CRBIB#405199

DRAFT

ORCHARD INVENTORY, IDENTIFICATION & MANAGEMENT PLAN

for the

HARTWELL TAVERN & NOAH BROOKS PROPERTIES

MINUTE MAN NATIONAL HISTORICAL PARK
Concord, Massachusetts



prepared for
Minute Man National Historical Park
by the
Olmsted Center for Landscape Preservation

ORCHARD INVENTORY, IDENTIFICATION AND MANAGEMENT PLAN

prepared for
MINUTE MAN NATIONAL HISTORICAL PARK

by the
OLMSTED CENTER FOR LANDSCAPE PRESERVATION

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DRAFT

PROJECT SUMMARY

The Olmsted Center for Landscape Preservation provided technical assistance with the inventory and identification of existing apple varieties on the Noah Brooks and Hartwell Tavern Properties within Minute Man National Historical Park. Field work was carried out in 1994 and 1995. In 1994 apples were collected from the northeast corner of the Noah Brooks property and the eastern half of the Hartwell Tavern property and sent to Geneva Agricultural Experiment Station for identification. In 1995 there were no apples on the trees at the Hartwell Tavern and some small apples were collected from the apple trees at the Noah Brooks property in the field to the east of the house and barn. Maps are included to illustrate the trees addressed in the project.

Apples of satisfactory quality were collected in 1994. However, 1995 was not a good year for apple identification at Minute Man NHP. Prolonged wet, cool weather at the time of flowering and petal fall increased fungal damage. In addition there was evidence of damage to flowers by tarnished plant bug. A small quantity of fruit did set, but was undersized and mishapen. The specialists at the New York Geneva Agricultural Experiment Station indicated that the condition of specimens made them extremely difficult to identify. In previous years with a dry spring, the fruit quality has been better, even without spraying. No apple trees at Minute Man were sprayed for this project. If further identification work is desired, a low input spray program would help to ameliorate the effects of weather, pests, and diseases.

During this project Olmsted Center staff focused on a) mapping existing apple and pear trees, b) identifcation of varieties, c) documentation of fruit characteristics through photographs, and d) an orchard managment plan with pruning, IPM and other maintenance recommendations. Detailed information relating to the project is contained in this notebook.

Based on discussions between Charlie Pepper at the Olmsted Center and Blaise Davi at Minute Man NHP, the following additional work will be carried out by the park and/ or the friends group: a) clearing of vegetation, b) research to determine appropriate apple varieties, c) the size and spacing of the orchard, d) the ordering and planting of the trees, e) maintenance practices and equipment. There are many sources of information that will be helpful in pursuing this work. The Massachusetts Horticultural Society library in Boston contains several excellent references on early apple varieties and orchard management techniques. There are also several more recent publications that review the history of apple varieties. Publications and sources of information are listed in both the Orchard Management Plan and in the appendices.

REQUEST FOR TECHNICAL ASSISTANCE

FROM THE OLMSTED CENTER FOR LANDSCAPE PRESERVATION
REGIONAL CULTURAL LANDSCAPE PROGRAM

Park Name: Minute Man National Historical Park

Project Name: Apple Orchard Tree Identification and Propagation - Noah Brooks Tavern, Hartwell Tavern

Park Priority: 2

Contact Person: Blaise Davi Phone #: 508 369 6993

Related RMP Project Number: MIMA-C-040.000, MIMA-N-011.000

1. __X__ Preservation Maintenance
___ Cyclic Preservation Work
_X_ Resource Protection
___ Emergency Stabilization
_X_ Maintenance Planning

2. ___ Preservation Planning

3. ___ Joint Projects

Is this project another phase of an existing Olmsted Center Project?
____ Yes __X_ No

Has this project been previously submitted to the Olmsted Center?
____ Yes __X__ No

Please describe the need and urgency for this project, including a description of the cultural landscape resource (attach additional information if necessary).

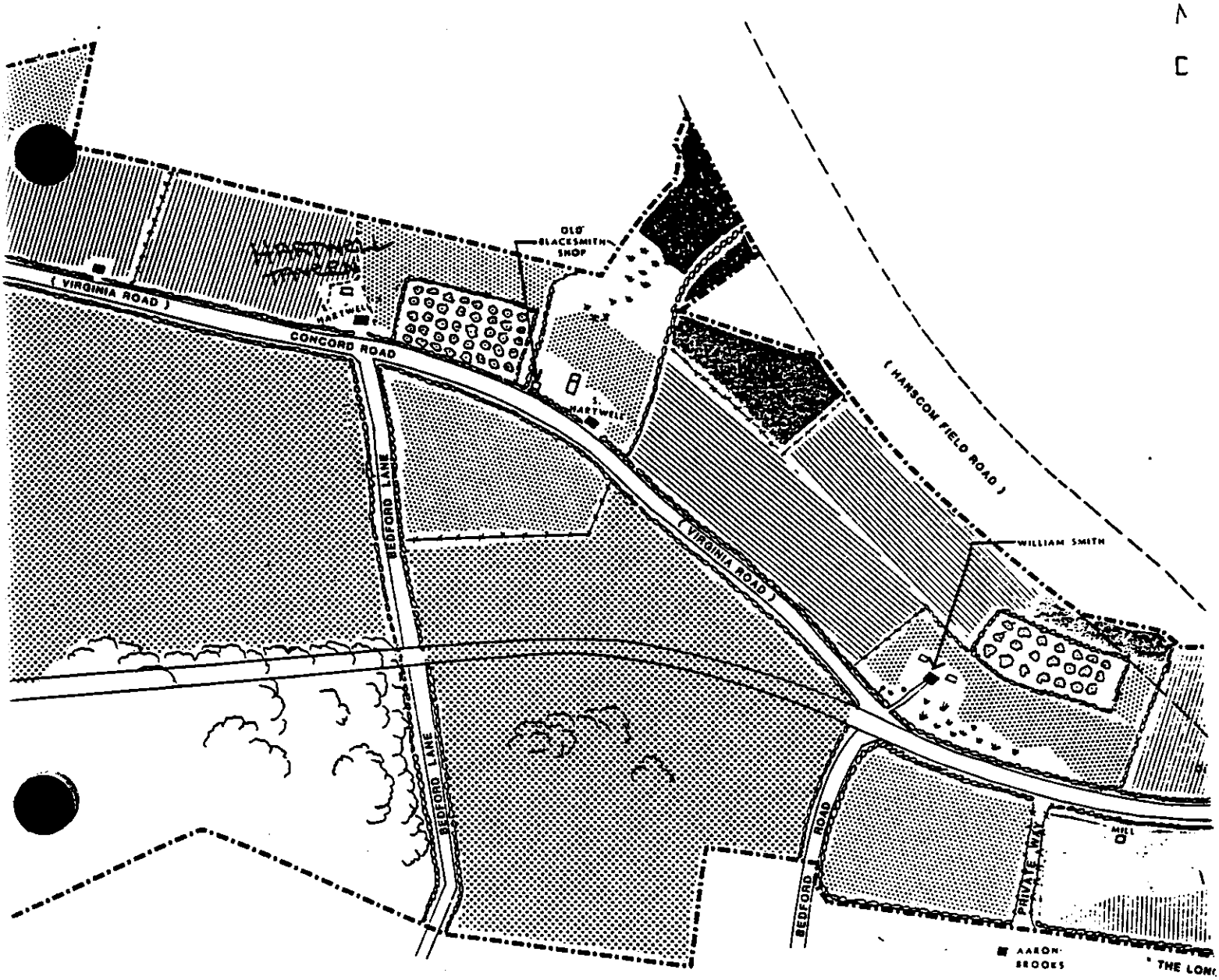
The 4 acre field east of Noah Brooks Tavern and the 3 acre field east of Hartwell Tavern have both been identified as sites for orchard reintroduction. A newly completed Cultural Landscape Report documents the historical use of these fields as orchards in the making of cider and for commercial profit. The CLR states..."Two crafts were practiced...one was cider making, which is best interpreted at Hartwell Tavern. ...Ephraim Hartwell reported 40 barrels of cider in 1749". Noah Brooks Tavern was purchased in 1857 by Samuel Hartwell..." and established a thriving orchard and market garden. By 1880 he had ten acres of apples and 5 of peach." Both sites are key cultural landscapes as it relates to the agricultural history of this site. An amendment to the parks enabling legislation calls for the preservation and interpretation of these historically significant agricultural landscapes. This project is needed to save existing significant apple trees that are still viable and significant to these sites, and to re-establish the site before further landscape integrity is lost.

Please describe the scope of services and technical assistance requested in this project. If this is a multi-year project, please briefly describe the scope of work for each fiscal year (attach additional information if necessary).

This project would be a one year project. We would require the assistance of the Olmsted Center for the following: 1. The identification of existing apple tree varieties; 2. Assessment of tree condition and maintenance requirements; 3. Propagation of transplantable stock from these existing trees. If propagation is not possible then recommendations for new nursery stock that can be substituted.

Please describe the anticipated contributions by both the Olmsted Center and the park (e.g. describe anticipated duration of project, park contributions, staff assistance, travel, housing, equipment, etc.).

Olmsted Center would perform the inventory, condition assessment, maintenance recommendations and propagation techniques for the eight existing apple trees. The park would supply any assistance with equipment or tools, as well as supply maintenance support for field or nursery related items. The anticipated duration for this project would be as follows:
- Inventory, assessment and maintenance recommendations - 3 days
- Apple tree propagation - 3 days (this does not include Arnold Arboretum time or nursery time as plants mature)



MINUTE MAN NATIONAL HISTORICAL PARK

SCALE

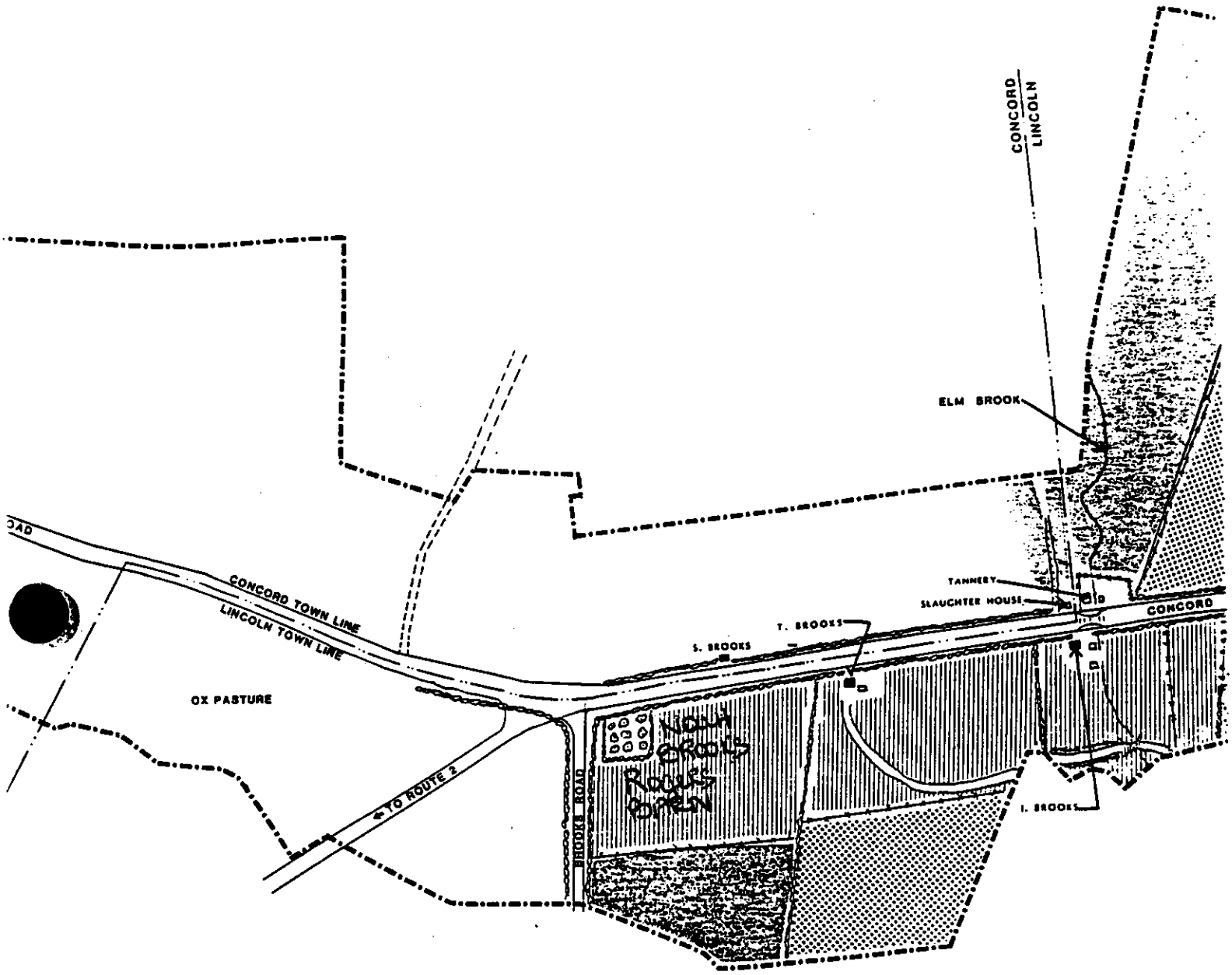
LEGEND

- House
- Barn Or Other Outbuilding
- Stone Wall
- Fence
- Bridge
- Orchard
- Tilled Field
- Rocky Field
- Pasture
- Meadow
- Swamp
- Woodland
- names in brackets: Modern Road Name
- in print: Old road Name

"The Scene of the Battle, 1775"
Historic Grounds Report
Joyce Lee Malcolm

MAP NUM

District IV

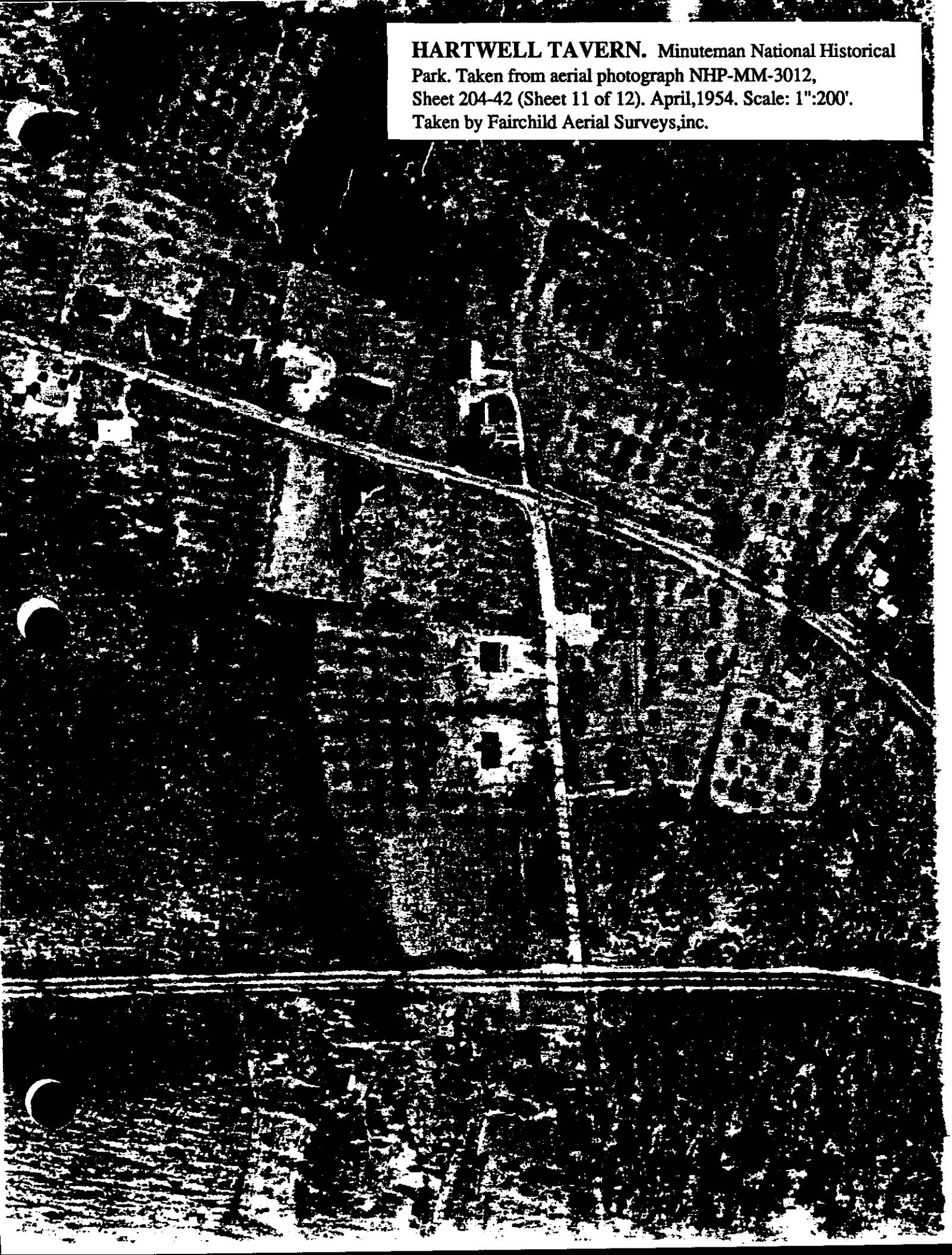


MINUTE MAN NATIONAL HISTORICAL PARK

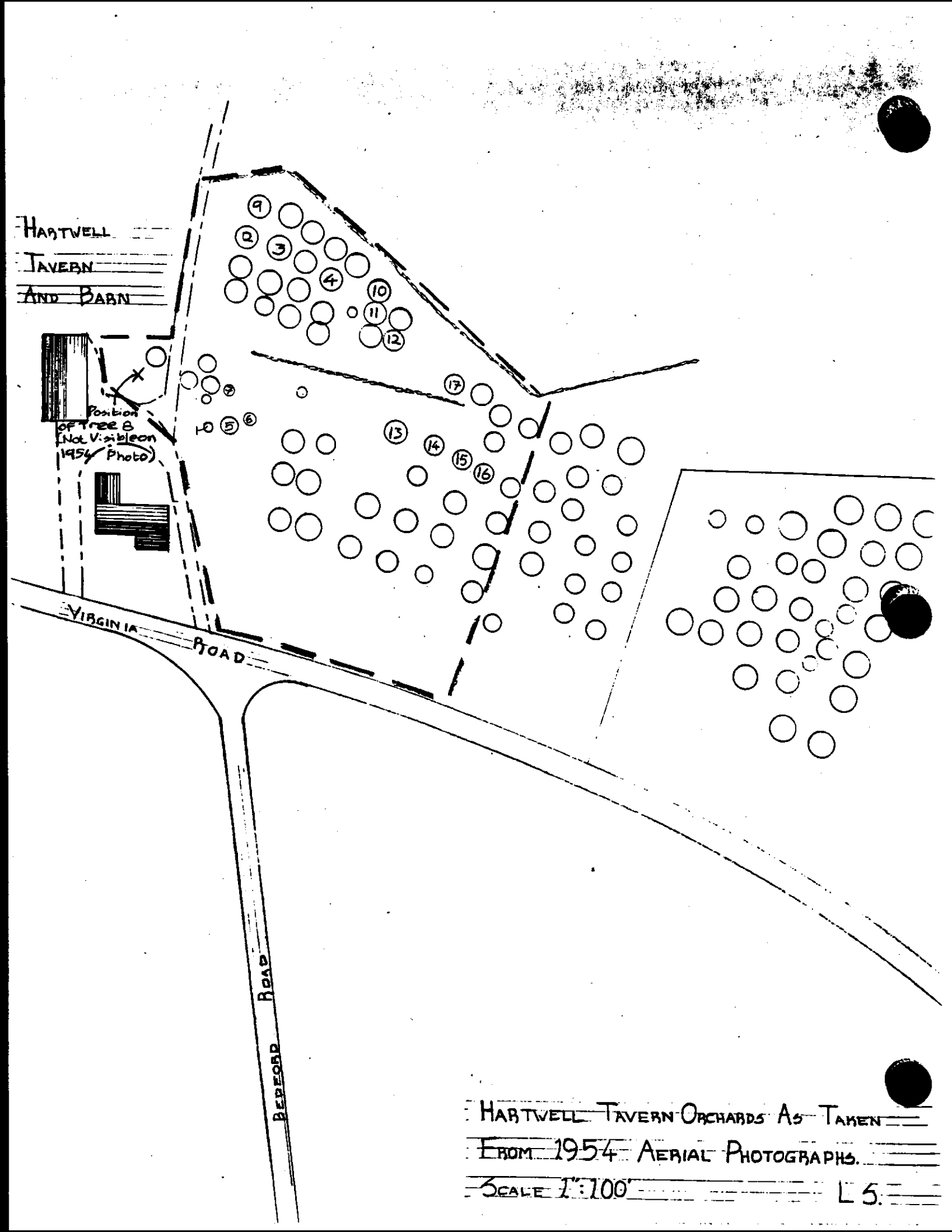
LEGEND

- House
- Barn Or Other Outbuilding
- Stone Wall
- Fence
- Tree
- Orchard
- Tilled Field
- Rocky Field
- Pasture
- Meadow
- Swamp
- Woodland
- (names in brackets) Modern Road Name
- (names in print) Old road Name

"The Scene of the Battle, 1775"
Historic Grounds Report
Joyce Lee Malcolm



HARTWELL TAVERN. Minuteman National Historical Park. Taken from aerial photograph NHP-MM-3012, Sheet 204-42 (Sheet 11 of 12). April,1954. Scale: 1":200'. Taken by Fairchild Aerial Surveys,inc.



HARTWELL TAVERN ORCHARDS AS TAKEN FROM 1954 AERIAL PHOTOGRAPHS.

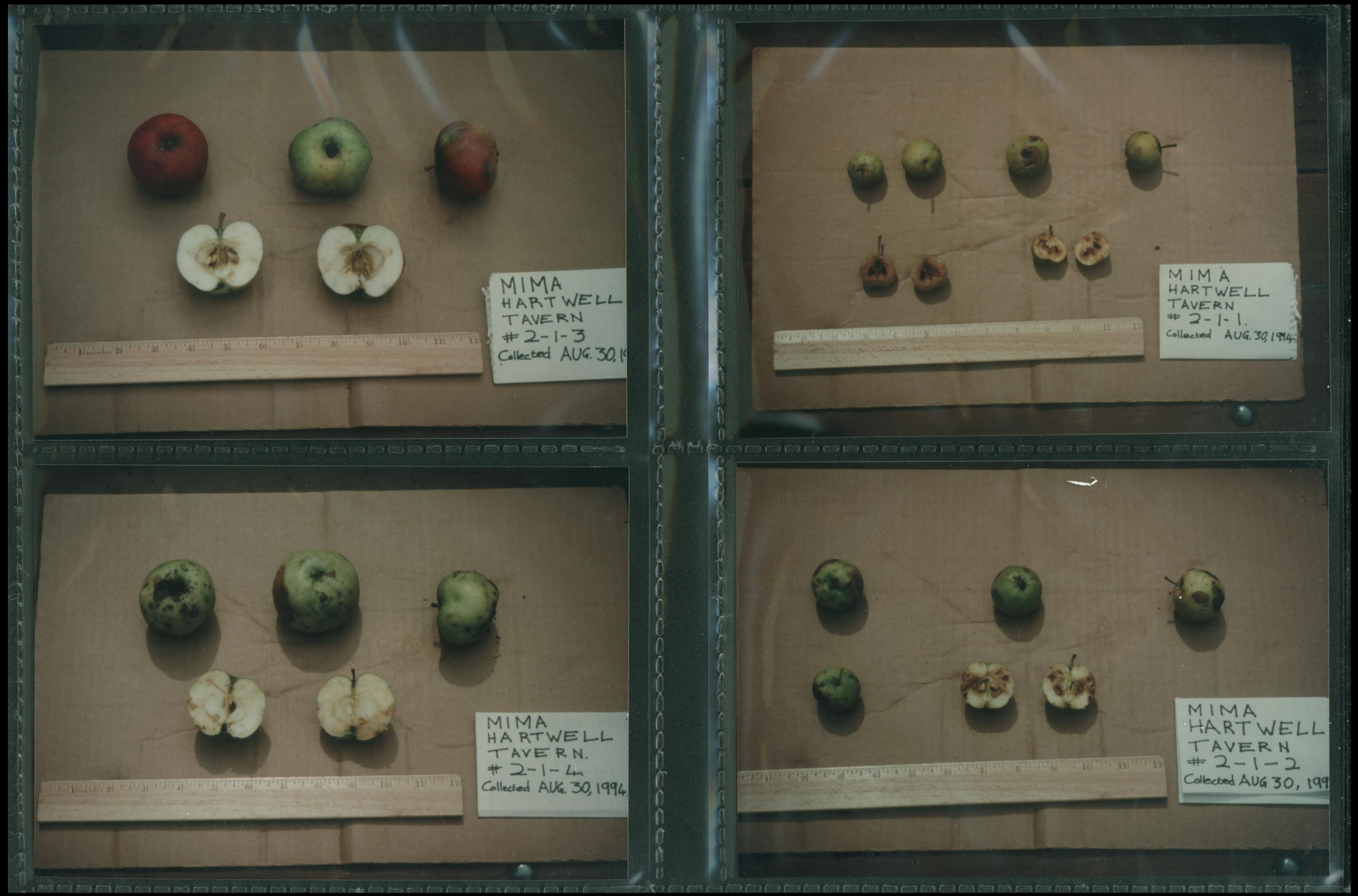
SCALE 1":100' L 5.

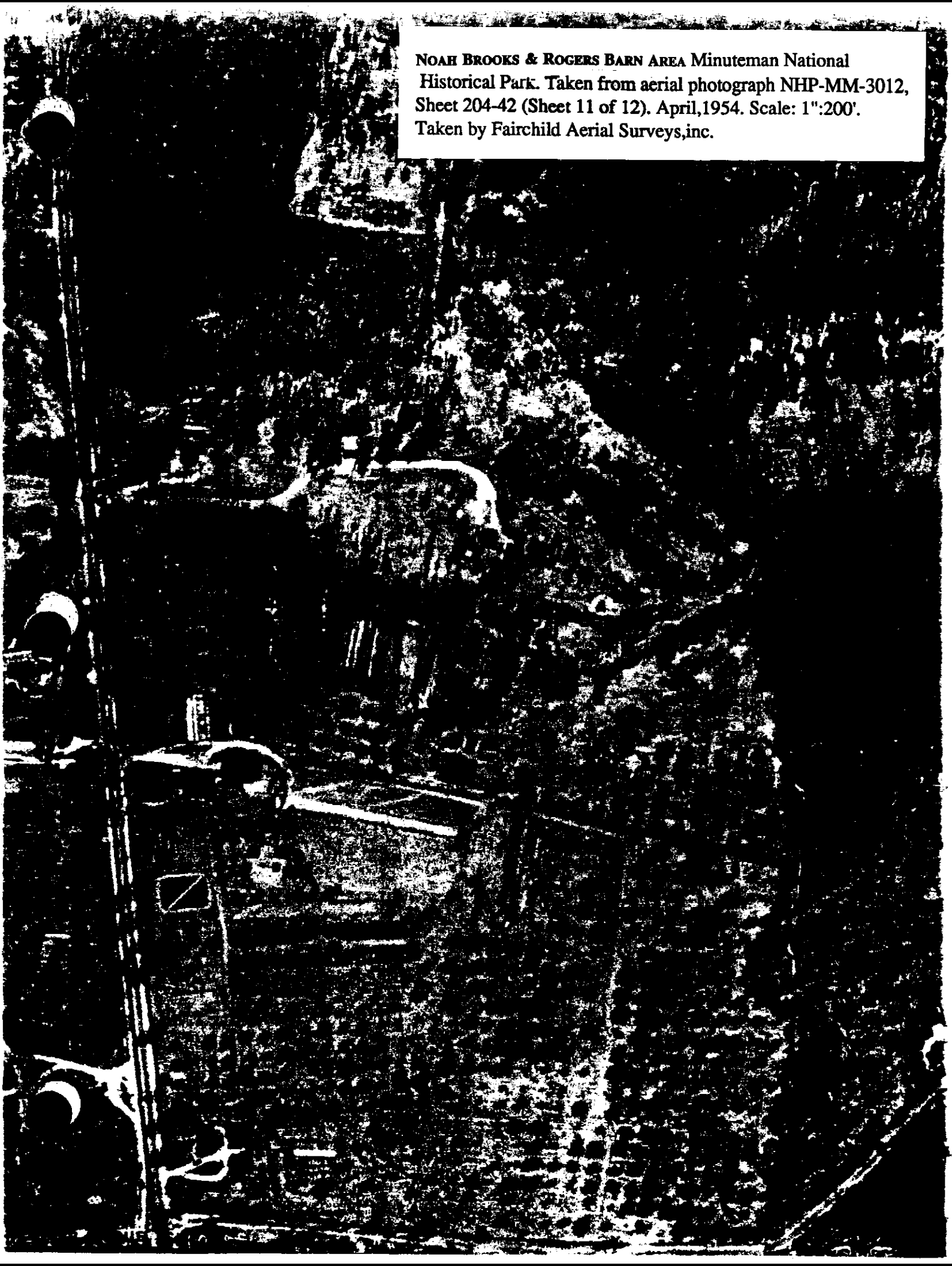
HARTWELL TAVERN

Id#	Name	Fruit	Identified By	Photo (tree)	Photo (fruit)
1	Pyrus sp. (seedling)	collected	Geneva*	11/1/94	8/30/94
2	Malus sp. (rootstock seedling)	collected	Geneva*	-	8/30/94
3	Malus 'Ben Davis'	collected	Geneva*	-	8/30/94
4	Malus sp. (may be seedling)	collected	Geneva*	-	8/30/94
5	Pyrus sp.	no fruit	-	11/1/94	-
6	Pyrus sp.	no fruit	-	11/1/94	-
7	Pyrus sp.	no fruit	-	11/1/94	-
8	Pyrus sp.	no fruit	-	11/1/94	-
9	Malus sp. (dead)	-	-	-	-
10	Malus sp. (dead)	-	-	-	-
11	Malus sp.	no fruit	-	-	-
12	Malus sp.	no fruit	-	-	-
13	Pyrus sp.	no fruit	-	-	-
14	Malus sp. (dead)	-	-	-	-
15	Malus sp. (dead)	-	-	-	-
16	Malus sp. (dead)	-	-	-	-
17	Malus sp. (dead)	-	-	-	-

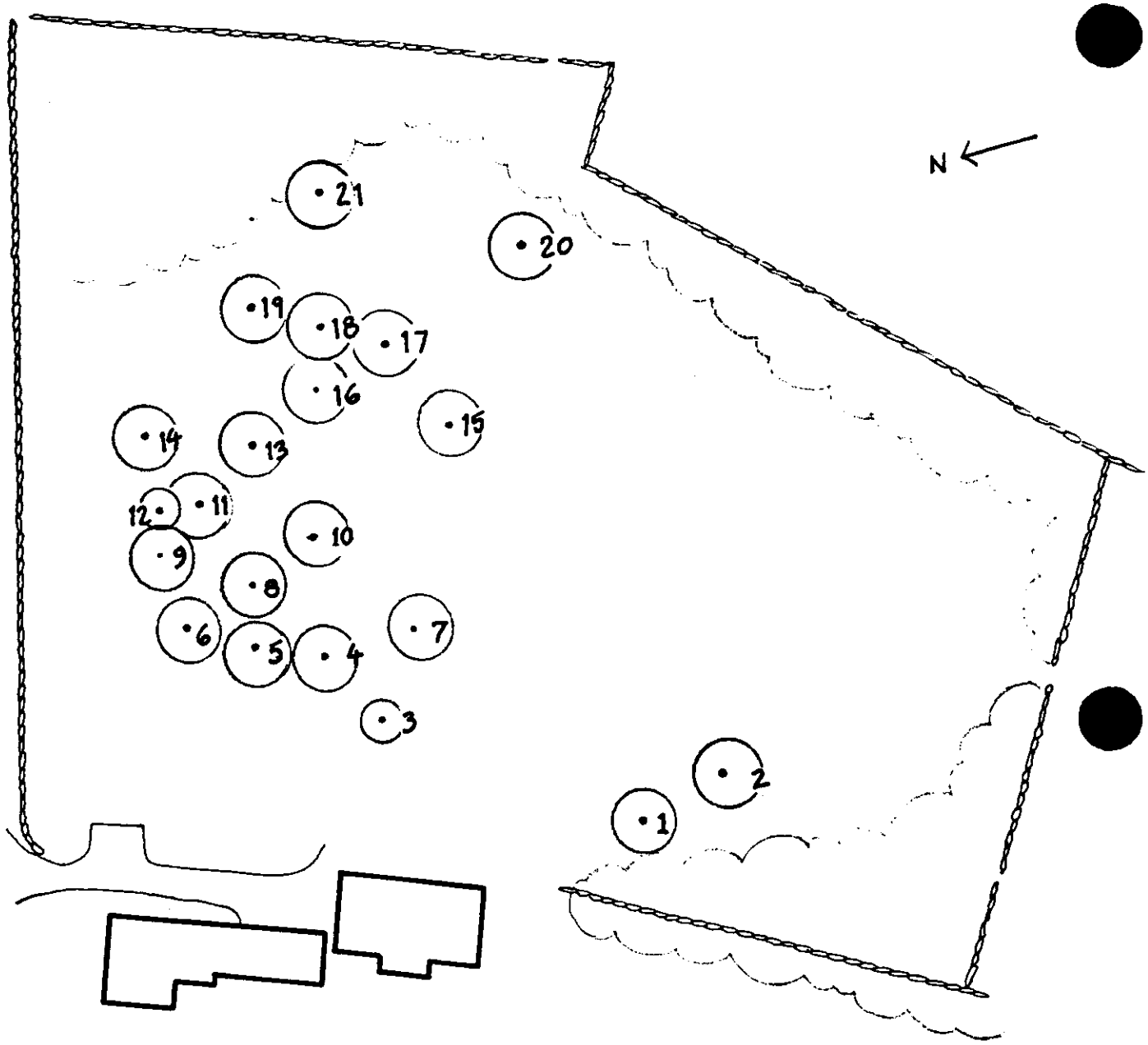
* Identified by Ken Livermore, Dr. Roger Way and Robert Lamb, at the NY Agricultural Experiment Station, Geneva, NY, on September 21, 1995.

Field inventory and inspection carried out by Margie Coffin and Lindsay Self, Olmsted Center for Landscape Preservation, Fall 1994 and 1995.


MIMA
HARTWELL
TAVERN
#2-1-3
Collected AUG. 30, 1
MIMA
HARTWELL
TAVERN
#2-1-1.
Collected AUG. 30, 1994
MIMA
HARTWELL
TAVERN.
#2-1-4
Collected AUG. 30, 1994
MIMA
HARTWELL
TAVERN
#2-1-2
Collected AUG 30, 199



NOAH BROOKS & ROGERS BARN AREA Minuteman National Historical Park. Taken from aerial photograph NHP-MM-3012, Sheet 204-42 (Sheet 11 of 12). April,1954. Scale: 1":200'. Taken by Fairchild Aerial Surveys,inc.



ORCHARD INVENTORY
NOAH BROOKS & ROGERS BARN AREA

MINUTE MAN NATIONAL HISTORICAL PARK
Concord, Massachusetts

Notes: Orchard inventory conducted in summer 1995 by Olmsted Center for Landscape Preservation. See attached sheets for condition and identification notes. Locations based on 1993 survey done by D. Clayton, Boston University. Map drawn by M. Coffin, not to scale.

NOAH BROOKS PROPERTY - EAST OF HOUSE AND BARN

Id#	Name	Fruit	Identified By	Photo (tree)	Photo (fruit)
1	Malus	none	-	-	-
2	Malus	under-sized	too mis-shapen	-	Sept 14, 1995
3	Malus	none	-	-	-
4	Malus	none	-	-	-
5	Malus	none	-	-	-
6	Malus	none	-	-	-
7	Malus	none	-	-	-
8	Malus	none	-	-	-
9	Malus 'Red Delicious'	under-sized	Geneva*	-	Sept 14, 1995
10	Malus	none	-	-	-
11	Malus 'Baldwin' (tentative)	under-sized	Geneva*	-	Sept 14, 1995
12	Malus 'Stayman Winesap' (tentative)	under-sized	Geneva*	-	Sept 14, 1995
13	Malus	none	-	-	-
14	Malus 'Stayman Winesap' (tentative)	under-sized	Geneva*	-	Sept 14, 1995
15	Malus	none	-	-	-
16	Malus	none	-	-	-
17	Malus	none	-	-	-
18	Malus	none	-	-	-
19	Malus	none	-	-	-
20	Malus	none	-	-	-
21	Malus	none	-	-	-

* Identified by Ken Livermore, Dr. Roger Way and Robert Lamb, at the NY Agricultural Experiment Station, Geneva, NY, on September 21, 1995.

Field inventory and inspection carried out by Margie Coffin, Olmsted Center for Landscape Preservation, Fall 1995.





