960. The beet armyworm, *Spodoptera exigua*, an economic pest of citrus in California. J. Econ. Entomol. 53: 616-19.

Harding, J.A. 1976. *Heliothis* spp.: parasitism and parasites plus host plants and parasites of the beet armyworm, diamondback moth and two tortricids in the lower Rio Grande Valley of Texas. Environmental Entomol. 5: 669-71.

McLeod, P.J., S.Y. Young III, and W.C. Yearian. 1978. Effectiveness of microbial and chemical insecticides on beet armyworm larvae on soybeans. Georgia Entomol. Soc. J. 13: 266-69.

Todd, E.L. 1975. New distributional records for the beet armyworm, *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae). U.S. Dep. Agr. Coop. Econ. Insect Rep. 25 (1-5): 14.

Wilson, J.W. 1934. The asparagus caterpillar: its life history and control. Florida Agr. Exp. Sta. Bull. 271. 26 pp.

### BLISTER BEETLES

Gilbertson, G.I. and W.R. Horsfall. 1940. Blister beetles and their control. South Dakota Agr. Exp. Sta. Bull. 340. 23 pp.

Horsfall, W.R. 1943. Biology and control of some common blister beetles in Arkansas. Arkansas Agr. Exp. Sta. Bull. 436. 55 pp.

### CORN EARNWORM

Barber, G.W. 1936. The corn earworm in southeastern Georgia. Georgia Agr. Exp. Sta. Bull. 192. 18 pp.

Isley, D. 1935. Relation of hosts to abundance of cotton bollworm. Arkansas Agr. Exp. Sta. Bull. 320. 30 pp.

Johnson, M.W., R.E. Stinner, and R.L. Rabb. 1975. Ovipositional response of *Heliothis zea* (Boddie) to its major hosts in North Carolina. Environmental Entomol. 4: 291-7.

Snow, J.W. and W.W. Copeland. 1971. Distribution and abundance of the corn earworm in the United States. U.S. Dep. Agr. Coop. Econ. Insect Rep. 21: 71-6.

Sterling, W.L., *et. al.* 1979. Economic thresholds and sampling of *Heliothis* species on cotton, corn, soybeans and other host plants. Regional Res. Proj. S-59, Southern Coop. Ser. Bull. 231. 159 pp.

### GRAPE COLASPIS

Barber, H.S. 1936. Some species of *Colaspis* from the *brunnea* confusion (Coleoptera: Chrysomelidae). Entomol. Soc. Washington Proc. 38: 198-204.

Bigger, J.H. 1928. Hibernation studies of *Colaspis brunnea* (Fab.). J. Econ. Entomol. 21: 268-73.

Rolston, L.H. and P. Rouse. 1965. The biology and ecology of the grape colaspis, *Colaspis flavida* Say, in relation to rice production in the Arkansas Grand Prairie. Arkansas Agr. Exp. Sta. Bull. 694. 32 pp.

GREEN CLOVERWORM

Hill, C.C. 1925. Biological studies of the green cloverworm. U.S. Dep. Agr. Bull. 1336. 19 pp.

Pedigo, L.P., G.L. Lentz, J.D. Stone, and D.F. Cox. 1972. Green cloverworm larval populations in Iowa soybean with special reference to sampling procedure. J. Econ. Entomol. 65: 414-21.

Pedigo, L.P., J.D. Stone, and G.L. Lentz. 1973. Biological synopsis of the green cloverworm in central Iowa. J. Econ. Entomol. 66: 665-73.

Pruess, K.P. 1974. Modeling economic thresholds for green cloverworm on soybean. Entomol. Soc. Amer. North Centr. Branch Proc. 29: 69-74.

Stone, J.D. 1973. The economic-injury level of the green cloverworm on soybean in Iowa. Entomol. Soc. Amer. North Centr. Branch Proc. 28: 179.

Stone, J.D. and L.P. Pedigo. 1972. Development and economic-injury level of the green cloverworm on soybean in Iowa. J. Econ. Entomol. 65: 197-201.

JAPANESE BEETLE

Britton, W.E. and J.P. Johnson. 1938. The Japanese beetle in Connecticut. Connecticut Agr. Exp. Sta. (New Haven) Bull. 411. 31 pp.

Fleming, W.E. 1963. The Japanese beetle: how to control it. U.S. Dep. Agr. Farmers' Bull. 2151. 16 pp.

Fleming, W.E. 1970. The Japanese beetle in the United States. U.S. Dep. Agr., Agr. Res. Service Agr. Handbook 236. 30 pp.

Fleming, W.E. 1976. Integrating control of the Japanese beetle—a historical review. U.S. Dep. Agr. Tech. Bull. 1545. 65 pp.

Hadley, C.H. and I.M. Hawley. 1934. General information about the Japanese beetle in the United States. U.S. Dep. Agr. Circ. 332. 23 pp.

Hawley, I.M. and F.W. Metzger. 1940. Feeding habits of the Japanese beetle. U.S. Dep. Agr. Circ. 547. 32 pp.

Ladd, T.L. 1976. Controlling the Japanese beetle. U.S. Dep. Agr. Home and Garden Bull. 159. 15 pp.

MEXICAN BEAN BEETLE

Cantelo, W.W. 1977. Controlling the Mexican bean beetle. U.S. Dep. Agr. Leafl. 548. 8 pp.

Crawford, J.C. 1924. The Mexican bean beetle in North Carolina. The Bull. of the North Carolina Dep. of Agr., November, 1924. 12 pp.

Harris, E.D. 1976. Mexican bean beetle. Georgia Coop. Ext. Service Leafl. 85. 2 pp.

Howard, N.F. and L.L. English. 1924. Studies of the Mexican bean beetle in the Southeast. U.S. Dep. Agr. Dep. Bull. 1243. 50 pp.

Nichols, M.P. and M. Kogan. 1972. A bibliography of the Mexican bean beetle *Epilachna varivestis* Mulsant (Coleoptera: Coccinellidae). Illinois Natur. Hist. Surv. Biol. Notes 77. 20 pp.

Thomas, F.L. 1924. Life history and control of the Mexican bean beetle. Alabama (Auburn Univ.) Agr. Exp. Sta. Bull. 221. 99 pp.

U.S. Department of Agriculture. 1960. The Mexican bean beetle in the East and its control. Farmers' Bull. 1624. 15 pp.

SOYBEAN LOOPER

Canerday, T.D. and F.S. Arant. 1967. Biology of *Pseudoplusia includens* and notes on biology of *Trichoplusia ni, Rachiplusia ou,* and *Autographa biloba.* J. Econ. Entomol. 60: 870-1.

Martin, P.B., P.D. Lingren, and G.L. Greene. 1976. Relative abundance and host preference of cabbage looper, soybean looper, tobacco budworm, and corn earworm on crops grown in northern Florida. Environmental Entomol. 5: 878-82.

Mitchell, E.R. 1967. Life history of *Pseudoplusia includens* (Walker) (Lepidoptera: Noctuidae). Georgia Entomol. Soc. J. 2: 53-7.

Reid, J.C. and G.L. Greene. 1973. The soybean looper: pupal weight, development time, and consumption of soybean foliage. Florida Entomol. 56: 203-6.

SOYBEAN STEM BORER

Campbell, W.V. and J.W. Van Duyn. 1977. Cultural and chemical control of *Dectes texanus texanus* on soybeans. J. Econ. Entomol. 70: 256-8.

Hatchett, J.H., D.M. Daugherty, J.C. Robbins, R.M. Barry, and E.C. Houser. 1975. Biology in Missouri of *Dectes texanus* a new pest of soybeans. Ann. Entomol. Soc. Amer. 68: 209-13.

Patrick, C.R. 1971. Notes on the weed cerambycid *Dectes texanus texanus* (Coleoptera: Cerambycidae). Georgia Entomol. Soc. J. 6: 254.

Patrick, C.R. 1973. Observations on the biology of *Dectes texanus texanus* (Coleoptera: Cerambycidae) in Tennessee. Georgia Entomol. Soc. J. 8: 277-9.

STINK BUGS

Daugherty, D.M., *et. al.* 1964. An evaluation of damage to soybeans by brown and green stink bugs. J. Econ. Entomol. 57: 719-22.

Miner, F.D. 1966. Biology and control of stink bugs on soybeans. Arkansas Agr. Exp. Sta. Bull. 708. 40 pp.

Rolston, L.H. and R.L. Kendrick. 1961. Biology of the brown stink bug *Euschistus servus* Say. Kansas Entomol. Soc. J. 34: 151-7.

Sailer, R.I. 1953. A note on the bionomics of the green stink bug. (Hemiptera: Pentatomidae). Kansas Entomol. Soc. J. 26: 70-1.

Underhill, G.W. 1934. The green stink bug. Virginia Agr. Exp. Sta. Bull. 294. 26 pp.

Woodside, A.M. 1946. Life history studies of *Euschistus servus* and *E. tristigmus.* J. Econ. Entomol. 39: 161-3.

THREECORNERED ALFALFA HOPPER

Meisch, M.V. and N.M. Randolph. 1965. Life-history studies and rearing techniques for the three-cornered alfalfa hopper. J. Econ. Entomol. 58: 1057-9.

Tugwell, P., F.D. Miner, and D.E. Davis. 1972. Threecornered alfalfa hopper infestations and soybean yield. J. Econ. Entomol. 65: 1731-3.

Wildermuth, V.L. 1915. Three-cornered alfalfa hopper. J. Agr. Res. 3: 343-61.

VELVETBEAN CATERPILLAR

Douglas, W.A. 1930. The velvetbean caterpillar as a pest of soybeans in southern Louisiana and Texas. J. Econ. Entomol. 23: 684-90.

Ellisor, L.D. 1942. Notes on the biology and control of the velvetbean caterpillar, *Anticarsia gemmatalis* Hbn. Louisiana Agr. Exp. Sta. Bull. 350: 17-23.

Greene, G.L. 1976. Pest management of the velvetbean caterpillar in a soybean ecosystem, pp. 602-10. *In* Proc. World Soybean Res. Conf., ed. L.D. Hill. The Interstate Printers & Publ., Inc., Danville, Ill. 1073 pp.

## References

Hinds, W.E. and B.A. Osterberger. 1931. The soybean caterpillar in Louisiana. J. Econ. Entomol. 24: 1168-73.

Leppla, N.C., T.R. Ashley, R.H. Guy, and G.D. Butler. 1977. Laboratory life history of the velvetbean caterpillar. Ann. Entomol. Soc. Amer. 70: 217-20.

U.S., Department of Agriculture. 1959. The velvetbean caterpillar—how to control it. Leafl. 348. 4 pp.

Watson, J.R. 1916. Life history of the velvetbean caterpillar *(Anticarsia gemmatilis* Hübner). J. Econ. Entomol. 9: 521-8.

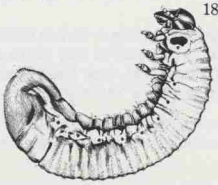
# PESTS OF TOBACCO

With approximately 154,656 hectares (382,000 acres) devoted to tobacco in 1980, North Carolina produces well over 40 percent of all tobacco in the nation. The Coastal Plain and northern Piedmont counties lead other states in the production of flue-cured tobacco, while burley, an air-cured tobacco, is an important crop on small farms in the Mountain counties. Although many insect pests attack tobacco from the time it is seeded until it is marketed, their importance varies from area to area and from year to year. The following key has been subdivided based on the growing schedule for flue-cured tobacco.

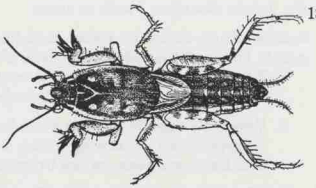
## Key to Tobacco Pests

A. Soil insects which attack plant bed tobacco by uprooting plants, boring into stems or stalks, or feeding on roots (Fig. 182A to B).

182A



182B



1. **Green June beetle larva**—This large white, six-legged grub has a blackish-brown head and is about 5 cm long when fully developed (Fig. 182A). It crawls on its back on the soil surface or burrows in the soil and uproots seedlings. .....p. 178

2. **Southern mole cricket**—About 32 mm long, the adult is brown with short front wings (the long membranous hind wings are usually tucked under the front wings) and shovel-like front legs for digging (Fig. 182B). The nymph is similar but smaller and wingless; both life stages uproot seedlings by tunneling and feeding on the roots. .....p. 185

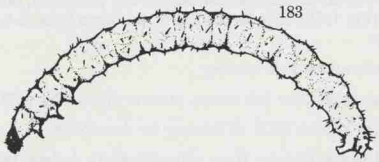


B. Insects which attack plant bed and field tobacco

1. Insects which bore into stems or stalks or feed on roots

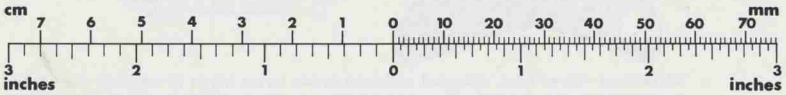
   a. **Tobacco flea beetle larva**—This white, 12-segmented larva, 4.3 to 4.8 mm long when fully developed, has a brownish head, three pairs of legs near the head, and a proleg on the last abdominal segment (Fig. 183). It may kill newly set plants by feeding on roots or tunneling in the stalk. .....p. 187

183



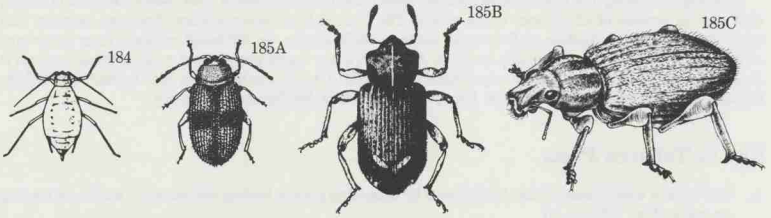
2. Insects damaging leaves by sucking sap

   a. **Green peach aphid**—This aphid is a soft-bodied, pear-shaped, winged or wingless insect about 2.0 mm long with a pair of long cornicles (tailpipe-like appendages) at the end of the abdomen (Fig. 184). The adult has a pale yellow, green, or yellowish-green abdomen with a dark, dorsal blotch; the nymph resembles the adult but is light green and never winged. Both life stages




* See also "Key to Caterpillars" on page 16.

damage plants by sucking sap from leaves, causing curled, stunted, distorted leaves, contaminated with honeydew and sooty mold fungi. .....p. 179




3. Chewing insects damaging leaves or stems

   a. **Beetles**—These insects have hard, shell-like forewings (wing covers or elytra) which meet in a straight line down the middle of the back (Fig. 185A to C). They may or may not be able to fly.

