TREE FRUIT FIELD GUIDE

to Insect, Mite, and Disease Pests and Natural Enemies of Eastern North America

A. Agnello, G. Chouinard, A. Firlej, W. Turechek,
F. Vanoosthuyse, and C. Vincent

Plant and Life Sciences Publishing
Cooperative Extension

PALS and the authors would like to thank the companies listed below for sponsoring this guide. For more information about sponsors, see page 232.

Arysta LifeScience
BASF Agricultural Products
Bayer CropScience LP
Cerexagri, Inc.
Chemtura Crop Protection
Dupont Crop Protection
FMC Corporation
Spectrum Technologies, Inc.
Syngenta Crop Protection
Valent USA

This guide was supported, in part, with funds from the Northeastern IPM Center. The Center fosters the development and adoption of IPM, a science-based approach to managing pests in ways that generate economic, environmental, and human health benefits. We work in partnership with stakeholders from agricultural, urban, and rural settings to identify and address regional priorities for research, education, and outreach. For more information: www.NortheastIPM.org

This guide is based on the original publication by G. Chouinard, A. Firlej, F. Vanoosthuyse, and C. Vincent, entitled *Guide d'Identification des Ravageurs du Pommier et de Leurs Ennemis Naturels* and published (in French) by the Institut de Recherche et de Développement en Agroenvironnement, Inc. (IRDA, Research and Development Institute for the Agri-Environment), Saint-Hyacinthe, Québec, 2000.

The IRDA is a nonprofit research corporation devoted to research, development, and technology transfer in agriculture and the environment. IRDA's team of experts in entomology and integrated fruit production are involved in research and development of environmentally responsible tools and strategies for sustainable production of pome fruits.

On the front cover: Background photo by James P. Blair/Getty Images. Inset photos (clockwise from top): (1) Cedar apple rust. Photo courtesy of Mike Szkolnik. (2) Hover fly larva. Photo courtesy of New York State Agricultural Experiment Station (NYSAES). (3) Alternaria fruit rot. Photo courtesy of NYSAES. (4) Pear scab. Photo courtesy of Alan Jones. Reprinted with permission from *Compendium of Apple and Pear Diseases,* 1990, American Phytopathological Society, St. Paul, MN, USA. (5) Redhumped caterpillar larva. Photo courtesy of Alan Eaton.

TREE FRUIT FIELD GUIDE

to Insect, Mite, and Disease Pests and Natural Enemies of Eastern North America

A. Agnello
Cornell University
New York State Agricultural Experiment Station
Geneva, New York

G. Chouinard
Research and Development Institute for the Agri-Environment
Saint-Hyacinthe, Québec

A. Firlej
Research and Development Institute for the Agri-Environment
Saint-Hyacinthe, Québec

W. Turechek
U.S. Department of Agriculture–Agricultural Research Service
Fruit Lab
Beltsville, Maryland

F. Vanoosthuyse
Research and Development Institute for the Agri-Environment
Saint-Hyacinthe, Québec

C. Vincent
Horticulture Research and Development Centre
Agriculture and Agri-Food Canada
Saint-Jean-sur-Richelieu, Québec

Plant and Life Sciences Publishing (PALS)
Cooperative Extension
34 Plant Science
Ithaca, New York 14853

NRAES–169

October 2006

ISBN-13: 978-1-933395-02-9
ISBN-10: 1-933395-02-8

Library of Congress Cataloging-in-Publication Data

Tree fruit field guide to insect, mite, and disease pests and natural enemies of eastern North America / by A. Agnello ... [et al.].
p. cm. — (NRAES ; 169)
Includes index.
ISBN-13: 978-1-933395-02-9 (pbk.)
ISBN-10: 1-933395-02-8 (pbk.)
1. Fruit—Diseases and pests—East (U.S.)—Identification. 2. Fruit—Diseases and pests—Canada, Eastern—Identification. 3. Beneficial insects—Identification. 4. Fruit—Diseases and pests—Integrated control. I. Agnello, A. (Art) II. Series: NRAES (Series) ; 169.
SB608.F8T74 2006
634'.049—dc22

2006016119

Plant and Life Sciences Publishing (PALS)
Cooperative Extension
34 Plant Science
Ithaca, New York 14853
Phone: (607) 255-7654
E-mail: PALSPUBLISHING@CORNELL.EDU
Web site: WWW.PALSPUBLISHING.COM

Reprinted August 2018

This guide is dedicated
to the memory of Ron Prokopy,
a colleague, teacher, and friend
of the fruit industry who was an innovator
in fruit IPM for many years at the
University of Massachusetts.
Always a source of startling inquisitiveness
and enlightenment, Ron constantly challenged
us to think and rethink our assumptions
about fruit insects and the role they play
in the natural world. His memory will provide
numerous stories and a high standard
of professionalism as a continuing
influence on his peers.

Table of Contents

Bees and Wasps

Lacewings

Thrips

Diseases (listed by damage symptoms)

Trees wilted, stunted, off-color, or prematurely defoliating

Cankers (may be associated with wilting of branches)

Symptoms on blossoms and/or wilting new shoots

Symptoms on leaves only

Symptoms on leaves and possibly fruit

Symptoms on fruit only

Symptoms on harvested or stored fruit

Preface

A picture may be worth a thousand words, but for tree fruit growers, a picture may save thousands of dollars! Indeed, tree fruit growers know that their trees shelter numerous species of insect, mite, and disease pests that often necessitate the use of expensive pest-management products. However, some arthropod species feed on insect and mite pests in the orchards, and others are present just in passing.

How do we recognize the diseases that need to be prevented and the insects and mites that should be preserved or protected? How do we differentiate the pests that need to be surveyed or controlled? This guide has been written specifically to answer those questions for people involved in tree fruit production in eastern North America. It is addressed not only to professionals (horticultural consultants, educators, and scientists) but also to growers, amateur gardeners, students, and individuals interested in tree fruit orchards and the various pests and beneficials they harbor.

This field guide should provide a better understanding of the close relationships that bind the fruit tree to its ecosystem. It also points out the possible consequences of actions aimed at controlling certain species and shows why the establishment of some species should be encouraged.

Good reading!

Arthur Agnello
Gérald Chouinard
Annabelle Firlej
William Turechek
Franz Vanoosthuyse
Charles Vincent

Acknowledgments

Parts of this guide were translated by N. Tanguay from the original French publication by G. Chouinard, A. Firlej, F. Vanoosthuyse, and C. Vincent, entitled *Guide d'Identification des Ravageurs du Pommier et de Leurs Ennemis Naturels* and published by the Research and Development Institute for the Agri-Environment (IRDA), Saint-Hyacinthe, QC, 2000.

The authors would like to thank all who participated in the production of this guide. Their names are listed below in alphabetical order.

Contributors and Editors

- Sylvie Bellerose (Research and Development Institute for the Agri-Environment/IRDA)
- Noubar J. Bostanian (Agriculture and Agri-Food Canada, Horticulture Research and Development Centre, Saint-Jean-sur-Richelieu, QC)
- Carole Brodeur (Agrilus, Inc., Saint-Alexandre, QC)
- Daniel Coderre (University of Québec at Montréal, QC)
- Daniel Cormier (Research and Development Institute for the Agri-Environment/IRDA, Saint-Hyacinthe, QC)
- Sandra Gagnon (Research and Development Institute for the Agri-Environment/IRDA, Saint-Hyacinthe, QC)
- Christian Hébert (Laurentian Forestry Centre, Sainte-Foy, QC)
- Jacques Lasnier (Co-Lab R & D, Inc., Granby, QC)
- Gaétan Racette (Agriculture and Agri-Food Canada, Horticulture Research and Development Centre, Saint-Jean-sur-Richelieu, QC)

Peer Reviewers

This guide was peer reviewed for technical accuracy and usefulness by those listed below.

- Noubar J. Bostanian (Agriculture and Agri-Food Canada, Horticulture Research and Development Centre, Saint-Jean-sur-Richelieu, QC)
- Jean-Denis Brisson (Ministry of Natural Resources and Wildlife, Sainte-Foy, QC)
- Daniel Cormier (Research and Development Institute for the Agri-Environment/IRDA, Saint-Hyacinthe, QC)
- Dena Fiacchino (Cornell Cooperative Extension, Oswego County, Mexico, NY)
- Henry W. Hogmire (West Virginia University, Tree Fruit Research and Education Center, Kearneysville, WV)
- Donn T. Johnson (University of Arkansas, Department of Entomology, Fayetteville, AR)
- Glen W. Koehler (University of Maine Cooperative Extension, Pest Management Office, Orono, ME)
- Kathleen Leahy (Polaris Orchard Management, Colrain, MA)
- Richard Marini (The Pennsylvania State University, Department of Horticulture, University Park, PA)
- Douglas G. Pfeiffer (Virginia Polytechnic Institute and State University, Department of Entomology, Blacksburg, VA)
- Vincent Philion (Research and Development Institute for the Agri-Environment/IRDA, Saint-Hyacinthe, QC)
- Dean Polk (Rutgers Cooperative Extension, Tree Fruit Research and Extension Center, Cream Ridge, NJ)
- Harvey Reissig (Cornell University, New York State Agricultural Experiment Station, Geneva, NY)

- David A. Rosenberger (Cornell University, Hudson Valley Laboratory, Highland, NY)
- Peter Shearer (Rutgers University, Agricultural Research and Extension Center, Bridgeton, NJ)
- Bernt Solymar (Earth Tramper Consulting, Inc., Simcoe, ON)

Photograph Credits

- Arthur Agnello (Cornell University, New York State Agricultural Experiment Station, Geneva, NY)
- American Phytopathological Society (St. Paul, MN)
- Thérèse Arcand (Natural Resources Canada, Canadian Forest Service, Sainte-Foy, QC)
- Erica Bent (Wolfville, NS)
- Paul Bertrand (University of Georgia, Tifton, GA)
- David Biddinger (The Pennsylvania State University, Fruit Research and Extension Center, Biglerville, PA)
- Guy Boivin (Agriculture and Agri-Food Canada, Horticulture Research and Development Centre, Saint-Jean-sur-Richelieu, QC)
- Jean-Marie Bossennec (INRA-MiCom-Photothèque, Paris, France)
- Philip Brannen (University of Georgia, Athens, GA)
- Deborah Breth (Cornell Cooperative Extension, Albion, NY)
- Lina Breton (Ministry of Natural Resources and Wildlife, Sainte-Foy, QC)
- Thomas Burr (Cornell University, New York State Agricultural Experiment Station, Geneva, NY)
- Daniel Coderre (University of Québec at Montréal, Montréal, QC)
- Jerry Cross (East Malling Research, Kent, England)
- Roger Desmarteau (Ministry of Agriculture, Fisheries, and Food, Saint-Hyacinthe, QC)
- Bernard Drouin (Ministry of Agriculture, Fisheries, and Food, Sainte-Foy, QC)
- Alan Eaton (University of New Hampshire, Durham, NH)
- Mike Ellis (The Ohio State University, Wooster, OH)
- David Epstein (Michigan State University, East Lansing, MI)
- Claire Fecteau (Ministry of Agriculture, Fisheries, and Food, Sainte-Foy, QC)
- Martine Giguère (Ministry of Agriculture, Fisheries, and Food, Sainte-Foy, QC)
- Gary Grove (Washington State University, Irrigated Agriculture Research and Extension Center, Prosser, WA)
- Mike Haas (Michigan State University, East Lansing, MI)
- Cathy Heidenreich (Cornell University, New York State Agricultural Experiment Station, Geneva, NY)
- William Howell (Washington State University, Irrigated Agriculture Research and Extension Center, Prosser, WA)
- Gus Howitt (Michigan State University, East Lansing, MI)
- Peter Jentsch (Cornell University, Hudson Valley Laboratory, Highland, NY)
- Alan Jones (Michigan State University, East Lansing, MI)
- Megan Kennelly (Cornell University, New York State Agricultural Experiment Station, Geneva, NY)
- Joseph Kovach (The Ohio State University, Wooster, OH)
- Norman Lalancette (Rutgers University, Agricultural Research and Extension Center, Bridgeton, NJ)
- Ginette Laplante (Ministry of Agriculture, Fisheries, and Food, Saint-Hyacinthe, QC)
- Jacques Lasnier (Co-Lab R & D, Inc., Granby, QC)
- Chris Maier (Connecticut Agricultural Experiment Station, New Haven, CT)
- Marcel Mailloux (Ministry of Agriculture, Fisheries, and Food, Saint-Hyacinthe, QC)
- Marucci Blueberry and Cranberry Research and Extension Center (Rutgers University, Chatsworth, NJ)
- Peter McGhee (Michigan State University, East Lansing, MI)
- Ian Merwin (Cornell University, Ithaca, NY)

- Themis Michailides (University of California, Kearney Research and Extension Center, Parlier, CA)
- NRAES–75, *Mid-Atlantic Orchard Monitoring Guide*. (Edited by Henry W. Hogmire Jr., West Virginia University, Morgantown, WV. Published in 1995 by the Natural Resource, Agriculture, and Engineering Service/NRAES; see www.nraes.org for more information.)
- Jim Nugent (Northwest Michigan Horticultural Experiment Station, Traverse City, MI)
- NYSAES/New York State Agricultural Experiment Station (Cornell University, Geneva, NY)
- OPIE (Office pour l'Information Éco-entomologique)/Rémi Coutin (www.inra.fr/Internet/produits/hyppz, France)
- PA DCNR/Pennsylvania Department of Conservation and Natural Resources (Harrisburg, PA)
- Michael Quinn (University of New Hampshire, Durham, NH)
- Linda Rayor (Cornell University, Ithaca, NY)
- Dave Rosenberger (Cornell University, Hudson Valley Laboratory, Highland, NY)
- Tara Sackett (McGill University, Sainte-Anne-de-Bellevue, QC)
- Dave Schmitt (Rutgers Cooperative Extension, Clayton, NJ)
- Ralph Scorza (U.S. Department of Agriculture–Agricultural Research Service, Appalachian Fruit Research Station, Kearneysville, WV)
- Lynn Scott (Dunrobin, ON)
- Peter Shearer (Rutgers University, Agricultural Research and Extension Center, Bridgeton, NJ)
- Léo-Guy Simard (Agriculture and Agri-Food Canada, Horticulture Research and Development Centre, Saint-Jean-sur-Richelieu, QC)
- Rob Smith (Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Centre, Kentville, NS)
- George Sundin (Michigan State University, East Lansing, MI)
- Turner Sutton (North Carolina State University, Raleigh, NC)
- Michael Szkolnik (Cornell University, New York State Agricultural Experiment Station, Geneva, NY)
- William Turechek (U.S. Department of Agriculture–Agricultural Research Service, Fruit Lab, Beltsville, MD)
- University of Illinois Cooperative Extension (Urbana, IL)
- Robert Vigneault (Oka, QC)
- Charles Vincent (Agriculture and Agri-Food Canada, Horticulture Research and Development Centre, Saint-Jean-sur-Richelieu, QC)
- John Weaver (New Hampshire Department of Agriculture, Markets, and Food, Concord, NH)
- Celeste Welty (The Ohio State University, Columbus, OH)
- Wayne Wilcox (Cornell University, New York State Agricultural Experiment Station, Geneva, NY)

Production Credits

This guide was copyedited by Cathleen Walker, NRAES production editor, and designed by Andrea Gray of Burlington, VT. The insect silhouettes were drawn by Franz Vanoosthuyse of the Research and Development Institute for the Agri-Environment (IRDA), Saint-Hyacinthe, QC.

About the Authors

Arthur Agnello, Ph.D., is a professor of entomology at Cornell University, New York State Agricultural Experiment Station, in Geneva. His work involves providing recommendations for insect and mite control in tree fruits; survey, diagnosis, biology, and management of fruit arthropods; and development of practical pest management programs in tree fruits, concentrating on sampling techniques for population monitoring and control decisions, mating disruption, and pesticide application technology.

Gérald Chouinard, agronomist, Ph.D. in entomology, conceived the *Guide d'Identification des Ravageurs du Pommier et de Leurs Ennemis Naturels* published by the Research and Development Institute for the Agri-Environment (IRDA) in 2001, which served as the base document for the present guide. He is an active researcher in integrated management of apple pests and beneficials, coordinator of the Québec Working Group on Apple Pest Management, and head of the Québec Apple Pest Warning Service.

Annabelle Firlej is a research assistant in the Plant Biology Research Institute of Montréal (IRBV). She obtained a master's degree in Biology from the University of Québec at Montréal and is finishing a Ph.D. in entomology. Her research focuses mainly on biological control by predators and parasitoids, and invasive species.

William Turechek, Ph.D., is a plant pathologist at the USDA–ARS Fruit Laboratory in Beltsville, Maryland. He currently works on the epidemiology and management of small fruit disease, primarily strawberry. Prior to working for the USDA, he was an assistant professor at Cornell University, where he was responsible for developing and providing recommendations for the management of tree fruit and berry crop diseases. His research at Cornell focused on the epidemiology of tree fruit and berry crop disease with an emphasis on developing and improving decision tools.

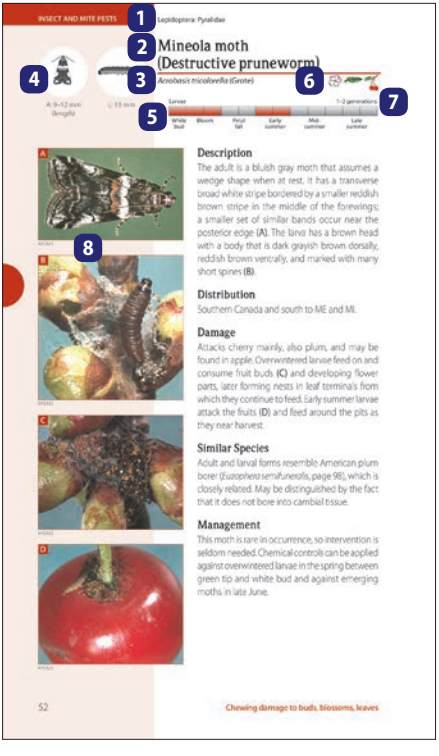
Franz Vanoosthuyse obtained a master's degree in biology from the University of Québec at Montréal. Currently a research assistant in entomology at the Research and Development Institute for the Agri-Environment (IRDA), he is studying the ecology of parasitoids of tortricid pests of apples, and plum curculio trapping systems. Coauthor and scientific illustrator for the *Guide d'Identification des Ravageurs du Pommier et de Leurs Ennemis Naturels,* his drawings have been published in popular and nonprofit societies' publications.

Charles Vincent, Ph.D., works for Agriculture and Agri-Food Canada (Saint-Jean-sur-Richelieu, Québec) on integrated pest management of horticultural insects, with an emphasis on alternative approaches to pesticides. He is adjunct professor at McGill University and the University of Québec at Montréal, and invited professor at the Université de Picardie Jules Verne (Amiens, France).

How to Use This Guide

This guide is a compilation of fact sheets separated into three sections, with each fact sheet covering a specific species or group of similar species. The first section (red) offers material on arthropod pests (insects and mites). The second section (green) describes beneficial insects, spiders, and mites. The third section (brown) lists tree fruit diseases. Information presented in the heading on each fact sheet is described below.

1. For arthropods, taxonomic classification:
   – Order (plus Suborder, for Hemiptera): Family
2. Common name
3. Scientific name and authority
4. For arthropods, silhouettes of life stages and lengths in mm (see inside back cover for quadrille grids in mm and inches)
   – A: adult (in Lepidoptera, wingspan)
   – L or N: last/largest larval/nymphal stage
5. For arthropods, principal period of activity in the crop (in red or blue, for indicated stages)
6. Feeding habits or site of attack (see page 2 for a key to icons)
7. For arthropods, number of generations per year
8. Photos of life stages and damage



Key to Icons

The following icons represent the feeding habits of the species. They illustrate which prey or part of the fruit tree is preferentially consumed or attacked (representing more than 90% of the species' total diet).

 : Mites (eggs and motile forms)

 : Insect eggs

 : Larvae

 : Leafhoppers

 : Scales

 : Aphids

 : Multiple insects and mites

 : Nectar, pollen (pollinators)

 : Shoots

 : Blossoms

 : Apples

 : Cherries

 : Peaches

 : Pears

 : Plums

 : Trunk and branches

 : Roots and crown

 : Foliage

Impact: Repetition of an icon indicates the importance (either in frequency or significance of economic impact) of each pest or beneficial:


One icon – Light; minor pest or beneficial


Two icons – Moderate; secondary pest or beneficial


Three icons – Important; major pest or beneficial

Insect and Mite Pests

In the first section, which deals with arthropod pests, the following information is given (not all sections are included for every species):

Description: Major traits used to identify the insect or mite. Note that younger nymphs or larvae may not have well-developed characteristic markings. These traits are not always unique to a particular species, but are used to distinguish it from other species presented in this guide.

Distribution: General geographic range of occurrence (in eastern North America only, even if species is more widely distributed).

Key:

CT - Connecticut
FL - Florida
IL - Illinois
MA - Massachusetts
MD - Maryland
ME - Maine
MI - Michigan
NB - New Brunswick
NH - New Hampshire
NJ - New Jersey
NS - Nova Scotia
NY - New York
OH - Ohio
ON - Ontario
PA - Pennsylvania
QC - Québec
RI - Rhode Island
SC - South Carolina
VA - Virginia
VT - Vermont
WV - West Virginia

Damage: Damage to the fruit or tree caused by the pest. In the interest of conserving space, life history details not directly related to species identification or pest activity on the crop (e.g., overwintering stage, mating or oviposition behavior, etc.) are not included in this guide.

Similar Species: Species of insects or mites that could be confused with the pest described.

Management: A synopsis of possible control management practices applicable and available when pest populations exceed tolerable levels. The reader is advised to consult local university or other expert guidelines for specific details on implementing these tactics.

Beneficial Insects, Spiders, and Mites

The second section, which deals with beneficial species, includes the following information:

Description: Traits useful in recognizing the insect, spider, or mite. These characteristics are not necessarily unique to a particular species, but are used to distinguish it from other species presented in this guide. When possible, other characteristics are indicated. They can be positive (☺) or negative (☹), such as the sensitivity of the natural enemy to pesticides.

Status: Information on the beneficial activity of the predator or parasitoid with respect to its stages of development.

Similar Species: Species of insects or mites that could be confused with the species described.

Diseases

Tree fruit diseases are addressed in the third section of this guide. For each disease, a list of fruit hosts and main tissues attacked is indicated, followed by a description of the disease symptoms. Also provided is a description of the disease's geographical range, any similar diseases or disorders with which it can be confused, and a brief description of recommended management tactics.

IMPORTANT! This book is not intended as a protection guide. To determine whether pest populations represent a threat and justify intervention, use adequate and validated scouting methods. For scouting methods and details of preferred management options, consult local university extension recommendations and "For Further Information" (page 230) for general reference materials. If you have doubts about the identity of a species or the risk it represents to a crop, consult a plant protection specialist.

Insect and Mite Diagnostic Keys

The following keys are a means of identifying the most likely causes of specific types of insect damage, according to the symptoms of injury evident in the field. Pests are listed approximately in decreasing order of severity and frequency of occurrence. Greatest accuracy in species identification will be ensured by collecting and examining actual insect specimens associated with the damage.

Field Damage Key for Identifying Insect and Mite Pests of Apple

A - Damage to buds, flowers, fruitlets, or terminals

1 • stings, holes, or depressions: tarnished plant bug (page 72), mullein plant bug (page 69), apple seed chalcid (page 92), click beetles (page 48)

2 • feeding damage, tunneling: obliquebanded leafroller (page 77), oriental fruit moth (page 90), European apple sawfly (page 86), green fruitworms (page 56), eyespotted bud moth (page 55), winter moth (page 60), pale apple leafroller (page 58), Mineola moth (page 52), green pug (page 51), cigar/pistol casebearers (page 54)

3 • parts died back, shriveled, eaten, or dropped: pear thrips (page 49), winter moth (page 60), spring cankerworm (page 66), apple pith moth (page 53), cigar/pistol casebearers (page 54)

B - Feeding or oviposition damage to fruit

1 • feeding or oviposition stings, punctures, or scars: apple maggot (page 83), plum curculio (page 82), tarnished plant bug (page 72), mullein plant bug (page 69), stink bugs (page 70), apple red bug (page 68), hawthorn dark bug (page 68), pear plant bug (page 68), apple seed chalcid (page 92)

2 • small holes or pitting: codling moth (page 88), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), oriental fruit moth (page 90), lesser appleworm (page 76), variegated leafroller (page 81), winter moth (page 60), Sparganothis fruitworm (page 81), Mineola moth (page 52)

3 • surface mining or depressions, or holes less than 6 mm (1/4") deep: plum curculio (page 82), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), redbanded leafroller (page 79), Japanese beetle/rose chafer (page 74), lesser appleworm (page 76), variegated leafroller (page 81), eyespotted bud moth (page 55), cherry fruitworm (page 87), winter moth (page 60), Mineola moth (page 52), European earwig (page 48), snowy tree cricket (page 97)

4 • channels, gouges, or large surface excavations or scars less than 6 mm (1/4") deep: obliquebanded leafroller (page 77), tufted apple bud moth (page 80), European apple sawfly (page 86), redbanded leafroller (page 79), green fruitworms (page 56), Japanese beetle/rose chafer (page 74), variegated leafroller (page 81), fruittree leafroller (page 59), fall webworm (page 62), multicolored Asian lady beetle (page 124)

5 • holes with tunnels more than 6 mm (1/4") deep, internal burrowing or trails, with or without frass: apple maggot (page 83), codling moth (page 88), oriental fruit moth (page 90), European apple sawfly (page 86), green fruitworms (page 56), lesser appleworm (page 76), European corn borer (page 89), cherry fruitworm (page 87), dock sawfly (page 85)

C - Fruit marking, deformation, or drop

1 • scars: plum curculio (page 82), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), tarnished plant bug (page 72), European apple sawfly (page 86), green fruitworms (page 56), mullein plant bug (page 69), variegated leafroller (page 81), stink bugs (page 70), apple red bug (page 68), pear plant bug (page 68)

2 • spots or scales: San Jose scale (page 109), white apple leafhopper (page 33), rose leafhopper (page 34), oystershell scale (page 108), Forbes scale (page 107), western flower/flower thrips (page 73)

3 • bumps or depressions: plum curculio (page 82), tarnished plant bug (page 72), mullein plant bug (page 69), stink bugs (page 70), cherry fruitworm (page 87), hawthorn dark bug (page 68), pear plant bug (page 68), apple seed chalcid (page 92)

4 • deformities: obliquebanded leafroller (page 77), rosy apple aphid (page 43), San Jose scale (page 109), fruittree leafroller (page 59), green fruitworms (page 56), mullein plant bug (page 69), spirea/apple aphids (page 39), winter moth (page 60)

5 • russet or sooty mold: rosy apple aphid (page 43), woolly apple aphid (page 44), spirea/apple aphids (page 39), Comstock mealybug (page 37), apple rust mite (page 111), apple sucker (page 35)

6 • drop: plum curculio (page 82), European red mite (page 112), spotted tentiform leafminer (page 47), twospotted spider mite (page 116), European apple sawfly (page 86), green fruitworms (page 56), pear thrips (page 49), stink bugs (page 70)

D - Damage to leaves

1 • curling, rolling, or cupping: obliquebanded leafroller (page 77), spirea/apple aphids (page 39), rosy apple aphid (page 43), redbanded leafroller (page 79), potato leafhopper (page 34), apple leaf(curling) midge (page 38), pale apple leafroller (page 58)

2 • holes or large feeding areas in leaf: obliquebanded leafroller (page 77), gypsy moth (page 63), variegated leafroller (page 81), Sparganothis fruitworm (page 81), winter moth (page 60), pale apple leafroller (page 58), Mineola moth (page 52), click beetles (page 48), leaf weevils (page 48), European earwig (page 48)

3 • skeletonizing: Japanese beetle/rose chafer (page 74), spring cankerworm (page 66), pear slug (page 64), redhumped caterpillar (page 67), apple-and-thorn skeletonizer (page 65), cigar/pistol casebearers (page 54)

4 • leaf stripping or defoliation: gypsy moth (page 63), eastern/forest tent caterpillars (page 61), fall webworm (page 62), climbing cutworms (page 50), redhumped caterpillar (page 67), apple leaf(curling) midge (page 38), green pug (page 51)

5 • flagging or wilting, distorted or reduced growth: rosy apple aphid (page 43), spirea/apple aphids (page 39), oriental fruit moth (page 90), roundheaded appletree borer (page 103), flatheaded appletree borer (page 104), dogwood borer (page 99), European corn borer (page 89), periodical cicada (page 96), green pug (page 51), apple sucker (page 35), apple pith moth (page 53)

6 • webbing: twospotted spider mite (page 116), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), redbanded leafroller (page 79), eastern/forest tent caterpillars (page 61), fall webworm (page 62), variegated leafroller (page 81), fruittree leafroller (page 59), eyespotted bud moth (page 55), winter moth (page 60)

7 • discoloration (bronzing, yellowing, browning): European red mite (page 112), twospotted spider mite (page 116), potato leafhopper (page 34), apple rust mite (page 111), oystershell scale (page 108), periodical cicada (page 96), buffalo treehopper (page 95), cigar/pistol casebearers (page 54)

8 • mottling, spots, blotches, honeydew/

mold, or scales: twospotted spider mite (page 116), white apple leafhopper (page 33), rose leafhopper (page 34), spirea/apple aphids (page 39), apple rust mite (page 111), Comstock mealybug (page 37), apple sucker (page 35), European fruit lecanium (page 105), European fruit scale (page 106)

9 • mines: spotted tentiform leafminer (page 47), apple (Lyonetia) leafminer (page 45)

10 • drop: European red mite (page 112), twospotted spider mite (page 116), apple leaf(curling) midge (page 38)

E - Damage to branches, twigs, or woody tissue

1 • boring, frass, or oviposition punctures: shothole borer (page 93), periodical cicada (page 96), buffalo treehopper (page 95), snowy tree cricket (page 97)

2 • stings, sap, honeydew/mold, spots, or scales: San Jose scale (page 109), tarnished plant bug (page 72), oystershell scale (page 108), European fruit lecanium (page 105), Forbes scale (page 107), European fruit scale (page 106)

3 • nodules: woolly apple aphid (page 44)

F - Damage to trunk, roots, or whole tree

1 • internal boring, galleries with frass: dogwood borer (page 99), roundheaded appletree borer (page 103), flatheaded appletree borers (page 104), American plum borer (page 98), Prionus borers (page 102)

2 • scales: San Jose scale (page 109), oystershell scale (page 108), Forbes scale (page 107)

3 • nodules: woolly apple aphid (page 44)

4 • loss of tree vigor or reduced production: European red mite (page 112), twospotted spider mite (page 116), San Jose scale (page 109), dogwood borer (page 99), roundheaded appletree borer (page 103), flatheaded appletree borer (page 104), American plum borer (page 98), oystershell scale (page 108), Prionus borers (page 102), climbing cutworms (page 50), green pug (page 51), European fruit scale (page 106)

Field Damage Key for Identifying Insect and Mite Pests of Pear

A - Damage to buds, flowers, fruitlets, or terminals

1 • stings, holes, or depressions: tarnished plant bug (page 72), mullein plant bug (page 69), click beetles (page 48)

2 • feeding damage, tunneling: green fruitworms (page 56), eyespotted bud moth (page 55), green pug (page 51), winter moth (page 60), cigar/pistol casebearers (page 54)

3 • parts died back, shriveled, eaten, or dropped: pear thrips (page 49), winter moth (page 60), cigar/pistol casebearers (page 54)

B - Feeding or oviposition damage to fruit

1 • feeding or oviposition stings, punctures, or scars: plum curculio (page 82), apple maggot (page 83), tarnished plant bug (page 72), mullein plant bug (page 69), stink bugs (page 70), apple red bug (page 68), hawthorn dark bug (page 68), pear plant bug (page 68)

2 • small holes or pitting: codling moth (page 88), obliquebanded leafroller (page 77), oriental fruit moth (page 90), tufted apple bud moth (page 80), winter moth (page 60)

3 • surface mining or depressions, or holes less than 6 mm (1/4") deep: plum curculio (page 82), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), oriental fruit moth (page 90), eyespotted bud moth (page 55), winter moth (page 60), European earwig (page 48)

4 • channels, gouges, or large surface excavations or scars less than 6 mm (1/4") deep: obliquebanded leafroller (page 77), tufted apple bud moth (page 80), green fruitworms (page 56), fruittree leafroller (page 59), fall webworm (page 62), winter moth (page 60)

5 • holes with tunnels more than 6 mm (1/4") deep, internal burrowing or trails, with or without frass: apple maggot (page 83), codling moth (page 88), oriental fruit moth (page 90), green fruitworms (page 56)

C - Fruit marking, deformation, or drop

1 • scars: plum curculio (page 82), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), tarnished plant bug (page 72), green fruitworms (page 56), mullein plant bug (page 69), apple red bug (page 68), pear plant bug (page 68)

2 • spots or scales: San Jose scale (page 109), oystershell scale (page 108), Forbes scale (page 107)

3 • bumps or depressions: plum curculio (page 82), tarnished plant bug (page 72), mullein plant bug (page 69), stink bugs (page 70), hawthorn dark bug (page 68), pear plant bug (page 68)

4 • deformities: obliquebanded leafroller (page 77), rosy apple aphid (page 43), San Jose scale (page 109), fruittree leafroller (page 59), green fruitworms (page 56), mullein plant bug (page 69), spirea/apple aphids (page 39), winter moth (page 60)

5 • russet or sooty mold: pear rust mite (page 113), pear psylla (page 36), spirea/apple aphids (page 39), rosy apple aphid (page 43), Comstock mealybug (page 37), woolly apple aphid (page 44), pearleaf blister mite (page 114)

6 • drop: European red mite (page 112), twospotted spider mite (page 116), green fruitworms (page 56), pear midge (page 91), pear thrips (page 49), stink bugs (page 70)

D - Damage to leaves

1 • curling, rolling, or cupping: spirea/apple aphids (page 39), rosy apple aphid (page 43), obliquebanded leafroller (page 77), pearleaf blister mite (page 114)

2 • holes or large feeding areas in leaf: obliquebanded leafroller (page 77), winter moth (page 60), leaf weevils (page 48), European earwig (page 48)

3 • skeletonizing: pear slug (page 64), redhumped caterpillar (page 67), cigar/pistol casebearers (page 54)

4 • leaf stripping or defoliation: pear psylla (page 36), fall webworm (page 62), green pug (page 51), climbing cutworms (page 50), redhumped caterpillar (page 67)

5 • flagging or wilting, distorted or reduced growth: pear psylla (page 36), spirea/apple aphids (page 39), rosy apple aphid (page 43), roundheaded appletree borer (page 103), flatheaded appletree borer (page 104), green pug (page 51)

6 • webbing: twospotted spider mite (page 116), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), eastern/forest tent caterpillars (page 61), fall webworm (page 62), fruittree leafroller (page 59), eyespotted bud moth (page 55), winter moth (page 60)

7 • discoloration (bronzing, yellowing, browning): European red mite (page 112), twospotted spider mite (page 116), pear rust mite (page 113), oystershell scale (page 108), periodical cicada (page 96), pearleaf blister mite (page 114), buffalo treehopper (page 95), cigar/pistol casebearers (page 54)

8 • mottling, spots, blotches, honeydew/mold, or scales: European red mite (page 112), pear psylla (page 36), spirea/apple aphids (page 39), twospotted spider mite (page 116), pear rust mite (page 113), Comstock mealybug (page 37), pearleaf blister mite (page 114), European fruit lecanium (page 105), European fruit scale (page 106)

9 • mines: spotted tentiform leafminer (page 47)

10 • drop: European red mite (page 112), pear psylla (page 36), twospotted spider mite (page 116)

E - Damage to branches, twigs, or woody tissue

1 • boring, frass, or oviposition punctures: shothole borer (page 93), periodical cicada (page 96), buffalo treehopper (page 95)

2 • stings, sap, honeydew/mold, spots, or scales: San Jose scale (page 109), tarnished plant bug (page 72), oystershell scale (page 108), European fruit lecanium (page 105), Forbes scale (page 107), European fruit scale (page 106)

F - Damage to trunk, roots, or whole tree

1 • internal boring, galleries with frass: roundheaded appletree borer (page 103), flatheaded appletree borer (page 104)

2 • scales: San Jose scale (page 109), oystershell scale (page 108), Forbes scale (page 107)

3 • loss of tree vigor or reduced production: European red mite (page 112), twospotted spider mite (page 116), San Jose scale (page 109), roundheaded appletree borer (page 103), flatheaded appletree borer (page 104), oystershell scale (page 108), climbing cutworms (page 50), green pug (page 51), European fruit scale (page 106)

Field Damage Key for Identifying Insect and Mite Pests of Cherry

A - Damage to buds, flowers, fruitlets, or terminals

1 • stings, holes, or depressions: tarnished plant bug (page 72)

2 • feeding damage, tunneling: green fruitworms (page 56), eyespotted bud moth (page 55), Mineola moth (page 52), winter moth (page 60)

3 • parts died back, shriveled, eaten, or dropped: pear thrips (page 49), winter moth (page 60)

B - Feeding or oviposition damage to fruit

1 • feeding or oviposition stings, punctures, or scars: cherry/black cherry fruit flies (page 84), plum curculio (page 82), apple maggot (page 83), stink bugs (page 70), tarnished plant bug (page 72)

2 • small holes or pitting: codling moth (page 88), obliquebanded leafroller (page 77), oriental fruit moth (page 90), tufted apple bud moth (page 80), winter moth (page 60)

3 • surface mining or depressions, or holes less than 6 mm (1/4") deep: plum curculio (page 82), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), eyespotted bud moth (page 55), winter moth (page 60)

4 • channels, gouges, or large surface excavations or scars less than 6 mm (1/4") deep: obliquebanded leafroller (page 77), tufted apple bud moth (page 80), fruittree leafroller (page 59), green fruitworms (page 56), fall webworm (page 62), winter moth (page 60)

5 • holes with tunnels more than 6 mm (1/4") deep, internal burrowing or trails, with or without frass: cherry/black cherry fruit flies (page 84), plum curculio (page 82), apple maggot (page 83), obliquebanded leafroller (page 77), oriental fruit moth (page 90), green fruitworms (page 56)

C - Fruit marking, deformation, or drop

1 • scars: cherry/black cherry fruit flies (page 84), plum curculio (page 82), green fruitworms (page 56), tarnished plant bug (page 72)

2 • spots or scales: Forbes scale (page 107)

3 • bumps or depressions: tarnished plant bug (page 72), stink bugs (page 70), cherry fruitworm (page 87)

4 • deformities: fruittree leafroller (page 59), green fruitworms (page 56), green peach aphid (page 41), winter moth (page 60)

5 • drop: European red mite (page 112), twospotted spider mite (page 116), green fruitworms (page 56), stink bugs (page 70), white peach scale (page 110)

D - Damage to leaves

1 • curling, rolling, or cupping: black cherry aphid (page 40), obliquebanded leafroller (page 77), plum rust mite (page 115)

2 • holes or large feeding areas in leaf: obliquebanded leafroller (page 77), Mineola moth (page 52), winter moth (page 60)

3 • skeletonizing: pear slug (page 64), redhumped caterpillar (page 67)

4 • leaf stripping or defoliation: fall webworm (page 62), redhumped caterpillar (page 67)

5 • flagging or wilting, distorted or reduced growth: European corn borer (page 89), black cherry aphid (page 40), green peach aphid (page 41), obliquebanded leafroller (page 77)

6 • webbing: obliquebanded leafroller (page 77), tufted apple bud moth (page 80), fall webworm (page 62), eyespotted bud moth (page 55), fruittree leafroller (page 59), winter moth (page 60)

7 • discoloration (bronzing, yellowing, browning): European red mite (page 112), twospotted spider mite (page 116), green peach aphid (page 41), pear rust mite (page 113), roundheaded appletree borer (page 103), flatheaded appletree borer (page 104), periodical cicada (page 96), plum rust mite (page 115), white peach scale (page 110), buffalo treehopper (page 95)

8 • mottling, spots, blotches, honeydew/mold, or scales: black cherry aphid (page 40), European red mite (page 112), twospotted spider mite (page 116), European fruit lecanium (page 105), terrapin scale (page 105), European fruit scale (page 106)

9 • mines: cherry leafminer (page 46), apple (Lyonetia) leafminer (page 45), apple blotch leafminer (page 47)

10 • drop: European red mite (page 112), twospotted spider mite (page 116), plum rust mite (page 115)

E - Damage to branches, twigs, or woody tissue

1 • boring, frass, or oviposition punctures: lesser peachtree borer (page 100), shothole borer (page 93), buffalo treehopper (page 95), periodical cicada (page 96), peach bark beetle (page 94), snowy tree cricket (page 97)

2 • stings, sap, honeydew/mold, spots, or scales: lesser peachtree borer (page 100), tarnished plant bug (page 72), European fruit lecanium (page 105), Forbes scale (page 107), peach bark beetle (page 94), terrapin scale (page 105), white peach scale (page 110), European fruit scale (page 106)

F - Damage to trunk, roots, or whole tree

1 • internal boring, galleries with frass: lesser peachtree borer (page 100), peachtree borer (page 101), American plum borer (page 98), roundheaded appletree borer (page 103), flatheaded appletree borer (104), peach bark beetle (page 94), Prionus borers (page 102)

2 • scales: Forbes scale (page 107), white peach scale (page 110)

3 • loss of tree vigor or reduced production: peachtree borer (page 101), lesser peachtree borer (page 100), American plum borer (page 98), European red mite (page 112), twospotted spider mite (page 116), roundheaded appletree borer (page 103), flatheaded appletree borer (page 104), black cherry aphid (page 40), white peach scale (page 110), European fruit scale (page 106)

Field Damage Key for Identifying Insect and Mite Pests of Peach and Nectarine

A - Damage to buds, flowers, fruitlets, or terminals

1 • stings, holes, or depressions: tarnished plant bug (page 72)

2 • feeding damage, tunneling: oriental fruit moth (page 90), green fruitworms (page 56), climbing cutworms (page 50)

3 • parts died back, shriveled, eaten, or dropped: plum curculio (page 82), green fruitworms (page 56), pear thrips (page 49)

B - Feeding or oviposition damage to fruit

1 • feeding or oviposition stings, punctures, or scars: plum curculio (page 82), oriental fruit moth (page 90), tarnished plant bug (page 72), stink bugs (page 70), tufted apple bud moth (page 80)

2 • small holes or pitting: oriental fruit moth (page 90), plum curculio (page 82), codling moth (page 88), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), tarnished plant bug (page 72)

3 • surface mining or depressions, or holes less than 6 mm (1/4") deep: Japanese beetle/rose chafer (page 74), green June beetle (page 75), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), plum curculio (page 82), tarnished plant bug (page 72), cherry fruitworm (page 87), snowy tree cricket (page 97), stink bugs (page 70)

4 • channels, gouges, or large surface excavations or scars less than 6 mm (1/4") deep: Japanese beetle/rose chafer (page 74), green June beetle (page 75), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), green fruitworms (page 56), fall webworm (page 62), multicolored Asian lady beetle (page 124)

5 • holes with tunnels more than 6 mm (1/4") deep, internal burrowing or trails, with or without frass: oriental fruit moth (page 90), codling moth (page 88), plum curculio (page 82), green fruitworms (page 56), tufted apple bud moth (page 80), European corn borer (page 89), cherry fruitworm (page 87)

C - Fruit marking, deformation, or drop

1 • scars: plum curculio (page 82), stink bugs (page 70), tarnished plant bug (page 72), green fruitworms (page 56), obliquebanded leafroller (page 77), tufted apple bud moth (page 80), western flower/flower thrips (page 73)

2 • spots or scales: San Jose scale (page 109), white peach scale (page 110)

3 • bumps or depressions: tarnished plant bug (page 72), stink bugs (page 70), cherry fruitworm (page 87)

4 • deformities: tarnished plant bug (page 72), stink bugs (page 70), green peach aphid (page 41), black peach aphid (page 42), green fruitworms (page 56), obliquebanded leafroller (page 77), San Jose scale (page 109), white peach scale (page 110)

5 • russet or sooty mold: green peach aphid (page 41), black peach aphid (page 42), Comstock mealybug (page 37), western flower/flower thrips (page 73)

6 • drop: European red mite (page 112), twospotted spider mite (page 116), green fruitworms (page 56), stink bugs (page 70), black peach aphid (page 42), San Jose scale (page 109), white peach scale (page 110)

D - Damage to leaves

1 • curling, rolling, or cupping: green peach aphid (page 41), black peach aphid (page 42), obliquebanded leafroller (page 77), western flower/flower thrips (page 73)

2 • holes or large feeding areas in leaf: obliquebanded leafroller (page 77), European corn borer (page 89)

3 • skeletonizing: Japanese beetle/rose chafer (page 74), green June beetle (page 75)

4 • leaf stripping or defoliation: fall webworm (page 62), eastern/forest tent caterpillars (page 61), climbing cutworms (page 50)

5 • flagging or wilting, distorted or reduced growth: oriental fruit moth (page 90), green peach aphid (page 41), European corn borer (page 89), western flower/flower thrips (page 73), periodical cicada (page 96)

6 • webbing: twospotted spider mite (page 116), fall webworm (page 62), obliquebanded leafroller (page 77), tufted apple bud moth (page 80)

7 • discoloration (bronzing, yellowing, browning): green peach aphid (page 41), black peach aphid (page 42), European red mite (page 112), twospotted spider mite (page 116), roundheaded appletree borer (page 103), flatheaded appletree borer (page 104), plum rust mite/peach silver mite (page 115), periodical cicada (page 96), buffalo treehopper (page 95), white peach scale (page 110)