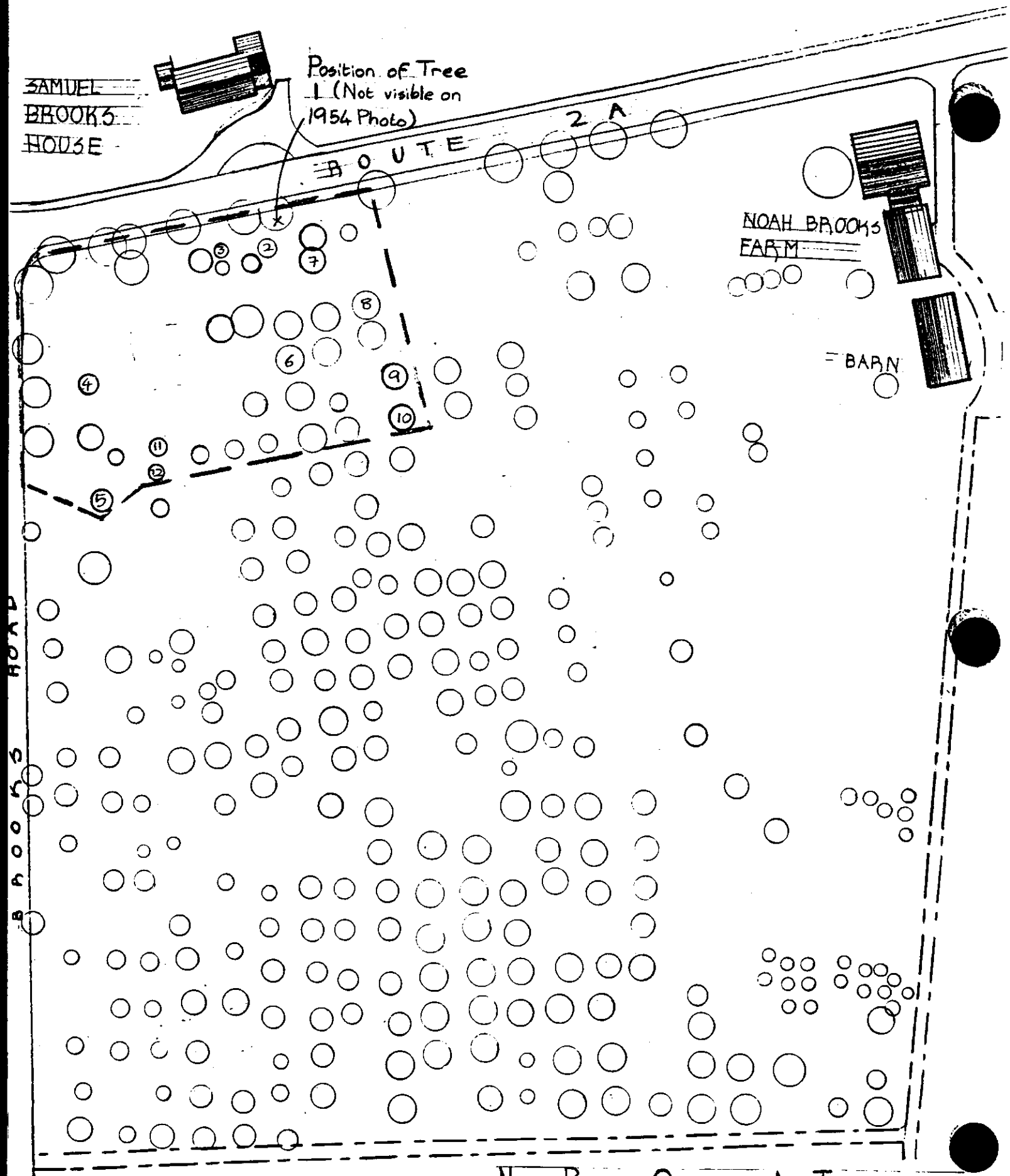
PHOTO ★ GUARD # 3205
LIGHT IMPRESSIONS®
Rochester, NY


#11 9·19·95
MIMA· Noah Brooks


#12 9·19·95
MIMA-Noah Brooks



NOAH BROOKS & ROGERS BARN AREA Minuteman National Historical Park. Taken from aerial photograph NHP-MM-3012, Sheet 204-42 (Sheet 11 of 12). April,1954. Scale: 1":200'. Taken by Fairchild Aerial Surveys,inc.



NOAH BROOKS ORCHARDS AS TAKEN FROM 1954 AERIAL PHOTOGRAPHS.

SCALE 1" 100'

L5

NOAH BROOKS PROPERTY - NORTHEAST CORNER

Id#	Name	Fruit	Identified By	Photo (tree)	Photo (fruit)
1	Malus 'Ribston'	collected	Geneva*	11/1/94	8/30/94
2	Malus 'Lady Apple'	collected	Geneva*	-	-
3	Malus sp. (dead)	-	-	11/1/94	-
4	Malus sp. (dead)	-	-	11/1/94	-
5	Malus 'McIntosh'	collected	Geneva*	11/1/94	-
6	Malus 'Duchess Oldenburg'	collected	Geneva*	11/1/94	-
7	Malus 'Duchess Oldenburg'	collected	Geneva*	11/1/94	-
8	Malus sp.	no fruit	-	11/1/94	-
9	Malus 'Duchess Oldenburg'	collected	Geneva*	11/1/94	-
10	Malus sp.	no fruit	-	11/1/94	-
11	Malus sp.	no fruit	-	11/1/94	-
12	Malus sp.	no fruit	-	11/1/94	-

* Identified by Ken Livermore, Dr. Roger Way and Robert Lamb, at the NY Agricultural Experiment Station, Geneva, NY, on September 21, 1995.

Field inventory and inspection carried out by Margie Coffin and Lindsay Self, Olmsted Center for Landscape Preservation, Fall 1994 and 1995.


MIMA.
NOAH BROOKS
FARM.
1
Collected AUG 30, 1994.

FEATURE DATA - Malus sp. (apple)

AREAS: Noah Brooks Farm & Hartwell Tavern

IDENTIFICATION: Geneva Agricultural Exp. Station, 1994 & 95

HISTORIC SIGNIFICANCE/ APPEARANCE/ INTENT:

Much of the land within Minute Man NHP was cleared and in agricultural production at the time of the American Revolution. There were orchards at the Hartwell Tavern, the Noah Brooks Farm, the William Smith House and other locations. Apples harvested from these orchards were used for the production of hard cider. Changes in the tax structure led to the abandonment of many of the cider orchards. In the early 1900's many orchards were re-planted with trees bearing varieties of dessert apples to sell to the expanding Boston market. In 1992, William Coli, Integrated Pest Management Specialist at the University of Massachusetts, inspected the orchards and incorporated his field notes into a nationwide inventory of orchards with in the NPS (notes attached in appendices).

DESCRIPTIVE CHARACTERISTICS:

'Baldwin' - located on the Noah Brooks property, east of the house and barn. Ripens very late in the season, in October. It is also known as Woodpecker and Butters Apple and was discovered in about 1750 as a chance seedling on the farm of Mr. John Ball Wilmington near Lowell, Mass. Colonel Baldwin of Woburn propagated and distributed the apple throughout Eastern Massachusetts in the 1780's. The apple was considered the most popular in New England throughout the 1800's. Commercial production diminished in the 1900's because the variety tends to produce extremely heavy then light crops in alternate years. The fruit is large and roundish in shape, the yellow skin is nearly covered with crimson. The flesh is crisp and subacid. This hard apple stores well through the winter.

'Ben Davis' - located at Hartwell Tavern. Ripens in the late season, typically in October. In fact it was typically planted in warmer climates because it requires a long season to fully ripen. The variety may have originated in Tennessee, Kentucky, or Virginia in the early 1800's. By the turn of the century (1900's) 'Ben Davis' was the most widely grown apple across the United States. It was favored because the tree is very hardy, healthy and vigorous and young trees bear fruit early. Fully ripened fruit is large, brightly colored, thick-skinned and stores well. It is characterized by its round, somewhat oblong shape, deep, acute stem cavity, waxy, bright skin, with clear yellow or greenish, mottled and washed with bright deep red. The flesh is whitish, slightly yellow and course but not very crisp. The flavor is aromatic, juicy, mildly subacid and good. The tree tends to produce a heavy canopy and thus requires pruning to maintain an open structure. The appearance of 'Ben Davis' apples varies in different parts of the country.

'Duchess Oldenburg' or 'Duchess' or 'Oldenburg' - located in northwest corner of Noah Brooks property, across from the Sam Brooks house. Ripens mid- season, typically in September. The variety originated in Russia and became extremely popular in the US in the 1800's due to its extreme hardiness. Its success led to the import of many other Russian apple varieties. It was tested by Robert Manning , Supt. of the Test Garden of the Mass. Horticultural Society in Salem who published the following description in 1838: "A valuable and handsome apple said to be of Russian origin. The size is middling, form round and rather flat; skin of beautiful yellow, striped with red; flavor very pleasant and good. It bears well and ripens in September and October." The apple was grown by commercial orchards in part because the apples handled and shipped well if kept cool. The tree is medium in size, form is upright and spreading to roundish. The fruit flesh is tinged with yellow, firm, crisp, tender, juicy, sprightly subacid, and generally favored as a culinary apple. It is considered too acidic for a good dessert apple.

'Lady Apple' or 'Api' - located in northwest corner of Noah Brooks property, across from the Sam Brooks house. Ripens late in the season and is a small dessert apple known for its beautiful color and delicate high flavor. In the 1905 edition of Apples of New York, Beach describes it as one of the most

desirable apples for fancy trade at the holiday season. It originated in France and was "sparingly disseminated throughout the US. It may be the Appian apple of the Roman Empire. The fruit is relative expensive to produce due to several factors: the tree bears heavily biennially; it is highly susceptible to apple scab and insect damage; young trees are slow to bear fruit; and the tree form is dense and upright and the fruit small, making it difficult to care for and harvest. the fruit is small to very small and uniform in size and shape. The skin is thick, tough, smooth, glossy, with a deep red blush which is often irregular and sharply outlined against the clear pale yellow or which in ground color. The skin color varies from creamy yellow in the shade to glossy crimson in sun. There are several varieties in the Lady Group including Star Lady, Large Lady, Rose-colored Lady, Black Lady, Helen and Highland Beauty.

'Macintosh' - located in northwest corner of the Noah Brooks property. Ripens in the middle of the season, typically in September. It originated as a chance seedling on the McIntosh homestead in Matilda township, Ontario, where Allan McIntosh began propagating it in the 1870's. It is part of the Fameuse group. The tree is a strong and hardy and is widely grown in commercial orchards. The fruit is roundish to somewhat oblate with a deep red and pale yellow skin color. The flesh tender and perfumed. The apple is typically identified by its smell.

'Red Delicious' - located on the Noah Brooks property, east of the house and barn. Ripens in September. It originated in 1872, at the farm of Jesse Hiatt in Peru, Iowa. In 1894, a nursery purchased the rights for propagation. Now with 300 variations the 'Red Delicious' is the most popular and widely grown apple in the United States. The fruit is red, large, round and elongated, and waxy. The flesh is tender, juicy, white, and crisp. The flavor is mild.

'Ribston' - located in nw corner of the Noah Brooks property, across from the Sam Brooks house. Ripens mid-late September and does not keep well. The variety originated in England were it was valued as a dessert apple. Part of the Hubbardston group, it was grown throughout northern New England because of its hardiness, vigor and longevity. Tree form is upright, spreading and irregular. Fruit is medium in size, uniform in shape. Skin is smooth or slightly rough with russet, deep yellow or greenish yellow over spread with dull red deepening to carmine stripes and splashes with conspicuous white dots. Flesh is tinged with yellow, firm crisp, juicy, aromatic, rich, sprightly subacid and very good.

'Stayman Winesap' - located on the Noah Brooks property, east of the house and barn. Ripens in early October. It originates from seed of Winesap in Leavenworth, Kansas by Dr. J. Stayman in 1866. The variety did not receive special attention until after 1890, when its good qualities were discovered. The fruit is medium to large, flattened at the base, and rounding toward the basin. The green becoming yellowish skin is often covered or striped with a dull red with large and conspicuous russet and gray dots (often heavy in the stem cavity). The flesh is yellow or greenish, firm, tender, juicy, and subacid.

seedling - located at Hartwell Tavern. Apples tend to cross-pollinate and do not breed true to their parent plant. In the event that an apple drops, a seed germinates, and grows to maturity, the fruit produced from this tree exhibits composition of characteristics of the two parent trees. When settlers first came to America, most of them brought seeds from the favored trees of their homeland. Farmers selected, named, and propagated by cuttings those seedlings that had desirable characteristics. Today pomologists continue to create crosses between different fruit varieties to find new varieties that are pest and disease resistant as well as flavorful.

rootstock seedling - located at Hartwell Tavern. Most apple varieties are grafted onto a rootstock. If the graft is poor or the scion wood dies back, the rootstock may generate vegetative growth. The resulting tree exhibits the characteristics of the rootstock.

Sources of information:

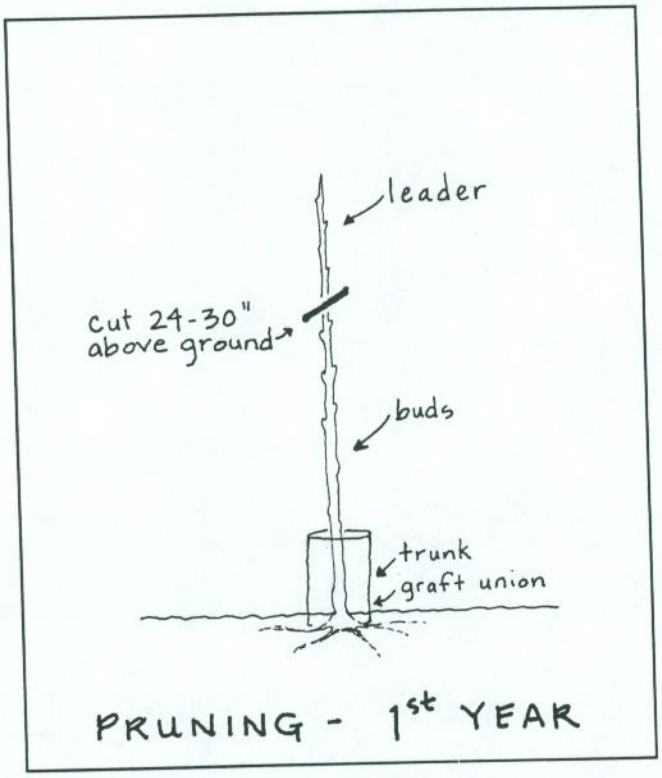
- Beach, S. A. The Apples of New York, I and II. Albany: J. B. Lyon Company, Printers. 1905
- Burford Brothers Apple Catalog, Monroe, Virginia, 1993).
- Manning, Robert. Book of Fruits. Salem: 1838. Second edition with title, New England Fruit Book. Revised by John M. Ives. Salem: 1844.

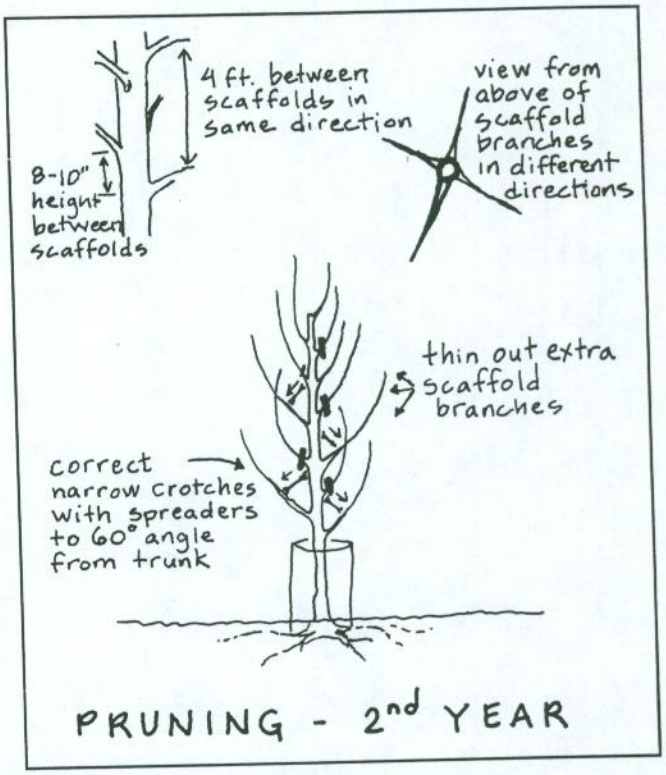
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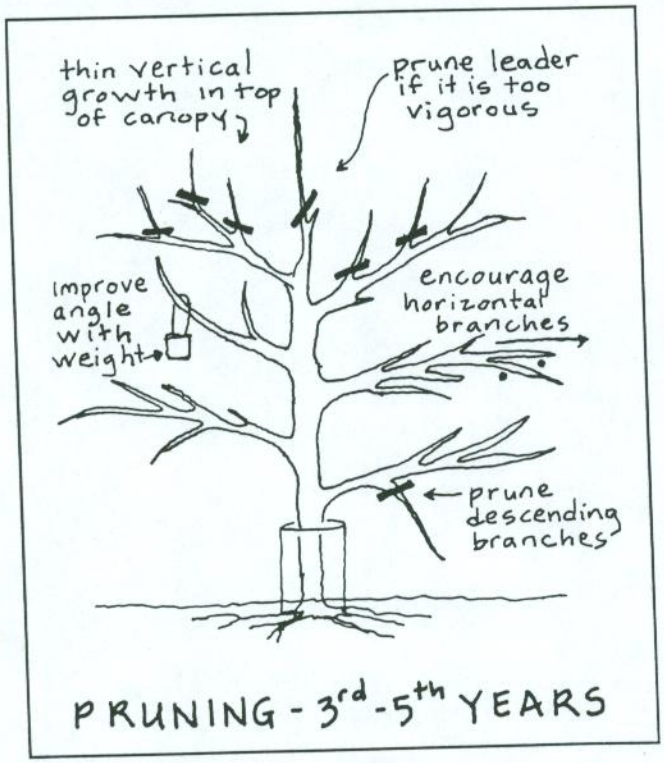
DECEMBER, JANUARY, FEBRUARY, MARCH -

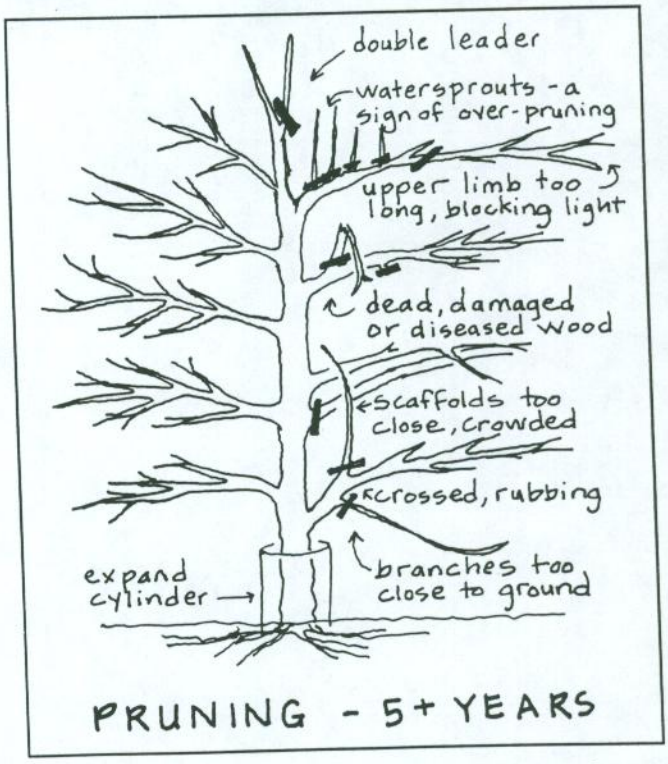
to preserve the health of the tree:

Prune in late winter, early spring to control structure of overall tree. Heavy cuts of branches with a diameter of 1" or more should be avoided since they induce excessive water-sprout growth. Pruning is also done during the summer as described in June/July.







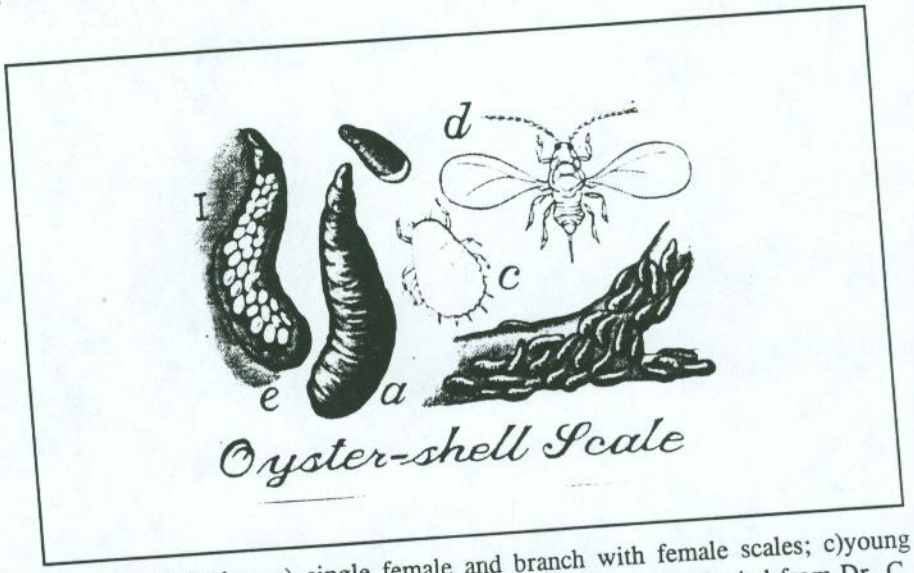


Prune young fruit trees in late winter or early spring to encourage good structure.

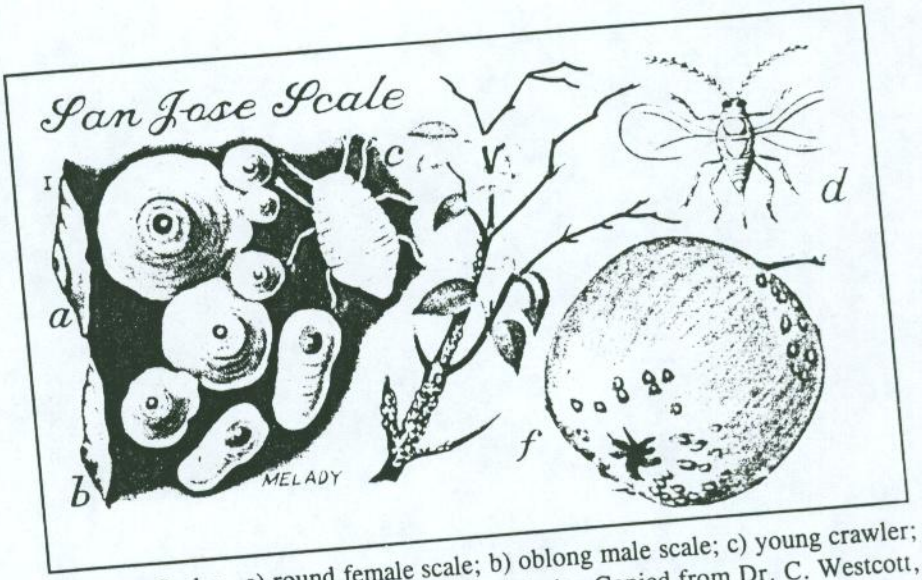
Prune older trees in late winter or early spring to maintain good structure and promote vigorous fruit production.

When pruning apple trees, inspect outer branches and trunk for oyster-like scales on bark caused by oystershell scale. Also inspect crevices of bark for circular scales of San Jose scale.

Low input treatment: Treat scale infestations with a spray of dormant oil in spring, just before bud break.



Oystershell Scale: a) single female and branch with female scales; c)young crawler; d) adult male; e) underside of female with eggs. Copied from Dr. C. Westcott, *The Gardener's Bug Book.*



San Jose Scale: a) round female scale; b) oblong male scale; c) young crawler; d) adult winged male; f) infested twig and fruit. Copied from Dr. C. Westcott, *The Gardener's Bug Book.*

Check Soil pH and soil nutrients. Collect several samples from each area, from the top seven inches of the soil. Mix and send one cup in a ziploc bag with $7 to: Soil Testing Lab, West Experiment Station, UMass, Amherst, MA 01003. ph (413)545-2311. Request analysis of nutrients, pH and lead. The soil pH should be between 6.5 and 7.0. If pH is much lower than 6.5, amend surface of soil with powdered or granulized limestone. If pH is above 7.0, amend soil with agricultural gypsum (calcium sulfate).

If soil or leaf analysis indicates that fertilizer is needed, fertilize in the late winter or early spring. Do not fertilize in the late summer or fall as this may increase the fruit tree's susceptibility to fireblight. If lawn area below trees is receiving fertilizer, additional fertilizer is not necessary. Also, light annual pruning throughout the tree tends to reduce the amount of fertilizer needed.

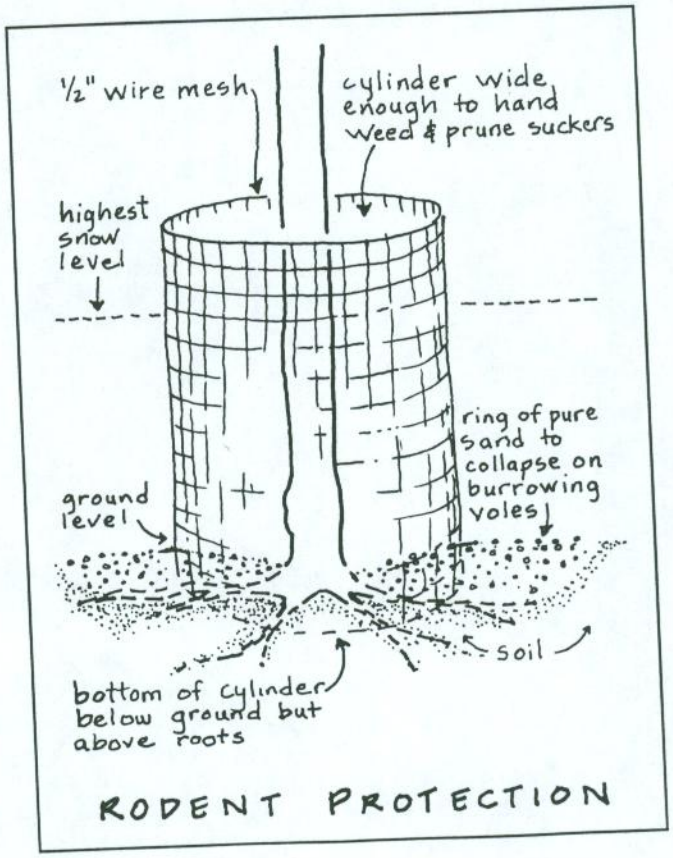
Low input fertilizer: mulch trees with composted manure (source of nitrogen and other micronutrients), bonemeal (source of phosphorus), and sul-po-mag or K-mag (source of potassium and magnesium).[1]

commercial fertilizer: broadcast granular fertilizer with composition of 5-10-10. Nitrogen content is low to minimize vegetative growth and maximixe fruit production.

Check records from previous year to determine which pests and diseases were problems.

Order integrated pest management supplies for coming season.

Protect trunks from mice and vole damage. Place tree guards around the base of each tree made of 3/8 or 1/2 inch wire mesh. Cut and rake vegetation around the bases of the trees in the late fall. Keep mulch away from the bark at the base of the trunk. If damage has been a problem in the past consider cultivating lightly and removing vegetation around the base of trees. Also try placing a one-foot wide, six-inch deep ring of crushed stones or gravel around the tree guard. Monitor for damage during the winter and early spring.



DECEMBER, JANUARY, FEBRUARY, MARCH -

to produce fruit:

Rake up dropped fruit, leaves and pruning cuttings and dispose off site in order to reduce populations of overwintering diseases and insects.

Remove mummified fruits hanging in trees to reduce overwintering diseases.

Inspect trees for overwintering pests including oystershell scale, San Jose scale, colding moth cocoons, mite and aphid eggs.

APRIL, MAY -

to preserve the health of the tree:

Complete all dormant season pruning by the beginning of April, before trees start to leaf out.

Transplant. Spring is the best time to transplant replacements trees. Water trees so that they recieve 1" of water every two weeks. For methods of watering, refer to June & July.

Check records from previous year to determine which pests and diseases were problems.

For pests that overwinter on the tree, such as aphids, oystershell scale, San Jose scale, other scales, mites, leafminers, mealybugs, whitefly, fruit tree leafroller, pear psylla, tent caterpillar, peach twig borer, leaf beetles or leafhoppers, apply a dormant oil spray when the green tips of the bud are just barely visible. Spray thoroughly in places where egg cases are typically located, including undersides of branches, branch crotches, and trunk cavities.

Low input treatment: Apply dormant oil to suffocate overwintering eggs.

Check Soil pH and soil nutrients. Collect several samples from each area, from the top seven inches of the soil. Mix and send one cup in a ziploc bag with $7 to: Soil Testing Lab, West Experiment Station, UMass, Amherst, MA 01003. ph (413)545-2311. Request analysis of nutrients, pH and lead. The soil pH should be between 6.5 and 7.0. If pH is much lower than 6.5, amend surface of soil with powdered or granulized limestone. If pH is above 7.0, amend soil with agricultural gypsum (calcium sulfate).

To ensure overall tree health, inspect trees for damage caused by cankerworms, flatheaded appletree borers, tent caterpillars, apple scab, and /or fireblight.

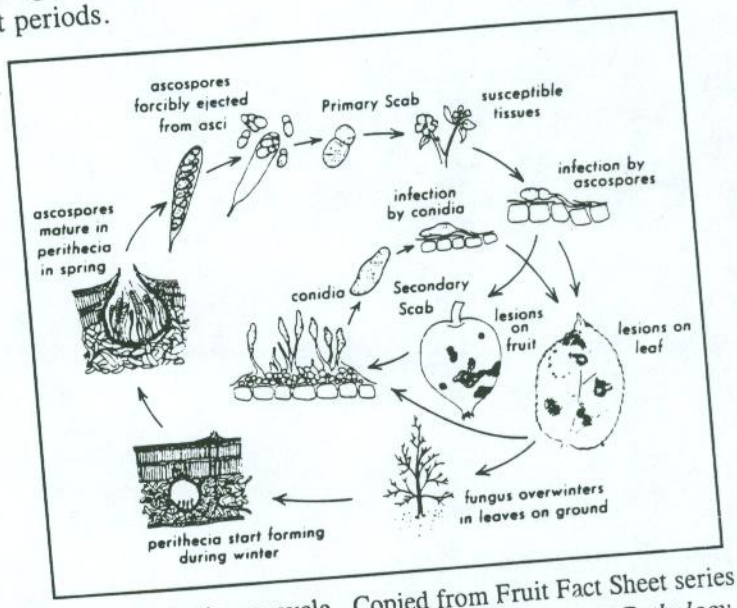
to produce fruit:

Set goals for orchard management and, if fruit is desired, prepare for IPM program that will begin when flower buds form.

Take hygrothermograph out of storage, and prepare to set up in early May.

If Apple Scab fungus is a problem, treat throughout expansion of leaves and flowers until petal fall.

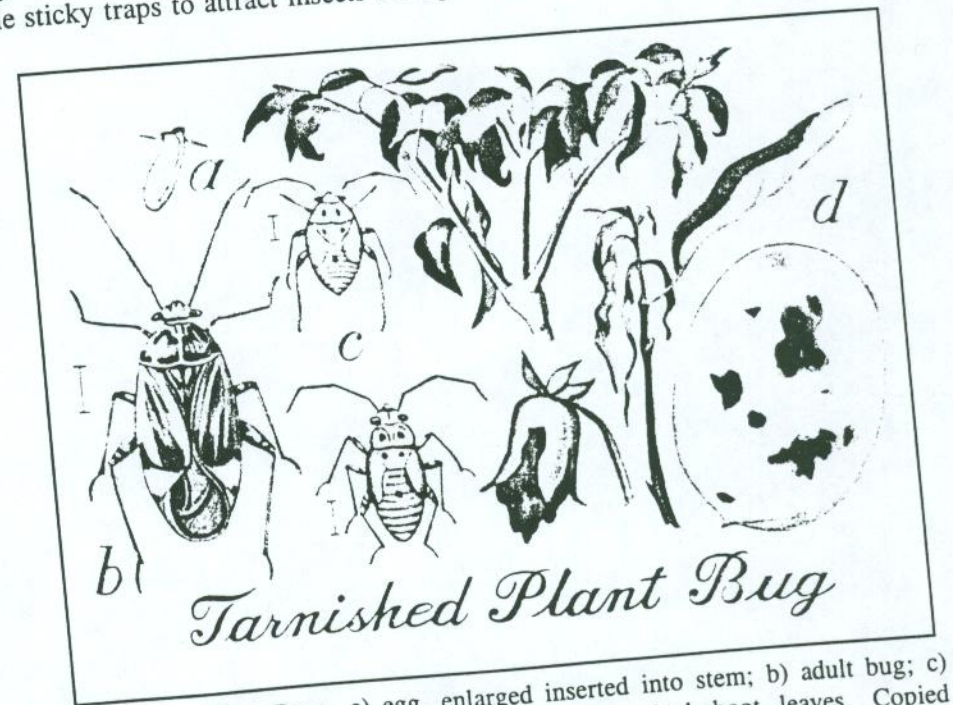
Low input treatment: Apple scab spores overwinter on dropped leaves and fruit, thus a sanitary program of raking up and removing dropped leaves is a good practice. Apple scab infections are worse during prolonged wet periods during flower and petal fall. Treat with fungicide only after wet periods.



Apple Scab disease cycle. Copied from Fruit Fact Sheet series, Cornell University. Adapted from G.Agrio's *Plant Pathology*.

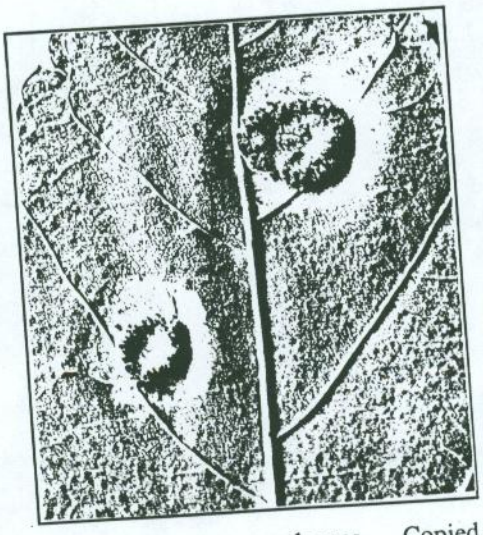
Monitor for Tarnished Plant Bugs. Hang white sticky rectangle traps in the lower half of the trees, near branch tips. Consider treatment when population goes over threshold of 8 - 10 insects per trap.[2]

Low input treatment: Disregard damage caused by bug as it primarily affects surface of fruit. Some parasitic insects will reduce populations. Do not mow orchard until after petal fall so that T. P. Bugs will feed on meadow flowers instead of fruit tree flowers.[3] Hang additional white rectangle sticky traps to attract insects after petal fall.[4]



Tarnished Plant Bug: a) egg, enlarged inserted into stem; b) adult bug; c) nymph in two instars; d) injury to fruit, bud, terminal shoot, leaves. Copied from Dr. C. Westcott, *The Gardener's Bug Book*.

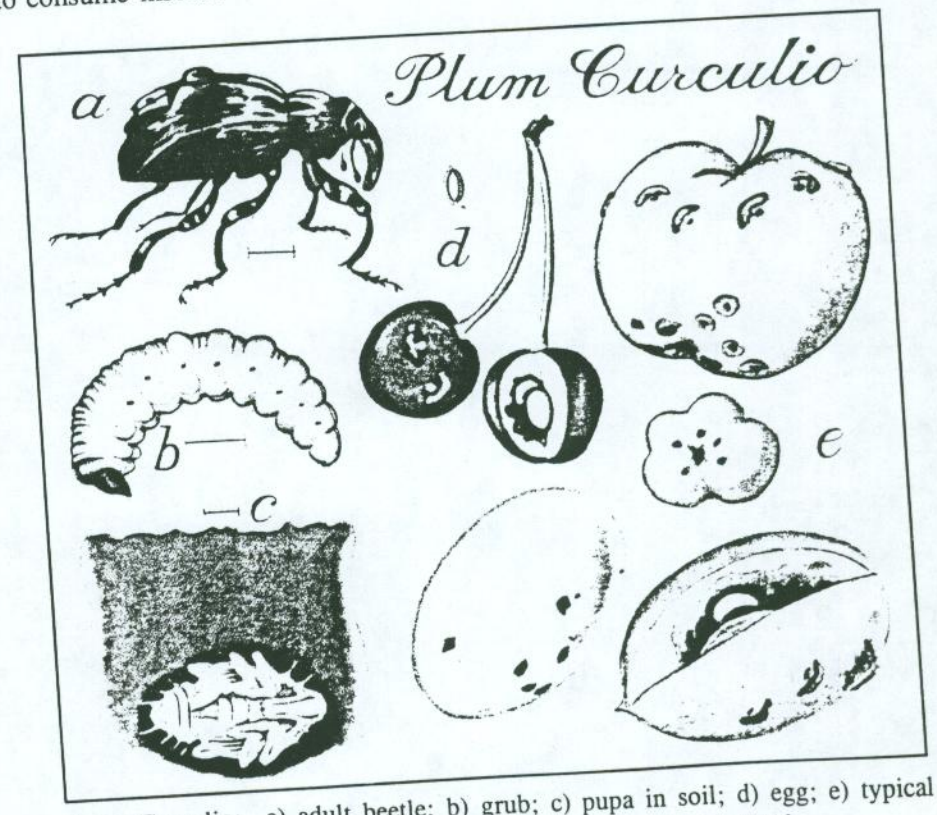
Inspect flowers and leaves for bright orage - yellow spots of Cedar-Apple Rust. Treatment is similar to Apple Scab above. If feasible, remove all Eastern Red Cedars, the alternate host species, from the surrounding area.



Cedar-apple rust on leaves. Copied from Smith and Carr, *Rodale's Garden Insect, Disease & Weed Identification Guide.*

After flower petals fall, inspect young fruit for crescent-shaped scars caused by Plum Curculio. Fresh scars produce ooze. When damage is visible, consider treatment.

Low input treatment: spread tarp below tree and shake tree twice a day. Allow chickens to forage under trees to consume insects.

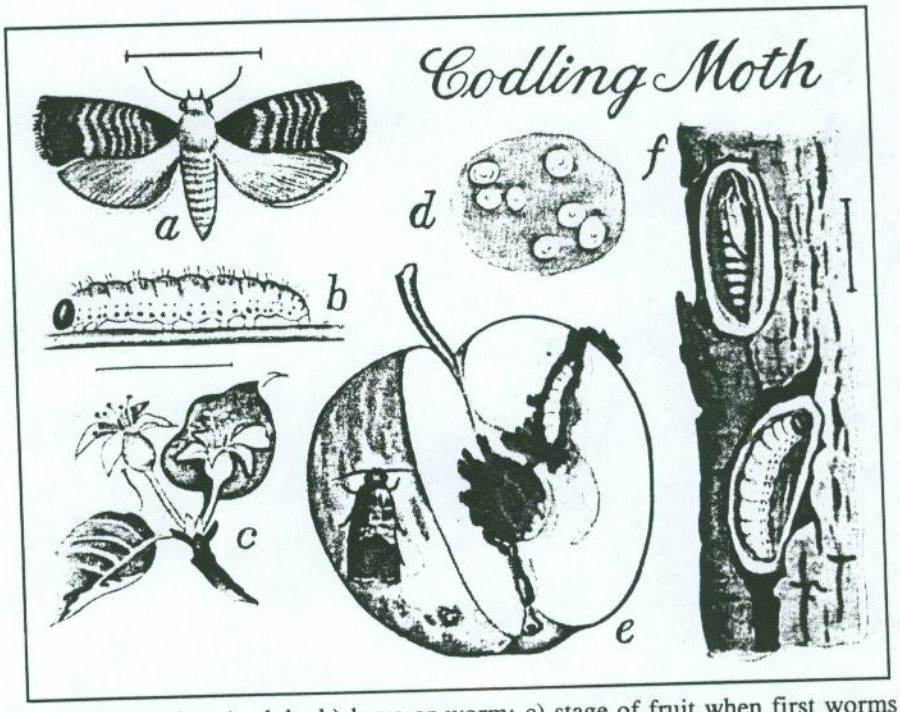


Plum Curculio: a) adult beetle; b) grub; c) pupa in soil; d) egg; e) typical injury. Copied from Dr. C. Westcott, *The Gardener's Bug Book.*

After flower petals fall, set out odor-baited red sphere traps, 3 - 4 in each tree to attract apple maggot flies. Before applying Tangle foot to surface, wrap each sphere with clear plastic. Later in the season the plastic can be removed and replaced with a new coat of Tangle foot. Apple maggot flies typically emerge between mid June and early July. Several generations follow in mid July, early August and mid August. Refer to these months for more information about treatment.