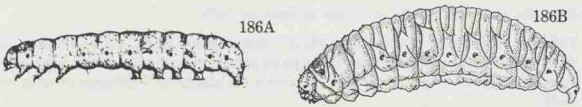
      i. **Tobacco flea beetle**—This very small (about 1.5 mm long), oval, black, jumping beetle (Fig. 185A) chews small round holes in leaves giving them a "shothole" appearance.p. 187

      ii. **Vegetable weevil**—About 6.4 mm long, this brown, snout beetle (Fig. 185B) has a light, V-shaped mark on its wing covers. It attacks seedlings and newly set plants feeding on both leaves and buds, leaving irregular holes. .....p. 188

      iii. **Whitefringed beetles**—Several species of these black, 11 mm-long beetles leave saw-tooth cuts on the outer edges of tobacco leaves. Covered with grayish scales, each of these snout beetles has two longitudinal stripes down its back and a marginal band of long, white hairs (Fig. 185C). These beetles cannot fly. .....p. 189

   b. **Cutworms**—Cutworm caterpillars have three pairs of legs near their heads and five pairs of prolegs (Fig. 186A). Several species of these thick-bodied, grayish to dark brown larvae, up to 50 mm in length, hide curled up in the soil by day and feed at night on seedlings or newly set plants in the field. They sever the stems of young plants, cut off leaves, or chew large holes in the leaves. .....p. 176





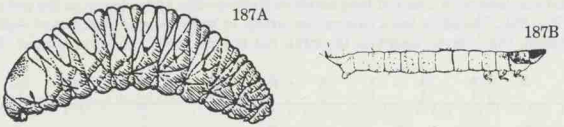

   c. **Vegetable weevil larva**—Soft-bodied, legless, and pale green, this larva is about 10 mm long when mature (Fig. 186B). Like its adult form, this larva feeds on both leaves and buds, leaving irregular holes. .....p. 188

C. Insects which primarily attack field tobacco

1. Insects that feed on roots, bore into stems, or sever stems (Fig. 187).

   a. **Cutworms**—See section B.3.b. of this key for description.

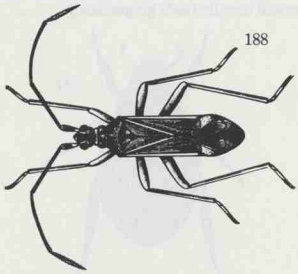
   b. **Whitefringed beetle larvae**—These yellowish-white, legless, 12-segmented grubs, up to 13 mm in length, have small, round, pale heads (Fig. 187A). They feed on roots, stunting or killing tobacco plants. .....p. 189




   c. **Wireworms**—These hard, elongated, yellowish-brown larvae (up to 19 mm long when fully developed) tunnel in the stalks of newly set plants, stunting or killing the plants. The tobacco wireworm's last segment terminates in a V-shaped notch, while the southern potato wireworm has an almost closed, oval notch (Fig. 187B). .....p. 190

2. Insects damaging foliage by sucking sap

   a. **Suckfly**—The adult is a green-black, slender plant bug, about 3.3 mm long, with long slender legs and antennae (Fig. 188); the fully developed nymph is green with reddish eyes and two pairs of wing pads. Both life stages suck plant sap from late-season tobacco, reducing the coloration, weight, and thickness of cured leaves. Excrement is present on the underside of leaves. .....p. 186



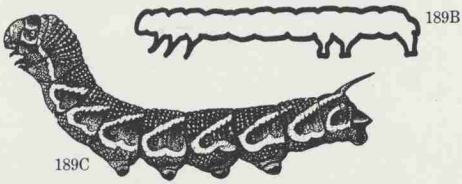
188

   b. **Green peach aphid**—See section B.2.a. of this key.

3. Insects damaging leaves by chewing holes

   a. **Caterpillars**—These soft-bodied moth larvae have three pairs of legs near their heads and three to five pairs of prolegs (Fig. 189A to C).

189A



189B

189C

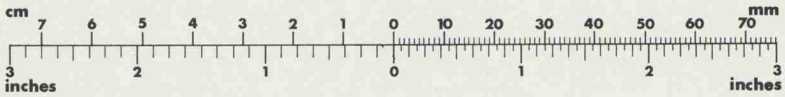


   i. **Budworms**—Up to 44 mm in length when mature, these moderately hairy caterpillars vary in color from greenish yellow or reddish brown to near black with pale, longitudinal stripes and scattered black spots; young larvae are cream colored or yellowish green with few markings. They have five pairs of prolegs (Fig. 189A). Damage from feeding in the bud area becomes apparent as the leaf expands. .....p. 173

   ii. **Cabbage looper**—This light-green larva, about 40 mm long when fully developed, tapers in width from the rear to the head. It has three pairs of thoracic legs near the head and three pairs of prolegs toward the rear (Fig. 189B). As it crawls, the looper arches the middle of its body. It chews ragged holes in leaves, leaving only the larger leaf veins. .....p. 175

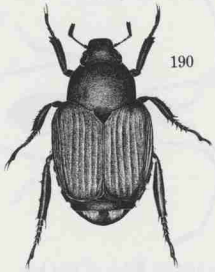
   iii. **Hornworms**—These large, green caterpillars (Fig. 189C) have either seven diagonal stripes on each side and a curved, red, posterior horn (tobacco hornworm) or eight V-shaped markings on each side and a straight, black horn (tomato hornworm). They are 75 to 85 mm in length when fully developed. .....p. 180

   iv. **Potato tuberworm**—This greenish-to-pink caterpillar, 13 to 19 mm in length when fully developed, has five pairs of prolegs (Fig. 189A). It tunnels between leaf surfaces causing papery, grayish blotches which become brownish and brittle. .....p. 183



v. **Variegated cutworm**—This smooth-bodied, dark brown, mottled larva has a distinct, pale-yellow dot down the back of at least the first four abdominal segments and has five pairs of prolegs (Fig. 189A). It is about 50 mm long when fully developed and, unlike the black cutworm, it may climb tobacco plants and feed on leaves. .....p. 176

b. **Japanese beetle**—This shiny, metallic-green beetle, about 1.3 cm long, has copper-brown wing covers and six tufts of white hairs on each side of the abdomen (Fig. 190). It chews numerous ragged holes in leaves and usually feeds gregariously. .....p. 182



190

## TOBACCO INSECT NOTES

### DESCRIPTION (two species)

**Adult**—Tobacco budworm moths are light olive to brownish olive, with a wingspan of about 32 mm. Each forewing bears three slanted, dark-olive or brown bands. Hind wings are white with dark margins. The corn earworm is usually a light yellowish olive with a single, dark spot near the center of each forewing and a wingspan of about 38 mm.

**Egg**—Eggs of both species are very similar in appearance—subspherical with a flattened base, about 0.6 mm in diameter, and white or cream in color. They develop a reddish-brown band just prior to hatching.

**Larva**—Both species are similar in appearance. About 1.5 mm long, newly emerged larvae are yellowish white with brown heads. With pale stripes running lengthwise on the body, fully developed larvae may be basically greenish yellow, reddish brown, or even black. Such larvae may be up to 44 mm long.

**Pupa**—Shiny and reddish brown at first, the pupae become dark brown before adult emergence.

### BIOLOGY

**Distribution**—The tobacco budworm occurs throughout the Western Hemisphere ranging as far north as Canada and as far south as Argentina. The corn earworm has a similar distribution but is more abundant in cooler regions, whereas the tobacco budworm is more abundant in warmer, southern regions. A recent North Carolina study indicates that 90 percent of the budworms found on tobacco are *Heliothis virescens.*

In North Carolina, budworms occur throughout the state but are generally more severe in the southern Coastal Plain. Some early-transplanted fields in heavily infested areas have had as many as 100 percent of plants infested.

**Host Plants**—Tobacco, cotton, and soybeans are the only cultivated crop hosts of the tobacco budworm in North Carolina. The corn earworm feeds on at least 16 cultivated plants. Tobacco is the most important host of the tobacco budworm whereas corn is the most important host of the corn earworm. The tobacco budworm does not infest corn, but both species are found on cotton and soybeans. Wild hosts of the tobacco budworm include deergrass and toadflax.

**Damage**—Budworms, primarily the tobacco budworm, are important pests of flue-cured tobacco in North Carolina. Both species feed on tobacco leaves, but such feeding causes little appreciable damage. Damage is most serious when feeding is in the vegetative bud of the plant. The larvae often cause distorted leaves by feeding upon the tips of the leaves in the developing bud. Large holes develop

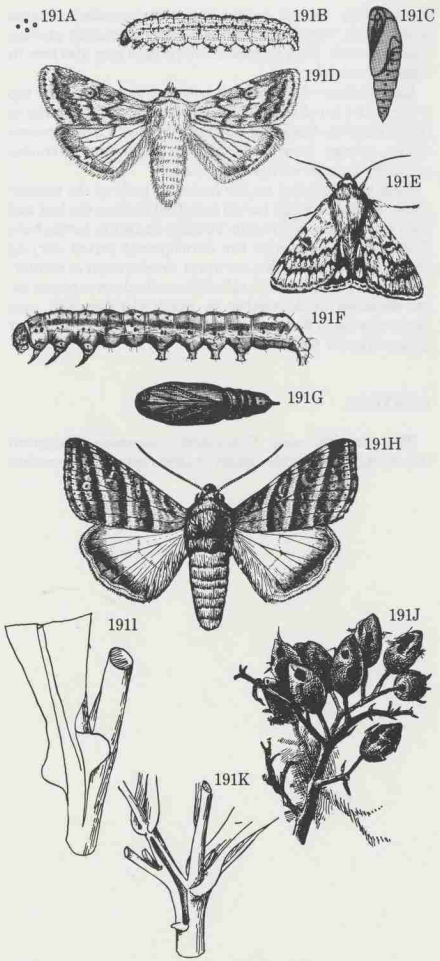
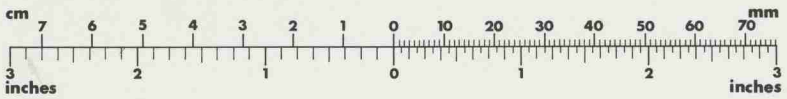



**Fig. 191 Budworms. A-E, Corn earworm eggs, larva, pupa, and adults. F-H, Tobacco budworm larva, pupa, and adult. I-K, Damage to tobacco.**




* Tobacco budworm, *Heliothis virescens* (Fabricius); Corn earworm, *Heliothis zea* (Boddie), Noctuidae, LEPIDOPTERA

from earlier feeding as the leaf tissue expands. Plants prematurely topped by budworm feeding produce profuse sucker growth. Both species of caterpillars may also bore in stalks or midribs.

**Life History**—Budworms overwinter as pupae in the top 5-10 cm (2-4 in) of soil. Tobacco budworm adults emerge in North Carolina from late April to mid-May. Corn earworm adults emerge from early May to early June. Females generally emerge earlier than males.

Eggs are deposited on the leaves or buds of the tobacco plant. After hatching, larvae may first feed on the leaf and then move to the bud region. Tobacco budworm larvae have five or six instars with the development period varying from 21 to 25 days. Corn earworm development is similar.

Pupation occurs in the soil. Tobacco budworm pupae enter diapause in September in North Carolina and corn earworms begin diapause in August. Both species have four generations in North Carolina.

## CONTROL

The parasitic wasp *Campoletis sonorensis* (Cameron) (Ichenumonidae) kills small budworms while another parasitic wasp *Cardiochiles nigriceps* Viereck (Braconidae) kills large budworms near pupation. Predators include several *Polistes* spp. paper wasps. Several diseases, including the microsporidian *Nosema heliothidis* Lutz and Spendor, also reduce budworm populations.

Topping plants, good sucker control, stalk destruction after harvest, and fall and winter plowing are all important cultural control practices to reduce diapausing populations. Budworms are difficult to control on tobacco prior to flowering because most of the larvae are hidden in the vegetative bud where it is difficult for insecticides to reach.

A number of insecticides, however, are available to control budworms. The economic threshold level for these pests is reached when 5 or more plants out of 50 are infested with budworms of any size prior to buttoning. Budworms will not cause loss of any importance after the plant has buttoned. For specific control recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*

## DESCRIPTION

**Adult**—This grayish-brown moth has a wingspan of approximately 38 mm. Each of the mottled, brown, front wings bears a small, silvery spot resembling a figure 8. The hind wings are a paler brown.

**Egg**—The dome-shaped, greenish-white egg is slightly smaller than a pinhead.

**Larva**—About 40 mm long when fully developed, the light-green larva has three pairs of slender legs near the head and three pairs of thickened prolegs on the abdomen. The body tapers from the rear to a small head and is generally humped up when at rest or moving.

**Pupa**—The green or brown pupa is nearly 19 mm long and enclosed in a flimsy, silken cocoon.

## BIOLOGY

**Distribution**—The cabbage looper is found from Canada to Mexico. In the United States, this insect is a pest primarily in the South.

**Host Plants**—Host plants include all of the plants of the cabbage family—cabbage, collards, etc. Also attacked are lettuce, spinach, beet, pea, celery, potato, cotton, soybean, tomato, tobacco, and certain flower species.

**Damage**—An occasional pest of tobacco, the cabbage looper leaves ragged holes as it feeds on tobacco leaves.

**Life History**—Cabbage loopers overwinter as pupae attached to host plant foliage which has fallen to the ground. The night-flying moths appear in May and lay eggs (up to 350 per moth) singly on cabbage, collards and other plants. The eggs hatch in about 3 days, depending on temperature. The loopers feed on leaves for 2 to 4 weeks before spinning cocoons and pupating. Ten days to 2 weeks later a new generation of moths emerges. In North Carolina, there are five to six generations per year, mostly on crucifers.