8 • mottling, spots, blotches, honeydew/mold, or scales: San Jose scale (page 109), terrapin scale (page 105), European fruit lecanium (page 105), white peach scale (page 110), Comstock mealybug (page 37), European fruit scale (page 106)

E - Damage to branches, twigs, or woody tissue

1 • boring, frass, or oviposition punctures: lesser peachtree borer (page 100), peach bark beetle (page 94), shothole borer (page 93), periodical cicada (page 96), buffalo treehopper (page 95), snowy tree cricket (page 97)

2 • stings, sap, honeydew/mold, spots, or scales: San Jose scale (page 109), European fruit lecanium (page 105), terrapin scale (page 105), white peach scale (page 110), lesser peachtree borer (page 100), tarnished plant bug (page 72), European fruit scale (page 106)

F - Damage to trunk, roots, or whole tree

1 • internal boring, galleries with frass: peachtree borer (page 101), lesser peachtree borer (page 100), Prionus borers (page 102), peach bark beetle (page 94), roundheaded appletree borer page 103), flatheaded appletree borer (page 104)

2 • scales: San Jose scale (page 109), white peach scale (page 110)

3 • loss of tree vigor or reduced production: peachtree borer (page 101), lesser peachtree borer (page 100), European red mite (page 112), twospotted spider mite (page 116), black peach aphid (page 42), climbing cutworms (page 50), San Jose scale (page 109), white peach scale (page 110), European fruit scale (page 106)

Field Damage Key for Identifying Insect and Mite Pests of Plum

A - Damage to buds, flowers, fruitlets, or terminals

1 • stings, holes, or depressions: tarnished plant bug (page 72)

2 • feeding damage, tunneling: green fruitworms (page 56), climbing cutworms (page 50), Mineola moth (page 52)

3 • parts died back, shriveled, eaten, or dropped: pear thrips (page 49), climbing cutworms (page 50), winter moth (page 60)

B - Feeding or oviposition damage to fruit

1 • feeding or oviposition stings, punctures, or scars: plum curculio (page 82), apple maggot (page 83), tarnished plant bug (page 72), stink bugs (page 70)

2 • small holes or pitting: oriental fruit moth (page 90), lesser appleworm (page 76), codling moth (page 88), Mineola moth (page 52), winter moth (page 60)

3 • surface mining or depressions, or holes less than 6 mm (1/4″) deep: plum curculio (page 82), lesser appleworm (page 76), Mineola moth (page 52), winter moth (page 60)

4 • channels, gouges, or large surface excavations or scars less than 6 mm (1/4″) deep: green fruitworms (page 56), fall webworm (page 62)

5 • holes with tunnels more than 6 mm (1/4″) deep, internal burrowing or trails, with or without frass: oriental fruit moth (page 90), plum curculio (page 82), apple maggot (page 83), codling moth (page 88), green fruitworms (page 56), lesser appleworm (page 76)

C - Fruit marking, deformation, or drop

1 • scars: plum curculio (page 82), green fruitworms (page 56), stink bugs (page 70), tarnished plant bug (page 72), western flower/flower thrips (page 73)

2 • spots or scales: San Jose scale (page 109), oystershell scale (page 108), Forbes scale (page 107)

3 • bumps or depressions: stink bugs (page 70), tarnished plant bug (page 72)

4 • deformities: green peach aphid (page 41), black peach aphid (page 42), San Jose scale (page 109), winter moth (page 60)

5 • russet: western flower/flower thrips (page 73)

6 • drop: plum curculio (page 82), European red mite (page 112), twospotted spider mite (page 116), pear thrips (page 49), stink bugs (page 70), white peach scale (page 110)

D - Damage to leaves

1 • curling, rolling, or cupping: black peach aphid (page 42), plum rust mite (page 115)

2 • holes or large feeding areas in leaf: Mineola moth (page 52), winter moth (page 60)

3 • skeletonizing: pear slug (page 64)

4 • leaf stripping or defoliation: eastern/forest tent caterpillars (page 61), fall webworm (page 62), climbing cutworms (page 50), plum rust mite (page 115)

5 • flagging or wilting, distorted or reduced growth: plum rust mite (page 115), western flower/flower thrips (page 73)

6 • webbing: eastern tent caterpillar (page 61), fall webworm (page 62), winter moth (page 60)

7 • discoloration (bronzing, yellowing, browning): European red mite (page 112), twospotted spider mite (page 116), plum rust mite (page 115), green peach aphid (page 41), oystershell scale (page 108), white peach scale (page 110), roundheaded appletree borer (page 103), flatheaded appletree borer (page 104), Prionus borers (page 102), periodical cicada (page 96), buffalo treehopper (page 95)

8 • mottling, spots, blotches, honeydew/mold, or scales: European red mite (page 112), twospotted spider mite (page 116), black peach aphid (page 42), European fruit lecanium (page 105), Forbes scale (page 107), spotted tentiform leafminer (page 47), European fruit scale (page 106)

9 • mines: cherry leafminer (page 46), apple (Lyonetia) leafminer (page 45), apple blotch leafminer (page 47)

E - Damage to branches, twigs, or woody tissue

1 • boring, frass, or oviposition punctures: lesser peachtree borer (page 100), shothole borer (page 93), peach bark beetle (page 94), periodical cicada (page 96), buffalo treehopper (page 95), snowy tree cricket (page 97)

2 • stings, sap, honeydew/mold, spots, or scales: San Jose scale (page 109), European fruit lecanium (page 105), white peach scale (page 110), Forbes scale (page 107), oystershell scale (page 108), tarnished plant bug (page 72), European fruit scale (page 106)

F - Damage to trunk, roots, or whole tree

1 • internal boring, galleries with frass: American plum borer (page 98), lesser peachtree borer (page 100), peachtree borer (page 101), roundheaded appletree borer (page 103), flatheaded appletree borer (page 104), peach bark beetle (page 94), Prionus borers (page 102)

2 • scales: San Jose scale (page 109), European fruit lecanium (page 105), white peach scale (page 110), Forbes scale (page 107), oystershell scale (page 108), terrapin scale (page 105)

3 • loss of tree vigor or reduced production: American plum borer (page 98), lesser peachtree borer (page 100), peachtree borer (page 101), European red mite (page 112), twospotted spider mite (page 116), dogwood borer (page 99), black peach aphid (page 42), climbing cutworms (page 50), San Jose scale (page 109), oystershell scale (page 108), white peach scale (page 110), European fruit scale (page 106)

Field Damage Key for Identifying Insect and Mite Pests of Apricot

A - Damage to buds, flowers, fruitlets, or terminals

1 • stings, holes, or depressions: tarnished plant bug (page 72)

2 • feeding damage, tunneling: green fruitworms (page 56)

3 • parts died back, shriveled, eaten, or dropped: pear thrips (page 49)

B - Feeding or oviposition damage to fruit

1 • feeding or oviposition stings, punctures, or scars: plum curculio (page 82), stink bugs (page 70), tarnished plant bug (page 72)

2 • small holes or pitting: oriental fruit moth (page 90), codling moth (page 88)

3 • surface mining or depressions, or holes less than 6 mm (1/4") deep: plum curculio (page 82)

4 • channels, gouges, or large surface excavations or scars less than 6 mm (1/4") deep: green fruitworms (page 56), fall webworm (page 62)

5 • holes with tunnels more than 6 mm (1/4") deep, internal burrowing or trails, with or without frass: oriental fruit moth (page 90), codling moth (page 88), green fruitworms (page 56)

C - Fruit marking, deformation, or drop

1 • scars: plum curculio (page 82), tarnished plant bug (page 72), stink bugs (page 70), green fruitworms (page 56), western flower/flower thrips (page 73)

2 • spots or scales: oystershell scale (page 108)

3 • bumps or depressions: tarnished plant bug (page 72), stink bugs (page 70)

4 • russet: western flower/flower thrips (page 73)

5 • drop: European red mite (page 112), twospotted spider mite (page 116), stink bugs (page 70), pear thrips (page 49), white peach scale (page 110)

D - Damage to leaves

1 • leaf stripping or defoliation: fall webworm (page 62)

2 • flagging or wilting, distorted or reduced growth: western flower/flower thrips (page 73)

3 • webbing: eastern tent caterpillar (page 61), fall webworm (page 62)

4 • discoloration (bronzing, yellowing, browning): European red mite (page 112), twospotted spider mite (page 116), white peach scale (page 110), oystershell scale (page 108), periodical cicada (page 96), buffalo treehopper (page 95)

5 • mottling, spots, blotches, honeydew/mold, or scales: European red mite (page 112), twospotted spider mite (page 116), European fruit lecanium (page 105), terrapin scale (page 105), European fruit scale (page 106)

E - Damage to branches, twigs, or woody tissue

1 • boring, frass, or oviposition punctures: lesser peachtree borer (page 100), peach bark beetle (page 94), shothole borer (page 93), periodical cicada (page 96), buffalo treehopper (page 95)

2 • stings, sap, honeydew/mold, spots, or scales: European fruit lecanium (page 105), white peach scale (page 110), oystershell scale (page 108), tarnished plant bug (page 72), European fruit scale (page 106)

F - Damage to trunk, roots, or whole tree

1 • internal boring, galleries with frass: lesser peachtree borer (page 100), peachtree borer (page 101), peach bark beetle (page 94)

2 • scales: oystershell scale (page 108), white peach scale (page 110)

3 • loss of tree vigor or reduced production: peachtree borer (page 101), European red mite (page 112), twospotted spider mite (page 116), oystershell scale (page 108), white peach scale (page 110), European fruit scale (page 106)

Disease Diagnostic Keys

The diagnostic keys for deciduous tree fruit diseases were developed to aid field personnel in the identification of diseases that are common to the Northeast and Mid-Atlantic regions of the United States. Many problems will not be diagnosed easily, because insect, rodent, bird, hail, and other mechanical damage; nutritional deficiencies; abiotic factors; herbicide injury; and other causes can often be mistaken for or appear concurrent with disease symptoms and signs. The more information that can be obtained, the greater the chance of arriving at the proper diagnosis. These keys are not complete for all possible diseases; diseases of uncommon occurrence have not been included.

How To Use the Keys

To use the keys, select a statement from the first set of statements that most closely describes your field observations. Continue to the next numbered statement that is specified by the line you've chosen. For example, in the "Key to Apple Disease Identification," if you read line 1a and agree with the description as it pertains to your problem, go to line 2. If after reading line 1a you disagree with it, then go to line 1b. If line 1b describes your symptom better than line 1a, proceed to line 7. Continue through the key in this manner until a numbered statement suggests a particular diagnosis. Then turn to the page of the disease and compare the description to what you have observed.

The following points should be considered when making a disease diagnosis:

1. Disease symptoms may vary slightly from season to season and on their time of appearance, often depending on environmental conditions.
2. It is essential to obtain fresh disease samples. Secondary organisms will often follow the primary pathogen and make diagnosis difficult or impossible.
3. The observer should record the varieties and rootstocks that are affected. Susceptibility of apple varieties and rootstocks to some diseases will vary greatly and may give a valuable clue to diagnosis.
4. The distribution of symptoms within an orchard and in individual trees will often aid in determining if the disorder is caused by a pathogen and how it spreads in the orchard.
5. Observe the areas surrounding the orchard for alternate hosts, abandoned orchards, and other sites of potential disease reservoirs. Observe the orchard configuration, contour, and soil type(s).
6. Complete records of timings and rates of all applications of pesticides, growth regulators, and fertilizers may be helpful in determining the problem.
7. Records of previous year's weather patterns, such as excessive rains, drought, or extremely cold winter periods, along with grower cultural practices in the orchard may help in diagnosis.
8. A history of previous orchard problems should be obtained if possible.

Key to Apple Disease Identification

1a • Trees stunted or weakened; foliage may be wilted, off-color with early reddening, or prematurely defoliating. No other obvious symptoms on tree. (go to 2)

1b • Obvious spots; wilting of blossoms; lesions, cankers, galls, or variegation patterns on leaves, blossoms, shoots, branches, or fruits. (go to 7)

1c • Symptoms are on harvested or stored apples. (go to 20)

2a • (from 1a) Roots and crown showing no obvious decay. (go to 3)

2b • Roots, crown, and/or lower trunk showing obvious galls, knots, or decay. (go to 4)

3a • (from 2a) Fibrous roots lacking or showing witches broom. **Root-Lesion Nematodes** (*Pratylenchus penetrans*; *Pratylenchus* spp.) (page 150)

3b • Distinct black sunken line at graft union apparent below bark. Trees easily snap or are weakened at the union. **Apple Union Necrosis and Decline/AUND** (Tomato Ringspot Virus) (page 141)

3c • Dense mat or web of white mycelium and/or masses of sclerotia (spherical, hardened, tan to dark brown fungal bodies 0.5–2.0 mm in diameter) evident at the base of the tree. **Southern Blight** (*Sclerotium rolfsii*) (page 152)

3d • Bark missing below the soil line. Gnawing marks sometimes visible in wood. Callus formed in bark at margin of bare wood. **Rodent Damage**

4a • (from 2b) Bark at crown and roots easily sloughs off, exposing dense white fungal growth with fan-shaped distribution at cambium. Black shoestring-like strands (rhizomorphs) may be obvious on surface of bark. Yellow-brown mushrooms may appear at base of tree in late summer or early fall. **Armillaria Root Rot** (*Armillaria mellea*) (page 142)

4b • Small to large, warty-appearing growths (galls) at crown or on roots. **Crown Gall** (*Agrobacterium tumefaciens*) (page 144)

4c • Bark missing above the soil line. Gnawing marks sometimes visible in wood. Callus formed in bark at margin of bare wood. **Rodent Damage**

4d • Affected tissue is reddish brown in color or slimy in appearance. A definite margin between healthy and infected tissue is often evident. (go to 5)

4e • Crown and root tissue is not reddish brown or slimy. (go to 6)

5a • (from 4d) Affected crown and/or root tissue appears reddish brown underneath bark. **Phytophthora Root and Crown Rot** (*Phytophthora cactorum* and other *Phytophthora* spp.) (page 147)

5b • Wood slimy in appearance. Margin of decay may or may not be distinct but is often restricted to interstem or rootstock. **Fire Blight (Rootstock Blight)** (*Erwinia amylovora*) (page 162)

6a • (from 4e) Foliar growth sparse and/or collapses shortly after bloom or during first postbloom stretch of warm, dry weather. Trunk may be cracked or have dead cambium layer. A funneled air space around base of tree where water collected and froze in contact with tree crown may be evident. **Winter Freeze Injury**

6b • Roots in waterlogged soils appear blue to gray when cut into. **Roots Killed by Asphyxiation**

7a • (from 1b) Leaf, twig, and early fruit lesions olive, brown, to black in color and velvety in appearance. Maturing fruit may have areas of rough, corky skin or may be cracked, misshapen, and/or warty in appearance. **Apple Scab** (*Venturia inaequalis*) (page 175)

7b • Individual blossoms or blossom clusters discolored and/or wilting. Symptoms may be confined to a few branches or may affect multiple branches on several trees. By

early summer, infected tissues often become scorched in appearance with killed shoots resembling a "shepherd's crook." **Fire Blight** (*Erwinia amylovora*) (page 162)

7c • Leaves of Golden Delicious show a distinct necrotic blotching; may be associated with yellowing and leaf drop. **Necrotic Leaf Blotch** (page 171)

7d • Leaves show distinct chlorotic or necrotic patterns, stunting, or distortion on single branches or entire trees, locally or widely spread throughout orchard. Check for virus (e.g., **Apple Mosaic Virus,** page 168), nutritional disorder, or pesticide injury.

7e • Symptoms not as described above. (go to 8)

8a • Symptoms occurring on blossoms, leaves, shoots, or fruits. (go to 9)

8b • Cankers evident on wood 1 year old and older. (go to 16)

9a • (from 8a) Symptoms on fruit only. (go to 10)

9b • Symptoms on leaves, blossoms, or shoots (may also be on fruits). (go to 13)

10a • (from 9a) Symptoms not restricted to calyx end (bottom of apple). (go to 11)

10b • Symptoms often localized at the calyx end of fruit. (go to 12)

11a • (from 10a) Gray to black, blotchy, sooty fungus growth on surface of fruit, most apparent near harvest. **Sooty Blotch** (a complex of organisms including: *Peltaster fructicola*, *Geastrumia polystigmatis*, and *Leptodontium elatius*) (page 206)

11b • Small to medium-sized areas of tiny black speckles on fruit; number of speckles can range from few to over 100. Growth superficial, not extending beyond skin. Most apparent near harvest. **Flyspeck** (*Schizothyrium pomi*) (page 206)

11c • Young lesions are small, light brown, and circular; older lesions are dark brown and form sunken or saucer-shaped depressions that may coalesce with other lesions to form irregular blotches. Cream- to salmon-colored spores may be produced on the surface of the lesion. Flesh beneath rot is V-shaped. **Bitter Rot** (*Colletotrichum* spp.) (page 193)

11d • Young lesions appear as small, slightly sunken brown spots that may be surrounded by a red halo. As the decay area expands, the core becomes rotten and eventually the entire fruit rots. Red-skinned fruit may "bleach" during the decay process and become light brown. Flesh may be soft and watery during periods of warm weather. **White Rot** (*Botryosphaeria dothidea*) (page 207)

11e • Small green to light brown, slightly sunken lesions appear on the surface of mature fruit. Individual lesions on fruit surface are dry and do not extend deep into the fruit; cutting into the fruit reveals numerous internal, dry lesions or pits. **Bitter Pit** (physiological disorder) (page 208)

11f • Lesions 1–5 mm in diameter, purplish black in color associated with stomata, primarily on Mutsu (Crispin). **Blister Spot** (*Pseudomonas syringae* pv. *papulans*) (page 196)

12a • (from 10b) Affected area may be dry or wet but generally restricted to calyx end. **Blossom End Rot** (*Botryosphaeria obtusa*) (page 194), **Calyx End Rot** (*Sclerotinia sclerotiorum*) (page 200), or **Dry Eye Rot** (*Botrytis cinerea*) (page 200)

12b • Fruits ripen early; cutting apple in half reveals black, fungal decay surrounding the seed cavity. Common on Delicious and its red sports. **Moldy Core** (*Alternaria alternata*) (page 202)

12c • Fruit lesions are dark green on the surface with necrotic tissues extending to the core; lesions rarely sporulate. No foliar lesions are present. Red cedar, the alternate host, may be observed near the orchard. **Quince Rust** (*Gymnosporangium clavipes*) (page 188)

12d • Irregular, slightly sunken dark green lesions usually at the calyx end of immature fruit. Older lesions are dark red or purple on red areas of the fruit and remain dark green on green or yellow areas. **Brooks Fruit Spot** (*Mycosphaerella pomi*) (page 197)

13a • (from 9b) Yellow to orange lesions apparent on leaves and sometimes on fruit. Red cedar, the alternate host, may be observed near the orchard. **Cedar Apple Rust** (*Gymnosporangium juniperi-virginianae*) (page 188)

13b • Symptoms affecting leaves, blossoms, and/or terminal shoots but generally not the fruit. Leaf lesions not yellow or orange in color. (go to 14)

13c • Symptoms affecting leaves and fruit; however, symptoms may not be evident on both tissues at all times. (go to 15)

14a • (from 13b) White powdery fungal growth on leaves and sometimes blossoms. Leaves may drop prematurely and fail to elongate and unfold normally, while those on new shoots may become narrow, strap-like, and distorted. May cause net-like pattern of russetting on fruit. **Powdery Mildew** (*Podosphaera leucotricha*) (page 185)

14b • Foliage silvery in appearance; symptoms associated with a major branch or, occasionally, an entire tree. Heartwood of affected tree often discolored. **Silver Leaf** (*Chondostereum purpureum*) (page 151)

14c • Leaves have circular, necrotic lesions with a light brown interior surrounded by a dark purplish halo. Defoliation can occur by late summer when infection is severe. Infection on fruit is uncommon (compare with 15b). **Alternaria Blotch** (*Alternaria mali*) (page 166)

14d • Yellow to orange lesions apparent on leaves, never on fruit; affects McIntosh and Cortland among others; also attacks Hawthorn. **American Hawthorn Rust** (*Gymnosporangium globosum*) (page 188)

15a • (from 13c) Leaf, twig, and early fruit lesions olive, brown, to black in color and velvety in appearance. Maturing fruit may have areas of rough, corky skin or may be cracked, misshapen, and/or warty in appearance. **Apple Scab** (*Venturia inaequalis*) (page 175)

15b • Leaf lesions are circular, necrotic with a light brown interior surrounded by a distinct purple border. Lesions may contain small black spherical structures (pycnidia). Fruit infections show extensive soft decay; pycnidia may be evident in affected area. Fruit and foliar symptoms may or may not occur simultaneously. **Black Rot** (*Botryosphaeria obtusa*) (page 194)

15c • Conical, smooth, shiny black swellings are evident on twigs; lesions on leaves begin as small, circular green spots surrounded by a red halo, expanding to 1.5–3 mm in diameter with the centers turning brown. On fruit, lesions appear shiny black, round, sunken, and 3–9 mm in diameter. **Black Pox** (*Helminthosporium papulosum*) (page 178)

16a • (from 8b) Wilting of new shoots adjacent to canker. (go to 17)

16b • Entire branches adjacent to canker may or may not be wilting (not just new shoots); depends upon the severity of infection. (go to 18)

17a • (from 16a) Wood beneath the bark is slimy to the touch; cankers may have

smooth or rough margins of infection. Milky ooze may be exuded from cankers in early spring. **Fire Blight** (*Erwinia amylovora*) (page 162)

17b • Pink to orange sporulation apparent near previous season's fruit scar (at the base of new shoot) or on older wood. Wilting and death of new shoots in midsummer. **Nectria Twig Blight** (*Nectria cinnabarina*) (page 165)

18a • (from 16b) Canker infection apparently initiated at large pruning cut or winter-injured site; older cankers may comprise a series of concentric rings. Black, pimple-like fungal bodies may be evident on canker surface. **Black Rot** (*Botryosphaeria obtusa*) (page 194)

18b • Canker does not originate at pruning wound. (go to 19)

19a • (from 18b) Infections initiated around lenticels, appearing as small circular spots or blisters. Older cankers are depressed and may show a watery exudate; black, pimple-like fungal bodies may be evident on canker surface; at this stage, the disease is indistinguishable from black rot. Outer bark of canker may slough and be papery, scaly, and orangish. **White Rot** (*Botryosphaeria dothidea*) (page 207)

19b • Target-shaped perennial cankers on limbs and/or trunk; often associated with nodes. **Nectria Canker** (*Nectria galligena*) (page 158)

19c • Infected bark tissue separates into small pieces and curls upward from the canker. On older cankers, the bark sloughs off, leaving only the bast fibers behind (looks like "fiddle strings"). **Apple Anthracnose** (*Pezicula malicorticis*) (page 154)

19d • Young branch lesions are elliptical; sunken; and orange, purple, or brown in color. A series of concentric callus rings is present on older cankers. **Perennial Canker** (*Pezicula perennans*) (page 160)

20a • (from 1c) Young infections appear as a soft, sunken, yellow to pale brown, circular lesion on the surface of the fruit. Lesions expand rapidly and can quickly macerate the fruit. Fruit have a strong earthy or musty odor and unpleasant taste. Blue-green tufts of spores may be evident on the surface of the fruit; sporulation typically does not occur under controlled-atmosphere conditions. **Blue Mold** (*Penicillium expansum*) (page 209)

20b • Grayish brown, light brown, or dark brown lesions originate from the calyx or stem end of the fruit. Rotted fruit is firm and has a relatively pleasant odor, rather than a musty odor like blue mold. White or grayish white mycelium may form on the surface; apples coming out of controlled-atmosphere storage appear firm and tan. **Gray Mold** (*Botrytis cinerea*) (page 210)

20c • Infected tissue appears light brown, soft, and watery. **Mucor Rot** (*Mucor piriformis*) (page 211)

20d • Small green to purplish to light brown, slightly sunken lesions appear on the surface of the fruit. Individual lesions on the fruit surface are dry and do not extend deep into the fruit; however, cutting into the fruit can reveal numerous internal lesions. **Bitter Pit** (physiological disorder) (page 208)

Key to Pear Disease Identification

1a • Trees stunted or weakened; foliage is wilted or off-color with early reddening. Trees may be prematurely defoliating. No other obvious symptoms on tree. (go to 2)

1b • Obvious spots, wilting of blossoms, lesions, cankers, or variegation patterns on leaves, blossoms, shoots, branches, or fruits. (go to 7)

1c • Symptoms are on harvested or stored pears. (go to 20)

2a • (from 1a) Roots and crown showing no obvious decay. (go to 3)

2b • Roots, crown, and/or lower trunk showing obvious galls, knots, or decay. (go to 4)

3a • (from 2a) Fibrous roots lacking or showing witches broom. **Root-Lesion Nematodes** (*Pratylenchus penetrans*; *Pratylenchus* spp.) (page 150)

3b • Bark missing at or below the soil line. Gnawing marks sometimes visible in wood. Callus formed in bark at margin of bare wood. **Rodent Damage**

4a • (from 2b) Bark at crown and roots easily sloughs off, exposing dense white fungus growth with fan-shaped distribution at cambium. Black shoestring-like strands (rhizomorphs) may be obvious on surface of bark. Yellow-brown mushrooms may appear at base of tree in late summer or early fall. **Armillaria Root Rot** (*Armillaria mellea*) (page 142)

4b • Small to large, warty-appearing growths (galls) at crown or on roots. **Crown Gall** (*Agrobacterium tumefaciens*) (page 144)

4c • Bark missing above the soil line. Gnawing marks sometimes visible in wood. Callus formed in bark at margin of bare wood. **Rodent Damage**

4d • Affected tissue is reddish brown in color or slimy in appearance. A definite margin between healthy and infected tissue is often evident. (go to 5)

4e • Crown and root tissue is not reddish brown or slimy. (go to 6)

5a • (from 4d) Affected crown and/or root tissue appears reddish brown in color underneath bark. **Phytophthora Root and Crown Rot** (*Phytophthora cactorum* and other *Phytophthora* spp.) (page 147)

5b • Wood slimy in appearance. Margin of decay may or may not be distinct but is often restricted to interstem or rootstock. **Fire Blight (Rootstock Blight)** (*Erwinia amylovora*) (page 162)

6a • (from 4e) Foliar growth sparse and/or collapses shortly after bloom or during first postbloom stretch of warm, dry weather. Trunk may be cracked or have dead cambium layer. A funneled air space around base of tree where water collected and froze in contact with tree crown may be present. **Winter Freeze Injury**

6b • Roots in waterlogged soils appear blue to gray when cut into. **Roots Killed by Asphyxiation**

7a • (from 1b) Spots, wilting of blossoms, lesions, ooze, or obvious fungal fruiting bodies evident on leaves, blossoms, fruits, or young shoots. (go to 8)

7b • Cankers on wood 1 year old and older. (go to 16)

8a • (from 7a) Milky droplets of ooze are exuded from blossoms, cankers on shoots, or fruit (if present). By early summer, infected tissues often become scorched in appearance with killed shoots resembling a "shepherd's crook." **Fire Blight (Canker or Shoot Blight)** (*Erwinia amylovora*) (page 162)

8b • Symptoms on fruit only. (go to 9)

8c • Symptoms occurring on blossoms, leaves, shoots, and/or fruits. (go to 12)

9a • (from 8b) Dark green spots appear on developing fruit about two to three weeks after petal fall; older fruit have pits, pits with necrotic centers, or are severely deformed, gritty, and difficult to slice through. **Pear Stony Pit** (unknown) (page 204)

9b • Symptoms restricted to fruit surface. (go to 10)

9c • Symptoms include internal browning or fruit rot. (go to 11)

10a • (from 9b) Gray to black, blotchy, sooty fungus growth on surface of fruit, most apparent near harvest. **Sooty Blotch** (a complex of organisms including *Peltaster fructicola*, *Geastrumia polystigmatis*, and *Leptodontium elatius*) (page 206)

10b • Small to medium-sized areas of tiny black speckles on fruit; number of speckles can range from a few to over 100. Growth superficial, not extending beyond skin. Most apparent near harvest. **Flyspeck** (*Schizothyrium pomi*) (page 206)

11a • (from 9c) Young lesions are small, light brown, and circular; older lesions are dark brown and form sunken or saucer-shaped depressions that may coalesce with other lesions to form irregular blotches. Cream to salmon-colored spores may be produced on the surface of the lesion. Flesh beneath rot is V-shaped. **Bitter Rot** (*Colletotrichum* spp.) (page 193)

11b • Young lesions appear as small, slightly sunken brown spots that may be surrounded by a red halo. As the decay area expands, the core becomes rotten and eventually the entire fruit rots. Flesh may be soft and watery during periods of warm weather. **White Rot** (*Botryosphaeria dothidea*) (page 207)

11c • Fruit lesions are dark green on the surface with necrotic tissues extending to the core; lesions rarely sporulate. No foliar lesions are present. Red cedar, the alternate host, may be observed near the orchard. **Quince Rust** (*Gymnosporangium clavipes*) (page 188)

12a • (from 8c) Symptoms occurring on blossoms and/or spurs. (go to 13)

12b • Symptoms occurring only on leaves and/or terminal shoots. (go to 14)

12c • Symptoms occurring on leaves, fruit, or both. (go to 15)

13a • (from 12a) Blossoms are wilted, browned, blackened, or necrotic. Individual flowers or the entire cluster may be affected; infection often travels into the shoot. Neighboring apples typically affected. **Fire Blight (Blossom Blight)** (*Erwinia amylovora*) (page 162)

13b • Blossoms are wilted, browned, blackened, or necrotic; infection generally limited to the fruiting spur. Neighboring apples appear unaffected. **Bacterial Blossom Blast** (*Pseudomonas syringae* pv. *syringae*) (page 161)

14a • (from 12b) White powdery fungal growth on leaves and sometimes blossoms. Leaves may drop prematurely and fail to elongate and unfold normally, while those on new shoots may become narrow, strap-like, and distorted. May cause net-like pattern of russetting on fruit. **Powdery Mildew** (*Podosphaera leucotricha*) (page 185)

14b • Circular lesions, 3–5 mm in diameter, with a grayish white interior and a distinct purple margin. **Mycosphaerella Leaf Spot** (*Mycosphaerella pyri*) (page 170)

14c • Foliage associated with a major branch or occasionally entire tree becomes silvery in appearance. **Silver Leaf** (*Chondostereum purpureum*) (page 151)

14d • Faint yellow vein banding, particularly of the secondary veins on current year's growth, and red mottling of various intensities are the most common symptoms. **Pear Vein Yellows** (Apple Stem Pitting Virus) (page 172)

14e • Yellow to orange lesions apparent on leaves, never on fruit. **American Hawthorn Rust** (*Gymnosporangium globosum*) (page 188)

15a • (from 12c) Circular lesions, approximately 10 mm in diameter, with a dark brown to black interior and purplish halo form on leaves; lesions may coalesce. On fruit, lesions have a similar appearance to those on leaves but tend to be larger and cause the fruit to crack. **Fabraea Leaf Spot** (*Diplocarpon mespili*) (page 179)

15b • Leaf, twig, and early fruit lesions are olive, brown, to black in color and velvety in appearance. Maturing fruit may have areas of rough, corky skin or may be cracked, misshapen, and/or warty in appearance. **Pear Scab** (*Venturia pirina*) (page 182)

15c • Black lesions on developing fruit; may be singular or cover entire fruit. Small lesions or shotholes may be apparent on leaves. **Bacterial Blossom Blast** *(Pseudomonas syringae* pv. *syringae)* (page 161)

15d • Conical, smooth, shiny black swellings are evident on twigs; lesions on leaves begin as small, circular green spots surrounded by a red halo, expanding to 1.5–3 mm in diameter with the centers turning brown. **Blister Canker** (*Helminthosporium papulosum*) (page 178)

15e • Leaf lesions are circular and necrotic with a light brown interior surrounded by a distinct purple border. Lesions may contain small black spherical structures (pycnidia). Fruit infections show extensive soft decay; pycnidia may be evident in affected area. Fruit and foliar symptoms may or may not occur simultaneously. **Black Rot** (*Botryosphaeria obtusa*) (page 194)

16a • (from 7b) Wilting of new shoots adjacent to canker. (go to 17)

16b • Entire branches adjacent to canker may or may not be wilting (not just new shoots); depends upon the severity of infection. (go to 18)

17a • (from 16a) Wood beneath the bark is slimy to the touch; cankers may have smooth or rough margins. Milky ooze may be exuded from cankers in early spring. **Fire Blight** (*Erwinia amylovora*) (page 162)

17b • Pink to orange sporulation apparent near previous season's fruit scar or on older wood. Wilting and death of new shoots in midsummer. **Nectria Twig Blight** (*Nectria cinnabarina*) (page 165)

18a • (from 16b) Canker infection apparently initiated at large pruning cut or winter-injured site; older cankers may comprise of a series of concentric rings. Black, pimple-like fungal bodies may be evident on canker surface. **Black Rot** (*Botryosphaeria obtusa*) (page 194)

18b • Canker does not originate at pruning wound. (go to 19)

19a • (from 18b) Infections initiated around lenticels, appearing as small circular spots or blisters. Older cankers are depressed and may show a watery exudate; black, pimple-like fungal bodies may be evident on canker surface; at this stage the disease is indistinguishable from black rot. Outer bark of canker may slough and be papery, scaly, and orangish. **White Rot** (*Botryosphaeria dothidea*) (page 207)

19b • Target-shaped perennial cankers on limbs and/or trunk; often associated with nodes. **Nectria Canker** (*Nectria galligena*) (page 158)

19c • Infected bark tissue separates into small pieces and curls upward from the canker. On older cankers, the bark sloughs off, leaving only the bast fibers behind (looks like "fiddle strings"). **Apple Anthracnose** (*Pezicula malicorticis*) (page 154)

19d • Young branch lesions are elliptical; sunken; and orange, purple, or brown in color. A series of concentric callus rings is present on older cankers.

Perennial Canker (*Pezicula perennans*) (page 160)

20a • (from 1c) Grayish brown, light brown, or dark brown lesions originate from the calyx or stem end of the fruit. Rotted fruit is firm and has a relatively pleasant odor, rather than a musty odor like blue mold. White or grayish white mycelium may form on the surface. **Gray Mold** (*Botrytis cinerea*) (page 210)

20b • Young infections appear as a soft, sunken, yellow to pale brown, circular lesion on the surface of the fruit. Lesions expand rapidly and can quickly macerate the fruit. Fruit have a strong earthy or musty odor and unpleasant taste. Blue-green tufts of spores may be evident on the surface of the fruit; sporulation typically does not occur under controlled-atmosphere conditions. **Blue Mold** (*Penicillium expansum*) (page 209)

20c • Infected tissue appears light brown, soft, and watery. **Mucor Rot** (*Mucor piriformis*) (page 211)

20d • Bumpy, uneven appearance on the surface of d'Anjou pear; affected areas may or may not be yellowed. Cutting into the fruit reveals numerous gray or brown corky lesions. **Cork Spot** (physiological disorder; see **Bitter Pit**) (page 208)

Key to Peach, Nectarine, and Apricot Disease Identification

1a • Trees stunted or weakened; foliage is wilted or off-color with early reddening or may be prematurely defoliating. No other obvious symptoms on tree. (go to 2)

1b • Obvious spots, lesions, cankers, galls, or variegation patterns on leaves, blossoms, fruits, shoots, branches, or crown. (go to 7)

2a • (from 1a) Canopy of infected trees flattened and compacted; foliage tends to be a darker green. **Phony Peach Disease** (*Xylella fastidiosa*) (page 146)

2b • Roots and crown showing no obvious decay. (go to 3)

2c • Roots, crown, and/or lower trunk showing obvious galls, knots, or decay. (go to 4)

3a • (from 2b or 5c) Foliar growth sparse and/or collapses shortly after bloom or during first postbloom stretch of warm, dry weather. Trunk may be cracked, and the bark may easily slough off at the crown area or southwest side of trunk; wood underneath is darkened. Larger roots may also be dead. **Winter Injury**

3b • Affected crown and/or root tissue appears reddish brown in color underneath bark; may be water-soaked and slimy. Affected tissue delimited by a definite margin of infection, sometimes extending into trunk or root area. **Phytophthora Crown Rot** (*Phytophthora cactorum*; *Phytophthora* spp.) (page 147)

3c • Bark at crown and roots easily sloughs off, exposing dense white fungus growth with fan-shaped distribution at cambium. Black shoestring-like strands (rhizomorphs) may be obvious on surface of bark, and yellow-brown mushrooms may appear at base of tree in late summer or early fall. **Armillaria Root Rot** (*Armillaria mellea*) (page 142)

3d • Dense mat or web of white mycelium and/or masses of sclerotia (spherical, hardened, tan to dark brown fungal bodies 0.5–2.0 mm in diameter) evident at the base of the tree. **Southern Blight** (*Sclerotium rolfsii*) (page 152)

4a • (from 2c) Fibrous roots lacking or showing witches broom. **Root-Lesion Nematodes** (*Pratylenchus penetrans*; *Pratylenchus* spp.) (page 150)

4b • Roots appear normal. (go to 5)

5a • (from 4b) Bark abnormally thick and spongy; wood underneath has severely pitted, grooved, and indented texture. Leaves may have upward cupping, turning reddish purple, then dropping. **Prunus Stem Pitting** (Tomato Ringspot Virus) (page 148)

5b • Bark missing at or below the soil line. Gnawing marks sometimes visible in wood. Callus formed in bark at margin of bare wood. **Rodent Damage**

5c • Bark easily sloughs off at crown area. (go to 3)

5d • Bark normal at crown area. (go to 6)

6a • (from 5d) Leaves wilted or browned on one or several scaffolds (flagging); rest of tree appears healthy. Dark streaks in sapwood of two- to three-year-old and older wood. Symptoms enhanced by water stress in midsummer. **Verticillium Wilt** (*Verticillium dahliae*) (page 153)

6b • Flagging is not evident. (go to 7)

7a • (from 1b or 6b) Small to large, warty-appearing growths (galls) at crown or on roots. **Crown Gall** (*Agrobacterium tumefaciens*) (page 144)

7b • Distinct spots, lesions, silvering of leaves, or distortion of leaves. (go to 8)

7c • Distinct spots, lesions on leaves and fruits; may be accompanied by twig cankers. (go to 10)

7d • Distinct spots, lesions, or blemishes on fruits only. (go to 11)

7e • Blossoms are blighted. (go to 12)

7f • Cankers on twigs or branches only. (go to 13)

8a • (from 7b) White, powdery fungal growth on leaf surfaces. Leaves may drop prematurely or fail to elongate and unfold normally, while those on new shoots may become narrow, strap-like, and distorted. **Powdery Mildew** (*Sphaerotheca pannosa* or *Podosphaera clandestina*) (page 186)

8b • Foliage associated with a major branch or occasionally entire tree becomes silvery in appearance. Heartwood is often discolored. **Silver Leaf** (*Chondostereum purpureum*) (page 151)

8c • Leaves cupped, swollen, distorted, or abnormally shaped. (go to 9)

8d • Distinct spots, lesions, or shotholes visible on the leaves. (go to 10)

9a • (from 8c) Leaves swollen and distorted along midrib early in the season, later turning red to purple, browning, and dropping from tree. Occasionally causing distortion of fruit. **Peach Leaf Curl** (*Taphrina deformans*) (page 181)

9b • Leaves curled inward after several months. Water-soaked spots turn red, necrotic, and drop out giving leaves a tattered appearance. Localized areas or the entire canopy defoliates, leaving foliage only at the tips. Entire tree may show symptoms two to three years after the initial infection. **X-Disease** (Mycoplasmalike Organism [MLO]) (page 190)

9c • Leaves cup upward; turn yellow, red; then drop from localized areas of the canopy. **Prunus Stem Pitting** (Tomato Ringspot Virus) (page 148)

10a • (from 7c or 8d) Small, brown or black, angular lesions surrounded by a light green halo. Later the lesions drop out (shothole). Dark brown lesions and/or blemishes on fruit often become sunken, causing the skin of the fruit to crack and forming deep pits. **Bacterial Spot** (*Xanthomonas arboricola* pv. *pruni)* (page 177)

10b • Small purple lesions surrounded by a green halo on leaves in the spring. Lesions become necrotic and fall out, giving leaves a tattered appearance.

Occasionally, a bare-branched or "leggy" condition results from buds and spurs being killed by cankers. **Bacterial Canker** [*Pseudomonas syringae* pv. *syringae* van Hall and/or *P. syringae* pv. *morsprunorum* (Wormald) Young et al.] (page 155)

10c • Leaves develop chlorotic spots, lines, and rings as they emerge. In severe cases, chlorotic areas become necrotic and fall out, leaving the leaves shotholed or tattered. **Prunus Necrotic Ringspot** (Prunus Necrotic Ringspot Virus) (page 173)

10d • On leaves, symptoms may include vein yellowing, banding, or the formation of light green to yellow rings. Peach and apricot fruit may develop light yellow rings on their skin, become misshapen, and/or develop necrotic lesions. **Plum Pox Virus** (Plum Pox Virus) (page 184)

11a • (from 7d) Soft brown spots on maturing fruits expand rapidly and produce tan powdery masses of spores. Infections from fruit may advance into wood, causing small cankers. Fruit that is entirely rotted becomes "mummified." **Brown Rot** (*Monilinia fructicola*) (page 198) or **Green Fruit Rot** (*Botrytis cinerea*) (page 201)

11b • Symptoms are similar to brown rot, but rot appears slightly darker; flesh may slip away from decaying flesh underneath. Visible fungal mycelium may be white and fluffy; looks like whiskers as the fungus sporulates. **Rhizopus Rot** (*Rhizopus stolonifer*) (page 212)

11c • White powdery areas on young peach or nectarine fruit. Hard, leathery, dark lesions on older fruits. **Rusty Spot** *(Podosphaera leucotricha)* (page 205) or **Powdery Mildew** *(Sphaerotheca pannosa)* (page 186)

11d • Small, circular, tan to brown spots on mature or nearly mature fruit. Lesions expand rapidly, with a tendency to form concentric rings, and may or may not be sunken. Individual lesions may reach a diameter of 4–5 cm, but infection can be more extensive when lesions coalesce. Lesions are firm to the touch but typically develop orange to pink, slimy spore masses in their centers. **Anthracnose** (*Colletotrichum acutatum*; *C. gloeosporioides*) (page 192)

11e • Velvety dark green to black, sunken lesions on mature fruit. Lesions associated with overripe or damaged fruit. **Alternaria Fruit Rot** (*Alternaria alternata*) (page 191)

11f • Small, circular, dark green spots sometimes concentrated around stem end of fruit. Small red lesions on twigs may also be present. **Peach Scab** (*Cladosporium carpophilum*) (page 203)

11g • Fruit develop light yellow rings on their skin, become misshapen, and/or develop necrotic lesions. **Plum Pox Virus** (Plum Pox Virus) (page 184)

12a • (from 7e or 13c) Powdery gray mass of spores develops on diseased areas during warm wet conditions. Infection may continue to spread into twigs, causing them to exude gum. **Brown Rot** (*Monilinia fructicola*) (page 198)

12b • Blossoms browned and withered during cool, wet weather. Brown lesions turn fuzzy gray from fungal sporulation. Disease does not spread into twigs. **Green Fruit Rot** (*Botrytis cinerea*) (page 201)

12c • Blossoms wither, dry, and turn dark brown. Infection may extend 2.5–5 cm into spur. No fungal sporulation or water-soaking on infected tissues is apparent. Freezing injury to blossoms favors infection. **Blossom Blast** (*Pseudomonas syringae*) (page 155)

13a • (from 7f) Perennial, elongated cankers surrounded by large, black, swollen rings of callus tissue and hardened gum. Canker associated with wounds, pruning stubs, peach tree borer, shaded-out twigs, or leaf scars. **Perennial Canker** (*Leucostoma cincta* and *L. persoonii*) (page 159)

13b • Flagging of current season's growth. Small, dark, oval cankers at buds, leaf scars, or bases of current season's twigs. Condition persists for only one year with symptoms most common in fall and spring. More frequent in warm regions. **Fusicoccum Canker** (*Phomopsis amygdali*) (page 164)

13c • Canker originating from blighted blossom. (go to 12)

Key to Cherry Disease Identification

1a • Trees stunted or weakened; foliage is wilted or off-color with early reddening or may be prematurely defoliating. No other obvious symptoms on tree. (go to 10)

1b • Obvious spots, lesions, cankers, galls, or variegation patterns on leaves, blossoms, fruits, shoots, branches, or crown. (go to 2)

2a • (from 1b or 12b) Small to large warty-appearing growths at crown or on roots. **Crown Gall** (*Agrobacterium tumefaciens*) (page 144)

2b • Small green, corky, elongated outgrowths (knots) on limbs. Knots turn black and woody after one season. Common on plum, occasionally found on tart cherry, rarely on sweet cherry. **Black Knot** (*Apiosporina morbosa*) (page 157)

2c • No knots, tumors, or galls. (go to 3)

3a • (from 2c) Blossoms are blighted. (go to 4)

3b • Distinct lesions or blemishes on fruits. (go to 5)

3c • Distinct lesions, silvering of leaves, or distortions of leaves. (go to 6)

3d • Cankers on twigs or branches only. (go to 9)

3e • Fruits pointed, small, or pale. (go to 15)

4a • (from 3a or 9c) Powdery gray mass of spores develops on diseased areas during warm wet conditions. Infection may continue to spread into twigs, causing them to exude gum. **Brown Rot** (*Monilinia fructicola*) (page 198)

4b • Blossoms browned and withered during cool wet weather. Brown lesions turn fuzzy gray from fungal sporulation. Disease does not spread into twigs. **Green Fruit Rot** (*Botrytis cinerea*) (page 201)

4c • Ooze present on infected blossoms, then they wither, dry, and turn dark brown. Infection may extend 2–5 cm into spur. No fungal sporulation or water-soaking on infected tissues is apparent. Freezing injury to blossoms favors infection. **Blossom Blast** (*Pseudomonas syringae*) (page 155)

5a • (from 3b) Soft brown spots on maturing fruits that expand rapidly and produce tan powdery masses of spores. **Brown Rot** (*Monilinia fructicola*) (page 198) or **Green Fruit Rot** (*Botrytis cinerea*) (page 201)

5b • Velvety dark green to black, sunken lesions on mature fruit. Lesions associated with overripe or damaged fruit. **Alternaria Fruit Rot** (*Alternaria alternata*) (page 191)

5c • Small, circular, tan to brown spots on mature or nearly mature fruit. Lesions expand rapidly, with a tendency to form concentric rings, and may or may not be sunken. Lesions are firm to the touch but typically develop orange to pink, slimy spore masses in their centers. **Anthracnose** (*Colletotrichum acutatum*; *C. gloeosporioides*) (page 192)

5d • Tart cherries, primarily 'Montmorency' or 'Morello', with corky, brown-discolored pits or rings in the epidermis and extending into the flesh of the fruit; fruit is off-flavor. **Green Ring Mottle Virus** (Green Ring Mottle Virus) (page 180)

5e • Deep black depressions on fruit associated with cankering of twigs or branches and tattered appearance of leaves. (go to 8)

6a • (from 3c or 15a) Small purple spots on upper leaf surface becoming dark red to brown. Pink to white spore masses developing from spots on underside of leaf during rainy weather. Infected leaves turning yellow and dropping. **Cherry Leaf Spot** (*Blumeriella jaapii*) (page 169)

6b • Leaves curled, slender, distorted, pale green, covered with white, powdery fungal growth. Affected terminals stunted, distorted; common on tart cherry. **Powdery Mildew** (*Podosphaera clandestina*) (page 187)

6c • Foliage associated with a major branch or occasionally entire tree becomes silvery in appearance. **Silver Leaf** (*Chondostereum purpureum*) (page 151)

6d • Leaves cupped, distorted, narrowed, yellowed or green mottled followed by defoliation. (go to 7)

6e • Distinct chlorotic or necrotic spots, rings, or lines; shotholing; or tattering of leaves. (go to 8)

7a • (from 6d) Interior canopy leaves of Montmorency turn yellow and green mottled, then drop. Margins may show a "constricting chlorosis" caused by restricted expansion of leaves along chlorotic veins. **Green Ring Mottle Virus** (Green Ring Mottle Virus) (page 180)

7b • Leaves cup upward; turn yellow, red; then drop from localized areas of the canopy. Associated with thick, spongy bark at crown area. **Prunus Stem Pitting** (Tomato Ringspot Virus) (page 148)

7c • Older leaves show irregular green to yellow mottling or interveinal chlorosis then drop three to four weeks after petal fall. Successive waves of mottling and dropping as temperatures fluctuate. Older trees show willowy growth from reduction of fruit spurs. Fruit sparse but large. **Sour Cherry Yellows** (Prune Dwarf Virus) (page 174)

8a • (from 6e or 9d) Small purple lesions surrounded by a green halo on leaves in spring. Lesions become necrotic and fall out, giving leaves a tattered appearance. Symptoms associated with deep black depressions on fruit and cankering of twigs and branches. Occasionally a bare-branched condition results from buds and spurs killed by cankers. Primarily on sweet cherry, occasionally sour cherry. **Bacterial Canker** [*Pseudomonas syringae* pv. *syringae* van Hall and/or *P. syringae* pv. *morsprunorum* (Wormald) Young et al.] (page 155)

8b • Individual branches or entire tree showing delayed foliation, stunted wavy leaves, and shortened blossom pedicels in spring. Leaves develop chlorotic spots, lines, or rings as they emerge. In severe cases, chlorotic areas become necrotic and fall out, leaving the leaves shotholed or tattered. **Prunus Necrotic Ringspot** (Prunus Ringspot Virus) (page 173)

9a • (from 3d) Large cankers on trunk or main branches with extensive gumming. **Bacterial Canker** [*Pseudomonas syringae* pv. *syringae* van Hall and/or *P. syringae* pv. *morsprunorum* (Wormald) Young et al.] (page 155)

9b • Perennial, elongated cankers surrounded by large, black, swollen rings of callus tissue and hardened gum.