After flower petals fall, hang Codling Moth Traps with phermone lure, 2 in each tree. If Colding Moths were a problem in the previous year, or 3 or more are found in trap, consider treatment.

Low input treatment: In early spring, scrape bark to remvoe overwintering cocoons and/ or spray with dormant oil. Release Trichogramma wasps in early spring and in summer to eat eggs.



Codling Moth: a) adult; b) larva or worm; c) stage of fruit when first worms enter; d) eggs, enlarged; e) larva tunneling out, moth on surface of apple, and sting from second-brood larva entering fruit. Copied from Dr. C. Westcott, *The Gardener's Bug Book.*

to preserve the health of the tree:

To ensure overall health of the tree, inspect trees for damage caused by cankerworms, flatheaded appletree borers, tent caterpillars, apple scab, and /or fireblight.

Water trees when necessary to supplement rainfall so that trees receive 1" of water every two weeks. Use a rain gage to monitor the amount of rainfall. Apply water directly to tree bases to minimize the spread of fungal diseases. Alternative watering methods include:

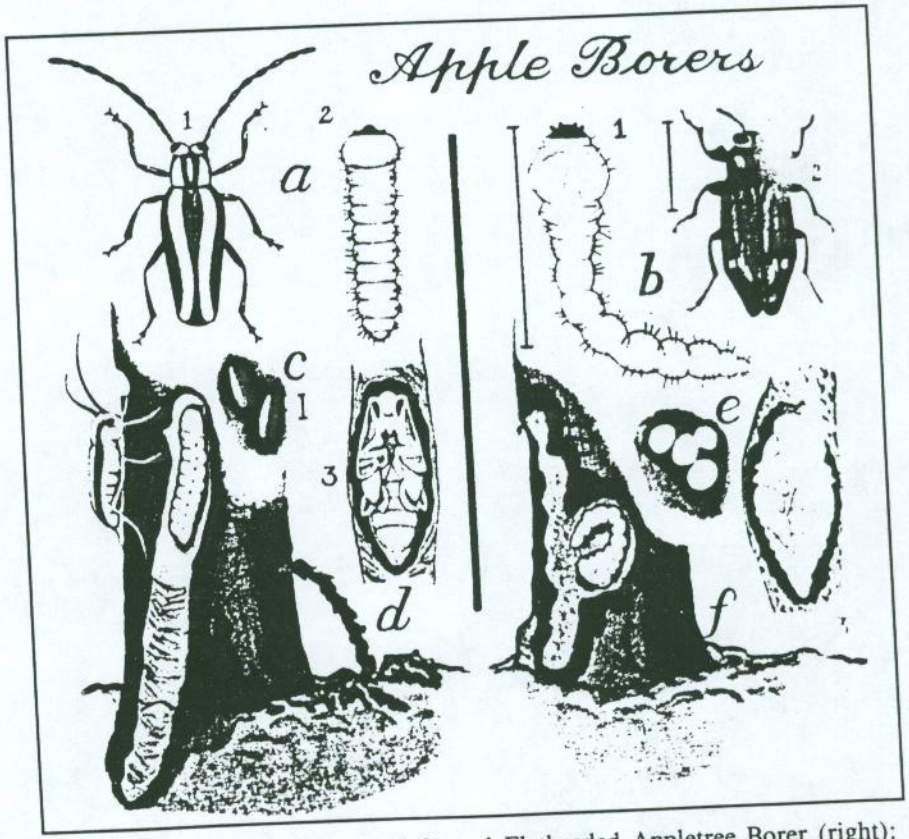
Gator bags. Place one "gator bag" around the base of each tree. Once filled with water, trees release water slowly.

Irrigation hoses. Set out a line of hoses with a valve or small hole at the base of each tree. Run water at a high pressure to provide water to all trees.

Sprinklers. Use sprinkler heads on low settings to avoid spraying tree canopies.

Inspect trees for large areas in decline, check the trunk near ground level for sawdust created by the Round-headed Appletree Borer.

Low input treatment: Insert a thin wire into the borer holes near sawdust excrement. Inject parasitic nematodes.[5] Latex paint applied to the trunk may discourage egg laying.[6]



Roundheaded Appletree Borer (left) and Flatheaded Appletree Borer (right): a) adult beetle; b) larvae; c) eggs; d) pupa in cell; e) eggs; f) larva in winter chamber in tree trunk. Copied from Dr. C. Westcott, *The Gardener's Bug Book*.

Remove all dropped fruit under apple trees to interrupt the life cycles of apple maggot, codling moth, and leafrollers. Dispose of fruits off-site.

Regular mowing under apple trees will reduce the humidity in the canopies, making conditions less suitable for the growth of diseases.

to produce fruit:

Prune after flower bloom to maximize cross pollination but before the middle of July so as not to reduce the next year's bud set. Prune to open up the center of the tree to light and air. Pruning should be done lightly and annually. Heavy cuts of branches with a diameter of 1" or more should be avoided since they induce excessive watersprout growth. Prune out water- sprouts. Prune of suckers at the base of the tree. Pruning is also done during the winter.

Cover fruit with permeable "apple bags" to protect fruit from insect and disease damage.

Monitor traps codling moth and tarnished plant bug. Also monitor for European red mites, two-spotted mites, plum curculio, and black rot. (UMass, MIMA NHP IPM Manual, draft 1994)

Re-coat red-sphere traps by removing insect-covered clear plastic wrap, putting on another piece of clear plastic wrap and coating with sticky tangle-foot traps to attract apple maggot flies.

Implement low-input spray program as determined by hygrothermograph readings, take down and store hygrothermograph at the end of June.

Inspect leaves and developing fruit for frog-eye like spots, black cankers, and rotting areas caused by Black Rot.

Low input treatment: remove all mummified fruit and diseased wood and dispose off-site.



Black Rot on apple. Copied from Smith and Carr, *Rodale's Garden Insect, Disease & Weed Identification Guide.*

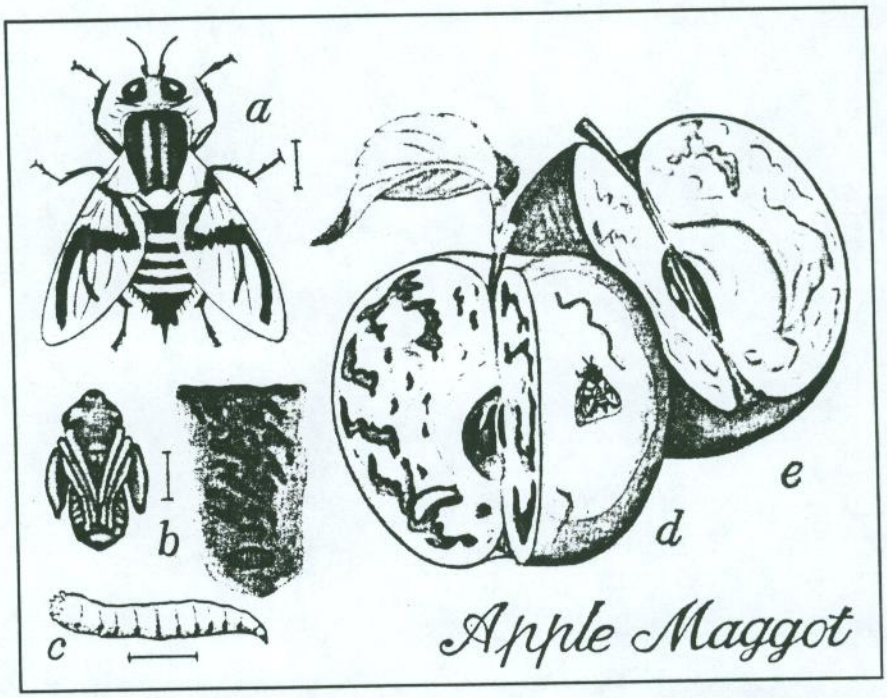
Thin fruit before it grows larger than marble-sized. Remove fruit that is stunted, insect damaged or diseased. Dispose off site. Leave the healthiest fruit spaced about 5 to 6 inches apart.

Regular mowing under apple trees will reduce the humidity in the canopies, making conditions less suitable for the growth of diseases.

Remove all dropped fruit under apple trees to interrupt the life cycles of apple maggot, codling moth, and leafrollers. Dispose of fruits off-site.

Monitor Apple Maggot Fly population with odor-baited or non odor-baited red sphere traps, 3 - 4 in each tree. Before applying Tangle foot to surface, wrap each sphere with clear plastic. Later in the season the plastic can be removed and replaced with a new coat of Tangle foot. Apple maggot flies typically emerge between mid June and early July. If 5 or more flies are found on an odor-batied trap, or 1 on a non-odor trap, consider treatment.

Low input treatment: Hang more red sphere traps with Tangle foot to reduce population. Removing dropped fruit can help reduce next years population.



Apple Maggot Fly: a) adult; b) pupa; c) maggot; d,e) injury. Copied from Dr. C. Westcott, *The Gardener's Bug Book.*

AUGUST, SEPTEMBER -

to preserve the health of the tree:

Water newly transplanted trees so that they receive one inch of water every 10 days. Place a rain gage in the orchard. During hot dry periods, check rain gage and provide supplemental water as needed.

to produce fruit:

If fruit desired, monitor traps and fruit for apple maggot fly and codling moth. (UMass, Minuteman NHP IPM Manual, draft 1994)

Rake up leaves and remove fruits and dispose off site to interrupt the life cycle of pests and diseases and reduce over-wintering inoculum, particularly of apple scab.

OCTOBER, NOVEMBER -

to preserve the health of the tree:

Protect trees, especially young trees, from rabbit, mice and vole damage. Place tree guards around the base of each tree made of 3/8 or 1/2 inch wire mesh. Cut and rake vegetation around the bases of the trees in the late fall. Keep mulch away from the bark at the base of the trunk. If damage has been a problem in the past consider cultivating lightly and removing vegetation around the base of trees. Also try placing a one-foot wide, six-inch deep ring of crushed stones or gravel around the tree guard. Monitor for damage during the winter and early spring. Check all tree guard cylinders around the base of trees to be sure they are still firmly set in the soil.

If soil or leaf analysis indicates that fertilizer is needed, fertilize in the late winter or early spring. Do not fertilize in the late summer or fall as this may increase the fruit tree's susceptibility to fireblight. If lawn area below trees is receiving fertilizer, additional fertilizer is not necessary. Also, light annual pruning throughout the tree tends to reduce the amount of fertilizer needed.

Low input fertilizer: mulch trees with composted manure (source of nitrogen and other micronutrients), bonemeal (source of phosphorus), and sul-po-mag or K-mag (source of potassium and magnesium).[7]

commercial fertilizer: broadcast granular fertilizer with composition of 5-10-10. Nitrogen content is low to minimize vegetative growth and maximixe fruit production.

to produce fruit:

Rake up leaves and remove fruits and dispose off site to interrupt the life cycle of pests and diseases and reduce over-wintering inoculum, particularly of apple scab.

PESTS, DISEASES AND CULTURAL PROBLEMS:

Pests -

Aphids suck the juice from the apple tree leaves and cause the leaves to crinkle or curl downward. Aphids are active during warm weather and tend to attack shoots, watersprouts, cracks, and fresh pruning cuts. Treat with soap if infestation level is high. (USDA, 1978) Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Apple Maggot. Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Cankerworms eat and shred buds and leaves. A large population can defoliate a tree. Two kinds of cankerworms, spring and fall cankerworm can cause damage. Larvae feed on the plant buds in the spring, then drop from the tree on silk strands. Eggs are laid in the trees and may be killed with horticultural oil. Also Bacillus thuringiensis can be used. (Johnson & Lyon, 1991, p.118; Cornell, 1993, p.70)

Codling Moth. Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Fall webworms are pale green or yellow and have a dark strip down their back and a yellow strip along each side. Webworms feed on leaves from May to September. They form loose, unsightly webs at the ends of branches. (USDA, 1978) Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Flatheaded appletree borer can severely damage a crabapple tree. Damage is caused by the larvae, which tunnel in the bark and sapwood of trees. The bark over tunneled areas becomes discolored and shriveled and finally dies. Larvae are slender, yellow-white grub about 1-1/4 inches long. They have broad and flattened body enlargement behind their small brown head. The adult borers are metallic olive-gray or brown beetles about 1/2 inch long. They appear on tree trunks in May or June. Damage is worst during dry weather. Trees with trunks exposed to the sun after excessive pruning are more susceptible to damage. Young infested trees often die from borer damage. (USDA, 1978)

Fruittree leafroller.

Japanese beetles skeletonize leaves. Use milky spore disease as a biological control for beetle larvae. Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Leafhoppers.

Oystershell Scale causes slow decline of twigs and overall loss of vigor. The scale can be seen at any time of the year on the twigs and branches of the tree. The shell of the scale is oyster or mussel-shaped. It can be controlled by dormant horticultural oil and pruning out and disposing of infested branches. (Johnson & Lyon, 1991, p.324; Cornell, 1993, p.91) Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Plum curculio: Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Red-banded leafroller.

Round-headed appletree borer.

Spider mites are reddish or greenish pests that feed on the undersides of leaves. They are barely visible to the naked eye but sometimes can be detected by fine webs on the undersides of leaves.

Infested leaves become yellow, gray, or brownish, and flowers become discolored or faded. Severely infested trees become stunted. Spider mites frequently attack severely during dry years. (USDA, 1978). Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Tarnished Plant Bug. Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Two-spotted Mite. Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Tent caterpillars have a white stripe and a row of blue spots on their back and brown and yellow lines along each side. Tent caterpillars feed on young leaves in the spring. They live in webs in the crotches of trees at night and feed during the day. (USDA, 1978)
Remove webs at night.

Voles can girdle a crabapple tree by chewing on the bark at the base of the tree, particularly during the winter as a food source. Keep soil and mulch away from the bark at the base of the trunk. Monitor for damage during the winter and early spring.

Diseases -

Apple scab is a fungal disease that infects the leaves & twigs. The disease appears on the leaves as dark-green velvety spots. The fungus over-winters in fallen leaves & reinfects trees during rainy weather in spring. (USDA, 1978) Refer to the Minuteman NHP IPM Manual, by UMass, draft 1994.

The critical time for scab control is from the time bud growth begins until about the middle of June. If scab infection can be prevented until all spores are discharged, the cycle can be broken and little further source of infection remains for the rest of the season. However, if early control is not obtained and if leaf and fruit infection occur, more spores will be produced by these lesions, and scab will be a constant threat whenever wet weather occurs during that season. (Coop. Ext., 1978)

In the spring, after rainstorms that cause infection, spray the tree with a high pressure nozzle to wash spores off of leaves. In the late summer and fall, rake up leaves and fallen fruits to reduce overwintering inoculum. If necessary, implement low-input spray program.

Black rot. Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Cedar apple rust is a fungal disease that causes premature defoliation of trees and reduction of fruits. The alternate host for the rust is eastern red cedar or juniper. (Sinclair,Lyon,&Johnson,1987,p. 240)

Fireblight is a bacterial disease that may severely damage susceptible varieties of flowering crabapple. Some varieties are immune to fireblight. Infected leaves turn brown or black and eventually dry up; they remain attached to the branch. The bark on the infected twigs becomes dark and sunken, Milky or brownish ooze may form on the infection. Cankers form where the disease enters a large branch or trunk. The bacteria overwinter in these cankers and are a source of infection the following year. Remove blackened leaves immediately with tools that are sterilized in bleach between cuts. (USDA, 1978 and Cooperative Extension, 1978)

Nectria.

Powdery mildew is characterized by a white, moldy, fungal growth that covers the leaves and stems. Treat with a spray solution of 4 Tablespoons of baking soda, 1 teaspoon of ivory soap flakes shaken up in one gallon of water (Stephen Scaniello, Brooklyn Botanic Garden). Refer to the Minuteman NHP IPM Manual, prepared by UMass, draft 1994.

Root diseases.

Cultural Problems -

Branches are susceptible to splitting during winter storms; prevent damage with cyclic pruning.

RECOMMENDED REPLACEMENT METHOD:

- ☐ propagate a genetic clone of the existing plant
- ■ graft the existing plant onto another rootstock
- ☐ seedling replacement or transplant from the vicinity
- ■ nursery stock or other off-site source
- ☐ different cultivar with similar characteristics
- ☐ substitute species with similar characteristics

PROPAGATION METHOD:

Propagate by root grafting or bud grafting and graft onto an invigorating or non-influencing rootstock to create a standard tree.

For bud grafting, during the summer, slice a small leaf bud from the parent apple and place in a slit in the bark of the understock a few inches above the ground. The top of the understock is cut off just above the newly placed bud in the spring.

For root grafting, during the winter, graft a 6" section of a dormant young branch on to an understock. If possible, train branch structure to duplicate historic appearance.

REPLACEMENT SOURCES:

Sources for old apple varieties -

Note: before contacting nurseries for specific varieties, check sources in:
Whealy, Kent, and Demuth, Steve, eds. Fruit, Berry & Nut Inventory, 2nd Edition. Seed Saver Publications, 3076 North Winn Road, Decorah, Iowa 52101 (An inventory of sources for each fruit, berry, and nut variety available by mail order in the United States.)

nurseries (* large selection) -

Ames' Orchard and Nursery, 6 E. Elm Street, Fayetteville, AR 72703 Guy and Carol Ames (501) 443-0282

Arbor & Espalier, 201 Buena Vista Avenue East, San Francisco, CA 94117 John C. Hooper & Harry Hull (415) 626-8880

Bear Creek Nursesry, PO Box 411, Bear Creek Road, Northport, WA 99157-0411 Donna and Hunter Carleton

* Burford Brothers Nursery, Munroe, Virginia 24574. Tom Burford, phone # (804) 929-4950.

Canadians Fruit Catalog

C and O Nursery, PO box 116, Wenatchee, WA 98807-0116

Fruit Testing Association Nursery, INc. PO Box 462, Geneva, NY 14456

Golden Bow Tree Farm, Marlbank, ON, Canada K0K 2L0 Josef Reeve

Greenmantle Nursery, 3010 Ettersburg Road, Garberville, CA 95440 Ram & Marissa Fishman ph: (707) 986-7504

Grootendorst Nursery, Lakeside, Michigan 49116.

Henry Leuthardt Nurseries, Montauk Highway, Box 666, East Moriches, NY 11940

Hidden Springs Nursery - Edible Landscaping, Route 14, Box 159, Cookeville, TN 38501. Hector Balck ph: (615) 268-9889

Lawson's Nursery, Box 472, Ball Ground, Ga. 30107, ph (404)893-2141

Living Tree Community/ Center, PO Box 10082, Berkeley, CA 94709 (510) 420-1440

Miller Nurseries, West Lake Road, Canandaigua, NY 14424

Newark Nursery

* Sonoma Antique Apple Nursery, 4395 Westside Rd., Healdsburg, CA (707) 433-6420

Southmeadow Fruit Gardens, 15310 Red Arrow Highway, Lakeside, MI 49116 ph (616) 469-2865

Stark Brothers Nursery, Highway 54, PO Box 10, Louisiana, MO 63353

Tolowa Nursery, PO Box 509, 8653 Wagner Creek Road, Talent, OR 97540. Jeanne Bieg & Greg Carey ph: (503) 535-5557

* Tower Hill Botanic Garden, S. Lothrop Davenport Preservation Apple Orchard, 11 French Drive, Boylston, MA 01505-1008 ph (508) 869-6111

Tsolum River Fruit Trees, PO box 68, Merville, BC, Canada V0R 2M0 Rennee Poisson ph: (604) 337-8004

Mail-order IPM supplies and orchard management equipment -

Gardens Alive!, 5100 Schenley Place, Lawrenceburg, IN 47025 ph (8112) 537-8650

Necessary Trading Company, One Nature's Way, New Castle, Virginia 24127-0305 ph (703) 864-5103

AppleCorps, 700 - 13th Street N.E., East Wenatchee, Washington 98802-4523 Ph (509) 886-9204

Orchard Equipment and Supply Co. , Route 116, Conway, MA 01341 Ph (800) 634-5557

ADDITIONAL SOURCES OF INFORMATION:

Barton, Barbara J. Gardening By Mail, A Source Book. Boston, MA: Houghton Mifflin Company, fourth edition, 1994. Provides a list of nurseries that sell antique apple varieites.

Beach, S. A. The Apples of New York, volumes I and II. Albany: J. B. Lyon Company, Printers. 1903, 1905.

Coli, William. "Low Input Spray Program" in report: An Integrated Pest Management Report for Historic Orchards Located at Adams, Morristown, and Roosevelt Vanderbilt National Historic Sites. University of Massachusetts, Amherst, MA. 1988.

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Cornell University, New York Cooperative Extension. 1993 Pest Management Recommendations for Commercial Production and Maintenance of Trees and Shrubs. 1993.

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Ellis, Barbara W. and Fern Marshal Bradley, Eds. The Organic Gardener's Handbook of Natural Insect and Disease Control. Emmaus, PA: Rodale Press. 1992.

Horst, R. Kenneth, ed. Westcott's Disease Handbook, Fourth edition. New York, NY: Van Nostrand Reinhold Company. 1979.

Johnson & Lyon. Insects that Feed on Trees and Shrubs. Cornell University Press, second edition. 1991.

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Waugh, F. A. The American Apple Orchard. New York, NY: Orange Judd Company, 1908.

Westcott, Dr. Cynthia. The Gardener's Bug Book, 4th Edition. Garden City, NY: Doubleday & Company, Inc. 1973.

Whealy, Kent, and Demuth, Steve, eds. Fruit, Berry & Nut Inventory, 2nd Edition. Seed Saver Publications, 3076 North Winn Road, Decorah, Iowa. 1993

Yepsen, Roger. Apples. New York, NY: W.W. Norton & Company. 1994.

Organizations -

Fruit Testing Association (this organization may disband in the near future), Geneva, NY (315) 787-2205

American Pomological Society, Tyson Building, University Park, PA 16802

North American Fruit Explorers, Route 1, Box 94, Capon, Illinois 62628

Cornell University Cooperative Extension

Periodicals -

Fruit Varieties Journal, published by American Pomological Society

Pomona, published by North American Fruit Explorers

Orchardists Companion, edited by A. Haffery (a quarterly journal devoted to the history, character, properties and modes of cultivation, and other matters apertaining to the fruits of the US.)

Fruit Notes, University of Massachusetts, Bowditch Hall, Department of Plant and Soil Sciences, Amherst, MA 01003. Edited by D. Wesley Autio. (a monthly publication for fruit growers in the northeast).

Cornell Recommendations for Tree Fruits (annual publication of methods for pest and disease control)

Home Fruit Planning Bulletin, University of Massachusetts Cooperative Extension.

ENDNOTES:

1. Page & Smillie. The Orchard Almanac: A Spraysavers Guide, p.16
2. Cooperative Extension. 1992 New England Apple Pest Mangement Guide. p. 45.
3. Cooperative Extension. 1992 New England Apple Pest Mangement Guide. p. 21.
4. Ellis & Bradley. The Organic Gardener's Handbook of Natural Insect and Disease Control, p.166.
5. Ellis & Bradley. The Organic Gardener's Handbook of Natural Insect and Disease Control, page 26.
6. Cooperative Extension. 1992 New England Apple Pest Mangement Guide. page 54.
7. Page & Smillie. The Orchard Almanac: A Spraysavers Guide, p.16

TREE FRUIT CROPS

CORNELL COOPERATIVE EXTENSION

IPM Integrated Pest Management

Insect Identification
Sheet No. 8
1991

Apple Maggot

Rhagoletis pomonella (Walsh)

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The apple maggot (AM), a native of eastern North America, originally bred in large fruited hawthorns *(Crataegus* sp.*)*. Later, it adopted apple as another host, and it has become a major fruit pest in the northeastern United States and Canada. During the early 1980s, the AM became established in California, Oregon, Washington, Idaho, Utah, and Colorado, although it has not yet become a serious pest in the major apple production areas in these western states. Thorough control is necessary because marketed apples must be free from all AM injury.

AM normally has a single generation a year, although there are two exceptions: AM may have a partial second generation in the southern part of its range, and some individuals remain in the soil two winters before emerging as adults.

Adults

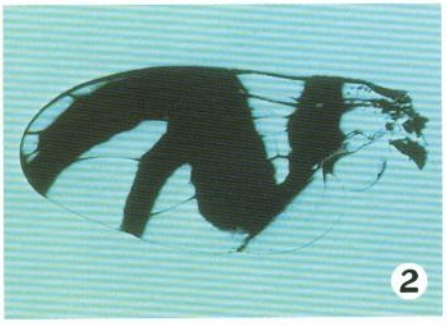
The first AM adults emerge from the soil from mid-June to early July. Peak emergence occurs during mid- to late July and is usually completed by the end of August. Emergence patterns vary considerably among different geographic locations and even within a specific area, depending on the host and environmental parameters, particularly temperature, soil type, and rainfall. Female flies are black, about 5.2 mm in length, with a wingspan of about 9.3 mm. They have a painted abdomen with four white cross bands (fig. 1). The males are smaller and have three cross bands on a rounded abdomen. AM wings are clear and marked with characteristic black bands (fig. 2). Newly emerged flies are sexually immature and spend considerable time on apple leaves feeding on honeydew excreted by aphids and other insects. The flies mature sexually 7 to 10 days after emergence and congregate on the fruit, where mating occurs. After mating, the female punctures the apple skin with her ovipositor to lay eggs. Females can lay an average of about 300 eggs over a 30-day life span.

Eggs

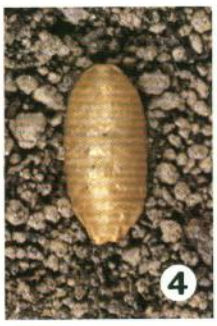
AM eggs are usually deposited singly just beneath the skin of the apple. The elongate (0.7 mm), curved eggs are smooth and white in color. Eggs hatch after a 2- to 10-day incubation period, depending on the ambient temperature.





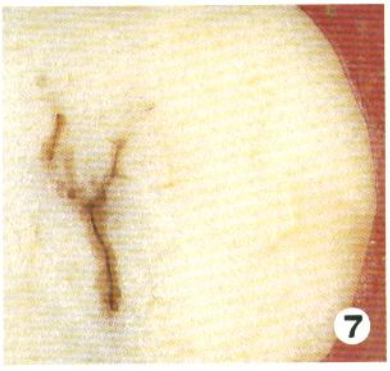














Larvae

The legless, cream-colored maggots are elongate, about 7 mm long at maturity, and have a blunt posterior that tapers down to a rounded point containing two black mouth hooks (fig. 3). The larvae pass through three instars, spending 20 to 30 days feeding within the fruit. The larvae develop more rapidly and mortality is lower in earlier-maturing, soft cultivars than in firmer-fleshed, later-ripening apples. Upon completing their third-instar feeding, the maggots drop to the ground, burrow into the soil, and molt to a fourth instar, which is quickly followed by another molt to the pupal stage.

Pupae

AM pupae are found within puparia made from the third-instar skin (fig. 4). The brownish-yellow puparia are about 4 mm long. The majority of pupae are located within 50 mm of the soil surface. Pupae pass the winter in diapause.

Injury

AM injury varies in appearance and severity among apple cultivars. Oviposition punctures may cause the fruit to become dimpled or distorted (fig. 5), and in softer cultivars the tissue around the wounds may darken and decay. These punctures or stings appear as pinpricks on the fruit surface (fig. 6). Young larvae tunnel throughout the apple, leaving small, brownish, irregular, threadlike trails (fig. 7). As the larvae grow, the tunnels become more conspicuous and are further enlarged by bacterial decay (fig. 8). Eventually, the apple becomes soft and rotten. This internal breakdown proceeds more rapidly and is more severe in the softer-fleshed, earlier-maturing cultivars.

Control

AM emergence and activity in an area can be determined by placing large cages over several seedings of infested fruit set up in late summer to monitor for the following spring and by hanging sticky traps in unsprayed apple or hawthorn trees. In pest management programs, sticky traps are placed in commercial orchards to monitor indigenous or immigrating AM flies to determine the need for and timing of insecticide sprays. Parasites and predators attack the AM but do not give adequate control. To obtain acceptable control in commercial orchards, insecticides must be applied to kill females before they oviposit. In conventional programs, the initial spraying is done 7 to 10 days after the first fly has emerged and then at 10- to 14-day intervals while adults are active. Consult Cooperative Extension for local recommendations on the use of sticky traps and the most effective insecticides against AM in your area.

GUIDE TO STAGES

Commercial orchards do not usually harbor resident apple maggot populations. Their presence and injury may be more readily observed on infested, abandoned trees.

Stage	Timing	Where to Look
Adults	June 15 through September	On early varieties and maturing fruit. Presence or migration may be monitored with sticky traps.
Eggs (Sting)	7–10 days after first emergence of adults	On sunny side of tree, more mature fruit; small but visible puncture, may cause dimpling.
Larvae (Maggot)	2–10 days after eggs are laid	In the flesh of the apple; tunneling may appear as a brownish, irregular, threadlike trail.
Pupae	Late July through early November	In soil within 50 mm (2 in) of surface.

Produced by Media Services at Cornell University for the New York State Integrated Pest Management Program, jointly sponsored by the New York State Department of Agriculture and Markets and Cornell University.

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TREE FRUIT CROPS

CORNELL COOPERATIVE EXTENSION

IPM Integrated Pest Management

Disease Identification
Sheet No. 9
1993

Apple Scab

Venturia inaequalis (Cooke) Wint.

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Apple scab is the most economically destructive disease of apples in the world. In the Northeast it is usually not possible to produce apples commercially without some program to control this disease.

Symptoms

Scab may occur on leaves, fruit, leaf and fruit stems, and green twigs. Infections of the leaves and fruit are most common and obvious. Early-season infections usually occur on the underside of the blossom cluster leaves because these are the first tissue surfaces to emerge from buds in the spring. Once the cluster leaves have unfolded and terminal leaves begin to develop, infections become evident on the upper surface of the leaves. Individual infections appear as roughly circular, brown to dark olive-green spots (lesions), which often seem slightly fuzzy or velvety in texture (fig. 1). Lesions along the veins or margins often cause those regions of the leaves to distort or crinkle. Primary (ascospore) infections are usually limited to one or two distinct spots per leaf, whereas secondary (conidia) infections are often much more numerous. Secondary infections occasionally are so numerous that the entire surface of the leaf appears covered with scab, a condition commonly referred to as sheet scab (fig. 2).

Lesions on young fruit initially resemble those on leaves but turn dark brown to black and become corky or scablike with time. Cells near lesions on young fruit may be killed, causing these regions to become deformed or cracked as they fail to grow and expand along with the remainder of the apple (fig. 3). Primary (ascospore) infections are usually limited to one or two distinct spots per fruit, often near the blossom end because it is upturned during the early stages of fruit development (fig. 4). Secondary infections are frequently much more numerous and may be clumped or grown together, particularly if the fruit is directly beneath a concentrated source of secondary spores such as an infected leaf (fig. 5). Secondary infections that occur in late summer or early fall are often numerous and relatively small in size, a symptom referred to as pin-point scab. Infections that occur just before harvest may be symptomless at picking yet develop into storage scab lesions after harvest.

Disease Cycle and Causal Organism

Apple scab is caused by the fungus *Venturia inaequalis*, which also is capable of infecting crabapple, hawthorn, mountain ash, and firethorn. Different but closely related *Venturia* species cause scab on European and Japanese pear.

In the Northeast, the scab fungus overwinters in infected leaves that have fallen to the ground. During autumn, the fungus begins to form tiny fruiting bodies (pseudothecia) which are embedded in the leaves near the surface. Sacs (asci) filled with the primary or spring spores of the fungus (ascospores) start to develop within the pseudothecia by late winter or early spring. The ascospores continue to develop and become mature as spring progresses (fig. 6). A few spores are usually mature at the time of bud break (green tip), and maturity progresses slowly until about the tight cluster stage of blossom development. After this time, the percentage of mature spores begins to increase rapidly whenever temperatures are favorable for tree growth. Most ascospores have matured by the end of bloom.

Mature ascospores are discharged into the air during periods of rain. In daylight, discharge usually begins within 30 minutes after the start of the rain and is largely completed within 3 to 6 hours. When rainfall begins at night, discharge is often delayed until daybreak, although significant night discharge can occur under some conditions. The number of spores discharged during any one rain is determined by both the size of the potential ascospore "crop" for the season (how many leaves were infected the previous year) and the percentage of these spores that have matured since the last discharge. Ascospore discharge usually peaks in the time from pink through bloom, and nearly all ascospores have been discharged within 1 or 2 weeks after petal fall.

Ascospores are blown to nearby trees by wind currents, then germinate in a film of water on the surface of leaves and fruit. If surface wetness continues long enough at prevailing temperatures (table 1), growth from the germinated spore penetrates and infects these organs just beneath the outer cuticle. Typical lesions, each bearing tens of thousands of secondary or summer spores (conidia), appear about 9 to 17 days later depending on temperature (table 1), although long periods of low humidity can delay their development. Conidia are dispersed by splashing rain throughout the rest of the season and are capable of causing new (secondary) infections. Because numerous additional conidia are produced on each new lesion, repeated secondary infections have a snowball or epidemic effect on disease development.

Incidence of infection is affected by the age of leaves and fruit; young tissues generally are most susceptible. Leaves are most susceptible 1 to 5 days after unfolding and become completely resistant from the time they finish expanding until shortly before leaf drop in the autumn. Fruit are highly susceptible until about 3 to 4 weeks after petal fall, but much longer wetting periods are required for infection to occur after this time. Precise requirements for infection of mature fruit are not known, but limited data indicate that wetting periods must last at least 48 hours for significant infection to occur immediately before harvest.



Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 6.

Control

On most apple varieties, fungicide sprays are required every year for control of scab. Fungicide programs can be minimized and made most efficient by designing them around weather conditions (infection periods), inoculum availability, cultivar susceptibility, and specific characteristics of the available fungicides.

Season-long control of apple scab is difficult if primary infections are allowed to develop. Even moderate numbers of primary lesions can produce an extremely large population of conidia, requiring an intensive fungicide program to protect fruit throughout the summer. Conversely, good control of primary infections allows use of fungicides to be reduced or omitted during the summer, once ascospores have been depleted and fruit become less susceptible.

Control of primary infections has traditionally begun at or shortly after green tip, when the first ascospores become mature. The percentage of spores that are mature at this time is low, and the actual number of mature spores may be insignificant during the early stages of bud development if very little leaf scab developed the previous year (that is, the seasonal ascospore "crop" is small). Various systems for determining when fungicide programs must begin in "clean" orchards have been developed; check with your adviser for their current status.

Apple scab fungicides control disease in different ways. Some are most effective as protectants, some when applied after an infection period, and some can suppress production of conidia from established lesions. Understanding these activities and knowing which fungicides exhibit them is important for maximizing the efficiency of a fungicide program. Such information is available through Cornell Cooperative Extension.

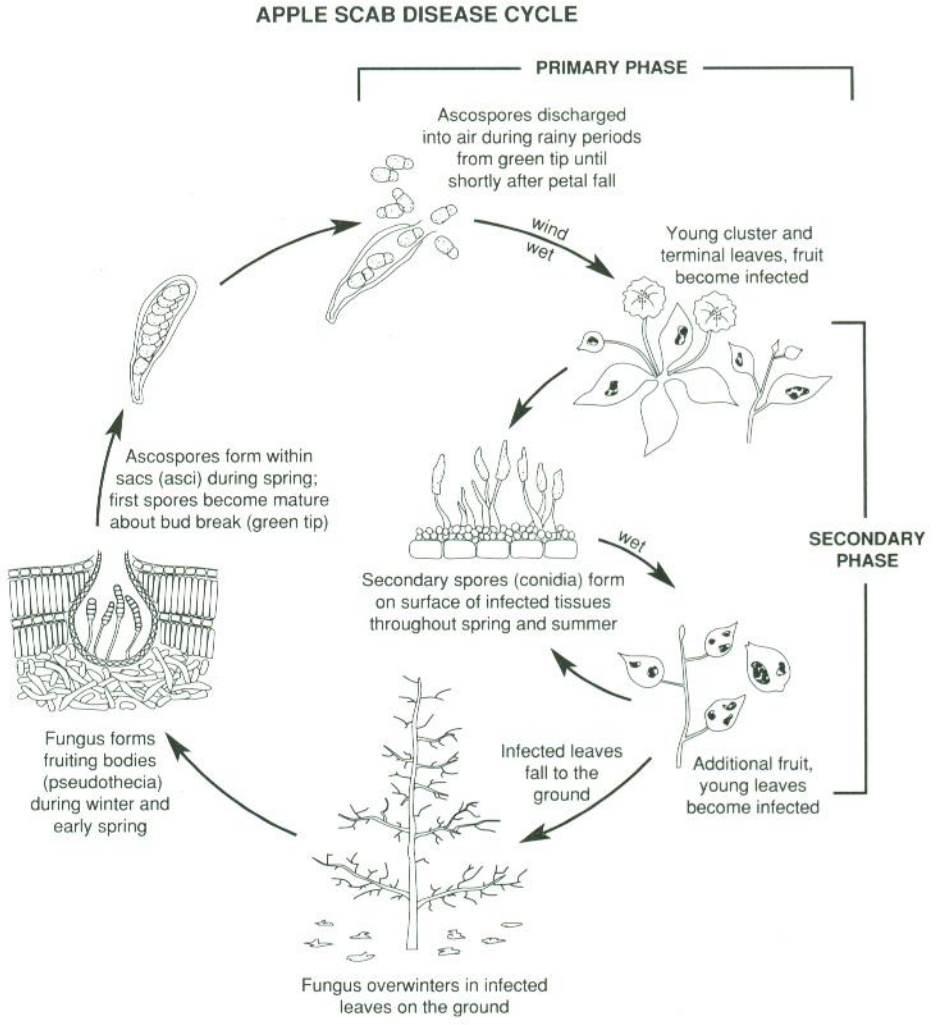
Standard apple cultivars vary widely in their susceptibility to scab, which will influence the intensity of the control program necessary for a particular variety. In the Northeast, Jersey Mac is extremely susceptible; McIntosh and its progeny (Cortland, Macoun, Empire) are highly susceptible; Rome, Red Delicious, R. I. Greening, Crispin, 20-Ounce, and Northern Spy are moderately susceptible; and Golden Delicious, IdaRed, Jonathan, and Paulared are moderately resistant. (Because the scab fungus has different races, these rankings are not necessarily applicable to other regions where different races may predominate.) Cultivars that are immune to apple scab are available, including some with fruit quality that appears to be commercially acceptable (e.g., Liberty, Florina, Goldrush); additional selections are being evaluated. Growers interested in minimal or "organic" pesticide programs should strongly consider planting such varieties.