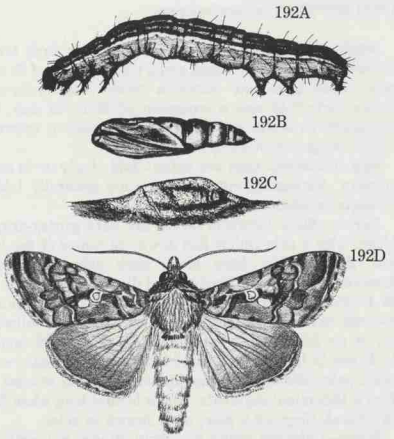
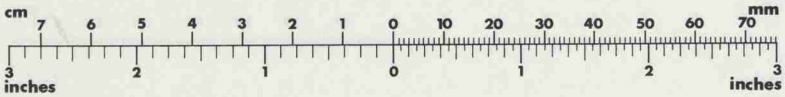



**Fig. 192 Cabbage looper. A, Larva. B, Pupa. C, Cocoon. D, Adult.**

## CONTROL

There is apparently a high degree of natural control of the cabbage looper by predators and parasites. Also a polyhedral virus disease seems to be a key factor in population changes of the cabbage looper. Insecticides are available to control the cabbage looper when it becomes abundant. Treatment is advised when 10 percent of the plants are affected. For specific chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*






* *Trichoplusia ni* (Hubner), Noctuidae, LEPIDOPTERA

## TOBACCO
### Cutworms*

**DESCRIPTION** (several species)

**Adult**—Adult black cutworm moths have dark brown forewings, white hind wings, and a wing expanse of 38 to 51 mm. Adult granulate cutworm moths have yellowish-brown forewings and a wingspan of 38 to 45 mm. The variegated cutworm moths may be yellowish or brownish with a wingspan of 38 to 50 mm.

**Egg**—Cutworm eggs are white—laid singly or in small clusters. Variegated cutworm eggs are generally laid in elongate patches.

**Larva**—Black cutworm larvae are dark greasy-gray to black, with a pale yellow line down the center of the back and three yellow lines along each side. Sometimes, however, these yellow lines are not distinct. The larvae are 38 to 45 mm long when fully developed and the skin is covered with convex, black granules. Granulate cutworm larvae are dusty brown with rough, granulated skin and up to 38 mm in length. Variegated cutworm larvae have a distinct, pale yellow dot on the mid-dorsal line of at least the first 4 abdominal segments. About 50 mm long when fully developed, they are a pale, dirty brown in color.

**Pupa**—Cutworm pupae are about 20 mm in length and dark brown or mahogany in color.

**BIOLOGY**

**Distribution**—Cutworms are cosmopolitan in their distribution and are common in Canada and the United States. The black cutworm is more abundant in the northern portions of its range while the granulate cutworm is more abundant southward. In North Carolina, cutworms are generally more of a problem in the Coastal Plain.



**Host Plants**—Cutworms attack many vegetable crops, grasses, and field crops such as tobacco, cotton, corn, and peanuts.

**Damage**—Several species of cutworms may injure tobacco in plant beds and newly set plants in the field. Larvae hide curled up in the soil by day and at night cut off young plants near the ground and feed on the foliage. The black cutworm is one of the most destructive cutworms. One larva cuts off a plant, moves to other plants and repeats the damage. Small populations can cause considerable injury, resulting in the need to replant. Granulate and variegated cutworms also sever seedlings, but the variegated cutworm may also climb tobacco plants and feed on the leaves. In North Carolina, granulate and black cutworms are the most common cutworms in tobacco plant beds.

**Life History**—Cutworms overwinter as larvae or pupae. In early spring, the overwintering larvae of some species become active and feed. In other cases, moths emerge from

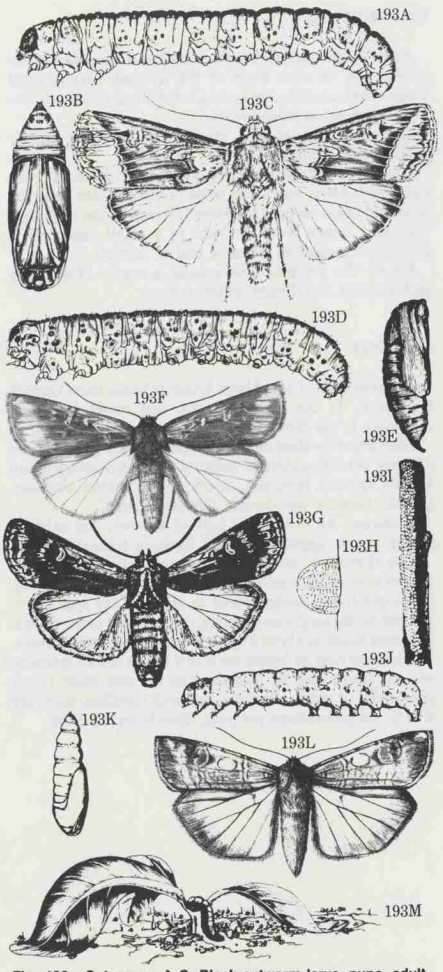
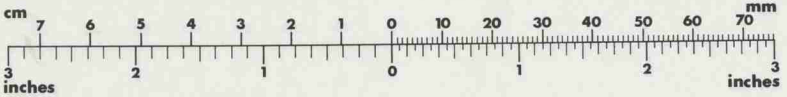



**Fig. 193** Cutworms. A-C, Black cutworm larva, pupa, adult. D-G, Granulate cutworm larva, pupa, and adults. H-L, Variegated cutworm egg, egg mass, larva, pupa, and adult. M, Cutworm damage to tobacco.




* Black cutworm, *Agrotis ipsilon* (Hufnagel); Granulate cutworm, *Feltia subterranea* (Fabricius); variegated cutworm, *Peridroma saucia* (Hübner), Noctuidae, LEPIDOPTERA

overwintering pupae and lay eggs on host plants or other vegetation. Therefore, depending on the species, damaging cutworms found in spring may be overwintered larvae or new generation cutworms.

Cutworms develop through five to eight larval instars. Pupation occurs in the soil. The number of generations depends on latitude. Generally there are two generations per year in Canada, four generations per year in North Carolina, and five to six generations per year in Florida.

## CONTROL

Since extensive damage may occur in a short period of time, plant beds and newly set plants should be inspected frequently. An economic threshold of 5 percent injured plants has been established for cutworms infesting newly set or young plants (within 3 weeks after transplanting). A bait may be used in infested plant beds or in newly set fields. For control recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*

## TOBACCO
### Green June Beetle*

### DESCRIPTION

**Adult**—Adults are large, thick-bodied, somewhat flattened, green beetles. Almost 25 mm long and about half as wide, they have bronze-to-yellow body margins.

**Egg**—Eggs are white, spherical and small (2 mm).

**Larva**—Larvae are large, full-bodied, dirty-white grubs with blackish-brown heads. They reach a length of about 48 mm when fully developed.

**Pupa**—Pupae more or less resemble the adult beetles in size and shape. Although white when first formed, pupae gradually darken to green before adult emergence.

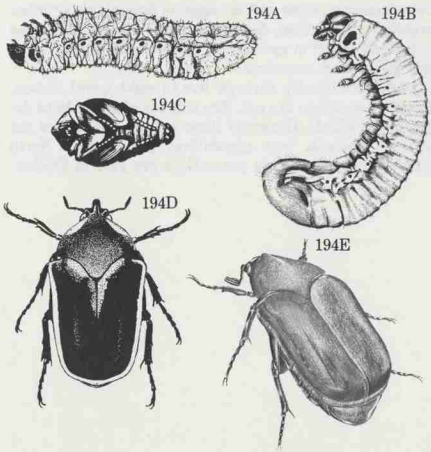



**Fig. 194 Green June beetle. A-B, Larvae. C, Pupa. D-E, Adults.**

### BIOLOGY

**Distribution**—The green June beetle is generally confined to the southern United States, extending northward into New York and southern Illinois. In North Carolina, the larva is more common in sandy loam soils with high organic matter.

**Host Plants**—Adult green June beetles feed on the foliage of a number of trees and shrubs and a variety of fruits such as grapes and peaches. By burrowing, tunneling, and some actual feeding, grubs injure the roots of grasses, vegetable and ornamental plants, and tobacco seedlings in plant beds.

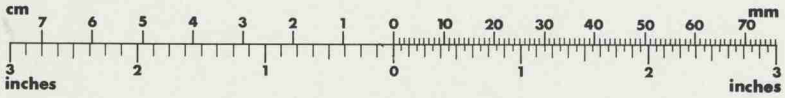
**Damage**—Grubs of the green June beetle are often serious pests of tobacco seedlings in plant beds. Becoming active when plants are in the 2- to 4-leaf stage, the grubs feed on organic matter in the soil, burrow through the soil (crawling on their backs) and injure tobacco seedlings by loosening the soil and uprooting plants. Due to this type of injury, damage is more severe during dry seasons. Injury rarely results from actual larval feeding on plant roots. Adults may also damage foliage and fruits of other crops by direct feeding.

**Life History**—The green June beetle overwinters as a grub 20 to 60 cm (8 to 24 inches) deep in the soil. In spring the grubs burrow close to the surface where they tunnel on their backs and feed on decaying matter. Following a heavy rain or at night, they may come out of the soil, piling soil around the burrow opening. There are three instars and in mid-spring the grubs pupate in earthen cells in the ground about 20 cm (8 inches) below the surface. Adults begin to emerge in June and are most abundant in July and August. Adult beetles feed on foliage and fruit of trees, shrubs, and fruit crops. Adults lay eggs about 7 or 8 cm (3 inches) deep in soils high in decaying organic matter. After 8 to 20 days the eggs hatch and the young grubs burrow and feed on the decaying matter until cold weather. There is one generation per year.



### CONTROL

Green June beetle grubs may be controlled in tobacco seedbeds by applying an insecticide drench to infested areas. For specific chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Cotinis nitida* (Linneaus), Scarabaeidae, COLEOPTERA

## DESCRIPTION

**Adult**—Adults are about 2.0 mm long, soft-bodied, pear-shaped, and either winged or wingless. They may be green, pink or black in color and have a pair of dark cornicles (tailpipelike appendages) at the end of the abdomen.

**Egg**—Eggs are first green but later turn shiny black. However, the egg stage is not known in North Carolina.

**Nymph**—Nymphs are green and resemble adults but lack wings.

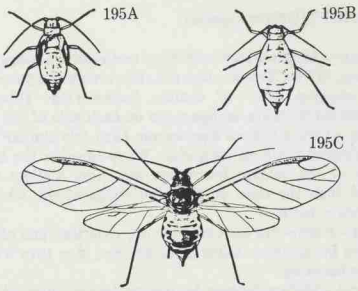



**Fig. 195 Green peach aphid. A, Nymph. B-C, Adults.**

## BIOLOGY

**Distribution**—Occurring in nearly all countries where tobacco is grown, the green peach aphid has a worldwide distribution.

**Host Plants**—The green peach aphid is a pest of a wide range of plants, including tobacco, vegetables, deciduous fruits, flowering plants and ornamental shrubs.

**Damage**—The green peach aphid is an important pest of tobacco in most of the tobacco-growing regions of the United States. It is a particularly important pest in the Georgia and Florida shade-grown tobacco belt and in Connecticut. In the southern United States, the green peach aphid attacks tobacco throughout the growing season, but in Maryland and Kentucky, aphid attacks usually occur in late-season tobacco. Although the green peach aphid occurred on tobacco in North Carolina for many years, it was not reported to be a serious pest until 1946. Severe infestations also occurred in 1947, 1948, and again in 1976 through 1979.

In North Carolina, the green peach aphid attacks tobacco in both plant beds and in the field. Aphids damage tobacco plants by sucking the sap from the leaves. Such feeding weakens plants, causing curled, stunted, distorted leaves. They also contaminate the leaves with cast skins and honeydew in which a black sooty mold fungus develops. Such leaves cure poorly and are low in quality. The green peach aphid also transmits viral plant diseases such as tobacco etch and potato virus Y (PVY).

**Life History**—In southern states the aphids are nearly all females. These adult females give birth to living nymphs. Most of the nymphs develop into green, wingless adults which in turn produce another generation of wingless females. The adults and nymphs of the wingless form look alike. Other nymphs develop into blackish, winged adults. There is no egg stage in North Carolina. Successive generations of females, mainly wingless, are produced throughout the year. This pattern of development occurs as far north as Tennessee and Maryland. In fall, winter and early spring host plants include cabbage, collard, turnip, wild mustard and dock. In spring, winged aphids fly to tobacco.

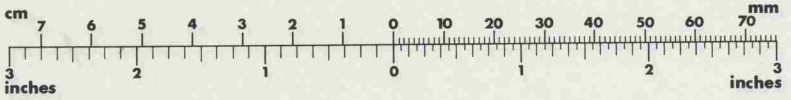
In colder northern climates, a generation of males and egg-laying females develop in the fall. Eggs are laid on certain fruit trees where they overwinter. Eggs hatch in spring, and the second or third generation of aphids infests tobacco. Aphids first appear in the plant beds. Once in the field, aphid populations may increase rapidly and cause serious damage before growers are aware of a problem. Numbers generally decline after plants have flowered, but can remain high on sucker growth.



## CONTROL

Lady beetles, lacewing larvae, syrphid fly larvae and stilt bugs all feed on aphids. Fungus diseases and high temperatures also reduce aphid populations. Winter hosts (collards, mustard, dock, etc.) should be destroyed in the vicinity of plant beds before tobacco plants begin to come up.

A number of insecticides are available to control aphids on tobacco. When 25 percent or more of the plants are moderately infested (100 or so aphids on each of two or more leaves), chemical control is warranted. Repeated applications of certain carbamate insecticides within intervals of a week or less are frequently conducive to aphid buildups. For specific chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Myzus persicae* (Sulzer), Aphididae, HEMIPTERA

## TOBACCO
## Hornworms*

**DESCRIPTION** (two species)

**Adult**—Adult tobacco hornworm moths have a wingspan of about 112 to 127 mm , and are slate brown compared to the ash-gray color of tomato hornworms. Tobacco hornworms have six orange spots on each side of the abdomen whereas tomato hornworms have five similar but less distinct spots on each side. Wavy lines on the hind wings of the tomato hornworm are more distinct and jagged than the lines on the hind wings of the tobacco hornworm moth.

**Egg**—Hornworm eggs are smooth, spherical, and about 1.3 mm in diameter. Light green at first, they turn white before hatching.