Canker associated with wounds, pruning stubs, shaded-out twigs, or leaf scars; primarily on sweet cherry. **Perennial Canker** (*Leucostoma cincta* or *L. persoonii*) (page 159)

9c • Cankers originating from blighted blossoms that remained attached. (go to 4)

9d • Twig cankers on sweet cherry associated with distinct tattered appearance of leaves. (go to 8)

10a • (from 1a) Decay is evident at the root and/or crown area. (go to 11)

10b • Decay is not evident at the root and/or crown area. (go to 12)

11a • (from 10a or 13a) Foliar growth sparse and/or collapses shortly after bloom or during first postbloom stretch of warm, dry weather. Trunk may be cracked, and the bark may easily slough off at the crown area or southwest side of trunk; wood underneath is darkened. Larger roots may also be dead. **Winter Injury**

11b • Affected crown and/or root tissue appears reddish brown in color underneath bark; may be water-soaked and slimy. Affected tissue delimited by a definite margin of infection, sometimes extending into trunk or root area. **Phytophthora Crown Rot** (*Phytophthora cactorum*; *Phytophthora* spp.) (page 147)

11c • Bark at crown and roots easily sloughs off, exposing dense white fungus growth with fan-shaped distribution at cambium. Black shoestring-like strands (rhizomorphs) may be obvious on surface of bark, and yellow-brown mushrooms may appear at base of tree in late summer or early fall. **Armillaria Root Rot** (*Armillaria mellea*) (page 142)

11d • Dense mat or web of white mycelium and/or masses of sclerotia (spherical, hardened, tan to dark brown fungal bodies 0.5–2.0 mm in diameter) evident at the base of the tree. **Southern Blight** (*Sclerotium rolfsii*) (page 152)

12a. (from 10b) Fibrous roots lacking or showing witches broom. Most common on light-textured soils. **Root-Lesion Nematodes** (*Pratylenchus penetrans*; *Pratylenchus* spp.) (page 150)

12b. Tumors or galls located on root or crown area. (go to 2)

12c. Roots appear normal. (go to 13)

13a • (from 12c) Bark easily sloughs off at crown area. (go to 11)

13b • Bark missing at or below the soil line. Gnawing marks sometimes visible in wood. Callus formed in bark at margin of bare wood. **Rodent Damage**

13c • Bark abnormally thick and spongy, wood underneath has severely pitted, indented texture. Leaves may have upward cupping, turning reddish purple, then dropping. **Prunus Stem Pitting** (Tomato Ringspot Virus) (page 148)

13d • Bark normal at crown area. (go to 14)

14a • (from 13d) Leaves wilted or browned on one or several scaffolds (flagging). Rest of tree appears healthy. Dark streaks in sapwood of two- to three-year-old or older wood. Symptoms enhanced by water stress in midsummer. **Verticillium Wilt** (*Verticillium dahliae*) (page 153)

14b • Flagging is not evident. (go to 15)

15a • (from 3e or 14b) Trees have a bare-branched or willowy appearance from lack of lateral spurs. (go to 6)

15b • Leaves on affected branches turn rusty red in late summer. Localized areas or the entire canopy defoliates, leaving foliage only at the tips; cherries small, flattened, pointed, and pale-colored. **X-Disease** (Mycoplasmalike Organism [MLO]) (page 190)

Key to Plum Disease Identification

1a • Trees stunted or weakened; foliage is wilted or off-color with early reddening or may be prematurely defoliating. No other obvious symptoms on tree. (go to 2)

1b • Obvious spots, lesions, cankers, galls, or variegation patterns on leaves, blossoms, shoots, or fruit. (go to 7)

1c • Small green, corky, elongated outgrowths (knots) on limbs; knots turning black and woody after one season. **Black Knot** (*Apiosporina morbosa*) (page 157)

2a • (from 1a) Roots and crown showing no obvious decay. (go to 3)

2b • Roots, crown, and/or lower trunk showing obvious galls, knots, abnormal growth, or decay. (go to 4)

3a • (from 2a or 5b) Foliar growth sparse and/or collapses shortly after bloom or during first postbloom stretch of warm, dry weather. Trunk may be cracked, and the bark may easily slough off at the crown area or southwest side of trunk; wood underneath is darkened. Larger roots may also be dead. **Winter Injury**

3b • Affected crown and/or root tissue appears reddish brown in color underneath bark; may be water-soaked and slimy. Affected tissue delimited by a definite margin of infection, sometimes extending into trunk or root area. **Phytophthora Crown Rot** (*Phytophthora cactorum*; *Phytophthora* spp.) (page 147)

3c • Bark at crown and roots sloughs off easily, exposing dense, white fungus growth with fan-shaped distribution at cambium. Black shoestring-like strands (rhizomorphs) may be obvious on surface of bark, and yellow-brown mushrooms may appear at base of tree in late summer or early fall. **Armillaria Root Rot** (*Armillaria mellea*) (page 142)

3d • Dense mat or web of white mycelium and/or masses of sclerotia (spherical, hardened, tan to dark brown fungal bodies 0.5–2.0 mm in diameter) evident at the base of the tree. **Southern Blight** (*Sclerotium rolfsii*) (page 152)

4a • (from 2b) Affected crown and/or root tissue appears reddish brown in color underneath bark; may be water-soaked and slimy. Affected tissue delimited by a definite margin of infection, sometimes extending into trunk or root area. **Phytophthora Crown Rot** (*Phytophthora cactorum*; *Phytophthora* spp.) (147)

4b • Fibrous roots lacking or showing witches broom. **Root-Lesion Nematodes** (*Pratylenchus penetrans*; *Pratylenchus* spp.) (page 150)

4c • Affected trees show a general decline and bear small, pale green leaves. The scion grows quicker than rootstock, giving the rootstock a constricted appearance just below the graft union. A distinct brown, sunken line at the union is apparent underneath the bark. **Constriction Disease of Stanley Plum** (Tomato Ringspot Virus) (page 143)

4d • Roots appear normal. (go to 5)

5a • (from 4d) Bark missing at or below the soil line. Gnawing marks sometimes visible in wood. Callus formed in bark at margin of bare wood. **Rodent Damage**

5b • Bark easily sloughs off at crown area. (go to 3)

5c • Bark normal at crown area. (go to 6)

6a • (from 5c) Leaves wilted or browned on one or several scaffolds (flagging). Rest of tree appears healthy. Dark streaks in sapwood of two- to three-year-old and older wood. Symptoms enhanced by water stress in midsummer. **Verticillium Wilt** (*Verticillium dahliae*) (page 153)

6b • Flagging is not evident. (go to 7)

7a • (from 1b or 6b) Small to large, warty-appearing growths at crown or on roots. **Crown Gall** (*Agrobacterium tumefaciens*) (page 144)

7b • Distinct spots, lesions, silvering of leaves, or distortions of leaves. (go to 8)

7c • Distinct spots, lesions, or blemishes on fruits. (go to 10)

7d • Blossoms are blighted. (go to 11)

7e • Cankers on twigs or branches only. (go to 12)

8a • (from 7b) Leaves swollen, thickened, and distorted along midrib, later turning red to purple, browning, and dropping from tree; may or may not occur with fruit symptoms. **Plum Pockets** (*Taphrina communis*) (page 183)

8b • White, powdery fungal growth on leaf surfaces. Leaves may drop prematurely or fail to elongate and unfold normally, while those on new shoots may become narrow, strap-like, and distorted. **Powdery Mildew** (*Sphaerotheca pannosa* or *Podosphaera clandestina*) (page 186)

8c • Foliage associated with a major branch or occasionally entire tree becomes silvery in appearance. Heartwood is often discolored. **Silver Leaf** (*Chondostereum purpureum*) (page 151)

8d • Distinct spots, lesions, or shotholes visible on the leaves. (go to 9)

9a • (from 8d) Small, brown or black angular lesions surrounded by a light green halo. Later the lesions drop out (shothole). Dark brown lesions and/or blemishes on fruit often become sunken, causing the skin of the fruit to crack and forming deep pits. **Bacterial Spot** (*Xanthomonas arboricola* pv. *pruni)* (page 177)

9b • Leaves develop chlorotic spots, lines, and rings as they emerge. In severe cases, chlorotic areas become necrotic and fall out, leaving the leaves shotholed or tattered. **Prunus Necrotic Ringspot** (Prunus Necrotic Ringspot Virus) (page 173)

9c • Small purple lesions surrounded by a green halo on leaves in the spring. Lesions become necrotic and fall out, giving leaves a tattered appearance. Occasionally, a bare-branched or "leggy" condition results from buds and spurs being killed by cankers. **Bacterial Canker** [*Pseudomonas syringae* pv. *syringae* van Hall and/or *P. syringae* pv. *morsprunorum* (Wormald) Young et al.] (page 155)

9d • Older leaves show irregular green to yellow mottling or interveinal chlorosis then drop three to four weeks after petal fall. Successive waves of mottling and dropping as temperatures fluctuate. Older trees show willowy type of growth from reduction of fruit spurs. Fruit sparse but large. **Sour Cherry Yellows** (Prune Dwarf Virus) (page 174)

10a • (from 7c) Soft brown spots on maturing fruits expand rapidly and produce tan powdery masses of spores. Infections from fruit may advance into wood, causing small cankers. Fruit that is entirely rotted becomes "mummified." **Brown Rot** (*Monilinia fructicola*) (page 198) or **Green Fruit Rot** (*Botrytis cinerea*) (page 201)

10b • Small, circular, tan to brown spots on mature or nearly mature fruit. Lesions expand rapidly, with a tendency to form concentric rings, and may or may not be sunken. Individual lesions may reach a diameter of 4–5 cm, but infection can be more extensive when lesions coalesce. Lesions are firm to the touch but typically develop orange to pink, slimy spore masses in their centers. **Anthracnose** (*Colletotrichum acutatum*; *C. gloeosporioides*) (page 192)

10c • Infection first appears as white to off-white spots or blisters on fruit. Infected fruit are distorted, spongy, and abnormally large. The tissues of the seed cavity wither and die, forming a pocket within the fruit; as the fruit dry, they wither and fall from the tree. **Plum Pockets** (*Taphrina communis*) (page 183)

10d • Dark brown lesions and/or blemishes on fruit often become sunken, causing the skin of the fruit to crack and forming deep pits. On leaves, small, brown or black angular lesions surrounded by a light green halo form; later the lesions drop out (shothole). **Bacterial Spot** (*Xanthomonas arboricola* pv. *pruni)* (page 177)

11a • (from 7d or 12c) Powdery gray mass of spores develop on diseased areas during warm wet conditions. Infection may continue to spread into twigs, causing them to exude gum. **Brown Rot** (*Monilinia fructicola*) (page 198)

11b • Blossoms browned and withered during cool, wet weather. Brown lesions turn fuzzy gray from fungal sporulation. Disease does not spread into twigs. **Green Fruit Rot** (*Botrytis cinerea*) (page 201)

11c • Blossoms wither, dry, and turn dark brown. Infection may extend 2.5–5 cm into spur. No fungal sporulation or water-soaking on infected tissues is apparent. Freezing injury to blossoms favors infection. **Blossom Blast** (*Pseudomonas syringae*) (page 155)

12a • (from 7e) Large cankers on trunk or main branches with extensive gumming. **Bacterial Canker** [*Pseudomonas syringae* pv. *syringae* van Hall and/or *P. syringae* pv. *morsprunorum* (Wormald) Young et al.] (page 155)

12b • Perennial, elongated cankers surrounded by large, black, swollen rings of callus tissue and hardened gum. Canker associated with wounds, pruning stubs, peach tree borer, shaded-out twigs, or leaf scars. **Perennial Canker** (*Leucostoma cincta* and *L. persoonii*) (page 159)

12c • Canker originating from blighted blossom. (go to 11)

These keys are modifications of those presented originally by M. R. Schwarz and T. J. Burr, 1984, New York's Food and Life Sciences Bulletin Number 108, *Diagnostic Keys for Identification of Diseases on Apple, Peach, and Cherry Trees in the Northeastern United States.*

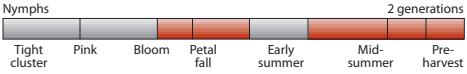
Insect and Mite Pests

Hemiptera: Auchenorrhyncha: Cicadellidae

A: 3 mm
N: 1.5 mm

White apple leafhopper

Typhlocyba pomaria McAtee



NYSAES

NRAES–75

NYSAES

NYSAES

Description

Adults are creamy white with short antennae, translucent wings, and a long wedge-shaped body **(A)**. Usually found on the undersides of leaves, they jump and fly with great agility. Nymphs **(B)** are yellowish, wingless, and very mobile; they generally move in a back-and-forth motion.

Distribution

Widespread in most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple mainly. Feeding causes white mottling of leaves, particularly on the interior of the canopy **(C)**. Shiny black excrement on leaves and fruit **(D)** occurs when adult populations are abundant. They can be a nuisance to pickers at harvest by flying in the nose, mouth, and eyes.

Similar Species

Potato leafhopper *(Empoasca fabae,* page 34), greenish in color, moves in a lateral fashion and appears later in the season. It is occasionally present on water sprouts, but damage appears as leaf yellowing or chlorosis followed by cupping. Rose leafhopper [*Edwardsiana rosae* (L.), page 34] is closely related and very similar in appearance, but dark spots at the bases of setae (hairs) can be seen on the thorax of *E. rosae* nymphs, whereas *T. pomaria* lacks spots. *E. rosae* has three generations per year in the Mid-Atlantic states and South.

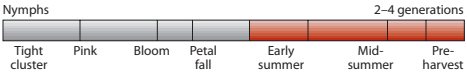
Management

Monitor the population on leaves (fruit cluster leaves for the first generation); when necessary, apply a selective insecticide against immature stages.

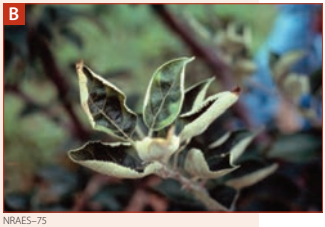
A: 3 mm
N: 1.5 mm

Potato leafhopper

Empoasca fabae (Harris)



NRAES–75



NRAES–75

NRAES–75

Description

Adults are yellowish green with short antennae, translucent wings, prominent leg spines, and a long wedge-shaped body **(A)**. Usually found actively moving on the leaf surface, they quickly run to the leaf underside when disturbed. Nymphs **(A)** are wingless and very mobile; they generally move in a lateral fashion. They overwinter in the Gulf Coast states; adults are carried into the Mid-Atlantic and Northeast states on weather fronts each year.

Distribution

Widespread in most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple as well as many agronomic crops. Adults and nymphs inject a toxic saliva while feeding, which damages the leaf tissue and causes a characteristic yellowing or chlorosis ("hopperburn"), followed by cupping of young terminal leaves **(B)**.

Similar Species

White apple leafhopper *(Typhlocyba pomaria*, page 33), moves in a back-and-forth motion and appears earlier in the season. Rose leafhopper [*Edwardsiana rosae* (L.) **(C)**] is closely related and very similar in appearance but the nymph has dark spots at the bases of its setae (hairs). Other diagnostic characteristics often include the genitalia and ovipositor, but they are difficult to apply in the field.

Management

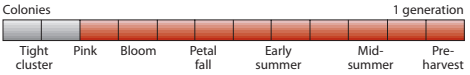
Monitor the population by examining leaf undersides, especially on younger trees. When necessary, apply a selective insecticide against immature stages.

Hemiptera: Sternorrhyncha: Psyllidae

A: 3 mm
N: 2 mm

Apple sucker

Cacopsylla mali (Schmidberger)



Eaton

Quinn

Description

The adult resembles a miniature cicada, greenish yellow to yellow in color but sometimes containing reds or browns, with eyes pale green to reddish brown and long, slender antennae. Wings are transparent and iridescent **(A)**. The nymph is pale yellowish green with green eyes and a short, broad body that has a flattened appearance, is rounded posteriorly, and has prominent wing pads **(B, arrow)**.

Distribution

Southern ON, QC, and south into New England and NY.

Damage

Attacks apple. Motile stages are "flush feeders" that suck sap from newer, tender growth and secrete excess fluid as honeydew. This collects on leaves and fruits, provides a good medium for sooty mold growth, and can kill leaf tissue. Excessive feeding and injection of toxic saliva can cause wilting and premature leaf drop.

Similar Species

The pear psylla (*Cacopsylla pyricola*, page 36) is closely related but can be distinguished by its darker coloration and the fact that it does not occur on apple.

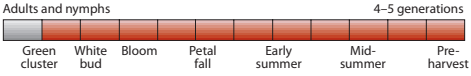
Management

Spring egg laying can be suppressed by pre-bloom oil applications. Many predacious insects are their natural enemies, but many commercial production practices (applications of broad-spectrum insecticides, highly refined summer oil, or insecticidal soap) will provide incidental control.

A: 2 mm
N: 1.5 mm

Pear psylla

Cacopsylla pyricola Foerster



NYSAES

NYSAES

NYSAES

NYSAES

Description

Adults **(A)** resemble very small cicadas and can be reddish brown (overwintered generation) or tan to light brown (summer forms). Smaller wingless nymphs are yellow with red eyes, are flat and oval in shape, and develop within a clear honeydew drop **(B)**. Larger "hard shell" nymphs are darker with black areas interspersed with green or brown coloration **(C)**; these forms have noticeable wing pads and are free-living.

Distribution

Widespread and a major pest in most fruit-growing states and provinces in eastern North America.

Damage

Attacks pear exclusively. Motile stages are "flush feeders" that suck sap from newer tender growth and secrete excess fluid as honeydew. This collects on leaves and fruits and provides a good medium for sooty mold growth **(D)**. Psylla feeding can kill leaf tissue (called "psylla scorch") in sunny, dry conditions. Excessive feeding and injection of toxic saliva can cause wilting and premature leaf drop.

Similar Species

The apple sucker (*Psylla mali*, page 35) is closely related but can be distinguished by its lighter coloration and the fact that it does not occur on pear.

Management

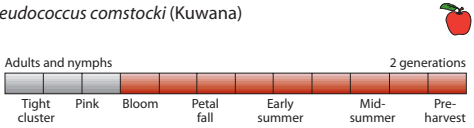
Spring egg laying can be suppressed by prebloom oil applications. Diligent hand removal of suckers can greatly reduce psylla populations. A balanced fertilizer program and avoidance of excessive nitrogen greatly reduces flush vegetative growth that attracts psylla. Many predacious insects are natural enemies, but commercial production often requires applications of broad-spectrum insecticides, highly refined summer oil, kaolin clay, or insecticidal soap.

Hemiptera: Sternorrhyncha: Pseudococcidae

A: 5 mm
N: 2.5 mm

Comstock mealybug

Pseudococcus comstocki (Kuwana)



NYSAES

NYSAES

NYSAES

Description

Adult females and nymphs are generally similar in appearance, having an elongate-oval shape, no wings, a many-segmented body, and well-developed legs **(A)**. The legs and antennae are inconspicuous. The body color is reddish brown, but the overall appearance is white, because it is covered with wax, particularly in the case of the adult female **(B)**, which additionally has long body filaments (including a pair caudally that are one-third as long as the body). The adult male is very small, gnat-like, and transient, so is rarely seen.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks mainly pear, apple, and peach. Adults and nymphs (crawlers) are sap-feeders on green tissue and congregate in the calyx and stem ends of fruits close to harvest. The pest status of Comstock mealybug derives both from the growth of sooty molds on the honeydew it secretes **(C)** and from the aesthetic and contaminant problems posed by its presence in processing.

Management

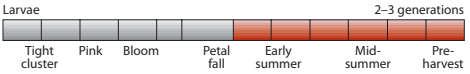
Examine terminal growth for crawler activity periodically throughout the summer; use double-sided tape traps on scaffold limbs to document movement towards fruit. An insecticide application can be made in midsummer to prevent fruit infestations if other pest sprays fail to provide incidental control.


A: 2.0 mm

L: 2–3 mm

Apple leaf(curling) midge

Dasineura mali (Kieffer)




A

Cross


B

NYSAES


C

NYSAES


D

Agnello

Description

The adult is a tiny dark brown fly **(A)**, and the larva is a yellow-white maggot with a reddish tinge **(B)**.

Distribution

NB, QC, ON, NY, New England states.

Damage

Larvae attack leaves and flowers of apple trees, which can impair the growth of young or grafted trees in particular. Larvae spend most of their lives within a rolled leaf **(C)** and then usually drop to the ground to pupate. Major symptoms of infestation are tightly rolled leaves caused by early instar larval feeding. Leaves subsequently become brown and brittle **(D)** and drop from the tree.

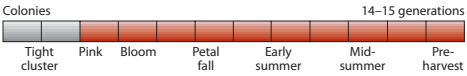
Management

Sprays are seldom required. They are generally not a problem in orchards receiving seasonal insecticide sprays for other pests, particularly in late spring, just as leaf symptoms would start to appear.

A: 2 mm

Spirea aphid

Aphis spiraecola Patch



A

Drouin

B

NYSAES

C

Drouin

Description

The eggs are oval and shiny black. The adults and nymphs **(A)** are both olive green with brown-black legs, antennae, and cornicles. They live in colonies.

Distribution

Widespread in most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple and pear. This aphid causes the curling of young leaves **(B)**, reduces the growth of infested shoots, and excretes honeydew on leaves and fruit, which favors the development of sooty mold.

Similar Species

The apple aphid, *Aphis pomi* De Geer, and the spirea aphid are impossible to differentiate in the field, even under magnification, and cause the same types of damage. In recent years, *A. pomi* has been almost entirely displaced by *A. spiraecola* in commercial apple plantings. Also, early in the season, the apple grain aphid, *Rhopalosiphum fitchii* (Sanderson), is present. Adults and nymphs **(C)** have three longitudinal dark green bands on the back and normally does not cause damage.

Management

Protect natural predators by the use of selective insecticides. Monitor colonies on growing shoots. Application of selective insecticide may occasionally be necessary if a high percentage of shoots have active aphid colonies (can simultaneously be used against leafhoppers and leafminers).

A: 3 mm

Black cherry aphid

Myzus cerasi (Fabr.)

NRAES–75

NRAES–75

Description

Adults and nymphs are shiny black soft-bodied insects; adults may or may not have wings. Nymphs are smaller but generally similar in appearance to the adults (A).

Distribution

Throughout the fruit-growing states and provinces in eastern North America.

Damage

Attacks cherry mainly, particularly sweet cherries. Adults and nymphs establish colonies on new foliar growth in the spring, usually on the undersides of the leaves of growing shoots. They feed by sucking sap out of the leaves and tender shoots, causing a curling and stunting of the leaves (B). Heavy infestations reduce crop quantity and quality on mature trees, limit fruit set the following year, and may kill young trees. Honeydew secreted by the aphids promotes a black sooty mold on the fruit and foliage.

Management

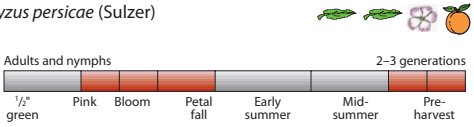
Protect natural predators. Monitor colonies on growing shoots. Application of selective insecticides may occasionally be necessary.

Hemiptera: Sternorrhyncha: Aphididae

A: 2 mm

Green peach aphid

Myzus persicae (Sulzer)



A NRAES–75

B NRAES–75

C NRAES–75

Description

These smooth-looking, pear-shaped insects have long antennae and a pair of cornicles extending from the posterior end of the body. Wingless adults and nymphs **(A)** are yellowish green with three darker green lines on the abdomen. Winged adults are similar in color but with a dark head and thorax.

Distribution

Widespread in most stone-fruit-growing states and provinces in eastern North America.

Damage

Attacks peach and all stone fruit crops and is the main vector of plum pox virus (reported from ON, PA, and NS; see page 184). Adults and nymphs suck the sap from leaf undersides, causing curling and yellowing of foliage **(B)**. Flowers and fruits may also be fed upon, resulting in distortion and discoloration **(C)**.

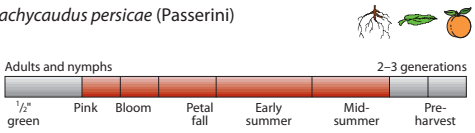
Management

A dormant oil application can help suppress overwintering egg hatch. Motile forms can be treated with an insecticide as they appear in the spring.

A: 2 mm

Black peach aphid

Brachycaudus persicae (Passerini)



Schmitt

Shearer

Description

These smooth-looking, pear-shaped insects have long antennae and a pair of cornicles extending from the posterior end of the body. Adults are shiny and black (A). Nymphs are reddish brown.

Distribution

Widespread in most stone-fruit-growing states and provinces in eastern North America.

Damage

Black peach aphid feeds on the roots of young peach and plum trees (B), causing stunted growth and predisposing them to other damage. Foliar colonies form in the spring and can cause leaf curling, yellowing, and premature drop. Some fruit distortion may occur, and honeydew from large colonies causes leaf spotting and sooty mold on the fruit.

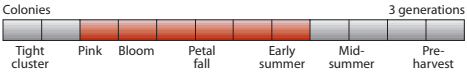
Management

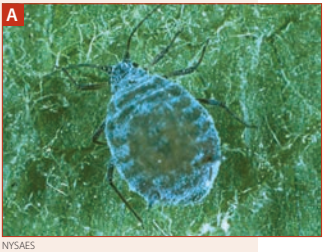
Black peach aphid is rarely a serious pest in commercial orchards. Motile forms can be treated with an insecticide as they appear in the spring. Conservation of natural enemies will contribute to management efforts.

A: 2.5 mm
N: 2 mm

Rosy apple aphid

Dysaphis plantaginea (Passerini)




A

NYSAES


B

NYSAES


C

NYSAES


D

NYSAES

Description

Populations arise from the overwintered stem mothers (A), which are wingless and purplish in color and form into colonies of rosy-purple nymphs with dark cornicles (B). They do not have the waxy, wool-like covering that the woolly apple aphid produces.

Distribution

Widespread in most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple mainly, also pear. This aphid causes the leaves to curl (C) and take on a crimson appearance; it stunts the growth of shoots and causes characteristic malformations on leaves and fruit (D). The honeydew it excretes favors the growth of sooty mold.

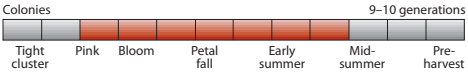
Management

Conserve natural enemies. Check for colonies in fruit clusters at pink bud stage and on interior and upper branches after petal fall; if necessary, apply selective insecticides (aphicides) at pink. Elimination of this species' summer weed hosts, especially narrow-leaved plantain and dock, can contribute to control efforts.

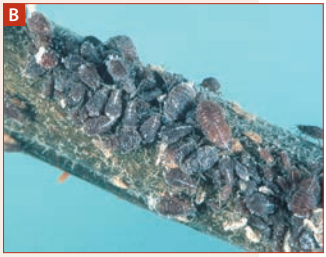
A: 2 mm
N: 1.3 mm

Woolly apple aphid

Eriosoma lanigerum (Hausmann)



NYSAES



NYSAES

NYSAES

Simard

Description

The colonies of reddish brown adults **(A)** and nymphs **(B)** produce waxy secretions, which resemble small tufts of wool or cotton batting **(C)**. The aphids are without cornicles, possessing only abdominal pores.

Distribution

Widespread and a major pest in most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple and pear. The woolly apple aphid causes the formation of nodules on the woody parts of trees and roots **(D)**. The nodules can split and develop into cankers. This aphid excretes honeydew on leaves and fruit that favors the growth of sooty mold.

Management

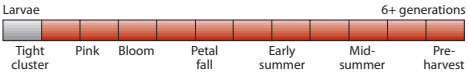
The use of resistant apple rootstocks is recommended. Protect natural enemies. Check for colonies on pruning scars and on interior and upper branches beginning in early to midsummer; if necessary, apply selective insecticides (aphicides) when they appear.


A: 7 mm


L: 5 mm

Apple (Lyonetia) leafminer

Lyonetia prunifoliella Hübner




A

NRAES–75


B

NYSAES


C

NYSAES

Description

The adult has narrow white forewings with extensive gray-black and brown markings apically; wing margins are fringed with long hairs (A). The larva is whitish and generally concealed within the leaf mine. The pupa is external and hangs suspended in a "hammock" from the leaf underside (B).

Distribution

Mainly in the northeastern United States and south through the Mid-Atlantic states.

Damage

Attacks apple, plum, and cherry. Larvae form a winding linear mine that widens into a blotch mine on the upper surface of the leaf (C). Black frass is ejected through holes chewed in the lower epidermis and is commonly seen hanging from the mine in threads.

Management

Removal of root initials and water sprouts may greatly reduce the amount of available food for larvae and thereby control adult numbers. Avoid excess fertilization that would enhance vegetative growth, particularly later in the season.

Lepidoptera: Nepticulidae

A: 4–5 mm L: 4–5 mm

Cherry leafminer

Stigmella slingerlandella (Kearfott)

Nugent

Howitt

Howitt

Description

The adult is a small, bronzy, tan-colored moth with a wavy, darkish brown to black band at the outer third of the forewings (A). The larva is an annulated caterpillar that is transparent in the early instars and turns a more opaque greenish white when full-grown (B).

Distribution

Reported from MI, OH, and NY.

Damage

Attacks cherry, plum, and prune. Larvae bore into the undersurface of the leaf and mine the tissue under the upper epidermis (C), which becomes nearly transparent. Mines are initially light-colored and filled with frass, later becoming more extensive and blotchy.

Management

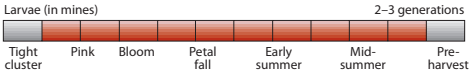
An insecticide applied one to two times after petal fall directed at adults can provide effective control.

Lepidoptera: Gracillariidae

A: 4 mm L: 4 mm

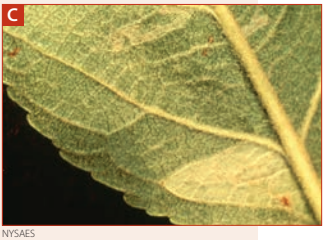
Spotted tentiform leafminer

Phyllonorycter blancardella (Fabr.)



NYSAES

NYSAES



NYSAES

NYSAES

NYSAES

Description

The adult is a tiny beige moth with heavily fringed wings striped with golden brown and white bands **(A)**. Eggs are laid individually on leaf undersurfaces. The yellowish larva has a dark head and lives inside the leaf **(B)**.

Distribution

Widespread in most fruit-growing states and provinces in eastern North America.

Damage

Apple is preferred. The first three larval instars feed on tissues between the two epidermal layers of the leaf, separating the outer layer of the leaf undersurface from the tissue above and causing a translucent sap-feeding mine that is visible only from the leaf undersurface **(C)**. The last two instars feed more extensively on leaf tissues; their tissue-feeding mines appear as clear, blotchy swellings **(D)** on the upper leaf surface and gray on the underside with a longitudinal pinch.

Similar Species

The apple blotch leafminer *(P. crataegella* Clemens) is nearly indistinguishable but has forewings that are usually smaller and less heavily marked with white scales **(E)**. *P. crataegella* is more prevalent in New England; its hosts include apple, pear, cherry, plum, and quince.

Management

Monitor populations with pheromone traps and use a degree-day developmental model to fix the period of second-generation mine occurrence; insecticide applications are normally unnecessary unless mines exceed one to two per leaf (check local threshold recommendations). Spur and leaf sampling for sap-feeding mines allows effective timing of spray applications. Selective insecticides allow parasitoids to markedly reduce larval populations.


Leaf weevil
A: 7 mm


European earwig
A: 16 mm


Click beetle
A: 10 mm

Leaf weevils
Coleoptera: Curculionidae

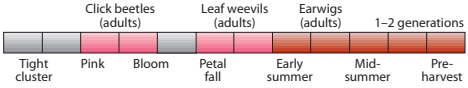
Polydrusus impressifrons Gyllenhal and *Phyllobius* spp.

European earwig
Dermaptera: Forficulidae

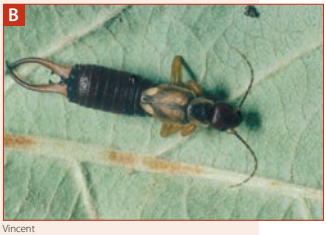
Forficula auricularia

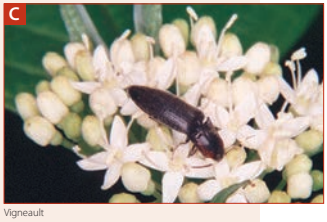
Click beetles
Coleoptera: Elateridae

Ctenicera spp., *Agriotes* spp.




A
Vincent


B
Vincent


C
Vigneault

Description
Leaf weevils are metallic green or brown curculios (A) with antennae borne on the snout. The European earwig is dark brown with an elongated body and pincer-like forceps at the rear of the abdomen (B). The short elytra do not entirely cover the abdomen. The click beetle is dark-colored (C) with a hard, elongated body; a characteristic pair of spurs; and sometimes colorful markings on its thorax. When set on its back, it can bend and suddenly straighten out, propelling itself into the air to right itself and emitting a distinctive "click" sound.

Distribution
P. impressifrons: QC, ON, CT, NY, MI, OH. Numerous earwig and click beetle species are widespread throughout the eastern fruit-producing states and provinces.

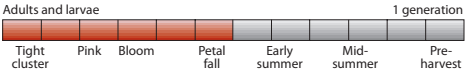
Damage
All occur in apple and pear and occasionally other tree fruits. Leaf weevils, which may be especially numerous on plum trees, create feeding holes in the leaves a few millimeters in size. The European earwig occasionally feeds on leaves or damaged fruit but is also a predator of aphids and caterpillars. The adult click beetle sometimes chews on and destroys flower buds, pistils, and stamens and may be found in tunnels made by European apple sawfly (page 86); larvae are found in soil and feed on roots.

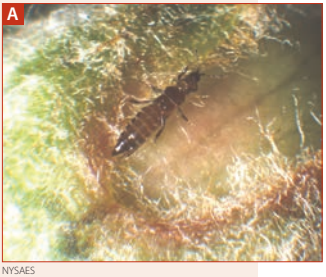
Management
These insects cause negligible problems. Tolerance is probably more economical than intervention.

A: 1.5 mm

Pear thrips

Taeniothrips inconsequens (Uzel)





A

NYSAES

B

Eaton

Description

The adult is slender and brown with short antennae and a swelling behind the head; the wings are long and narrow with fringes of long hairs (A). Young pear thrips are small and white with red eyes.

Distribution

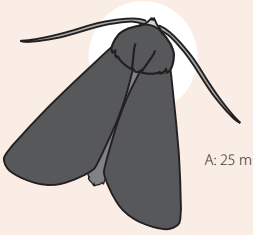
QC, NY, and New England south to MD.

Damage

Attacks pear, apple, and all deciduous fruit trees. Adults enter the bud or start feeding on the bud tip and gradually work themselves in. Eggs are laid under the bud scales, petals, and sepals; on stems; and in other succulent flower and leaf parts. The larvae feed voraciously for about three weeks, adding to the damage already caused by the adults. Feeding is usually concentrated on flower parts, which gives the blossom buds a shriveled, scorched appearance or causes them to fall off completely (B).

Management

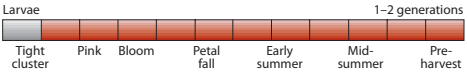
Because much of this insect's life is spent underground, control of damaging populations is very difficult. An oil spray is advised against the egg-laying adults as they emerge, timed between the bud burst and green cluster stages of pear and plum.


A: 25 mm


L: 30–40 mm

Climbing cutworms

Darksided cutworm: *Euxoa messoria* (Harris)
Dingy cutworm: *Feltia jaculifera* (Guenée)
Mottled cutworm: *Abagrotis alternata* (Grote)
Spotted cutworm: *Xestia c-nigrum* (L.)
Variegated cutworm: *Peridroma saucia* (Hübner)
W-marked cutworm: *Spaelotis clandestina* (Harris)



NRAES–75

NYSAES

Description

A large complex of similar species. Adults are dark brown or grayish-colored moths. Larvae tend to be smooth caterpillars with few hairs; brown or black head capsules (sometimes with distinctive markings); and bodies having a dull gray-brown background color with stripes or spots or dark brown, black, yellow, or white splotches **(A, B)**.

Distribution

Most notable as pests in the central and Mid-Atlantic states.

Damage

Various species attack apple, peach, pear, and plum. Partly grown larvae overwinter and begin activity in the spring, when they climb trees from the orchard floor at night to feed on buds, blossoms, and young foliage and return to seek shelter during the day. Feeding tends to be confined to the lower central canopy and trunk areas, but high populations can strip whole trees. Small trees can be stunted or exhibit abnormal growth. In two-brood species, the second brood feeding is minor.

Management

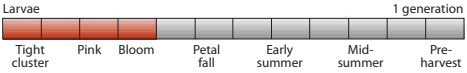
Elimination of weeds, particularly around young trees, will help suppress cutworm damage. Because of the sporadic nature of this pest complex, thresholds have not been established. Small trees are harmed the most by heavy defoliation, but large trees can withstand even several successive years of heavy defoliation in spring.

A: 11–12 mm

L: 9–13 mm

Green pug

Chloroclystis rectangulata (L.)



Maier

Maier

Description

The adult is a grayish moth with mottled or scalloped dark striations toward the wing margins (A). The larva is a green inchworm with a dark head and a dark reddish brown dorsal midline present in later instars (B).

Distribution

NS and south to New England, NY, and NJ.

Damage

Attacks apple and possibly pear. In spring, the larvae feed on buds, flowers, and occasionally developing leaves. When abundant, they can defoliate trees, causing reduced growth and loss of crop, especially on young trees and new grafts.

Similar Species

It resembles the winter moth (*Operophtera brumata*, page 60), particularly in the first two instars, but may be distinguished by distribution and larval coloration (the green pug has a single reddish dorsal stripe in later instars, as opposed to several white stripes in the winter moth).

Management

The green pug is normally not a serious problem in regularly sprayed orchards; the early feeding tends to thin out fruit buds before they are pollinated. If necessary, an insecticide application shortly before the beginning of bloom will control larval infestations.

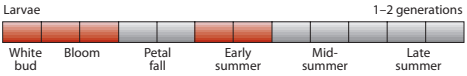
Lepidoptera: Pyralidae

Mineola moth (Destructive pruneworm)

Acrobasis tricolorella (Grote)

A: 9–12 mm (length)

L: 13 mm



NYSAES

NYSAES

NYSAES

NYSAES

Description

The adult is a bluish gray moth that assumes a wedge shape when at rest. It has a transverse broad white stripe bordered by a smaller reddish brown stripe in the middle of the forewings; a smaller set of similar bands occur near the posterior edge **(A)**. The larva has a brown head with a body that is dark grayish brown dorsally, reddish brown ventrally, and marked with many short spines **(B)**.

Distribution

Southern Canada and south to ME and MI.

Damage

Attacks cherry mainly, also plum, and may be found in apple. Overwintered larvae feed on and consume fruit buds **(C)** and developing flower parts, later forming nests in leaf terminals from which they continue to feed. Early summer larvae attack the fruits **(D)** and feed around the pits as they near harvest.

Similar Species

Adult and larval forms resemble American plum borer (*Euzophera semifuneralis*, page 98), which is closely related. May be distinguished by the fact that it does not bore into cambial tissue.

Management

This moth is rare in occurrence, so intervention is seldom needed. Chemical controls can be applied against overwintered larvae in the spring between green tip and white bud and against emerging moths in late June.

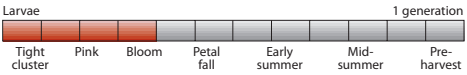
Lepidoptera: Agonoxenidae

A: 9–11 mm

L: 7–8 mm

Apple pith moth

Blastodacna atra (Haworth)



A

Weaver

B

Eaton

C

Eaton

Description

The adult's **(A)** head is covered with white scales. The narrow forewings are mostly black or dark brown with white marks; usually have an irregular, faint, rusty yellow line in the middle; and have two prominent black scale tufts. When the wings are folded, they appear to have three pairs of white spots. Young larvae are yellowish with a dark brown head but turn more reddish in color in the final instar **(B)**.

Distribution

ME, NH, MA, CT, RI.

Damage

Attacks apple. Damage is most noticeable in the spring, either just before or after bloom, when the larvae are actively feeding in the woody tissues at the bases of new shoots, causing leaf wilt and die-back of blossoms and terminal shoots **(C)**. The larvae usually attack spurs and the stems of apical shoots, which stimulates the growth of laterals.

Management

Effective control can be obtained by the application of an insecticide in late summer (about two months after petal fall), when adults are active, as well as in early spring, when overwintering caterpillars emerge from their shelters.

Cigar casebearer
A: 10 mm L: 9 mm

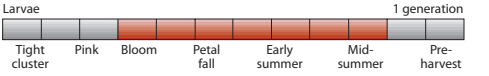
Pistol casebearer
A: 12 mm
L: 6 mm

Cigar casebearer

Coleophora serratella (L.)