Table 1. Approximate number of hours of leaf wetness necessary to produce primary apple scab infections and approximate number of days required for lesions to appear

Average temp. (°F)	Infection (Hours)[a]	Lesions (Days][b]	Average temp. [°F)	Infection (Hours)[a]	Lesions (Days][b]
33–36	48	?	49	14.5	17
37	41	?	50	14	17
38	37	?	51	13	16
39	33	?	52–53	12	15
40	29	?	54	11.5	14
41	26	?	55–56	11	13–14
42	23	17	57–59	10	12–13
43	21	17	60	9.5	11
44	19	17	61–75	9	9–10
45	17	17	76	9.5	
46	16	17	77	11	
47–48	15	17	78	13	

[a]Hours of wetness from the beginning of rain (data of W. D. Mills as modified by A. L. Jones). If secondary spores (conidia) are already present, wetting periods required to produce secondary infections are about 3 hours shorter than listed in the table for primary infection.

[b]Number of days required for lesions to appear after infection period has begun. Additional days may be required if temperatures are above 80° F or weather is dry for long periods of time.



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TREE FRUIT CROPS

CORNELL COOPERATIVE EXTENSION

IPM Integrated Pest Management

Insect Identification
Sheet No. 22
1991

Comstock Mealybug

Pseudococcus comstocki (Kuwana)

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The Comstock mealybug (CMB) was first reported in the United States in 1918 concurrently in New York and California, and has since spread to all coastal states and the Ohio and Mississippi River valleys. Its fruit hosts include pear, apple, and peach, and it is also a pest of several ornamental plants such as catalpa, mulberry, pine, and others. CMB was first recognized as a fruit pest in the 1930s. From 1950 to 1980, it was infrequently noticed as a fruit pest, but in the early 1980s it caused damage to apple crops in the Hudson and Champlain valleys, and to pears in western New York later in the eighties.

Adults

The Comstock mealybug adult female (fig. 1) is wingless and elongate-oval in shape, with a many-segmented body (2.5 to 5.5 mm long) and well-developed legs. It has 17 pairs of body filaments, with the caudal (posterior) pair being one-third as long as the body. The legs and antennae are inconspicuous. The body of the adult female is reddish-brown, but has a white appearance because it is covered with wax.

Because of its small size and short life span, the adult male (fig. 2) is very unlikely to be seen in the field unless it is captured in pheromone traps; even then it is difficult to distinguish without the aid of a microscope. It has a gnat-like appearance, with delicate, almost veinless wings, a light reddish-brown body (about 1 mm long), and two caudal filaments as long as or longer than the body (not shown in fig. 2). It is peculiar in having three pairs of eyes (dorsal, lateral, and ventral). The legs and 10-segmented antennae are apparent, but mouthparts are absent.

There are two generations of Comstock mealybug in New York, each taking 60 to 90 days to complete, depending on seasonal temperatures. The egg is generally thought to be the primary overwintering stage, but recent evidence from western New York indicates that some nymphs and adult females from the second (summer) generation overwinter, with eggs being laid in the spring rather than the previous fall. Adult females and males emerge at the same time, from late June to mid-July for the first (overwintering) generation, and late August to mid-September for the second (summer) generation. Adult females are present for a total of four to six weeks, and oviposit for about one week after mating. Males survive for only a few days after emerging.

Eggs

The eggs are elliptical (0.3 mm long and 0.17 mm wide) and bright orange-yellow (fig. 3), but may appear duller because of the waxy filaments covering them. Eggs are laid in jumbled masses along with the waxy filamentous secretions (fig. 4) in protected places such as under bark crevices (fig. 5), near pruning cuts, and occasionally in the calyx of fruit. The summer-generation eggs are laid from mid-June through late July, and the overwintering eggs from mid-August into October. The summer-generation eggs have an incubation period of about 11 days.



Fig. 1. Adult females in pear calyx.



Fig. 2. Adult male.



Fig. 3. Eggs of Comstock mealybug.



Fig. 4. Egg mass.



Fig. 5. Egg mass in bark.



Fig. 6. Crawler on bark.



Fig. 7. Nymphs on young tissue.



Fig. 8. Sooty mold on apple.



Fig. 9. Tape trap.

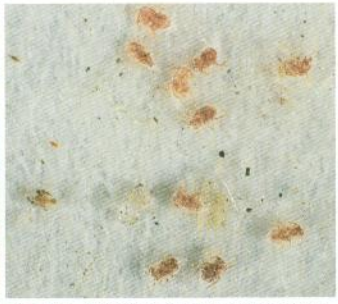


Fig. 10. Nymphs stuck on tape trap.

Larvae (crawlers)

The first and second larval instars of the female and male CMB (fig. 6) are virtually indistinguishable. They appear similar to adult females except that they are smaller, more oval-shaped, lack the long body filaments, and are more orange-yellowish because they have less wax covering. The first instar female crawler is flattened (0.3 to 0.5 mm long) and pale yellow, becoming darker in time. The second (0.9 to 1.2 mm long) and third (1.7 to 2.5 mm long) instar females are similar in appearance, but become progressively browner and redder.

The third instar of the immature male, called a "pro-pupa," is contained in a cocoon that begins forming toward the end of the second instar. It is 0.9 to 1.2 mm long and elongate-oval, with the head, thorax, and abdomen fused. The fourth stage of the immature male is the pupa. It is elongate, 1.2 to 1.4 mm long, and light reddish-brown. As with the adult male, it has three pairs of eyes and 10-segmented antennae.

The overwintered eggs hatch from mid-April through May and the nymphs (crawlers) migrate from the oviposition sites (fig. 4) to their feeding sites on terminal growth (fig. 7) and leaf undersides of trees and shrubs. This hatch is completed by the petal fall stage of pears. Nymphs that hatch from these overwintered eggs are active from roughly early May to early July. As the nymphs approach the adult stage, they tend to congregate on older branches at a pruning scar, a node, or at a branch base, as well as inside the calyx of pears. Second- (summer) generation nymphs are present from about mid-July to mid-September.

Damage

The Comstock mealybug poses two major concerns for the pear processing industry of New York: First, the emergence of crawlers and adult females from the calyx of pears (fig. 1) at the packinghouse creates a nuisance to workers. Second, pears to be made into puree typically are not peeled or cored by New York processors, so infestations can potentially result in unacceptable contamination of the product.

Another problem, of concern to apple growers in the 1930s and 1940s, and again in the Hudson and Champlain valleys in the early 1980s, is that the honeydew secreted by the crawlers is a substrate for sooty molds growing on the fruit surface (fig. 8). This problem also occurs on peaches in Ontario, Canada. These molds result in a downgrading of the fruit, and are therefore an additional cause of economic loss.

Monitoring and Control

To date, the Comstock mealybug has been a problem to growers of processing pears because of the contamination and aesthetic reasons noted. Crawler infestation of pears destined for processing can be determined by examination of the calyx end. Cut the pear lengthwise to expose the inner calyx area (fig. 1), which is often concealed in the whole fruit. Once the insects have reached these sites, it is nearly impossible to remove them. Such an infestation generally indicates the need for one or more insecticide sprays during the growing season, directed against the migrating crawlers.

Examine the terminal growth for crawler activity periodically throughout the summer. Crawler and adult female activity can also be monitored by wrapping black electrical or white carpet tape (fig. 9) around scaffold branches and inspecting for crawlers that have been caught by the tape (fig. 10). They can be recognized with a hand lens or, with some experience, by the unaided eye.

For appropriate control materials and procedures in your area, consult your local source of recommendations.

GUIDE TO STAGES

Stage	Timing	Where to Look
Adults		
females—overwintering generation	late June to mid-July	green succulent tissue, scaffolds, bark
males—overwintering generation	late June to mid-July	in pheromone traps
females—summer generation	late August to mid-September	inside calyx of fruit, green succulent tissue, scaffolds, bark
males—summer generation	late August to mid-September	in pheromone traps
Eggs		
overwintering generation	October through May	in pear calyx at harvest, under bark, crevices, pruning cuts
summer generation	mid-June through late July	under bark, crevices, pruning cuts
Nymphs (crawlers)		
overwintering generation	mid-May to early July	green succulent tissue, scaffolds, bark
summer generation	mid-July to mid-September	in pear calyx at harvest, under bark, crevices, pruning cuts



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Cornell Cooperative Extension

Helping You Put Knowledge to Work

TREE FRUIT CROPS

CORNELL COOPERATIVE EXTENSION

IPM Integrated Pest Management

Insect Identification
Sheet No. 20
1991

European Apple Sawfly

Hoplocampa testudinea (Klug)

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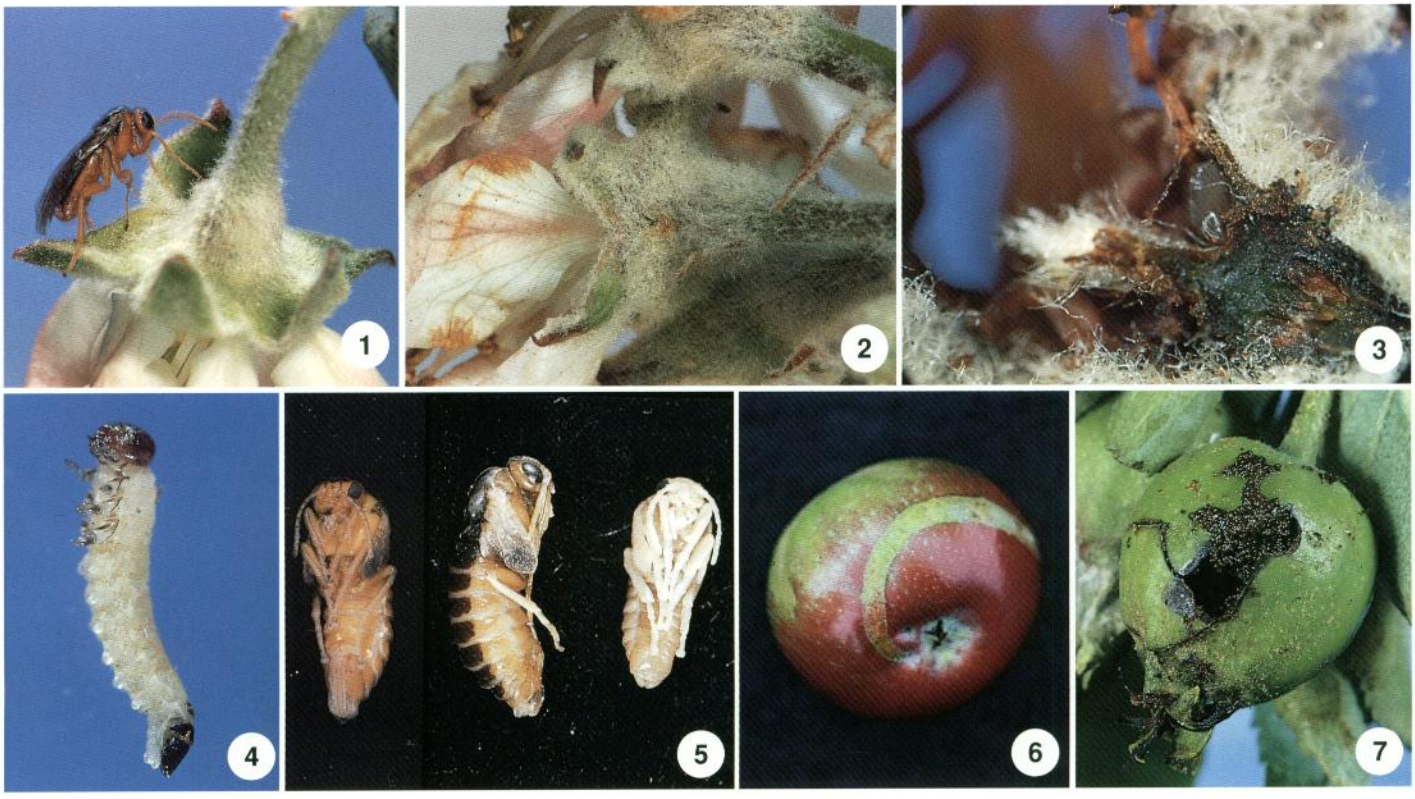
The European apple sawfly is an introduced pest that was first noted in North America infesting crabapples on Long Island (Farmingdale, N.Y.) and Vancouver Island (Victoria, B.C.) during 1939 and 1940, respectively. Since then it has spread into southern New Jersey, Vermont, New Hampshire, and the Southern Tier of New York State. The pest is especially troublesome in the apple-growing regions of Massachusetts, Connecticut, Rhode Island, and the Hudson Valley of New York. In the Pacific Northwest, the European apple sawfly appears to be limited to Vancouver Island. The pest is distributed over the entire continent of Europe but is most common in the north. It is found throughout England but is abundant only in certain localities. The larvae feed on all apple and crabapple varieties but show a preference for early or long-blooming varieties with a heavy set of fruit. Sawflies are primitive hymenopterous insects and are related to bees, wasps, and ants. Although two generations a year have been reported in England, only one seems to occur in populations in North America.

Adults

The European apple sawfly overwinters as a mature larva in a cocoon a few inches below the surface of the soil. The larva pupates early in the spring and emerges as an adult "fly" or wasp (fig. 1) about the time apple trees come into bloom. Adults are 6 to 8 mm in length, with the male smaller than the female. The head is yellow with yellow antennae and black eyes. The wings are covered with tiny black hairs, giving them a dusky appearance. The body is brown; the upper surface appears almost black and shiny and the lower surface lighter and orange to yellow. The males emerge first in the season, and as the season progresses both sexes can be found flying unsteadily about the blossoming apple trees. When they alight, they move rapidly around, quickly vibrating their antennae. The adults apparently feed on pollen and are most active when the sun is intense, usually around midday. The average adult life span is from one to two weeks.

Eggs

The female sawfly lays her eggs in apple blossoms, often at the base of the stamens. She inserts her ovipositor (the saws) through the sepal. The insertion and withdrawal of the ovipositor often leaves a brownish discoloration on the sepal or receptacle (fig. 2), which helps in detecting infested blossoms. The egg is about 0.8 mm in length, oval, colorless, and shiny (fig. 3). The eggs hatch within one to two weeks depending on daily temperatures.



Larvae

The larva measures about 1.7 mm in length at hatch. It is light cream colored with a black head and caudal (rear) shield. The head and shield become lighter as the larva matures until they are pale brown in the mature fifth-instar stage. The larva increases in size by approximately 1.4 times during each instar so that when mature it is 9 to 11 mm long (fig. 4). The codling moth and similar lepidopterous larvae (e.g., the lesser appleworm), which may be feeding on the apple fruit at the same time as the sawfly, may be distinguished from the sawfly larvae by the number of prolegs on the abdomen. Prolegs are the fleshy, stumplike appendages that extend beneath the abdomen behind the three slender pairs of true legs. There are seven pairs of prolegs on sawfly larvae but only five pairs on the larvae of the lepidopterous pests. When mature, the sawfly larvae leave the fruit, enter the soil, and construct cocoons in which they remain as pupae until the following spring. The cocoons are egg-shaped, parchmentlike brown cases usually 4 by 8 mm in size. The appendages of the pupae (fig. 5) are not glued to the body, and they resemble mummified adults.

Damage

The first larval instar commences feeding just below the skin of the fruit, creating a spiral path usually around the calyx end. Should the fruit receive no further injury, this early larval feeding will persist as a scar that is very visible and objectionable at harvest (fig. 6). Following this feeding, the larva usually molts and begins tunneling toward the seed cavity of the fruit or an adjacent fruit. The larva's feeding to the core usually causes the fruit to abort. As the larva feeds internally, it enlarges its exit hole, which is made highly conspicuous by the mass of wet, reddish-brown frass, or insect excrement (fig. 7). The frass may drip on adjacent fruit and leaves, giving them a similarly unsightly appearance. The secondary feeding activity of a single sawfly larva can injure all the fruit in a cluster, causing stress on that fruit to abort or drop during the traditional "June drop" period. The time of insecticide application usually determines the extent of sawfly injury; for example, a late application, after petals fall, will often kill developing sawfly larvae in the early tunneling stage so that tunneling scars will be short and indistinguishable from damage caused by the tarnished plant bug.

Monitoring and Control

European apple sawfly adults are visually oriented toward apple blossoms. Field trials found sticky-coated, non-ultraviolet-reflecting white rectangles to be the most effective trap for capturing and monitoring sawfly adult populations. The number of adults captured may determine the necessity for treatments directed at the pest.

Application of an insecticide at calyx (petal fall) usually provides adequate control of the pest. Before using chemical control measures, one should consult with the local Cooperative Extension or IPM specialist about the best materials and use patterns for the area.

Because the sawfly is a hymenopterous insect, insecticides that control it also adversely affect bees. Because bees play an essential role in the pollination of the apple crop, no insecticide sprays should be permitted during the bloom period. This poses a problem at petal fall because certain apple varieties lose their petals before others. Thus in blocks of trees where petal fall has occurred on one variety but not the others, the variety that has lost its petals is likely to sustain some fruit injury from the European apple sawfly until the insecticide is applied. Growers can remedy this situation by choosing pollenizer varieties that do not overlap widely.

Because the sawfly is an introduced pest, many of its natural enemies probably remained behind in Europe. The absence of such enemies may be a major reason for the pest's highly successful establishment in this country. Studies comparing the European apple sawfly parasite and predator fauna between continents would be useful and could lead to the introduction of more effective natural enemies.

GUIDE TO STAGES

Stage	Timing	Where to Look
Adult	Late pink to fruit set	On the blossom clusters during warm days
Egg	Bloom to fruit set	Oviposition scars visible on fruit sepals
Larva	Petal fall to "June drop"	In fruit
Pupa	Midsummer to next spring	In soil



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Tree Fruit IPM
Disease Identification Sheet No. 5
1981

cedar apple rust

Gymnosporangium juniperi-virginianae Schw.

INTRODUCTION

Cedar apple rust (CAR) is an important fungal disease of apple in North America east of the Rocky Mountains. It can defoliate trees and blemish fruit making them unmarketable. The CAR fungus requires two hosts, apple and eastern red cedar (*Juniperus virginiana* L.), to complete its life cycle. Spores produced on apple do not infect apple, but only cedar and spores produced on cedar infect only apple.

DISEASE CYCLE

The CAR fungus overwinters in spherical galls on cedar trees (Fig. 1). Spring rains cause horn-like structures, called telia, to extrude from galls (Fig. 2). When these horns absorb water, they become jelly-like and swollen. Between rains they dry to dark brown threads (Fig. 3). The telial horns are comprised of thousands of two-celled spores called teliospores. Swelling and drying of telial horns may occur 8-10 times during the season. Each time, the horns push out further and expose more teliospores until the supply is exhausted.

During rains, after the telial horns absorb water, the teliospores germinate to produce a germ tube (basidium) from each cell. Four basidiospores are produced on each basidium (Fig. 4). At optimum temperatures, basidiospores are produced within 4 hours of the horns absorbing water.

Basidiospores are forcibly discharged into the air immediately after being formed. They can be carried long distances. Basidiospores that land on young apple tissue may germinate and infect if a film of water is present for an adequate amount of time (Table 1). One to two weeks after infection, orange pustules (pycnia) containing pycniospores appear on the upper side of leaves (Fig. 5) or on fruit (Fig. 6).

Table 1.—Temperature and moisture requirements for cedar apple rust infection periods.

Temperature (C)	Temperature (F)	Hours Wetting Required: A Basidiospore Formation	B Infection: Light	B Infection: Severe
2	36	-	24	-
4	39	-	12	24
6	43	-	8	10
8	46	7	6	7
10	50	5	5	6
12	54	4	4	5
14	57	4	3	5
16	61	4	3	4
18	64	4	3	4
20	68	4	2	4
22	72	4	2	4
24	75	4	2	4
26	79	-	-	-
28	82	-	-	-
30	86	-	-	-

No basidiospores form at these temperatures.

Light infection—unlikely to cause economic loss.

No infections have been observed at these temperatures.

Note: Only use this table when determining CAR infection on susceptible apple varieties that are located close to eastern red cedars.

Instructions [Using hourly temperature records].

Basidiospores are formed when the temperature during a wetting period averages 11-25 C (52-77 F) for 4 continuous hours. It takes slightly longer when the temperature averages 7-11 C (45-52 F) (Table 1, part A). Once you have determined basidiospores were formed, determine if infection has taken place (Table 1, part B). Average the temperature *starting at the time when you determined basidiospores had been formed.* The hours listed in part B is the minimum time required for light or severe infection.

One to two months after the appearance of pycnia, the rust produces other fungal structures,called aecia, on the underside of the leaf (Fig. 7) or on fruit (Fig. 8). The aecia produce aeciospores which are released into the air during dry conditions in late summer. Aeciospores that land on young leaves of cedar may germinate, infect, and cause gall formation. Generally, in the second year after infection, the gall matures and produces teliospores, thereby con-



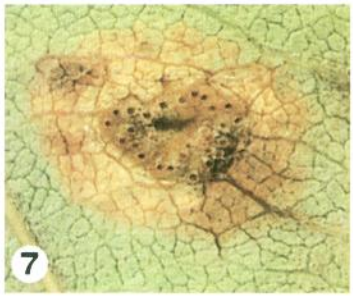


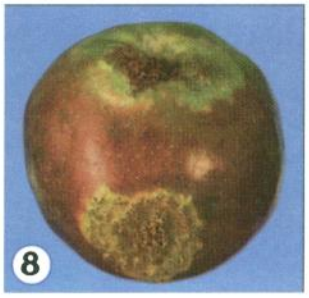












tinuing the disease cycle (Fig. 9). Because most galls produce teliospores for only one season, a new crop of galls is required each year if infection of apples is to occur.

INFECTION OF APPLE

Before apple can be infected, adequate moisture must be present in a temperature range of 8-24 C (46-75 F) to allow for formation of basidiospores on cedar galls. Then, the basidiospores will infect apple when susceptible leaf and fruit tissues are wet for certain lengths of time at specific temperatures (Table 1).

Leaves are most susceptible to infection when 4-8 days of age, and fruit are susceptible from tight cluster through bloom.

CONTROL

Control strategies for CAR are based on fungicides, removing nearby red cedars, and using resistant varieties. Table 2 presents four categories of resistance for 44 cultivars. CAR can be minimized on susceptible cultivars if red cedars are eliminated from their vicinity. Where susceptible cultivars are grown in proximity to red cedars, a fungicide program should be followed from tight cluster through first cover. Use chemicals on a schedule recommended by the local extension service.

Table 2.—Resistance of apple varieties to the cedar apple rust fungus.

Very Resistant	Resistant	Susceptible	Very Susceptible
Delicious (and its red sports)	Akane	Burgundy	Golden Delicious
Jerseymac	Early McIntosh	Cortland	Jonathan
Liberty	Empire	Idared	Lodi
McIntosh	Gravenstein	Jonagold	Prima
Milton	Jonamac	Julyred	Rome Beauty
Nova Easygro	Macoun	Macfree	Twenty Ounce
Novamac	Niagara	Monroe	Vista Bella
Priscilla	Paulared	Mutsu	York Imperial
Tydeman's	Puritan	Northern Spy	
	Spartan	Quinte	
	Viking	Rhode Island Greening	
		Sir Prize	
		Stayman	
		Wayne	
		Wealthy	

Very Resistant: No chemical control is ever needed.
Resistant: Chemical control is needed only under high disease pressure.
Susceptible: In areas where the disease is prevalent chemical control is usually needed.
Very Susceptible: Control is always needed and these varieties should receive first priority when chemical control is called for.

Cedar apple rust disease cycle. Adapted in part by Rose McMillen from G. Agrio's Plant Pathology. 2nd Edition. Used with permission of the author and publisher, Academic Press, Inc.

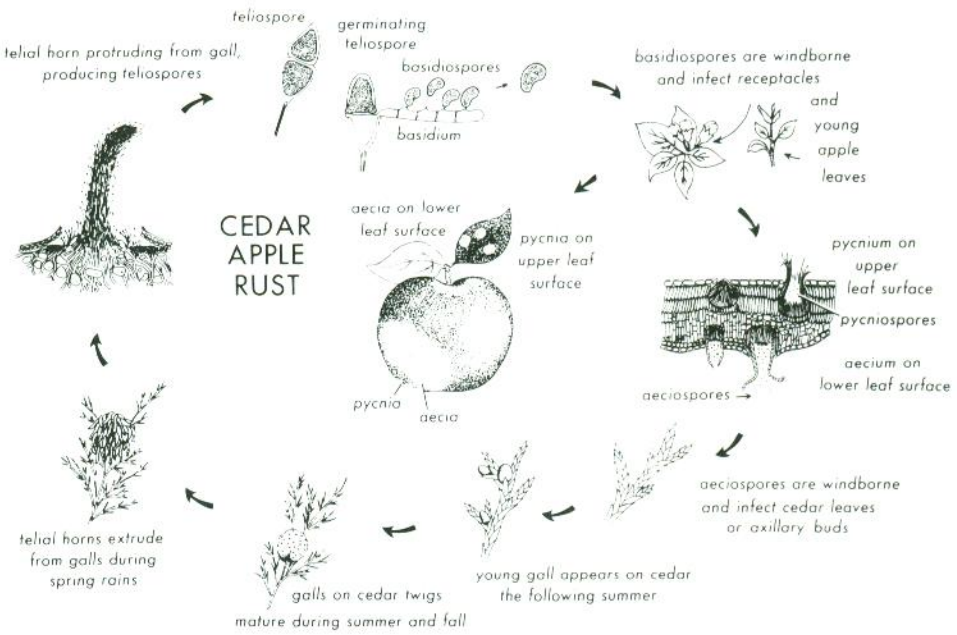


Figure 9

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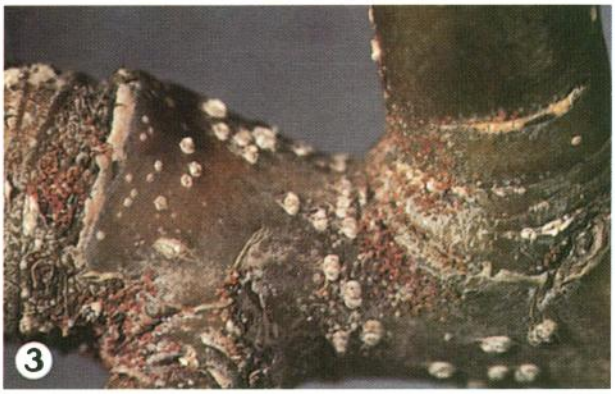
Tree Fruit IPM 1980
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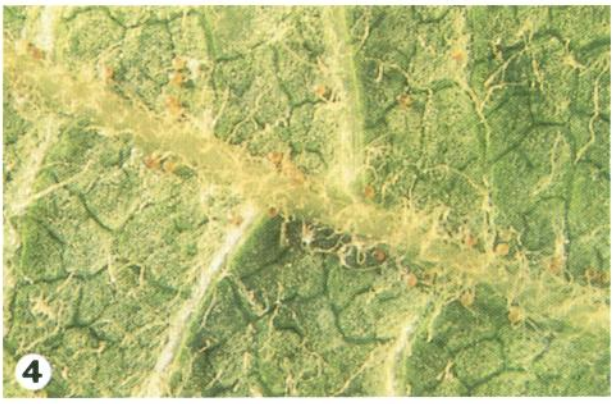
European red mite

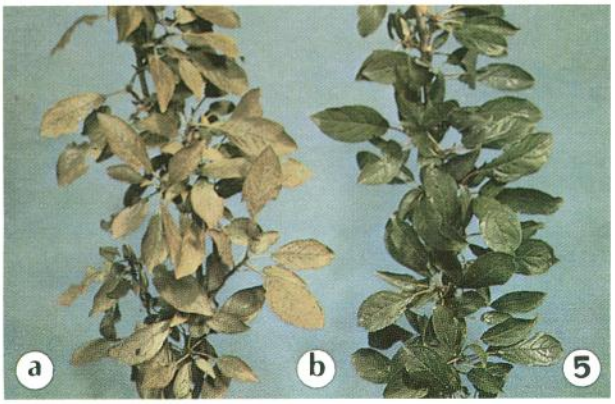
Panonychus ulmi (Koch)


1


2


3


4


a b 5

INTRODUCTION

The European red mite (ERM) is a European species introduced to North America in the early 1900's. It rapidly extended its range, and is now established in most deciduous fruit growing areas. It is the most important mite species attacking tree fruits in North America. ERM can also be a pest of grapes and raspberries.

THE ADULTS

There are 4-9 generations of the ERM a year, depending on the locality and the length of the growing season. The sexes of the adults are readily differentiated. The female (Fig. 1) has a globular body which ranges in length from .38-.40 mm, is velvety brown to brick red, and has 4 rows of dorsal setae or spines borne on raised white tubercles. The body color and setal pattern distinguish this species from all other plant feeding mites.

The male is smaller, .26-.28 mm in length, lighter in color and has a pointed abdomen and proportionately longer legs (Fig. 2).

The rate of development is temperature dependent, being slower in the spring and fall, and more rapid during the hot summer months. The first generation generally requires about 3 weeks to develop, while summer generations may develop in 10 to 14 days. Reproduction can be both sexual and parthenogenetic. Unfertilized eggs give rise to males only, while mated females produce both sexes.

The average preoviposition period of females is about 2 1/2 days. Although some females in insectary studies have lived 39 days, the average life span is 18 days. The oviposition period averages 12.5 days with 18.8 eggs produced per female.

THE EGGS

The ERM overwinters as fertilized eggs. The environmental factors triggering winter egg production are diminishing food supply, temperature and photoperiod. The bulk of winter egg deposition occurs from mid to late August, but may continue until late September. Overwintering eggs (Fig. 3) are deposited in groups, on roughened bark areas, especially around the base of buds and fruit spurs. These eggs may be so numerous that the infested areas take on a reddish cast. Egg hatch is closely correlated with bud development and first occurs when buds are in the tight cluster stage; hatch is better than 50% complete at the pink stage, and virtually 100% complete by the end of bloom. The first summer eggs as a rule can be found at petal fall or at latest by fruit set.

The summer eggs are globular and somewhat flattened (onion shaped) (Fig. 4). They are bright red to dark orange, and average .13 mm in diameter. The overwintering egg is deeper red and slightly larger, averaging .14 mm. The egg surface is ridged with the grooves running toward the top center from which a slender tapering stalk (.1 mm) arises.

The average incubation period of the summer eggs for each generation varies from 6.7 to 14.4 days, the shortest period being in mid-summer.

THE LARVAE AND NYMPHS

The ERM passes through 3 stages between egg hatch and adulthood. They are called the larva, protonymph and deutonymph. A quiescent or resting period precedes each molt to the following stage. The hatching larva is about .2 mm in length, light orange in color and 6 legged. All subsequent stages have 8 legs. With the exceptions of an increase in size and the ability to differenciate sexes in the deutonymphal stage, there are no conspicuous changes in structure or color between the nymphal instars. The average developmental time from eclosion to adulthood ranges from 5.5-15 days, depending on the generation.

INJURY

Although a pest of all tree fruits, apple and plum suffer most severely. Injury is caused by the feeding of all stages on the foliage. The lower leaf surface is preferred. Under high populations both surfaces are fed upon. The injury is caused by the piercing of the cell walls by the bristle-like mouthparts and the ingestion of their contents, including the chlorophyll. The injury results in off-color foliage which in severe cases becomes bronzed (Fig. 5a) as compared to uninfested foliage (Fig. 5b). The leaf efficiency and productivity is directly affected. Heavy mite feeding early in the season (late June and early July) not only can reduce tree growth and yield but also drastically affect fruit bud formation, and thereby reduce yields the following year. Additionally, mite injured leaves will not respond to growth regulators applied to delay harvest drop.

CONTROL

Mite predators are generally distributed in commercial apple plantings and contribute to the control of the ERM and should be protected. The ERM can be readily controlled by thorough and timely acaricide applications. The most effective treatments are those applied after new growth has appeared but ahead of bloom. Seasonal control can often be obtained with a single petroleum oil spray directed against the overwintering eggs or the application of an acaricide toxic to the newly hatched forms. Against established populations in the summer it is often necessary to make 2 applications 10-14 days apart. Consult your local recommendations for timing and best materials to use in your area.

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Tree Fruit IPM
Insect Identification Sheet No. 4
1980

green fruitworm

Orthosia hibisci (Guenee)

INTRODUCTION

The larvae of several Lepidoptera are collectively called green fruitworms because of their general appearance and tendency to damage apple and pear fruit. One species, *Orthosia hibisci*, which will be referred to as the green fruitworm (GFW), is currently a serious pest in commercial orchards. It is native to and a pest of deciduous fruits across North America. The larvae feed on a variety of deciduous shade, forest, and fruit trees and shrubs. The GFW has only one generation annually.

THE ADULTS

GFW adults are night fliers. Their flight closely parallels apple bud development. It begins at about green tip, peaks at tight cluster, and is completed by the pink stage.

GFW adults are about 16 mm in length (Fig. 1). The forewings are grayish pink; each is marked near the middle with 2 purplish gray spots, outlined by a narrow pale border. The hindwings, which are not visible when the moth is at rest, are slightly lighter in color than the forewings.

Females begin egg laying on twigs and developing leaves when apples are in the half-inch green stage. A female is capable of laying several hundred eggs, but normally deposits only 1 or 2 at any given site.

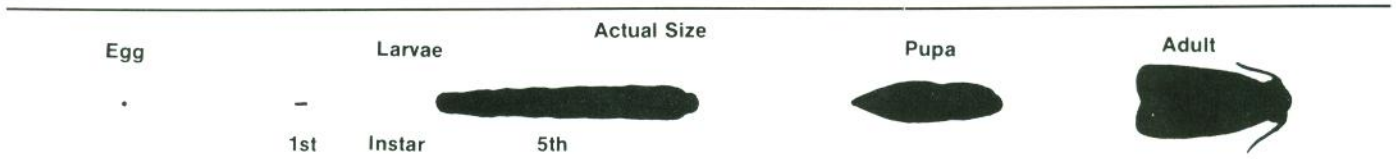
THE EGGS

GFW eggs are about 0.8 mm in diameter and 0.5 mm in height. Freshly laid GFW eggs are white with a grayish tinge and have numerous ridges radiating from the center. Shortly before hatching the egg takes on a mottled appearance (Fig. 2).

THE LARVAE

GFW larvae pass through 6 instars. Newly hatched larvae are 2-3 mm in length and have a grayish green body with a brown head and thoracic shield. Mature larvae are 30-40 mm in length and have a light green body and head. Several narrow white stripes run longitudinally along the top of the body and a slightly wider, more distinct white line runs along each side. The green areas between the stripes are covered with numerous white speckles.

Young larvae feed on new leaves and flower buds and can often be found inside a rolled leaf or bud cluster (Fig. 3).













Older larvae damage flower clusters during bloom and continue to feed on developing fruit and leaves for 1-2 weeks after petal fall (Fig. 4). They then drop to the ground, burrow 50-100 cm beneath the soil surface, and pupate.

THE PUPAE

The GFW overwinters 50-100 mm (2-4 in) underground in the pupal stage. The pupae are dark brown and about 16 mm in length.

INJURY

Most flower buds and blossoms damaged by GFW larvae abort. Most fruit damaged just prior to and shortly after petal fall also drop prematurely. Some, however, remain at harvest and exhibit deep corky scars and indentations (Fig. 5). This injury is indistinguishable at harvest from that caused by the overwintering larvae of the obliquebanded leafroller.

CONTROL

Several parasites attack GFW larvae, but do not adequately control this pest in commercial orchards. An insecticide may be applied at the half-inch green stage of apples and at the bud burst stage of pears to control adults and young larvae. If necessary, a spray can also be applied at the pink bud stage of apples and white bud stage of pears, and again at petal fall to kill the larger larvae before they seriously damage fruit. Consult your local recommendations to determine which insecticides are most effective in your area.

GUIDE TO STAGES

Stage	Timing	Where to Look
Adults	Green tip through pink	Nocturnal flier.
Eggs	Half-inch green through pink	Twigs and developing leaves, deposited singly or in pairs.
Larvae		
(Small)	Tight cluster through bloom	Terminal leaves and flower clusters.
(Large)	Bloom through 30 days past petal fall	Flower cluster and developing fruit.
Pupae	Late June through the next season's green tip	Beneath soil surface, 50 to 100 mm.

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Tree Fruit Fact Sheet
102GFSTF-M1
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TREE FRUIT CROPS

CORNELL COOPERATIVE EXTENSION

Meadow Vole and Pine Vole

Microtus pennsylvanicus (Ord)
Microtus pinetorum (LeConte)


1

Meadow voles occur throughout most of the northern and eastern United States and Canada in low wetlands, open grasslands, and orchards. Meadow voles are most active above the ground, as evidenced by surface trails—often littered with droppings and grass cuttings—in the ground vegetation where they live (fig. 1). They sometimes live underground where the soil has been cultivated or where a burrow system is already present.

Pine voles live throughout the eastern half of the United States and favor open woodlands and orchards. Pine voles spend much of their time in underground burrows and usually have an extensive subsurface trail system that is excavated about 3 to 5 cm (1 to 2 in.) deep. These burrows open to the surface and often connect to above-ground runways.


2

Identification

The pine vole is a stocky little rodent with a blunt nose, short legs, and a tail that is shorter than the head-and-body length. Adult meadow voles are larger than pine voles, have longer tails, and have dark brown fur (fig. 2). A number of other physical, social, and ecological differences distinguish these two species (see table).


3


4

Damage

Both species cause substantial damage to commercial fruit trees and are pests of the home gardener and horticulturist. By girdling the trunk and roots, these rodents kill trees, reduce harvest yields, and prolong the time required for new plantings to come into production. Meadow voles usually girdle the trunks of trees at or above ground level (fig. 3). Pine voles commonly damage underground roots, making them look as though they were sharpened with a pencil sharpener (fig. 4). Pine voles can also girdle the crowns of trees at ground level, especially under cover of snow.


5

Management

Voles are prolific breeders, and their populations have the potential to irrupt every three to five years unless their numbers are controlled or the carrying capacity of the habitat is reduced. Mowing the groundcover reduces the availability of foods preferred by voles, removes cover that protects them from predation, and exposes the animals to the seasonal elements. Maintaining a bare strip underneath the canopy discourages voles from living near the base of trees. Wrapping 1/4-inch-mesh galvanized hardware cloth around the base of young trees (fig. 5) prevents meadow voles from girdling trees, although it does not prevent pine voles from girdling the roots and trunk below the mesh.

Distinguishing Characteristics of Meadow Voles and Pine Voles

Characteristic	Meadow Voles	Pine Voles
length (head and body)	90 to 125 mm (3.5 to 5 in.)	70 to 105 mm (2.8 to 4.2 in.)
tail	35 to 65 mm (1.4 to 2.6 in.) at least twice the length of the hind foot	15 to 25 mm (0.6 to 1 in.) less than or equal to the length of the hind foot
adult fur	course, dark brown mixed with black	soft, auburn, lacking guard hairs
eyes	large	small
ears	large	inconspicuous
nest	usually above ground, but occasionally in shallow burrows	in burrows, usually less than 30 cm (1 ft) deep
sociality	females maintain exclusive territories during breeding seasons: males are mobile	family units maintain year-round exclusive territories
food	grasses, sedges, seeds, grain, bark, some insects	bulbs, tubers, seeds, bark
damage	girdle tree trunks at or near ground surface; may girdle higher under cover of snow; sometimes damage roots	girdle crown and roots

Early detection and control of populations before they reach high levels is important. The economic threshold for voles is very low; any sighting indicates the need for control measures. Allowing populations to multiply increases the probability of damage to trees, makes future control more difficult, and can necessitate that greater amounts of poisonous bait be introduced into the environment.