**Larva**—Mature tobacco hornworm larvae usually have green bodies with fine, white hairs and seven diagonal stripes on each side; the posterior horn is usually curved and red. Tomato hornworm larvae have eight V-shaped markings on each side; the horn is straight and black. Both species are about 75 to 85 mm long when fully grown.

**Pupa**—Pupae are brown, hard, spindle-shaped, and about 50 mm long. They have a curved, pitcher-handle-like tongue case. The tongue case of the tomato hornworm is longer and more curved than the tongue case of the tobacco hornworm.

**BIOLOGY**

**Distribution**—The tobacco hornworm ranges from
180 southern Canada to Argentina. The range of the tomato hornworm, however, extends only from southern Canada through the southern United States. In North Carolina, the tobacco hornworm is more common in the Eastern and Border Belts while the tomato hornworm is more common in the Old and Middle Belts of the Piedmont.

**Host Plants**—Tobacco is the principle host of hornworms, though other plants of the family Solanaceae are consumed, such as tomato and horsenettle.

**Damage**—These important tobacco pests consume large quantities of leaf tissue, particularly as fifth instars. Two or more healthy larvae can completely defoliate a tobacco plant, leaving only midribs and stem. Severe damage most commonly occurs during late July and August.

**Life History**—Hornworms overwinter in the soil as pupae. Moths of this overwintering generation begin to emerge in early June and may continue to emerge as late as August. Nocturnal in habit, hornworm moths frequently can be seen hovering over plants at dusk. At night, eggs are deposited on the underside of leaves. Each moth deposits one to five eggs per plant visit and may lay up to 2,000 eggs. Larvae emerge about 4 days later, depending upon tem-

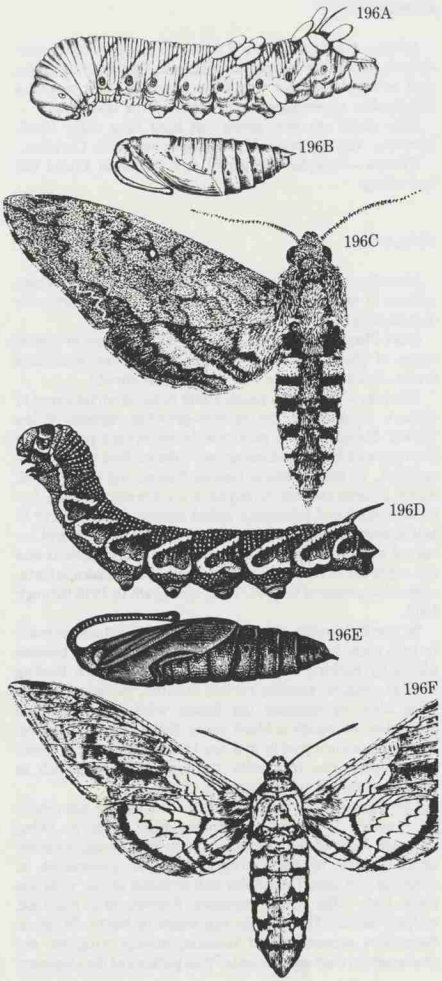
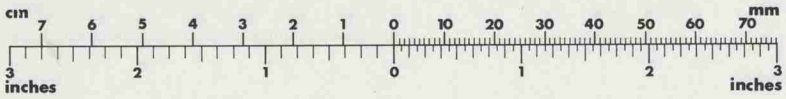



**Fig. 196** Hornworms. A-C, Tobacco hornworm larva with parasite cocoons, pupa, and adult. D-F, Tomato hornworm larva, pupa, and adult.




* Tobacco hornworm, *Manduca sexta* (Linnaeus); Tomato hornworm, *Manduca quinquemaculate* (Haworth), Spingidae LEPIDOPTERA

perature. After feeding for 3 weeks, hornworms burrow into the soil and spend 4 days as prepupae. In summer the pupal period lasts 3 weeks after which a new generation of moths emerges. Heavy egg deposition is common in August and early September due to a peak in overwintering moth emergence along with that of a second (or possibly third) brood.

In North Carolina, at least two and one-half generations occur each year. Early generations are potentially damaging to marketable tobacco. Later ones feed after harvest on noncommercial suckers. However, these last generations are important because they produce the overwintering pupae. Pupae are stimulated to enter diapause (the resting period) after the second week of August by the shorter day lengths they encountered as larvae.

## CONTROL

There are a number of natural enemies that help control hornworm populations. The stilt bug *Jalysus spinosus* (Say) attacks hornworm eggs. *Polistes* spp. wasps prey on larvae. The braconid parasite, *Apanteles congregatus* (Say) lays eggs in first to third instar larvae. Offspring emerge from fourth and fifth instar larvae and spin numerous white cocoons on their backs. *Bacillus sphinigidis* White causes hornworm septicemia disease. Two flies (Tachinidae) lay their eggs on hornworm larvae and the developing fly larvae kill the hornworm pupae.

Use of cultural practices is very important. Early planted tobacco, proper (not excessive) nitrogen fertilization, sucker control, stalk destruction, and fall plowing all help to reduce overwintering populations.

Hornworms should be treated with insecticides when infestations exceed the economic threshold level of 5 or more large, unparasitized larvae, 2.5 cm (1 inch) or longer, found per 50 plants. Parasitized hornworms (with small white cocoons) eat less and are counted at one-fifth of a larva. If applications are necessary during harvest, make them immediately after rather than before priming. For specific chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*

## TOBACCO
### Japanese Beetle*

### DESCRIPTION

**Adult**—The adult is a shiny, metallic-green beetle with copper-brown wing covers. There are six tufts of white hairs on each side of the abdomen near the wing covers. It is about 13 mm long.

**Egg**—The egg is white or cream colored, spherical, and 1.5 mm in diameter when first laid. After being in the ground for about a week, the egg begins to swell and eventually almost doubles its original size.

**Larvae**—The larva or grub is about 26 mm long fully grown and white to grayish white with a reddish-brown head.

**Pupa**—The pupa resembles the mature beetle except, that legs, antennae and wings are closely folded to the body. Pupae are about 13 mm long, first pale cream in color, later becoming tan.

### BIOLOGY

**Distribution**—The Japanese beetle was first found in the United States in 1916 in a nursery near Riverton, N.J. It has now spread north to Maine, south to Florida, and westward to the Mississippi. In North Carolina, this beetle is a more serious pest of burley than flue-cured tobacco.

**Host Plants**—Adult Japanese beetles attack 300 kinds of trees, shrubs, fruits, field crops and garden plants. Larvae are serious pests of turf and other grass crops.

**Damage**—The adult Japanese beetle has become a more important pest of field tobacco in recent years. Adults sometimes migrate into tobacco fields when their favorite vegetation is scarce. Damage commonly occurs in small, localized areas, usually near field borders. The beetles damage tobacco plants by eating ragged holes in the leaves. Larvae feed on grass roots but do not damage tobacco roots.

**Life History**—Japanese beetles overwinter in the soil as partly grown grubs. In spring, they migrate up near the soil surface and feed on grass roots. Pupation occurs in early May in North Carolina. Adult beetles begin to emerge in mid-May but populations do not peak until about mid-July. Soon after emerging, females deposit 40 to 60 eggs in small batches 5 to 8 cm deep in the ground. Under extremely dry conditions, many eggs and larvae perish. However, during warm, wet summers populations thrive and eggs hatch about 2 weeks after deposition. The newly emerged larvae feed until cold weather forces them into hibernation. Only one generation occurs each year.

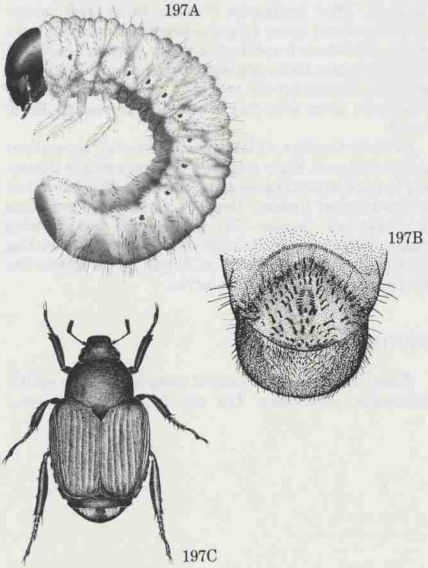



**Fig. 197 Japanese beetle. A, Larva. B, Larval setal pattern. C, Adult.**

### CONTROL

If present in large numbers, Japanese beetles may severly damage tobacco leaves. They should be treated when 10 percent of the plants have several leaves damaged. For specific chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*




**Popillia japonica* Newman, Scarabaeidae, COLEOPTERA

## DESCRIPTION

**Adult**—The small, slender moth has narrow, gray forewings with dark-brown spots. The hind wings are yellowish brown. Both sets of wings are fringed. The moth's body is about 8 mm long and its wingspan about 13 mm. The female is slightly larger than the male.

**Egg**—The oval egg is about 0.5 mm in length. At first white in color, it becomes yellowish before hatching.

**Larva**—The larva, upon hatching, is creamy white with a dark-brown head. The larva varies from greenish to pink as it matures and just before pupation takes on a purplish cast. The larva is 13 to 19 mm long when fully grown.

**Pupa**—White at first with green blotches, the spindle-shaped pupa soon turns brown. It is about 8 mm long and enclosed in a flimsy, white, silken cocoon.

## BIOLOGY

**Distribution**—The potato tuberworm is a cosmopolitan pest, occurring in most areas where potatoes or other solanaceous plants are grown. It occurs in at least 25 states from the Atlantic to Pacific Coasts.

**Host Plants**—The potato tuberworm generally attacks Irish potato foliage and tubers, but will also feed on tobacco, tomato, eggplant, pepper and jimsonweed.

**Damage**—The potato tuberworm, also known as the tobacco splitworm, generally attacks potato foliage and tubers. However, if Irish potatoes are stored or planted near tobacco fields, the potato tuberworm may also damage tobacco. The potato tuberworm feeds and tunnels between the upper and lower surfaces of leaves causing papery, grayish blotches which become brownish and very brittle. Tuberworm injury is usually concentrated on the older, lower leaves.

**Life History**—Potato tuberworms overwinter as larvae or pupae in the soil or in potatoes that are not subjected to freezing temperatures. Most active at dusk and dawn, the weak-flying moths emerge in spring and flutter from plant to plant. Each female deposits, singly, 60 to 200 eggs in 4 days or less. Eggs usually are placed on rough surfaces such as the hairy underside of a leaf. Hatch occurs 3 to 6 days later, depending on temperature. Larvae feed and mature in 7 to 10 days under ideal summer conditions, but take longer at cooler temperatures. When fully grown, larvae leave their hosts and pupate in the soil near the base of plants, in leaf remains, or in some other suitably sheltered site. A new generation of moths emerges in 6 to 9 days. Five or six generations occur each year.

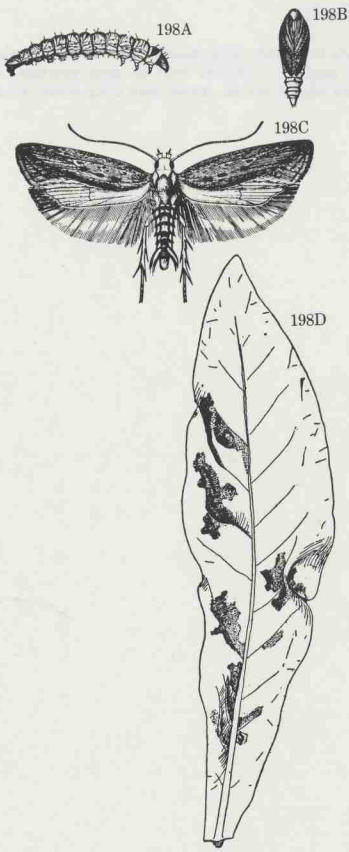
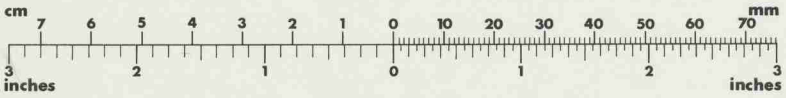



**Fig. 198** Potato tuberworm. A, Larva. B, Pupa. C, Adult. D, Damage.






* *Phthorimaea operculella* (Zeller), Gelechiidae, LEPIDOPTERA

## CONTROL

Potato tuberworm infestations can be avoided if tobacco is not grown in rotation with or near potatoes. Irish potatoes should not be stored near unharvested tobacco.

Tuberworm-infested tobacco should be treated when 25 percent of the plants are damaged. For chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*

## DESCRIPTION

**Adult**—The beady-eyed adults are about 32 mm long, brown, and covered with fine, short hairs. They have short front wings, long and membranous hind wings which fold under the forewings and short, broad, shovel-like front legs for digging.

**Egg**—Eggs are oval and about 3.3 mm long.

**Nymph**—Nymphs are similar in appearance to adults but are smaller and wingless.

## BIOLOGY

**Distribution**—The mole cricket occurs from North Carolina to Texas. In North Carolina it is more prevalent in the Coastal Plain.

**Host Plants**—The nymphs and adults tunnel in the soil and feed on decomposing organic matter and roots. By tunneling, mole crickets injure tobacco seedlings, garden vegetables, peanuts, strawberries and grasses.

**Damage**—The southern mole cricket is one of several species of mole crickets which injure plant bed tobacco. Tobacco seedlings are uprooted by the tunneling activity of these insects. Mole crickets may also cause damage by drying out the soil and feeding on roots.

**Life History**—The southern mole cricket overwinters as a nymph or adult, migrating downward in cold weather. In the spring eggs are laid in the soil in cells constructed by the females. About 35 eggs are placed in each cell. Hatch occurs in 10 to 40 days depending on temperature. Nymphs develop through six or seven molts and either become adults by winter or overwinter as immatures. One generation occurs per year.