Pistol casebearer

Coleophora malivorella Riley



NYSAES

NYSAES

NYSAES

NYSAES

Description

The adults of both species are dark gray with fringed wings. The small yellowish larva of the cigar casebearer has a black head and builds and hides in a cigar-shaped shelter **(A, B, C)** that it carries with it while feeding or attaches to leaves and branches of apple trees. The pistol casebearer is similar in appearance, but its case is curled at the end, resembling a pistol handle **(D)**.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attack apple mainly, also pear and quince. Cigar casebearer larvae eat the epidermis of leaves and their tender tissues, causing the leaves to turn brown. Those of the pistol casebearer attack the expanding buds and later the flowers and foliage, which may be eaten entirely or, in the case of leaves, skeletonized.

Management

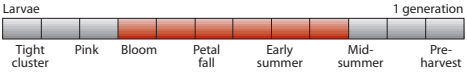
These insects cause little damage, and tolerance is probably more economical than intervention. Economic infestations can be controlled by the use of selective (e.g., *Bacillus thuringiensis*) or broad-spectrum insecticides.

A: 14–15 mm

L: 12 mm

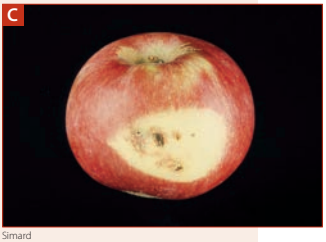
Eyespotted bud moth

Spilonota ocellana (Denis & Schiffermüller)



Drouin

Vincent



Simard

Description

Adult forewings are bluish gray with a central cream-colored band **(A; puparium is on the left)** and black spots. The chocolate brown larva has a black head and thoracic shield **(B)**.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Apple, pear, and cherry are attacked. Larvae tunnel in fruit buds in the spring. During bloom, damaged leaves are tied together as a shelter. In August, larvae attack the fruit by digging tiny holes close together, which often appear in a discolored zone and are arranged in a triangle **(C)**. They also feed on the lower surface of the leaves and on their parenchyma tissue.

Management

This insect causes little damage, and tolerance is more economical than intervention. Economic infestations can be controlled by the use of selective (e.g., *Bacillus thuringiensis*) or broad-spectrum insecticides.

Speckled green fruitworm
A: 38 mm
L: 40 mm

Widestriped green fruitworm
A: 36 mm
L: 35 mm

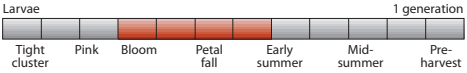
Humped green fruitworm
A: 42 mm
L: 35 mm

Green fruitworms

Speckled green fruitworm:
Orthosia hibisci (Guenée)

Widestriped green fruitworm:
Lithophane antennata (Walker)

Humped green fruitworm:
Amphipyra pyramidoides Guenée



Description

O. hibisci: The adult is grayish beige with two purplish gray spots on its wings and a hairy thorax (A). The eggs are laid on the upper surface of the leaves. The larva is yellowish green with numerous whitish flecks and three longitudinal white stripes along the dorsum (B).

NYSAES

L. antennata: The adult has bluish or steel gray wings marked with inconspicuous mottled patches. The light green larva is similar to *O. hibisci*, but white stripes and spots are more pronounced, and a wide white band appears along each side (C).

NYSAES

A. pyramidoides: The adult's forewings are gray and marked with light and dark areas for two-thirds of their length; the outer one-third is a lighter gray. The larva, which has a pronounced rear hump, is apple green, often with a milky overcast, and marked with broken white dorsal lines and a yellow and white band along each side (D).

NYSAES

Distribution

Mainly southeastern Canada and northeastern United States to the Mid-Atlantic states.

Damage

Attack all deciduous tree fruits. Larvae feed on young leaves (E) and dig tunnels in buds and young fruit (B), often leaving a symmetrical round hole. Fruit drop when the core is injured or otherwise remain on the tree and develop corky scars (F).

Green fruitworms (continued)

NYSAES

NYSAES

NYSAES

NYSAES

Similar Species

Many other fruitworm species are present in eastern North America. Most are similar in appearance (green with dots, dashes, lines, or stripes of white, cream, or yellow), and all can be considered as members of the "green fruitworm" complex. These include *Lithophane baileyi* Grote, Bailey green fruitworm **(G)**, and *Himella fidelis* Grote, fourlined green fruitworm.

Management

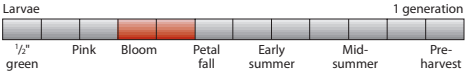
Use broad-spectrum or selective (e.g., *Bacillus thuringiensis*) insecticides, if necessary, before or after bloom.


A: 14–16 mm


L: 10 mm

Pale apple leafroller

Pseudexentera mali Freeman




A
Simard


B
Simard


C
Simard

Description

The adult is elongated and dull gray **(A)**. The larva is creamy white with an amber head that turns black in the penultimate instar **(B)**.

Distribution

NS, QC, and ON south to NY, OH, and probably other temperate eastern states.

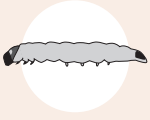
Damage

Attacks apple mainly. Larvae eat and fold leaves **(C)** to create a shelter, where they hide. They also tunnel in the buds.

Management

This insect causes few problems. When necessary, use broad-spectrum insecticides (which can simultaneously be used against the plum curculio) or selective insecticides (*Bacillus thuringiensis* and insect growth regulators).

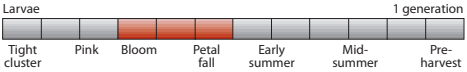
A: 18–21 mm



L: 19 mm

Fruittree leafroller

Archips argyrospila (Walker)



Breton

Breton

Desmarteau

Description

The adult is red-brown with mottling **(A)**. The translucent green caterpillar has a reddish to dark brown head and an amber to pale green thoracic shield edged with brown **(B)**.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple and pear mainly, plus other tree fruits on occasion. A silky web usually ties together leaves and young, partially eaten fruit; injured apples have pronounced deformations at maturity **(C)**.

Similar Species

The late-instar larva is difficult to distinguish from the obliquebanded leafroller (*Choristoneura rosaceana*, page 77) unless reared out to the adult stage, but the larva of the fruittree leafroller tends to be more active when held and is absent from the orchard a few weeks after fruit set.

Management

This insect seldom causes problems. When necessary, use broad-spectrum insecticides (which can simultaneously be directed against the plum curculio) and selective insecticides (*Bacillus thuringiensis* and insect growth regulators).

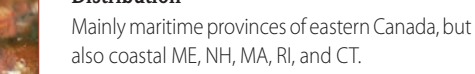

(female)


L: 25–30 mm


A: 25 mm
(male)

Winter moth

Operophtera brumata (L.)




A

OPIE/Remi Coutin


B

OPIE/Remi Coutin


C

Bent

Description

The adult male has grayish brown wings; the female has vestigial wings and cannot fly. This, in combination with the female's large body, makes the legs appear to be long and gives her the superficial appearance of a spider (A). Early larvae are olive green with a black head; later forms are a brighter green with white stripes along the back and sides (B).

Distribution

Mainly maritime provinces of eastern Canada, but also coastal ME, NH, MA, RI, and CT.

Damage

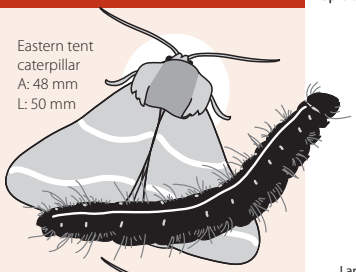
Attacks apple mainly, but also may be found on pear, cherry, and plum. Larvae feed on early foliage, loosely spinning leaves together and eating holes in them; later they may eat flower buds and bite holes in developing fruitlets. Damaged sites heal and appear at harvest as a flat or concave area with a corky surface or sometimes as a deep cleft if the feeding was deep (C).

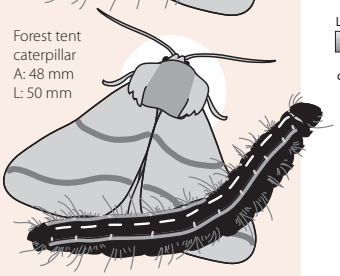
Similar Species

Winter moth resembles the green pug (*Chlorochlystis rectangulata*, page 51), particularly in the first two instars, but may be distinguished by distribution and larval coloration (several white stripes in later instars of winter moth, as opposed to a single reddish dorsal stripe in the green pug).

Management

If needed, insecticide applications may be directed against the young caterpillars soon after hatch, normally from the tight cluster to pink bud stages.

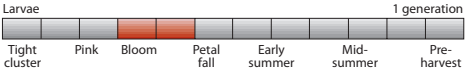

Eastern tent caterpillar
A: 48 mm
L: 50 mm


Forest tent caterpillar
A: 48 mm
L: 50 mm

Tent caterpillars

Eastern tent caterpillar:
Malacosoma americanum (Fabr.)

Forest tent caterpillar:
Malacosoma disstria Hübner



Description
Adults are reddish brown with two transverse parallel bands that are white in the eastern tent caterpillar **(A)** and brown in the forest tent caterpillar **(B)**. Masses of shiny black eggs are laid in a ring around twigs. Larvae have long silky hairs on their bodies. The eastern tent caterpillar has a yellow line on its back **(C)**; the forest tent caterpillar has a row of elongated spots along its back **(D)**.

Distribution
Most fruit-growing states and provinces in eastern North America.

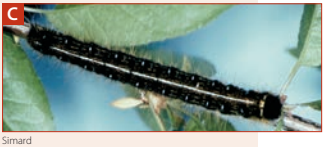
Damage
Attacks apple, peach, and plum. Defoliation of infested branches occurs within a few days. Only the eastern tent caterpillars build silken tents between the branches of infested trees **(E)**.

Similar Species
Infestations can be differentiated from those of fall webworm (*Hyphantria cunea*, page 62) by timing (spring, rather than midsummer and later for fall webworm) and location of webbing (in the central crotches, rather than outer regions of branches for fall webworm).

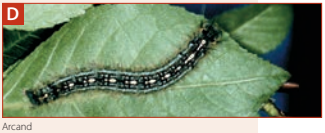
Management
Physically control the colonies by removing webs and larvae from the tree and removing egg masses when detected while pruning. Use localized intervention on the most severely infested trees. Economic infestations can be controlled with selective (e.g., *Bacillus thuringiensis*) or broad-spectrum insecticides.

Simard

Simard



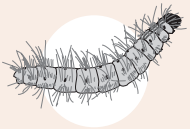
Simard



Arcand

Mailloux

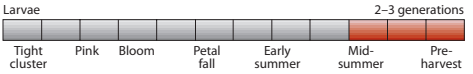
A: 30 mm



L: 25 mm

Fall webworm

Hyphantria cunea (Drury)



Description

The adult is a white moth with dark spots on the wings that may be less distinct in northern specimens **(A)**. The pale yellow larva has a dark head and dark tubercles with clumps of hairs **(B)**.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks all deciduous fruit trees. Larvae feed gregariously within loosely woven dirty white webs that enclose the foliage on the ends of the branches **(C)**. Within the feeding area, leaves are stripped and fruit is damaged **(D)**. Foliar loss is more important on young trees.

Similar Species

Infestations can be differentiated from those of eastern tent caterpillar (*Malacosoma americanum*, page 61) by timing (midsummer and later, rather than spring for eastern tent caterpillar) and location of webbing (the outer regions of branches, rather than in the central crotches for eastern tent caterpillar).

Management

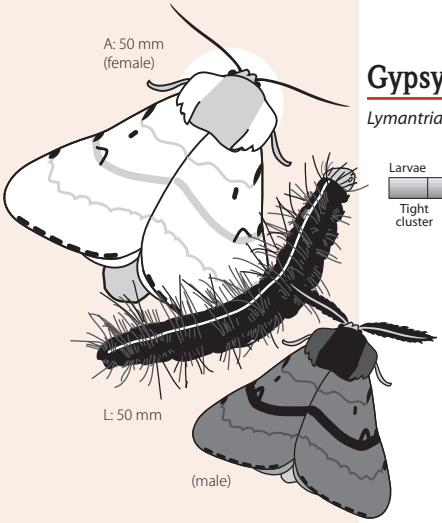
This insect causes little damage in orchards receiving a seasonal insecticide spray program, and tolerance is more economical than intervention. When necessary, removal of webs and larvae or, if they are out of reach, the use of selective (e.g., *Bacillus thuringiensis*) or broad-spectrum insecticides is also effective.

NYSAES

NRAES–75

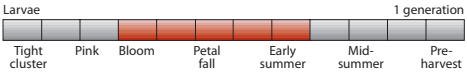
NRAES–75

NYSAES



Gypsy moth

Lymantria dispar (L.)



Description

The adult male is brownish and marked with blackish zigzag lines **(A)**. The adult female is whitish with brown transverse zigzag stripes **(B)** and does not fly. The masses of oval, yellow eggs are laid on the trunk of trees and covered with hair left by the female. The blackish caterpillar **(C)** has a yellow head and long hairs and bears tubercles on its back (four blue followed by six red).

Distribution

Most fruit-growing states and provinces in eastern North America.

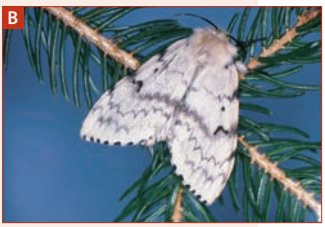
Damage

Most species of deciduous trees are susceptible to attacks from the gypsy moth **(D)**, and apple trees are minimally affected. Eggs are laid in large masses, and the abundance of caterpillars can cause the defoliation of young trees.

Management

Use localized intervention on trees that are severely affected. Selective insecticides (e.g., *Bacillus thuringiensis*) can be used, particularly against small airborne larvae that can show up from adjacent areas during bloom and cause noticeable foliar feeding; broad-spectrum insecticides can also be used, postbloom.

Simard



Simard

Simard

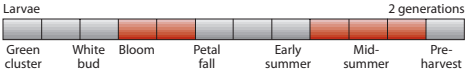
Agnello


A: 5 mm


L: 12 mm

Pear slug (Pear sawfly)

Caliroa cerasi (L.)



NYSAES

NYSAES

NYSAES

Description

The adult looks similar to a small, black-bodied wasp with the ventral side and legs yellow in color. The larva is small, fleshy, dark green to orange, slug-like, and slime-covered with the front part of the body enlarged **(A)**. As the pear slug grows in size, it becomes somewhat lighter in color until it is nearly orange-yellow when full-grown **(B)**.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks pear, cherry, and plum. Larvae feed on the surface of leaves, which they skeletonize, leaving only a framework of veins **(C)**.

Management

Foliar insecticide sprays applied shortly after petal fall will control pear slug. Larvae can also be washed off the foliage of backyard trees with a strong stream of water. It is rarely a pest in commercial plantings.


A: 13 mm


L: 14 mm

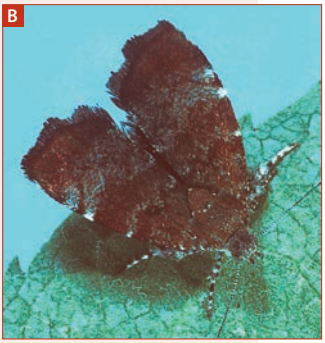
Skeletonizers

Apple-and-thorn skeletonizer:
Choreutidae: *Choreutis pariana* (Clerck)

Appleleaf skeletonizer:
Pyralidae: *Psorosina hammondi* (Riley)

Birch skeletonizer:
Bucculatricidae: *Bucculatrix canadensisella* Chambers

Arcand



NYSAES

NYSAES

Description
The adults of the skeletonizers are brown and short with transverse bands (A, B) on each forewing. The larvae are yellow to pale green with numerous hairy discs on each segment of the body (C).

Distribution
C. pariana: Most fruit-growing states and provinces in eastern North America and south to VA.

P. hammondi: Southeastern Canada and south through the central and Mid-Atlantic states.

B. canadensisella: Mainly southeastern Canada.

Damage
Attack apple and other fruit trees. Larvae of the skeletonizers feed on the upper leaf surface, leaving only the veins and the lower epidermis of the leaf. *C. pariana* creates webbing in leaf creases.

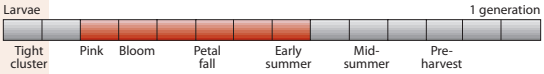
Management
These insects cause few problems. The removal and destruction of affected branches is usually sufficient to eliminate the caterpillars observed on the trees.

Skeletonizing damage to leaves

(female)

Spring cankerworm

Paleacrita vernata (Peck)



A: 30 mm
(male)

L: 25 mm

Description

The spring cankerworm adult male is gray and has winding lines on its forewings; the female has stumpy gray wings **(A)**. The larva is pale green to dark brown with two yellow longitudinal bands on the sides **(B)**. It moves in a looping inchworm fashion.

Distribution

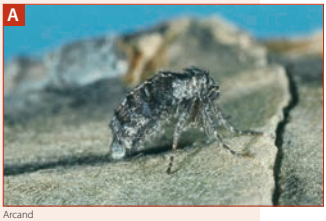
Most fruit-growing states and provinces in eastern North America.

Damage

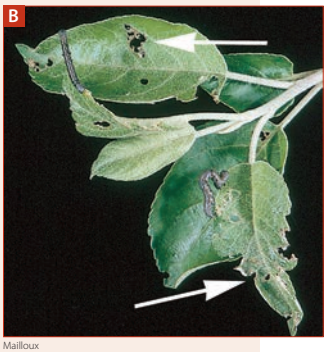
Attack apple and other fruit trees. Larvae of the spring cankerworm feed on foliage **(B, arrows)** and developing fruit **(C)**. They devour the entire leaf except for the veins.

Management

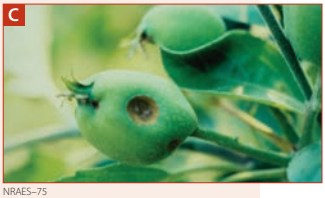
These insects cause few problems. The removal and destruction of affected branches is usually sufficient to eliminate the caterpillars observed on the trees.



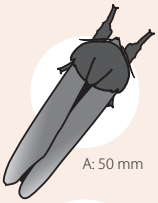
Arcand



Mailloux



NRAES–75

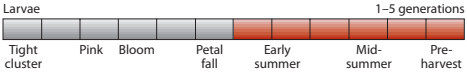


A: 50 mm

L: 38 mm

Redhumped caterpillar

Schizura concinna (J. E. Smith)



Description

The adult is a grayish brown moth **(A)**. The larva is yellow with a red head and is lined longitudinally with orangish, black, and white stripes. Several prominent black tubercles arise from the back, and there is a large reddish hump on top of the first abdominal segment **(B)**.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple, pear, cherry, and quince. Young larvae feed at first as a group on a single leaf with their heads all pointing toward the outer edge of the leaf; they initially skeletonize the leaf, but within a few days they increase in size and spread out, entirely consuming a number of leaves **(C)**. Defoliation of entire trees can occur occasionally, resulting in sunscald on the fruit.

Management

This insect causes little damage in regularly sprayed orchards. Remove and destroy larvae from affected branches. Use localized intervention on trees that are severely affected. Economic infestations can be controlled by the use of selective (e.g., *Bacillus thuringiensis*) or broad-spectrum insecticides.

Scott

Eaton

Smith

Skeletonizing damage to leaves


Apple red bug
A: 7 mm


Pear plant bug
A: 6 mm


Hawthorn
dark bug
A: 7 mm

Apple red bug

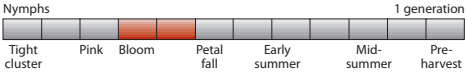
Lygidea mendax Reuter

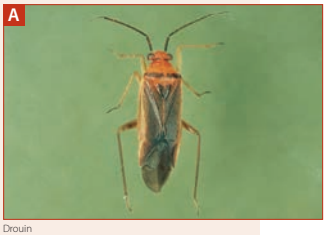
Pear plant bug (Green apple bug)

Lygocoris communis (Knight)

Hawthorn dark bug

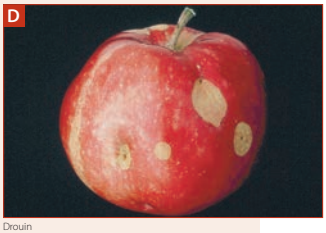
Heterocordylus malinus Reuter

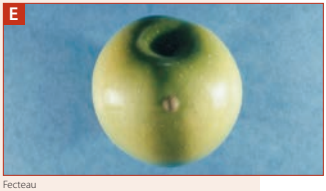



A
Drouin


B
Drouin


C
Vincent


D
Drouin


E
Fecteau

Description

The adult apple red bug has a bright red head and thorax and brown wings **(A)**. The adult pear plant bug is brownish yellow with two dark bands on the thorax **(B)**; the extremities of its anterior wings are yellowish. The hawthorn dark bug young adult is black with red wing markings **(C)** that disappear a few days after it metamorphoses into an adult.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

All three attack apple and pear. The apple red bug nymph stings the fruit, causing the appearance of a sap droplet; the damage develops into brownish, rough flat scars **(D)**. The pear plant bug nymph causes the same damage, except the brownish rough scars are raised **(E)**. The hawthorn dark bug nymph causes slight depressions on the fruit that disappear as the fruit develops.

Similar Species

The tarnished plant bug (*Lygus lineolaris*, page 72) can be distinguished by its coloration, particularly its cream-colored scutellum. Contrast also with apple brown bug (*Atractotomus mali*, page 69).

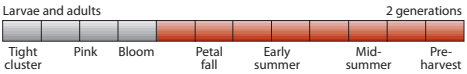
Management

Apply broad-spectrum insecticides, if necessary, soon after petal fall (this is seldom required).

A: 3 mm
N: 1–2 mm

Mullein plant bug

Campylomma verbasci (Meyer)



Boivin

NYSAES

NYSAES

NYSAES

Description

The adult is grayish green with black spots on the legs (A). The nymph (B) resembles an apple aphid or a white apple leafhopper and is solitary, very mobile, and lacks cornicles.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple mainly, particularly Red and Golden Delicious, Spartan, Yellow Transparent, Northern Spy, Empire, and Melba. Nymphs puncture the epidermis of developing flowers or young fruitlets. Damage first appears as reddish "pimples" (C), which become raised, corky, brown or black wart-like blemishes as the fruit expands. Fruit deformities can result in severe cases. Though sporadic, this pest can cause extensive crop damage. In varieties and growing conditions where nymph hatch does not correspond with the occurrence of a susceptible fruit stage, mullein plant bug is regarded as a predator (page 133).

Similar Species

Nymphs of apple brown bug, *Atractotomus mali* (Meyer), occur on buds and fruitlets at the same time and cause similar damage, but they are mahogany brown, have enlarged second antennal segments, and are slightly larger than mullein plant bugs occurring at this time (D).

Management

In varieties and growing conditions where nymphs hatch before fruitlets are large enough to resist feeding damage, an insecticide can be used during the pink bud stage or at petal fall.

Green stink bug
A: 16–19 mm; N: 12 mm

Brown stink bug
A: 13 mm; N: 10 mm

Dusky stink bug
A: 10 mm; N: 7 mm

Brown marmorated stink bug
A: 17 mm; N: 12 mm

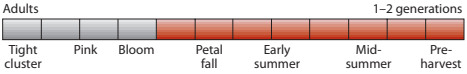
Stink bugs

Green stink bug: *Acrosternum hilare* (Say)

Brown stink bug: *Euschistus servus* (Say)

Dusky stink bug: *Euschistus tristigmus* (Say)

Brown marmorated stink bug:
Halyomorpha halys (Ståhl)



Description

Stink bug adults have a broad, flattened, shield-shaped body and a narrow head. *A. hilare* is uniformly grassy green **(A)**, *E. servus* is brown to grayish brown and slightly speckled **(B)**, and *E. tristigmus* is dark brown with sharp shoulder projections **(C)**.

H. halys is usually brown with whitish antennal segments and darker bands on the membranous, overlapping portion of the hind wings. Patches of coppery or bluish metallic-colored punctures occur on the head and pronotum **(D)**. Nymphal stages of *H. halys* have white antennal segments and white bands on their tibia. Their bodies are reddish brown and have horn-like projections near the eyes.

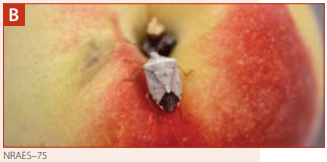
Distribution

A. hilare and E. tristigmus: Most fruit-growing states and provinces in eastern North America.

E. servus: New England south to FL and west to IL.

H. halys: Current distribution is from northeastern PA, NJ, and MD south to SC and west to WV, but it is expected to increase as this is an introduced pest.

NRAES–75



NRAES–75

NRAES–75

Stink bugs (continued)

Shearer

NRAES--75

Jentsch

Shearer

Damage

These species can sometimes cause fruit damage in all tree fruits under conditions that are not yet fully understood. Adult feeding during bloom and shuck split can cause the fruit to abort. Feeding later in the summer can cause a deep catfacing injury **(E)**, such as that caused by tarnished plant bug (*Lygus lineolaris*, page 72), or depressed, dimpled, corky or water-soaked areas on the skin **(F, G)**. All tree fruits are attacked, especially peaches and apples. Other species of stink bugs are predators (page 131).

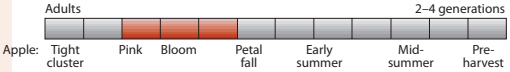
Management

Elimination of alternate host broadleaf weeds, especially legumes, in the orchard will contribute to management efforts. If control is needed, insecticides should be timed to kill immigrating adults as they appear in the orchards to prevent feeding damage and subsequent mating and egg laying.

A: 6 mm
N: 4 mm

Tarnished plant bug

Lygus lineolaris (Palisot de Beauvois)




A

NYSAES


B

NYSAES


C

NYSAES


D

NYSAES

Description

The adult is brown, and the extremities of its wings are translucent with a cream-colored scutellum (triangular plate) on its back **(A)**. The nymph is pale green; from the third nymphal stage, it has five black points on the back **(B)**. This insect usually abandons fruit trees for alternate hosts soon after bloom.

Distribution

Widespread in most fruit-growing states and provinces in eastern North America.

Damage

Attacks most deciduous tree fruits. Prebloom stings on woody tissue or the floral peduncle leave a droplet of sap and often cause the abortion of flower buds. Stings at the base of the floral receptacle or on the fruit result in funnel-like depressions **(C)**; fruit feeding in stone fruits can cause corky scars **(D)** or catfacing injury.

Similar Species

The pear plant bug (*L. communis*, page 68) can be present on the trees all season long; it can be distinguished by differences in body coloration.

Management

Watch for the presence of adults on buds. In apple, monitor with sticky white board traps; if necessary, apply broad-spectrum insecticides during the prebloom period. Elimination of alternate host broadleaf weeds—especially legumes, mullein, chickweed, and dandelion, as well as pigweed, lambsquarters, plantain, goldenrod, and aster—in the orchard can contribute to management efforts.

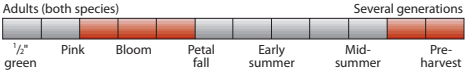
A: 1.5 mm

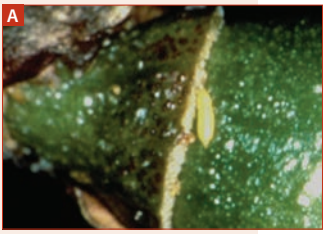
Western flower thrips

Frankliniella occidentalis (Pergande)

Flower thrips

Frankliniella tritici (Fitch)





NRAES–75

Rosenberger

NRAES–75

Description

These two species are indistinguishable without a microscope. Adults are slender and yellowish with short antennae; the wings are long and narrow and held over the abdomen (A). Larvae are smaller and wingless but otherwise resemble adults.

Distribution

QC, NY and PA, and south through the Mid-Atlantic states.

Damage

Both species attack nectarine and other stone fruits. Adults infest developing fruit during bloom and again as the fruit ripens. Larval and adult feeding at bloom through shuck fall causes scars on the fruit surface that expand as the fruit grows (B). Feeding near harvest can result in a silvering or russetting of the fruit surface (C). High thrips infestations feeding on terminal growth can cause distortion of leaves and excess branching.

Management

Injury tends to be more severe in orchards located in proximity to greenhouses, and under drought conditions. Insecticide sprays may be necessary at petal fall and close to harvest.


Japanese beetle
A: 12 mm

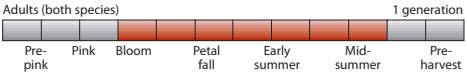

Rose chafer
A: 13 mm

Japanese beetle

Popillia japonica Newman

Rose chafer

Macrodactylus subspinosus (F.)




A
NRAES–75


B
Haas


C
NYSAES


D
McGhee

Description

Japanese beetle adults are metallic green or greenish bronze with reddish wing covers and several white spots near the abdomen tip and along the sides **(A)**. Rose chafer adults are slender, long-legged, and fawn-colored with a reddish brown head and thorax; the undersurface of the body is black **(B)**. Larvae of both species are larger C-shaped grubs that live in the soil.

Distribution

Southeastern Canada and in most fruit-growing states in the eastern United States.

Damage

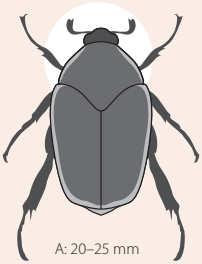
Both attack all tree fruits, particularly peach and apple. Adults (only) feed on fruit surfaces and leaves of deciduous fruits **(C, D)**. Fruit may be partly peeled and gouged in irregular shallow patches or nearly devoured. Leaves are skeletonized **(C)**. Damage is more severe in sandy locations, often occurring especially at orchard edges near grassy areas.

Similar Species

These insects are relatives of green June beetle (*Cotinis nitida*, page 75), with which Japanese beetle sometimes co-occurs in the adult stage. They can be distinguished by differences in size and coloration. Also, green June beetle injures both green and ripening fruit; Japanese beetle prefers fruit that is close to ripe.

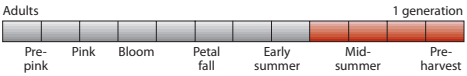
Management

Adult feeding damage is sporadic and transient during summer. Insecticide can be applied when leaf damage or insects feeding on foliage are noted in the trees; retreatment may be necessary. Japanese beetle may be biologically controlled with milky spores of bacteria or nematode products.


A: 20–25 mm

Green June beetle

Cotinis nitida L.



Description

The adult is velvet green dorsally with yellow-orange margins on the elytra (A). Ventrally it is a shiny metallic green mixed with orangish yellow. The larva is a large, C-shaped grub that lives in the soil and is not found in the trees.

Shearer

Shearer

Distribution

CT and southeastern NY south to FL, and west beyond the Mississippi.

Damage

Attacks all tree fruits, particularly stone fruits and apple. Besides feeding on petioles and leaves, adults are attracted to the ripe fruit, feeding on the surface in groups and causing large gouges (B). Most injury occurs in mid- to late summer.

Similar Species

This insect is a relative of Japanese beetle (*Popillia japonica*, page 74), with which it sometimes co-occurs in the adult stage. The two species can be distinguished by the differences in their size and coloration. Also, unlike Japanese beetle, green June beetle can injure both green and ripening fruit.

Management

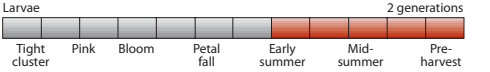
Feeding damage from adults is sporadic and transient during the summer. If needed, an insecticide can be applied when leaf damage or the insects feeding on foliage are noted in the trees.


A: 10–11 mm


L: 9 mm

Lesser appleworm

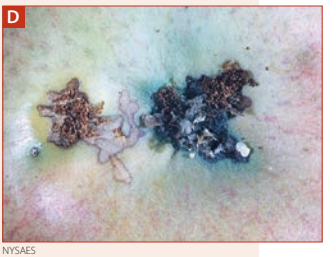
Grapholita prunivora (Walsh)




A
NYSAES


B
NYSAES


C
NYSAES


D
NYSAES

Description

The adult is a small gray moth with distinct small orange bands or patches on the wings; some blue is also evident in newly emerged specimens **(A)**. The larva is pinkish white with a dark head and an anal comb **(B)**.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple, plum, and cherry. Larvae form extensive shallow mines (with characteristic reddish frass) under the fruit skin **(C)** and may burrow deeper (although not to the core) as they mature. Feeding injury in the fall is often limited to the calyx region **(D)**. Damage can be confused with that of the redbanded leafroller (*Argyrotaenia velutinana*, page 79), which does not produce reddish frass.

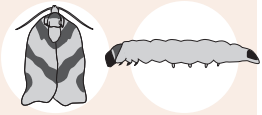
Similar Species

It strongly resembles cherry fruitworm (*G. packardi*, page 87), which usually does not attack apple. Larvae resemble oriental fruit moth (*G. molesta*, page 90), which also has an anal comb but is somewhat larger. Lesser appleworm larvae tend to remain pinkish when boiled and preserved in alcohol, as compared with the aforementioned species. Codling moth (*Cydia pomonella,* page 88) damage is concurrent, but it tunnels to the fruit core and has no anal comb.

Management

Historically, this insect has caused little damage in orchards receiving seasonal insecticide sprays, although softer programs may encourage an increase. Species presence and flight activity can be monitored with pheromone traps. Summer control measures against codling moth and oriental fruit moth will provide incidental control.

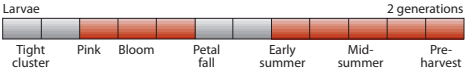
Lepidoptera: Tortricidae



A: 21–27 mm L: 20 mm

Obliquebanded leafroller

Choristoneura rosaceana (Harris)



NYSAES

NYSAES

NYSAES

NYSAES

Description

Adult wings are beige, tinged with red. Forewings are crossed with oblique brown bands **(A)**. The female is larger than the male. The green eggs are laid in masses **(B)** on the upper surface of leaves. The larva is yellowish green to olive green; its head and thoracic shield vary from tan to brown or blackish **(C)**.

Distribution

Southern Canada and most fruit-growing states in eastern North America.

Damage

Attacks apple mainly and occasionally pear, peach, and cherry. Larvae feed on the epidermis of fruit **(D)**, often close to the peduncle or where two apples are in contact; they roll up leaves and hide in these shelters **(E, page 78)**. Injuries occurring early in the season cause pronounced deformations of the fruit and are impossible to differentiate from the damage of green fruitworms (page 56). Late-season fruit feeding causes small pits in the surface **(F, page 78)** that may go undetected until after long-term storage, during which time necrosis can occur.

Similar Species

The fruittree leafroller (*Archips argyrospila*, page 59) and threelined leafroller, *Pandemis limitata* (Robinson) **(G, H, page 78)** have the same general appearance but cause few problems. Occasional fruit damage **(I, page 78)** is found in proximity to maple stands and other deciduous forests.

(continued on next page)

Obliquebanded leafroller (continued)

E

NYSAES

F

NYSAES

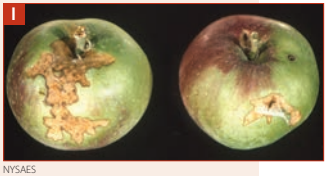
G

NYSAES

H

NYSAES

I



NYSAES

Management

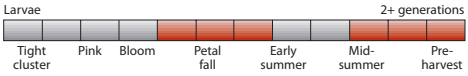
Monitor the adults with pheromone traps and use a degree-day developmental model to time insecticide sprays. Thinning fruit and pruning water sprouts in midsummer is helpful in reducing fruit damage. These insects may be difficult to control with insecticides, even with selective insecticides (*Bacillus thuringiensis* and insect growth regulators). Selective pesticides will preserve important natural enemies. More than one spray may be needed during the summer because of this species' extended flight and egg-laying periods.


A: 13–16 mm


L: 15 mm

Redbanded leafroller

Argyrotaenia velutinana (Walker)




A
NYSAES


B
NYSAES


C
NYSAES

Description

The adult's forewings are grayish brown with a subtle dark red and brown oblique band **(A)**. The larva is pale green with a yellow or green head **(B)**.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple mainly; other fruit trees may be affected. Larvae cause rolling of the leaves; they feed on the surface of fruit **(C)** and dig superficial tunnels in the flesh of fruit. Damage can be confused with that of the lesser appleworm (*Grapholita prunivora,* page 76), but in the case of the redbanded leafroller, damage is not accompanied by reddish frass.

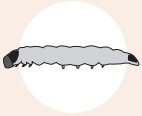
Similar Species

Resembles other tortricid larvae, but most, including obliquebanded leafroller (*Choristoneura rosaceana,* page 77), fruittree leafroller (*Archips argyrospila,* page 59), and threelined leafroller (*Pandemis limitata*, page 77), are larger and have a darker head.

Management

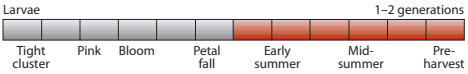
This insect can be more problematic in orchards under a softer pesticide program or those relying on mating disruption for other species rather than seasonal insecticide sprays. Species presence and flight activity can be monitored with pheromone traps. Economic infestations can be controlled by the use of selective (e.g., *Bacillus thuringiensis*) or broad-spectrum insecticides.


A: 12–25 mm


L: 18 mm

Tufted apple bud moth

Platynota idaeusalis (Walker)




A

NRAES–75


B

NRAES–75


C

NRAES–75


D

NRAES–75

Description

The adult **(A; female on left, male on right)** is an inconspicuous moth, varying from mottled gray at the wing base to brown at the wing tip with a lighter-colored margin along the wing's leading edge. Two or three groups of tufted scales occur on top of the wings. Larva is initially yellowish with a black head; later forms are light brown to grayish tan with a chestnut brown head, dark thoracic shield, and dark stripe down the back **(B; upper is virus-infected, lower is healthy)**.

Distribution

NS, QC, ON, and south to Mid-Atlantic states.

Damage

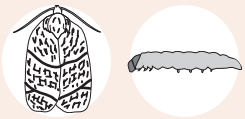
Attacks apple, pear, peach, and cherry. It webs leaves against fruit and feeds underneath, causing tiny holes, irregular scarring, or channeling of the fruit surface **(C, D)**. Feeding sites are subject to rots or corking; larvae may enter the calyx and feed in the seed cavity. Generally an economic pest only from PA south.

Similar Species

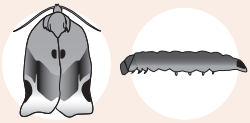
Biology, feeding habits, and injury are similar to the obliquebanded leafroller (*Choristoneura rosaceana,* page 77), but tufted apple bud moth isn't as green and its adult flight period is slightly advanced (starting at about petal fall, as opposed to fruit set for obliquebanded leafroller).

Management

Remove spring apple root suckers and suppress broadleaf weed groundcover under trees. Insecticide resistance has made control increasingly difficult. Use pheromone traps and a degree-day developmental model to time sprays against small larvae starting after the fruit-thinning period and again in late summer. Treat economic infestations with selective (e.g., *Bacillus thuringiensis,* growth regulators) or broad-spectrum insecticides.



Sparganothis fruitworm
A: 13–17 mm L: 14–16 mm



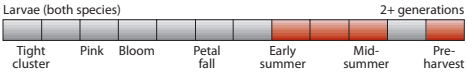
Variegated fruitworm
A: 15–17 mm L: 15–18 mm

Sparganothis fruitworm

Sparganothis sulfureana Clemens

Variegated leafroller

Platynota flavedana Clemens



Description

S. sulfureana: The adult is a vivid yellow moth with grayish magenta V-shaped marks on the forewings (which form an "X" when folded) and reddish orange lace-like markings **(A)**.

P. flavedana: The adult is grayish magenta with dark brown bands on the middle and end of the forewing **(B; male on left, female on right)**. Larvae of both species are pale green with yellowish green heads **(C, *S. sulfureana;* D, *P. flavedana*)**, but in *S. sulfureana,* the dorsal side is a darker green than the ventral side, and the thoracic shield is narrowly edged with dark brown; antennae are black, borne on a white socket.

Distribution

S. sulfureana: NS to ON and south at least to NY and NJ.

P. flavedana: Southern parts of MI and NY to MA, and south to FL.

Damage

Both species attack apple. Both overwinter as early-stage larvae in the orchard groundcover and feed in early spring on low growth under trees. Adults lay eggs on apple leaves in early summer; larvae feed on foliage until midsummer. After a second flight, larvae may feed on fruit in late summer, causing pinhole or excavation damage **(E)**.

Management

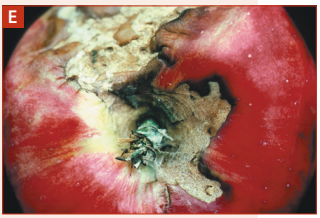
They are generally a problem only in selected sites and can be monitored using pheromone traps, but summer leaf inspection is recommended to determine severity. Economic infestations can be controlled by the use of selective (e.g., *Bacillus thuringiensis*) or broad-spectrum insecticides.

NYSAES

NRAES–75

NYSAES

NRAES–75



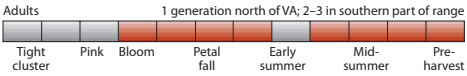
Howitt


A: 5 mm


L: 7 mm

Plum curculio

Conotrachelus nenuphar (Herbst)



A


NYSAES

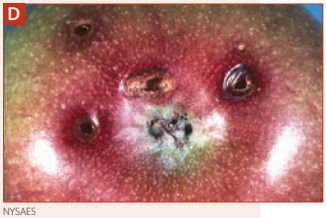
B


NYSAES

C


NYSAES

D


NYSAES

E


Simard

Description

The adult is mottled grayish black and brown **(A)**. Its head is prolonged into a large but short snout that bears antennae. Each elytron has a series of humps with the second and third pairs separated by a clear transverse band. The white elliptical eggs are deposited under the skin of the fruit in a crescent-shaped slit. The whitish larva, with no functional legs, has a C-shaped body, an elliptical head, and a brown thoracic shield **(B)**.

Distribution

Widespread and a major pest in most fruit-growing states and provinces in eastern North America.

Damage

Attacks all deciduous tree fruits. A crescent-shaped scar **(C)** is left by egg-laying activities of the adult on young apple and pear fruit beginning shortly after petal fall. The larvae bore into and create galleries in stone fruits. In August, the adults that will overwinter (north) or those that will produce a second generation (south) feed on fruits **(D)** before seeking overwintering sites in leaf litter near the orchard. Some oviposition of this brood also results in larval fruit infestations in late summer.

Similar Species

The apple curculio *(Anthonomus quadrigibbus* Say) is smaller (4.5 mm) with a longer and slender snout **(E)** and rarely causes damage to apples in commercial plantings, as larvae feed mainly on June drops or mummified apples on the tree.

Management

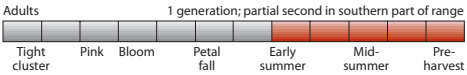
Monitor regularly for fresh damage on fruit. Apply protective sprays during the egg-laying period, starting at petal fall. A degree-day model can be used to predict the portion of the oviposition period during which insecticide protection would be required.


A: 5 mm


L: 7 mm

Apple maggot

Rhagoletis pomonella (Walsh)




A

NYSAES


B

NYSAES


C

Drouin


D

NYSAES

Description

Adults are black flies with three (males) or four (females) white cross bands on the abdomen, a prominent white spot at the posterior end of the thorax, and wings that are marked with black bands in the shape of an "F" **(A)**. The cream-colored eggs are laid singly under the skin of the fruit. The larva is a milky white, legless maggot without a distinct head but with a pointed front tip **(B)**.

Distribution

Widespread and a major pest in most fruit-growing states and provinces in eastern North America, but more of a problem north of the Mid-Atlantic states.

Damage

Attacks apple mainly; may be found in European plum, pear, and cherry. On the surface of the fruit, oviposition causes punctures that appear as small reddish spots **(C)**, which are sometimes accompanied by a white deposit. The larva digs brownish trails **(D)** in the flesh of the fruit.

Similar Species

The apple maggot can be confused with the cherry fruit fly (*Rhagoletis cingulata*, page 84) and the black cherry fruit fly (*Rhagoletis fausta*, page 84). These insects do not attack apples and can be distinguished by the patterns of their wing bands.

Management

Sticky red sphere or yellow board traps can be used for monitoring of adults to detect potentially damaging numbers; intensive trapping to reduce numbers to acceptable levels may be practical in small plantings. Remove unsprayed apple trees within 100 m. Apply protective insecticides, if necessary, in mid- and late summer.

Cherry fruit fly
A: 7 mm L: 5 mm

Black cherry fruit fly
A: 7 mm

Cherry fruit flies

Cherry fruit fly: *Rhagoletis cingulata* (Loew)
Black cherry fruit fly: *Rhagoletis fausta* (Osten Sacken)

NYSAES

NYSAES

NYSAES

NYSAES

Description

The adult cherry fruit fly has a yellowish brown head and legs and white crossbands on the abdomen **(A)**. The black cherry fruit fly is slightly larger with a black abdomen **(B)**. Both have clear wings with distinct markings; bands on black cherry fruit fly wings are darker and wider with a characteristic "doughnut-hole" marking. Both larvae are cream-colored maggots with no legs or visible head; the posterior end is blunt, and the front end tapers to a point with two dark mouth hooks **(C)**.

Distribution

One or both species occur in most fruit-growing states and provinces in eastern North America, but *R. fausta* reaches only as far south as PA.

Damage

Both attack cherry, piercing fruit with the ovipositor to insert eggs singly just below the skin. A scar results, which may cause a dimple on green fruit **(A)**. Larval feeding separates the pit from the pulp and causes fruit to brown; sometimes the skin shrivels over the injured area. Infested fruit will not drop prematurely; brown rot (*Monilinia* sp., page 198) can start in wormy fruit **(D)** and spread.

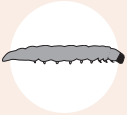
Similar Species

Apple maggot (*Rhagoletis pomonella*, page 83) is closely related and similar in appearance but does not infest cherries.