Application of toxic bait is the quickest and most effective method for removing troublesome populations. Broadcasting baits across the orchard floor by hand, spreader, or airplane is the most common method of application. However, placing baits directly in runways and burrow openings may be a more effective way to control pine voles, especially when they confine their activity to below a heavy thatch layer or below thick vegetation on the ground.

In apple orchards, baits frequently are applied during the fall after the harvest. However, in some orchards, winter and/or early spring applications may also be necessary to control residual populations or reinvading animals. When conditions allow, winter applications may be particularly effective because 1) most girdling occurs at this time; 2) vole trails are readily apparent in melting snow (fig. 5); and 3) bait acceptance is likely to be greatest because preferred foods will be scarce.

Adherence to safeguards will foster efficacious use of toxic baits for the control of voles in orchards. Mowing the groundcover and raking away the vegetation, leaf litter, and other debris under the dripline helps to insure that the bait reaches the ground where voles can find it. Applying baits only when several days of dry weather are expected allows voles sufficient time to find and eat a lethal dose of bait before it decomposes. Alternating from one type of toxic bait to another forestalls or prevents the development of physiological resistance and bait shyness.

Authored by M. E. Tobin and M. E. Richmond. Photographs by M. E. Tobin and J. Ogrodnick (fig. 2). Published through the New York State Integrated Pest Management Program, New York State College of Agriculture and Life Sciences, Cornell University. Funded in part by the New York Cooperative Fish and Wildlife Research Unit. Cornell Cooperative Extension provides equal program and employment opportunities.

Tree Fruit IPM
Insect Identification Sheet No. 5
1980

obliquebanded leafroller

Choristoneura rosaceana (Harris)

INTRODUCTION

The obliquebanded leafroller (OBLR) is native to and widely distributed throughout temperate North America. Larvae feed on a wide range of plants; members of the rose family are their preferred hosts. OBLR outbreaks have resulted in severe damage to apple, peach, and pear fruit. The OBLR may have 1-2 generations a year, depending on the locality.

THE ADULTS

The spring flight of OBLR adults begins about 3-4 weeks after petal fall on apples, and continues for 3-4 weeks. In areas where the OBLR has 2 generations, a second flight occurs from early August through early September.

OBLR adults are 9-12 mm in length and have a wingspan of 20-27 mm. The forewings are reddish-brown and crossed by 3 oblique chocolate brown bands (Fig. 1). The hind wings, which are not visible when the moth is at rest, are pale yellow.

After emergence, females have a 24 hr preoviposition period. They then begin laying egg masses which gradually diminish in size with each succeeding egg mass laid. A female is capable of laying up to 900 eggs during her 7-8 day oviposition period.

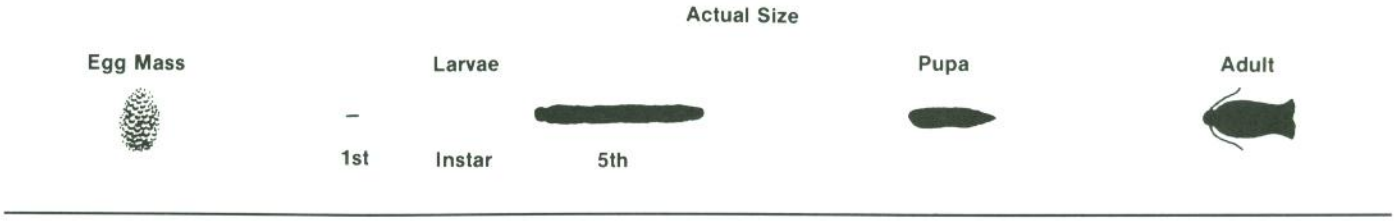
THE EGGS

OBLR eggs are laid on the upper surface of leaves. They appear as greenish yellow masses measuring about 5 x 9 mm (Fig. 2) and may contain 200 or more eggs. The black head capsules of embryonic larvae become visible prior to hatching which usually occurs in 10-12 days.

THE LARVAE

OBLR larvae are indiscriminate feeders that pass through 6 instars. Newly hatched larvae have a yellowish green body and a black head and thoracic shield. Mature larvae are 20-25 mm in length and the head and thoracic shield may be either black or various shades of brown (Fig. 3). The first summer brood of larvae emerge in early July and complete their development in late July or early August. Second brood larvae begin to emerge in mid-August, and feed until they reach the third instar in the fall, when they construct hibernation sites on twigs or bark and enter winter diapause. These overwintering larvae resume activity the following spring when the tree breaks dormancy and complete their development about 3 weeks after the apple blossom period.

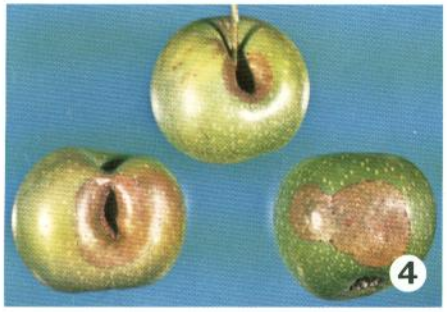
Overwintered OBLR larvae (springbrood) first feed on water sprouts and then move throughout the tree. Those















feeding on developing flower buds do so before bloom and continue to consume floral parts throughout the blossom period. After petal fall, these larvae continue feeding on the developing fruit. Newly hatched larvae of the first summer brood move to and feed on tender growing terminals, water sprouts, or developing fruit. As these larvae reach the third instar they display an increasing propensity to damage fruit. The second brood larvae, which develop in late summer and fall, feed primarily on leaves until they enter diapause, although they may occasionally damage fruit.

THE PUPAE

OBLR pupae are dark brown, about 11 mm in length, and are usually found in rolled leaves on the tree.

INJURY

The most serious injury from overwintering OBLR larvae occurs just prior to and shortly after petal fall when the developing fruit is damaged. Many of these damaged fruits drop prematurely, but a small percentage remain on the tree, exhibiting deep corky scars and indentations at harvest (Fig. 4). Leaf injury by all broods is characterized by the larvae rolling leaves and feeding on surrounding foliage (Fig. 5). The first summer brood larvae feed on the surface of developing fruit in late July and early August (Fig. 6). This injury is similar to that caused by several other species of leafrollers. Fruit damage caused by first summer brood OBLR larvae is usually more serious than spring feeding by overwintered larvae because more of the fruit injured later in the season remains on the tree at harvest.

CONTROL

Several parasites attack OBLR larvae but do not adequately control the pest. Insecticides, effective against large larvae, must be applied at petal fall. If necessary, another spray should be applied in the summer, when most of the summer brood eggs have hatched.

An alternative strategy is to control overwintering larvae at petal fall as previously described, and apply sprays during June to kill the first summer brood adults and newly hatching larvae. Conventional organophosphate insecticides can be used in this program. The flight of adults can be monitored with pheromone traps. The first spray should be applied about 7 days after the first male moth is captured and subsequent sprays should be applied at 14 day intervals as long as the flight continues.

Consult your local recommendations on the use of pheromone traps for this insect and the relative effectiveness of insecticides against OBLR adults, newly hatched larvae, and large larvae.

GUIDE TO STAGES

Stage	Timing	Where to Look
Adults (1st flight)	3 weeks after petal fall and continuing up to 4 weeks	Pheromone traps and resting on upper leaf surfaces.
(2nd flight)	Early August through early September	Same as above.
Eggs	Same as adult flight	Upper leaf surfaces.
Larvae (overwintering)	Previous fall through 2 weeks past petal fall	Overwinters in protected sites throughout tree and in the spring moves to tender growth and flower buds.
Larvae 1st generation	Early July through early August	Terminal growth and developing fruit.
Larvae 2nd generation	Mid August through harvest	Primarily leaves and occasionally fruit.
Pupae	Three weeks past petal fall through early September	Tightly enclosed in or near feeding sites.

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TREE FRUIT CROPS

CORNELL COOPERATIVE EXTENSION

Oriental Fruit Moth

Grapholitha molesta (Busck)

The Oriental fruit moth (OFM), native to China, was introduced to the United States from Japan about 1913 on infested nursery stock. The OFM is now found in all regions of North America where peaches are grown. Although it is most important as a pest of peach, the OFM has an extensive host range that includes apple, quince, pear, plum, cherry, apricot, nectarine, and some rosaceous ornamentals. In the northeastern United States, the OFM has three generations (flights) per year. In areas with a longer growing season, it may have up to five generations per year.

The Adult

The adult OFM (fig. 1) is a small, grayish moth with a wingspan of approximately 13 mm (0.5 in.). Adults of the overwintering generation begin to emerge about the time of apple bloom, and females begin to lay eggs after a two- to five-day pre-oviposition period. Each female can lay up to 200 eggs during her seven- to ten-day oviposition period.

The Eggs

Eggs are found on upper leaf surfaces, frequently on the terminal leaf of a young shoot. Each egg is slightly oval, measuring 0.6 x 0.7 mm (.02 x .03 in.). It is translucent white when first laid, changing later to an amber color (fig. 2). The incubation period varies with temperature, ranging from three to four days at midsummer, to seven to fourteen days during the cooler part of the season. Just before the larva hatches, the dark head capsule can be seen through the egg. This is known as the "black head" stage.

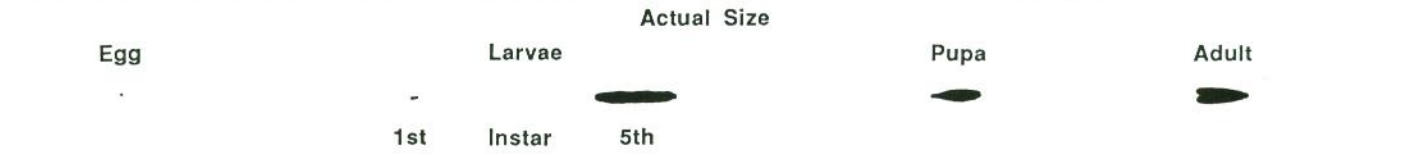
The Larvae

Shortly after hatching, larvae enter young terminals or fruit and begin to feed. The larvae pass through four to five instars, and range in length from 1.5 mm (.06 in.) when newly hatched to approximately 12 mm (.5 in.) when mature. Newly hatched larvae are white, with a black head capsule. Mature larvae are dirty white to pink in color, with a reddish brown head capsule (fig. 3). If a terminal becomes unsuitable as a food source before larval development is complete, larvae seek other terminals, or move to fruit to complete their development.

Mature larvae leave their feeding sites to spin cocoons in which they either pupate, or enter diapause to overwinter. Diapause is a resting period that allows many species of insects to suspend development until weather conditions become favorable. In the OFM, diapause is induced by decreasing day length in late summer.

The Pupae

Pupae are found within cocoons on the trunk (usually







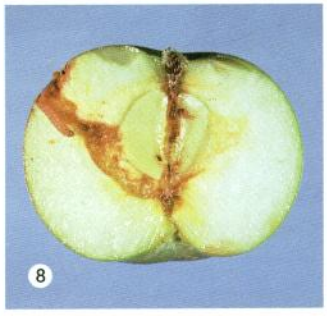












GUIDE TO STAGES

Stage	Timing	Where to look
Adults		
First flight (late April)	Half-inch green (apple); Half-inch green to bloom (peach); until mid-June	Pheromone traps
Second and third flights	Early July through harvest	Pheromone traps
Eggs (late April)	Tight cluster through harvest (apple); pink through harvest (peach)	Upper leaf surface and fruit
Larvae	Bloom through harvest	In tender shoots and fruit
(Overwintering)	August to mid-March	In cocoons under bark scales and in leaf litter under tree
Pupae	Early spring through summer	In cocoons under bark scales and in leaf litter under tree

within two feet of the ground) or in debris on the ground under the tree. The cocoons are constructed of silk, and are covered with particles of the surface on which they are spun. Early in the season, nearly all of the larvae pupate soon after spinning a cocoon. The pupal stage lasts from twelve to fifteen days in the summer, and somewhat longer at cooler temperatures during the spring. Later in the season, as day length decreases, an increasing proportion of larvae enter diapause to overwinter. Diapausing larvae pupate and emerge the following spring.

Damage

On peach, the OFM feeds in both vegetative growth and fruit. The first generation, which is feeding when terminals are succulent and tender, develops almost exclusively in the vegetative growth. The larvae often enter the terminal at the base of a young leaf, and tunnel toward the base of the shoot. Infested terminals wilt and die back to the margin of feeding, and are commonly called "strikes" or "flagged shoots" (fig. 4). Heavy twig infestations of nursery stock can adversely affect the shape of the tree. Axillary buds often begin to grow when the terminal shoot is killed, causing the tree to have a bushy appearance.

Fruit that are infested when very small often drop. Early–infested peaches that do not drop have obvious entrance holes with frass and gum exuding from them (fig. 5). Larvae attacking nearly ripe peaches usually enter the fruit near the stem, leaving only a very small, inconspicuous entrance hole. The larvae tunnel in the fruit, and frequently excavate cavities near the pit (fig. 6).

Terminal feeding on apple is similar to that on peach. Infested apples have a collection of frass at the exit hole of the insect's feeding tunnel (fig. 7), or at the calyx end. It is difficult to distinguish between OFM damage and codling moth damage. OFM larvae feed randomly in the apple, and usually do not feed on the seeds (fig. 8), while codling moth larvae usually tunnel directly to the core of the apple and feed on the seeds. Later instar larvae of the two species may be distinguished by the presence or absence of the anal comb at the tip of the abdomen. The anal comb is present in the OFM and absent in the codling moth (fig. 9).

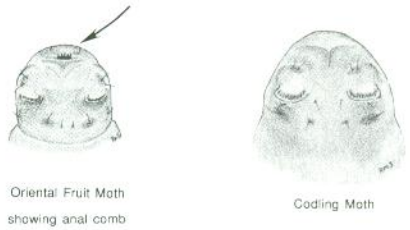


Figure 9.

Control

More than 130 species of parasitoids have been reported attacking OFM; however, parasitism probably plays a very minor role in OFM control in today's commercial orchards because of the sensitivity of many parasitoids to commonly used insecticides. Before the advent of DDT, attempts were made to supplement naturally occurring biological control of the OFM. Inundative releases of the braconid wasp *Macrocentrus ancilivorus* provided an average 50% reduction in number of infested fruit. However, because of the large pest complex on apple, biological control of one pest is difficult to achieve, since broad-spectrum insecticides are still needed for other pests.

Research has shown that if a synthetic sex pheromone is released in high concentrations in an orchard, male Oriental fruit moths cannot locate a female to mate. This control method, known as mating disruption, has proven effective in field tests.

The OFM is rarely a problem in orchards with a regular insecticide program, but could become a more important pest as patterns of insecticide use change, or if insecticide resistance develops. Check local Cooperative Extension recommendations for the best materials and timing for OFM control in your area.

Authored by A. J. Seaman and H. Riedl. Photographs by J. Ogrodnick and G. Catlin. Illustrations by R. McMillen-Sticht. Published through the New York State Integrated Pest Management Program, New York State College of Agriculture and Life Sciences, Cornell University. Cornell Cooperative Extension provides equal program and employment opportunities.

Tree Fruit IPM 1980
Disease Identification Sheet No. 4

powdery mildew of apple

Podosphaera leucotricha (Ell. & Evherh.) Salm.

INTRODUCTION

Powdery mildew (PM) is a fungal disease that can reduce the vigor and productivity of apple trees. The cultivars Baldwin, Cortland, Idared, Jonathan, Monroe, and Rome are particularly susceptible to PM. Other cultivars may also become infected when inoculum is present and conditions are favorable for infection. The PM fungus may kill vegetative shoots and flower buds, and infected fruits become russetted.

DISEASE CYCLE

Dormant Period

PM overwinters as fungal strands (mycelium) in vegetative or fruit buds which were infected the previous season. Infected terminals may have a silvery gray color, stunted growth, and a misshapen appearance (Fig. 1) and are more susceptible to winter kill than are noninfected terminals. Temperatures near -28 C (-18 F) kill a majority of mildewed buds and the fungus within them. Even at lower temperatures, however, some PM survives.

The PM fungus produces masses of small black structures called perithecia or cleistothecia on infected leaves and terminals in the late summer and fall. Although the perithecia contain spores, they do not cause infections.

Primary Infection and Spread

As buds break dormancy, the PM fungus resumes growth and colonizes developing shoots causing primary infections. The powdery white appearance on infected shoots consists of many thousands of spores (conidia) which are responsible for spreading the fungus and causing the secondary infections. Primary mildew infections may occur on vegetative shoots (Fig. 2) and blossoms (Fig. 3a—healthy, 3b—infected) and thereby cause a reduction in yield. Prunning of severely infected trees often results in poor tree structure.

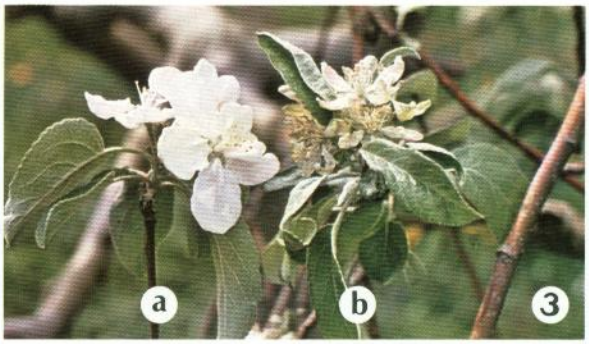
Secondary Infection

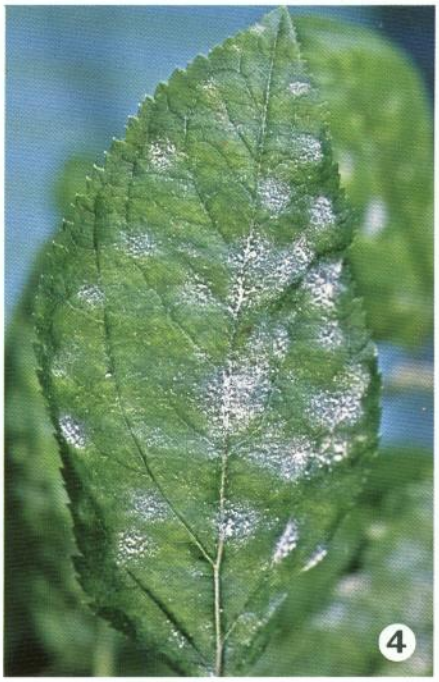
Secondary infections are important because they produce the overwintering infected buds. Secondary infections usually develop on leaves and buds (Fig. 4) before they harden off and may reduce the vigor of the tree. Fruitlets may become infected shortly after bloom, resulting in a weblike russetting on the mature fruit (Fig. 5).

FAVORABLE CONDITIONS FOR INFECTION

PM infections occur when the relative humidity is greater than 90% and the temperature is between 10-25 C (50-77 F). The optimum temperature range for the fungus is 19-22 C (66-72 F). Although high relative humidity is required for infection, the spores will not germinate if immersed in water. Leaf wetting is, therefore, not conducive to PM development. Under optimum conditions, PM will be obvious to the naked eye 48 hr after infection. About 5 days after infection, a new crop of spores is produced. Nongerminated powdery mildew spores can tolerate hot dry conditions and may persist until favorable conditions for germination occur.







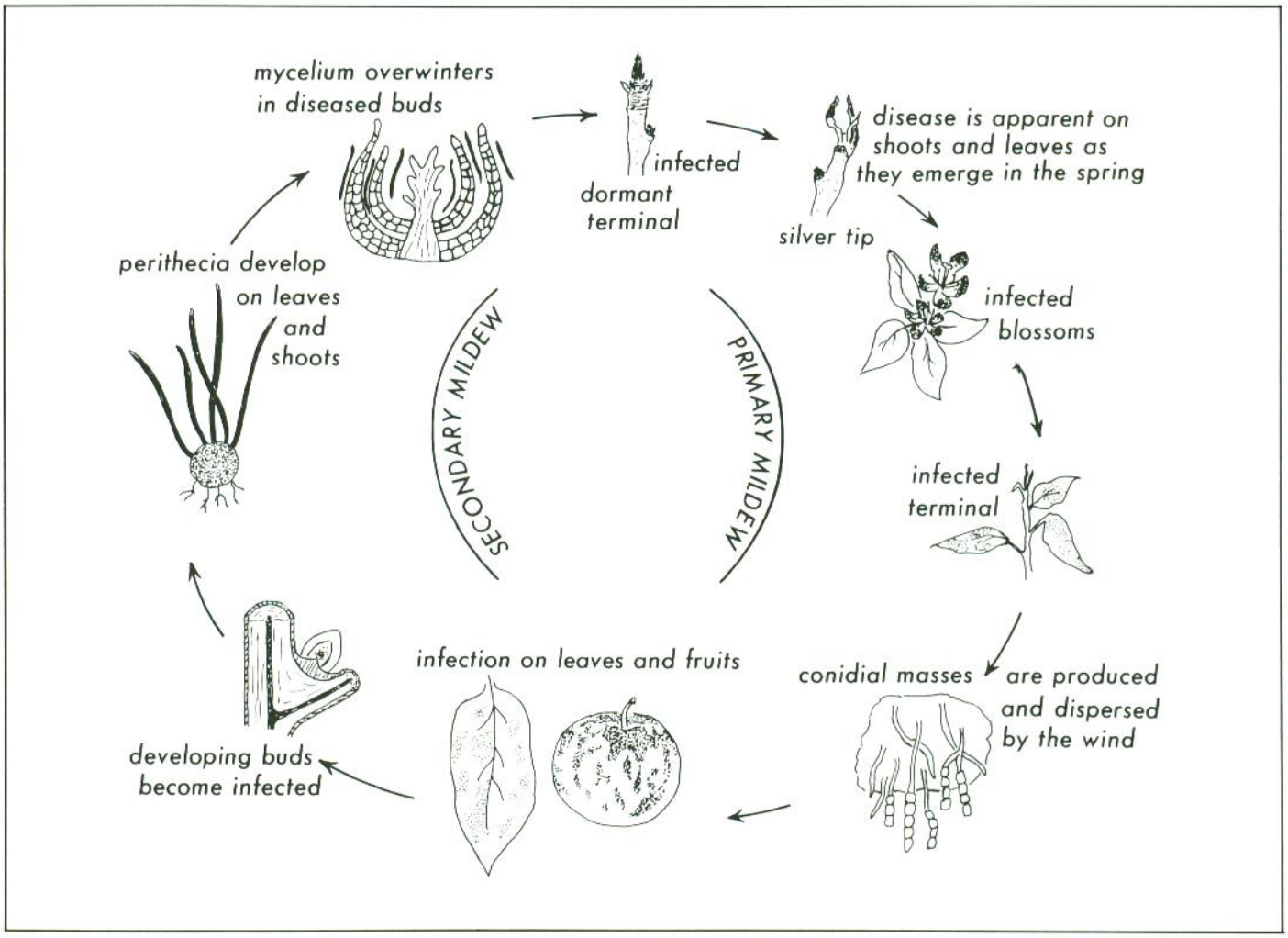




CONTROL

Where PM susceptible varieties are grown and favorable environmental conditions exist, a fungicide spray program is necessary to control the disease. The major objectives of the spray program are to: 1) reduce the number of spores produced on newly-developing infected tissues in the spring (primary mildew), 2) prevent infections of new shoots, buds, and leaves during the growing season (secondary mildew), and 3) prevent fruit infections. In general, sprays at 5-7 day intervals starting at tight cluster and continuing through petal fall are recommended. Cover sprays should also be applied until terminal buds have set and are no longer susceptible to infection. Since the fungus is infective during dry periods of high relative humidity when redistribution of fungicides by rain does not occur, spray coverage is extremely important. Refer to your local recommendations for the fungicides and spray timing recommended in your area.

Pruning infected buds during the dormant season has not proven to be an effective cultural practice in erradicating overwintering inoculum and is generally not used in commercial operations.



Powdery mildew disease cycle.

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Tree Fruit IPM 1980
Insect Identification Sheet No. 3

plum curculio

Conotrachelus nenuphar (Herbst)

INTRODUCTION

The plum curculio (PC), a native of North America, is a major pest of pome and stone fruits in the United States and Canada east of the 100th meridian. The PC has a single generation in most areas but may have a partial second generation in the southern areas of its range.

Most commercial orchards are free of resident PC populations and are infested by adults moving in from adjoining hedgerows and woodlands. Therefore, injury in most commercial orchards is normally heaviest close to these sites. The out-of-orchard sites should also be examined in scouting for first plum curculio activity in the spring.

THE ADULTS

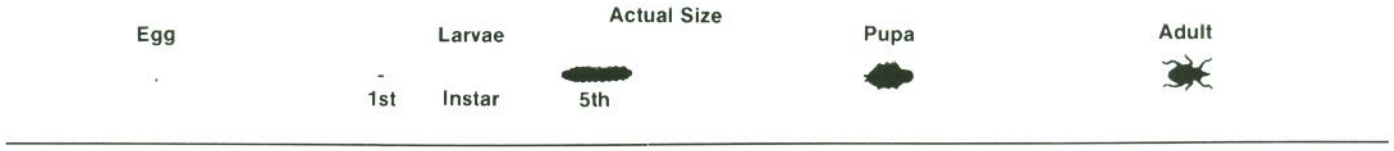
Adult PC are typical snout beetles (Fig. 1). They are dark brown to steely gray in color with patches of white or gray. They have four humps on their wing covers (elytra) and measure 4-6 mm in length. The beak or snout is 1/4 the body length, with the mouth parts located at the end.

PC overwinter as adults in ground litter or the soil and become active in the spring following several days of either a mean temperature above 15.5C (60F) or maximum temperatures above 24C (75F). This time period normally coincides with the blossom period of apples. If temperatures drop and conditions become unfavorable the adults may return to hibernation sites. Although the emergence period for PC lasts for several weeks, 40-60%of the total emergence occurs on a single day.

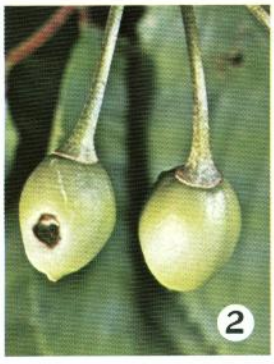
Upon emerging in the spring, the PC fly to the trees where they feed on the buds, flowers, and newly set fruit. In feeding, the adult cuts a hole in the skin of the fruit and hollows out a cavity about 3 mm deep (Fig. 2).

The beetles then mate. The length of the preoviposition period, following hibernation, is temperature-dependent and varies from 6-17 days. In egg laying, a female cuts a cavity under the fruit's skin with her snout. She then turns around and deposits an egg in the hole. Turning around again, she pushes the egg into the cavity with her snout. In front of the hole in which she has laid her egg, the female cuts a crescent-shaped slit which extends beneath the egg cavity so as to leave the egg in a flap of flesh (Fig. 3). This protects the egg from being crushed by the rapidly developing fruit. Feeding and oviposition wounds on apples frequently exude sap that dries to a white crust (Fig. 4).

The progeny of the adults that emerged in the spring appear as adults in July or August. They fly to the trees and feed on the developing fruit but do not reproduce in most instances. They are the adults that find hibernation sites in which to overwinter and produce their offspring the following year.

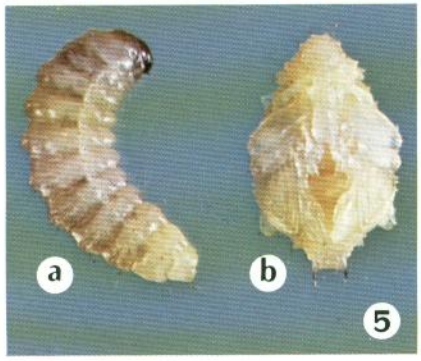


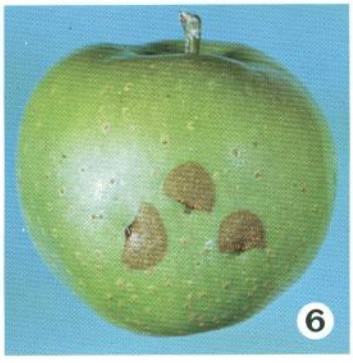




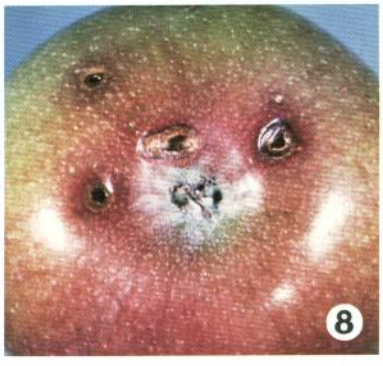












THE EGGS

PC eggs are laid singly in the newly developing fruit. The white, oval eggs measure about 0.35 by 0.6 mm and hatch in 2-12 days.

THE LARVAE

Upon hatching, the young larvae bore into the fruit. On stone fruits, the larvae will feed to but not on the seed. Larvae will feed on the seeds of pome fruits. Larvae are killed in apples by the pressure of the growing fruit cells and can only complete their development in dropped fruit.

PC larvae are grayish-white, legless grubs with curved bodies and brown heads (Fig. 5a). The newly hatched larvae are about 1 mm long, while full grown larvae measure between 6-9 mm in length. The larval developmental time spent within the fruit is between 2-3 weeks. Upon becoming full grown, the larvae burrow an inch or two into the soil and construct a pupal chamber. It is normally 12-16 days before the larvae pupate after leaving the fruit.

THE PUPAE

The pupae are white and measure 4.5-7 mm long (Fig. 5b). Two to 3 weeks are spent in the pupal stage before PC become adults. Several additional days pass before the cuticule of the adults harden and they emerge from the ground.

PLANT INJURY

PC injury to fruit falls into several categories: surface feeding and oviposition wounds from overwintered beetles that can scar (Fig. 6) and/or misshape the fruit by harvest; internal injury produced by burrowing larvae (Fig. 7); premature drop of the fruit; and feeding punctures made by adults in the late summer and fall (Fig. 8).

CONTROL

In the spring, PC control can be obtained with 1-3 insecticide applications, depending upon the spray timing and severity of the problem. The first spray should be applied at about petal fall. Consult your local recommendations for the best materials to use in your area.

Sprays directed specifically at late summer and fall control of PC are normally not needed. Materials directed at other pests at this time normally provide control.

GUIDE TO STAGES

STAGE	TIMING	WHERE TO LOOK
Adults	Spring when temperatures exceed 15.5C (60F)	In orchard adjacent to hedgerow. Feeding wounds are frequently the first sign of adult presence.
	Late July to hibernation (temperatures below 15.5C (60F)	Same as above
Eggs	Petal fall and 30 days thereafter	On developing fruit within crescent shaped oviposition wounds.
Larvae	Early June through mid-July	Within injured, dropped fruit.
Pupae	Mid-July through mid-August	In soil within 25 mm (1 in.) of surface.

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Tree Fruit Crops
102GFS-I19
1989

TREE FRUIT CROPS

CORNELL COOPERATIVE EXTENSION

IPM Integrated Pest Management

Redbanded Leafroller

Argyrotaenia velutinana (Walker)

The redbanded leafroller (RBLR) has been reported to feed on apple since the 1870s, but was not found to be an economic pest of commercial apples in northeastern United States until 1918. It remained a minor pest until the mid-1940s, when it became a major concern to apple growers in New York. Although RBLR is still a potentially serious pest of apples, it has not been considered a major problem since the introduction of azinphosmethyl and similar organophosphate insecticides in the 1960s. At present, it is generally controlled by sprays for other pests.

RBLR feeds on a wide variety of unrelated plants, including tree fruits and small fruits, vegetables, weeds, flowers, and forest or ornamental trees and shrubs. On tree fruits, it is most important on apple, but is also a pest of plum, prune, peach, and cherry. In New York, there are usually two generations per year, but a third brood can occur if the growing season is particularly warm.

Adults

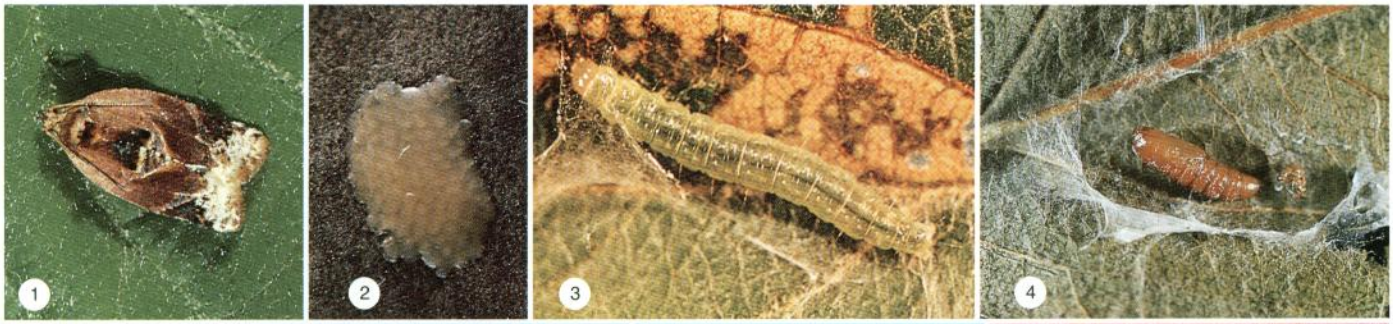
The adult RBLR is reddish-brown with lighter markings of silver, grey, and orange (fig. 1). The name of the pest refers to the distinct reddish-brown band extending across the wings, and its habit of rolling, folding, or attaching leaves together. The RBLR measures 6.3 to 9.5 mm (3/8 to 1/4 in.) long. The male is smaller than the female, and has a slender, tubular abdomen with a tuft of hairs at the tip. The female's abdomen is wider than the male's, spindle-shaped, and bluntly rounded at the end.

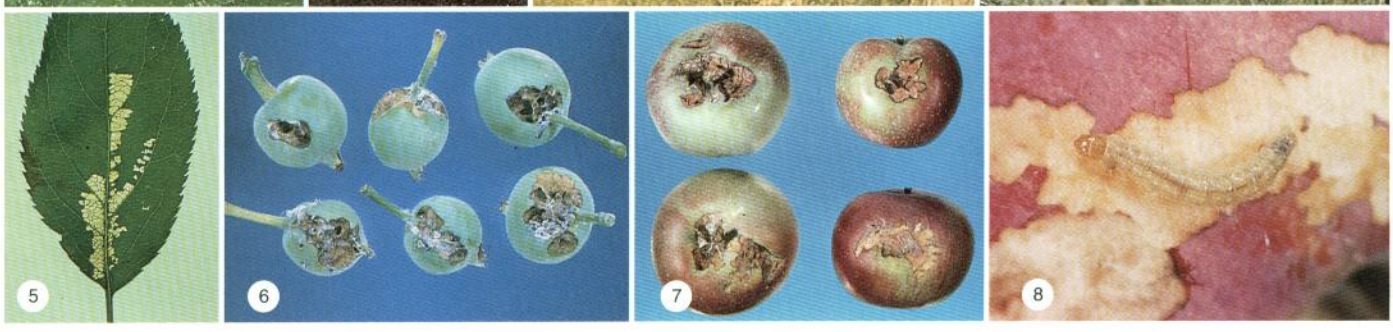
The first RBLR moths emerge in the spring from overwintered pupae in the ground cover, before or soon after the green-tip stage of apple (early April). This first flight peaks in the tight cluster to pink bud stages. The moths can be found resting on trunks and scaffold limbs, and can sometimes be flushed from the ground cover. The second adult flight occurs from mid-June to mid-July, and the third flight, if it occurs, is from from late August to mid-September.

Eggs

Eggs are laid in groups of a few to nearly 150, but a typical egg mass usually contains about 40 eggs deposited in oval patches (fig. 2) that measure 3.0 by 5.0 mm (1/16 by 3/16 in.). The eggs resemble overlapping scales in the patch, and are pale yellowish or cream colored. Each egg is about 0.8 mm (1/32 in.) in diameter. First brood eggs appear in the pink to early-bloom periods, and are laid primarily on the trunk and scaffold limb bark; hatch coincides with the petal fall stage of apples (mid-May). The summer brood eggs, which are more difficult to find, are laid mostly on the upper surfaces of leaves.







Larvae

The larva (fig. 3) is small, unmarked, and green to pale yellow, depending on the food consumed. The head capsule and thoracic shield (the hardened plate behind the head) are the same color (green to yellow) as the rest of the body. This is important in distinguishing RBLR from other leafrollers, in which the head and thoracic shield are darker than the rest of the body. Newly-emerged larvae are about 1.6 mm (1/16 in.) long; the last larval stage is about 16 mm (5/8 in.) long.

First brood larvae crawl along trunks and limbs in search of leaves to eat; watersprouts are readily accepted as food. Small larvae feed on leaf undersides near the midrib or large veins, and spin a flimsy web, which expands as the larva grows. Larvae are more likely to feed on fruit as they grow. As with the first brood larvae, those of the second brood feed on the undersides of leaves within a web. In late August and early September they begin to move about on the tree and feed more on fruit, and this feeding may continue until October, when they fold a leaf around themselves and pupate within.

Pupae

Pupae (fig. 4) are initially greenish-brown, but later turn a deep brown. They are 9.5 to 12.8 mm (3/8 to 1/2 in.) long. RBLR overwinters as a pupa in a folded leaf in the ground cover, whereas summer brood pupae can be found on the tree in folded leaves or in two leaves fastened together.

Damage

RBLR damages both foliage and fruit, but foliar damage is not significant except in cases of very severe infestations. Leaf-feeding by young larvae produces a skeletonized band near the midrib (fig. 5) or veins. The young larval stages of all broods tend to feed on the leaves, but they prefer fruit as they become larger. Damage to the fruit causes concern and economic loss to the grower. Fruit damage by the first brood larvae is likely to occur when two apples are tied together with webbing, and can be quite deep (fig. 6), because the apples are small. These damaged areas eventually cork over, resulting in deformed fruit (fig. 7).

Damage to the larger fruit by the summer broods is typically shallow and irregular (fig. 8); in contrast, other leafrollers have deeper feeding patterns. These later broods of RBLR tend to tie a leaf to an apple and feed on the apple under its protection. Damage by the summer broods can be late enough in the season that corking may not occur, leaving exposed tissue (fig. 8). Such exposed tissue is susceptible to rot diseases and moisture loss, and the injured apples do not store well.

Monitoring and Management

Examine the bark of major scaffold limbs for eggs prior to bloom, particularly on the underside of limbs with smooth bark. By tagging these egg masses and observing them regularly, precise time of egg hatch can be observed. However, detection of egg masses is a difficult task. A reliable monitoring technique is to estimate egg hatch by counting ten to twelve days from the first adult catch in pheromone traps. Watch for the presence of larvae on foliage, particularly watersprouts, in late June, early August, and September. Pupating larvae and pupae can be located by searching for folded leaves.

Egg parasites are very effective biological control agents in unsprayed trees, but are apparently eliminated by the sprays applied in commercial orchards.