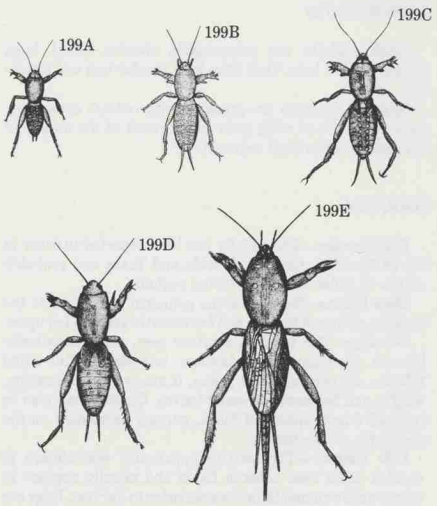
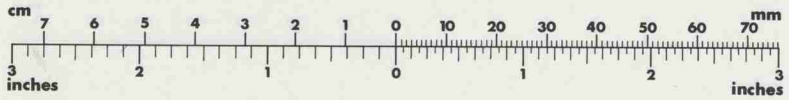



**Fig. 199 Southern mole cricket. A-D, Nymphs. E, Adult.**

## CONTROL

Mole crickets may be controlled in tobacco plant beds by using an insecticide bait or drench. Baits should be scattered by gloved hand at dusk in the infested areas. For specific chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*






* *Scapteriscus acletus* Rehn & Hebard, Gryllotalpidae, ORTHOPTERA

## TOBACCO
### Suckfly*

### DESCRIPTION

**Adult**—Adults are green-black, slender, plant bugs about 3.3 mm. long. They have long slender legs and antennae.

**Nymph**—Nymphs are greenish with reddish eyes. They have two pairs of wing pads which reach to the middle of the second abdominal segment.

### BIOLOGY

**Distribution**—The suckfly has been reported to occur in North Carolina, Georgia, Florida and Texas and probably occurs in other tobacco-growing regions.

**Host Plants**—Tobacco is the principal host plant of the suckfly, although tomato and horsenettle are also fed upon.

**Damage**—The suckfly, a minor pest, may periodically become abundant and damage late-season flue-cured tobacco. By sucking plant juices, it may reduce coloration, weight and thickness of cured leaves. Quality may also be reduced due to specks of black, gummy excrement on the underside of the leaves.

**Life History**—The suckfly apparently overwinters in wooded areas near tobacco fields and usually appears in tobacco about a month or 6 weeks prior to harvest. Eggs are laid singly in leaf tissue and hatch in about 4 days. Nymphs feed on the underside of leaves and molt five times before becoming adults.



### CONTROL

If necessary, suckflies may be controlled with insecticides on late-planted tobacco. Treatment should begin when 25 percent or more of the plants show readily visible signs of infestation (e.g. excrement and suckfly nymphs on underside of leaves). For specific chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*

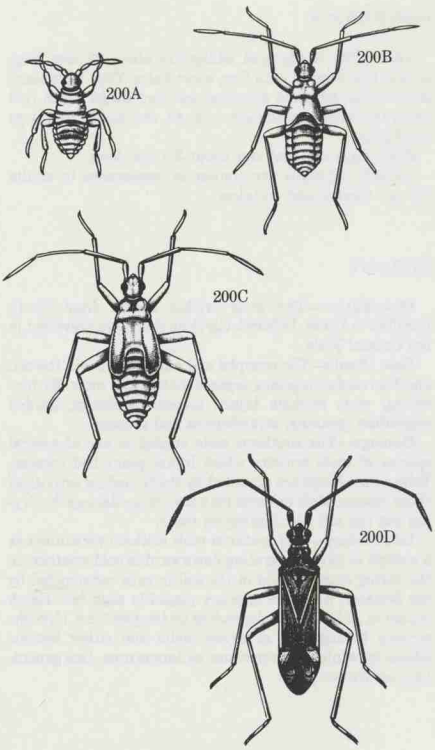
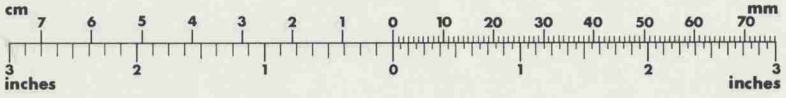



**Fig. 200 Suckfly. A-C, Nymphs. D, Adult female.**




* *Cyrtopeltis notatus* Distant, Miridae, HEMIPTERA

## DESCRIPTION

**Adult**—The adult is a hard-shelled, black, very active beetle about 1.5 mm long. Wing covers have rows of fine distinct punctures. The eyes are black and the antennae 12-segmented.

**Egg**—The egg is very small (smaller than a pinhead), white when first laid, elongate and pointed at one end.

**Larva**—The larva is 4.3 to 4.8 mm long when fully developed with a slender, white, 12-segmented body and brownish head. It has three pairs of short, jointed legs on the thorax and a proleg on the last segment.

**Pupa**—The pupa is whitish with the head bent downward which is typical of pupae of the Chrysomelidae family (leaf-feeding beetles).

## BIOLOGY

**Distribution**—The tobacco flea beetle is present wherever tobacco is grown from Connecticut to Florida.

**Host Plants**—The tobacco flea beetle is a pest of tobacco, tomato and potato and will also attack jimsonweed, horsenettle and ground cherry.

**Damage**—The tobacco flea beetle is a major pest of tobacco seedlings in plant beds and of tobacco plants in the field. Adult flea beetles damage tobacco plants from the time the plants begin growing in plant beds until harvest by chewing small, rounded holes through the leaves resulting in a "shot hole" appearance. Larvae feed on the roots of the tobacco plant and may tunnel into stalks. Large numbers of larvae may kill seedlings or severely damage newly set plants.

**Life History**—Adults generally overwinter in litter and trash around tobacco fields. Some may hibernate in tobacco fields if stalks were not destroyed after harvest. In early spring adults migrate into plant beds. They attack seedling and lay eggs on the soil surface beneath tobacco plants. Eggs hatch in about a week and the small, slender, white larvae feed on and tunnel in the roots and stems of tobacco plants for 4 to 5 weeks. There are three instars. After 4 to 7 days as pupae in the soil, adults emerge. With three to four generations per year, tobacco flea beetles continue to attack field tobacco until after harvest when they migrate to litter and trash surrounding the fields for hibernation.

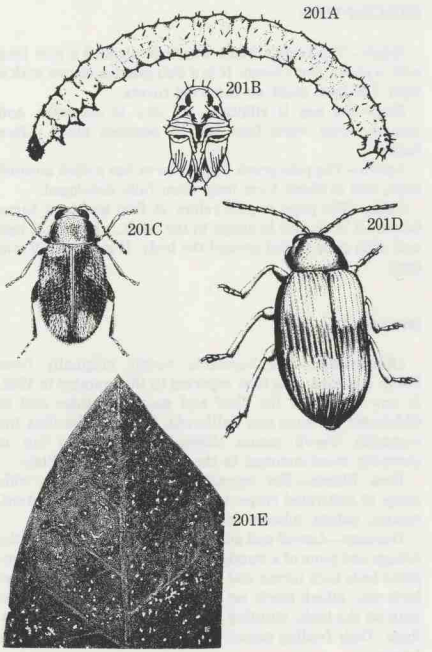


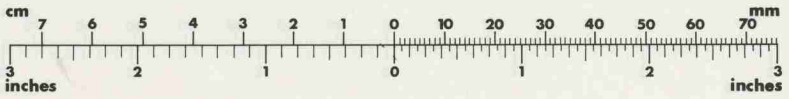

**Fig. 201 Tobacco flea beetle. A, Larva. B, Pupa. C-D, Adults. E, Beetle injury to leaves.**

## CONTROL

Control of the tobacco flea beetle in plant beds is important because the plant bed is often the source of field infestations and because healthy seedlings are important for a good crop. Trash around plant beds where beetles hibernate should be destroyed and plant beds should be covered. A braconid wasp, *Microtonus epitricis* (Viereck), is a natural enemy of the adult tobacco flea beetle.

A number of insecticides are available to control the flea beetle in both plant beds and in the field when flea beetle populations reach the economic threshold which averages eight or more adults per small plant. Larger plants should be sprayed when there are 62 or more beetles per plant late in the season. For specific chemical control recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*






* *Epitrix hirtipennis* (Melsheimer), Chrysomelidae, COLEOPTERA

## TOBACCO
### Vegetable Weevil*

### DESCRIPTION

**Adult**—The female adult weevil is about 6.4 mm long with a short, stout snout. It is a dull grayish brown with a light V-shaped mark on the wing covers.

**Egg**—The egg is elliptical, 0.5 mm in diameter, and creamy white when first laid. It becomes black before hatch.

**Larva**—The pale green, legless larva has a dark mottled head, and is about 1 cm long when fully developed.

**Pupa**—The pupa is pale yellow at first and later turns brown. It is similar in shape to the adult, with snout, legs and wing pads folded around the body. It is about 7.9 mm long.

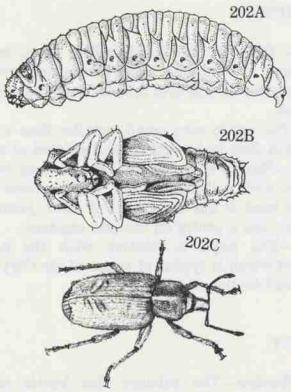



**Fig. 202 Vegetable weevil. A, Larva. B, Pupa. C, Adult.**

### BIOLOGY

**Distribution**—The vegetable weevil, originally from South America, was first reported in this country in 1922. It now occurs in the Gulf and southern states and in Oklahoma, Arizona and California. In North Carolina the vegetable weevil occurs throughout the state but is generally more common in the southern Coastal Plain.

**Host Plants**—The vegetable weevil feeds on a wide range of cultivated crops: turnip, carrot, collard, mustard, tomato, potato, tobacco and also a number of weeds.

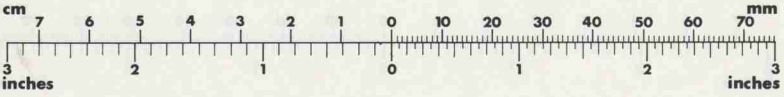
**Damage**—Larval and adult vegetable weevils attack the foliage and roots of a number of vegetable crops. In tobacco plant beds both larvae and adults attack the seedlings and both may attack newly set plants in the field. Larvae feed both on the buds, stunting growth, and the leaves of seedlings. Their feeding causes irregularly shaped holes in the leaves.



**Life History**—The adult vegetable weevil is active during fall, winter and spring and aestivates (enters dormancy) during the summer in trash, leaves or grass at the edges of fields. Reproduction is parthenogenetic (no males, females lay eggs which develop into females) and some individuals may live 2 years. After coming out of aestivation, adults feed for several days to a month before depositing eggs on turnips or collards. Oviposition begins in fall and may continue into spring of the next year. Hatch occurs after an incubation period of 2 or more weeks depending on the temperature. Larvae feed on tobacco seedlings (and other vegetable crops) and become fully grown in 23 to 45 days. Pupation occurs in earthen cells in the soil in spring or in fall and late winter and will last from a few days to 2 weeks depending on the temperature. Adults emerge from January to June. The length of time from egg hatch to adult emergence may vary from 1 to 4 months. There is one generation per year.

### CONTROL

Cultivation in fall and winter is important in reducing populations. Insecticides are also available for control of the vegetable weevil. Treatment should begin when 5 percent or more of small, newly set plants (within 3 weeks after transplanting) are killed or injured. For specific recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*




* *Listroderes costirostris obliquus* (Klug), Curculionidae, COLEOPTERA

**DESCRIPTION** (several species)

**Adult**—About 11 mm long, these black beetles are covered with dark-gray and grayish-brown scales. They have two longitudinal stripes and a marginal band of white hairs. All whitefringed beetles are females and are incapable of flight.

**Egg**—The white, oval eggs are slightly less than 1 mm long and become pale yellow before hatching. They are covered with a sticky secretion which soon hardens.

**Larva**—The slightly curved, yellowish-white larvae are legless, have a light-brown head, and measure up to 13 mm long.

**Pupa**—Approximately 13 mm in length, the white pupae gradually darken as they mature.

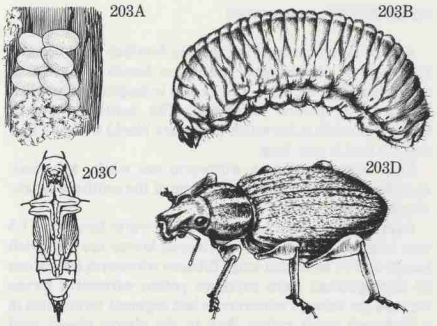



**Fig. 203 Whitefringed beetle. A, Eggs. B-C, Larvae. D, Adult.**

## BIOLOGY

**Distribution**—Native to South America, whitefringed beetles were first reported in this country in 1936 as pests of peanuts in Florida. They now occur from Florida to New Jersey and westward to Missouri and eastern Texas. They were first found in North Carolina in 1942 and now occur in scattered localities throughout the state.

**Host Plants**—Whitefringed beetles infest at least 385 plant species. However, plants with taproots and smooth, broad leaves are most commonly damaged. Some important host plants include tobacco, peanut, corn, Irish potato, soybean, velvet bean, strawberry, okra, cowpea, sweet potato, bean, cotton, cauliflower, cabbage, cocklebur, and aster. Small grains can also be infested but their fibrous root systems are more tolerant to damage.

**Damage**—Whitefringed beetles are relatively innocuous foliage feeders which leave sawtooth cuts on outer edges of leaves. The larvae, however, are particularly destructive to taproots and underground stems. Infested plants turn yellow and, if severely injured, wilt and die. However, damage to N. C. tobacco is rarely of economic concern.

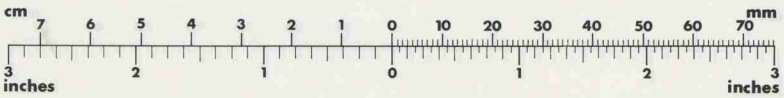
**Life History**—Whitefringed beetles usually overwinter as grubs although eggs may survive the winter in protected locations. After feeding on roots of tobacco throughout March, April, and May, the grubs burrow 5 to 15 cm into the soil and pupate for 13 days. By early July, most larvae have matured and entered the pupal stage. Adults emerge mainly in June or July. There are no males, and females produce eggs without mating. Eggs are usually deposited in clusters of 15 to 20 in the soil around the base of host plants. The actual number of eggs laid, however, depends on the type of host upon which the adults are feeding. Beetles raised on legumes or other broadleaf plants lay more eggs than those raised on grasses. Unless they overwinter, the eggs hatch 17 days after oviposition. The newly emerged larvae infest the roots of host plants until the onset of cold weather. One generation occurs each year.

## CONTROL

Summer legumes are favorable to high beetle populations. Grasses, including corn and small grains are poor food for adults. Therefore, in known problem fields, tobacco should be rotated with grass crops to reduce pest populations.