Management

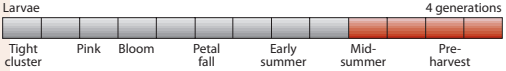
Remove unsprayed, abandoned cherry and wild *Prunus* trees. Use yellow board traps to determine the first adult emergence. Apply insecticide sprays to prevent infestation starting seven days after the first trap catch.


A: 8 mm


L: 16 mm

Dock sawfly

Ametastegia glabrata (Fallén)




A
Laplante


B
Fecteau


C
NYSAES

Description

The adult is bluish black with red legs **(A)**. The larva is a smooth velvety green worm with white legs (three pairs of true legs and seven pairs of prolegs) and a dark head **(B)**.

Distribution

Mainly southern Canada and northern United States south to PA and IL.

Damage

Attacks apple mainly. The larva digs brownish circular holes **(C)** on the surface of nearly mature fruit and creates short tunnels in the flesh. Larvae of only the last one to two generations are found in the trees.

Similar Species

The adult European apple sawfly (*Hoplocampa testudinea*, page 86) has an orange body, and the larva is white.

Management

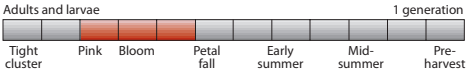
This insect causes few problems, most of which are related to the proximity of plants from the buckwheat family (dock, sorrel, knotweeds, bindweeds, etc.). An effective weed-management program constitutes a good means of prevention.


A: 7 mm


L: 9–11 mm

European apple sawfly

Hoplocampa testudinea (Klug)




A

NYSAES


B

NYSAES


C

NYSAES


D

NYSAES

Description

The adult looks similar to a small, orange-brown wasp with the ventral side and legs orange in color (A). It has transparent wings with many veins. The egg, oval and translucent, is inserted into the receptacle of the flower. The larva is cream-colored with a black head (B) and seven pairs of prolegs, the last four of which are called "pseudopods."

Distribution

Southeastern Canada to New England, NY, and south to VA.

Damage

Attacks apple mainly. Early larval feeding leaves brown spiral scars on the skin of the fruit (C). Later, more serious damage consists of larval tunneling and exit holes (D), from which flows wet, reddish brown frass with a strong odor. Larvae will enter more than one fruit, frequently leaving frass-covered entry holes; loss of whole clusters can occur.

Similar Species

The larvae of the codling moth (*Cydia pomonella*, page 88) and lesser appleworm (*Grapholita prunivora*, page 76) are pinkish in color. They can be distinguished by the number of prolegs (five); also, both occur as larger larvae in the fruit later (five or more weeks after petal fall) than apple sawfly (two to three weeks after petal fall).

Management

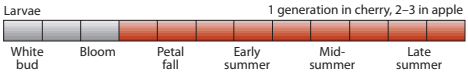
Monitor adults with sticky board traps. Apply broad-spectrum insecticides just before or just after the bloom period (can be used simultaneously against the codling moth and the plum curculio).


A: 8–11 mm


L: 8–9 mm

Cherry fruitworm

Grapholita packardi Zeller




A

NYSAES


B

Marucci

Description

The adult is a small, brownish gray moth with a median gray band on the forewings and a dark spot at the base of the hind wings **(A)**. Although whitish gray with a black head when young, the larva eventually becomes pink-tinted with a brownish tan head **(B)**. Larvae possess an anal comb.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks cherry, apple, and peach. Larvae bore into the fruit shortly after hatching and form small, brown tunnels as they feed. More extensive feeding produces sunken, rough, brownish areas on the surface. The inside of the cherry, next to the pit, is completely eaten away; a larva may damage more than one fruit.

Similar Species

Resembles the oriental fruit moth (*Grapholita molesta*, page 90) and lesser appleworm (*G. prunivora,* page 76), which are in the same genus, but the former lacks the median gray band on the forewings, and the latter has orange and bluish patches mixed in with the gray; neither has the dark hindwing spot. Separating the larvae of these species is more difficult, but compared with the other two, *G. packardi* has larger and more prominent dorsal plates, each containing several setae (hairs) on its last two abdominal segments.

Management

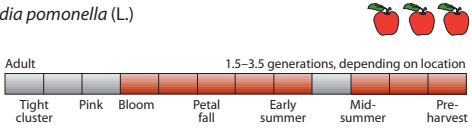
An insecticide applied one to two times after petal fall can provide effective control.


A: 15–22 mm


L: 14–18 mm

Codling moth

Cydia pomonella (L.)

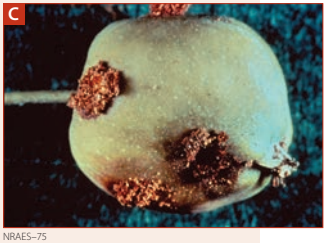



A

NYSAES


B

NYSAES


C

NRAES–75


D

NYSAES

Description

The adult's forewings are striped with fine brown-gray lines and a distinctive bronze to brown-black oval spot at the tip **(A)**. Eggs are laid on the leaves or fruit. The pinkish larva has a black head and a brown thoracic shield **(B)**.

Distribution

Widespread and a major pest in most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple and pear mainly, although all deciduous tree fruits are susceptible. The larva produces reddish brown frass at the point of entry into the fruit—usually the calyx ("bottom") end **(C)**—and galleries in the flesh to the core of the fruit **(D)**.

Similar Species

The larva can be confused with other species in this family, particularly oriental fruit moth (*Grapholita molesta,* page 90), which is very similar in appearance but possesses an anal comb. The lesser appleworm (*G. prunivora,* page 76), which also has an anal comb, is similar in appearance but is smaller (only 6 mm in length when full-grown) and less abundant than both codling moth and oriental fruit moth. Damage sometimes can be differentiated by the fact that lesser appleworm makes superficial tunnels under the surface of the fruit; codling moth, as contrasted with *G. molesta,* tends to damage the seeds as well as the fruit flesh.

Management

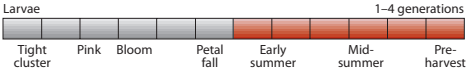
Monitor the adults with pheromone traps and use a degree-day developmental model to time insecticide sprays; in the summer, broad-spectrum insecticides, kaolin clay, or selective viruses can be applied. Pheromone mating disruption has been of value in larger plantings (at least 5 acres).

A: 25 mm

L: 25 mm

European corn borer

Ostrinia nubilalis (Hübner)



Description

The adult is a pale yellowish brown moth with irregular darker bands running in wavy lines across the wings; the male is distinctly darker than the female (A). The larva is pale brown or pinkish gray with a black head and inconspicuously marked with small, round, brown spots (B).

Distribution

Most fruit-growing states and provinces in eastern North America, south to northern FL. More serious from NY south.

Damage

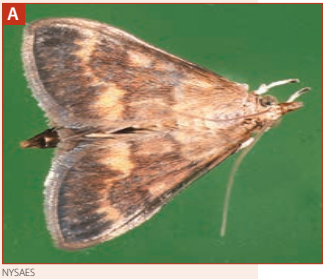
Attacks apple mainly, and occasionally cherry and peach. Larvae feed on foliar terminals of young plantings (C) in early summer, causing leaves to turn brown and wilt, which can disfigure the tree. Partly grown larvae migrate from weed hosts and attack fruits later in the summer, tunnelling through the flesh and creating galleries filled with frass (D).

Similar Species

Larvae may resemble those of oriental fruit moth (*Grapholita molesta*, page 90) or codling moth (*Cydia pomonella,* page 88). They may be distinguished from the former by the lack of an anal comb, and in both cases by coloration and the presence of raised brown tubercles on abdominal segments of *O. nubilalis,* which are more evident in later instars.

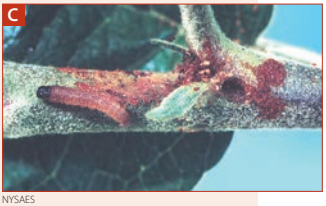
Management

Infestations tend to occur under unusually hot and dry conditions and in orchards near woods. Elimination of alternate host weeds in the orchard can reduce chances of infestations. The pest's presence and flight activity can be monitored with pheromone traps. A selective insecticide such as *Bacillus thuringiensis* can be applied during late summer, when regular spray programs tend to be relaxed.



NYSAES

NYSAES



NYSAES

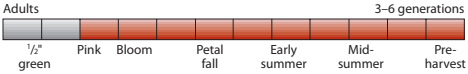
NYSAES


A: 12–14 mm


L: 11 mm

Oriental fruit moth

Grapholita molesta (Busck)




A
NYSAES


B
NYSAES


C
NYSAES


D
NYSAES


E
NYSAES

Description

The adult is a small moth with dark gray mottled wings that lighten somewhat at the outer edges **(A)**. The larva is dirty white to pinkish with a reddish brown head and an anal comb **(B)**.

Distribution

Widespread and a major pest in ON and most fruit-growing states in eastern North America.

Damage

Attacks all deciduous fruits, particularly peach and apple. On peach, larvae feed first on new terminal growth, tunnelling toward the shoot base and causing it to wilt and die back ("flagging") **(C)**, similar to periodical cicada oviposition damage (page 96). Later broods attack young fruit, causing conspicuous frass-covered holes **(D)** as the larva tunnels near the pit. On apple, terminal feeding is similar to that in peach but less obvious; feeding damage in fruit **(E)** is often marked by frass near the calyx.

Similar Species

Larvae resemble (1) codling moth (*Cydia pomonella*, page 88), which does not possess an anal comb and (in apple) tends to eat seeds as well as fruit flesh; (2) lesser appleworm (*G. prunivora*, page 76), which also has an anal comb but is smaller in size; and (3) cherry fruitworm (*G. packardi*, page 87), which usually does not attack apple.

Management

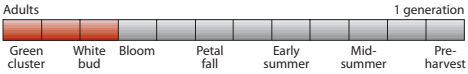
Historically the major internal worm pest in peaches, it is becoming more serious in apples. Monitor adults with pheromone traps and use a degree-day developmental model to time insecticide sprays. Summer applications of insecticides against codling moth can provide control. Success has been achieved using mating disruption alone (especially in area-wide programs) or, under heavy population pressure, in combination with insecticide sprays.

Diptera: Cecidomyiidae

A: 3 mm

Pear midge

Contarinia pyrivora (Riley)



NYSAES

NYSAES

Description

The adult resembles a very small mosquito or gnat; the body is brown and the wings transparent with simple veins. The larva is a white maggot with no legs or visible head; the posterior end is blunt, and the front end tapers to a point **(A)**.

Distribution

CT, NY, NJ, and ON.

Damage

Attacks pear mainly. Adult females deposit eggs between the petals of unopened fruit buds, and the larvae feed in the seed cavities and internal fruit tissue. Infested pears enlarge more rapidly than normal and are distorted in shape **(B)**, turning black and dropping by early summer.

Similar Species

Larvae of apple leaf(curling) midge (*Dasineura mali,* page 38); apple maggot (*Rhagoletis pomonella*, page 83); and the cherry fruit flies (*Rhagoletis* spp., page 84) are similar in appearance, but none of these infest pears, and all may be distinguished by their adult forms and later timing of appearance in the year.

Management

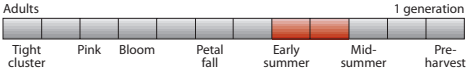
Sprays are seldom required, but if there is a history of damage from this pest, an insecticide should be applied as soon as the fruit buds reach the swollen bud to green cluster stage of development. A second spray may be necessary seven to ten days later, particularly if cool weather delays the white bud stage.

A: 4 mm

L: 3 mm

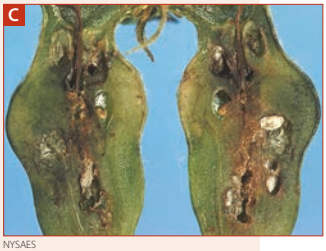
Apple seed chalcid

Torymus varians (Walker)



NYSAES

NYSAES



NYSAES

Description

The adult is a small, dark wasp with a bright green head, a thorax and abdomen with coppery or bronze metallic reflections, brownish yellow legs, clear hyaline wings, and a long ovipositor **(A)**. The larva is white and grub-like with dark sclerotized mandibles and is tapered at the caudal end **(B)**.

Distribution

NS, QC, and ON, south at least to PA, and west to MI.

Damage

Attacks apple. After overwintering as a larva in the seed, the adult emerges in early summer. The female pierces the flesh of the developing fruit with her ovipositor to deposit an egg directly into a seed. The puncture is visible as a small black dot on the surface of light-skinned fruits, surrounded by a depression. The developing grub feeds in the seed cavity and causes fruit distortion **(C)**. A brown strand of hard, dry tissue extends into the core, sometimes resembling an apple maggot trail (page 83).

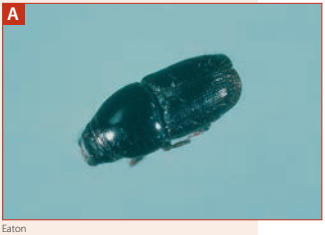
Management

This is seldom an economic pest in properly managed orchards. Dropped fruit can be collected and discarded in the fall to prevent populations from increasing. Elimination of outside sources of infestation such as wild seedling and crab apples near the orchard is recommended.

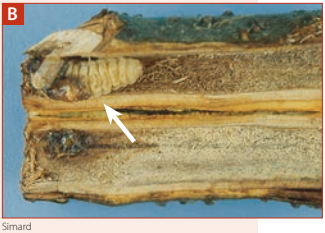
A: 2.5 mm
L: 3–4 mm

Shothole borer

Scolytus rugulosus (Müller)



Eaton



Simard

Mailloux

Agnello

Description

The adult is stocky with a hard, black body **(A)** and reddish brown antennae, leg segments, and tips of elytra; its head is not visible from above. The larva **(B)** is a legless grub, pinkish white, and slightly enlarged just behind the reddish head.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks all deciduous fruit trees. It is normally found in dead or dying wood but can be attracted to living trees that are in a somewhat unhealthy condition. The adult produces small (1 mm) holes through the bark on the twigs of fruit trees **(C)**, especially above a bud or other projection. Holes are sometimes indicated by sawdust or borings on the bark. On stone fruits, the holes are usually covered and sealed in by dried droplets of gum, which resemble tear drops. The female constructs an egg gallery about 2.5 cm long under the bark, parallel with the grain. Larvae are present year-round inside branches. When the insects are abundant, fruit clusters become wilted, and associated leaves become brown **(D)**, resembling a fire blight infection (page 162).

Similar Species

Peach bark beetle (*Phloeotribus liminaris*, page 94), which has a brown body with yellow hairs, is similar.

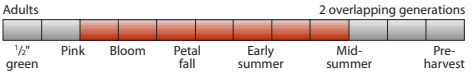
Management

Remove all piles of wood with bark from the adjacent area; destroy any damaged or dying limbs. An insecticide can be applied against active adults but is rarely required.

A: 2.5 mm
L: 0.5 mm

Peach bark beetle

Phloeotribus liminaris (Harris)



PA DCNR

PA DCNR

Description

The adult's body is brown with many punctures from which arise yellowish hairs **(A)**. The larva is a small, legless grub.

Distribution

Most stone-fruit-growing states and provinces in eastern North America.

Damage

Attacks peach and cherry mainly, also plum. Adults bore into healthy or unhealthy trees just beneath the outer layer of bark in the trunk or branches, causing gum to flow from the wounds **(B)**. They leave small burrow holes filled with frass. The tunnelling weakens the tree and can kill it.

Similar Species

This insect is very similar in form and habits to the shothole borer (*Scolytus rugulosus*, page 93), but the peach bark beetle's burrow hole is filled with particles of frass held together by fine silk threads, and its brood chamber runs across the grain instead of parallel to it.

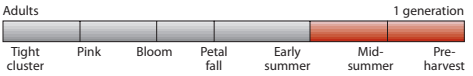
Management

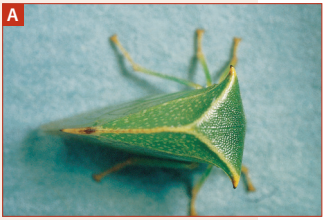
Eliminate breeding places (dead trees, brush heaps, wood piles, or prunings) adjacent to orchard. Maintain a balanced nutrition program to restore weakened trees; remove those that will not recover.

A: 7 mm

Buffalo treehopper

Stictocephala bisonia Kopp & Yonke





Drouin

Simard

Description

The pale green adult exhibits a large thorax with two "horns" and a long posterior wedge-shaped body **(A)**. The cream-colored eggs are laid in a groove on the tree bark, where they overwinter.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks all deciduous fruit trees. Egg laying causes slits in the bark of trees **(B)** and can lead to the withering of young trees.

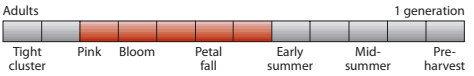
Management

Eliminate all alternative hosts such as leguminous plants growing in close proximity; remove shoots infested with eggs; if necessary, apply broad-spectrum insecticides to foliage if adults appear on young apple trees in June or July (seldom required).

A: 25–38 mm

Periodical cicada

Magicicada septendecim (L.)



Description

Adults are wedge-shaped and nearly black with red eyes and red-orange wing veins. The clear wings are held tent-like over the body (A). Mature nymphs resemble small crayfish and are sometimes seen clinging to vertical tree surfaces with their grasping front legs just before adult emergence.

Distribution

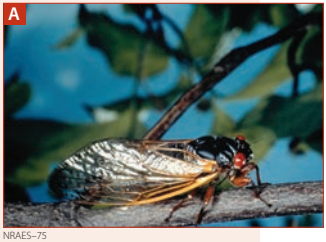
Most fruit-growing states and provinces in eastern North America; not in QC, ME, NH, or VT. Highly cyclic; local adult populations emerge every 17 years.

Damage

Attacks apple and most other deciduous fruit trees. Ovipositing females create roughened punctures in the twigs and small branches of trees, usually from 25–100 mm in length. The bark is pushed from the wood, and the wood is cut and raised with small bundles of splinters protruding from the surface (B). Adults may also feed through bark, causing oozing of sap (C). Oviposition damage may also result in terminal wilting and dieback.

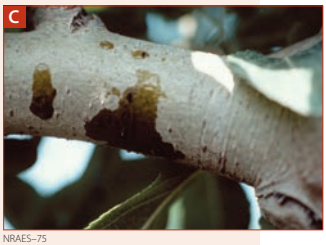
Management

Young trees may be covered with mosquito netting or other cloth when the adults are on the wing. Tree trunks can be banded with stickem-covered cardboard bands and the trapped insects removed each morning. Insecticide sprays applied at intervals during egg laying will reduce tree damage.

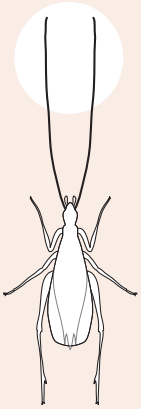


NRAES–75

NRAES–75



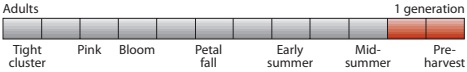
NRAES–75



A: 19 mm
N: 12 mm

Snowy tree cricket

Oecanthus fultoni Walker



Description

The adult somewhat resembles a field cricket but is pale green in color and has a longer, more slender body and smaller head. Antennae are much longer than the body; males have stiff veins in their flat wings **(A)**. Nymphs look similar to adults but are more pale and slender, without fully developed wings.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple, also plum, peach, and cherry. The female drills a pin-size hole up to the cambium of twigs to deposit an egg, usually making a single row of punctures along one side and sealing each with excrement or chewed plant tissue after the egg is laid **(B)**. Punctures are often entry sites for canker-producing fungi and other pathogens. The adult causes further injury by eating holes in ripe fruits **(C)**, which can subsequently rot.

Management

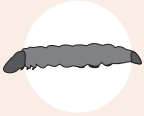
This insect is normally not a serious problem in regularly sprayed orchards. Eliminating weedy alternate hosts, such as brambles, will reduce chances of orchard infestations.

NYSAES

Breth

NYSAES

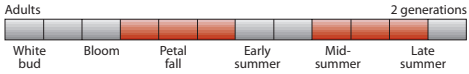
A: 17–28 mm



L: 18–25 mm

American plum borer

Euzophera semifuneralis (Walker)



Description

The adult is a light grayish brown moth with reddish brown forewings marked by wavy black and brown vertical bands about two-thirds the distance from the base (A). The larva ranges in color from grayish green to grayish purple with a yellow to brown head capsule, cervical shield, and anal plate (B).

Distribution

Most fruit-growing states and provinces in eastern North America. Generally not an economic pest in QC.

Damage

Attacks plum, cherry, and apple. Larvae feed in the cambium layer of the trunk or scaffolds (C), which they can access only through openings created by mechanical damage, disease, sunscald, winter injury, etc. Because they feed horizontally, girdling can eventually occur. Drought conditions intensify feeding effects.

Management

Species presence and flight activity can be monitored with pheromone traps. Minimize trunk damage caused by mechanical harvesting and cankers. Coarse insecticide sprays may be applied to the trunk shortly after petal fall and again, if necessary, in midsummer.

NYSAES

NRAES–75

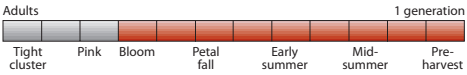
NRAES–75


A: 18–22 mm


L: 15 mm

Dogwood borer

Synanthedon scitula (Harris)




A

NYSAES


B

NYSAES


C

NYSAES

Description

The adult is bluish black with yellow bands and has clear wings (A), resembling a wasp. The larva is creamy white to pink with a sclerotized reddish head (B).

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple and plum. Larva is present throughout the whole season. It digs tunnels in the trunk or in burr knots (which is less serious but indicative of potential problems), creating accumulations of reddish frass at the tunnel exits and causing loss of tree vigor (C).

Similar Species

The larva resembles that of peachtree borer (*Synanthedon exitiosa,* page 101) and lesser peachtree borer (*S. pictipes,* page 100), which are much larger and do not attack apple.

Management

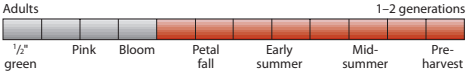
Species presence and flight activity can be monitored with pheromone traps. Keep the area around the trunk weed-free and open to sunlight to decrease the tendency for burr knot development. Protect bases of trees: mound soil around the trunk (but not so high as to allow scion rooting), install mosquito netting, and use white latex paint on the trunk for protection. Destroy larvae with a knife or a metallic skewer. When required, use broad-spectrum insecticides as a trunk spray against established infestations before bloom and before egg laying begins around the time of fruit set.

A: 18–22 mm

L: 19–25 mm

Lesser peachtree borer

Synanthedon pictipes (Grote & Robinson)



NRAES–75

NRAES–75

NYSAES

Description

The adult is a clear-winged, metallic blue moth with two or more yellow bands across the abdomen that give it a wasp-like appearance (A). The larva is white or cream-colored and hairless with legs and a yellowish brown to dark brown head (B).

Distribution

Widespread in most stone-fruit-growing states and provinces in eastern North America.

Damage

Attacks damaged areas of scaffold limbs of all stone fruits, mainly peach and cherry. Larvae feed on the inner layer of bark, killing the cambium and girdling the conductive tissue, which causes significant production loss in older orchards. Larvae normally enter at areas injured by Cytospora canker, winter injury, split limbs from heavy loads, or pruning or mechanical wounds. Infestation tends to occur on the upper trunk or lower limbs and often causes a flow of frass-containing gum (C).

Similar Species

All forms are very similar to the peachtree borer (*S. exitiosa*, page 101), but the adult female peachtree borer has one broad orange band across the abdomen and the male has three to four pale yellow bands; both male and female lesser peachtree borers have two pale yellow bands. *S. exitiosa* infestations are restricted to trunks near or just below the soil surface. The species often occur together.

Management

Species presence and flight activity can be monitored with pheromone traps. Mating disruption is effective for both species in multi-acre plantings. Insecticide drenches or sprays to wounds on scaffold limbs can be applied at bud swell or in summer.

A: 27–38 mm
(female)

(male)

L: 38 mm

Peachtree borer

Synanthedon exitiosa (Say)

Description

The adult is a clear-winged, metallic blue moth with one broad orange (female) or two or more yellow (male) bands across the abdomen **(A; female on left, male on right)**; both sexes have more amber sheen on the wings than lesser peachtree borer adults. The larva is white or cream-colored and hairless with legs and a yellowish brown to dark brown head **(B)**.

Distribution

Widespread in most stone-fruit-growing states and provinces in eastern North America.

Damage

Attacks all stone fruits, mainly peach. Larvae burrow into bark, usually entering at a crack or wound near the soil surface; feed on the cambium; and tunnel between the inner bark and the sapwood. They normally attack the trunk between 7.5 cm below ground to 25 cm above ground; larger roots are occasionally attacked. Areas attacked often have masses of gum, mixed with frass, exuding from the bark **(C)**. Young trees may be completely girdled and eventually die; older trees are debilitated and more susceptible to other insects or diseases.

Similar Species

Very similar to the lesser peachtree borer (*S. pictipes*, page 100), except both the male and female lesser peachtree borers have two pale yellow bands across the abdomen. Also, the lesser peachtree borer infests higher up on the trunks and in the lower branches. The species often occur together.

Management

Species presence and flight activity can be monitored with pheromone traps. Mating disruption is an effective option in multi-acre plantings. Summer or postharvest trunk sprays of contact insecticides can be applied.

NRAES–75

NYSAES

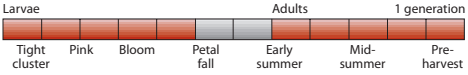
NYSAES

A: 37–45 mm
(shown at 50% actual size)

L: 90 mm
(shown at 50% actual size)

Prionus borers

Broadnecked root borer: *Prionus laticollis* (Drury)
Tilehorned Prionus: *Prionus imbricornis* (L.)



Description

Adults are robust, broad, somewhat flattened blackish to reddish brown beetles with antennae roughly half the length of their bodies **(A)**. Larvae are large, fleshy, elongate grubs, creamy white to yellowish in color with three pairs of small legs, a swelling behind the small head capsule, and strong black mandibles **(B)**.

Distribution

Most fruit-growing states and provinces in eastern North America. Generally not an economic pest in QC.

Damage

Attack apple, cherry, peach and plum. Larvae of both species feed on root and crown wood, which they hollow, girdle, or sever **(C, D)**; the larval stage can last three years or more. Affected trees show a gradual thinning and yellowing of foliage and limb-by-limb mortality. Young trees can be chewed off just below the surface; established trees may have only one or two roots left intact and can be blown over by wind.

Management

Keep the bases of trees free from weeds to encourage predators. Use oviposition barriers of netting or screening on the bottom 30–60 cm of trunks. A surface deterrent or insecticide can be sprayed on trunks in early summer.

NYSAES

NYSAES

Agnello

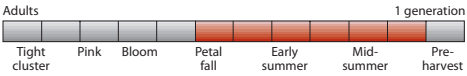
Agnello

A: 20 mm

L: 25 mm

Roundheaded appletree borer

Saperda candida Fabr.



Description

The adult **(A)** has a hard, elongated body with white and brown longitudinal stripes and long antennae. The larva is a fleshy, cream-colored, legless grub with a dark brown head and blackish mandibles. The first thoracic segment is broader than the rest of the body **(B)**.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks apples mainly, but most deciduous tree fruits are susceptible. The larvae dig tunnels, most often at the base of the tree trunk. The roundheaded borer leaves accumulations of reddish frass at the entrance of galleries. Infested trees have a sickly appearance, producing sparse, pale-colored foliage **(C)**. Continued yearly attacks can kill the tree or weaken it so that it is broken off by the wind. Young trees that have been girdled will often bloom profusely and set a heavy crop of fruit and then die in the process of bringing it to maturity.

Management

This pest can easily become a serious problem in neglected or backyard apple trees. Eliminate alternative hosts (rosaceous trees) growing in close proximity. Protect trees against egg laying at the bases of trunks (use mosquito netting), and eliminate weeds at the bases of trunks. An insecticide can be applied to the trunk against egg-laying adults in early to midsummer.

NYSAES

NYSAES

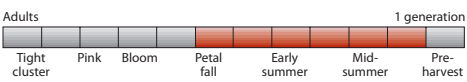
NYSAES

A: 15 mm

L: 25 mm

Flatheaded appletree borer

Chrysobothris femorata (Olivier)



Description

The adult is a shorthorned beetle, flattened above, with short antennae and large conspicuous eyes **(A)**. The upper surface of the body is dark metallic brown with slightly patterned wing covers. Underneath the wing covers (as seen in flight), the body is a bright metallic blue. The beetle's undersurface is coppery bronze. The larva **(B)** is light yellow and has a characteristic enlargement of the thoracic segments (just behind the head), which gives this insect its common name.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks apples mainly, but most deciduous tree fruits are susceptible. The larvae dig tunnels along the extent of the trunk. Injured spots are slightly depressed and darker in color **(C)**. These depressions may split over time and can be enlarged every year by succeeding generations that attack the dead wood on the border of the injured area. The borers will often girdle a small tree, and a single larva can kill the tree.

Management

Flatheaded borers are attracted to diseased or weakened trees and newly transplanted nursery stock. Trees suffering from sunscald are particularly susceptible. An insecticide can be applied to the trunk against egg-laying adults in early to midsummer.

NYSAES

NYSAES

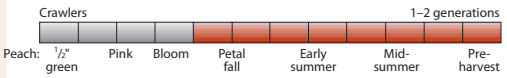
University of Illinois Cooperative Extension

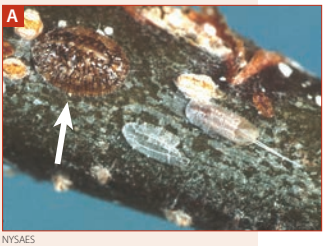
Hemiptera: Sternorrhyncha: Coccidae

A: 5 mm N: 0.5 mm

European fruit lecanium (Brown apricot scale)

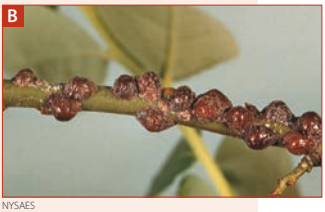
Parthenolecanium corni (Bouché)





A

NYSAES



B

NYSAES

C

NRAES–75

Description

The adult female **(A, arrow)** scale is nearly hemispherical and shiny brown with several ridges along the back. Nymphs (crawlers) are light-colored.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks all deciduous tree fruits, particularly peach. Female scales cover the undersides of twigs **(B)** and are most noticeable during the dormant season. Crawlers feed on the leaves throughout the summer and into the fall, covering the fruit with honeydew on which a sooty black fungus grows.

Similar Species

The terrapin scale, *Mesolecanium nigrofasciatum* (Pergande), is similar in biology and appearance **(C)** but slightly smaller than the European fruit lecanium. It also has dark stripes radiating outward from the center.

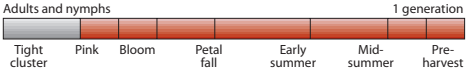
Management

Spray a delayed dormant oil when buds are showing green tissue but before pink bud to prevent development of eggs under the scale covers. An insecticide can be applied at the completion of crawler hatch five to six weeks after peach petal fall. However, soft scales (family Coccidae) are usually controlled by a complex of parasitic wasps; this can be facilitated by avoiding disruptive sprays.

A: 1.3 mm

European fruit scale

Quadraspidiotus ostreaeformis (Curtis)



Simard

Simard

Drouin

Description

The female is immobile and covered with a circular waxy shell that becomes dark gray over time and is elevated at the center **(A)**. The adult male is brownish red with an elongated abdomen, long antennae, and wings. The minuscule nymph (crawler) is bright yellow and has long antennae.

Distribution

Mainly southeastern Canada.

Damage

Attacks all deciduous tree fruits. An accumulation of the scale covers of this pest resembles minuscule round spots on the bark and can seriously weaken trees **(B)**. On leaves, the fruit scales form spots encircled by a red halo **(C)**.

Similar Species

San Jose scale (*Quadraspidiotus perniciosus*, page 109), although darker in color, is difficult to distinguish from European fruit scale with the naked eye.

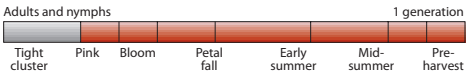
Management

Spray a delayed dormant oil when buds are showing green tissue but before pink bud. Insecticide applications may be made to control newly hatched crawlers five to six weeks after petal fall.

A: 2 mm

Forbes scale

Quadraspidiotus forbesi (Johnson)



Howitt

Howitt

Howitt

Description

This gray scale is round or elongate and has a raised reddish area in the center **(A, B)** that distinguishes it from the San Jose scale (*Quadraspidiotus perniciosus*, page 109).

Distribution

Most fruit-growing states and provinces in eastern North America. Generally not an economic pest in QC.

Damage

Attacks cherry, apple, apricot, pear, plum, and quince. Masses of gray, thin, flaky scales occur on the bark of the trunk and branches, sometimes completely covering it **(C)**. Crawlers make their way to fruits, where their feeding produces small red spots about 3 mm in diameter with a light-colored area in the center.

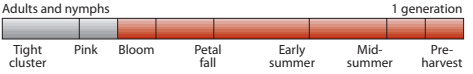
Management

Spray a delayed dormant oil when buds are showing green tissue but before pink bud. Insecticide applications may be made to control newly hatched crawlers in early summer.

A: 3 mm

Oystershell scale

Lepidosaphes ulmi (L.)



Drouin

Simard

NYSAES

Description

The adult female remains immobile under a small, brown, oystershell-shaped scale (A) attached to the bark of branches. The white, oval eggs (B) are laid inside the scale, and crawlers emerge in the spring during the petal fall stage of apple.

Distribution

Most fruit-growing states and provinces in eastern North America and south through the Mid-Atlantic states.

Damage

Attacks apple, pear, quince, plum, and apricot. Small, dark brown scales cluster on bark or fruit (C), at times entirely covering it, causing cracks and a scaly appearance. Infested trees are weak, and foliage is undersized and specked with yellow.

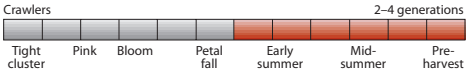
Management

Spray a delayed dormant oil when buds are showing green tissue but before pink bud.

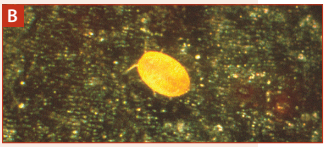
A: 2 mm
N: 0.2 mm

San Jose scale

Quadraspidiotus perniciosus (Comstock)



Eaton



NYSAES

NYSAES

Description

Adult males are minute, winged insects about 1 mm long and golden brown with a reddish tinge. Scales may be either disk-shaped (females) or oval (males) and are composed of concentric rings of gray-brown wax radiating from a tiny white knob **(A)**. Nymphs (crawlers) are bright yellow and resemble spider mites **(B)**.

Distribution

Widespread and a major pest in most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple, peach, pear, and plum. Scale infestations on the bark can be heavy and contribute to an overall decline in tree vigor, growth, and productivity. Tree death is possible. Feeding on the fruit induces local red to purple discoloration around the feeding sites **(C)**. Early-season fruit infestations may result in small, deformed fruit.

Similar Species

Forbes scale (*Quadraspidiotus forbesi*, page 107) looks similar but can be distinguished by a raised reddish area in the center of the scale. European fruit scale (*Q. ostreaeformis*, page 106) is also difficult to distinguish, although it tends to be lighter in color than San Jose scale.

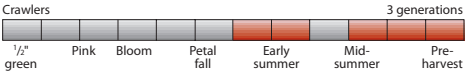
Management

Spray a delayed dormant oil when buds are showing green tissue but before pink bud. Insecticide applications may be made to control newly emerged crawlers in early summer. Use pheromone traps to monitor adult males. A degree-day developmental model can predict crawler emergence after petal fall or trap biofix.

A: 2 mm
N: 1.5 mm

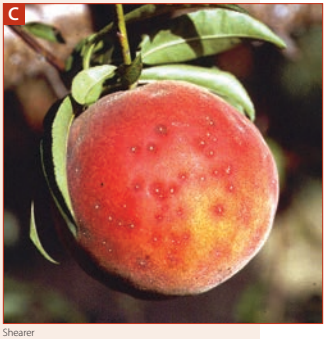
White peach scale

Pseudaulacaspis pentagona (Targioni Tozzetti)



NYSAES

Shearer



Shearer

Description

The adult female is creamy white to reddish orange and covered by a round, waxy scale that is grayish to brownish white **(A)**. Adult males are tiny yellow two-winged insects, and nymphs (crawlers) are oval and white to orange **(B)**.

Distribution

Mainly PA and south throughout the Atlantic Coast states.

Damage

Attacks peach and other stone fruits, particularly in Virginia and south. Scales cluster on the trunk and scaffolds, giving them a whitewashed appearance; they can also occur on the fruit **(C)**. Feeding reduces tree vigor; foliage of affected trees may become sparse and yellow. Fruit size may be reduced, and premature drop is likely. Heavy infestations can cause death of twigs, branches, and the entire tree if left unattended.

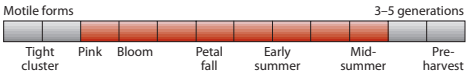
Management

Apply a dormant oil just before the tree breaks dormancy. Insecticide applications may be made to control newly hatched crawlers in early summer.

A: 0.07 mm
(shown at 15X actual size)

Apple rust mite

Aculus schlechtendali (Nalepa)



NRAES–75

NRAES–75

Eaton

Description

The vermiform adult has two pairs of legs at the front of its body **(A)**. Brownish yellow in color, they are invisible to the naked eye, requiring a minimum magnification of 15X to be observed.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks apple mainly. Yellowish brown leaf discoloration occurs under very populated conditions (hundreds per leaf), sometimes accompanied by silvery white blotches **(B)**. Browning of the lower surface and drying out of the leaves occur as well **(C; healthy foliage on left, damaged foliage on right)**. It may occasionally russet fruit.

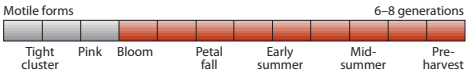
Management

Preserve mite predators. Monitor populations on leaves during the summer with a 15X magnifying glass. Miticides can be used if populations are very high (greater than 200–500 per leaf), but lower numbers are valuable as prey for predator mites.

A: 0.3–0.4 mm
(shown at 15X actual size)

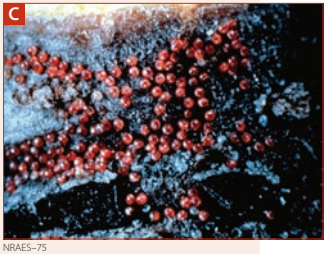
European red mite

Panonychus ulmi (Koch)

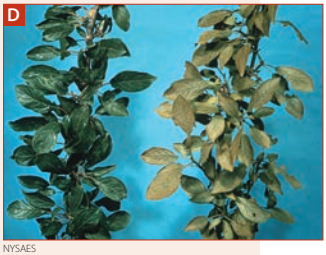


NYSAES

NYSAES



NRAES–75



NYSAES

Description

The adult female is dark red and has silky hairs on its back borne on raised whitish tubercles **(A)**. The male is smaller, lighter in color, and has a pointed abdomen **(B)**. The mites feed mainly on the undersurface of the leaves. Eggs are red and are laid principally on the underside of leaves. Overwintering eggs are darker in color and are laid between mid-August and the beginning of October on spurs, in bark crevices **(C)**, and in the fruit calyx.

Distribution

Widespread and a major pest in most fruit-growing states and provinces in eastern North America.

Damage

Attacks foliage of apple mainly, and other tree fruits less often. Leaves become speckled under light infestation. Bronzing occurs during serious infestations **(D; healthy foliage on left, damaged foliage on right)**. A severe attack can reduce fruit growth and cause preharvest drop on certain varieties.

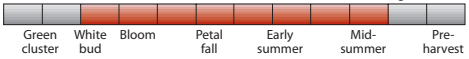
Management

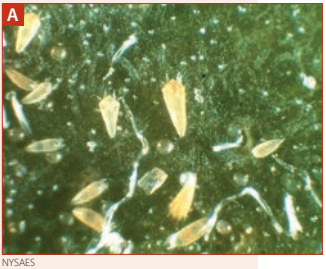
Spray a delayed dormant oil when buds are showing green tissue but before pink bud to kill overwintered eggs; preserve predators of mites. Monitor motile forms on leaves after fruit set; use miticides (based on thresholds) or horticultural mineral oil to reduce numbers during the summer period. A selective pesticide program may allow biological control by predator mites (pages 119–121), glassy-winged mirid bug (*Hyaliodes vitripennis,* page 130), or spider mite destroyer *(Stethorus punctum,* page 126).

A: 0.07 mm
(shown at 15X actual size)

Pear rust mite

Epitrimerus pyri (Nalepa)





NYSAES

NYSAES

NYSAES

Description

The overwintering stage is a light brown, wedge-shaped adult that cannot be seen without a 15X hand lens **(A)**. The summer forms are nearly white in color and even smaller than the overwintered adults.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks pear. The mite feeds on the first green tissue at the bud base, later moving to the foliage or fruit. Feeding causes leaves to turn brown or bronze **(B)**, which may stunt the growth of young trees; on older trees, the damage to fruit is far more significant. Severe russetting of the fruit can leave the entire surface rough and brown **(C)**, which alters or destroys the desirable varietal skin appearance. Early in the growing season, mite feeding at the calyx or stem ends gives a localized russetting to those areas. If mite growth is unchecked, this feeding and russetting may spread over the fruit entirely.

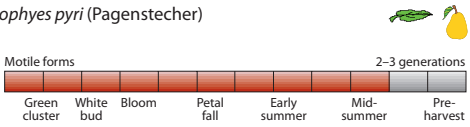
Management

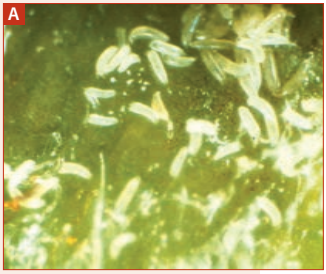
Outbreaks may be worse in areas receiving extensive sprays of materials destructive to predators. The development of miticide-resistant strains are suspected in some cases. A preventive petal fall spray of a contact miticide is probably most advisable in blocks with a history of rust mite infestations.

A: 0.07 mm
(shown at 15X actual size)

Pearleaf blister mite

Eriophyes pyri (Pagenstecher)





NYSAES

NYSAES

NRAES–75

Description

The adults are very small and cannot be seen without a 15X hand lens. The body is white and elongate oval in shape, like a tiny sausage **(A)**.

Distribution

Most fruit-growing states and provinces in eastern North America.

Damage

Attacks pear. During winter, the feeding of the mites under the bud scales is believed to cause the bud to dry and fail to develop. This type of damage is similar to and may be confused with bud injury from insufficient winter chilling. Fruit damage occurs as a result of mites feeding on the developing pears, from the green tip stage through bloom, causing russet spots. These spots, which are often oval in shape, are usually depressed with a surrounding halo of clear tissue. They are 6–12 mm in diameter and frequently run together. A third type of injury is the curling **(B)** or blistering of leaves **(C)**; blisters are 3–6 mm across and, if numerous, can blacken most of the leaf surface.

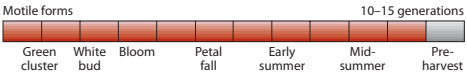
Management

A postharvest insecticide application may be elected in the fall, when there is no danger of frost for at least 24–48 hours after the spray. If needed, a spray of insecticide mixed with oil in the spring, just before the green tissue begins to show, will improve control.

A: 0.15 mm
(shown at 15X actual size)
N: 0.13 mm

Plum rust mite (Peach silver mite*)

Aculus fockeui (Nalepa & Trouessart)



Howitt

Howitt

Description

The adult is minute and worm-like with two pairs of legs and pale yellow to brownish yellow in color (A). The nymph is pale yellowish white and closely resembles the adult.

Distribution

Most stone-fruit-growing states and provinces in eastern North America.

Damage

Attacks plum, peach, and cherry. Mites live on upper and lower surfaces of leaves along the midribs, feeding extensively on young foliage. Feeding causes leaves to roll upward longitudinally and turn brown. Early leaf injury may cause dwarfing of the foliage and a brown or bronze scurfy condition on the lower leaf surface (B). On plums, individual leaves may exhibit "chlorotic fleck," which is the occurrence of spots of abnormally yellow plant tissue up to 1–2 mm in size. In severe cases, the leaf may become twisted or rosetted. Partial defoliation may occur in cherries.

Similar Species

* This species is also called peach silver mite due to the synonymy of *Aculus fockeui* with *Aculus cornutus* (Banks).

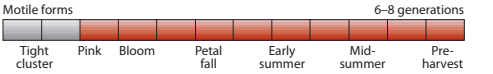
Management

Miticide sprays may be needed in cases of severe infestation, particularly after harvest in cherries.

A: 0.3–0.4 mm
(shown at 15X actual size)

Twospotted spider mite

Tetranychus urticae Koch

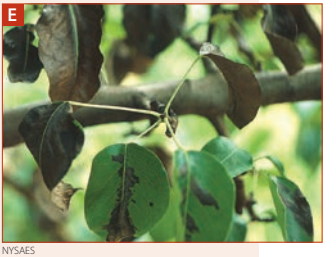


NYSAES

Vincent

Lasnier

Anonymous



NYSAES

Description

Adult and nymphal mites are yellowish to pale green with a dorsal pair of apparent dark "spots" (which are actually internal tissue contents visible through the cuticle) **(A)**. Males are smaller than females and have a pointed abdomen. The female takes on an orange tinge in the fall (referred to as the "carmine phase") **(B)**. They live in small colonies and aggregate in the crevices of the bark or in the groundcover to overwinter. Eggs, spherical and translucent, are laid individually on the underside of leaves **(C)**.

Distribution

Widespread and a major pest in most fruit-growing states and provinces in eastern North America.