Chemical sprays directed at RBLR larvae in apple orchards are typically applied at petal fall and in cover sprays according to action thresholds. Thorough coverage is essential for good control. In extreme cases, sprays are sometimes applied against overwintering brood adults at half-inch-green stage, although researchers express doubts about the need for this approach. During the last several years, pink and petal fall sprays have adequately controlled this pest. For correct pest management procedures, growers should consult local Cooperative Extension recommendations.

GUIDE TO STAGES

Stage		Timing	Where to Look
Adults	1st flight	Green tip to fruit set	Trunk and scaffolds
	2nd flight	Mid-June to Mid-July	Trunk and scaffolds
	3rd flight (if present)	Late August to early September	Trunk and scaffolds
Egg	1st brood	Early bloom	Trunk and scaffold limbs
	2nd brood	July	Upper leaf surface
	3rd brood (if present)	September	Upper leaf surface
Larvae	Younger larvae	Mid-April to September	Leaf undersides near midrib
	Older larvae	May to September	Between 2 tied apples or under leaf webbed to apple
Pupae	1st brood	June to September	Leaves on tree, folded or fastened
	2nd brood and possible 3rd brood	July to October	In folded leaf in ground cover litter if overwintering; if not, leaves on tree, folded or fastened

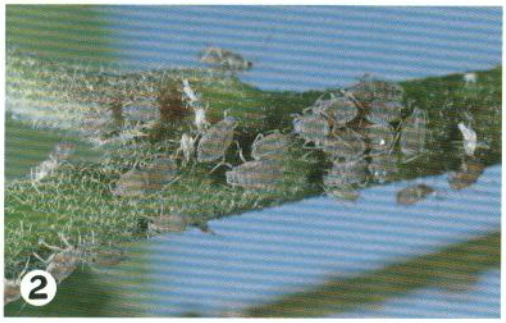
Authored by S. Spangler and A. Agnello, Department of Entomology, Cornell University, NYS Agricultural Experiment Station, Geneva, New York. Figures from NYSAES and the Hudson Valley Laboratory, Highland, New York. Photo layout by R. McMillen-Sticht. Produced through the New York State Integrated Pest Management Program, jointly sponsored by the New York State Department of Agriculture and Markets and Cornell University. Cornell Cooperative Extension provides equal program and employment opportunities. 6/89 10M.

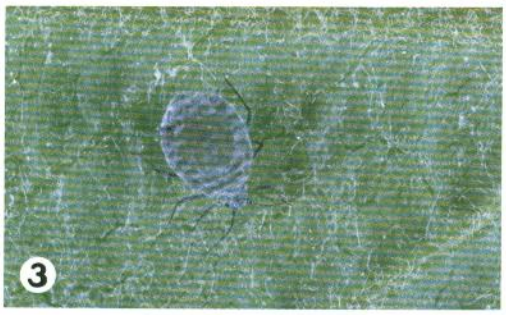
Tree Fruit IPM
Insect Identification Sheet No. 11
1980

rosy apple aphid

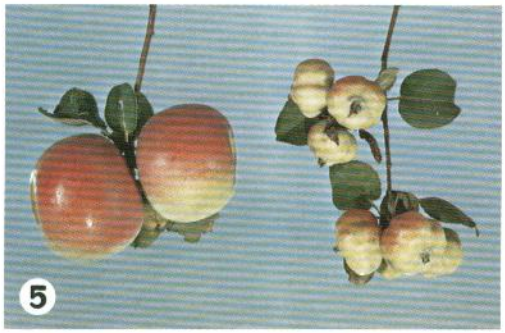
Dysaphis plantaginea (Passerini)


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INTRODUCTION

The rosy apple aphid (RAA) can be found throughout the apple growing regions of North America. In the spring, the aphids feed on apple leaves and fruits, and in the summer move to alternate hosts, such as narrow-leaved plantain. The RAA will attack all apple varieties, but varieties such as Cortland, Monroe, Rhode Island Greening, Ida Red, and Golden Delicious are particularly susceptible.

THE EGGS

The RAA produces eggs only in the fall and continues to do so until heavy frosts kill all the females. The aphid overwinters in the egg stage. The ovate eggs, which measure .4 mm in length, are laid in the fall on twigs, bud axils, or in crevices in the bark. The eggs are a pale green color when first laid and then turn shiny black (Fig. 1), and are impossible to differentiate from apple grain aphid and green apple aphid eggs. The eggs hatch between silver tip and half-inch green.

THE NYMPHS

The RAA passes through 5 nymphal instars, increasing in size from .4 to 2.0 mm (Fig. 2). As the aphids grow, their color changes from dark green to rosy brown or purple and they acquire a powdery white covering. In early spring, the RAA move to the developing fruit clusters and become reproductive adults during bloom. It takes 2 to 3 weeks for a RAA to mature.

THE ADULTS

The overwintering eggs give rise to only female aphids known as stem mothers (Fig. 3) which give birth to living young. A few winged adults are produced in the second generation and proportionately more are produced in the third and fourth generations. These winged adults, produced between May and mid-July, leave the apple trees and move to weed host plants to spend the summer. The winged migrant adults are colored brownish-green and black and are 2.0 - 2.5 mm in length. Narrow-leaved plantain and dock are two of the more important summer hosts for the RAA. They feed and produce wingless asexual forms until late summer or early fall when winged adults are again produced and the RAA migrates back to the apple trees. These adults produce offspring that in turn produce both male and female offspring. This is the only time male RAA are produced. When these males and females become adults, they mate and the females lay eggs to carry the species through the winter.

PLANT INJURY

RAA feeding causes apple leaves to curl (Fig. 4) and often turn a bright crimson. Leaf curling normally does not become obvious until about petal fall. Feeding on the leaves of fruit clusters often results in bunching, stunting, and malformation of the fruit (Fig. 5), which becomes noticeable as the fruit develops and renders it unmarketable. Honeydew produced by the aphids provides a media for the growth of a sooty mold fungus which can affect the fruit finish.

Actual Size

Egg	Nymphs		Adult	Winged adult
	1st	5th		

CONTROL

Although there are several predators or parasites of the RAA, they cannot be relied upon to provide acceptable biological control.

Chemical control must therefore be relied on to obtain commercially acceptable fruit. Coverage is essential in the chemical control of the RAA. Control is best achieved when the insecticide is applied dilute or at least no greater than 6X.

GUIDE TO STAGES

STAGE	TIMING	WHERE TO LOOK
Adults (wingless)	Pink to mid-July and again in the fall	Cluster or terminal leaves
(winged)	Petal fall through mid-July and again in late summer through frost	Leaves and twigs
Eggs	Fall to bud burst	Twigs, bud axils, bark crevices
Nymphs	Silver tip through June often found on apple several weeks after bloom	Cluster or terminal leaves

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Tree Fruit IPM
Insect Identification Sheet No. 12
1980

San Jose scale

Quadraspidiotus perniciosus (Comstock)

INTRODUCTION

The San Jose scale (SJS) is a pest of tree fruit. Trees attacked include apple, peach, and pear. Originating in the Orient, it was introduced into California's San Jose Valley on infested plant stock in 1870. The SJS has since spread throughout the United States and Canada. The SJS may have up to 3 generations per year, depending upon the locality and the length of the growing season.

ADULTS

Adult male SJS are minute, winged insects, about 1 mm long and golden brown in color (Fig. 1). Following a period of maturation beneath elongate scale covers (Fig. 2), males emerge in flights to search out female SJS and mate. Male SJS flights coincide with the females' period of receptivity and their production of a sex pheromone. The seasonal male flight pattern is characterized by a distinct spring flight which often occurs during apple bloom. This is followed by a series of up to 3 overlapping flights from mid-summer through autumn.

The scale covering secreted by adult female SJS is circular and composed of concentric rings of grey-brown wax radiating from a tiny white knob and measures about 1.4 mm across (Fig. 3). The actual insect body, found beneath the scale, is bright yellow, lacks appendages, and is almost circular in outline (Fig. 4). Female SJS do not deposit eggs, but rather produce live crawlers within 4 to 6 weeks following mating. A female may produce crawlers for 6 to 8 weeks at a rate of about 10 per day.

NYMPHS

Crawlers are bright yellow, mobile forms which resemble larval spider mites and measure about 0.24 mm by 0.1 mm (Fig. 5). After exiting from beneath the female's cover, the crawlers walk or are air-borne to new sites of infestation on the bark, fruit, and leaves. Within 24 hours following birth, crawlers settle, tuck in their legs and antennae, and insert their mouthparts into the host.

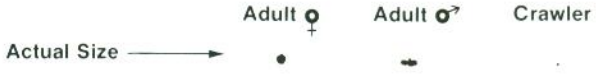
After settling, the first instar nymph secretes a white waxy covering and is known as the "white-cap" form. The third and final phase of the first instar (the "black-cap") is initiated as peripheral rings of darkened wax are secreted and the "white-cap", except for its center tuft, blackens (Fig. 6).

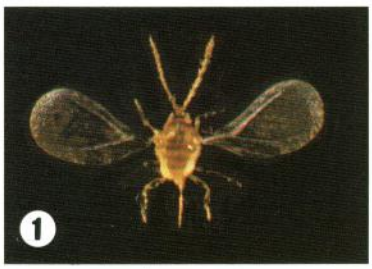
The first molt occurs beneath the "black-cap" within 3 weeks following crawler emergence. The scale covering of the immobile second instar females gradually increases in diameter to accommodate the growing insect beneath. A second and final molt to the adult stage female occurs 3 to 4 weeks later. Males become distinguishable from females during the second instar as their scale coverings elongate. Following the second molt, male SJS pass through two non-feeding instars prior to the final molt to adults.

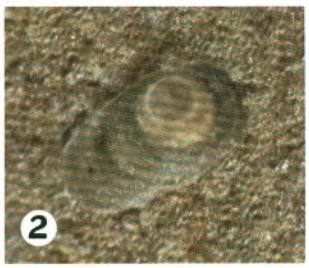
The SJS overwinters on bark in the "black-cap" phase of the first instar. Development resumes as spring temperatures exceed 10 C (50 F). In warmer climates, gravid females may also survive the winter. First generation crawler production by all overwintering stages is synchronized, and usually occurs within 4 to 6 weeks following bloom.

PLANT INJURY

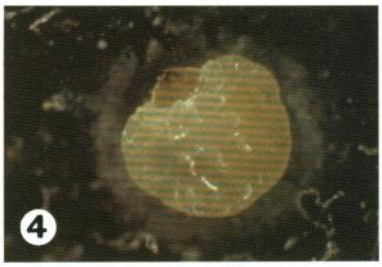
SJS infestations on the bark (Fig. 7) contribute to an overall decline in tree vigor, growth, and productivity.



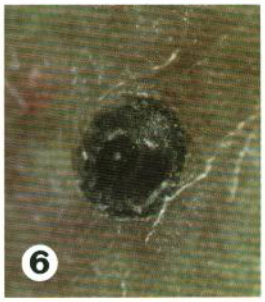
















Feeding on the fruit induces local red to purple discoloration around the sites of feeding (Fig. 8) and decreases the cosmetic quality of the crop. Early season fruit infestations may result in small deformed fruit. Since crawlers are produced continuously over the season, fruit infestations are a constant threat once crawlers begin to emerge.

CONTROL

Several chalcid wasps are known to parasitize the SJS, but none has demonstrated effective control in commercial orchards.

Insecticidal sprays may be applied to developing overwintered individuals, first flight males, or first generation crawlers, depending upon the regional relationship between crop development and timing of the pest.

Control measures for SJS are recommended when the scale or their feeding blemishes have been found on fruit at harvest during the previous season. Examination of the bark and twigs during pruning may also be valuable in detecting infestations which are not otherwise apparent since populations are often irregularly distributed within orchards and may be hidden beneath loose bark in older trees. Pruning is also important in removing infested branches and suckers, as well as opening up the canopy to allow for better spray coverage in tree tops where SJS are often concentrated.

GUIDE TO STAGES

STAGE	TIMING	WHERE TO LOOK
Adult females	Pink through leaf drop	On trunk and branches prior to fruit set. Check beneath loose bark on older trees. Mid-season through harvest, spurs and fruit, especially stem and calyx ends.
Adult males	Pink through petal fall. Mid-season through leaf drop.	Difficult to detect without pheromone traps.
Crawlers and "white-caps"	Approximately 4 to 6 weeks after bloom, through leaf drop.	Trunk and branches, often beneath loose bark. On suckers, spurs, and fruit.
"Black-caps"	Dormant and approximately 5 to 7 weeks after bloom, through leaf drop.	On trunk and branches. Also on suckers, spurs and fruit.

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TREE FRUIT CROPS

CORNELL COOPERATIVE EXTENSION

IPM Integrated Pest Management

Insect Identification
Sheet No. 21
1991

Tarnished Plant Bug

Lygus lineolaris (Palisot de Beauvois)

Steve M. Spangler, Richard W. Weires, Jr., and Arthur M. Agnello

Department of Entomology, New York State Agricultural Experiment Station, Geneva

The tarnished plant bug is found throughout North America, but it is primarily a pest in temperate nondesert areas. It feeds on more than fifty economically important plants, including alfalfa, cotton, strawberries, brambles, and most tree fruits grown in the United States. It has two to five generations per year, depending on the location. The tarnished plant bug is a true bug (order Hemiptera), with piercing-sucking mouthparts.

Adults

Adults are 6 to 6.5 mm (0.25 in.) long, oval, and somewhat flattened. They are greenish brown in color, with reddish brown markings on the wings. A distinguishing characteristic is a small but distinct yellow-tipped triangle in the center of the back, behind the head (fig. 1).

Tarnished plant bugs overwinter as adults under leaf litter, stones, and tree bark and in other protected places. At the end of April, the adults become active and begin laying eggs in crop and weed hosts. The overwintering adult population peaks at about the pink stage of apple (early May in New York State). Two to four indistinct generations can occur annually, with development from egg to adult taking 25 to 40 days. Adults feed throughout the summer, but are found on apple trees from the silver tip stage until 2 to 3 weeks after petal fall.

Eggs

Eggs are about 1 mm (0.04 in.) long, cream colored, and flask shaped. They are laid in plant tissue so only the small anterior end is visible. Eggs can be laid on fruit crops (fig. 2), but are generally deposited on weeds and grasses. On apple trees, although some early oviposition may take place in the buds, most eggs are laid in the developing fruit starting at bloom.

Nymphs

Eggs hatch into nymphs about 7 days after being laid. Young nymphs are pale green and resemble aphids (fig. 3), except that their legs are more robust, their movements are more rapid, and they have no abdominal cornicles (backward-pointing structures that resemble short stems). Because the tarnished plant bug has incomplete metamorphosis, the nymphs resemble adults without wings. Newly hatched nymphs are about 1 mm (0.04 in.) long and remain greenish throughout their five stages, or instars. Nymphs in later instars turn brown and develop wing pads. They have two black dots on their thorax, two between their developing wing pads, and one in the middle of their abdomen (fig. 4).



Fig. 1. Adult



Fig. 2. Egg on a fruit bud



Fig. 3. Young nymph

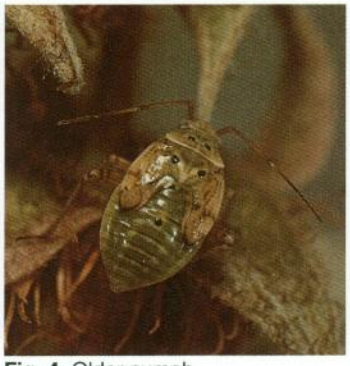


Fig. 4. Older nymph



Fig. 5. Dimple on an apple caused by feeding



Fig. 6. "Catfacing" damage to a peach



Fig. 7. Dimple on an apple caused by oviposition



Fig. 8. White sticky trap used for monitoring

Damage

The tarnished plant bug causes injury to tree fruits when it feeds and lays eggs. Damage occurs primarily in the spring on flower buds, blossoms, and young fruit, although bleeding of sap may result from twig and shoot injury.

The insect feeds first on buds and later on developing fruit. Small droplets of exudate may be present on the surface of injured buds. Within 1 or 2 weeks, the flower clusters may appear dried and the leaves distorted, with a distinct hole where the insect fed.

Generally, later damage to developing fruit is more important than earlier feeding on flower buds. In apples, feeding can cause punctures or deep dimples to form as the fruit develops (fig. 5), and in peaches various deformities known as "catfacing" occur (fig. 6).

The damage to apples caused by egg laying is usually deeper, resulting in more distorted fruit often with blemishes or "scabs" (fig. 7). Damage early in the season tends to be near the calyx end of the fruit, and later injuries tend to be elsewhere. Cultivars differ in their susceptibility to damage, with depressions or scabs in some being less pronounced.

Damage to mature trees is slight after June, but much damage can occur to nursery stock throughout the summer. In peach trees, the tarnished plant bug punctures the tips of tender growing shoots, causing the leaves to wilt beyond the point of damage and resulting in trees with a dwarfed and bushy appearance. Damage to peach fruit can occur throughout the summer. Nursery apple trees damaged by the tarnished plant bug have curled leaves and stunted growth.

Monitoring and Control

From mid-April to early May, look for adults on flowers and foliage or for bleeding wounds on shoots. Adults fly when disturbed and are difficult to observe in the field. Therefore, the use of unbaited, nonreflective, white sticky boards hung low in the trees is an effective monitoring method (fig. 8). The best places to set the traps are in lower areas such as ditch banks and in hedge rows, which are favorable overwintering sites of the adults. White sticky traps are available commercially.

The tarnished plant bug has a number of natural enemies, such as other true bugs (nabids, geocorids), ladybird beetles, spiders, and parasitic wasps, but they are not able to control the pest effectively. Satisfactory chemical control is difficult on tree fruits because the frequently long bloom period, when no pesticides can be applied, prevents optimum timing of control sprays. Also, prebloom pesticide treatments may dissipate during the prolonged period of bloom. The mobility of the tarnished plant bug also makes control difficult.

Despite control efforts, a small amount of fruit injury is often inevitable. Most damage is shallow and undetectable, however, and generally not noticed in normal grading procedures.

Consult your local Cooperative Extension association for recommendations about the proper procedures and materials to use in your area.

Guide to Stages

Stage	Timing	Where to Look
Adult	Overwintering generation—dormant to fruit set of apple	On tree fruit flower buds (look for damage), in alfalfa fields. Use white sticky traps.
	Summer generations—summer to fall	Nursery stock, peach fruit, other hosts (legumes such as alfalfa, clovers)
Egg	Tight cluster to fruit set	Inserted in buds, fruit, or similar soft plant parts
	Summer generations—summer to fall	Other hosts (legumes such as alfalfa, clovers)
Nymph	May through fall	Flower buds, fruit, alfalfa, weedy areas



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Tree Fruit IPM
Insect Identification Sheet No. 13

1980

white apple leafhopper

Typhlocyba pomaria McAtree


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INTRODUCTION

The white apple leafhopper (WALH) is native to and widely distributed throughout the apple growing regions of North America. The WALH has 2 generations a year and overwinters in the egg stage.

A number of other leafhoppers can be found on apple but none tend to be as serious a pest as the WALH. The potato leafhopper, which migrates into the northern apple growing regions as adults in the spring, is perhaps the most common of the other species that can be found on apple. The two species can be differentiated by the way they walk when disturbed. The WALH walks to the front or backwards while the potato leafhopper walks sideways or "crab like."

THE ADULTS

The first WALH adults (Fig. 1) begin appearing in early June. They are a pale yellowish-white color and measure about 3 mm long. Under close observation, particularly on the males, a slight orange tinge may be seen on the head and thorax.

Female WALH have about a 10-day preoviposition period and then produce eggs for about 3 weeks. They may live about a week after oviposition ceases.

Second brood WALH adults begin emerging about mid August and by early September most have emerged. They normally remain active until killed by the first good frost in the fall. When present in large numbers at harvest, second brood WALH adults can be a nuisance problem to pickers.

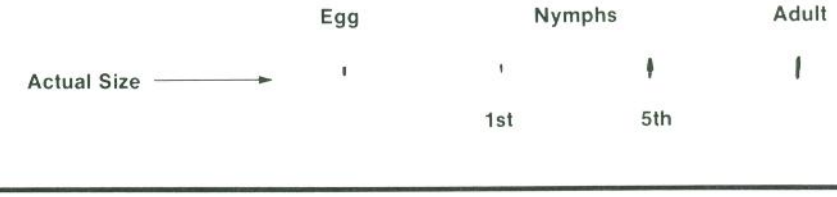
THE EGGS

The overwintering WALH eggs (Fig. 2) are deposited by the second brood females just beneath the bark surface on 1- to 5- year old wood. These egg laying sites appear as elongate, oval, blister-like swellings, measuring about 1.5 mm long, and characteristically run perpendicular to the terminal growth. Overwintered eggs begin hatching about late pink and hatch is completed by petal fall.

The second brood eggs are laid in the petiole, mid-vein and large veins of leaves from late June through mid July. These eggs begin hatching in late July and in some years emergence may continue into September.

THE NYMPHS

Newly hatched WALH nymphs (Fig. 3) are about 1 mm long, pale white and wingless. The eyes of newly hatched nymphs are red and change to a pale white color with the first molt. They migrate to the undersurface of older leaves where they begin feeding. WALH nymphs pass through 5 instars and will characteristically com-



plete their development on a single leaf or cluster of leaves. Their white cast skins frequently remain hanging from the leaf undersurface. As the nymphs reach the third instar the wing pads become noticeable. Fifth instar WALH nymphs measure about 2.8 mm long (Fig. 4).

INJURY

WALH nymphs and adults are mesophyl feeders. Feeding injury causes a white mottling of the leaves and with heavy infestations the leaves can become nearly completely white (Fig. 5).

Feeding WALH also excrete a honeydew which may drop onto lower leaves and fruit. Once dried on the fruit the honeydew appears as "tobacco juice" colored spots or streaks that are difficult to remove (Fig. 6). Under humid conditions, the honeydew remains moist and is an excellent media for sooty molds.

CONTROL

Several parasites, predators, and a fungus attack the WALH. Normally, natural enemies cannot adequately control the WALH in commercial orchards and growers must rely on insecticidal control.

The WALH has developed resistance to the organophosphate insecticides in many apple growing regions. Therefore, consult your local recommendations for the best materials to use in your area.

GUIDE TO STAGES

STAGE	TIMING	WHERE TO LOOK
Adults	Early June to mid-July. Mid-August to first good frost.	Undersurface of leaves. same as above
Eggs (overwintering)	Late August to petal fall.	Beneath the bark surface of 1- to 5-year old wood.
(summer)	Late June to end of August.	In the petiole, and large veins of leaves.
Nymphs	Late pink to mid-July. Late July through late September.	Undersurface of leaves. same as above

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TREE FRUIT CROPS

CORNELL COOPERATIVE EXTENSION

Tree Fruit Crops
102GFS-I18
1989

IPM Integrated Pest Management

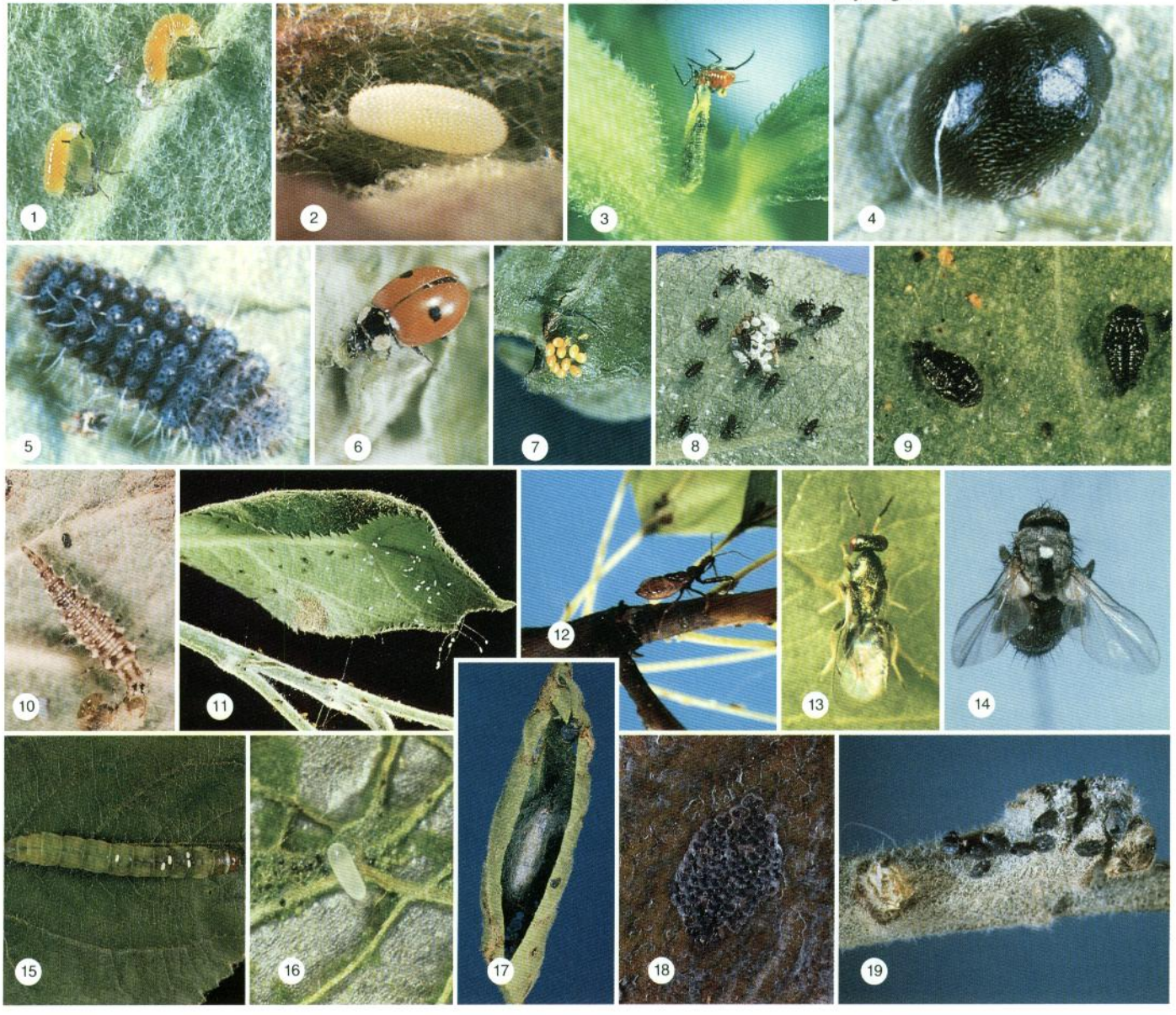
Beneficial Insects

Many insects in apple orchards benefit growers by feeding on pest species. It is important that growers be able to recognize these beneficial insects so that they are not mistaken for pests. This fact sheet reviews the major beneficial insects that are likely to be seen in New York orchards, concentrating on the most commonly seen life stages. A previous factsheet, "Predatory Phytoseiid Mite," reviews mites that are important predators of leaf-feeding mites.

The best way to conserve beneficial insects is to spray pesticides only when necessary. If a pesticide must be used, try to select the least toxic material available (see *Cornell Recommendations for Commercial Tree-Fruit Production).*

Cecidomyiid Larvae (Family Cecidomyiidae)
Predacious cecidomyiid (pronounced SEH-sid-oh-my-EE-id) larvae are present throughout the summer. There are three to six generations per year.

The insect shown in figure 1 *(Aphidoletes aphidimyza)* is an aphid predator that overwinters as a larva or pupa in a cocoon. Adults emerge from this cocoon and mate; then females lay eggs among aphid colonies. The adult flies are delicate, resembling mosquitoes, and are not likely to be seen. The eggs are very small (about 0.3 mm or 1/85 in. long) and orange. They hatch into small, brightly colored, orange larvae that can be found eating aphids on the leaf surface (fig. 1). They also feed on soft-bodied scales and mealybugs.



Syrphid Fly Larvae (Family Syrphidae)

The Family Syrphidae contains the "hover flies," so named because of the adults' flying behavior. They are brightly colored with yellow and black stripes, resembling bees. Syrphids overwinter as pupae in the soil. In the spring, the adults emerge and mate. The female lays several long, single, whitish eggs (fig. 2) on foliage or bark. These are laid through mid-summer, usually among aphid colonies. The larvae are cylindrical and taper toward the head (fig. 3). There are five to seven generations per year. They feed on aphids by piercing their bodies and sucking the fluids, leaving shriveled, blackened aphid bodies. They may also feed on scales and caterpillars.

Ladybird Beetles (Family Coccinellidae)

Stethorus punctum. This ladybird beetle is an important predator of European red mite in parts of northeastern United States, particularly Pennsylvania. It has been observed intermittently in the Hudson Valley of New York, and occasionally in western New York. *Stethorus* overwinters as an adult in the "litter" and ground cover under trees, or in nearby protected places. The adults (fig. 4) are rounded, oval, uniformly shiny black, and are about 1.3 to 1.5 mm (1/16 in.) long.

Eggs are laid mostly on the undersides of leaves near the primary veins, at a density of one to ten per leaf. They are pale white and small, about 0.3 mm (1/85 in.) long. Eggs turn black just prior to hatching.

The larva (fig. 5) is gray to blackish with numerous hairs, but becomes reddish as it matures, starting on the edges and completing the change just prior to pupation. There are three generations per year in south-central Pennsylvania, with peak periods of larval activity in mid-May, mid-June and mid-August. The pupa is uniformly black, small and flattened, and is attached to the leaf.

Other Ladybird Beetles. Ladybird beetles are very efficient predators of aphids, scales, and mites. Adults (fig. 6) are generally hemisphere-shaped, and brightly colored or black, ranging in size from 0.8 mm to at least 8.0 mm (0.03 to 0.3 in.). They overwinter in sheltered places and become active in the spring.

Eggs are laid on the undersides of leaves, usually near aphid colonies They are typically yellow, spindle-shaped, and standing on end (fig. 7). Females may lay hundreds of eggs.

The larvae have well-developed legs and resemble miniature alligators (fig. 8). They are brightly colored—usually black with yellow. The pupal case (fig. 9) can often be seen attached to a leaf or branch. There are usually one to two generations per year.

Lacewings

Adult lacewings are in the Family Chrysopidae (pronounced cry•SOAP•ih•dee). They are green or brown insects with net-like, delicate wings, long antennae, and prominent eyes. The larvae (fig. 10) are narrowly oval with two sickle-shaped mouthparts that pierce the prey and extract fluids. Often the larvae are covered with "trash," which is actually the bodies of their prey and other debris. Lacewings overwinter as larvae in cocoons, lodged inside bark cracks or in leaves on the ground.

In the spring, adults become active and lay eggs on the trunks and branches. These whitish eggs are laid singly and can be seen connected to the leaf by a long, threadlike "stem" (fig. 11). Lacewings feed on aphids, leafhoppers, scales, mites, and eggs of butterflies and moths.

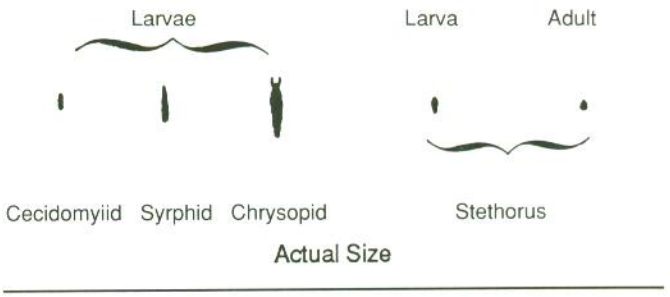
True Bugs (Order Hemiptera)

There are many species of "true bugs" that feed on plants (such as the tarnished plant bug), but a number of them are predators of insect pests. The ones most likely to be seen are "damsel bugs" or nabids (Family Nabidae), and "assassin bugs" or reduviids (Family Reduviidae), as in figure 12. These types of predators typically have front legs that grasp and hold their prey.

Parasitoids

Parasitoids are insects that feed on or in the tissue of other insects, consuming all or most of their host and eventually killing it. They are typically small wasps (Order Hymenoptera; fig. 13), or flies (Order Diptera; fig. 14). Although the adult flies or wasps may be seen occasionally in an orchard, it is much more common to observe the eggs, larvae, or pupae in or on the parasitized pest insect. Eggs may be laid directly *on* a host, such as on the oblique-banded leafroller (fig. 15). Eggs may also be laid *near* the host, such as in the mine of a spotted tentiform leafminer (fig. 16).

After the parasitoid consumes the pest, it is not unusual to find the parasitized larvae (fig. 17) or eggs (fig. 18) of a moth host, or aphids that have been parastized (fig. 19). Exit holes can be seen where the parasitoid adult has emerged from the aphid mummy.



Authored by S. Spangler and A. Agnello, Department of Entomology, Cornell University, NYS Agricultural Experiment Station, Geneva, New York. Figures 4 and 5 by L. Hull, Pennsylvania State University. All others from NYSAES and the Hudson Valley Laboratory, Highland, New York. Photo layout by R. McMillen-Sticht. Produced through the New York State Integrated Pest Management Program, jointly sponsored by the New York State Department of Agriculture and Markets and Cornell University. Cornell Cooperative Extension provides equal program and employment opportunities. 6/89 10M.

Disease Identification
Sheet No. D11
1994

TREE FRUIT CROPS

CORNELL COOPERATIVE EXTENSION

IPM Integrated Pest Management

Sooty Blotch

Gloeodes pomigena (Schwein.) Colby

and

Flyspeck

Schizothyrium pomi (Mont. and Fr.) Arx

Wayne F. Wilcox
Department of Plant Pathology, NYS Agricultural Experiment Station at Geneva, Cornell University

Sooty blotch and fly speck are the two most common "summer diseases" of apples in the Northeast; they are also problems on pears. Although caused by two different organisms, the diseases often occur together since both are confined to the fruit surface and are favored by similar environmental and horticultural conditions. Disease incidence and severity can be highly variable among production regions, growing seasons, and even individual orchards. Economic losses result primarily from the diminished appearance and commercial quality of infected fruit.



Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.

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II. VARIETIES OF YESTERYEAR

ARTHUR P. FRENCH

IT IS NOW WELL OVER 300 YEARS SINCE DISSEMINATION OF the Roxbury Russet—one of the oldest known American apple varieties—began. Beach (2, p. 294) records that soon after 1649 this variety was taken from Massachusetts to Connecticut. According to Taylor (4, p. 311) the earliest known trans-atlantic shipment of an American apple variety was "that of a package of Newtown Pippins of the crop of 1758 sent to Benjamin Franklin while in London." While there are few records for that period concerning the date of origin, it is certain that two other American apple varieties which later gained commercial importance—Baldwin and Rhode Island Greening—were known during the first half of the 18th century. In all probability Ben Davis and Winesap were also grown during that period. Varieties originating during the next one hundred years, 1750-1850, and which became commercially prominent in the present century, include Jonathan, Rome Beauty, Grimes Golden, Maiden Blush, Tompkins King, Northern Spy, McIntosh, and York Imperial. Of our present 15 leading commercial apple varieties only Wealthy, Stayman, Delicious, Golden Delicious and Cortland originated since 1850. With the exception of Cortland, which is the product of the scientific plant breeder, all of these are of chance-seedling origin, mostly without knowledge even of the seed parent.

These are but a few of the many scores of superior chance seedlings discovered, propagated, and grown, in the eastern states and provinces during that great testing period of North

American fruit varieties during the 18th and 19th centuries. A list of the more prominent of the old favorites would certainly include Black Gilliflower (Sheepnose), Blue Pearmain, Bonum, Chenango, Esopus Spitzenburg, Hubbardston Nonesuch, Peck Pleasant, Porter, Rambo, Red Canada, Smokehouse, Sutton, Sweet Bough, Wagener, Westfield (Seek-no-further), Williams and Winter Banana in addition to most of those listed in the 1915 part of Table 1. Names such as Nonesuch and Seek-no-further suggest the high esteem in which these old favorites were held in their day. An incident which occurred at the New England Fruit Show in the early 1920's illustrates the regard with which one of these old varieties was held. An elderly lady on approaching a plate of extra large beautiful Golden Delicious, being exhibited by the introducer of that variety, was heard to exclaim to her companion "There are the first real Porter apples I have seen in years."

Modern commercial apple orcharding with its emphasis on high yield per acre and efficiency of operations, made necessary by ever increasing costs of production, has been responsible for the great reduction in the number of varieties propagated. In all probability the total number of apple varieties offered for sale by all nurserymen in North America today does not exceed 10% of the list of 878 varieties compiled by Bailey (1) in 1892 from 95 nursery catalogues. This elimination of many old favorites has been lamented by many a connoisseur of the apple. The sentiments of that group have been well expressed by Liberty Hyde Bailey (1), the late dean of American horticulturists, in the following quotations from his writings:

> "A person has a right to gratify his legitimate tastes."
> "There is merit in variety itself. It provides more points of contact with life and leads away from uniformity and monotony."
> "To the lover of choice fruit nothing is old; every succeeding crop is as choice and new as is the new year itself."
> "Quantity-production will be an increasing source of wealth, but it cannot satisfy the soul."

Individual varieties do have their faults which make them unsuited and therefore unprofitable to grow commercially. Furthermore, with the advent of cold storage and, now, the modern controlled atmosphere technique, the need for a succession of varieties maturing from early summer to late winter has been greatly reduced. In the not too distant past most families bought at least several varieties of winter apples by the bushel—or even barrel—for storage in the dirt-floor cellar of the home.

Just how greatly the list of leading apple varieties in the United States has been changed in the last 50 years may be seen in Table 1 which ranks, percentage-wise, the leading varieties of the 1915 era and those of 1964. The basis of reporting has changed over this 50-year period. In 1915 the *total* apple crop of the country was 230,011,000 bushels (5, p. 488-489) whereas in 1964 the *commercial* apple crop was 140,345,000 bushels (6). However for the following variety observations from this table the change from total to commercial crop is relatively unimportant:

1) With 13.4% of the total crop there must have been about 31 million bushels of Baldwin produced in 1915, whereas the 24.3% of the commercial crop which were Delicious in 1964 amounts to over 34 million bushels.

2) The number of varieties reported has shrunk from 35 in 1915 to 18 in 1964, reflecting the trend toward fewer varieties now in commercial plantings.

3) Delicious, Golden Delicious and Cortland, which were too new to be listed in 1915, account for 35% of the 1964 crop.

4) McIntosh has jumped from no better than 28th in 1915 to 2nd place in 1964.

5) Baldwin, Ben Davis and Gano, a Ben Davis sport, which accounted for almost 28% of the crop 50 years ago, dropped to 2.2% of the 1964 crop.

6) Seven summer varieties—Early Harvest, Maiden Blush, Oldenburg, Red Astrachan, Red June, Yellow Transparent, and Gravenstein—produced 12.8% of the crop then; whereas only one summer variety, Gravenstein, with 2.3% is listed for 1964.