In the past, quarantines were used to prevent the movement of infested soil and plant materials. At the present time, there is no insecticide registered for control of whitefringed beetles on tobacco. For the most up-to-date control information, contact the North Carolina State Agricultural Extension Service.






* *Graphognathus* spp., Curculionidae, COLEOPTERA

## TOBACCO
### Wireworms*

**DESCRIPTION** (two species)

**Adult**—Adult wireworms are the familiar click beetles. The body of the tobacco wireworm beetle is flattened, somewhat tapered, hard, 7 to 11 mm in length, and reddish brown with yellow markings. The southern potato wireworm adult is brownish (some are black) with tan legs and 6.0 to 8.5 mm long.

**Egg**—Eggs of tobacco wireworm are white, spherical, and about 0.5 mm in diameter. Eggs of the southern potato wireworm are similar.

**Larva**—Newly hatched tobacco wireworm larvae are 1.5 mm long and white. Fully developed larvae are yellowish brown and 14 to 19 mm long. Tobacco wireworm larvae can be distinguished from southern potato wireworm larvae because the tobacco wireworm's last segment terminates in a V-shaped notch rather than in the almost closed, oval notch of the southern potato wireworm.

**Pupa**—Tobacco wireworm pupae are first white, but later change to reddish brown. They are slightly larger than the adults (about 12.7 mm in length). Southern potato wireworm pupae are also slightly larger than adults and change from white to creamy yellow.

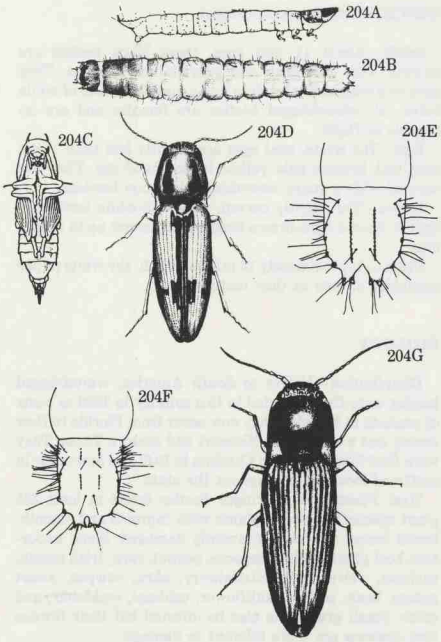



**Fig. 204 Wireworms. A-E, Tobacco wireworm larvae, pupa, adult, and last abdominal segment. F-G, Southern potato wireworm last abdominal segment and adult.**

### BIOLOGY

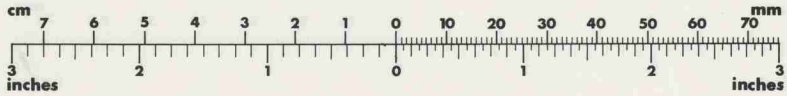
**Distribution**—The tobacco wireworm is common in the southeastern states. It is very common throughout the Coastal Plain of North Carolina. The southern potato wireworm, introduced from South America, now occurs from North Carolina to Louisiana. It is widely distributed in South Carolina and in the Border Belt counties of North Carolina. However, economic injury also occurs in the other belts.



**Host Plants**—Tobacco, corn, cotton, potatoes and other crops are hosts of the tobacco wireworm. Irish potatoes are the preferred host of the southern potato wireworm; however, newly set tobacco seedlings, roots of sweet potato, corn seedlings, and carrot are also infested. Less frequently attacked are melons, beet roots, and strawberry fruits that touch the soil surface.

**Damage**—The tobacco wireworm and the southern potato wireworm are the most common of several wireworm species that attack the stems of newly set tobacco. Wireworms damage newly set tobacco plants by boring into and tunneling in the stalks. Some plants may be killed or stunted which results in the need to replant. The resulting irregular stand has plants of varying size and maturity. More management problems occur with topping, suckering, and harvesting. The amount of damage varies from year to year and from field to field depending on weather, transplants, soil type, crop rotation, etc. Wireworms are more commonly a problem in Coastal Plain soils, especially if the field has not been plowed during fall and winter, or if the field was planted to a winter cover crop. However, the use of a cover crop is usually warranted in terms of erosion control.

**Life History**—The tobacco wireworm overwinters in the larval stage in North Carolina. Most larvae begin to pupate in mid-May and adult beetles emerge in June and July. Eggs (average 240/female) are laid on or slightly beneath the soil surface. After hatch, larvae bore into and tunnel in the stalks of tobacco plants. In North Carolina, the life cycle requires about 348 days (egg, 10 days; larva, 315 days; pupa, 10 days; and adult preoviposition period, 13 days).




* Tobacco wireworm, *Conoderus vespertinus* (Fabricius); Southern potato wireworm, *Conoderus falli* Lane, Elateridae, COLEOPTERA

One generation occurs each year, though a very small number of larvae may survive a second winter.

The southern potato wireworm also overwinters in the larval stage. Two generations of the southern potato wireworm occur per year in coastal South Carolina: a short-cycle summer brood and a long-cycle winter brood. Adult beetles emerge in May and June and again in late August and September. Summer-brood larvae infest plants throughout summer whereas winter-brood larvae are a problem in early fall and again in early spring.

## CONTROL

Wireworms may be controlled by a number of insecticides which should be applied and incorporated during or into the soil prior to setting tobacco plants. For specific chemical recommendations, consult the current *North Carolina Agricultural Chemicals Manual.*

## TOBACCO
## References

### GENERAL


Chamberlain, F.S. and A.H. Madden. 1942. Insect pests of cigar-type tobaccos in the southern districts. U.S. Dep. Agr. Circ. 639. 54 pp.

Collins, W.K., S.N. Hawks, F.A. Todd, W.F. Congleton, R. Watkins, C.R. Pugh, and S. Southern. 1979. 1980 Tobacco Information. North Carolina Agr. Ext. Service Pub. Ag-187. 78 pp.

Dominick, C.B. 1973. Early season control of several foliage-feeding tobacco insects. Tobacco Sci. 17: 82-3.

Kuitert, L.C. and A.N. Tissot. 1956. Insect pests of flue-cured tobacco and their control. Florida Agr. Exp. Sta. Bull. 573. 34 pp.

Mistric, W.J., Jr. and F.D. Smith. 1974. Leptophos and other insecticides for control of insects on flue-cured tobacco. Tobacco Sci. 18: 87-8.

Nettles, W.C., H.A. McGee, J.M. Lewis, and J.R. Mattison. 1947. Tobacco insects and diseases in South Carolina. South Carolina Agr. Exp. Sta. Bull. 109. 40 pp.

Rabb, R.L. 1971. Naturally-occurring biological control in the eastern United States, with particular reference to tobacco insects, pp. 294-311. *In* Biological Control, ed. C.B. Huffaker. Plenum Publ. Corp., New York. 511 pp.

Rabb, R.L., F.E. Guthrie, H.E. Scott, and C.F. Smith. 1955. Tobacco insects of North Carolina and their natural enemies. North Carolina Agr. Exp. Sta. Bull. 394. 31 pp.


### BUDWORMS


Allen, N. and F. Lawson. 1962. The tobacco budworm, how to control it. U.S. Dep. Agr. Farmers' Bull. 2174. 12 pp.

Danks, H.V., R.L. Rabb, and P.S. Southern. 1979. Biology of insect parasites of *Heliothis* larvae in North Carolina. Georgia Entomol. Soc. J. 14: 36-64.

Girardeau, J. H., Jr. 1969. The effect of level of fertilization and variety of flue-cured tobacco on damage by the tobacco budworm *Heliothis virescens*. Georgia Entomol. Soc. J. 4: 85-9.

Guthrie, F.E., R.L. Rabb, R.L. Baron, and J.E. Flynn. 1957. Methods and materials for controlling budworms on flue-cured tobacco. J. Econ. Entomol. 50: 328-32.

Johnson, A.W. 1978. Effects of tobacco budworm control at different treatment levels with several insecticides on flue-cured tobacco. J. Econ. Entomol. 71: 183-5.

Mistric, W.J., Jr. and F.D. Smith. 1969. Behavior of tobacco budworm larvae on flue-cured tobacco and possibilities of improving the effectiveness of insecticidal treatments applied mechanically for control. J. Econ. Entomol. 62: 16-21.

Neunzig, H.H. 1969. The biology of the tobacco budworm and the corn earworm in North Carolina. North Carolina Agr. Exp. Sta. Tech. Bul. 196. 76 pp.

Rabb, R.L., H.H. Neunzig, and H.V. Marshall, Jr. 1964. Effect of certain cultural practices on the abundance of tobacco hornworms, tobacco budworms, and corn earworms on tobacco after harvest. J. Econ. Entomol. 57: 791-2.

Reagan, T.E., R.L. Rabb, and W.K. Collins. 1974. Tobacco budworm: influence of early topping and sucker control practices on infestations in flue-cured tobacco. J. Econ. Entomol. 67: 551-2.


### CABBAGE LOOPER


Elsey, K.D. and R.L. Rabb. 1967. Biology of the cabbage looper on tobacco in North Carolina. J. Econ. Entomol. 60: 1636-9.

Elsey, K.D. and R.L. Rabb. 1970. Analysis of the seasonal mortality of the cabbage looper in North Carolina. Ann. Entomol. Soc. Amer. 63: 1597-1604.


### CUTWORMS


Chamberlin, F.S. and N. Allen. 1957. Tobacco cutworms—how to control them. U.S. Dep. Agr. Leafl. 417. 8 pp.

Crumb, S.E. 1929. Tobacco cutworms. U.S. Dep. Agr. Tech. Bull. 88. 180 pp.

Snow, J.W. and P.S. Callahan. 1968. Biological and morphological studies of the granulate cutworm, *Feltia subterranea* (F.) in Georgia and Louisiana. Georgia Agr. Exp. Sta. Res. Bull. 42. 23 pp.


### GREEN JUNE BEETLE


Davis, J.J. and P. Luginbill. 1921. The green June beetle or fig eater. North Carolina Agr. Exp. Sta. Bull. 242. 41 pp.

Dominick, C.B. 1952. Green June beetle larvae control in tobacco plantbeds. Virginia Agr. Exp. Sta. Bull. 454. 15 pp.

Dominick, C.B. 1955. Further experiments with insecticides for control of green June beetle larvae. J. Econ. Entomol. 48: 621-2.

Scott, L.B. 1956. Tests with new insecticides to control green June beetle larvae in tobacco plant beds. J. Econ. Entomol. 49: 868-9.

U.S. Department of Agriculture. 1962. Controlling green June beetle larvae in tobacco plant beds. Leafl. 504. 6 pp.


### GREEN PEACH APHID


Chamberlin, F.S. 1958. History and status of the green peach aphid as a pest of tobacco in the United States. U.S. Dep. Agr. Tech. Bull. 1175. 12 pp.

Kennedy, J.S. and H.L.G. Stroyan. 1959. Biology of aphids. Annu. Rev. Entomol. 4: 139-60.

Kennedy, J.S., M.F. Day, and V.F. Eastop. 1962. A conspectus of aphids as vectors of plant viruses. The Eastern Press Ltd., London. 114 pp.

Lawson, F.R. and F.S. Chamberlin. 1960. Aphids on tobacco . . . how to control them. U.S. Dep. Agr. Leafl. 405. 8 pp.

Mistric, W.J., Jr. and F. D. Smith. 1973. Effect of dosage and formulation of carbaryl on tobacco flea beetle, tobacco budworm, and green peach aphid infestations on flue-cured tobacco. J. Econ. Entomol. 66: 1226-8.

Semtner, P.J. 1977. Influence of *Myzus persicae* (Sulzer) (Homoptera: Aphididae) infestations on flue-cured tobacco yield and quality. New York Entomol. Soc. J. 85: 198-9.

Thurston, R. 1965. Effect of insecticides on the green peach aphid, *Myzus persicae* (Sulzer), infesting burley tobacco. J. Econ. Entomol. 58: 1127-30.

Van Emden, H.F., V.F. Eastop, R.D. Hughes, and M.J. Way. 1969. The ecology of *Myzus persicae*. Annu. Rev. Entomol. 14: 197-270.

Webster, J.A. and R. Thurston. 1965. Occurrence of alate and apterous green peach aphids on burley tobacco in Kentucky. Ann. Entomol. Soc. Amer. 58: 132.

### HORNWORMS

Allen, N., C.R. Hodge, A.R. Hopkins, and J.D. Early. 1953. Tobacco hornworm control with organic insecticides. J. Econ. Entomol. 46: 604-8.

Creighton, C.S., W.S. Kinard, and N. Allen. 1961. Effectiveness of *Bacillus thuringiensis* and several chemical insecticides for the control of budworms and hornworms on tobacco. J. Econ. Entomol. 54: 1112-4.

Gentry, C.R., F.R. Lawson, C.M. Knott, J.M. Stanley, and J.J. Lam, Jr. 1967. Control of hornworms by trapping with blacklight and stalk cutting in North Carolina. J. Econ. Entomol. 60: 1437-42.

Lawson, F.R., R.L. Rabb, F.E. Guthrie, and T.G. Bowery. 1961. Studies of an integrated control system for hornworms on tobacco. J. Econ. Entomol. 54: 93-7.

Lawson, F.R. and R.L. Rabb. 1964. Factors controlling hornworm damage to tobacco and methods of predicting outbreaks. Tobacco Sci. 8: 145-9.

Madden, A.H. 1945. Biology of the tobacco hornworm in the southern cigar-tobacco district. U.S. Dep. Agr. Tech. Bull. 896. 51 pp.

Rabb, R.L. 1966. Diapause in *Protoparce sexta* (Lepidoptera: Sphingidae). Ann. Entomol. Soc. Amer. 59: 160-5.

Rabb, R.L. 1969. Environmental manipulations as influencing populations of tobacco hornworms. Proc. Annu. Tall Timbers Conf. on Ecol. Anim. Control by Habitat Range, February 27-28, 1969: 175-91.

Rabb, R.L. and F.R. Lawson. 1957. Some factors influencing the predation of polistes wasps on the tobacco hornworm. J. Econ. Entomol. 50: 778-84.

Rabb, R.L., H.H. Neunzig, and H.V. Marshall, Jr. 1964. Effect of certain cultural practices on the abundance of tobacco hornworms, tobacco budworms, and corn earworms on tobacco after harvest. J. Econ. Entomol. 57: 791-2.