Damage

Attacks all deciduous fruit trees. Leaves become speckled **(D; damaged leaf on left, healthy leaf on right)** as a result of mite feeding. In pears, leaves turn dark brown or black **(E)**, especially if intense feeding occurs over a relatively short period. A serious infestation can delay tree growth, reduce fruit size, and cause premature drop.

Management

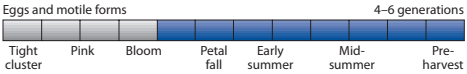
These mites move into the trees from nearby dying weeds. Monitor foliage and watch for outbreaks following herbicide applications to broadleaf weeds in early to midsummer. Use miticides (based on thresholds) or horticultural mineral oil to reduce numbers during the summer period. A selective pesticide program may allow biological control by predator mites (pages 119–121), glassy-winged mirid bug (*Hyaliodes vitripennis*, page 130), or spider mite destroyer (*Stethorus punctum*, page 126).

Beneficial Insects, Spiders, and Mites

A: 0.33 mm
(shown at 10X actual size)

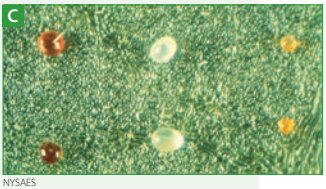
Phytoseiid mites

Amblyseius (= *Neoseiulus) fallacis* (Garman)
Typhlodromus pyri (Scheuten)
T. caudiglans Schuster
T. longipilus Nesbitt
T. vulgaris Ehara



NYSAES

NYSAES



NYSAES

Description

Adults have a translucent teardrop-shape body **(A)**. A dark mark in the form of an "H" sometimes appears within the body. This mark is red when they feed on European red mites and yellow when they feed on twospotted spider mites. They move very rapidly on the leaves. Nymphs are similar in appearance and pale-colored **(B)**. Eggs are elliptical and clear white **(C, center)**.

☹ These predators are very sensitive to pyrethroid and carbamate insecticides. However, observations suggest that certain populations may develop resistance.

Status

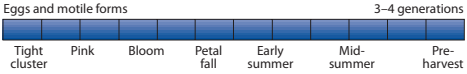
Along with stigmaeid mites (page 120), the phytoseiids are the most abundant predatory mites in apple orchards in eastern North America. They appear in the tree canopy mostly during the latter half of the season. *Amblyseius fallacis* tends to be more noticeable in the tree later as the summer progresses because of prey availability, but it is present in the orchard groundcover season-long. A number of different *Typhlodromus* species may be present in eastern fruit orchards; they cannot be differentiated without a microscope.

☺ If not disrupted by the use of nonselective pesticides, established populations of phytoseiids are capable of effecting seasonal biological control of phytophagous mites.

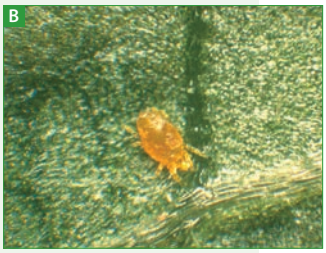
A: 0.33 mm
(shown at 10X actual size)

Stigmaeid/"Yellow" mites

Agistemus fleschneri (Summers)
Zetzellia mali (Ewing)

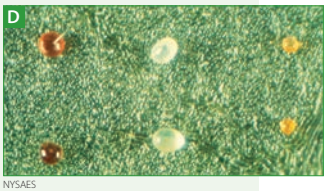


Howitt



NYSAES

NYSAES



NYSAES

Description

Agistemus fleschneri is the principal species found in QC and northern ON orchards, while *Zetzellia mali* predominates in the United States, southern ON, and the maritime provinces. Immature stages are bright yellow. Adult females of *Agistemus* are orange-red **(A)** and can be confused with the European red mite *(Panonychus ulmi,* page 112) but do not possess its silky white hairs. *Zetzellia* adults are bright yellow **(B)**, but can appear reddish after feeding on red mites **(C)**. Eggs are round and yellow **(D, right)**.

☹ In general, these mites are sensitive to broad-spectrum insecticides but less so than phytoseiid mites.

Status

Along with phytoseiids (page 119), stigmaeid mites are the most abundant predatory mites in apple orchards in eastern North America. They feed on the eggs and larval forms of apple rust mite and European red mite, among others. It should not be confused with the yellow spider mite, *Eotetranychus carpini borealis* (Ewing), which is a pest of brambles but can occur on tree fruit.

☺ In combination with either the phytoseiid mites or other mite predators, these species contribute to the maintenance of pest mite populations below economic levels.

Erythraeidae A: 0.7 mm
(shown at 10X actual size)

Trombidiidae A: 0.3 mm
(shown at 10X actual size)

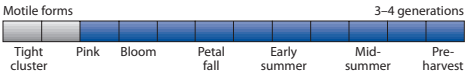
Anystidae A: 0.4 mm
(not shown)

Red velvet mites

Erythraeidae: *Balaustium* spp.

Trombidiidae: *Allothrombium* spp.

Anystidae: *Anystis baccarum* (L.)



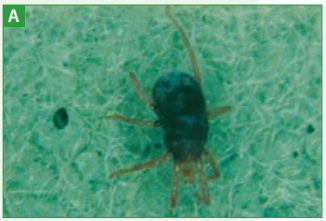
Description

Balaustium is a large, bright red mite with a tick-like shape and a dense velvet-like covering of dorsal setae; chelicerae are long and retractable (**A**). It moves very quickly over the plant surface. *Allothrombium* is also a bright red mite but with few hairs and nonretractable chelicerae (**B**). *Anystis* is a small red mite that can be found moving rapidly along the foliage (**C**).

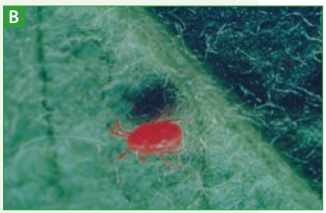
☹ Sensitivity of these species to insecticides is not well known.

Status

Balaustium is an important predator of mites, scales, and moth eggs at the beginning and end of the season. *Allothrombium* feeds on aphids and mites. *Anystis* hatches from eggs in soil litter during early spring; it feeds on leafhoppers and phytophagous mites. Prey searching occurs along apple leaf veins and edges. They may eat up to 40 adult twospotted mites per day.



Lasnier



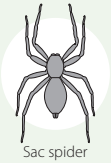
Drouin

Lasnier


Jumping spider

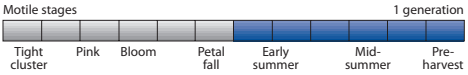

Crab spider

A: 2–35 mm


Sac spider

Spiders: Foliage hunters

Jumping spiders: Salticidae
Crab spiders: Thomisidae and Philodromidae
Sac spiders: Clubionidae



Description

The body of a spider is divided into two regions, the cephalothorax and abdomen. The cephalothorax bears the eyes (various numbers and arrangements), mouthparts, pedipalps, and legs (four pairs). The unsegmented abdomen bears the genital structures, spiracles, anus, and spinnerets (silk-spinning structures).

Jumping spiders **(A)**, active hunters, are stout-bodied and short-legged with prominent front eyes and a rather hairy body that is often brightly colored or iridescent; size ranges from 2–20 mm. These are often the most common spiders in the tree canopy.

The two families of crab spiders are ambush hunters; they sit and wait for their prey. The first two pairs of legs face forward in a crab-like posture. Philodromid crab spiders **(B)** have flattened bodies and legs of equal length, whereas Thomisid crab spiders **(C)** have the first two pairs of legs longer than the others.

Sac spiders **(D)** are pale with few markings. They construct tubular retreats in rolled-up leaves.

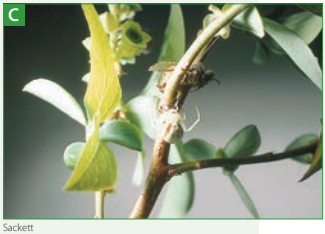
☹ Broad-spectrum insecticide applications in the summer are harmful to the establishment of spider populations.

Status

Numerous hunting species that may be found in the tree foliage searching for prey.

Sackett

Sackett



Sackett

Sackett


Orb-weaver

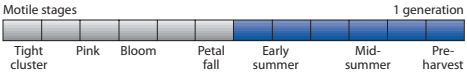
A: 2–35 mm


Cobweb spider


Meshweb weaver

Spiders: Foliage web-builders

Orb-weavers: Araneidae
Cobweb spiders: Theridiidae
Meshweb weavers: Dictynidae
Sheetweb spiders: Linyphiidae




A

Rayor


B

Sackett


C

Sackett

Description

The body of a spider is divided into two regions, the cephalothorax and abdomen. The cephalothorax bears the eyes (various numbers and arrangements), mouthparts, pedipalps, and legs (four pairs). The unsegmented abdomen bears the genital structures, spiracles, anus, and spinnerets (silk-spinning structures).

Orb-weavers are usually large. Among them are the common garden spiders, which are often bright black and yellow or black and red **(A)**.

Cobweb spiders **(B)** often have a small cephalothorax and a large, rounded abdomen with the legs bent. They are usually found hanging upside down in irregularly spun webs.

Meshweb weavers **(C)** are small (mostly less than 1 cm) and stout. They often spin small webs in the concavity of the top surface of leaves.

The sheetweb spiders are also small and not often seen, although their webs are conspicuous, particularly when covered with dew; they are flat and sheet-like, sometimes bowl- or dome-shaped, and usually with an irregular mesh of silk around or above the sheet. The spider is often found on the underside of the web.

Refer to the "For Further Information" section of this guide (page 230) for references on distinguishing spider families.

☹ Broad-spectrum insecticide applications in the summer are harmful to the establishment of spider populations.

Status

Numerous trapping species that spin webs.


2-spotted
A: 5 mm

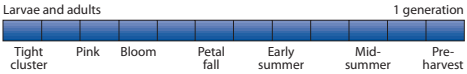

7-spotted
A: 7 mm


14-spotted
A: 4 mm


Multicolored
Asian
A: 7 mm

Lady beetles

2-spotted lady beetle: *Adalia bipunctata* (L.)
7-spotted lady beetle: *Coccinella septempunctata* L.
14-spotted lady beetle: *Propylea quatuordecimpunctata* L.
Multicolored Asian lady beetle
(Halloween beetle): *Harmonia axyridis* (Pallas)




A
Coderre


B
Vincent


C
Coderre


D
Laplante

Description

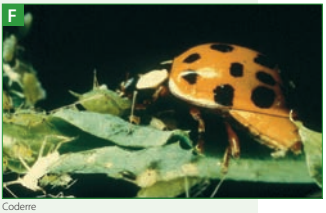
Adults are oval and convex in shape, often brightly colored (e.g., orange-red or yellow) and usually with black spots or marks on their wing covers **(A, 2-spotted; B, 7-spotted)**, sometimes with a checkerboard appearance **(C, 14-spotted)**. *H. axyridis* is one of the largest lady beetles present in apple orchards; they have an orange tint that may vary from dark to very faint. The number of spots can vary from none to 20 **(D, E, F)**. Lady beetle larvae resemble small alligators [e.g., 7-spotted has a black head and is bluish gray with yellow spots, **(G)**]. Eggs are laid in masses of 10–50 on the undersides of leaves, on fruit, and often close to aphid colonies.

☹ The lady beetles are sensitive to most broad-spectrum insecticides.

☺ *H. axyridis* are the most voracious lady beetles found in orchards.

Lady beetles (continued)

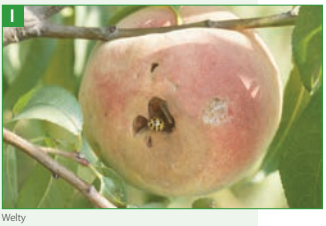
Laplante



Coderre

Drouin

Kovach



Welty

Status

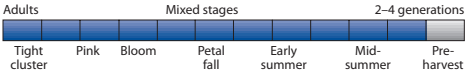
Lady beetle larvae and adults are valuable predators of mites, aphids, and immature stages of many other soft-bodied insects that live in trees.

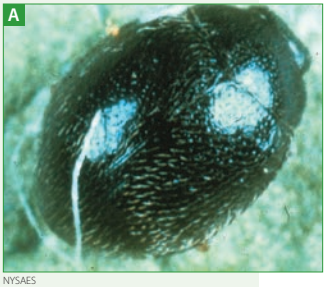
A native of Asia, *H. axyridis* was intentionally imported and released in different parts of the United States by the U.S. Department of Agriculture during the 1970s and 1980s in an effort to control several aphid and scale pests of trees and field crops. Over time, it has adapted to conditions in the United States and may be replacing some native species. It is now increasingly occurring in tree fruit orchards. Large aggregations on houses and other buildings in the spring and fall can be a nuisance to homeowners when the beetles crawl into the living space of buildings. They may also feed on overripe or previously damaged fruits such as apples or peaches **(H, I)**.

A: 1.5 mm L: 2 mm

Spider mite destroyer

Stethorus punctum (LeConte)




A

NYSAES


B

NYSAES


C

NRAES–75

Description

Adults are oval, convex, uniformly shiny black, and covered with sparse, fine yellowish to white hairs (A). The larva is gray to blackish and has many long-branched hairs and black patches (B). As the larva matures, it becomes reddish, at first on the edges of the body and eventually entirely, just prior to pupation (C).

☹ This species is sensitive to most broad-spectrum insecticides.

Status

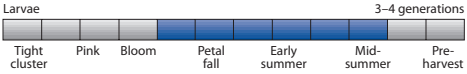
The larvae and adults are important predators of mites. They are normally not found in tree fruits north of PA.

☺ Both forms can consume as much as 100 motile forms per day.

A: 3 mm L: 2 mm

Gall midges

Aphidoletes spp.



A

Drouin

B

Drouin

C

NYSAES

Description

The adult resembles a small mosquito (A). The bright orange larvae are legless and have no distinct head capsule; the front part of the body is tapered (B). The orange elongated eggs are laid on the leaf surface among aphid colonies.

☹ The gall midges are sensitive to broad-spectrum insecticides.

Status

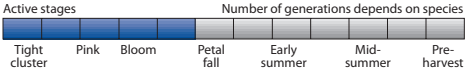
Larvae are predators of aphids and other soft-bodied insects as well as mites. An example species is *Aphidoletes aphidimyza* (C).

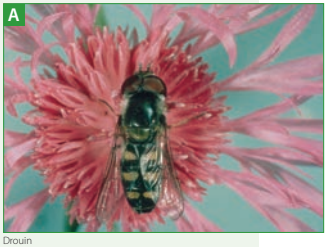
☺ One larva per 20 to 40 aphids is usually sufficient to attain natural control.

A: 10 mm

L: 6 mm

Hover flies





Drouin

NYSAES

NYSAES

Description

The adult is a fly that mimics the coloration of wasps; it often hovers during flight **(A)**. The eggs are white with a stippled sculptured surface **(B)**. The larva **(C)** is a maggot of variable color (gray, yellow, orange, green, or a combination of these colors). It is found among aphid colonies, often co-existing with other predators such as the gall midge (page 127).

☹ The hover flies are sensitive to several broad-spectrum insecticides, especially the organophosphates.

Status

Numerous species have been identified in apple orchards. The hover flies are both pollinators (adults) and predators (larvae).

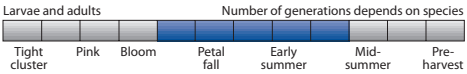
☺ The hover flies help to maintain aphid populations at a low level.

Similar Species

The hover flies can be confused with some wasps, but they have larger eyes, are without the narrow "waist," and have only one pair of wings. The wasps have two pairs of wings, are generally larger, and may have a sting.

A: 8 mm

Tachinid flies



Simard

Description

The adults are similar to a housefly but are covered with stiff hairs **(A, center)**. The larvae have the appearance of small maggots and feed inside caterpillars and other hosts. Females lay their eggs on the back of several species of caterpillars, such as the obliquebanded leafroller [*Choristoneura rosaceana,* page 77, and **(A, left)**]; on stink bugs; and on the cocoons of the forest tent caterpillar (*Malacosoma disstria,* page 61).

Representative species of this group include *Actia interrupta* Curran, *Nilea erecta* Coquillett, and *Hemisturmia parva* Bigot. The pupa of *A. interrupta* often can be found on the leaf next to the dead obliquebanded leafroller larva **(A, right)**.

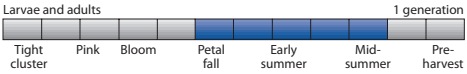
Status

Several species commonly occur in many orchard plantings and can significantly reduce caterpillar populations if not disrupted by pesticide sprays. Their abundance varies from year to year, at least partly in response to weather conditions.

A: 5 mm

Glassy-winged mirid bug

Hyaliodes vitripennis (Say)



Drouin

Drouin

Description

The adult is similar to the tarnished plant bug (*Lygus lineolaris,* page 72) but with a more elongated head and translucent wings crossed with two black lines that form an angle at the ends of the forewings **(A)**. It also lacks the cream-colored scutellum seen in *L. lineolaris.* The antennae are striped. The nymph is green with a banana-shaped process that is often red in color at the end of its abdomen **(B)**.

☺ These bugs are less sensitive to certain organophosphate insecticides, such as those used against the apple maggot.

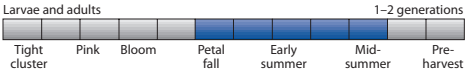
Status

The nymphs and adults are predators of various insects such as aphids, caterpillars, psylla, and both phytophagous and predacious mites.

Hemiptera: Heteroptera: Pentatomidae

A: 10–20 mm

Stink bugs



A

Laplante

B

Giguère

C

NYSAES

Description

The adult has an oval shield-shaped body, grayish or brownish in color; a spur is present on each side of its thorax **(A)**. Eggs, grouped in masses of 20–30, are in the shape of small barrels. They are gray, cream or gold-colored, and decorated by a ring of small hairs. The nymphs are often of contrasting colors (orange-red and black), without wings, and round in shape **(B)**.

☹ These bugs are sensitive to organophosphate and carbamate insecticides.

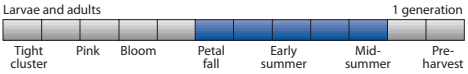
Status

The larvae and adults of several species can feed on both plants and insects, and some are considered pests (page 70), particularly of stone fruits. However, other species such as *Podisus maculiventris* (Say), the spined soldier bug, are predacious **(C)**.

A: 10–20 mm

Assassin bugs

Reduviidae



Laplante

NYSAES

Description

The head is narrow and elongate with a neck-like portion behind the eyes **(A, B)**. Sometimes a sculptured crest may be found on the pronotum. The front legs are specialized for hunting.

☹ These bugs are sensitive to organophosphate and carbamate insecticides.

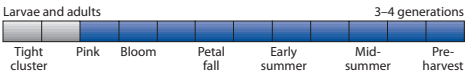
Status

The larvae and adults are generalist predators but may also be pests of fruit.

A: 4 mm

Minute pirate bugs

Anthocoridae



Drouin

Description

Adults are very similar in size to the mullein plant bug (*Campylomma verbasci*, page 133), but their head is narrower and their wings are colored contrasting white and black **(A)**.

☹ These bugs are sensitive to organophosphate and carbamate insecticides.

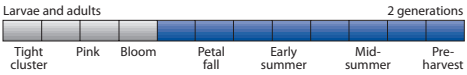
Status

The larvae and adults, which can be abundant in orchards, are predators of aphids, mites, thrips, caterpillars, and insect eggs. An example species is *Orius insidiosus* (Say).

A: 3 mm
N: 1–2 mm

Mullein plant bug

Campylomma verbasci (Meyer)



Boivin

NYSAES

Description

The adult is grayish green with black spots on the legs **(A)**. The nymph **(B)** resembles an apple aphid or a white apple leafhopper and is solitary, very mobile, and lacks cornicles.

☹ These bugs are sensitive to organophosphate and carbamate insecticides.

Status

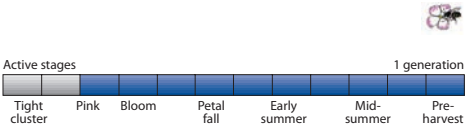
This bug is regarded mainly as a pest (page 69) in ON, NY, and New England; however, in varieties and growing conditions where nymph hatch does not correspond with the occurrence of a susceptible fruit stage, mullein plant bug is regarded as a predator of phytophagous mites, eggs, and aphids.

Bee

A: 5–20 mm

Bumble bee

Bees and bumble bees



Description

Principal species are honey bees and bumble bees. Bumble bees, e.g. *Bombus* sp. **(A)**, have a robust black body covered with hair of variable colors (yellow, orange, black, and white). Honey bees, e.g. *Apis mellifera* L. **(B)**, are more delicate; they are golden brown with yellow rings on the abdomen and have a hairy body.

Status

Pollinator insects.

Similar Species

The bees can be confused with some wasps, but the latter are darker and are not covered with hair. Carpenter bees may be mistaken for bumble bees, but the former have the dorsum of the abdomen largely bare.

☺ Other families of bees are commonly found (Megachilidae, leafcutting bees; Halictidae and Andrenidae, both solitary bees; Colletidae, plasterer bees; Anthophoridae, digger bees; etc). They are distinguished by their smaller size and fewer hairs. Many are extremely efficient pollinators.

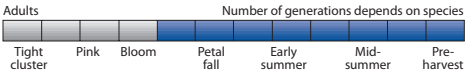
☹ These Hymenopterans are very sensitive to insecticides, particularly those having broad-spectrum efficacy.

Simard

Vincent

A: 10 mm

Ichneumonid parasitic wasps



Drouin

Simard

Description

The representative species of this group, such as *Gambrus* sp. **(A)** and *Itoplectis conquisitor* (Say) **(B)**, are larger than other parasitic wasps. They have a slender body; very distinct head, thorax, and abdomen; two pairs of membranous wings; and long segmented antennae. The female's needle-like ovipositor (at the tip of the abdomen) is as long as or longer than its body. They are harmless to humans.

☹ These wasps are extremely sensitive to most broad-spectrum insecticides.

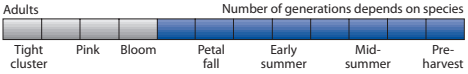
Status

Most ichneumonids are parasitoids of caterpillars. Females lay their eggs in the body of the host, and larvae feed on the inside.


Braconid wasp
A: 3 mm


Chalcid wasp
A: 3 mm

Braconid and chalcid parasitic wasps




A
Drouin


B
Simard


C
Simard


D
Eaton

Description

Brown or black, these wasp species are small and difficult to differentiate from one another, except that chalcids have greatly enlarged hind femora (third leg segment). They have two pairs of membranous wings; segmented antennae; and a very distinct head, thorax, and abdomen. Females often have a needle-like ovipositor at the tip of their abdomen. They are harmless to humans.

☹ These wasps are extremely sensitive to most broad-spectrum insecticides.

Status

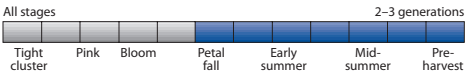
These parasitic wasps attack many harmful insects such as the apple aphid (page 39) and woolly apple aphid (page 44), larvae of the spotted tentiform leafminer (page 47), obliquebanded leafroller (page 77), and eggs of the codling moth (page 88). Females lay their eggs in the body of the host, and larvae feed on the inside.

☺ The braconid *Pholetesor ornigis* (Weed) attacks the spotted tentiform leafminer **(A)**. *Macrocentrus linearis* (Nees) **(B)** is a parasitoid of the oblique-banded leafroller. Aphids **(C)** can be the victims of many wasps such as *Praon* sp. **(D)**.

A: 10–20 mm

L: 8 mm

Lacewings



Description

The adult is green (Chrysopidae) or light brown (Hemerobiidae) with large translucent membranous wings **(A)** that are held roof-like over the body. Brown lacewings are typically half the size of green lacewings. The larva has a tapered abdomen and large mandibles **(B)**. Chrysopid eggs (1 mm) are whitish green and are deposited, singly or grouped, on long thread-like stalks **(C)** (10 mm); those of hemerobiids are laid singly on plant surfaces without a stalk.

☹ The lacewings are sensitive to most broad-spectrum insecticides.

Status

Larvae and adults of many species are predators of mites and soft-bodied insects.

☺ Natural control of aphids is possible when there is one larva per 70 aphids.

Drouin

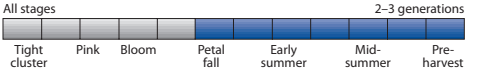
NYSAES

NYSAES

A: 1.5 mm
L: 0.5 mm

Black hunter

Leptothrips mali (Fitch)



NRAES–75

NRAES–75

Description

The adult is a slender, sharply pointed, blue-black insect with silvery wings, which are held over the abdomen **(A)**. The nymph is nearly colorless after hatching but soon turns a dark maroon as it matures **(B)**.

Status

Overwintered adults become active in the spring and search for prey among the buds, leaves, and blossoms of most tree fruits. Populations increase slowly, as most females lay only one or two eggs.

☺ Black hunter is the most economically valuable predatory thrips in eastern North America. It is solitary in habit but very active, feeding especially on European red mite (page 112), twospotted spider mite (page 116), and apple rust mite (page 111).

Diseases

Apple union necrosis and decline (AUND)

Tomato Ringspot Virus [TmRSV]

NRAES–75

NRAES–75

Host

Apple

Symptoms

AUND is due to an incompatibility at the graft union where a resistant scion is grafted onto a susceptible but tolerant rootstock, most commonly MM.106. Symptoms appear about four to six years after planting. Affected trees show a general decline beginning with delayed budbreak. The canopy tends to be sparse, bearing small pale green leaves. Premature defoliation is possible. A distinct black sunken line at the union appears underneath the bark **(A)**. The graft union may be so weakened that the scion and rootstock separate partially or completely or crack under stress **(B)**.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Any disease or disorder affecting the root system or rootstock/scion union can produce similar aboveground symptoms.

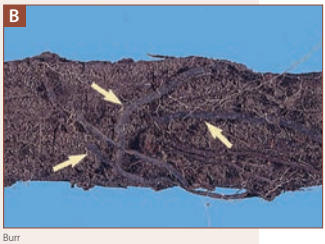
Management

TmRSV can survive in many weed hosts, is seed-transmitted in dandelion, and is vectored by the dagger nematodes *Xiphinema americanum* Cobb and *X. rivesi* Dalmasso. Practicing good weed control and preplanting site preparation and selecting resistant rootstock or, in some instances, using a resistant interstem will reduce the incidence of disease. Though ranking rootstocks has sometimes been difficult due to inconsistent reports, those considered tolerant to AUND include MM.106 (particularly on Delicious), M.26, and P.2; those considered resistant include M.4, M.7, and Ottawa 3. Several others, including M.9, MM.111, G.16, G.30, and B.9, have given mixed results.

Armillaria root rot

Armillaria mellea (Vahl:Fr.) P. Kumm.

Burr



Burr

Jones

Host

Apple, Apricot, Cherry, Nectarine, Peach, Pear, Plum

Symptoms

The bark at the crown and roots sloughs off easily, exposing the dense white growth of the fungus **(A)**. The growth extends in a fan-like pattern underneath the bark. Black shoestring-like strands (rhizomorphs) may be obvious on the surface of the bark **(B)**. In the fall, yellow/brown mushrooms may appear at the base of the tree, especially if killed trees are left in place **(C)**. Trees in affected orchards will often die in a circular pattern from one or more foci in the orchard.

Distribution

Occurs in all fruit-growing regions in eastern North America, but uncommon.

Similar Diseases and Disorders

Any disease or disorder affecting the root system or rootstock/scion union can produce similar aboveground symptoms. The presence of rhizomorphs distinguishes this disease from similar disorders.

Management

There are no practical control options. Stone fruit tend to be more susceptible to infection than apple and pear; however, susceptibility varies with the choice of rootstock. Of the stone fruit rootstock, Lovell, Mahaleb, Myrobalan, and Nemaguard are considered most susceptible, whereas Marianna and Mazzard are considered moderately resistant.

Constriction disease of Stanley plum (Brown line)

Tomato Ringspot Virus [TmRSV]

Burr

Burr

Host

Plum

Symptoms

Brown line disease is due to an incompatibility at the graft union when Stanley plum and some other European or hybrid plum varieties are grafted onto Myrobalan (*Prunus cerasifera*) rootstock. Asian plums are not affected. Infected trees show a general decline and bear small, pale green leaves. The scion grows quicker than the rootstock, giving the rootstock a constricted appearance just below the graft union **(A)**. A distinct brown, sunken line at the union is apparent underneath the bark **(B)**.

Distribution

Widespread; the virus is endemic to North America.

Similar Diseases and Disorders

Any disease or disorder affecting the root system or rootstock/scion union can produce similar aboveground symptoms. Brown line can be distinguished from similar diseases by cutting away the bark and observing the darkening at the graft union.

Management

The resistant plum rootstock, Marianna 2624, can be substituted for Myrobalan. TmRSV can survive in a number of weed hosts, is seed-transmitted in dandelion, and is vectored by the dagger nematodes *Xiphinema americanum* Cobb and *X. rivesi* Dalmasso. Thus, good weed control and preplanting site preparation can help to reduce the incidence of this disease when Myrobalan rootstock must be used.

Crown gall

Agrobacterium tumefaciens (Smith and Townsend) Conn

Burr

Burr

Host

Apple, Apricot, Cherry, Nectarine, Peach, Pear, Plum

Symptoms

Infected trees are often stunted and produce small, chlorotic leaves. Spherical to elongated swellings (galls) along the roots or on the trunk just above the soil line are the primary symptom (A). Young galls are smooth and soft, and the bark tissue is often pale relative to the surrounding healthy tissue, but galls darken as they age. The galls may completely surround the root or crown or may appear as a growth off to one side (B). Galls start small and can grow to a typical 0.6 to 10 cm in diameter.

Distribution

Widespread; common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Any disease or disorder affecting the root system or rootstock/scion union can produce similar aboveground symptoms. The presence of galls distinguishes this disease from similar disorders.

Management

It is necessary to carefully inspect nursery trees for the disease before planting, as serious problems can often be attributed to the introduction of infected nursery material. In the orchard, natural infections can be avoided by minimizing wounds to the trunk along the soil line; natural infections, however, rarely result in serious losses. Infected trees should be removed. However, populations of bacteria do not diminish markedly during the first several months after their removal (and may actually persist for several years); therefore, replanting in the same site with a susceptible host should be avoided.

Peach tree short life (PTSL)

(Disease complex)

Bertrand

Bertrand

Host

Apricot, Nectarine, Peach, Plum

Symptoms

Trees in their third to sixth year show a sudden wilt and collapse of new blossoms and death of branches, with tree death following within weeks **(A)**. The bark appears reddish and water-soaked, and gum exuding from these tissues often has a "sour sap" odor. Cracking of the outer bark is common and extends into the xylem. The cambial tissue is discolored, but the discoloration does not extend below the soil line **(B)**. Few secondary or feeder roots are evident, but the primary roots generally appear healthy.

Distribution

Most important in the southeastern United States.

Similar Diseases and Disorders

PTSL may be confused with replant disorder (page 149) but can be differentiated by the rapid tree death caused by PTSL. The disease can be differentiated from crown and root rot caused by *Phytophthora* spp. by the absence of the characteristic discoloration of crown or root tissue associated with Phytophthora crown and root rot (page 147).

Management

Factors that contribute directly to PTSL are winter injury (associated with bark injury), bacterial canker caused by *Pseudomonas syringae* pv. *syringae* (associated with blossom and shoot death), and perennial canker (*Leucostoma* spp.). Other factors, such as the presence of ring nematodes (*Criconemella* spp.), budding onto susceptible rootstock (e.g., Nemaguard), pruning in late fall/early winter, planting trees in compacted soils or in soils with pH < 6.0 (which inhibits tree growth), predisposes trees to PTSL.

Phony peach disease

Xylella fastidiosa Wells et al.

Bertrand

Host

Peach

Symptoms

The canopy of infected trees is flattened and compacted due to shortening of the internodes; the foliage tends to be a darker green (A). Infected trees may also flower and set fruit earlier, bear smaller fruit, and suffer a substantial reduction in yield.

Distribution

Endemic to the southeastern United States. Occurs as far north as the Carolinas. Limited in distribution to where the sharpshooter leafhopper vectors, such as the glassy-winged sharpshooter, *Homalodisca coagulata* (Say); *Oncometopia nigricans* (Walker); and perhaps others, occur.

Similar Diseases and Disorders

The characteristic dwarfing and the fact that the tree is not killed outright helps to distinguish this disease from other diseases that cause a general decline.

Management

The disease is caused by a xylem-limited bacterium, whose geographical distribution appears to be limited to milder regions where the sharpshooter leafhopper vectors occur. Managing the insect vectors and removing infected trees (including hedgerow wild plum) to reduce the source of inoculum are the primary management practices.

Phytophthora root, crown, and collar rot

Phytophthora cactorum (Lebert & Cohn) J. Schröt.

Burr

Burr

Burr

Host

Apple, Apricot, Cherry, Nectarine, Peach, Pear, Plum

Symptoms

Collar rot affects bark tissue of the scion portion of the tree at or just below the soil line. Crown rot affects bark tissue of the rootstock portion of the tree. Infected trees often have a normal bloom, but developing fruits tend to be small, the leaves wilt and drop, and the tree shows a general decline and eventually dies **(A)**. Apple symptoms usually develop over several seasons, becoming progressively worse. Apple, cherry, peach, and apricot are more susceptible than pear and plum. *Phytophthora*-infected tissue often shows a clearly delineated reddish brown discoloration of the inner bark several inches below the soil line **(B, C)**.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Rootstock blight (caused by fire blight), "wet feet" (root asphyxiation), borers in burr knots, winter injury, and apple union necrosis (tomato ringspot virus) are often misdiagnosed as Phytophthora root and crown rot. The reddening and stark delineation of infected tissue is often diagnostic. Winter injury and rootstock blight are unlikely if the reddening is mostly below the soil line. *Phytophthora*-infected trees are likely to be in low-lying, historically wet areas or in heavy soils.

Management

The fungus requires standing water or saturated soils, so avoid sites that drain poorly, dry slowly, or flood periodically. Plant trees on berms or ridges. The use of resistant rootstocks is necessary on historically wet sites. Fungicides may also be used in early spring or in the fall.

Prunus stem pitting

Tomato Ringspot Virus [TmRSV]

NRAES–75

Burr

Host

Cherry, Peach

Symptoms

Affected trees appear weak and show a general decline (A). Leaves may have upward cupping, turn prematurely yellow or reddish purple, droop, and then prematurely drop. The bark is abnormally thick and spongy, and the wood underneath has a severely pitted, indented texture (B). Symptoms are most severe in the wood just above and below the soil line.

Distribution

Widespread; the virus is endemic to North America.

Similar Diseases and Disorders

Any disease or disorder affecting the root system or rootstock/scion union can produce similar aboveground symptoms. The presence of deep pits and grooves in the wood underneath the bark is characteristic of this disease.

Management

TmRSV can survive in a number of weed hosts, is seed-transmitted in dandelion, and is vectored by the dagger nematodes *Xiphinema americanum* Cobb and *X. rivesi* Dalmasso. Thus, good weed control and preplanting site preparation can help to reduce the incidence of this disease. Certified virus-free trees should be purchased.

Replant disorders

(Disease complex)

Merwin

Host

Apple, Cherry, Nectarine, Peach, Pear, Plum

Symptoms

Trees show slow and uneven growth within the first three years of planting **(A)**. Both specific (e.g., apple after apple) and nonspecific (e.g., stone fruit after vegetables) replant disorders are known. The disorder is characterized by reduced shoot growth, severe stunting, rosetted leaves, and reduced fruit production. Root systems are fibrous, poorly developed, and often decaying.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Organisms and pathogens associated with replant disease include fungi in the genus *Cylindrocarpon, Phytophthora cactorum* (Lebert & Cohn) J. Schröt., *Phytophthora* spp., *Pythium* spp., and *Rhizoctonia solani* Kühn; and nematodes including the lesion nematode [*Pratylenchus penetrans* (Cobb) Filipjev & Schuur.- Stek.], root-knot nematodes (*Meloidogyne* spp.), ring nematodes (*Criconemella* spp.), and sometimes dagger nematodes (*Xiphinema* spp.). The consensus is that replant is caused by a complex of organisms, and no truly diagnostic symptom exists.

Management

In replant sites, soils should be tested for known causal organisms and low pH, which is known to exacerbate the disease. Cultural strategies include planting new trees in the drive alley or digging holes the autumn before planting to expose the causal organisms to harsh conditions. Preplant soil fumigation, particularly with methyl bromide, metam sodium, or chloropicrin, is often effective in minimizing losses.

Root-lesion nematodes

Pratylenchus penetrans (Cobb) Filipjev & Schuurmans-Stekhoven

Merwin

Host

Apple, Apricot, Cherry, Nectarine, Peach, Pear, Plum

Symptoms

Root-lesion nematodes (A) are microscopic, migratory endoparasites that feed on the root systems of many crops. Affected trees appear stunted, may exhibit chlorosis or yellowing of the leaves, and have poor yields; young trees may be killed. Newly infected roots typically show a reddish brown, elongated lesion in the vicinity of invasion. Severely infected root systems lack fine-textured, fibrous roots or may have tufts of necrotic roots that resemble a witches' broom. The disease is common on light-textured soils.

Distribution

Widespread; common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Any disease or disorder affecting the root system or rootstock/scion union can produce similar aboveground symptoms. Positive diagnosis generally requires isolation of the nematodes.

Management

Avoid planting on sites with a history of root-lesion nematode or on light-textured soils; have soils tested before planting.

Silver leaf

Chondostereum purpureum (Pers.:Fr.) Pouzar

Burr

Turechek

Host

Apple, Apricot, Cherry, Nectarine, Peach, Pear, Plum

Symptoms

Silvering of the foliage is the characteristic symptom (A). At first, silvering may be associated with only one or two major branches, but eventually the entire tree becomes silvery in appearance. When infection is severe, the leaves may curl upward. On apple, symptoms are usually evident shortly after petal fall. The symptoms progress over several seasons, and trees slowly decline before dying. In some instances, affected limbs may recover and produce no symptoms in following years. The heartwood of affected trees is typically stained brown. In autumn, the fruiting bodies of the fungus (basidiocarps) appear on the surface of dead or severely infected limbs or the trunk (B).

Distribution

Widespread; the fungus affects many hosts.

Similar Diseases and Disorders

The silvering of the foliage is a unique symptom of this disease.

Management

Pruning cuts are susceptible to infection from spores released from basidiocarps during periods of rainy weather. The wounds are susceptible for about a week. Trees under stress are prone to attack; therefore, adequate drainage and fertilization help to reduce the incidence of disease. Infected trees should be rogued prior to the production of basidiocarps to reduce inoculum pressure. There are no practical chemical control measures to prevent infection.

Southern blight

Sclerotium rolfsii Sacc.

Sutton

Sutton

Sutton

Host

Apple, Apricot, Cherry, Nectarine, Peach, Plum

Symptoms

Trees attacked by the fungus show a general decline **(A)**. In the early phase of disease, a dense mat or web of white mycelium is evident at the base of the tree **(B)**. The mycelium eventually disappears and leaves behind masses of hardened, fungal bodies called sclerotia **(C)**. The sclerotia are globular, vary in size from 0.5–2.0 mm in diameter, and are at first white in color and turn tan to reddish or dark brown as they age.

Distribution

Mostly a problem from the Carolinas southward.

Similar Diseases and Disorders

Any disease or disorder affecting the root system or rootstock/scion union can produce similar aboveground symptoms. The presence of mycelium or sclerotia at the base of the tree can be used to distinguish this disease from similar disorders.

Management

The fungus is a natural and resilient inhabitant of many soils in the South. It is best to avoid establishing orchards in locations that have a history of the disease. Young trees are most susceptible to attack.

Verticillium wilt

Verticillium dahliae Kleb.

Burr

Burr

Burr

Host

Apricot, Cherry, Nectarine, Peach, Plum

Symptoms

Leaves are wilted or browned on one or several branches, often remaining attached (flagging); the rest of the tree appears healthy **(A)**. Young trees are often killed by infection. Older trees, except for sweet cherry, can recover from infection, often leafing out in the following year only to be affected again. Affected trees often have dark streaks in the sapwood of two- to three-year-old or older wood **(B, C)**. Symptoms become more severe with water stress in midsummer.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Any disease or disorder affecting the root system or rootstock/scion union can produce similar aboveground symptoms, but the presence of streaking in the sapwood can be used to distinguish Verticillium wilt from similar disorders.

Management

Sweet cherry is most susceptible, followed by apricot, peach, and nectarine; plums are least affected. Because the fungus is a natural resident of many soils, management is generally through the practice of avoidance; that is, plantings are established in soils where low or undetectable levels of the pathogen occur. Preplanting sites with various grasses or monocots for one or more years before orchard establishment helps to reduce the pathogen in soils where the pathogen was introduced.

Apple anthracnose

Pezicula malicorticis (H. Jacks.) Nannf

Grove

Host

Apple, Pear

Symptoms

Branch lesions first appear as small, circular spots that are purple or red when wet. As lesions enlarge, they become elliptical, sunken, and turn orange to brown. A distinct margin develops between healthy and diseased tissue, which eventually causes the bark to crack around the infected area **(A)**. The infected bark tissue over the canker separates into small pieces and curls upwards from the lesion. On older cankers, the bark sloughs off leaving only the bast fibers behind. These fibers run lengthwise across the lesion, and their appearance as such has often been referred to as "fiddle strings." Anthracnose cankers typically do not enlarge during their first year of growth.

Distribution

Apple anthracnose is uncommon in eastern North America, but it has been reported in Canada, MI, and some New England states.

Similar Diseases and Disorders

Can be confused with other cankers.

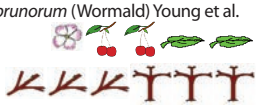
Management

While pesticide applications may reduce the spread of cankers, they are not effective at eradicating existing cankers. It is better to prevent new cankers by removing existing cankers as inoculum sources and following good horticultural practices to promote tree vigor, such as following a good fertility program and ensuring adequate water drainage.

Cankers (may be associated with wilting of branches)

Bacterial canker (Blossom blast)

Pseudomonas syringae pv. *syringae* van Hall
Pseudomonas syringae pv. *morsprunorum* (Wormald) Young et al.



Turechek

Sundin

Turechek

Turechek

Host

Apricot, Cherry, Nectarine, Peach, Plum

Symptoms

Leaf scars, stomata, and areas of injury are the principal sites of infection. The most conspicuous symptoms are limb and trunk cankers **(A, B)**, blossom blast **(C)**, "dead bud," and leaf spotting; these symptoms may or may not occur together. Cankers can girdle and kill entire limbs, reducing the tree's fruiting capacity. Infection of the trunk, particularly on young trees, often results in tree death. Crotches are particularly susceptible to infection, which often leads to extensive gumming **(D)**. Infections of the blossoms cause blossom blast and loss of fruiting spurs **(E, page 156)**. Infections of dormant flowering and vegetative buds result in a condition called "dead bud" in which buds fail to break dormancy in spring. On leaves, lesions are tan to brown and initially surrounded by a yellow halo. Lesions may be small, or they may coalesce to form large areas of infection. They are eventually walled off, and the center of the lesion drops out to give the leaf a shotholed appearance **(F, page 156)**. On fruit, lesions tend to be circular, brown, and sunken **(G, page 156)**.

Distribution

Bacterial canker is common to all fruit-growing regions in eastern North America. The disease is most common on sweet cherry and apricot.

Similar Diseases and Disorders

Blossom blast can be confused with blossom blight, caused by *Monilinia fructicola* (G. Wint.) Honey (page 198); fungal sporulation (although not always present or evident) helps to differentiate brown rot from bacterial canker. X-disease (page 190) can cause a dieback in older cherry trees that might be confused with bacterial can-

(continued on next page)

Bacterial canker (continued)

Sundin

Burr

Turechek

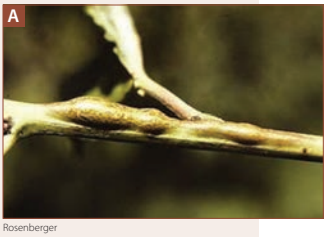
ker. Branch or trunk cankers may be confused with perennial canker (page 159); however, perennial cankers form alternating callus rings, whereas cankers caused by *Pseudomonas* do not.

Management

Although most serious on sweet cherry and apricot, the disease also affects tart cherry, peach, and plum. Orchards should not be established on poor sites such as those on acidic or sandy soils, in areas prone to flooding or drying, or in the vicinity of wild *Prunus* spp., which can harbor the disease. Stone fruit are most susceptible to infection in late autumn and early spring. Copper bactericides can be used to manage the disease, although they are generally considered ineffective. Cankers should be pruned from trees when feasible. Infection of pruning cuts can be minimized by pruning trees during the summer rather than in spring, when the bacteria are active. Tree training methods that cause bark injury should be avoided (e.g., limb spreaders), especially on sweet cherries and apricots.

Black knot

Apiosporina morbosa (Schwein.:Fr.) Arx



Rosenberger

Turechek

Turechek

Host

Cherry, Plum

Symptoms

Black knot usually develops over two seasons. The disease first appears in late summer or autumn as an olive green swelling on new shoots **(A)**. The disease develops rapidly the following summer, forming a characteristic dark, course-textured warty knot **(B, C)**. Knots vary from 2.5 cm to nearly 30 cm in length and may or may not encircle the branch. The vascular tissue becomes restricted in infected branches, ultimately leading to the death of the branch.

Distribution

Widespread; the disease is very damaging on many varieties of plum, less so on sour cherry.

Similar Diseases and Disorders

Black knot is often unmistakable.

Management

Black knots should be pruned from infected trees and removed from the orchard during the dormant season. Wild plum, prune, and cherry seedlings should be removed from fencerows, woodlots, and the orchard perimeter, as they serve as a source of the disease. Fungicides should be applied to protect trees between white bud and petal fall growth stages, but treatment is likely to be ineffective if pruning and sanitation are not practiced.