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TABLE 1. *Apple Production by Varieties**

1915		1964	
	%		%
Baldwin	13.4	Delicious	24.3
Ben Davis	13.3	McIntosh	13.1
Northern Spy	6.1	Golden Delicious	8.0
Winesap	5.1	Rome Beauty	7.8
Rhode Island Greening	4.7	Jonathan	7.3
Jonathan	3.6	Winesap	5.4
Rome Beauty	3.1	York Imperial	5.0
Early Harvest	2.8	Stayman	4.8
Wealthy	2.2	Yellow Newtown	2.7
Grimes Golden	2.2	Cortland	2.7
York Imperial	2.1	Rhode Island Greening	2.6
Maiden Blush	2.0	Northern Spy	2.6
Oldenburg	1.9	Gravenstein	2.3
Red Astrachan	1.9	Baldwin	1.6
Fall Pippin	1.7	Wealthy	.9
Gano	1.6	Grimes Golden	.8
Yellow Newtown	1.6	Ben Davis & Gano	.6
Limbertwig	1.6	Black Twig	.1
Red June	1.6	Other varieties	7.4
Stayman	1.5		
Yellow Transparent	1.5		
Yellow Bellflower	1.4	(1915 cont.)	
Tompkins King	1.4		
Golden Russet	1.4		
Fameuse	1.3		
Gravenstein	1.1	Missouri Pippin	.8
Tolman Sweet	1.0	Arkansas (Black Twig)	.7
McIntosh	.9	White Pearmain	.5
Wolf River	.9	Other varieties	10.4
Arkansas Black	.9		
Northwestern Greening	.9		
Horse	.9		

*Percentage of total production

and the production of all summer varieties in 1964 was only 4.2% of the crop.

7) On the basis of percentage of total crop from 1915 to 1964 (Table 1), Jonathan, Rome Beauty, York Imperial, Yellow Newtown, Stayman, and Gravenstein have gained in relative importance; Winesap has held steady; while Northern Spy, R.I. Greening, Wealthy and Grimes Golden have lost ground.

8) In addition to the first six summer varieties listed above, the following fall and winter varieties are no longer grown in sufficient quantity to deserve a listing—Fall Pippin, Limber-twig, Yellow Bellflower, Tompkins King, Golden Russet, Fameuse, Tolman Sweet, Wolf River, Arkansas Black, Northwestern Greening, Horse, Missouri Pippin, and White Pearman.

Later chapters of this book will be devoted to full discussion of the most important commercial varieties of the present time. However, the minor varieties of the 1964 list (Table 1) and some of those which have disappeared from commercial listing since 1915 still merit some individual consideration.

Baldwin, originating as a chance seedling in the town of Wilmington, Massachusetts about 1740, was for years known locally as the Pecker or Woodpecker apple because the tree was frequented by birds of that type. It was called Baldwin only after Colonel Baldwin (whose attention was directed to it by Samuel Thompson) began its propagation and introduced the variety throughout eastern Massachusetts. A granite monument (Fig. 1), topped by a good carved likeness of the apple, marks the spot near which the original tree stood.

The Baldwin became the leading winter variety of the Northeast chiefly because of its general adaptability, good color when well grown, desirability for eating raw, cooking or juice, satisfactory keeping ability, high productivity, and longevity of its vigorous tree. It was doubtless responsible more than any other variety for the familiar saying "An apple a day keeps the doctor away." However, neither tree nor fruit are without serious weaknesses. The strong biennial—and in some cases even

triennial—bearing habit of individual trees or parts of the tree has made for irregular production, and the occasional severe winters of the northern regions have seriously weakened or killed many Baldwin trees. The greatest weakness of the fruit is its susceptibility to Baldwin spot or bitter pit. These faults of tree and fruit have, alas, been the downfall of this variety, once king of North American apples.

At least two color sports of Baldwin have been discovered and propagated: the Double Red Baldwin which originated in 1924 at Sawyer Orchards, Salisbury, New Hampshire; and the Galbraith Baldwin which was found in 1934 as a small limb sport in the orchards at the University of Massachusetts.

Ben Davis. Little is known of the origin of this variety but it doubtless dates back at least to the beginning of the 19th century. As the Baldwin dominated the northern apple belt, so the Ben Davis and its high colored forms, Black Ben and Gano, once ruled supreme in the more southerly apple growing regions. There a longer and warmer growing season brought this variety to its mediocre best but caused Baldwin to become a large, soft, fall apple of poor color.

The tree of Ben Davis is generally vigorous, hardy, comes into bearing early, bears annually, and is abundantly productive. One of the tree's major weaknesses is its susceptibility to nailhead canker disease which usually is fatal. Never known for quality, its attractively striped bright red fruits were extremely firm and would keep under ordinary cellar conditions late into the winter. Because of this firmness, many of them were formerly shipped by bulk in boxcars into the deep South where they were handled by the "scoop-shovel" method. An apple distributor would spot his carload on a railroad siding in some village or city, advertise the fact, and customers would come with their own containers to buy apples at a low price scoop-shoveled from the boxcar floor into their containers. This provided persons of low income with fruit which they could not

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have afforded to buy if handled through a retail store. Even after the skin has become oily and the fruit overripe it still makes a fairly palatable apple sauce. However, as evidence of its poor quality, the writer can attest to the fact that Ben Davis is the only variety which an instructor can use for a class exercise in grading or packing apples and expect to pick up as many apples at the end of the exercise as he put out at the beginning.

Fall Pippin. Although never of great commercial importance, this fine old fall apple was widely distributed in early orchards of the Northeast. A red skin instead of a greenish-yellow one would have given the variety an appearance commensurate with its tender, aromatic, fine quality, yellow flesh. Otherwise both the fruit and the tree have mostly desirable characteristics. Its origin is completely unknown.

Fameuse. Usually considered to be of eastern Canadian origin, before 1700, the Fameuse or Snow apple was one of the most important varieties found in commercial orchards of northern New York and Vermont prior to the McIntosh era. It was highly prized chiefly as a fall and holiday dessert apple having attractive red color, tender white flesh, and excellent flavor. Small size of fruit and susceptibility to apple scab are its two greatest weaknesses. The tree is medium in size, hardy and productive, but usually biennial in bearing and not suited to all soils.

Gravenstein. Even though this variety is of European origin the small but important niche which it fills in the commercial apple crop necessitates its inclusion in this list. Its fruit is good size, attractively striped when allowed to ripen on the tree, and excellent in quality. For sauce and pies, it is unexcelled in its season. As evidence of that fact, some years ago the writer was informed by the commissary manager of one of the large restaurant chains in greater Boston that, if available throughout the year, they would use nothing but Gravenstein for apple pies. In

support of his statement he produced records showing that during the period when they use Gravenstein their daily average apple pie consumption jumped to almost double what it was during the rest of the year.

Unfortunately the weaknesses of the tree are serious. The crop ripens over an extended period of time and drops so readily that many southern New England orchardists have harvested by placing a thick layer of hay under each tree and picking up the fallen apples daily. Those which are unbruised are sold as hand-picked since they show no evidence of having been on the ground. Furthermore the tree is only moderately resistant to winter cold. Several times during the past 50 years many mature Gravenstein trees have been winter-killed in New England.

The variety is still commercially important chiefly in two areas (1) Nova Scotia and (2) California. According to A.D. Crowe of the Research Station, Kentville, Nova Scotia, Gravenstein was brought there about 1835 from the gardens of the London Horticultural Society. By 1875 it had become one of the leading varieties of the province. Presently some 85% of the total production of the variety in Nova Scotia comes from color strains of which the Crimson Gravenstein is the most important.

The Gravenstein reached California about 1820, being one of several apple varieties planted at a Russian settlement near the present town of Bodega in Sonoma County. However, the present Gravenstein acreage around nearby Sebastopol did not get started until about 1863 when William J. Hunt brought young budded trees of the variety from the East. Today this is the leading Gravenstein area, producing about 2.9 million bushels annually. Because of its superior culinary quality, about 92% of this volume is used by processors.*

Possibly no other variety, unless it be Delicious, has been so subject to bud variation involving color. Many apparent limb color-sports have been observed by fruit growers in the

*This paragraph compiled from material supplied by D.C. Alderman, Davis, California.

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Northeast at least. A few of them have been propagated and planted in commercial orchards. The first such color-sport to gain prominence was the Banks which was discovered and propagated by C.E. Banks of Berwick, Nova Scotia about 1886. More recently the Washington Red Gravenstein discovered about 1907 by Van Sent V. Whipple, San Juan County, Wash. and introduced commercially in 1924 has become the chief, if not the only, red sport of this variety available in eastern U.S. nurseries. The Rosebrook Gravenstein was discovered by a man of that name at Sebastopol, Cal. in 1920 and introduced in that State in 1925. One other red sport, the Mead Gravenstein, has been recorded in the *Register of New Fruit and Nut Varieties.* It was discovered by R.J. Fiske, Lunenburg, Mass. in 1927 and introduced in 1939. The New York Agricultural Experiment Station at Geneva reports this strain to be superior to others tested there, but in recent years it has contracted the flatlimb virus disease. Crimson Gravenstein apparently was discovered about 1910 by A.S. Banks, Waterville, Nova Scotia.

Grimes Golden. Before the advent of Golden Delicious, Grimes Golden was highly prized as a dessert apple in the "Ben Davis" belt, particularly in the states bordering on the Ohio River. A bowl of Grimes Golden and Jonathan made a most attractive display, and good eating too, on the "side-board" or dining-room table in many a midwestern home from harvest time through the holiday season. Pies made from Grimes Golden apples won many a prize at county fairs.

However, the variety has many weaknesses which have contributed to its decline in importance. The fruit tends to run small on older trees, and is subject to serious scalding in storage. The tree is frequently biennial in bearing habit, only moderately vigorous, and is very susceptible to collar-rot.

The variety originated in West Virginia prior to 1800, which was also the state of origin of the Golden Delicious more recently. Nursery trees as well as fruit of the two varieties have so many physical characteristics in common that the writer is

led to believe that Golden Delicious could be an offspring of Grimes Golden.

Northwestern Greening. Having originated prior to 1872 in Waupaca County, Wisconsin—which is about 50 miles west of Green Bay—this variety possesses great winter hardiness and is an excellent keeper when grown in the north. It never ranked high with commercial orchardists in the east because its fruit quality is distinctly inferior to the Rhode Island Greening. When grown in southern Pennsylvania, the Northwestern Greening becomes a fall variety and is planted there as an early processing variety.

The tree is a vigorous grower, a bit slow to come into bearing, but eventually becoming a reliable cropper, usually biennial. The fruit is large, smooth-skinned, greenish or pale yellow in color, and quite subject to water core especially on young trees.

Russets. It is a bit puzzling to find Golden Russet but not Roxbury Russet included in the list of varieties in orchards 50 years ago (Table 1). While both varieties were important in their day, there is little doubt that the Roxbury was the more important of the two from the volume production standpoint. Confusion concerning the identity of both still exists in the minds of some elderly fruit growers possibly traceable to the substitution of one for the other by nurserymen. Even though typical fruits of each variety may be mistaken for the other by the noncritical observer, the trees in nursery row as well as orchard are vastly different, particularly in leaf size, leaf form, and lenticels on young bark.

The day of the russet apple departed with the development of cold storage as both varieties were noted for their long keeping in common storage. However, producers of fine quality sweet cider still like to blend juice from either Russet with that of other winter varieties for distinctive flavor and aroma.

Tolman Sweet. This variety was once the leading sweet apple but has gone the way of all truly sweet apples, into oblivion. Few

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people today know the pleasure of eating a sweet apple raw, baked or combined with quinces into a tasty chunky sauce. Truly they are being deprived, as Bailey might have said, of a soul satisfying experience. The nearest approach to the true sweet apple today is the mild-flavored Delicious variety. Poor color, small size, and lack of market demand are mostly responsible for the disappearance of Tolman Sweet, the origin of which is unknown.

Tompkins King. Once in demand as a high quality dessert apple, especially fine for salads, this variety is no longer favored commercially chiefly because of serious weaknesses of the tree. Its most serious defects are shy production, lack of adequate hardiness, tardiness in bearing, very sparse branching, and susceptibility to collar-rot. The fruit frequently is over-size and quite subject to water-core. Apparently having originated near Washington, N.J. the variety was taken to Tompkins County, N.Y. in 1804 for which it was named.

Wealthy. Peter Gideon of Excelsior, Minn. planted seed of the Cherry Crab about 1860. One of the resulting seedlings became the Wealthy variety. It gained commercial status not only in that region, where it proved to be winter hardy, but also in many orchard areas throughout North America. The tree is rather small of stature and comes into bearing early which makes it an excellent filler tree. Its desirability as a filler tree caused the variety to be greatly overplanted during second and third decades of this century so that the fruit almost became a drug on the market. The tree is also rather distinctly biennial in bearing. The fruit is attractive, red striped, smooth-skinned and fairly good quality. However the fruit, which matures just ahead of McIntosh, has a tendency to drop badly, and on older trees runs small and is apt to lack color. In regions where McIntosh is the main variety, Wealthy is being replaced by newer varieties which have better fruit characteristics and mature somewhat earlier in season.

One color-sport, Double Red Wealthy, has been registered.

It was discovered by James G. Chase, Sodus, N.Y. in 1933 and introduced commercially in 1940.

Wolf River. Here is another very hardy variety from the east-central part of Wisconsin. Beach (3, p. 246) states that it was "Originated by W.A. Springer, near Wolf River, Fremont County, Wis., hence its name." The present writer fails to find either a town by the name of Wolf River or a county named Fremont in any current atlas or Wisconsin road map available. However, there is a village called Fremont, west of Appleton, through which the Wolf River flows.

Besides winter hardiness of tree, the chief merit of this variety is its very large, attractive red fruits. At one time the fruit was in considerable demand for baking. One ingenious Massachusetts fruit grower has used trays of this variety spaced along the roadside on the approaches to his roadside stand to attract attention. Doubtless the widespread mixture of this variety in nursery rows of McIntosh during the late "teens" and "twenties" had much to do with the wide distribution of Wolf River in the Northeast. As that mixture has long since been eliminated from most eastern nurseries and many orchard trees have been either topworked or pulled out, the Wolf River has disappeared as a commercial variety.

Yellow Bellflower. The oblong-conic, more or less ribbed fruit with prominent ridges near the apex would distinguish this large, yellow apple from almost any other variety of that color. It was prized more for culinary purposes than dessert, yet after it had mellowed, its rather strong, distinctive flavor was quite acceptable. Apparently it needed a rather mild climate for it developed best in New Jersey, where it originated long before 1800, and in the coastal valleys of California where it was very highly regarded at the beginning of this century. While the tree is vigorous, productive and long-lived, the fruit and foliage are very susceptible to apple scab. Its place has undoubtedly been taken by Golden Delicious.

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*Yellow Newtown.** Frequently called Albemarle Pippin in Virginia and adjoining areas, this variety supposedly originated in Newtown, Long Island, N.Y. at least early in the 18th century. Being greatly influenced by soil and climate, the Newtown variety developed best in only a few regions: (1) the lower Hudson Valley in New York, (2) the Piedmont and mountain regions of Virginia and North Carolina, and (3) the Pacific Coast States. Because of its very limited adaptability, commercial production of this variety has not materially changed in 50 years. Although it is an attractive, high-quality apple when well grown, its chief merits are firmness of flesh and very late season of usefulness. These features have made it an excellent export variety in the past, but now it is being planted only to a limited extent in the Hood River Valley of Oregon.

Growers started planting Yellow Newtown in the Hood River Valley of Oregon about the turn of the century. During this period and up to the severe freeze of 1919, Yellow Newtown was the leading apple variety there. The Yellow Newtown, which represented about 60% of the total apple acreage prior to the 1919 freeze, declined to approximately 40% during the next decade. Presently, Newtown production is still equal to the total production of all other apple varieties in the Hood River Valley. The variety still meets with ready acceptance as a late keeper for domestic markets. A limited number of young plantings have been established, mainly because of its late bearing habit. Certain of the clonal rootstocks have been shown to overcome this difficulty and future plantings will be on the growth-controlling stocks.

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*The concluding paragraph is by Walter Mellenthin of Hood River, Oregon.

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OF APPLES IN NEW YORK FOR
TY YEARS[1]

	Total receipts (barrels)	Total value	Average price per barrel	
. . .	231,863	$805,873	$3.43	1893-94
. . .	520,338	1,368,716	2.60	
. . .	736,487	1,627,907	2.21	
. . .	1,420,546	2,018,411	1.41	
. . .	877,077	2,336,934	2.66	
. . .	650,686	2,116,021	3.25	2.62
. . .	921,648	2,147,728	2.33	
. . .	895,967	2,238,004	2.50	
. . .	553,816	2,057,679	3.72	
. . .	1,540,005	3,196,204	2.08	1902-03
. . .	2,643,666	4,880,324	2.39	
. . .	1,865,459	3,895,384	2.09	
. . .	1,566,855	5,176,719	3.30	
. . .	2,227,527	5,389,810	2.04	
. . .	1,687,719	5,150,687	3.05	2.87
. . .	1,858,267	5,992,356	3.22	
. . .	1,868,268	6,045,390	3.18	
. . .	1,932,327	6,904,624	3.57	
. . .	1,875,168	5,028,725	2.68	
. . .	2,438,666	6,320,706	2.59	1912-1913

EARLOADS OF APPLES SHIPPED ON
HUDSON RIVER RAILROAD FROM
RK STATE FRUIT BELT IN 1909

Below is a statement of the number of cars shipped during the year 1909 from stations at which storage warehouses are located.

Albion	763 cars
Lockport	728 cars
Hilton	563 cars
Medina	551 cars
Burt	541 cars
Gasport	455 cars
Carlton	222 cars
Lyndonville	216 cars
Hamilton	204 cars
Ashwood	198 cars
Le Roy	196 cars
Waterport	173 cars
Total	480 cars

Figuring on the basis of 175 barrels per car, this produces 841,750 barrels.

which would indicate what proportion of the apples houses are located originated in the vicinity of such rehouses, and the proportion shipped from near-by quently, if the figures for this latter table were used, ge of apples which may have been shipped from t table to the storage points.

7493 cars, or approximately 1,311,275 barrels.

w multiplying the receipts for each month (Table V) by 'The total value divided by the total receipts gives the e method of determining the price with the figures avail- re the receipts for July were omitted. This was neces- 5; August, 1907–1908; and August, 1912–1913.

TABLE VIII. CHART SHOWING THE PREFERENCES OF DIFFERENT UNITED STATES MARKETS FOR VARIOUS APPLE VARIETIES[1]

APPLES	Baldwin	Greening	Ars	Hubbardston	Wagener	King	Gillflower	Rome Beauty	Ben Davis	Newtown Pippin	Roxbury Russet	Golden Russet	Seek-no-Further	Jonathan	Yellow Trans.	Duchess	Wealthy	Alexander	Maiden Blush	Twenty Ounce	Pound Sweet	Tolman Sweet	Holland P.	York Pippin	Snow	Mcintosh	Greenings	Red Astrachan
Baltimore	ex	f-ex	ex	v g	f-g	ex	f-ex	f-ex	f-g	ex	f v g	v g	cx	ex	v g	f-g	f-g	b-	p ex	f-v g	f-g	g-v g	f	f	g	g-v g	g-ex	f
Boston	ex	ex	ex	p-f	p-f	g-ex	p-f	p-g	p-f	p-g	f g	f-g	p-g	f-g	p-g	f-g	p-ex	p-vg	f-v g	f-ex	f-ex	f-ex	p-g	p-g	f-ex	f-ex	ex	f-g
Buffalo	ex	ex	ex	p-g	p-ex	ex	f	p-g	f	v p-f	p-g	p-g	f-ex	v g	f-v g	ex	p-g	i-ex	f-v g	ex	ex	p-v g	f-g	f-g	ex	p-ex	ex	f-v g
Chicago	ex	ex	ex	f-v g	g	ex	f-v g	g	g	f g	f-g	g-ex	f g	ex	g	ex	v g	g-ex	g-ex	ex	f-ex	f-v g	f-g	f-g	f-ex	f-ex	f-v g	p-g
Cincinnati	ex	ex	ex	g	g	ex	g-v g	g-v g	p-g	f-v g	v g	v g	f-v g	ex	ex	g	f-v g	ex	ex	ex	f-g	p	f	g	f-ex	g-v g	v g	p
Cleveland	ex	ex	v g	f	f-g	ex	p-f	f-g †	f-g	p-f	f-v g	f	p-f	g	v g	f-g	f-v g	v g	g-v g	g ‡	f ‡	p-f	f-g	p-g	g-v g	f-v g	f-v g	f-v g
Columbus	v g	v g	v g	f	g	v g	f	v g	p-g	v g	f	f-g	p-g	v g	f	v g	v g	v g	ex	ex	p-v g	p-v g	v g	v g	v g	un *	v g	v g
Denver	g	g	g	un *	g	un *	un *	v g	v g	g				v g														
Detroit	v g	g-ex	v g	p-g	f-v g	v g	p	f	f-ex	f-v g	g-ex	g ex	p-g	ex				v g	v g	v g	ex	ex	p	p	ex	ex	v p	v g
Indianapolis	ex	v g	v g	ex	f	g	f	g-ex	f	f	f	f	f	f	g-ex	v g	v g	f-g	v g	g	f	f	f	f	g	v g	g	f
Kansas City	v g	g	f g	f	f	f-g	f	f	g	f-g	p	p	p-f	ex	g	f	g	f	g	f	p-f	f	p-f	p-f	p-f	p-f	p-f	f
Louisville	ex	g	v g	f-v g	f-v g	ex	f-g	g-ex	p-ex	p-v g	f-v g	p-v g	f-v g	ex	p-ex	p-ex	g	f-v g	ex	ex	p-f	p-f	p-g	p-g	p-g	p-g	g	g
Memphis	ex	f	f	f	f-g	ex	f-g	f-v g	v g	f g	f-g	f-v g	f	ex	g	g	f-ex	f-ex	f-v g	f-ex	v g	v g	n g ¶	g v	p	n g ¶	f-g	v g
Milwaukee	ex	ex	ex	p-g	f-ex	ex	p-g	p-g	p-ex	p-g	p-g	p g	g	ex	p-g	g	g	g	p-g	f-g	g §	f-g	g ††	f-g ††	g-v g ‖	g ‖	g	p-g
Mobile	ex	v p	f g	f g	f g	ex	f	v g	p	g	v g	g	f	ex	un *	p	f	g	g	f	p	p	p	v p	p	n g ¶	p	n g ¶
New Orleans	f-ex	v p	p-f	p-g	p-g	g-ex	p-f	f-v g	g-ex	p-v g	f-v g	f	p-f	g-ex	p-g	p-f	p g	f-g	g-ex	f-g	p-g	p-g	p	p-g	f	p-f	p-f	p-f
New York	ex	ex	v g	f-v g	g	g-ex	f-v g	f-g	g	f g	f-g	f-g	f-g	ex	f	g	g-ex	v g	g	v g	f-v g	f-v g	f-v g	f-v g	ex	v g-ex	v g	p-g
Norfolk	ex	p	p-g	f-g	f g	v g	f-g	f	f g	f-v g	p-g	p-f	f	p-g	g	g	f-v g	f	g	p-g	g	g	g	g	p-g	g	g	g
Omaha	g	g	g	f-g	f-g	g	g	g	g	g	g	g	g	g	f g	g	g	g	v g	v g	g	g	g	g	g	g	g	g
Peoria	ex	ex	ex	v g	g	ex	f-g	v g	p-f	g	f-g	f-g	v g	v g	g	v g	v g	v g	v g	v g	g	f g	g	g	g	g	g	g
Philadelphia	ex	ex	ex	v g	g	ex	v g	v g	g	g	g	g	g	g	v g	v g	g-v g	v g-ex	v g	p-g	p-v g	f-v g	f-v g	v g	f-v g	v g	v g	v g
Pittsburgh	ex	p-f	g-ex	f-g	f-v g	ex	f-ex	f g	p-f	p-g	f-ex	p-g	p-g	f-v g	f-v g	g-ex	g-ex	g-ex	g-ex	g-ex	f	f	f g	f-g	p-g	f-v g	g-ex	g-ex
Richmond	ex	p-v g	f	f	ex	ex	ex	f-v g	p-f	f-v g	f-v g	f-g	f	f-g	f-g	f-g	v g	f-v g	f-v g	f-v g	f-g	f-v g	f	f	f-v g	un *	f-v g	v g
St. Louis	v g	v g	f-v g	p-f	f-g	ex	p-f	p-g	p-f	f	f-g	g	p	ex	f	f	ex	f-g	v g	f-ex	p-f	p-f	f	f	f-g	un *	p	p-f
St. Paul	ex	ex	ex	g	v g	ex	v g	v g	p	p	v g	v g	v g	v g	g	v g	v g	v g	v g	ex	g	v g	g	g	v g	g	g	g
Toledo	v g	v g	v g	v g	v g	v g	f	f	f	f	f	f	g	v g	v g	v g	v g	v g	v g	v g	g	g	v g	v g	v g	v g	v g	v g
Washington	ex	ex	f-g	f g	f-g	ex	ex	g	g	g	g	g	g	v g	g	g	g	g	g	g	g	f-g	g	g	g	g	g	f-v g

KEY (in descending order of merit). Ex = "excellent," and so reported by every one; v g = "very good," and so reported; g = "good," and so reported; f g = "fairly good," and so reported; f = "fair"; p = "poor"; un * = "unknown"; n g ¶ = "no good"; † = "late"; ‡ = "few wanted"; †† = "gaining"; § = "best sweet"; ‖ = "to January 1." Anything reported "excellent" or "v g" = "a very good demand." When any other term is used before "ex" or "v g," as "f to ex," it indicates that some of the trade in that market has an excellent demand for the variety, and some of it has but a fair demand. Any market reporting poor or fair for a variety might be taken as a safe indication that the variety is either in poor favor or little known.

[1] By Samuel Fraser, Geneseo, N.Y.

The Apple: A practical treatise dealing with the latest modern practices of apple Culture. Albert E. Wilkinson. 1915

Harvard - Economic Botany SB363.W65

er [redacted]es in 1964 was only

total crop from 1915 to 1964
auty, York Imperial, Yellow
nstein have gained in relative
eady; while Northern Spy, R.I.
Golden have lost ground.
mer varieties listed above, the
s are no longer grown in suffi-
ng—Fall Pippin, Limber-twig,
ng, Golden Russet, Fameuse,
rkansas Black, Northwestern
n, and White Pearman.
l be devoted to full discussion
l varieties of the present time.
the 1964 list (Table 1) and
eared from commercial listing
idual consideration.

seedling in the town of Wil-
740, was for years known lo-
er apple because the tree was
t wa[redacted]d Baldwin only after
n wa[redacted]cted to it by Samuel
n and introduced the variety
s. A granite monument (Fig.
ss of the apple, marks the spot
d.

ading winter variety of the
eneral adaptability, good color
eating raw, cooking or juice,
roductivity, and longevity of
s responsible more than any
ng "An apple a day keeps the
ree nor fruit are without seri-
ial—and in some cases even



FIG. 1. Baldwin apple monument, Wilmington, Mass.
(Courtesy, A.P. French)

avor of it. It is a good dessert
r and this is true of few apple
ng sometimes lets it get by a
the ledger it is late coming into
bearing, forms tree crotches
it is easily bruised. With the
improved methods of culture
be possible. One of these days,
a spur type Spy giving much
red rootstocks. Another possi-
h growth retarding chemicals.

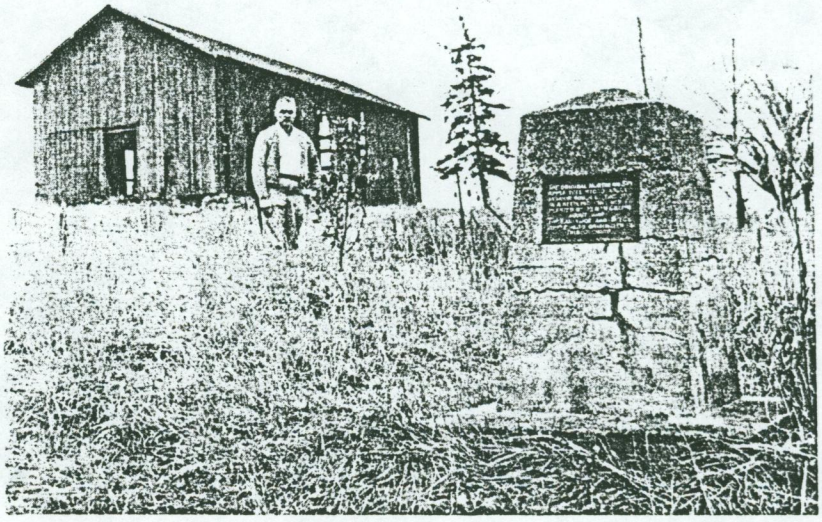


FIG. 1. Right, Northern Spy marker; left, Dr. Roger Way, Experiment Station, Geneva, N.Y. beside Northern Spy tree planted during the 1964 Ceremony. Picture taken Nov. 1965.
(Courtesy, Agr. Exp. Station, Geveva, N.Y.)



FIG. 2. The plaque on the Northern Spy marker.
(Courtesy, Agr. Exp. Station, Geneva, N.Y.).

aining of orchards through hewn

s disappointments. One summer
e broke into his nursery, ate off
of his foot high apple trees, about
lated loss of $800—a heavy blow

cIntosh clan was Sandy, Allan's
rs his junior. He was known as
d set out each spring with a load
his back selling his goods and
oods. One time he was known to
ough barter. He had a reputation
through the contours being able
occupation the children were
up against modern aptitude tests
was a super salesman and did a
tribute the McIntosh apple.
ey (1863–1940), was the one to
Wit[illegible] an inherited 50 acres
ssary, [illegible] keep supply up to de-
g of nursery trees on other farms
arvey McIntosh had four or five
planting the following spring.
cards to prospective customers
t with date of being there. He
horse-drawn wagon. Often he

k over his father's business after
sery became much less impor-
5 acres mostly of the McIntosh

vas only 15 feet away from the
se burned down in 1894 the tree
nade desperate efforts to save it
wards did some repair work on



FIG. 1. The original McIntosh tree as it looked in 1896. Fire, which burned down the nearby house in 1894, badly damaged the trunk. The tree broke off in 1910. Allan McIntosh, son of the discoverer, stands beside the tree.
(Courtesy, Canadian Department of Agriculture, Ottawa)

FROM: AUDUBON MAGAZINE, NOV/DEC 1995

Apples Preserved

By Mimi Sheraton

IN CORNELL'S ORCHARDS, SCIENTISTS ARE SAVING EXOTIC AND OLD-TIME APPLES—INCLUDING THOSE FANCIED BY THE ANCIENT ROMANS—WHILE WORKING TO PRODUCE THE PERFECT FRUIT.

AT THE RATE OF AN APPLE A DAY, it would take nine years and two weeks to sample every one of the 3,300 apple varieties grown in the orchards of the New York State Agricultural Experiment Station, operated by Cornell University in Geneva, New York. Walking through the rows of softly packed earth in one of these orchards is as magical in spring, when clouds of ice-pink blossoms burst forth, as in fall, when green, yellow, russet, and red apples hang like Christmas ornaments on dark-leafed branches. This is, in fact, an apple library, cataloguing living descendants of fruit trees that developed through the centuries in various parts of the world. Like the animals in Noah's Ark, there are two (or more) trees of each type, and for the same reason—to maintain a diverse gene pool.

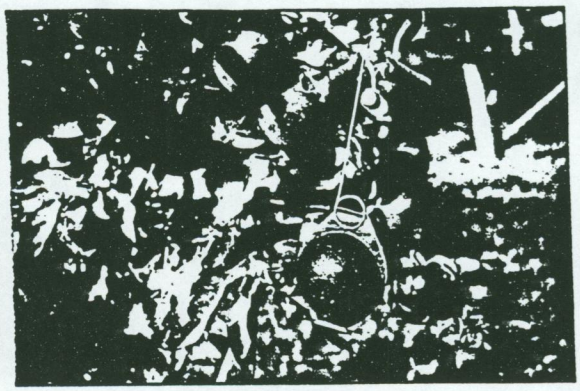
No variety is cultivated here unless it adds a genetic trait otherwise unrepresented. No plant is eliminated simply because it has not been of recent usefulness. To be prepared for new diseases, or for the return of some considered eradicated, plant pathologists hold on to each unique apple cultivar—the term for a cultivated apple variety that can be reproduced.

That explains the presence not only of all our familiar, mass-distributed apples and their old-timey cousins, often found at farmers' markets, but of even more esoteric specimens such as the tiny, acrid Japanese crab apple no bigger than a cherry; the miniature, blushing Lady, or Pomme d'Api, whose ancestors were thought to have been taken home from France by the ancient Romans and which is considered to be the oldest continuously grown apple; and the McIntosh Wijcik, a tree with an improbable columnar shape that suggests a candelabra.



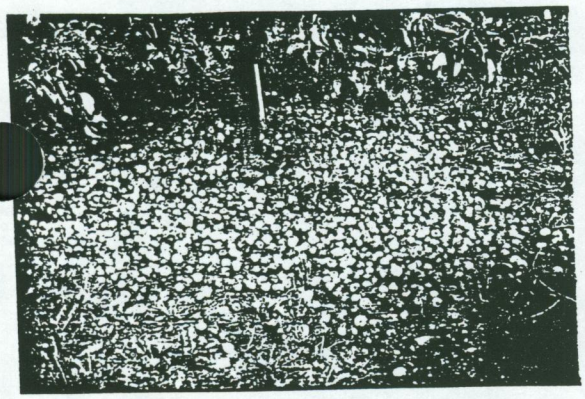
Red Delicious apples, such as this one at Cornell University's agricultural research station, are the most popular variety among Americans, who like their apples big, red, and shiny.





Empire apple trees (below) at the Corne station are grown on trellises so the fruit is exposed to maxi um sunlight. A pher ne-permeated "false (left) used to lure an trap maggots; Royal Empire apples (far lef a variety developed at station. Right: A harv of sugar crab apples.







To an apple lover it might seem that the primary reason for breeding should be to create juicier, more succulent specimens, but that is only part of it. An equally high priority at the Cornell station is developing strains that are naturally resistant to insects and to the most common apple diseases: scab, cedar apple rust, fire blight, and powdery mildew, among others. By collecting the genetic material from apple varieties that resist these diseases, plant breeders can then introduce natural protection into commercially acceptable offspring, reducing the need for chemical fungicides, pesticides, and insecticides, which may threaten human health and the environment.

Much of the work at the station focuses on commerce—creating apples that are hardier on the tree, that are better "keepers" (having longer shelf life in cold storage and deteriorating less when sealed in plastic bags for marketing), that ripen at different times to ensure a staggered supply of fresh apples, or that resist frost and so make it possible to grow apples farther north. Apples are also bred for salability through eye appeal—the biggest, shiniest, and reddest being the prizewinners in this country.

"Europeans eat with their tongues, but Americans eat with their eyes," says Robert C. Lamb, a pomologist who has helped create many new apple varieties at the Cornell station. "And they like their apples red, with no bruises or lesions, and big—even if they cannot finish an apple that's three inches in diameter, and a smaller size would be more practical."

Many apples we take for granted as being nature's own were bred at Cornell, including Cortlands, developed in 1915; Macouns, in 1923; Jonagolds, in 1943; Empires, in 1945; and Jonamacs, in 1972. Among disease-resistant apples created here, the most recent successes are the dark-red Liberty and the red- and yellow-striped Freedom, both not yet generally known to the public. The Liberty claims as its parents the Macoun (a McIntosh derivative) and the Purdue. The somewhat blander, lighter-textured Freedom has an involved lineage that includes the Macoun, the Golden Delicious, and the Rome baking apple, among other cultivars. Both have been grown for 23 years with few or no fungicides and are among the triumphs of Cornell plant pathologist Herbert S. Aldwinckle and pomologists Lamb and David E. Terry.

MANY OF THE APPLES WE TAKE FOR GRANTED AS BEING NATURE'S OWN WERE BRED AT CORNELL, INCLUDING CORTLANDS, DEVELOPED IN 1915.

The New York Agricultural Station was established in 1880 by the state legislature; in 1883 its apple collection was begun by horticulturist Emmet S. Goff. By 1900 it included more than

700 varieties of apples and crab apples, and it is now considered the largest collection in the world; since 1923 it has been associated with the College of Agriculture and Life Sciences of Cornell University.

The station's 900 acres encompass farms, vineyards, orchards, greenhouses, and more than 20 buildings; there are 330 employees. The apple collection is divided among a dozen or so orchards scattered around the countryside, some belonging to Cornell, others rented. The station, whose $19 million annual budget is financed largely through federal and state funds, also does research on wine grapes, berries, deciduous fruit trees, and vegetables, especially the vegetables of the cabbage, or *Brassica*, family.

The New York station stocks 2,500 types of apple germ plasm, genetic material that the station sells or exchanges with nine other apple research centers in the United States, as well as with pomologists and marketers in Japan, Italy, Germany, and elsewhere.

These days, the great hope of appledom is *Malus sieversii*, a wild specimen tracked down in a remote region of Kazakhstan in 1989 by U.S. plant scientists, among them Cornell's Aldwinckle. One of the earth's oldest apples, *Malus sieversii* is thought to contain genes that can resist many of the more serious diseases. It was cultivated and propagated in the station's laboratory by Philip L. Forsline, curator of Cornell's Plant Genetic Resource Unit, and seedlings were planted in 1992. This year a promising 15 percent of them produced blossoms. "It's great to have that much fruiting in so short a time," Forsline says. "It usually takes six or seven years after planting in the field."

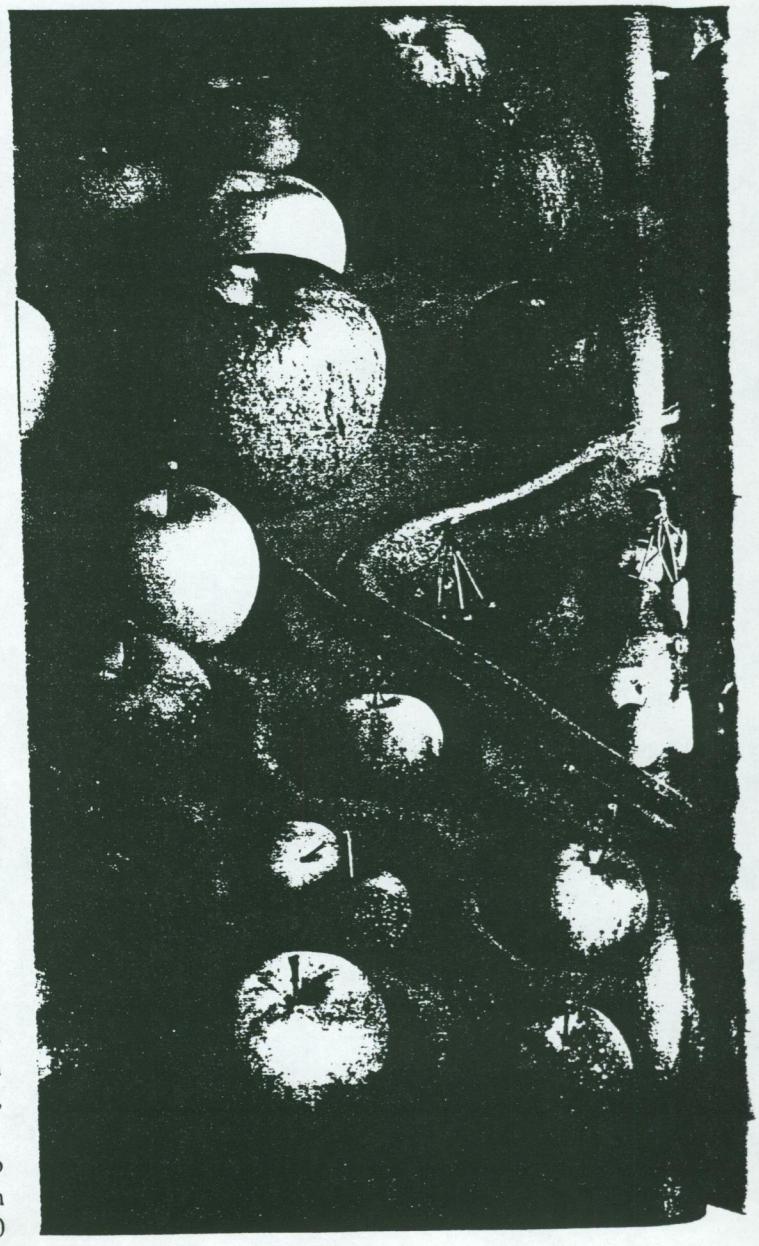
ONE OF THE EARTH'S OLDEST APPLES IS MALUS SIEVERSII, A RARE WILD SPECIMEN THAT SCIENTISTS TRACKED DOWN IN KAZAKHSTAN IN 1989.