Reagan, T.E. and R.L. Rabb. 1977. Some factors influencing development, behavior and survival of hornworms on post-harvest tobacco. Ann. Entomol. Soc. Amer. 70: 140-3.

Reagan, T.E., R.L. Rabb, and W.K. Collins. 1978. Selected cultural practices as affecting production of tobacco hornworms on tobacco. J. Econ. Entomol. 71: 79-82.

Thurston, R. 1977. The synchronization of behavioral changes in the tobacco hornworm with the emergence of its parasite, *Apanteles congregatus*. Tobacco Sci. 21: 72-3.

Yamamato, R.T. 1968. Mass rearing of the tobacco hornworm. I. Egg production. J. Econ. Entomol. 61: 170-4.

### JAPANESE BEETLE

Fleming, W.E. 1963. The Japanese beetle: how to control it. U.S. Dep. Agr. Farmers' Bull. 2151. 16 pp.

Fleming, W.E. 1970. The Japanese beetle in the United States. U.S. Dep. Agr., Agr. Res. Service Agr. Handbook 236. 30 pp.

Hadley, C.H. and I.M. Hawley. 1934. General information about the Japanese beetle in the United States. U.S. Dep. Agr. Circ. 332. 23 pp.

Hawley, I.M. and F.W. Metzger. 1940. Feeding habits of the Japanese beetle. U.S. Dep. Agr. Circ. 547. 32 pp.

### POTATO TUBERWORM

Dudley, J.E., Jr., B.J. Landis, and W.A. Shands. 1952. Control of potato insects. U.S. Dep. Agr. Farmers' Bull. 2040. 52 pp.

Graf, J.E. 1917. The potato tuber moth. U.S. Dep. Agr. Dep. Bull. 427. 56 pp.

Morgan, A.C. and S.F. Crumb. 1914. The tobacco splitworm. U.S. Dep. Agr. Dep. Bull. 59. 7 pp.

### SOUTHERN MOLE CRICKET

Tappan, W.B. 1963. Mole cricket control in shade tobacco plant beds. Florida Entomol. 46: 235-41.

U.S. Department of Agriculture. 1953. Control of mole crickets. Leafl. 237. 8 pp.

### SUCKFLY

Gilmore, J.U. 1950. The suckfly on tobacco, suggestions for control. U.S. Dep. Agr. Bur. Entomol. and Plant Quarantine Pub. EC-15. 8 pp.

### TOBACCO FLEA BEETLE

Dominick, C.B. 1943. Life history of the tobacco flea beetle. Virginia Agr. Exp. Sta. Bull. 355. 39 pp.

Dominick, C.B. 1968. Late-season feeding and emergence of the tobacco flea beetle. J. Econ. Entomol. 61: 1743-4.

Dominick, C.B. 1969. Evaluation of insecticides for tobacco flea beetle control. Tobacco Sci. 13: 164-5.

Dominick, C.B. 1971. Overwintering and spring emergence of the tobacco flea beetle. J. Econ. Entomol. 64: 88-9.

Dominick. C.B. 1972. Tests with insecticides for tobacco flea beetle control in plant beds and on newly transplanted tobacco. Tobacco Sci. 16: 104.

Mistric, W.J., Jr. and F.D. Smith. 1970. Organophosphorus and carbamate insecticides as substitutes for DDT in controlling the tobacco flea beetle on flue-cured tobacco. J. Econ. Entomol. 63: 509-11.

### VEGETABLE WEEVIL

Beckham, C.M. 1953. Biology and control of the vegetable weevil in Georgia. Georgia Agr. Exp. Sta. Tech. Bull. 2. 36 pp.

High, M.M. 1939. The vegetable weevil. U.S. Dep. Agr. Circ. 530. 26 pp.

Tappan, W.B. 1974. Vegetable weevil: control in cigar-wrapper and flue-cured tobacco plant beds. J. Econ. Entomol. 67: 699-701.

### WHITEFRINGED BEETLES

Roberts, R.A. 1952. Whitefringed beetle, pp. 608-11. *In* Insects. U.S. Dep. Agr. 1952 Yearbook of Agr. 780 pp.

## TOBACCO
### References

U.S. Department of Agriculture. 1972. Controlling whitefringed beetles. Leafl. 550. 8 pp.

Young, H.C., B.A. App, J.B. Gill, and H.S. Hollingwworth. 1950. Whitefringed beetles and how to combat them. U.S. Dep. Agr. Circ. 850. 15 pp.

### WIREWORMS

Creighton, C.S., W.S. Kinard, and N. Allen. 1963. The southern potato wireworm, a new pest of tobacco. J. Econ. Entomol. 56: 292-4.

Day, A., F.P. Cuthbert, Jr., and W.J. Reid, Jr. 1971. The southern potato wireworm, its biology and economic importance in coastal South Carolina. U.S. Dep. Agr. Tech. Bull. 1443. 33 pp.

Guthrie, F.E., R.L. Rabb, and D.A. Mount. 1963. Distribution and control of cyclodiene-resistant wireworms attacking tobacco in North Carolina. J. Econ. Entomol. 56: 7-10.

Mistric, W.J., Jr. and F.D. Smith. 1969. Chemical control of tobacco and southern potato wireworms on flue-cured tobacco during 1964-1968. J. Econ. Entomol. 62: 712-5.

Rabb, R.L. 1963. Biology of *Conoderus vespertinus* in the Piedmont section of North Carolina (Coleoptera: Elateridae). Ann. Entomol. Soc. Amer. 56: 669-76.

*Abdomen*, in insects, the posterior of the three main body regions

*Acaricide*, a chemical which kills and controls mites and ticks

*Aestivation*, summer dormant or resting period

*Agronomic crop*, a field crop, as opposed to orchard, fruit, or vegetable crop

*Alate*, winged

*Anal*, pertaining to the last abdominal segment

*Antennae*, the paired, segmented, sensory appendages located on the head of an insect, millipede, centipede, sowbug, etc.

*Anterior*, at or near the front

*Apex*, uppermost point, top, tip

*Aphid*, a tiny, soft bodied, winged or wingless insect that sucks sap from plants and has a pair of cornicles extending from its abdomen; commonly referred to as a plant louse

*Apical*, pertaining to the apex; at or near the top

*Apterous*, wingless

*Armyworm*, a name ascribed to the caterpillars of certain moths, particularly those caterpillars which migrate in an army-like group

*Arthropod*, an animal having a segmented body, an exoskeleton, and jointed legs

*Awns*, bristle-like fibers occurring on a head of grain, such as barley, oats, rye, or wheat

*Axil*, the acute angle formed by a leaf, twig, or branch and the main stem of the plant

*Bacterial wilt*, a disease of plants often transmitted by sap-sucking insects; the causative bacteria clog the plant's water-conducting tissues by producing slime

*Bait*, a pesticide and food substance mixture used to attract and kill various pests

*Basal*, at or near the base

*Billbug*, a type of weevil (snout beetle) which uses its beak to feed on tender, young, unfurled leaves hidden within grass stems

*Biological control*, a pest control strategy which employs methods such as introduction, augmentation, and mass release of parasites, predators, and disease organisms

*Biotype*, a strain of an insect species having its own unique set of characteristics; sometimes referred to as a race

*Blast*, wither or dry up; usually a symptom of plant disease or insect injury associated with small grain or sorghum seed heads

*Blight*, a rapid plant dieback, usually involving drying, withering, loss of color and often death

*Boll*, seed pod of the cotton plant

*Bract*, one of several leaf-like structures occurring at the base of flowers or seed pods

*Broadleaf (or broadleaved) plant*, a plant with broad, flat leaves as opposed to the needle-like leaves of evergreens or the narrow, blade-like leaves of grasses

*Brood*, individuals, usually offspring of the same parents, that hatch at approximately the same time

*Bug*, in the truest sense, any insect belonging to the order Heteroptera, e.g. stink bugs

*Calyx*, leaf-like structure situated between the bracts and the flower petals (not a part of all fruiting structures)

*Canopy*, foliage which forms a covering over the ground, producing a dense shade

*Carmine*, a red or purplish-red color; crimson

*Carpel*, that part of the flower in which seed develop; in cotton, each of the 4 rind-like sections of the boll

*Caterpillar*, the larva of a moth, butterfly, skipper, or sawfly

*Caudal*, at or near the tail

*Cell*, closed area of an insect wing bounded by veins

*Centimeter*, metric unit of length; 0.394 inch

*Certified seed*, seed meeting certain basic standards for purity and viability

*Chemical Control*, the use of pesticides, attractants, repellants, growth regulators, etc. to control or prevent the buildup of economically damaging pests

*Chlorinated hydrocarbons*, a group of synthetic, organic, insecticidal chemicals known for their persistence in the environment and for their action as nerve poisons

*Chlorosis*, yellowing of normally green plant tissues; a common symptom of insect damage, disease or nutrient deficiency

*Class*, in the animal kingdom, a division lower than a phylum and higher than an order, e.g. the Class Hexapoda or Insecta

*Click beetle*, an adult of the insect family Elateridae; a beetle capable of jumping into the air by "clicking" 2 body segments together

*Cocoon*, a silken or fibrous case spun by a larva to afford protection during its pupal period

*Coleoptile*, the protective sheath which covers the leaves of a germinating seedling

*Complete metamorphosis*, the development of an insect through four morphologically different life stages: egg, larva, pupa, and adult

*Contiguous*, adjacent, adjoining; next to each other

*Convex*, raised or curved like the surface of a sphere

*Cornicle*, one of a pair of "honey tubes" which extend from the abdomen of an aphid

*Corrugated*, having parallel grooves or ridges

*Cosmopolitan*, common throughout most of the world

*Cover crop*, a crop grown in orchards between rows of trees or in fields between cropping seasons to prevent erosion and loss of soil nutrients

*Crochets*, curved spines located on the tips of the prolegs of lepidopterous larvae

*Crop residue*, stalks, dried leaves, seed pods, etc. left in the field after harvest

*Crown*, basal area of stem where roots emerge

*Crucifer*, any plant of the mustard family, including cabbage, turnip, collard, mustard, and radish

*Cucurbit*, any plant of the gourd family, including pumpkin, squash, and cucumber

*Cultural control*, a pest control strategy employing methods such as crop rotation, destruction of crop residue, proper planting dates, weed control, crop fertilization, etc.

*Cuneus*, a nearly triangular area of the hemelytra (thickened area of forewing) separated from the rest of the wing by a suture; found mostly in the family Miridae of the order Hemiptera

## Glossary

*Curculio*, a weevil, or snout beetle

*Cutworm*, a caterpillar of the moth family Noctuidae; particularly, one which severs seedlings near the soil line at night

*Defoliant*, a chemical used to induce plant defoliation

*Defoliation*, loss of foliage

*Desiccant*, a drying agent

*Deutonymph*, a third instar of a mite

*Diapause*, a period of dormancy induced by factors other than an unfavorable environment

*Disc (or disk)*, to break up the soil, usually performed shortly before planting

*Dorsal*, top or uppermost; pertaining to the back or upper side

*Double seeds*, pairs of hollowed cotton seeds tied together with silk by the pink bollworm

*Economic injury*, sufficient damage to cause monetary loss

*Economic threshold*, the pest density at which controls should be employed to prevent the population from causing economic injury

*Egg pod*, a soil particle capsule containing the egg mass of a grasshopper

*Ellipsoid*, a 3-dimensional, elliptical or oval object, shaped roughly like a football

*Elytra*, thickened, leathery forewings which cover the hind wings, common to beetles and earwigs

*Epidermis*, outer layer of cells in plants and animals

*Eradicate*, to completely eliminate a particular pest from a designated area

*Estivation*, see Aestivation

*Fallow*, cropland idle for at least 1 growing season

*Family*, in animal and plant classification, a subdivision of an order containing many related genera

*Femur*, in insects, the third leg segment from the body

*Fibrous roots*, slender, thread-like roots, particularly common in grasses

*Filiform*, long and slender, thread-like

*Flare*, to open or spread at one point, e.g. "flared" cotton squares

*Flaxseed*, the dark brown puparium of the Hessian fly

*Fly-free date*, date after which wheat can safely be planted to avoid Hessian fly injury

*Forewings*, the front pair of insect wings which usually cover the smaller hind wings

*Frass*, insect droppings, usually a combination of leaf fragments or wood borings, and excrement

*'Frego' bract*, cotton with twisted bracts which do not close over the boll; a characteristic which inhibits oviposition by the boll weevil

*Fungi*, lower plants which contain no chlorophyll and are responsible for many plant diseases; molds, mildews, and rusts

*Fungicide*, a chemical used to kill or inhibit fungi

*Gall*, a tumor-like swelling of plant tissues induced by the development of another plant or an animal (including an insect); usually very characteristic in size, shape, location, etc., for the species inducing it

*Generation*, a group of offspring of the same species which develop in approximately the same time

*Genus (pl. genera)*, a group of closely related species

*Germination*, the process by which a plant emerges from a seed

*Germ tissue*, reproductive tissue of both parents of plants and animals but particularly the embryo within a seed

*Girdle*, to sever the water conducting tissues of a plant around the entire stem thereby causing the plant to wilt and die

*Glabrous*, smooth; hairless

*Gooseneck*, a crook in a plant stem, usually indicative of disease, insect, herbicide, air pollution or wind injury

*Gossypol*, a pigment normally found in cotton which gives this crop some resistance to insects

*Gradual metamorphosis*, see Simple metamorphosis

*Granulate*, rough; composed of granules; to appear rough, e.g. granulate cutworm

*Gregarious*, living, feeding, and/or moving in a group

*Growing point*, bud; meristem; area from which new growth originates

*Grub*, typically a sluggish, C-shaped beetle larva of the family Scarabaeidae having 3 pairs of forelegs and a fat, whitish body; also, used loosely to refer to many soil-inhabiting larvae of Coleoptera and Hymenoptera

*Halter (pl. halteres)*, in Diptera, a slender, knobbed structure which takes the place of each hind wing

*Head*, the first of the 3 major body regions in insects

*Hectare*, a metric unit of an area; 2.471 acres

*Hemispherical*, dome-shaped

*Hibernation*, winter period of rest or dormancy

*Hind wings*, the second, and usually smaller, pair of wings normally hidden by the forewings when the insect is at rest