Nectria canker

Nectria galligena Bres. in Strass.

Burr

Jones

Host

Apple, Pear

Symptoms

Cankers are frequently associated with nodes, often appearing as elliptical sunken areas **(A)**. Sometimes callus production stops fungal invasion, and cankers die by season's end. Other times, the fungus, walled off by callus formation during the current growing season, reinvades callus tissue when active growth resumes the following season, giving older cankers a zonate or target-like appearance **(B)**. Enlarging cankers girdle infected twigs and branches, killing tissue above cankers. During damp weather, gelatinous white to cream-colored sporodochia produce spore masses that ooze from cankers; bright red to orange fruiting bodies (perithecia) may appear on older cankers (similar to Nectria twig blight, page 165).

Distribution

Common to the northeastern United States and southeastern Canada and westward, but problems usually persist only in maritime climates or where infected nursery stock was planted.

Similar Diseases and Disorders

Nectria can be confused with other cankers, but the appearance of the colorful sporodochia helps to distinguish this disease from similar cankers.

Management

The disease is common in cold pockets and on poorly drained soils. Where it occurs at relatively high elevations, it is most common on exposed slopes with shallow or infertile soils. While pesticide applications reduce the spread of cankers, they are not usually effective at eradicating existing cankers. It is better to prevent canker establishment by removing existing cankers and following good horticultural practices, such as maintaining a good fertility program.

Cankers (may be associated with wilting of branches)

Perennial canker of stone fruit

Leucostoma cincta (Fr.:Fr.) Höhn.
Leucostoma persoonii Höhn.

Turechek

Turechek

Wilcox

Host

Apricot, Cherry, Nectarine, Peach, Plum

Symptoms

Small twig infections are usually found around winter-killed buds, leaf scars, and picking and pruning injuries. They appear as sunken discolored areas with alternating zonation lines and may ooze amber gum. On infected branches, leaves often turn yellow, wilt, and die **(A)**. Dead twigs, branches, and canker margins become covered with pinhead-sized black pimples (pycnidia) that break through the bark **(B)** and exude flesh- to orange-colored tendrils of spores under wet conditions. Main trunk and branch infections usually start at pruning wounds or winter-killed tissue. Cankers are elliptical, exude lots of amber-colored gum, and often develop a series of concentric callus rings, reflecting the yearly alternation of callus formation and tissue invasion **(C)**.

Distribution

Widespread, but most damaging in cooler climates such as the northeastern United States and Canada.

Similar Diseases and Disorders

Perennial canker can be confused with bacterial canker (page 155) (particularly on sweet cherry) or constriction canker (page 164). Perennial canker is also known as Cytospora or Valsa canker.

Management

No fungicides are registered specifically for *Leucostoma*; those applied for peach leaf curl and brown rot control give only minimal control. Pruning out cankers removes the source of disease for new cankers, and eliminating wild hosts around the orchard periphery reduces disease pressure. Training young trees to produce scaffold limbs with wide crotch angles is essential for avoiding infections that weaken crotches in older trees.

Perennial canker of apple and pear

Pezicula perennans (Kienholz) Nannf.

Grove

Host

Apple, Pear

Symptoms

Branch lesions are elliptical, sunken, and orange, purple, or brown in color. A raised layer of callus tissue forms around the infected tissue to isolate the diseased tissue. This occurs year after year as the fungus continues to invade healthy tissue, resulting in a series of concentric callus rings (A). Acervuli are produced in the most recently colonized tissue and appear as small, raised black bodies. The woolly apple aphid (*Eriosoma lanigerum*, page 44) can be found invading these cankers in regions where they both exist.

Distribution

Uncommon in eastern North America, but it has been reported in Canada, Michigan, and some New England states.

Similar Diseases and Disorders

Perennial canker can be confused with other cankers such as those associated with white rot (page 207) and black rot (page 194). The presence of callus rings, associated with older cankers, helps to differentiate perennial canker from white and black rot cankers.

Management

While pesticide applications reduce the spread of cankers and their associated diseases, they are not effective at eradicating existing cankers. It is better to prevent canker establishment by removing existing cankers and following good horticultural practices.

Bacterial blossom blast of pear

Pseudomonas syringae pv. *syringae* van Hall

Rosenberger

Rosenberger

Host

Pear

Symptoms

The most common symptoms are wilting followed by browning or blackening of blossoms that often spreads through the entire blossom truss and kills the fruiting spur **(A, B)**. If infection is restricted to the calyx-cup and the blossom is not killed, this may lead to the development of black lesions on developing fruit; many of these fruit drop. Infection of the leaves leads to the development of small lesions and shotholes; entire leaves may be killed.

Distribution

Common to all fruit-growing regions in eastern North America; most common in cool and wet climates.

Similar Diseases and Disorders

Blossom blast can be confused with fire blight (page 162). However, fire blight infections often lead to extensive damage of shoots and limbs and will often be found in neighboring apple orchards; *P. syringae* pv. *syringae* does not affect apple.

Management

Blossom blast is a problem when cool and wet weather prevail during bloom, especially when blossoms are injured by a light frost. The disease is difficult to manage. The application of copper-based bactericides is the only practical control option. Streptomycin applied to control fire blight may reduce disease severity.

Fire blight

Erwinia amylovora (Burrill) Winslow et al.

Turechek

Turechek

Turechek

NRAES–75

Host

Apple, Pear

Symptoms

Blossom blight occurs in the spring. Infected blossoms first exhibit a water-soaked appearance, followed by their wilting and eventually turning brown on apple and nearly black on pear **(A)**. Individual flowers or the entire cluster may be affected. Typically, infected blossoms do not fall and bacteria progress into the tender shoot growth. In the shoot, the bacteria travel along the midvein of the leaves, and they soon wilt, shrivel, and turn brownish black, killing the entire shoot. Bacterial ooze may be observed under warm and humid conditions **(B)**. Flowers will cling to the infected stem and often remain attached throughout the season. Infected fruit appear black and shriveled and usually remain attached to the tree.

Shoot blight develops in late spring or early summer on actively growing terminal shoots, including suckers and water sprouts. Infected shoots first have an oily appearance and turn a dark green. On apple, the infected shoot becomes light to dark brown, in contrast to pear, in which the shoot becomes black. Blighted shoots often form a characteristic "shepherd's crook" at their tip, and the dead leaves remain clinging to the affected twigs **(C)**. The disease can progress to whole limbs and, when infection is severe, the whole tree appears to be scorched by fire, hence the name fire blight.

Rootstock blight is the result of infections that travel from infected blossoms or shoots into the rootstock, although direct infection of the rootstock through sucker growth is possible. Infected rootstocks are discolored, and there is usually a sharp demarcation between infected rootstock tissue and scion tissue when the bark is peeled back **(D)**. Under favorable conditions, the bacteria may ooze from the rootstock, leaving streaks down the rootstock.

Symptoms on blossoms and/or wilting new shoots

Fire blight (continued)

Turechek

Distribution

Occurs throughout the United States and Canada but is most problematic in warmer production regions, such as the Mid-Atlantic states.

Similar Diseases and Disorders

Blossom and shoot blights can be confused with Nectria twig blight (page 165), but they can be differentiated by noting that fire blight infections progress from infected blossom clusters or the tips of shoots downwards. *Nectria* infections, however, progress from the base of shoots upwards. Rootstock blight can be confused with Phytophthora crown rot (page 147), but rootstocks infected with *Erwinia* do not exhibit the reddening that is characteristic of *Phytophthora*-infected tissue, particularly below the soil line.

Management

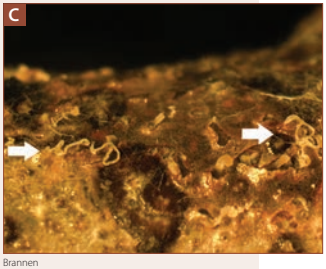
Managing blossom blight is achieved through well-timed bactericide sprays, usually streptomycin, during bloom. After bloom, management focuses on minimizing shoot blight and the development of cankers that overwinter and serve as next year's inoculum source. It is important to prune out infected limbs as soon as symptoms are detected and before extensive necrosis develops **(E)**. Pruning cuts should be made at least 30 cm below symptoms. Rootstock blight is best managed through the use of fire blight–resistant rootstock. Several of the newer dwarfing rootstocks have been selected for fire blight resistance.

Fusicoccum canker (Constriction canker)

Phomopsis amygdali (Delacr.) Tuset & Portilla

Lalancette

Lalancette



Brannen

Host

Peach

Symptoms

On new shoots, small, reddish brown to dark, oval cankers centered on infected buds or leaf scars, or at the base of the current season's twigs, are found in early spring **(A, B)**. As lesions enlarge, they develop a necrotic center surrounded by a purplish halo and eventually girdle and kill the branch above the lesion, giving it a blighted appearance. Lesions may be dotted with very tiny black fruiting bodies (pycnidia). Tendrils of conidia are exuded from pycnidia under favorable conditions and can be seen with a hand lens **(C)**. On leaves, large, irregularly shaped brown spots are formed.

Distribution

Common to all fruit-growing regions in eastern North America; most problematic in warm and humid production regions.

Similar Diseases and Disorders

The appearance of blighted shoots can be confused with blossom blight (page 198) caused by *Monilinia fructicola* (G. Wint.) Honey; look for the cankers as a means of differentiating the two.

Management

Pruning and destroying infected branches reduces disease pressure. Fungicides applied prior to infection reduces incidence of the disease.

Nectria twig blight

Nectria cinnabarina (Tode:Fr.) Fr.

Wilcox

Wilcox

Burr

Host

Apple, Pear

Symptoms

Typically, small cankers can be found girdling the base of cluster buds that bore fruit the previous year. This leads to the wilting and dying of leaves and twigs on the current season's growth **(A)**. Bright pink to orange fruiting bodies appear at the nodes **(B)** or on developed cankers or pruning stubs during wet weather in early summer **(C)**.

Distribution

Occurs from the eastern United States and Canada, west to Michigan.

Similar Diseases and Disorders

The blighting of shoots may resemble fire blight infections (page 162), but infected shoots do not have blighted blossoms attached, and they wilt from the base of the canker upwards rather than from the tip downwards.

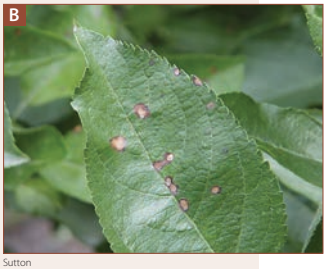
Management

Infections are almost always associated with "pulled stems" left when harvesters remove apples but leave stems in the trees. Disease incidence is greatest in years when wet harvest weather is followed by winter weather that causes cold injury. The pathogen typically attacks varieties with large cluster-bud bases such as Ben Davis, Northern Spy, Rome Beauty, and Twenty Ounce.

Alternaria blotch

Alternaria mali Roberts

Sutton



Sutton

Sutton

NRAES–75

Host

Apple

Symptoms

The disease primarily affects the foliage, causing circular, necrotic lesions with a light brown interior (A) that later become surrounded by a darker purplish halo (B). Defoliation can occur by late summer on susceptible varieties that are heavily infected (C). The pathogen can also attack green, woody tissue, but it rarely attacks the fruit.

Distribution

An increasing problem in eastern North America, but it has yet to be found north of Virginia.

Similar Diseases and Disorders

This disease can be confused with frogeye leaf spot (page 194) and with leaf spotting caused by numerous other pathogens, including cedar apple rust on rust-resistant varieties. Injury from azoxystrobin fungicide (Abound) may also appear similar, but injury from azoxystrobin is most severe on McIntosh, Cortland, Empire, and Gala, whereas Delicious leaves are not affected by azoxystrobin. Similarly, injury from the fungicide captan may produce similar symptoms (D). Alternaria blotch may sometimes be confused with magnesium deficiency. Isolation of the pathogen is usually needed to confirm diagnosis.

Management

The disease occurs primarily on the variety Delicious. Management requires an integrated approach. Shredding leaf litter in the fall helps to reduce disease pressure the following season (this will also help at reducing apple scab). Controlling red mite populations is essential to achieving control of Alternaria blotch. The strobilurin fungicides are the most effective at controlling Alternaria blotch.

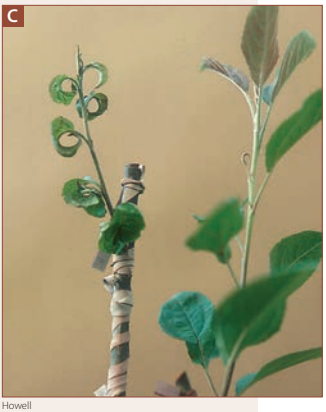
Symptoms on leaves only

Apple latent viruses

Apple chlorotic leaf spot virus [ACLSV]
Apple stem grooving virus [ASGV]
Apple stem pitting virus [ASPV]

Howell

Howell



Howell

Host

Apple

Symptoms

Latent viruses survive in their host without causing symptoms. They are transmitted when a virus-infected scion is grafted onto a susceptible rootstock. There are a number of latent viruses that affect apple, but these three are the most common. They may occur together, in pairs, or singly. Affected trees begin to show a general decline one to two years after grafting. Familiar symptoms associated with the specific viruses are ACLSV, chlorotic leaf spots, leaf distortion, or leaf stunting **(A)**; ASGV, chlorotic leaf spots, stem grooving and pitting, union necrosis, and swelling above the graft union **(B)**; and ASPV, pitting and grooving, epinasty, and decline **(C)**.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Depending upon the virus or viruses infecting the host, symptoms can be confused with apple union necrosis and decline (TmRSV) (page 141), various nutritional deficiencies, and any disease or disorder that results in general tree decline.

Management

No natural vectors are known for any of the three viruses; infected trees can grow adjacent to healthy trees for years. These viruses are expressed only when an infected scion has been grafted onto a susceptible rootstock. The Geneva series rootstocks, in particular G.16, G.30, and G.65, are susceptible to one or more of the latent viruses, thus virus-free scions must be used with these rootstocks. Most other rootstocks, including the Malling (M) series and the Malling-Merton (MM) series of rootstocks, are tolerant.

Symptoms on leaves only

Apple mosaic virus

Apple Mosaic Virus [ApMV]

Wilcox

Host

Apple

Symptoms

Young leaves develop pale to bright cream-colored spots, blotches, bandings, or patterns as they expand in the spring **(A)**. These turn brown and become necrotic as they age, and premature defoliation may occur when infection is severe. Symptom expression is highly variable among varieties.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

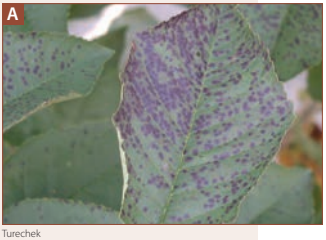
None

Management

The virus is exclusively mechanically transmitted; i.e., there are no known insect vectors. Therefore, apple mosaic virus can be avoided by planting trees that are certified virus-free. Transmission can occur in the orchard through root grafts; roguing infected trees will limit the spread. Almost all varieties are susceptible to the virus, but some express symptoms more readily than others. Golden Delicious, Granny Smith, and Jonathan are very susceptible; McIntosh is moderately susceptible. Infected trees may still produce a good crop.

Cherry leaf spot

Blumeriella jaapii (Rehm) Arx


A

Turechek


B

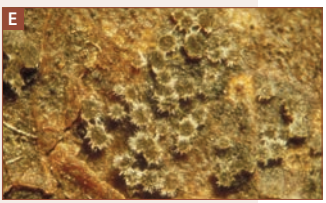
Turechek


C

Sundin


D

Turechek


E

Courtesy Alan Jones. Reprinted with permission from *Compendium of Stone Fruit Diseases,* 1995, American Phytopathological Society, St. Paul, MN, USA.

Host

Cherry, Plum

Symptoms

Lesions begin as small, circular, red to purplish spots on the upper leaf surface **(A)**. Spots enlarge as they grow older, typically coalescing and turning brown **(B)**. Lesion centers may eventually drop out to give the leaf a shotholed appearance, particularly on plum. The most striking symptom of cherry leaf spot, especially on sour cherry, is the yellowing of older leaves prior to their falling from the tree **(C)**. When infection is severe, the entire tree may be defoliated by midsummer. Spores are produced on the underside of leaf lesions in acervuli and appear as a white to pinkish mass in the center of the lesion **(D)**.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

The striking discoloration of the foliage along with the production of acervuli on the undersides of leaves helps to distinguish this disease from other foliar diseases, such as bacterial canker (page 155).

Management

The disease is managed through the application of fungicides from petal fall and continuing through midsummer. Removal or destruction of fallen leaves will reduce leaf spot pressure the following season, because the first infections each spring are caused by inconspicuous apothecia that develop on dead leaves on the ground **(E)**. Sour cherry is most susceptible to the disease; sweet cherry and European plum are affected but less so than sour cherry.

Symptoms on leaves only

Mycosphaerella leaf spot

Mycosphaerella pyri (Auersw.) Boerema

Courtesy Turner Sutton. Printed with permission from *Compendium of Apple and Pear Diseases*, 1990, American Phytopathological Society, St. Paul, MN, USA.

Host

Pear

Symptoms

Lesions are primarily circular, 3–5 mm in diameter, and have a grayish white interior with a distinct purple margin. Small, black pycnidia develop in the interior of older lesions **(A)**. The fungus occasionally attacks the fruit, producing small, dark lesions.

Distribution

Widespread, although of minor economic importance in sprayed commercial orchards.

Similar Diseases and Disorders

The disease can be confused with Fabraea leaf spot (page 179); Fabraea lesions tend to be darker.

Management

Fungicide programs targeting Fabraea leaf spot will effectively control Mycosphaerella leaf spot.

Necrotic leaf blotch

Physiological disorder

Turechek

Turechek

NRAES–75

Host

Apple

Symptoms

Medium to large, irregular necrotic lesions occur on the foliage of mature leaves during mid- to late summer. The remaining green tissue generally turns yellow shortly after the appearance of symptoms **(A, B)**. The onset of symptoms is often sudden and occurs in two to four waves during the summer. Defoliation rapidly follows the onset of symptoms and may affect fruit quality if it is extensive.

Distribution

This is a physiological disorder affecting only Golden Delicious and its bud sports.

Similar Diseases and Disorders

This disorder can be confused with magnesium deficiency **(C)**.

Management

Necrotic leaf blotch is caused by the rapid synthesis of gibberellins triggered by environmental factors. Treating trees with zinc-containing fungicides (e.g., Ziram) or foliar sprays containing zinc nutrients can decrease the severity of necrotic leaf blotch. Zinc oxide applied every two weeks from budbreak to harvest can diminish symptoms.

Pear vein yellows

Apple Stem Pitting Virus [ASPV]

Howell

Host

Pear

Symptoms

Faint yellow vein banding, particularly of the secondary veins on the current year's growth, is the most common symptom. Red mottling or the development of necrotic spots of various intensities may also accompany vein-banding symptoms **(A)**; the specific symptoms are dependent upon the particular strain of the virus.

Distribution

Common to all fruit-growing regions in eastern North America; it is the most common virus disease of pear.

Similar Diseases and Disorders

None

Management

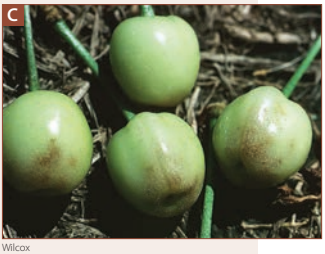
The disease is almost exclusively managed in the nursery through the use of disease-free propagating material. In the orchard, trees displaying symptoms one year may not show symptoms in subsequent years.

Prunus necrotic ringspot

Prunus Necrotic Ringspot Virus [PNRSV]

Jones

Burr



Wilcox

Host

Cherry, Peach, Plum

Symptoms

Individual branches or the entire tree shows delayed budbreak or foliation; stunted, wavy leaves; and shortened blossom pedicels in spring. Leaves develop chlorotic spots, lines, or rings as they emerge (A). In severe cases, chlorotic areas become necrotic and fall out, leaving the leaves shotholed or tattered (B). Fruit maturity may be delayed, and fruit may be marked (C). In other cases, trees may develop symptoms as described one year ("shock" symptoms) and then remain symptomless in subsequent years.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Any disease or disorder that causes shothole symptoms, such as bacterial spot, bacterial canker, and sour cherry yellows may be confused with PNRSV infection. Generally, identification of the pathogen is needed to confirm diagnosis.

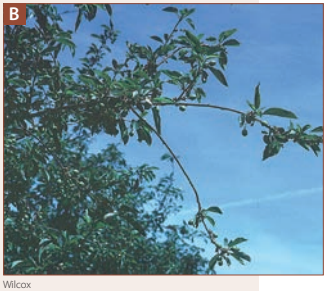
Management

PNRSV can be transmitted to healthy trees during pollination by bees or during propagation. PNRSV is managed through nursery-based virus-certification programs and, in the orchard, by roguing affected trees.

Sour cherry yellows

Prune Dwarf Virus [PDV]

Burr



Wilcox

Host

Cherry, Plum

Symptoms

Young leaves develop chlorotic yellow rings or mottle; shothole may occur in severe cases or as lesions age. These symptoms rarely recur after the first year of infection. In subsequent years, leaves develop a distinct, irregular, green to yellow mottling and interveinal chlorosis, then drop three to four weeks after petal fall **(A)**. Successive waves of mottling and dropping occur in response to day/night temperature fluctuations. Older trees show a willowy type of growth or bare wood from a reduction of fruiting spurs **(B)**. Fruit are sparse but large. Similar symptoms occur on sweet cherry. Infected plum develops narrow, strap-like leaves that are thicker than normal.

Distribution

The pathogen is widely distributed in the United States.

Similar Diseases and Disorders

Sour cherry yellows may be confused with green ring mottle (page 180) but can be differentiated by noting the absence of green blotches. However, the two viruses may be found infecting the same tree; thus, symptoms of both diseases may be evident.

Management

PDV is carried on or in pollen grains and can infect seeds. The virus can be transmitted to healthy trees during pollination by bees or during propagation. PDV is managed through nursery-based virus-certification programs and, in the orchard, by roguing affected trees.

Apple scab

Venturia inaequalis (Cooke) G. Wint.

Turechek

Turechek

Turechek

Turechek

Host

Apple

Symptoms

On leaves, young lesions are velvety brown to olive green with indistinct margins and will often not be readily noticeable until after petal fall in commercial orchards **(A)**. The number of lesions can vary from a few to several hundred per leaf, depending on the season and varietal susceptibility. Older leaf lesions are typically raised, with a corresponding cupping on the underside of the leaf, and dark green to gray to brown in color with distinct margins **(B, C)**. Leaves that are heavily infected tend to curl, shrivel, and fall from the tree.

On the fruit, young lesions appear similar to those on leaves **(D)**. Although the entire surface of the fruit is susceptible to infection, lesions often cluster around the calyx end of the fruit. As lesions get older, they become brown and corky and take on a "scabby" appearance **(E, page 176)**.

Distribution

Common to all fruit-growing regions in eastern North America. Often less severe and easier to control in arid or warmer climates and in dry years.

Similar Diseases and Disorders

Apple scab is one of the common diseases of apple and is usually easily distinguishable from other diseases. However, older, exhausted lesions in late summer and fall, particularly those in sprayed orchards, may be confused with any number of maladies due to the absence of visible, olive green sporulation.

Management

Apple scab overwinters in leaf litter as small black

(continued on next page)

Apple scab (continued)

Turechek

fruiting structures called pseudothecia. Ascospores, the primary inocula, form in the spring and are discharged in response to wetting events. Ascospores can be released as early as green tip, but peak ascospore release generally coincides with bloom.

Apple scab is managed primarily through the application of fungicides from green tip through midsummer. The destruction of leaf litter in the fall by flail mowing or through the application of chemicals that hasten leaf litter degrading, such as urea, helps reduce primary inoculum.

The severity of infection depends on a variety's inherent resistance. Cortland, McIntosh, Paula Red, and Crispin are extremely susceptible; Delicious, Empire, Gala, Golden Delicious, Ida Red, and Spartan are moderately susceptible. Resistant varieties include Goldrush, Enterprise, Florina, Liberty, Jonafree, Macfree, Novamac, Nova Easygro, Prima, Priscilla, Sundance, Scarlet O'Hara, and William's Pride.

Bacterial spot

Xanthomonas arboricola pv. *pruni* (Smith) Vauterin et al.

Turechek

Kennelly

Turechek

Host

Apricot, Nectarine, Peach, Plum

Symptoms

On leaves, lesions are small and tan to brown in color, eventually become necrotic, and usually are surrounded by a yellow halo. There are often numerous lesions on a leaf, and they tend to be restricted to areas between veins, which gives them an angular appearance. Lesions are eventually walled off, and the center of the lesion drops out, giving the leaf a tattered or shotholed appearance (A). Severe foliar infections results in the yellowing of leaves and premature leaf drop. Bacteria from leaf infections move to the current year's twig growth, leading to canker formation. On fruit, the bacteria cause dark brown lesions or blemishes. Lesions often become sunken, and the skin of the fruit cracks, causing deep pits that leave the fruit unmarketable (B, C).

Distribution

Most common in warm and wet climates; tends to be a greater problem in orchards with a history of disease. It is one of the most serious diseases in southeastern U.S. peach production.

Similar Diseases and Disorders

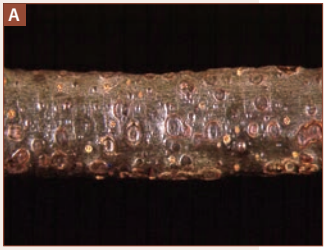
Captan spray injury is similar, especially on some plum varieties.

Management

Primary fruit and leaf infections occur during rainy weather from bloom to one month after shuck split. During this period, regular applications of a bactericide are needed when disease pressure is high or when highly susceptible varieties are grown. The most effective way to manage bacterial spot is to avoid planting susceptible varieties such as Babygold 5 and Autumn Lady.

Black pox of apple (Blister canker of pear)

Helminthosporium papulosum Berg.



Courtesy Turner Sutton. Printed with permission from *Compendium of Apple and Pear Diseases*, 1990, American Phytopathological Society, St. Paul, MN, USA.

NRAES–75

Sutton

Host

Apple, Pear

Symptoms

On apple, conical, smooth, shiny, black swellings are evident on the current season's growth. As lesions age, they become ovoid with raised borders **(A)**. On leaves, lesions begin as small, circular, green spots surrounded by a red halo. Lesions expand to 1.5–6 mm in diameter, and the centers of the lesions turn brown. On apple fruit, lesions are approximately 3–9 mm in diameter and appear shiny, round, black, and sunken **(B)**. On pear branches, fully developed lesions are generally circular, and the interior of the lesion cracks, exposing the darkened wood beneath the bark **(C)**.

Distribution

Most common from the southern edge of the Mid-Atlantic region southward, but has been reported as a problem as far north as NJ.

Similar Diseases and Disorders

Infection of the twigs can be confused with the disorder internal bark necrosis (or measles). This disorder, however, is primarily a problem on Delicious and its sports.

Management

The disease is typically controlled with fungicides that target control of apple scab and summer diseases.

Fabraea leaf spot

Diplocarpon mespili (Sorauer) Sutton

NRAES–75

Rosenberger

Rosenberger

Host

Pear

Symptoms

Lesions on leaves and petioles start as small, circular, purple to black pinpoint spots (**A, B**). They enlarge quickly to a diameter of about 10 mm, develop a dark brown to black interior, and may coalesce to form larger areas of infection. On fruit, lesions have a similar appearance to those on leaves but tend to be larger and cause the fruit to crack (**C**). Heavily infected leaves and fruit drop prematurely.

Distribution

Common to all fruit-growing regions in eastern North America; most problematic in warm and humid production regions.

Similar Diseases and Disorders

Mycosphaerella leaf spot (page 170) is similar, but the interior tissue of lesions caused by *Mycosphaerella* is much lighter than those caused by *Diplocarpon*.

Management

Removal or destruction of leaf litter can reduce early-season disease pressure. Regular applications of fungicides from white bud through late summer may be necessary to prevent disease in orchards that were severely diseased in previous years. Primary infections usually occur during the six weeks after petal fall. Bosc and Seckel pears are more susceptible than Bartlett.

Green ring mottle virus

(Green Ring Mottle Virus)

Jones

Jones

Host

Cherry

Symptoms

The virus produces symptoms on sour cherry, primarily the variety Montmorency. Apricot, peach, and sweet cherry are symptomless hosts. Yellow mottling with irregularly shaped green islands or rings appear on the leaves of infected trees **(A)**. A less common symptom is yellowing of the lateral veins, usually accompanied by a tip distortion **(B)**. Fruit are misshapen with corky brown, discolored pits, streaks, or rings in the epidermis that extend into the flesh of the fruit. Infected fruit are bitter.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

May be confused with sour cherry yellows (page 174) but can be differentiated by noting the presence of green blotches. The two viruses, however, may be found infecting the same tree, thus symptoms of both diseases may be evident.

Management

No insect vector has been identified, but the disease appears to spread slowly in the orchard to neighboring trees, suggesting the role of root grafts. Infected trees should be removed. Management hinges on planting virus-certified trees.

Peach leaf curl

Taphrina deformans (Berk.) Tul.

Burr

Turechek

NRAES–75

Host

Nectarine, Peach

Symptoms

The pathogen infects young undeveloped tissue of leaves and fruit. Infection is most severe when cool conditions prevent rapid development of the foliage. Infected leaves curl and blister, leaving them severely deformed **(A)**. Blisters may become discolored, ranging from light green to purplish **(B)**. Severely infected leaves eventually shrivel and fall to the ground. Infected fruit either drop prematurely or remain on the tree and develop blisters or wart-like deformities on their surfaces **(C)**.

Distribution

Tends to be sporadic in managed orchards in eastern North America.

Similar Diseases and Disorders

Aphid damage can be confused with peach leaf curl, although aphid damage is not common until later in the season, and evidence of their feeding can be found on the undersides of the leaves.

Management

Spores become lodged under bud scales in autumn, overwinter, and then initiate primary infection in the spring. This disease is easily controlled with one well-timed fungicide application either in autumn when 90% of the leaves have fallen or in spring just before bud swell.

Pear scab

Venturia pirina Aderh.

Turechek

Turechek

Courtesy Turner Sutton. Printed with permission from *Compendium of Apple and Pear Diseases*, 1990, American Phytopathological Society, St. Paul, MN, USA.

Courtesy Turner Sutton. Printed with permission from *Compendium of Apple and Pear Diseases*, 1990, American Phytopathological Society, St. Paul, MN, USA.

Host

Pear

Symptoms

Lesions on leaves begin as pinpoint spots, enlarging and becoming velvety brown to olive green with indistinct margins (A). Older lesions may remain singular or coalesce with other leaf lesions; they eventually stop expanding and develop distinct margins. On fruit, young lesions appear similar to those on leaves and can be found starting one month after fruit set (B). Although the entire surface of the fruit is susceptible to infection, lesions often cluster around the calyx end of the fruit. Infected fruit tend to be misshapen and eventually have dark brown to black spots or patches where fruit are infected (C). New lesions on developing shoots appear similar to leaf and fruit lesions. Eventually, the lesions become corky in appearance; they will overwinter and produce conidia the following season (D).

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

None

Management

Pear scab is typically not as destructive as apple scab. In seasons that favor the development of pear scab, fungicides applied from green tip through early summer are used to manage the disease.

Plum pockets

Taphrina communis (Sadebeck) Giesenh.

Courtesy Alan Jones. Reprinted with permission from *Compendium of Stone Fruit Diseases,* 1995, American Phytopathological Society, St. Paul, MN, USA.

Jones

Host

Plum

Symptoms

Infections occur soon after blossoms open and are first evident on fruits when they reach 6–12 mm in diameter. Symptoms first appear as white to off-white spots or blisters that enlarge rapidly to cover the entire fruit. Infected fruit are distorted, spongy, and abnormally large **(A)**. The tissues of the seed cavity wither and die, forming a pocket within the fruit **(B)**. As the fruit dry, they turn velvety gray as a result of spore production on their surfaces and eventually turn brown, wither, and fall from the tree. Diseased leaves are thickened and curled, similar to peach leaf curl. Symptoms on leaves may or may not coincide with fruit symptoms.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

None

Management

This disease is easily controlled with one well-timed fungicide application that is most effective when applied either in autumn after 90% of the leaves have fallen or in spring just before bud swell.

Plum pox virus

Plum Pox Virus (PPV-D)

Scorza

Scorza

Scorza

Scorza

Scorza

Host

Apricot, Nectarine, Peach, Plum

Symptoms

Symptoms vary considerably, depending on the species, variety, age, and nutritional status of the tree. Leaf symptoms may include vein yellowing, banding, or the formation of light green to yellow rings **(A)**. Peach and apricot fruit may develop light yellow rings on the skin or pits, become misshapen, or develop necrotic lesions **(B, C, D)**. Plums are the most severely affected. Fruit develop distinct dark rings or spots on the skin, the flesh shows red discoloration, and fruit may drop prematurely **(E)**. Affected fruit tend to be tasteless due to lowered sugar content, and the flesh may be dry.

Distribution

Worldwide. Plum pox virus strain D (PPV-D) first appeared in the United States in PA in October 1999; in the Niagara Peninsula, ON, in June 2000; and in certain regions of NS shortly thereafter. A quarantine zone was established around the original site in PA, but the virus continues to occur within the zone and was discovered in Niagara County, NY, in July 2006 and in a plum tree sample from southwestern MI in August 2006. Discovery of the disease outside of the zone indicates that stone fruit plantings throughout the United States are in jeopardy; routine scouting and testing should continue diligently.

Similar Diseases and Disorders

None

Management

Accidentally introduced into North America in the 1990s, the disease is currently regulated by federally imposed quarantines in the United States and Canada. Quarantines mandate the certification of nursery stock, removal and destruction of infected trees or orchard blocks, and strict management of aphid vectors.

Symptoms on leaves and possibly fruit

Powdery mildew of apple and pear

Podosphaera leucotricha (Ellis & Everh.) E. S. Salmon

Turechek

Burr

NRAES–75

Host

Apple, Pear

Symptoms

The fungus overwinters in leaf buds and sometimes flower buds. The mycelium develops rapidly on unfolding leaves and appears as white, felt-like patches or as a solid mat on the upper or undersurface of the leaf **(A)**. Infections on the underside of the leaf may cause chlorotic patches or spots to occur on the upper side of the leaf. Infected leaves tend to crinkle, curl, or roll upwards along the edges, giving them a narrow appearance. The blossoms, petals, sepals, receptacles, and peduncles may become infected and covered with the fungus. Blossom infections are less common but are important, because infected blossoms will either fail to set fruit **(B)** or produce small, stunted or russetted fruit **(C)**.

Distribution

Occurs almost everywhere apples are grown; particularly problematic in arid climates.

Similar Diseases and Disorders

High populations of apple rust mite (page 111) can cause white spots on leaves that may be confused with powdery mildew.

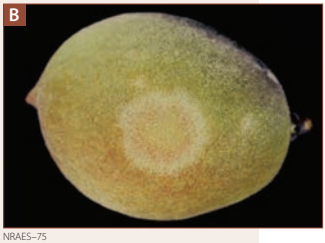
Management

Powdery mildew is managed through the application of fungicides from tight cluster or bloom through midsummer, and through the use of resistant varieties. In regions where apple scab occurs, a powdery mildew program is typically integrated with that of apple scab.

Powdery mildew of apricot, nectarine, peach, and plum

Sphaerotheca pannosa (Wallr.:Fr.) Lév.
Podosphaera clandestina (Wallr.:Fr.) Lév.

NRAES–75



NRAES–75

NRAES–75

Host

Apricot, Nectarine, Peach, Plum

Symptoms

Infection appears as white circular patches of powdery growth on either side of the leaf or on the terminal ends of new shoot growth. Severely infected leaves curl upward or blister, may be stunted, but eventually drop as infection progresses (A). Leaves on new shoots may be narrow, strap-like, and distorted. Except for plum, young foliage is affected by *S. pannosa*; older foliage is affected by *P. clandestina*. Infections of the fruit begin with the appearance of white, circular spots (B). On young fruit, the infection may progress and cover the entire fruit, causing them to become deformed. On older fruit, the lesions eventually cause the surrounding tissue to become necrotic and scabby; nectarines remain green (C).

Distribution

Occurs all along the East Coast.

Similar Diseases and Disorders

None

Management

Powdery mildew is managed through a combination of fungicides, starting from petal fall and continuing through pit hardening, and the use of resistant varieties. Many fungicides used for brown rot control are effective against powdery mildew.

Powdery mildew of cherry

Podosphaera clandestina (Wallr.:Fr.) Lév.

Kennelly

Burr

Host

Cherry

Symptoms

The fungus attacks young leaves and shoots and tends to cause more damage on sour cherry than sweet cherry. Infections appear as white, circular lesions or patches of powdery growth on either side of the leaf or on the terminal ends of shoots (A). Severely infected leaves curl upward or blister but eventually drop as infection progresses. Towards the end of the season, small, black fungal bodies (cleistothecia) are visible within powdery mildew colonies (B). Infected fruit are deformed when infected young or develop circular, slightly sunken lesions when infected at maturity.

Distribution

Occurs all along the East Coast.

Similar Diseases and Disorders

None

Management

Powdery mildew is managed through a combination of fungicides, starting from petal fall and continuing through pit hardening, and the use of resistant varieties. Many fungicides used for brown rot control are effective against powdery mildew.

Rust diseases

Cedar apple rust:
Gymnosporangium juniperi-virginianae Schwein

Quince rust:
Gymnosporangium clavipes (Cooke & Peck) Cooke & Peck in Peck

American hawthorn rust:
Gymnosporangium globosum (Farl.) Farl.

NRAES–75

Rosenberger

Szkolnik

Rosenberger

Host

Apple, Pear

Symptoms

Cedar Apple Rust: On leaves, the disease appears on the upper surface as small, faint, yellow spots **(A)** shortly after the appearance of active cedar galls **(B)** on the alternate host for this fungus, the red cedar (*Juniperus virginiana* L.). Lesions eventually turn dark yellow to yellow-orange and develop a reddish border **(C)**. Tiny pustules form in the center of these lesions and eventually turn black. Blisters form on the underside of lesions by midsummer and produce small, tubular projections **(D)**. As lesions age, they split, and the walls curve back, forming a cup with masses of powdery orange to brown spores.

On the fruit, lesions usually appear on the calyx end, similar to those on leaves, but they are a bit larger and usually slightly raised. A dark green border forms around the yellow- to orange-colored lesions as they age **(E, F)**.

Quince Rust: This disease attacks only the fruit (not the leaves) of apple and pear. Symptoms begin as a purplish lesion, usually appearing on the calyx end of the fruit. As the disease progresses, the entire calyx end becomes blistered and deformed. Tube-like structures eventually form and produce powdery, bright orange spores **(G)**.

American Hawthorn Rust: This disease attacks only the leaves (not the fruit) of apple and pear and affects the apple varieties McIntosh and Cortland in particular **(D)**.

Symptoms on leaves and possibly fruit

Rust diseases (continued)

NRAES–75

NRAES–75

Rosenberger

Distribution

Primarily limited to eastern North America where *Juniperus* species occur. Cedar apple rust is the most common rust on apple; it does not affect pear. Quince rust affects both apple and pear, but it is a minor disease on pear. American hawthorn rust affects the leaves of both apple and pear.

Similar Diseases and Disorders

These diseases can be confused with each other but can be differentiated in part based on the plant tissue infected.

Management

Eliminating red cedar trees in the vicinity of orchards helps to reduce disease pressure. However, it is difficult to remove all sources of disease, because the infective spores can travel on air currents for several miles. Pruning the "cedar apples" from cedar trees is an alternative to removing the trees. Where the disease is a problem, fungicides are applied from tight cluster through petal fall. The varieties Cortland, Crispin, Golden Delicious, and Jonagold are susceptible to both cedar apple and quince rust; Ida Red and Paula Red are susceptible to cedar apple rust; and Delicious and Empire are susceptible to quince rust.

X-disease

Phytoplasma

Burr

Burr

NRAES–75

NRAES–75

Host

Cherry, Peach

Symptoms

Caused by a mycoplasma, X-disease infects many stone fruits. On cherry, trees tend to develop dieback and an unthrifty appearance **(A)**. The rate of decline depends on the rootstock. On resistant rootstock, such as Mahaleb, decline is rapid because of a hypersensitive response at the graft union. On susceptible rootstock, such as Mazzard or Colt, decline occurs over several years. Cherry fruit tend to be small, flattened, pointed, pale-colored, and confined to a few branches (but mixed with some normal fruit) **(B)**. On peach, leaves curl inward after several months. Water-soaked spots turn red, become necrotic, and drop out **(C)**. Localized areas or the entire canopy defoliates, leaving foliage only at the tips. The entire tree may show symptoms two to three years after the initial infection **(D)**.

Distribution

Eastern United States, primarily MI, the Hudson Valley of NY, and southern New England, with occasional reports from the Cumberland-Shenandoah region.

Similar Diseases and Disorders

Nitrogen deficiency can cause red spotting on peach leaves. Bacterial canker (page 155) can cause dieback in older cherry trees. Overcropping of sweet cherries on Gisela rootstocks can cause uneven fruit ripening.

Management

Chokecherry (*Prunus virginiannae* L.) is a natural host/reservoir for the pathogen. The disease is spread by leafhoppers. The only effective control measure is eradicating chokecherry and infected cherry trees within a 150-mile radius of all peach, nectarine, and cherry orchards.

Alternaria fruit rot

Alternaria alternata (Fr.:Fr.) Keissl

Jones

Jones

Host

Apricot, Apple, Cherry, Peach, Pear

Symptoms

The disease appears as velvety dark green to black, circular, sunken lesions on mature fruit; the infected tissue is firm and brown **(A, B)**. The disease is typically associated with overripe or damaged fruit or fruit held in storage (where serious losses can occur). The pathogen has also been reported to cause superficial red spotting on the surface of apricots and peaches. The spots eventually turn tan to brown and become necrotic but typically retain a red halo.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

On stone fruit, this disease can be confused with brown rot (page 198) or *Rhizopus* infections (page 212). *Rhizopus* infections, however, tend to be softer than *Alternaria*-infected fruit. Brown rot–infected fruit will produce powdery gray to light brown spores, whereas *Alternaria*-rotted fruit will develop a dark green to brown to nearly black mass of spores.

Management

Avoid damaging mature fruit, particularly during harvest. There are no practical chemical control recommendations.

Anthracnose

Colletotrichum acutatum J. H. Simmonds
Colletotrichum gloeosporioides (Penz.) Penz. & Sacc. in Penz.

Lalancette

Host

Cherry, Peach, Plum

Symptoms

Lesions start as small, circular, tan to brown spots on mature or nearly mature fruit. Lesions expand rapidly with a tendency to form concentric rings that may or may not be sunken. Lesions are firm to the touch but typically develop orange to pink, slimy spore masses in their centers. Individual lesions may reach a diameter of 4–5 cm but may coalesce to form more extensive areas of infection (A).

Distribution

Common to all fruit-growing regions in eastern North America but most serious in warmer production regions.

Similar Diseases and Disorders

Young lesions can be confused with brown rot infections (page 198). Evidence of sporulation is typically needed to differentiate the various fruit rots.

Management

The disease is difficult to manage when disease pressure is high. Fungicides can be used from fruit ripening through harvest; the strobilurin fungicides and captan are the most effective.

Bitter rot

Colletotrichum acutatum J. H. Simmonds
Colletotrichum gloeosporioides (Penz.) Penz. & Sacc. in Penz.

Rosenberger

NRAES–75

Sutton

Host

Apple, Pear

Symptoms

Bitter rot appears on young fruit as small, circular, brown lesions. Lesions expand rapidly and radially under wet and warm conditions. As they age, they turn darker brown and become sunken **(A)**. When several lesions occur on a fruit, they tend to coalesce and no longer appear circular. The spores of the fungus are creamy, white to pink, and tend to form in concentric circles within the lesion **(B)**. The rotted flesh is often watery and appears V-shaped in cross-section **(C)**. The fruit eventually dries, mummifies, and may fall to the ground or remain hanging from the tree throughout the duration of the winter.

Distribution

Common to all fruit-growing regions in eastern North America. It is an important fruit-rotting disease in warmer apple-growing regions such as the Mid-Atlantic and southern United States.

Similar Diseases and Disorders

Early symptoms can be confused with early symptoms of black rot (page 194) or white rot (page 207).

Management

The bitter rot fungi overwinter as saprophytes in many wild hosts and in mummified fruit within the orchard. Spores from these sources are produced in abundance during periods of warm (>20°C) and wet or humid weather. Mummified fruit and dead wood should be removed to reduce the source of inoculum. Regular fungicide applications from early summer through harvest are usually necessary to manage disease in problem orchards; the strobilurin fungicides and captan are the most effective. No apple variety is completely immune to disease; however, some varieties like Fuji, Golden Delicious, and Empire are more susceptible.

Symptoms on fruit only

Black rot
(Blossom end rot, Frogeye leaf spot)

Botryosphaeria obtusa (Schwein.) Shoemaker

Rosenberger

Burr

Turechek

Host

Apple, Pear

Symptoms

Fruit: Fruit infections that occur early in the season appear at the calyx end and typically develop into blossom end rot that may not appear until the fruit begin to mature **(A)**. Seed cavity infections are associated with infections of the carpel, particularly in varieties with Delicious parentage, and often lead to premature fruit drop within one month after petal fall. Late fruit infections occur through cracks in the cuticle, wounds, and possibly lenticels. On mature fruit, lesions enlarge rapidly (slower in the Northeast), typically producing a series of concentric bands that alternate in color from brown to black **(B)**. The flesh beneath the rot remains firm and leathery. Infected fruit color early and ripen in advance of healthy fruit, up to three to six weeks earlier in the Southeast. Small black fungal bodies form on rotted fruit surfaces. Eventually, infected fruit dry down to mummies that remain attached to the tree, serving as inoculum sources in the spring.