*Honeydew*, a sugary liquid excreted by certain insects of the suborder Homoptera, including aphids, whiteflies, and scales

*Hopperburn*, a disease of alfalfa, peanuts, potatoes, and other plants caused by the injection of a toxic substance by the potato leafhopper; symptoms include yellowing and spotting of leaves, and a reddening of leaf veins

*Hornworm*, a caterpillar with a horn-like projection on the dorsal side of its 8th abdominal segment; a larva of a sphinx moth

*Host*, a plant or animal suitable for the nutrition of another plant or animal

*Hot spot*, a localized area of stressed plants within a field; area indicative of a root problem, chemical injury, or severe injury by above-ground pests

*Humus*, organic material in the soil; decayed plant or animal material

*Hybrid*, the offspring of two animals or plants of different varieties, races, biotypes, or species

*Immobile*, fixed; incapable of movement

*Infestation*, the presence of large numbers of an animal or plant pest species where they are likely to cause damage or annoyance to man

*Insect:* a six-legged arthropod that, as an adult, has 1 pair of antennae, 3 distinct body regions and, often, 1 or 2 pairs of wings

## Glossary

*Instar,* the life stage of an arthropod between successive molts

*Integrated control,* a pest control strategy in which all possible techniques are considered and consolidated, thereby preventing economic damage and minimizing adverse environmental repercussions

*Internode,* area of stem, or stalk, between nodes

*Joint,* a node, particularly in grasses

*Kilometer,* a metric unit of length (distance); 0.621 mile

*Labial palps,* a pair of jointed sensory appendages arising from the mouthparts of an insect

*Larva (pl. larvae),* in reference to insects with complete metamorphosis, the immature form occurring between the egg and pupal stages; in reference to mites and ticks, the 6-legged first instar

*Latitude,* the distance in angular degrees north and south of the equator

*Leafminer,* a small beetle, wasp, moth, or fly larva that tunnels within leaf tissues

*Leaf sheath,* the basal part of the leaf enclosing the stem

*Legume,* any plant of the family Leguminosae, including bean, pea, cowpea, soybean, alfalfa, and clover, which is capable, in association with bacteria, of fixing nitrogen

*Life cycle,* the development of an insect or mite from its egg to its reproductive stage

*Lint,* cotton fiber

*Litter,* forest or crop debris, consisting of decaying or dried plant material often mixed with soil

*Lock,* a single locule or compartment within a cotton boll

*Lodging,* the tendency of a plant to fall over, usually due to root or lower stalk damage

*Looper,* a moth larva that moves with a distinct humping motion due to the presence of 3 or fewer pairs of prolegs

*Maggot,* the larva of a fly

*Mallow family,* plants of the family Malvaceae, including hollyhock, cotton, marsh mallow, and okra

*Maturity group,* a group of varieties of a photoperiodic crop (e.g. soybeans) ranked according to the approximate maturity dates of its members

*Mechanical control,* a pest control strategy which employs the use of various types of mechanical devices or barriers, such as window screens, ditches, earthen walls, fly swatters, fly paper, traps, etc.

*Mesothorax,* second thoracic ring bearing the front pair of wings and/or the middle pair of true legs

*Metamorphosis,* a change in form during development; see also: Simple metamorphosis, and Complete metamorphosis

*Metathorax,* third thoracic ring bearing the hind pair of wings and/or the hind pair of legs

*Meter,* a metric unit of length; 1.094 yards

*Methyl parathion,* an organophosphate insecticide and acaricide extremely toxic to most forms of animal life although relatively non-toxic to plants; a nerve poison with relatively little residual action

*Midge,* a small, two-winged, gnat-like insect in the order with flies: Diptera

*Migration,* directed movement over a relatively great distance

*Millimeter,* a metric unit of length; .0394 inch

*Milky disease or milky spore disease,* a bacterial disease of the Japanese beetle; sometimes used in reference to a commercial spore preparation used to control the Japanese beetle

*Mite,* a minute arthropod, lacking antennae and wings, and usually eight-legged as an adult; closely related to ticks, more distantly to spiders

*Miticide,* a chemical compound with mite-killing properties

*Molt,* the process of shedding the outer layer of skin

*Morphological characters,* those pertaining to size and shape, form and structure

*Mosaic,* a virus disease symptom consisting of wrinkled and yellow-green mottled foliage

*Moth,* an adult insect (Order: Lepidoptera) with 2 pairs of scale-covered wings and variously shaped (but never clubbed) antennae

*Motile,* capable of movement

*Muck soils,* fertile soils extremely rich in organic matter content, common primarily in the coastal regions of the south

*Natural control,* control of pests by such natural forces as weather and unmanipulated parasites, predators, and diseases

*Nectar,* a sugary liquid secreted by flowers from a gland known as the nectary

*Nectariless cotton,* cotton having no nectaries and, therefore, moderately resistant to several cotton pests, including *Lygus* spp., the cotton fleahopper, and *Heliothis* spp.

*Nematode,* an unsegmented, elongate worm (plant pathogenic species usually minute in size)

*Nocturnal,* active at night

*Node,* that part of a stem from which a leaf grows

*Nymph,* in reference to insects with simple metamorphosis, the immature form between egg and adult; in reference to mites and ticks, the 8-legged immature form

*Okra-leaf cotton,* cotton varieties with leaves shaped like those of okra plants and having some resistance to whiteflies

*Order,* in animal and plant classification, a subdivision of a class or sub-class containing a group of related families

*Organophosphates,* a class of synthetic, organic pesticides which contain phosphorus, generally have a short residual life, and act as nerve poisons on most animals

*Overwinter,* to survive the winter, often, but not always, in a state of dormancy

*Oviposit,* to lay eggs

*Ovipositor,* an elongated structure extending from the abdomen of some female insects through which eggs are deposited

*Ovoviviparous,* producing eggs which are retained and hatch inside the body of the female

*Palatable,* attractive to the taste

*Parasite,* any plant or animal which lives in or on another organism to the detriment of the host

*Parasitoid,* a parasite that eventually kills its host

*Parthenogenetic,* capable of reproduction without mating or male fertilization

*Partial metamorphosis,* see Simple metamorphosis

## Glossary

*Perforation*, a hole or series of holes; the state or process of being perforated

*Pericarp*, the wall of a ripened ovary or seed vessel

*Petiole*, the stem of a leaf

*Phylum*, a major subdivision of classification in the animal kingdom

*Physical control*, a pest control strategy that employs methods such as heat, cold, electricity, and sound waves

*Piercing-sucking mouthparts*, a type of insect mouthparts composed of a slender stylet for piercing tissue and a strong pumping mechanism for withdrawing fluids, similar to a hypodermic needle

*Pinaculum (pl. pinacula)*, in caterpillars, a usually flattened plate on the body, usually harder and often darker than the body and bearing setae

*Pith*, soft, spongy tissue located in the center of the stems of some plants

*Plow*, to till, make furrows or turn soil thoroughly

*Pollen*, tiny, male germ cells, or fertilizing elements, of flowering plants

*Pollination*, the fertilization of the female flower (or the female part of the flower) by pollen

*Posterior*, the rear, or hindmost part; of or pertaining to the rear

*Predaceous*, hunting and killing other animals for food

*Predator*, an animal which kills other animals for food

*Preovipositional period*, the time interval between emergence of the adult female and the initiation of her egg-laying period

*Prepupa*, the flat, sluggish, non-feeding last larval instar just prior to pupating; or, in reference to thrips and male scale insects, the next to the last nymphal instar that has wing pads and short, thickened legs

*Progeny*, offspring

*Proleg*, a fleshy, abdominal leg of some insect larvae, particularly caterpillars

*Pronotum*, the upper or dorsal surface of the anterior part of the thorax

*Propodosoma*, the middle body segment of mites to which the first 2 pairs of legs are attached

*Propupa*, see Prepupa

*Protonymph*, the second instar of a mite

*Protozoan*, a one-celled animal

*Pubescent*, hairy, fuzzy

*Pupa (pl. pupae)*, in insects with complete metamorphosis, the life stage between larva and adult

*Puparium*, in some Diptera, the hardened skin of the last larval instar which becomes a protective covering for the pupa

*Pupate*, to become quiescent and develop from a larva into an adult

*Quarantine*, a ban on the movement of certain materials or living organisms from one area to another in an effort to prevent the spread of harmful organisms

*Quiescent*, in a state of rest or inactivity

*Race*, see Biotype

*Reinfestation*, the return of a pest population, usually after the cessation of control measures

*Resistance*, a. of plants to insects, the ability of a plant variety to repel, appear unattractive to, or tolerate insects, thereby exceeding the yield of other varieties at similar levels of insect infestation; b. of pests to pesticides, the ability of species, races or biotypes to withstand normally lethal doses of pesticides due to genetic or behavioral selection

*Reticulated*, net-like; arranged in a net-like manner

*Rootlets*, small roots

*Rosette*, a stout, compact, flower-like plant structure, often the result of some disease or damage which causes shortening of internodes

*Rotation*, a succession of crops planted on the same land over a period of years; a cultural method of disease and insect control

*Sanitation*, the act of keeping clean; cultural method of disease and insect control involving the removal and destruction of infested or diseased plant material

*Sap*, any plant fluid; usually used in reference to the liquids in the conducting tissues of trees

*Scavenger*, any organism which feeds on dead plants and/or animals and decaying organic matter

*Scout*, to periodically check crops for the purpose of determining the necessity of chemical pest control; a person who performs such a task

*Scutellum*, in insects of the suborder Heteroptera, a more or less triangular plate located on the thorax behind the pronotum

*Secretion*, the release of a substance from an organism as a waste product or for the performance of a specialized function

*Segment*, a section; a section of an appendage or one of many distinct body sections of larvae or pupae

*Semiarid*, characterized by low yearly rainfall and scrub vegetation

*Seta (pl. setae)*, a hair-like structure

*Shank*, the basal or lower part

*Shatterworm injury*, a term referring to corn damaged by early season caterpillars, usually corn earworms, and characterized by the ragged appearance of young leaves as they unfurl

*Silk*, the style of a female flower of the corn plant

*Simple metamorphosis*, the development of an insect through three morphologically different life states (egg, nymph, adult) with no prolonged resting stage; gradual or partial metamorphosis

*Skeletonize*, to feed upon leaf tissue to the extent that only the midrib and veins remain

*Solanaceous*, of or pertaining to plants of the family Solanaceae which includes tomato, tobacco, potato, pepper, and many weeds

*Sooty mold*, a dark, fungal growth which develops on foliage covered with honeydew secretions from insects

*Species*, a genetic subdivision whose members are capable of mating and producing fertile progeny

*Spikelet*, a small, single spike, consisting of two glumes and a floret, within a flower cluster of a grass

*Spindly*, tall, elongated

*Spiracle*, a pore through which diffusion of gases, or respiration, takes place

*Spittle*, a foamy, frothy mass which protects immature spittlebugs

*Square,* the flower bud of a cotton plant and the bracts which enclose it

*Stippled,* finely dotted or spotted

*Striate,* having or appearing to have parallel stripes, ridges, or furrows

*Subhumid,* slightly humid

*Subterranean,* below ground

*Subtropic,* of or pertaining to near tropical conditions

*Succulent,* in reference to plants, young, tender, and turgid

*Systemic insecticide,* a chemical absorbed by a plant or consumed by an animal which subsequently kills insects feeding on or within the treated organism

*Taproot,* a large, central, fleshy root

*Tarsal formula,* the number of tarsal segments on the front, middle and hind tarsi, respectively

*Tarsus (pl. tarsi),* the last (fifth) major insect leg segment, itself often divided into several small segments

*Tassel,* the male flowers of a corn plant; to produce tassels

*Taxonomic,* of or pertaining to the systematic classification of living organisms

*Temperate zone,* either of two regions of the earth (one in each hemisphere) which lie between the polar circles and the tropics

*Terminal,* of or pertaining to the end; occurring at the top or tip

*Thoracic,* of or pertaining to the thorax

*Thorax,* the second major body region of adult insects from which the legs and wings arise

*Thrips,* a minute insect that has two pairs of fringed wings and rasps plant tissues

*Tibia (pl. tibiae),* fourth segment of an insect leg, located between the femur and the tarsus

*Toxin,* a poisonous substance

*Translocate,* to move a substance within a plant from one site to another

*Transverse,* across; from side to side

*Trap crop,* a crop planted primarily for the purpose of luring pests away from another susceptible crop usually destroyed later.

*Tropic zone,* that region of the earth along the equator extending north and south of the temperate zones

*Tuber,* an enlarged portion of an underground stem

*Tubercle,* small, knob-like or wart-like protuberance

*Unpalatable,* displeasing to the taste

*Variety,* a strain within a plant species having its own characteristics

*Vector,* an agent of transmission; carrier; an insect bearing disease organisms

*Ventral,* of or pertaining to the underside

*Vestigial,* rudimentary; degenerate, atrophied; of or pertaining to the last trace that something once existed

*Virus,* a submicroscopic, disease-causing agent

*Viviparous,* bearing live young as opposed to laying eggs

*Volunteer,* a plant which emerges from seed or other remnants of a previous year's crop

*Voracious,* insatiably hungry

*Webworm,* a moth caterpillar that characteristically spins a conspicuous web on its host plant, whether a tree or a lawn grass

*Weevil,* a snout beetle often found feeding among flowers, seed, or stored grain including billbugs and curculios

*Whitefly,* a minute, white insect, moth-like in appearance, that has two pairs of wings and is related to aphids and leafhoppers

*Whorl,* a circular arrangement of leaves around the stem, as in corn or sorghum

*Wilt,* to become flaccid and droop; sometimes, a symptom of insect damage or disease, usually evidence of poor water translocation

*Wing covers,* see Elytra

*Wing pads,* small, rudimentary wings seen on late instar nymphs before they molt into winged adults

*Wingspan,* width of insect across the wings when they are fully spread

*Wireworm,* the slender, soil-inhabiting, root-feeding larva of a click beetle

## INDEX BY NAME

## INDEX BY HOST PLANT

## INDEX
## BY HOST PLANT

## INDEX
## BY HOST PLANT

## INDEX
## BY HOST PLANT

## INDEX
## BY HOST PLANT

## INDEX
## BY HOST PLANT

## INDEX
## BY HOST PLANT

## INDEX
## BY HOST PLANT