Frogeye leaf spot: Lesions start as small purple specks on the upper surface of leaves one to three weeks after petal fall and enlarge to 3–6 mm in diameter. Mature lesions are circular and tan to brown with distinct purple margins **(C)**. Heavily infected leaves become chlorotic and drop.

Cankers: Cankers appear primarily in trees where the older wood has been extensively invaded by wood-rotting fungi **(D, E)**, the presence of which is denoted by darkened wood visible in the center of a cross-section of an infected limb **(F)**. Healthy apple limbs show no darkened wood in cross-section.

Black rot (continued)

NRAES–75

NRAES–75

Wilcox

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Infections of the fruit can be confused with white rot infections (page 207), calyx end rot (page 200), or dry eye rot (page 200). Foliar infections can be confused with Alternaria blotch (page 166) and with leaf spotting caused by numerous other pathogens, including cedar apple rust (page 188) on rust-resistant varieties. Injury from captan or azoxystrobin fungicide (Abound) may also appear similar, but injury from azoxystrobin is most severe on McIntosh, Cortland, Empire, and Gala, whereas Delicious leaves are not affected by azoxystrobin. Black rot cankers can be confused with almost any canker.

Management

The black rot fungus overwinters in cankers, on old prunings, and in mummified fruits. Spores are produced in pycnidia (conidia) or pseudothecia (ascospores) on diseased tissue and are carried to susceptible tissues by wind or splashing water. To reduce disease pressure, prunings, dead wood, and mummified fruit should be removed from the orchard and destroyed. In addition, timely applications of appropriate fungicides will help to control frogeye leaf spot and the fruit rot phase of the disease.

Blister spot

Pseudomonas syringae pv. *papulans* (Rose 1917) Dhanvantari 1977

Turechek

Wilcox

Wilcox

Host

Apple

Symptoms

Lesions begin as small, darkened, water-soaked areas, generally around lenticels and typically on the lower half of the apple. Small raised blisters form shortly thereafter, becoming purplish black as they expand **(A)**. The infections are shallow, not extending more than 1–4 mm into the fruit flesh. The epidermal layer covering the blister dies and will often flake off the surface **(B)**. The lesions are generally circular and rarely become larger than 4–5 mm in diameter. Leaves of Mutsu may also experience a midvein necrosis **(C)**.

Distribution

Economically damaging only on the variety Mutsu (Crispin).

Similar Diseases and Disorders

None

Management

Blister spot is managed primarily through the timely application of bactericides during the three weeks after petal fall.

Brooks fruit spot

Mycosphaerella pomi (Pass.) Lindau

NRAES–75

Szkolnik

Host

Apple

Symptoms

Symptoms appear as irregular, slightly sunken, dark green lesions on immature fruit. On red-skinned varieties, fully developed lesions are dark red to purple and are generally no larger than 10 mm in diameter **(A)**. On lighter-skinned varieties, lesions turn dark green. Brooks fruit spot does not cause significant browning of the flesh beneath the lesion **(B)**.

Distribution

Occurs throughout the Northeast and Mid-Atlantic United States and has been reported in Canada.

Similar Diseases and Disorders

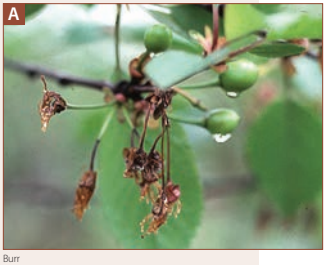
Symptoms can be confused with physiological disorders such as bitter pit and Jonathan spot, but these disorders do not appear until later in the season. The disease may also be confused with stink bug damage (page 70).

Management

The disease is of minor importance because it is usually controlled by fungicides applied to control other diseases. It is occasionally seen on Jonathan, Golden Delicious, Grimes Golden, Rome Beauty, Stayman, and Winesap.

Brown rot

Monilinia fructicola (G. Wint.) Honey
Monilinia laxa (Aderhold & Ruhland) Honey



Burr

NRAES–75

Turechek

Burr

Host

Apricot, Cherry, Nectarine, Peach, Plum

Symptoms

Infected flowers turn brown, wither, and either become fixed to twigs as a gummy mass or drop like unpollinated flowers **(A)**. Apricot is the most susceptible to blossom blight, followed by prune, sweet cherry, peach, sour cherry, and then plum. If infected blossoms do not drop off, the fungus may grow through the flower stem and into the twig below. Twigs develop elliptical to fusoid cankers with profuse gumming at the margin between diseased and healthy tissue **(B)**. Leaves on infected shoots turn brown and wither but remain attached. In some instances, twigs are girdled and killed.

On the fruit, infection first appears as soft brown spots. These rapidly expand and become covered with powdery masses of tan spores **(C)**. Infections spread rapidly from fruit to fruit when they are touching one another. Rotted fruits typically shrink into a wrinkled "mummy" as they dry on the tree **(D)**. Both immature and mature fruit infected with brown rot tend to remain on the tree and form mummies **(E)**. Mummies that fall to the ground may produce a spore-bearing, mushroom-like structure called an apothecia the following spring **(F)**; its importance in the disease cycle is thought to be minimal in the Northeast and Mid-Atlantic regions.

Distribution

Widespread; common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Blossom blight can be confused with blossom blast (page 155) caused by *Pseudomonas syringae* pv. *syringae* van Hall; fruit rot can be confused with Alternaria fruit rot (page 191) and Rhizopus rot

Brown rot (continued)

Turechek

NRAES–75

(page 212). The presence of fungal sporulation helps to differentiate the different diseases. Brown rot–infected fruit will produce powdery gray to light brown spores, whereas *Alternaria*-rotted fruit will develop a dark green to brown to nearly black mass of spores. *Rhizopus*-infected fruit develop a softer rot than brown rot–infected fruit. Also, *Rhizopus* produces whisker-like tufts of grayish white sporangiophores capped with a black spore mass at their tips; the sporangiophores can exceed 1 cm in length.

Management

Prune out mummified fruit and cankers during the dormant season, and burn or bury them deep in the soil. Remove wild or neglected stone fruit trees in the area that may serve as reservoirs for disease. Fungicides should be applied during bloom if warm rains (> 18°C) are predicted, especially in orchards where inoculum levels are high. Fruit are very susceptible to infection one to three weeks after shuck split and again from three weeks prior to harvest through the harvest period. Fungicides are often used during these periods to protect fruit.

Calyx end rot

Sclerotinia sclerotiorum (Lib.) de Bary

Dry eye rot (Blossom end rot)

Botrytis cinerea Pers.:Fr.

Burr

Turechek

Host

Apple

Symptoms

Symptoms of both diseases begin at the calyx end of the fruit, causing a reddish discoloration at the site of infection. The rot is at first soft but eventually dries out, turning tan to brown with a red border. Dry eye rot is caused by the "gray mold" fungus, and calyx end rot is caused by the "white mold" fungus. Fruit infected with either of the pathogens have a tendency to drop prematurely. If harvested, though, fruit infected with dry eye rot will develop gray mold in storage.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

The two diseases are often confused with each other and may also be confused with blossom end rot infection caused by black rot (page 194). Usually, isolation of the pathogen is necessary for positive identification. One field characteristic, however, is that calyx end rot lesions tend to form to one side of the calyx **(A)**, whereas dry eye rot lesions are centered about the calyx **(B)**.

Management

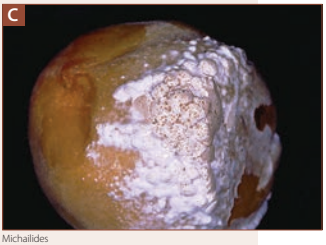
The diseases are relatively uncommon and occur only in seasons when wet and cool conditions occur during bloom and petal fall. Neither disease spreads to other fruit once symptoms appear. Generally, practices employed to control other diseases will keep these two diseases from becoming economically damaging.

Green fruit rot

Botrytis cinerea Pers.:Fr.
Sclerotinia sclerotiorum (Lib.) de Bary

Michailides

Michailides



Michailides

Host

Apricot, Cherry, Plum

Symptoms

Both fungi attack the blossoms but rarely invade the twig **(A)**. Blighting of the blossoms followed by gray spore masses is typical of infection from *B. cinerea*. *S. sclerotiorum* infects senescing floral parts; the white mycelium of the fungus is sometimes observed on blighted blossoms. Fruit infection occurs when developing fruit are in direct contact with blighted blossoms. *Botrytis*-infected fruit develop a typical gray sporulation **(B)**. *Sclerotinia*-infected fruit develop a dense white fungal growth that often leaves the fruit deformed **(C)**.

Distribution

Common to all fruit-growing regions in eastern North America; most common in wet seasons.

Similar Diseases and Disorders

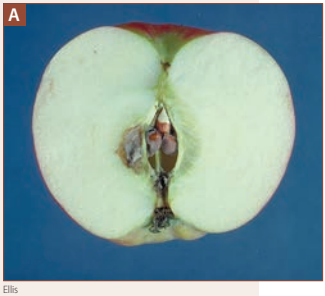
Blossom blight can be confused with brown rot (page 198) infections. Microscopic examination of the spores may be necessary to differentiate the two.

Management

The disease is sporadic and rarely causes major losses; no practical control recommendations exist.

Moldy core and core rot

Alternaria spp.
Cladosporium spp.
Epicoccum spp. and others



Ellis

Ellis

Host

Apple

Symptoms

Moldy core is associated with several different fungi. Infection is initiated at the calyx end, and the fungi proceed to grow inward into the carpel tissue or locules and cause a core rot. External rot symptoms are rare. Fruits ripen early, and decay is only obvious when fruit are cut in half **(A, B)**. Core rot appears similar but occurs after harvest when the fruit are dipped into contaminated water in the packinghouse. A wet rot develops once the fruit are in storage.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

This disease can be confused with blossom end rots (page 194).

Management

These diseases are important on varieties with an open sinus extending from the calyx to the core, such as Delicious and its red sports. Fungicides applied at bloom may reduce incidence of moldy core.

Peach scab

Cladosporium carpophilum Thuem.

NRAES–75

NRAES–75

Host

Peach

Symptoms

On fruit, lesions begin as small, greenish, circular spots that gradually enlarge and darken as spore production begins (A). These spots appear when fruit are half grown and are most common on the stem end of the fruit but can occur over the whole surface. Secondary infections may occur on twigs (B) and late-season-variety fruit.

Distribution

Common to all fruit-growing regions in eastern North America, but is most important in warm and humid production regions.

Similar Diseases and Disorders

Peach scab can be confused with bacterial spot infections (page 177) but can be differentiated by the presence of dark green sporulation.

Management

Symptoms develop after a very long incubation period of 40 to 70 days. Because of the long incubation period, only the infections that occur between shuck split and pit hardening develop fruit symptoms. Fungicides are typically used to protect fruit during this period.

Pear stony pit

Unknown, virus suspected

Rosenberger

Host

Pear

Symptoms

Dark green spots appear on developing fruit about two to three weeks after petal fall. The tissue around the affected areas continues to grow, forming deep pits. Older pits develop necrotic centers. Heavily infected fruit are often severely deformed, gritty, and difficult to slice through **(A)**. Doing so, however, reveals pitting throughout.

Distribution

Widespread; it is the most important viral disease of pear.

Similar Diseases and Disorders

Similar symptoms can be caused by the pear plant bug (page 68).

Management

Pear stony pit is almost exclusively managed in the nursery through the use of disease-free propagating material. In the orchard, trees affected one year may not be affected in subsequent years.

Rusty spot

Podosphaera leucotricha (Ellis & Everh.) E. S. Salmon

Kennelly

Host

Peach

Symptoms

Lesions begin as small, circular, tan to orange blemishes approximately 3–5 mm in diameter. The discoloration is due to discoloring of the fuzz on the fruit **(A)**. As lesions enlarge, the interior, reddened fuzz is shed. At this point, lesions appear green and smooth, surrounded by a tan to orange halo. Lesions may continue to expand and may coalesce with other lesions to form larger smooth patches of infection. Eventually, lesions stop expanding, harden, and turn orange-brown.

Distribution

Widespread; the disease occurs wherever powdery mildew of apple occurs.

Similar Diseases and Disorders

Rusty spot can be confused with powdery mildew infection (page 186) caused by *Sphaerotheca pannosa* (Wallr.:Fr.) Lév. or *Podosphaera clandestina* (Wallr.:Fr.) Lév.

Management

Fungicide programs targeted for control of brown rot or peach scab will often provide appreciable control of rusty spot. Programs geared specifically for powdery mildew control will also be effective. Rusty spot is caused by the same fungus that causes powdery mildew on apple. Therefore, controlling powdery mildew infections on neighboring apple trees will reduce the incidence of rusty spot.

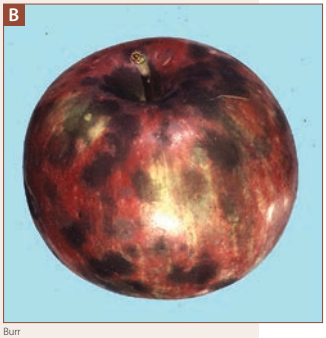
Sooty blotch

Peltaster fructicola (Johnson, Sutton, Hodges)
Leptodontium elatius (G. Mangenot) De Hoog
Geastrumia polystigmatis Batista & M. L. Farr, and other fungi

Flyspeck

Schizothyrium pomi (Mont.:Fr.) Arx

Turechek



Burr

Turechek

Host

Apple, Pear

Symptoms

Sooty blotch and flyspeck are found together on the same fruit and affect only the epidermal layer of the fruit **(A)**. Sooty blotch appears as various shades of olive green on the surface of the fruit. Colonies range in shape from nearly circular colonies with distinct margins to large, amorphous colonies with diffuse margins **(B)**. The variation in colony appearance can be attributed to the interaction among the different fungi causing the disease and environmental conditions, specifically temperature and relative humidity.

Flyspeck colonies appear as distinct groupings of shiny, black fungal bodies on the surface of the fruit **(C)**. The number of colonies or "specks" ranges from a few to over 50 per grouping.

Distribution

Sooty blotch and flyspeck occur almost everywhere apples are grown, often together. They are more severe in humid and warmer climates.

Similar Diseases and Disorders

None

Management

The primary means of managing sooty blotch and flyspeck is through the scheduled use of fungicides from mid-June through August. However, summer pruning and regular mowing helps to reduce disease pressure by lowering orchard humidity and promoting quicker drying of fruit surfaces. In addition, removal of raspberry and other brambles along the orchard border reduces outside sources or inoculum.

Symptoms on fruit only

White rot

Botryosphaeria dothidea (Moug.) Ces. & De Not.

NRAES–75

NRAES–75

Host

Apple, Pear

Symptoms

Fruit lesions are visible four to six weeks before harvest as small, circular, slightly sunken, tan to brown spots sometimes surrounded by a red halo on yellow-skinned fruit. On red fruit, the halo is dark purple to black. Expanding cylindrical lesions develop to the core. Rotted fruit are tan to light brown (A); clumps of black fruiting structures develop on the surface in the late stages. Fruit may become soft and watery in warm weather; under cooler conditions, it is firmer and has a deeper tan color.

Cankers begin as small, sunken, reddish brown lesions in spring and enlarge during the season, often girdling the limb. Pimple-like fruiting bodies develop on canker surfaces four to eight weeks after infection (B). Shoot dieback may appear above the canker, particularly when the branch is girdled; striking yellow foliage may appear in late May to early June. In the Northeast, infection may remain superficial, surviving in the outer bark without damaging the phloem or cambium until drought stress allows the fungus to penetrate these tissues.

Distribution

Occurs throughout eastern North America.

Similar Diseases and Disorders

The fruit rot phase can be confused with bitter rot (page 193) or black rot (page 194). Bitter rot lesions, however, tend to be V-shaped The canker phase can be confused with other canker diseases.

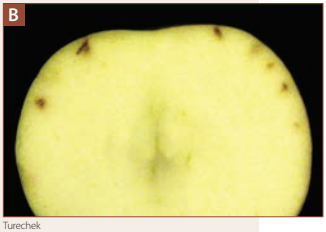
Management

Avoid wounding or pruning during drought. Remove and destroy infected branches, cankers, and other inoculum sources, such as mummified fruit. Use fungicides to control summer diseases such as apple scab, fruit rots, sooty blotch, and flyspeck to decrease canker symptoms.

Bitter pit and cork spot

Physiological disorder

Turechek



Turechek

Host

Apple, Pear

Symptoms

Small, green to purplish to light brown, slightly sunken lesions appear on the surface of mature fruit (A). Individual lesions on the fruit surface are dry and do not extend deep into the fruit (B); however, cutting into the fruit can reveal numerous internal lesions. Bitter pit usually develops in storage and is most severe at the calyx end. A similar calcium-related disorder that occurs only on d'Anjou pears is named cork spot.

Distribution

Widespread

Similar Diseases and Disorders

On apple, symptoms can be confused with other calcium-related physiological disorders such as Jonathan spot and the disease Brooks fruit spot (page 197).

Management

This is a physiological disorder associated with calcium deficiency in apple fruit. It is common on the varieties Cortland, Gravenstein, Honeycrisp, Northern Spy, and York. Losses can be minimized by avoiding excessive tree vigor (because shoots compete with fruit for calcium) and applying calcium sprays during summer.

Blue mold

Penicillium expansum Link

Rosenberger

Rosenberger

Rosenberger

Host

Apple, Pear

Symptoms

Blue mold enters fruit through wounds, stem-end invasion, or as a core rot **(A)**. Infection is first visible as a soft and sunken, yellow to pale brown, circular lesion on the surface of the fruit. Lesions expand rapidly and can quickly macerate the fruit **(B)**. A diagnostic symptom of this rot is a strong earthy or musty odor and unpleasant taste. If fruit are stored under wet or humid conditions, the fungus produces numerous blue-green tufts of spores on the surface of the fruit **(C)**; sporulation typically does not occur under controlled-atmosphere conditions (compare with gray mold, page 210).

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

In the absence of sporulation, blue mold can be confused with other postharvest diseases such as gray mold (page 210). Gray mold–rotted tissue, however, tends to be firmer than tissue infected with blue mold and does not separate easily from healthy tissue. Unlike blue mold, gray mold–rotted fruits have a relatively pleasant odor rather than a musty odor.

Management

Postharvest applications of fungicides can be useful for preventing infections, but sanitation of picking bins and packinghouses is also essential. Quaternary ammonia sanitizers can be used to clean empty bins and storage rooms. Chlorination or other approved biocides should be used in the packinghouse to control inoculum in dump tanks and flume water. Packinghouse floors should be cleaned daily, and all decayed fruit should be removed as soon as possible.

Gray mold

Botrytis cinerea Pers.:Fr.

Rosenberger

Rosenberger

Host

Apple, Pear

Symptoms

Lesions usually start at the calyx or stem end of the fruit or at wound sites as small water-soaked areas. As lesions age, they enlarge, turning from grayish brown to light brown and eventually to a darker brown. White or grayish white mycelium forms on the surface of the rot under humid conditions, leading to the production of tufted gray spore masses **(A)**; however, little sporulation occurs at cold-storage temperatures. Apples coming out of controlled-atmosphere storage appear firm and tan and, when completely decayed, look like baked apples **(B)** (compare with blue mold, page 209).

Distribution

Worldwide; common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

In the absence of sporulation, gray mold can be confused with other postharvest diseases such as blue mold (page 209). The rotted tissue tends to be firmer than tissue infected with blue mold and does not separate easily from healthy tissue. Unlike blue mold, gray mold–rotted fruits have a relatively pleasant odor rather than a musty odor.

Management

Gray mold can be effectively treated with postharvest applications of fungicides. (See management options under blue mold, page 209.)

Mucor rot

Mucor piriformis E. Fischer

Michailides

Michailides

Host

Apple, Pear

Symptoms

Infected tissue appears light brown, soft, and watery (A). The infection usually develops at wound sites, at the calyx end, or at the stem end of the fruit. Complete decay occurs rapidly under packinghouse conditions and in about two months in cold storage (B). Fully rotted apples release large amounts of liquid containing the infective propagules of the fungus; this may spread the disease but is relatively uncommon.

Distribution

Common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

Mucor rot can be confused with other postharvest disorders; however, no other disease liquefies the fruit as readily.

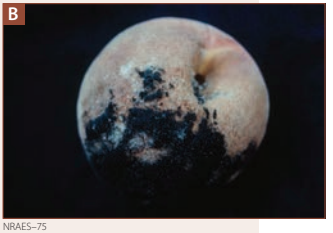
Management

Harvesting fruit in dry weather, placing fruit in clean bins, and not placing fruit that have fallen to the ground into bins will reduce the incidence of Mucor rot. Fungicides applied prior to harvest are generally ineffective. After harvest, removing fallen fruit from the orchard floor will help to reduce the buildup of the pathogen in the field. In the packinghouse, dump tanks and flume water can be treated to reduce spore levels.

Rhizopus rot

Rhizopus stolonifer (Ehrenb.:Fr.) Vuill.

Lalancette



NRAES–75

Host

Peach

Symptoms

Although the rot is predominantly a postharvest problem, symptoms may also develop in the field. Rotted fruit appears similar to brown rot, but *Rhizopus*-affected fruit appears slightly darker, the skin may slip away from decaying flesh underneath, or the fruit may be very leaky. Visible fungal mycelium may be white and fluffy, appearing like whiskers when the fungus sporulates. Infected fruit lying on the orchard floor or in packaged containers will often be engulfed by the fungus, appearing fluffy, with the fungus turning from gray to black as the fruiting bodies develop at the tips of the "whiskers" **(A, B)**.

Distribution

Widespread; common to all fruit-growing regions in eastern North America.

Similar Diseases and Disorders

This disease can be confused with brown rot (page 198) in the early stage of infection.

Management

Pre- and postharvest chemical treatments and storing fruit at cool temperatures will help to reduce the incidence of Rhizopus rot on harvested fruit. In the orchard, minimize wounding, disease, and fruit feeding by insects, as infection by *Rhizopus* usually occurs as the result of wound colonization.

Glossary

Abdomen: Posterior segment of the body of insects, spiders, and mites that holds the genital organs (figure 1).

Acervulus (pl., **acervuli**)**:** A compact, conidia-bearing fungal fruiting body.

Anal comb: In some Lepidopteran larvae (e.g., oriental fruit moth), a brown, comb-like, hardened projection adjacent to the anus used to eject feces.

Annulated: With ring-like segments or divisions.

Ascospore: A sexual fungal spore produced in apothecia, perithecia, and pseudothecia.

Basidiocarp: A spore-bearing fungal fruiting body (e.g., many mushrooms).

Bast fibers: The strong fibers of the phloem.

Burr knot: A mass of tender root tissues that develops above soil level on the trunk of young apple trees.

Callus: A mass of undifferentiated cells often formed in response to wounding.

Calyx: A collective term for all the sepals.

Cambium: The tissue that lies between, and is the source of, phloem and xylem.

Canker: Lesion caused by a pathogen that develops in the vegetative tissues of a leaf, peduncle or bud scar, trunk, etc.

Carpel: The female reproductive organ of the flower consisting of the stigma, style, and ovary.

Catfacing: In stone fruits, a deformation of the fruit caused by insect feeding damage, resulting in a fruit shape similar to a cat's face.

Caudal: Pertaining to the tail or the posterior part of the body.

Cephalothorax: In spiders and other arthropods, a body region consisting of head and thoracic segments.

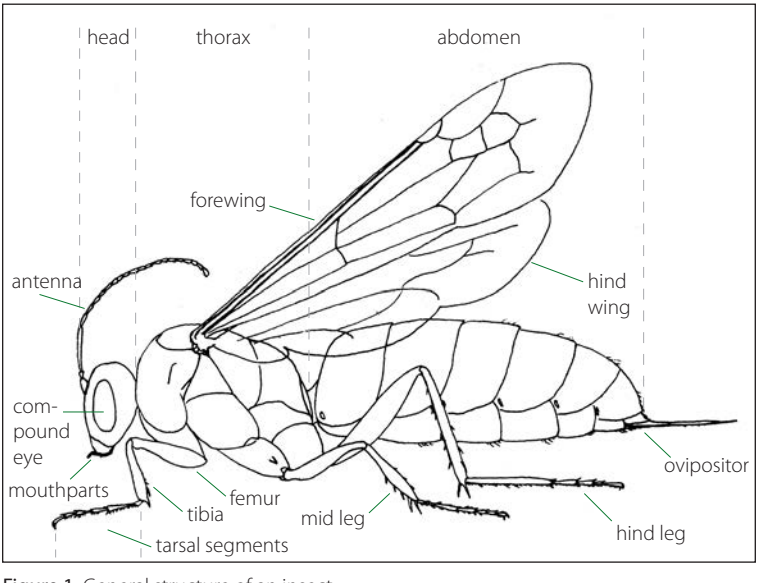


Figure 1. General structure of an insect

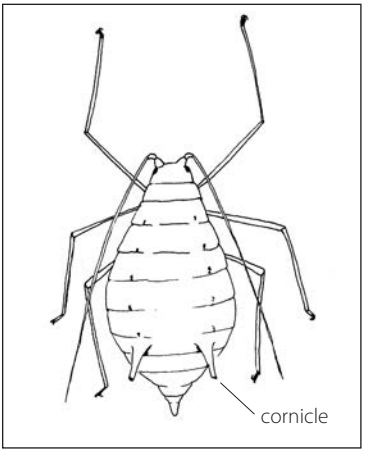


Figure 2. General form of an aphid

Cervical: Pertaining to the neck or cervix.

Chelicera (pl., **Chelicerae**)**:** Pincer-like first pair of appendages in spiders and mites.

Chlorophyll: The green photosynthetic pigment of the plant.

Chlorosis (chlorotic): The condition in which leaves turn pale green, yellow, or yellow-white due to either insufficient quantities of or the destruction of chlorophyll.

Conidium (pl., **Conidia**)**:** An asexual fungal spore often produced freely on conidiophores or in acervuli, pycnidia, or sporodochia.

Conidiophore: A specialized fungal structure bearing conidia.

Cornicle: Tubular structure located on the posterior part of an aphid's abdomen.

Cuticle: The protective waxy covering of the epidermal cells of leaves and shoots.

Dorsum: Upper surface of the body.

Dorsal: Belonging/pertaining to the upper surface.

Elytron (pl., **Elytra**)**:** Thickened and horny anterior wing of some insects, such as Coleoptera (e.g., plum curculio) and Dermaptera (e.g., earwigs).

Endoparasite: A parasite that lives inside its host.

Epidermis: The outermost layer of cells of the leaves, shoots, roots, and young woody tissues.

Epinasty: A downward bending of leaves caused by excessive growth on the upper side.

Femur (pl., **Femora**)**:** The third leg segment of an insect, located before (closer to the body than) the tibia (figure 1, page 213).

Flagging: Plant shoot damage caused by insect feeding or disease, in which the terminal end of the shoot wilts and hangs vertically from the point of the damage.

Floral receptacle: Extension of the flower's peduncle, which holds all the floral parts.

Frass: Plant fragments made by an insect with chewing mouthparts, usually mixed with excrement.

Fusoid: Spindle-shaped, tapering to a point at the ends.

Gall: An abnormal growth of plant tissues caused by the stimulus of an insect or pathogen.

Gibberellin: A plant growth hormone involved in stem elongation.

Girdling: Damage to a plant in the form of a ring around the trunk, limb, or shoot.

Grub: A thick-bodied larva with a well-developed head and thoracic legs, without abdominal prolegs, and usually sluggish.

Honeydew: A sweet, sticky liquid that is discharged from the anus of fluid feeders such as aphids, and which attracts ants and other insects; can serve as a medium for growth of sooty mold.

Host: An organism that harbors one or several parasites, and which they feed on for their development.

Hyaline (wings)**:** Like glass; transparent, colorless.

Inoculum: The living part of the pathogen, usually the spores, that initiates disease or causes it to spread.

Insect growth regulators: Chemical compounds very close or identical to natural hormones produced by insects and certain plants. They have more specific effects and are therefore less harmful to nontarget species than synthetic broad-spectrum insecticides.

Internode: A portion of the stem between nodes.

Interstem: A piece of stem tissue grafted between a rootstock and a scion.

June drops: Developing fruits (usually apples) that are thinned to optimize size development in the remaining fruits, and which drop off the tree, normally in June.

Larva (pl., **Larvae**)**:** In insects with complete metamorphosis, the immature stage between the egg and pupal stages.

Lenticel: A region of loosely packed cells on the surface of stems or fruit that permit air exchange; often they appear as numerous raised, small, oval or rounded spots on the stem, branch, or fruit.

Locule: A small cavity or space within the fruit where the seeds develop.

Maggot: Larva of a fly, legless and without a well-developed head.

Motile forms: Active stages (nymphs and larvae) of mites and other arthropods.

Mandibles: A pair of sickle-shaped mouthparts typically used for chewing.

Mottling: Yellow or pale green, irregular blotches on a leaf.

Mycelium (pl., **Mycelia**)**:** A mass of fungal tissue, often thread- or web-like in appearance, that constitutes the body of the fungus.

Necrotic: Dead (tissue).

Node: The part of the stem of a plant from which a leaf or branch grows.

Nodule: A small swelling on a root or a twig.

Nymph: In insects that do not undergo complete metamorphosis, the immature stage between egg and adult that resembles the adult stage except in size and lack of distinctive adult structures such as wings.

Ovipositor: Egg-laying organ of female insects (having a needle-like shape in the parasitic wasps) (figure 1, page 213).

Parasite: An organism that lives or depends on another living organism (host or "prey"), at least for a part of its life cycle.

Parasitoid: An organism that lives or depends on a host, at least for a part of its life cycle, eventually killing it.

Parenchyma: Plant cells having a photosynthetic or storage function.

Pedicel: The stalk of an individual flower.

Pedipalps: The second pair of appendages of a spider, used to manipulate food.

Peduncle: The stalk that supports a flower structure.

Perithecium (pl., **Perithecia**)**:** A hollow, spore-bearing fungal body that is often partially embedded in plant tissue. Spores are released through a small opening protruding from the plant tissue from which it is embedded.

Phloem: The living tissue that carries nutrients throughout a plant; it lies underneath the bark.

Phytophagous: Feeds on plant material.

Pollinator: An organism that transports pollen as an agent of flower fertilization.

Predator: A species that feeds on other arthropods.

Prolegs: The fleshy abdominal leg-like appendages of some insect larvae.

Pronotum: The dorsal portion or plate of the first thoracic segment.

Pseudothecium (pl., **Pseudothecia**)**:** A perithecium-like fruiting body.

Pupa (pl., **Pupae**)**:** The stage between the larva and the adult in insects with complete metamorphosis, a nonfeeding and usually an inactive stage. (**Pupate**: to change into the pupal stage.)

Pustule: A raised grouping of spores that forms underneath and eventually ruptures the epidermis.

Pycnidium (pl., **Pycnidia**)**:** An asexual, hollow fruiting body lined with conidiophores.

Rhizomorph: An organized fungal structure resembling a root.

Russetting: A course-textured, reddish brown discoloration that forms on the epidermis of fruit as a result of cell death.

Saprophyte: An organism that obtains its nutrients from dead or decaying plant matter.

Scaffold: A branch that grows laterally from a tree trunk.

Scion: The stem portion that is grafted onto a rootstock that will eventually form the aboveground portion of the tree.

Sclerotium (pl., **Sclerotia**)**:** A hard resting body produced by certain fungi that remains dormant until the return of favorable conditions.

Sclerotized: Hardened (area of cuticle).

Scurfy: A general roughening or darkening of the plant surface.

Scutellum (pl., **Scutella**)**:** A small triangular or round plate on the thorax of many Heteropterans (e.g., plant bugs, stink bugs, leafhoppers) and some Coleopterans.

Sepal: The green leaf-like structures of a flower that form below the flower petals.

Seta (pl., **Setae**)**:** A bristle arising from the body of an arthropod.

Shuck split: In stone fruits, when one-half of the developing fruitlet is exposed by the slipping and splitting of the shuck (a papery enclosure formed from the flower's calyx).

Sooty mold: A pathogenic or nonpathogenic fungus that grows on plant surfaces and leaves a black deposit.

Spinneret: In spiders and other arthropods, a structure, usually fingerlike in shape, with which silk is spun.

Spiracle: An external opening of the tracheal (respiratory) system; a breathing pore.

Spore: A reproductive cell of fungi. These microscopic reproductive cells correspond to seeds in the higher plants.

Sporodochium (pl., **Sporodochia**)**:** A cushion-shaped fungal body bearing conidia or asexual spores.

Spur: A very small branch that terminates with a fruit bud.

Sting: A pointed and hollowed organ at the posterior end of certain insects that replaces the ovipositor and is a means of offense/defense used to "sting" and inject a venom.

Stomate (pl., **Stomata**)**:** A leaf pore that permits gas or water exchange.

Sucker: A vigorous shoot that grows from a root system at ground level.

Thoracic shield: Hardened part of the thorax of certain caterpillars.

Thorax: The middle segment of an insect's body (figure 1, page 213).

Tibia: Fourth segment from the base of an insect leg; a long part immediately before the final tarsal segments (figure 1, page 213).

Trap biofix: The first sustained insect trap catch of the season or of a specific generation's flight.

Truss: A cluster of flowers or fruit.

Tubercle: A small knob-like or rounded protuberance.

Ventral: Pertaining or belonging to the lower or under surface of the abdomen.

Water sprout (sucker): A fast-growing vertical shoot of a tree that stunts the growth of the adjacent branches as it uses the tree's nutrients for its own growth.

Wing pads: In insects without a complete metamorphosis, undeveloped wings or tissue that will become wings in the adult stage.

Witches' broom: A dense and often loosely organized cluster of twigs.

Xylem: The water-conducting tissue of a plant.

Index/Cross-Reference
(Common Name, Scientific Name, and Family Name)

B

C

D

E

F

G

H

I

J

L

M

N

O

P

Q

R

S

T

V

W

X, Y, Z

For Further Information

Source Materials

Chapman, P. J., and S. E. Lienk. 1971. *Tortricid Fauna of Apple in New York*. Special Publication. Geneva, NY: New York State Agricultural Experiment Station.

Chouinard, G. (ed.). 1999. *Québec Apple Pest Monitoring Guide*. Sainte-Foy, Québec: Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ). [Available from: Réseau d'avertissements phytosanitaires (RAP): 200, chemin Sainte-Foy, 9e étage, Québec (Québec) G1R 4X6. By phone: (418) 380-2100, extension 3551 or 3581; by fax: (418) 380-2181.]

Chouinard, G., A. Firlej, F. Vanoosthuyse, and C. Vincent. 2000. *Guide d'Identification des Ravageurs du Pommier et de Leurs Ennemis Naturels*. Institut de Recherche et de Développement en Agroenvironnement (IRDA). Edited by the Conseil des Productions Végétales du Québec.

Horton, D., and D. Johnson (eds.). 2003. *Southeastern Peach Growers' Handbook*. Athens, GA: University of Georgia College of Agricultural and Environmental Sciences, Cooperative Extension Service.

Howitt, A. J. 1993. *Common Tree Fruit Pests*. Extension Publication NCR–63. East Lansing, MI: Michigan State University.

Jones, A. L., and H. S. Aldwinckle (eds.). 1990. *Compendium of Apple and Pear Diseases*. St. Paul, MN: American Phytopathological Society.

Jones, A. L., and T. B. Sutton. 1996. *Diseases of Tree Fruits in the East*. Extension Publication NCR–45. East Lansing, MI: Michigan State University.

Metcalf, R. L., and R. A. Metcalf. 1993. *Destructive and Useful Insects: Their Habits and Control*. 5th edition. New York: McGraw-Hill.

Naqvi, S. A. M. H. (ed.). 2004. *Diseases of Fruits and Vegetables: Diagnosis and Management*. Volume I. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Ogawa, J. M., E. I. Zehr, G. W. Bird, D. F. Ritchie, K. Uriu, and J. K. Uyemoto. 1995. *Compendium of Stone Fruit Diseases*. St. Paul, MN: American Phytopathological Society.

Identification Manuals

Alford, D. V. 1984. *A Colour Atlas of Fruit Pests: Their Recognition, Biology, and Control*. London: Wolfe Publishing Ltd.

Baudry, O. 1996. *Recognizing Natural Enemies in Orchards and Vineyards (Reconnaître les Auxiliaires en Vergers et Vignes)*. Paris: Ctifl Editions.

Brisson, J. D., M. Fréchette, B. Drouin, and L. Breton. 1992. *Les Insectes Prédateurs: Des Alliés dans Nos Jardins*. Montréal, Québec: Éditions Versicolores, Inc., Collection Fleurs Plantes Jardins.

Brisson, J. D., M. Lajoie, J. Allard, and A. Jacob-Remacle. 1994. *Les Insectes Pollinisateurs: Des Alliés à Protéger*. Montréal, Québec: Éditions Versicolores, Inc., Collection Fleurs Plantes Jardins.

Chouinard, G. 1997. *Manuel de l'Observateur: Pommier*. Sainte-Foy, Québec: Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ).

Flint, M. L, and S. H. Dreistadt. 1999. *Natural Enemies Handbook: The Illustrated Guide*

to Biological Pest Control. Division of Agriculture and Natural Resources (DANR) Publication 3386. Oakland, CA: University of California Press.

Leahy, C., and R. E. White. 1987. *Peterson First Guide to Insects of North America*. Boston: Houghton Mifflin.

Philip, H. G. and L. Edwards. 1991. *Field Guide to Harmful and Beneficial Insects and Mites of Tree Fruits.* Victoria, British Columbia: British Columbia Ministry of Agriculture and Fisheries.

Ubick, D., P. Paquin, P. E. Cushing, and V. Roth (eds.). 2005. *Spiders of North America: An Identification Manual*. American Arachnological Society. WWW.AMERICANARACHNOLOGY.ORG

Integrated Pest Management Manuals

Chouinard, G. (ed.). 2001. *Guide de Gestion Intégrée des Ennemis du Pommier.* Sainte-Foy, Québec: Centre de Référence en Agriculture et Agroalimentaire du Québec.

Coli, W. M. (ed.). 1984. *Integrated Management of Apple Pests in Massachusetts and New England.* Cooperative Extension Service Publication C-169. Amherst, MA: University of Massachusetts.

Giraud, M., O. Baudry, R. Orts, and J. P. Gendrier. 1996. *Protection Intégrée Pommier-Poirier*. Paris: Ctifl Editions.

Hogmire, H. W., Jr. (ed.). 1995. *Mid-Atlantic Orchard Monitoring Guide*. NRAES–75. Ithaca, NY: Northeast Regional Agricultural Engineering Service (current name: Natural Resource, Agriculture, and Engineering Service).

Paradis, R. O. 1983. *Lutte Rationnelle Contre les Ravageurs des Pommiers au Québec.* Saint-Jean-sur-Richelieu, Québec: Agriculture and Agri-Food Canada.

Solymar, B. 1999. *Integrated Pest Management for Ontario Apple Orchards*. Publication 310. Toronto, Ontario: Ontario Ministry of Agriculture, Food, and Rural Affairs.

Useful Internet Sites

Note: The following web site addresses were current as of August 2006, but due to the dynamic nature of the Internet, they may have changed.

Cornell University Fruit Resources Page: HTTP://WWW.FRUIT.CORNELL.EDU

Illinois Fruit and Vegetable News: HTTP://WWW.IPM.UIUC.EDU/IFVN/INDEX.HTML

The Mid-Atlantic Regional Fruit Loop: HTTP://WWW.CAF.WVU.EDU/KEARNEYSVILLE/FRUITLOOP.HTML

Midwest Biological Control News (back issues only): HTTP://WWW.ENTOMOLOGY.WISC.EDU/MBCN/MBCN.HTML

Northwest Michigan Horticultural Research Station: HTTP://WWW.MAES.MSU.EDU/NWMIHORT

Nova Scotia Fruit Growers Association — Nova Scotia Apples: HTTP://WWW.NSAPPLES.COM/PHOTOID.HTM

Ohio ICM Fruit News: HTTP://IPM.OSU.EDU/FRUIT

Ontario Ministry of Agriculture, Food, and Rural Affairs — Crops Home Page: HTTP://WWW.OMAF.GOV.ON.CA/ENGLISH/CROPS/INDEX.HTML

Réseau-Pommier du Québec: HTTP://WWW.AGRIRESEAU.QC.CA/RESEAUPOMMIER/DEFAULT.ASP

University of Massachusetts Fruit Advisor: HTTP://WWW.UMASS.EDU/FRUITADVISOR

Vermont/Northeastern United States — The Virtual Orchard: HTTP://VIRTUALORCHARD.NET

About Our Sponsors

PALS and the authors would like to thank the following companies for sponsoring this guide:

Arysta LifeScience
BASF Agricultural Products
Bayer CropScience LP
Cerexagri, Inc.
Chemtura Crop Protection
Dupont Crop Protection
FMC Corporation
Spectrum Technologies, Inc.
Syngenta Crop Protection
Valent USA

For more information about our sponsors, see their ads on pages 233–237.

About PALS

Plant and Life Sciences Publishing (PALS) is a program of the Horticulture Section in the School of Integrative Plant Science, in the College of Agriculture and Life Sciences at Cornell University. PALS assists university faculty and their colleagues in publishing, marketing, and distributing books for small farmers, gardeners, land owners, workshops, college courses, and consumers. The University of Maine is a member university.

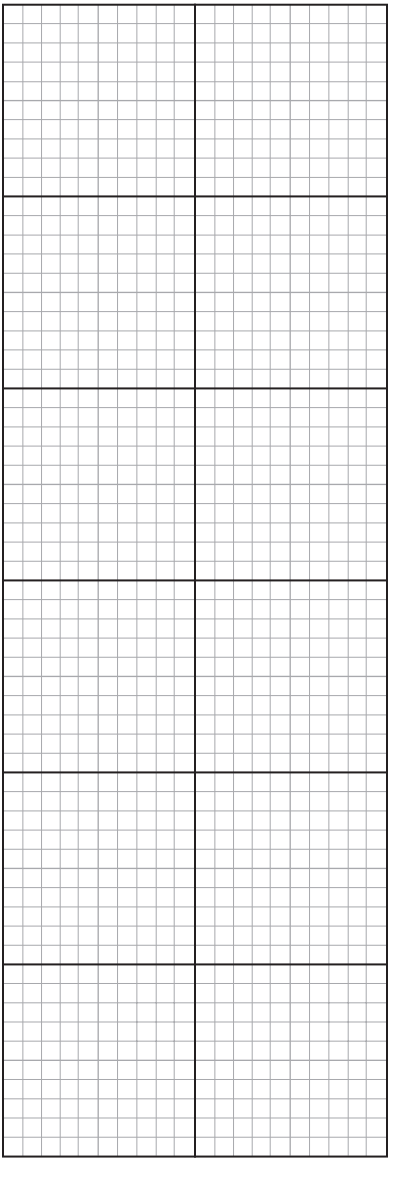
PALS books are practical and comprehensive. They are based on decades of grower experience and university research. Book categories include garden and landscape, small-scale farming, small-fruit production, composting, pasture-based livestock production, rural-land management and personal finance. The gardening, small-scale farming, small-fruit production, rural-land management and pasture-based livestock production books were written for the Northeast, Mid-Atlantic and Great-Lakes states and adjoining Canadian provinces. Most contain knowledge that will be useful to a wider audience.

Visit PALS web site for descriptions of books distributed.

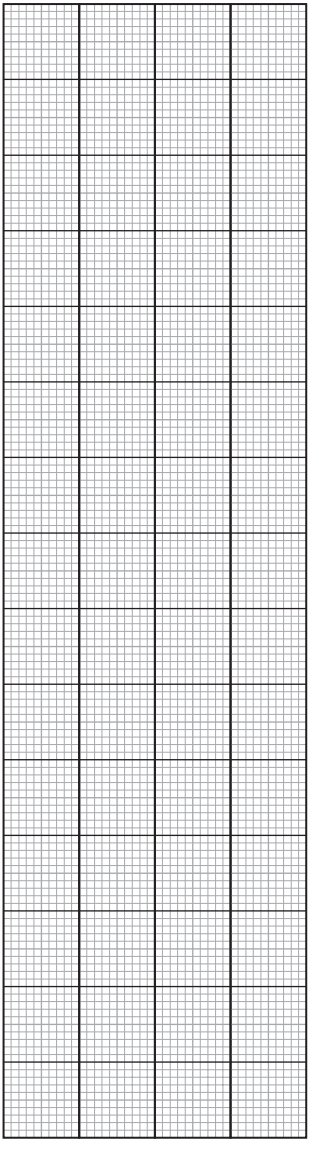
Plant and Life Sciences Publishing (PALS)
34 Plant Science
Ithaca, New York 14853
Phone: (607) 255-7654
E-mail: palspublishing@cornell.edu • Web site: palspublishing.com
Marty Sailus, PALS Director

Quadrille Grids – Tenths of an Inch and Millimeters

Tenths of an Inch



Millimeters



How to Use This Guide

Insect and Mite Diagnostic Keys

Disease Diagnostic Keys

Insect and Mite Pests

Beneficial Insects, Spiders, and Mites

Diseases

Glossary

Index/Cross-Reference

TREE FRUIT FIELD GUIDE

to Insect, Mite, and Disease Pests and Natural Enemies of Eastern North America

Recycled Paper
NRAES–169

ISBN 1-933395-02-8
9 781933 395029