Heading an expedition to the same region of Asia in 1993, Forsline and his team not only tracked down many varieties of wild grapes and other apples, but found additional fruiting *Malus sieversii* trees.

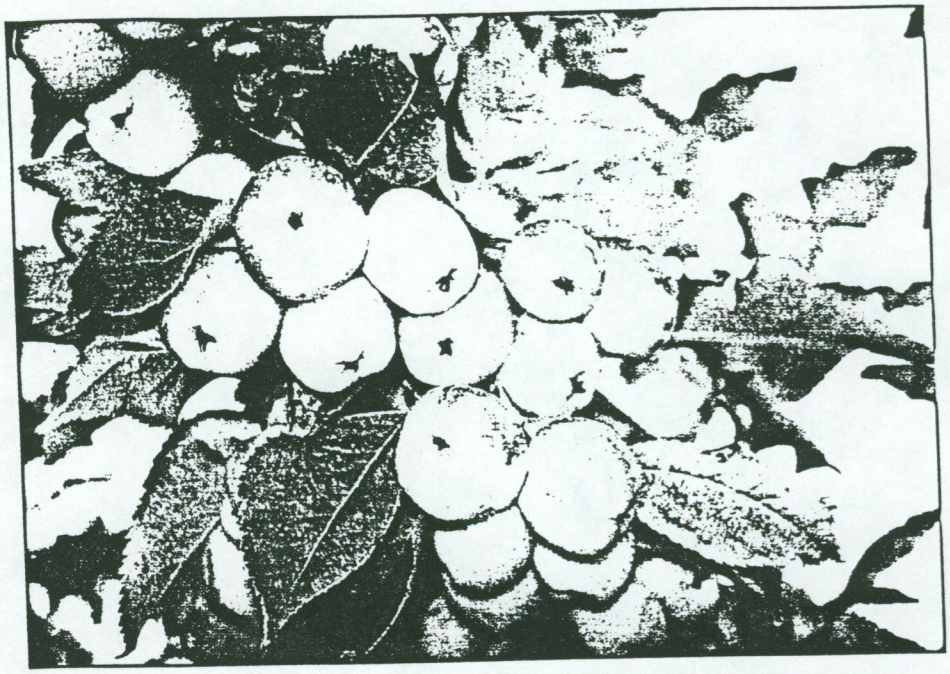
Because Kazakhstan and neighboring Kyrgyzstan were on the much-traveled Silk Route, traders are thought to have carried seeds of those apples back to many parts of the ancient world and planted them, making *Malus sieversii* one of the first cultivated apples. Originally, of course, all apples grew wild—beginning, most irresistibly perhaps, with the biblical specimen that tempted Adam and Eve. Wild apples were also known throughout ancient Europe, in northern India, and in the Caucasus.

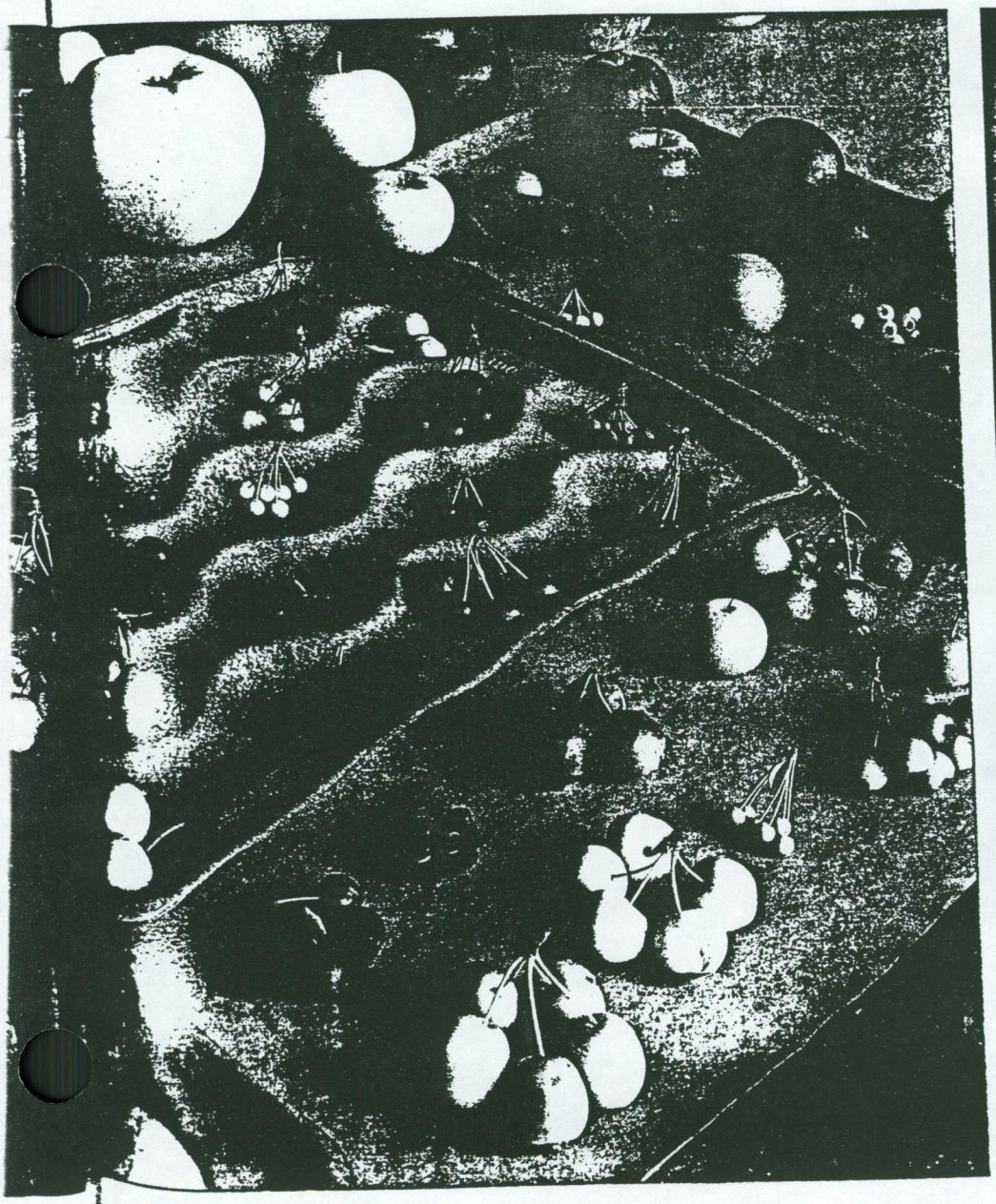
Native American wild apples were of the crab variety, generally inedible when raw, but English settlers brought trees and seeds here about 300





A display (below) showing the variety of apples developed and cultivated at the Cornell station in Geneva, New York. Right: Malus prunifolia *(top), a wild apple collected in the field and cultivated at the station;* Malus sieversii *(middle), one of the earth's oldest apples, was brought back from Kazakhstan;* Malus floribunda *(bottom), a wild apple that plant geneticists may use to breed a better eating apple. Left: Royal Empires, developed for the richness of their color.*









years ago; others came with the Dutch, the Swedes, the Russians, and the Huguenots.

The apple is this country's favorite fruit, but it can require more chemicals per acre than any other crop grown in the United States. As many as 15 sprayings may be needed within a single growing season. Labor and materials for spraying are expensive for producers, who worry about consumer distrust of agricultural chemicals (many growers still shudder at the mention of Alar, remembering the public scare over that chemical spray in 1988) and the regulations imposed by the Food and Drug Administration and the Environmental Protection Agency.

THE APPLE IS THIS COUNTRY'S FAVORITE FRUIT, BUT IT CAN REQUIRE MORE CHEMICALS PER ACRE THAN ANY OTHER CROP GROWN HERE.

So far, natural resistance to insects has proven elusive. One of the more canny, nonspray alternatives is the false apple, a pheromone-permeated, bright-red impostor hung on a tree branch to lure apple maggots, which become trapped on its sticky surface. Scientists are developing natural anti-insect ploys such as apples with more tightly closed calyxes (the small round depression at the bottom of an apple) so that mold spores cannot get inside the fruit.

"Even here we have to keep nature in balance," says Lamb. "We don't want to totally eliminate a species, not even of insects."

Seeds produce uncontrollable, random combinations of genes and therefore unpredictable offspring, so once a desired cross has been bred from seeds and pollen, plant geneticists graft buds of branches onto a rootstock to ensure clones with the desired characteristics.

Sometimes an unexpected bonus results from a crossing. A case in point is the apple designated as NY 674, a cross between Golden Delicious and Monroe cultivars that has not yet been subjected to the poetic and commercial considerations that go into giving a new apple an official, registered, marketable name. NY 674 has a low enzyme and phenolic-compound content and so is slow to oxidize. Once cut, it does not turn brown as rapidly as most apples and therefore requires no chemical antioxidant for commercial use in baked goods or canning (which allow apples' acidic overtones to be modified with sugar).

Maintaining considerable acreage for Cornell's valuable library is costly, and weather can damage the stock, so cryogenic preservation promises to be the future method of choice. In this technique, dehydrated apple buds are frozen in liquid nitrogen. It is much like the method being tried in California (where else?), where people are having their bodies preserved in liquid nitrogen in the hope of being resurrected whenever there are

TASTING MR. JEFFERSON'S APPLE

TO AN APPLE LOVER, simple hedonism seems justification enough for the project at the Cornell station. Certainly, that's what drew me there. An inveterate apple eater, I buy about 12 varieties each fall as they come to my local farmers' market, in New York City, and I count myself lucky to have so wide a choice after the limited array in supermarkets.

Imagine, then, my excitement at sampling descendants of antique specimens such as the Yellow Newton (shown below), known to be present in this country before 1759 and a favorite of Thomas Jefferson, and the petite, blushing Lady, or Pomme d'Api, which the ancient Romans brought back from France (although I found it disappointingly bland). The rough-skinned Gravenstein—related to a 1669 original from Denmark—proved thickly fruity in flavor, if somewhat mushy and in marked contrast to the sharper, crystalline, white flesh of the Fameuse, or Snow, apple, believed to be the 18th-century Canadian parent of the McIntosh. The family resemblance is still strong, and one I appreciated, because my favorites among contemporary apples are the McIntosh and its offspring the Macoun—both white-fleshed, crisp, and juicy, with an acidic, quintessentially appley pungency. They are the opposites of America's favorite, the Red Delicious apple, which I deplore. The Red Delicious is mealy and simplistically sweet, although a little better than our most banal, the popular Golden Delicious, which I use only for apple Tarte Tatin because of its dryness.



Wantonly biting into one specimen after the other, I agreed with Thomas Jefferson about the Yellow Newton (as about so many other essentials). It is a slightly flattened orb of yellow-green that shows rose patches here and there. It is succulently juicy, with a very strong, aromatic apple essence.

An even stronger and sweeter flavor distinguished one of the most extraordinary apples I tasted—Cox's Orange Pippin. This rough, russet-skinned apple is beloved in England and France, and no wonder, for its flavor is deeply rich, almost like that of a baked apple, and its intense sweetness has sophisticated overtones of fermentation, like well-aged cider. It has not grown well in this country and seems to have little domestic appeal anyway, despite its large size, because of its color and patina.

Then, of course, I bit into a highly prized *Malus sieversii* that had been refrigerated for several weeks. I found it pleasant, only moderately sweet, and with a mildly defined apple flavor.

On a futuristic note, I had a taste preview of New York State's newest apple, the round, shiny, brightly red Fortune, designated as number 429 before its christening. Developed by Susan K. Brown, the apple breeder and geneticist in Cornell's Department of Horticultural Sciences, the Fortune is basically a cross between an Empire and a Red Spy. Although not disease resistant, it is gently sweet and reminiscent of the Delicious apple that is part of its genetic makeup, but with a juicy McIntosh snap when bitten into. With a name that should be appealing to the market, its expected introduction late this year should prove it an easy crowd pleaser. —*M. S.*

cures for the diseases that killed them.

Germ plasm, in the form of cuttings, is sold to and exchanged with plant scientists all over the world. If the cuttings are regerminated annually, they can be held stable in liquid nitrogen for at least six years. One of the station's tanks, which is five feet in diameter, currently holds 660 cuttings, an amount that would require five to seven acres of land. This economy of space explains the interest in cryogenic preservation in a small country such as Japan, where research on the subject was pioneered in the 1960s.

As practiced now at Cornell's rather simple, spare plant-genetics laboratory, the process of cryogenic propagation begins by cutting a piece of one-year-old wood growth in late winter, when the tree is dormant. The twigs are dehydrated so that when they are placed in vials and set in liquid nitrogen, the temperature can be greatly reduced without forming ice crystals that would kill cells.

The prepared branches are rehydrated and their buds grafted by insertion into slits in growing rootstock, then secured with a simple rubber band. After 17 days, the top of the growing rootstock is cut off and the sprouted bud grown in a greenhouse, producing blossoms in anywhere from two to seven years.

Given the ever-increasing knowledge and skills of plant geneticists and the competition of the marketplace, there's no telling what sort of apples our great-grandchildren will bite into, or if they will know the pastoral pleasures of an old-time orchard. Just consider the ambitions apple scientists have for the scab-resistant McIntosh Wijcik, whose shape seems to have everything going for it. Being columnar, it can be enclosed in wire-mesh screening to protect it from insects without spray. Its splayed branches expose all fruit to an even share of sunlight. Finally, its low branches require little pruning and permit easy, ladderless picking. That last attribute alone is enough to give its germ plasm influence in orchards all over the world. Never mind the romantics who still consider a summer afternoon ideal if it has been spent under the spreading shade of an old apple tree.

GIVEN THE SKILLS OF THE PLANT GENETICISTS, THERE'S NO TELLING WHAT SORT OF APPLES OUR GREAT-GRANDCHILDREN WILL BITE INTO.



Cuttings of Malus sieversii, *the wild apple from Kazakhstan that scientists believe contains genes that can resist many diseases.*

A supply of any number of said Trees can be had on the shortest notice, at said Nursery, on the most reasonable terms; and at a small expense they will be delivered at any of the above places. Directions will be given with the Trees how to plant and cultivate the young orchard. An allowance will be made to such as take a large quantity.

Aquila Jones, on Bowly's Wharf, Baltimore, will receive and forward any order left with him, to said nursery.

In an advertisement in the *Federal Gazette,* Philadelphia, 20 October 1800, the Oldmixon peach is first mentioned in print. Coxe, and Prince, a little later, state that this is the first American-grown peach to receive a name. The variety was named after Sir John Oldmixon, who came to America in the eighteenth century. Downing supposes that he brought peach pits with him, from one of which this variety originated. The variety is more than 200 years old, though it is doubtful if it could now be found. The writer remembers it well, fifty years ago, as a rich, juicy, white-fleshed peach—one of the best of all peaches:

NURSERY

William *Leeson,* Nursery and Seedsman, In the Northern Liberties, opposite the Old Rising Sun Tavern, continues to sell at his Nursery, the following assortment of Fruit and Forest Trees, Flowering Shrubs, &c. such as

Apples, pears, plumbs, cherries, apricots, nectarines, peaches, quinces, English walnuts, almond, filbert, weeping willow, Lombardy poplar, English elms, catalpa, and plaintree, commonly called button-wood, with a number of other plants, too tedious to mention. The subscriber has in addition to his former collection, that admirable fruit called the Oldmixon Peach, which for beauty, size and flavor, exceeds any of the peach kind that has yet been discovered. He has also a large assortment of Garden Seeds of the last year's saving, fit for the West India Islands. . .

From an advertisement in the *Federal Gazette,* Philadelphia, 20 October 1800, one learns that hedges were coming in vogue in Philadelphia and its environment in 1800. The orange and lemon trees offered were no doubt in tubs so that they might be given shelter in winter:

Sales of Fruit and other Trees, Flower-roots, Garden Seeds, &c. . . .
The whole nursery stock of John Lithen, deceased, consisting of a great number of Fruit trees of the very best and most esteemed kinds in this country—a great quantity of Lombardy Poplars, and other ornamental trees and shrubs—a large quantity of white and other Thorns, in excellent order for planting out in hedges—as good Thorns is an article rarely to be met with, it is hoped Gentlemen desirous of introducing the elegant improvement of Hedges (the most beautiful and durable of all fences) on their Estates, will avail themselves of this opportunity of procuring them—a large collection of Flower roots, such as Hyacinths, Tulips, and many other bulbous and fiberous ornamental flowering plants—a large quantity of Garden seeds, of the most useful sorts, fresh and genuine in their kinds, which will be put up in complete assortments and quantities suitable for the use of private families, also in large quantities suitable for the West Indies. . .

A few fine healthy Orange and Lemon Trees, will be offered for sale at the same time.

John Connelly, Auctioneer.

Besides issuing several broadsides, one of which is reproduced in Plate IV, and a series of catalogues, which began as early as 1791, the Princes were large advertisers in the newspapers of the day.

It was William Prince who first grew trees of the pecan for sale. In 1772 he planted 30 nuts from which he raised 10 plants. Eight of these he sold in England at ten guineas each. After this small start, pecans were offered almost continuously by the Prince nurseries, and soon were for sale by other nurseries.

The pecan might have been known to southern explorers, but it seems to have been brought to notice first in the North and in Europe by Captain Wangenheim, an officer in the Hessian troops that fought for England in the Revolution. The captain was a forester and during his stay in America, a period of eight years, he gave attention to the forest trees of this country. In 1781 and again in 1787 he published descriptions of different forest species, one of which was the pecan, *Carya Pecan.* The drawings in Wangenheim's books are poor, and that of the pecan is far from accurate. The nut is made to look like a peanut and is described as 'kidney shaped.' Probably the author had only seen the young trees growing in Prince's nursery. Wangenheim tells us that the pecan was unknown in the American colonies until 1762, when fur traders brought nuts to New York from the South.

While a diplomat in France, Jefferson spent two months in England, where he visited some of the famous gardens. The Baedeker of English gardens at that time was Thomas Wheatley's *Observations on Modern Gardens Illustrated by Descriptions,* published in London in 1770. Jefferson studied English landscapes with Wheatley in hand, marking passages that might be of use in planting his gardens.

Writing home, he described Hampton Court, Enfield Chase, Moor Park, Blenhem, Wotton, Pope's garden at Twickenham, the Duke of Devonshire's garden at Chiswick, and several other estates considered show places because of their fine grounds. This visit was important for those in America who were planting gardens, since he wrote to his friends telling them of things that might be of use.

A very good description of Monticello is given by Edmund Bacon, long an overseer on the estate. After having served Jefferson twenty years, Bacon moved to Kentucky, where, in his old age, he wrote what he could remember of his years at Monticello.[3]

Bacon places the house, as we know it, far up on the sugar-loaf mountain reached by a winding road. When he came to Monticello only ten acres were cleared and leveled, on the highest point of which the house stood. Under the house and the terraces that surrounded it were cisterns, icehouse, cellar, kitchen, and rooms for all sorts of purposes. These were warm in winter and cool in summer. Here, underground, was storage room for vegetables, fruit, cider, and wood. There were no Negro quarters around the mansion, as there were generally in plantations in the South.

The grounds around the house were planted with flowers and shrubbery. There were walks and borders, and flowers that Bacon had 'never seen nor heard of elsewhere.' Some, he says, 'were in bloom from early in the spring until late in the winter.' A good many of them, the manager thought, 'were foreign.' Back of the house was a lawn of two or three acres where Jefferson's grandchildren played. The garden, which Bacon planted while Jefferson was President, was on the side of the mountain. In it were vegetables of all kinds, grapes, figs, and the 'greatest variety of

[3] These remembrances were published in 1862 by Hamilton W. Pierson, president of Cumberland College in Kentucky.

fruit.' High up on the mountain, out of the reach of frosts, 'fruits never failed.'

According to Bacon, Jefferson sent home a great many kinds of trees and shrubbery from Washington during his stay in the White House. 'I [Bacon] used to send a servant there with a great many fine things from Monticello for his [Jefferson's] table, and he would send back the cart loaded with shrubbery from a nursery near Georgetown that belonged to a man named Maine, and he would always send me directions what to do with it.' The President, his manager says, 'knew all about everything in every part of his grounds and garden. He knew the name of every tree, and just where one was dead or missing.'

There follow in Mr. Pierson's text a great number of letters, mostly from Jefferson, many of them labeled 'Directions for Mr. Bacon' or 'Memorandum for Mr. Bacon.' These memoranda have to do with many things about the farm, orchard, lawn, garden, house, stables, and slaves. Here are a few of the orders for the care of the orchard, lawn, and garden:

> If the weather is not open and soft when Doug arrives, put the box of thorns into the cellar, where they may be entirely free from the influence of cold, until the weather becomes soft, when they must be planted in the places of those dead through the whole of the hedges which enclose the two orchards, so that the old and the new shall be complete at six inches' distance from every plant. If any remain plant them in the nursery of thorns. There are 2000. I send Mr. Maine's written instructions about them, which must be followed most minutely. The other trees he brings are to be planted as follows:
>
> 4 Purple beeches. In the clumps which are in the southwest and northwest angles of the house (which Wormly knows). There were 4 of these trees planted last spring, 2 in each clump. They all died, but the places will be known by the remains of the trees, or by the sticks marked No. IV in the places. I wish these now sent to be planted in the same places.
>
> 5 Prickly ash. In the S. W. angle of the house there was planted one of these trees last spring and in the N. W. corner 2 others. They are dead. 3 of these now sent are to be planted in their places, which may be found by the remains of the trees, or by the sticks marked VII. The fourth may be planted in some vacant space of the S. W. angle.

6 Spitzenberg apple trees. Plant them in the S. E. orchard, in any place where apples have been planted and are dead.

500 October peach stones; a box of Pecan nuts. The nursery must be enlarged, and these planted in the new parts, and Mr. Perry must immediately extend the paling to include these, and make the whole secure against hares.

In other memoranda, quite too lengthy to quote in full, are items such as these:

Keep the thorns constantly cleansed. . .

Wormly must be directed to weed the flower beds about the house, the nursery, the vineyards, and rasberry beds, when they want it. . .

Consider the garden as your main business, and push it with all your might when the interruptions permit. . .

According to Bacon, there were 300 acres enclosed in the tract about the house. 'Mr. Jefferson,' he says, 'would never allow a tree to be cut.' There were roads and paths winding all around and over the estate where the family could ride and walk for pleasure. 'How often I have seen him walking over these grounds and his grandchildren following after him as happy as they could be.'

At one time and another, Jefferson wrote to various Americans about grape growing and wine making, and, we are told by a recent biographer,[4] that he tried his hand at both. Some time before the Revolution, he conceived the idea of growing Old World grapes and making wines on a large scale in the neighborhood of Monticello. To further his plans he persuaded Philip Mazzei to bring over from Tuscany a number of Italian *vignerons*. Vineyards were planted on the hillsides near Charlottesville, but, as was the case with many other such efforts, grapes could not be grown and no wine was made. Several of the Tuscans were employed at Monticello and from wild native grapes they made wine, some of which Jefferson gave to his friends as the product of his own vintage. He continued, however, to stock his own cellar with French wines.

John James Dufour, founder of the Kentucky Vineyard Society, visited Monticello in 1799 and found that the vineyard 'had been abandoned, which proved that it had not been profitable.' Jefferson did not lose interest in the vine, however, for in 1809 he wrote John Adlum, speaking of the variety Alexander: 'I think it will be well to push the culture of that grape without losing time and efforts in search of foreign grapes which it will take centuries to adapt to our soil and climate.'[5] And, later, he declared that wine made from the Catawba was 'worthy of the best vineyards of France.'

[4] Bowers, [illegible]923.

Perhaps there were too many experiments under way at Monticello for good practice in farming. Jefferson, in his last years, when his poverty and destitution were pathetic, wrote to his lifelong friend Monroe: 'To keep a Virginia estate together requires in the owner skill and attention. Skill I never had, and attention I could not have; and really, when I reflect on all circumstances, my wonder is that I should have been so long as sixty years in reaching the result to which I am now reduced.'

Not only his experiments with foreign grapes were a failure, but one suspects from the following quotation that he was not a good grower of the peach, a fruit in which he delighted and often mentioned: 'Five acres of peach trees at twenty-one feet apart will furnish dead wood enough to supply a fireplace all winter, and may be kept up at the trouble of only planting about seventy peach stones a year.' Manifestly, an orchardist who had 'dead wood enough to furnish a fireplace all winter' from a five-acre tract of peaches was a poor grower of this fruit.

Jefferson was the forerunner of the efficiency experts of modern agriculture. His farm book has notes on better methods of plowing, harvesting, thrashing, and other farm operations. Here is a record of the efficiency of the two-wheeled barrow as compared with the one-wheeled:

Julius Shard fills the two-wheeled barrow in 3 minutes, and carries it 30 yards in 1½ minutes, more. Now this is 4 loads of the common barrow with one wheel. So that suppose the 4 loads put in at the same time *vis.* 3 minutes, 4 trips will take $4 \times 1\frac{1}{2}$ minutes = 6, which added to three minutes filling = 9 minutes to fill and carry the same earth which was filled and carried in the two-wheeled barrow in 4½.

A. J. Downing is usually considered one of America's first good landscape gardeners. Great he was, but not the first to create beau-

[5] Adlum, p. 149.

tiful landscapes in America. Long before Downing lived, there were in Virginia, the Carolinas, and Georgia a hundred landscapes as perfectly planned as any by Downing. Monticello was such a one and it was not the result of happy chance, for Jefferson had studied not only architecture in France but landscape gardening as well. To lay out the grounds and gardens at Monticello required as much study and planning as to build the house.

Under the title 'General Ideas for the Improvement of Monticello,' Jefferson, in 1804, made a memorandum of plans to eliminate the aspect of a farm in the grounds about the house. There were to be lawns and plantings of trees, diversified by thickets, 'all so arranged as to give advantageous prospects' from the roads and paths that circled the little mountain on which Monticello stood. On the lower slopes of the mountain there were to be a park, orchards, and a riding ground. A fish pond was to be built where it could be seen from the house. The park was to be broken by clumps of oaks, elms, maples, and other native trees 'as the open grounds of the English are broken by clumps of trees.' There were to be thickets of dogwood, guelder roses, magnolias, azaleas, rhododendrons, and honeysuckle; there were to be recesses in which to build a 'temple or seat.'

Jefferson's gardening did not end with the landscape. He took great pride in his vegetable and flower gardens, which were also planned for in his 'General Ideas for the Improvement of Monticello.' Unfortunately, his financial resources sank lower and lower from the time he entered the White House in 1801, and his grand plan was never fully carried out, although as long as he lived there were annual additions and improvements.

As President, Jefferson was not too busy to keep track of the green grocery market in Washington. He made a chart showing the dates in the summer months in which garden crops came to market. Those he lists are: lettuce, parsley, spinach, sprouts, corn salad, radishes, sorrel, asparagus, broccoli, cucumbers, cabbages, strawberries, peas, turnips, potatoes, snaps (beans), artichokes, squashes, carrots, parsnips, watermelons, corn, salsify, raspberries, tomatoes, grapes, endive, celery, eggplant, lima beans, cauliflowers, melons, mushrooms, and cresses.

A great opportunity to serve botany and gardening came to Jefferson in 1803 when he obtained money from Congress to send Lewis and Clark up the Missouri and on to the Pacific to explore the Far West.[6] That he had the natural history of the region in mind, especially botany, cannot be doubted, from the fact that Lewis was sent to Philadelphia for nine months to study botany under Barton, leading botanist of the country, to prepare himself in this subject. A great number of seeds and herbarium specimens were collected, which, after several mishaps, came into the hands of William Hamilton and Bernard M'Mahon, gardener and author from Philadelphia, both of whom, after some bickering with other botanists, grew a number of notable plants that were introduced into cultivation. Many shrubs and flowers from the great Northwest were sent to the Prince Nursery for propagation and distribution. Perhaps the most noteworthy of these was the *Mahonia nervosa* or Oregon-grape, which at once became so popular that plants sold for $20 each. It has often been said the Lewis and Clark expedition was planned in M'Mahon's house in Philadelphia. Hamilton, by the way, employed the seedsman Landreth to grow plants from the seeds that came to him.

Until after the turn of the nineteenth century, fruit and vegetable growing for the market hardly existed. Indeed, in these two fields of horticulture there was little change in methods, varieties, and marketing from those of the colonial period. The newspapers carry market reports in which the coarser vegetables are mentioned and occasionally prices of fresh fruits are listed, but more often dried apples and peaches are noted rather than fresh ones. Cider and brandy are found in nearly every market report. Richmond and Norfolk in Virginia and Charleston in South Carolina were the only towns with more than 5000 population in the South in 1800, so that the markets for fruits and vegetables were small.

Besides, there were few good roads in any part of the South at this time. In Virginia, the Wilderness Road through Cumberland Gap was the only well-traveled road for wagons in the state, and at this time it was crowded with a rush of people to Kentucky and Tennessee.

[6] See pp. 331 ff.



TO BE SOSD, BY

WILLIAM PRINCE,

At FLUSHING-LANDING, 1771

On LONG-ISLAND, near NEW-YORK,

A large Collection of Fruit Trees, as follows,

English Cherries.

MAY DUKES,
Black hearts,
Carnations,
Bleeding hearts,
Ox hearts,
Amber,
Red hearts,
Duke cherry,
Double blossom'd cherry,
Clusters cherry,
Spanish hearts,
Jews hearts,
Harrison's hearts,
Honey cherry,
Kentish cherry,
Morello cherry,
Morello cherry.

Plumbs.

Green gage plumb,
Yellow gage do. as large as an hen's egg,
White Imperial do.
Orleans do. very large and fine,
Damascene do.
Red nutmeg do.
Cadwallader plumb,
Cherry plumb,
Bonum magna do.
Large green plumb,
White Imperial do.
Duke D'Orle do.
Perdi do.
Apricot do.
White damascene do.
Large red damascene do.
White nutmeg do.
Red gage do.
Wheeler do.
Jews hearts do.
Damascene de tours do.
Frankendorf do.
Damask violet do.
Red nutmeg do.
White gage do.
Large violet do.
Yellow do.
Clyster do.
White damson do.
Large red damson do.
Large Mahogany do.
Early French damson do.
Red damson nutmeg do.

Apricots.

Large early apricot,
Large French Roman do.
Orange do.
Alkermes do.
Black do.
Algier do.
Moorish do.
Turkey do.
Small fruit do.

Nectarines.

Palmer's early nectarine,
Large green clingstone do.
Yellow do.
Red Roman do.
Yellow Roman do.
Murry do.
Temple's do.
Violet or bloodnut do.
Elruge violet do.
Newington do.
Green do.
Romane do.

Peaches.

The freestone morning peach,
The green morning or early ann, ripe in July,
The rare ripe peach,
Old newington do.
New newington do.
Large early clingstone do.
Large early do.
Large red clingstone, weighs from 11 to 15 oz.
Yellow clingstone call'd the Carolina Cornish, weighs a pound,
Four large French peach call'd monstrous,
Fine red clingstone, equal to a great apple for gardenfull,
English Roman peach,
Large violent do. weighs from 10 to 15 oz.
Large yellow clingstone, weighs 10 or 11 oz. ripe Octo. 15th,
Large white clingstone, weighs 14 oz.
Large freestone clingstone,
English double rich peach,
Large sweet clingstone do.
Large yellow nutmegstone do.
Large yellow white clingstone do.
Large white flesh do.
White sweet clingstone do.
Blood peach,
Carolina clingstone do.
Washington do.
Bandaine yellow clingstone do.
Rhenish peach,
Yellow nutmegstone do.
Red cheek nutmegstone do.

Pears.

Bergamot pear,
Colmar do.
Virgalieu do.
July do.
Musket Jean do.
Town violet do.
French Primate do.
Winter Jean cornice do.
Robet bergamot do.
Amber do.
Chrismomelle do.
Ruffelet do.
Early Ingot do.
Butter tart do.
Winter bonum do.
Beurre de roy do.
Green chifel do.
Bergamot royal do.
Colmar do.
Crafan do.
Spanish bon crotian do.
Large bell pear,
Citron de carme do.
Summer bergamot do.
Autumn bergamot do.
Autumnelle do.
Lent St. Germain do.
Bloom do.
Templet do.
Robet or bergamot do.
Virgalieu violet do.
Newington do.
Crasan do.
Bonnum do.

Plumbs.

The freestone morning peach,
The green morning or early ann, ripe in July,
The rare ripe peach,
Old newington do.
New newington do.
Large early clingstone do.
Large early do.
Large red clingstone, weighs from 11 to 15 oz.
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Green chifel do.
Bergamot royal do.
Colmar do.
Crafan do.
Spanish bon crotian do.
Large bell pear,
Citron de carme do.
Summer bergamot do.
Autumn bergamot do.
Autumnelle do.
Lent St. Germain do.
Bonnum bergamot do.
Winter bergamot do.
Jargonelle do.
Rambler do.
Chaffemberg do.
Green cushion do.
La Chaffere do.
Monsieur's bergamot do.
Dodor Uvedale's St. Germain do.
Large summer do. weighs near two pounds,
Pear warden,
Kingsale pear,
Large damask bolong do.
The black pear of Worcester or Portugal's warden,
The Scotch do.

Apples.

Nonsuch pippin,
Kings Spanenburg,
Pear mains,
Vandevals,
Large pippins, weighs a pound or more,
Large red and green fream apple, ripe at midsummer, weighs a pound or more,
Large early apple, two or three weeks earlier than other jennetting or best apple,
English codlin,
Early bore apple,
Early pennange,
Red Streaks,
Newtown Spitzenburgh,
Jersey greens,
Golden pippins,
Golden russetin,
Rollerings,
Lady apple,
Longstreet,
Lukington,
Rhode Island greenings,
Sweet apple,
Large white fanning,
Bell flowers,
White pippins.

Mulberries.

Large black English,
Black Antigoua mulberry.

Fig Trees.

Currants.

Large red currants, 9/6 each,
Large black do. 9/6
Large white do. 9/6

Quince Trees.

Madeira Nut Trees, 1/6

Black Walnut Trees, 1/0

Grapes, 9/6 each Vine.

Goose-berries.

Great amber goose-berry, 9/6
Large yellow oval do. 9/6
Green goose-berry, 9/6

Raiberries.

White raiberry,
English red raiberry, 9/6
American do. 9/6

Strawberries.

Large hautboys strawberries,
The alpine do.
The ratheroak do.
The hautboy and alpine strawberry roots 3/6 per dozen,
The wood strawberry 9/6 per do.

Ever-green Trees and Shrubs.

Red Virginia cedar, 9/6 each.
Weymouth's pine, 9/6
Pitch pine, 9/6
Jersey pine, 9/6
Black spruce fir, 9/6
Red spruce fir, 9/6
Hemlock spruce fir, 9/6
Large silver fir, 9/6
Silver leav'd holly, 9/6
Common holly, 9/6
Virginia holly, 9/6

Timber Trees and flowering Shrubs.

American white oak, 9/ each.
American black oak, 9/
Scrubby white oak, 9/
Scarlet oak, 9/
Ballard black oak, 9/
Black oak of the mountain, 9/
Swamp chestnut oak, 9/
American chestnut oak, 9/
American white thorn, 9/6
Scarlet maple, 9/
Common maple, 9/
Sugar maple, 9/
Common ash, 9/
Water ash, 9/
Black ash, 9/
Sweet chestnut, 9/6
Bear chestnut, 9/6
Cork, 9/6
Broad leav'd dog wood, 9/6
White dog wood, 9/6
Magnolia, 9/6
Tulip tree, 9/6
Swamp bull tree, 9/6
Ballard sumerous tree, 9/6
Locust tree, 9/6
Roman tree of Virginia, 9/6
Sweet bay, 9/6
Blue lilac, 9/6
White lilac, 9/6
Syringa, 9/6
Missisipy American lilac tree, 9/6
Carolina berry myrtle, 9/6
Poplar, 9/6
Hungarian tree, 1/6
Sugar birch, 9/6
Black birch, 9/6
Sallafras, 9/6
American elder, 9/6
Carolina bird cherry, 9/6
Dwarf elder, 9/6
Filberts, 1/6.

Any perfon inclining to purchafe any of the above mentioned trees, there is many thoufands of a proper fize; if any of the above trees fhould be wanted to fend over fea, the purchafer may depend upon being there fafely put up in either mats, cafk, or boxes, with earth, without any other cafk except the firft cafk of the trees, cafk or boxes.

The price of the fruit trees is 9/6 each, except the fig trees 3/. the mazzaline cherry 5/. the morello cherry 5/. quince trees 5/.

Any perfon having a mind for any of the above trees, and chufes to have them fent to New-York, they can have them fent on Tuefday and Friday of every week, as there is a fmall boat conftantly goes from Flufhing to New-York on thofe days, and may commonly be found at Boring's Slip, (John Vanx, maiter.) If any perfon fhould want to find their orders for trees, and the boat fhould not be there, they are defired to leave them with Mr. William Field, merchant, at the head of Boring's Slip, in New-York. If any of the fpoil of the above-mention trees, ever-green fhrubs, or flower trees, fhould be wanted, the perfon may be fupplied by applying to faid William Prince.

NEW-YORK: Printed by H. GAINE, in HANOVER-SQUARE.

IV. The first catalogue of fruits published in America.

surcharge of electric fluid.' It could be controlled, it was thought, by hanging in the trees old horseshoes, hoops of iron, pieces of wire, or any metal that would conduct the 'floating electric current' from the trees. In 1837 the Pennsylvania Horticultural Society offered a prize of $500 for an effective remedy for pear blight. The offer brought many panaceas, samples of which are: soaking the ground with soapsuds; hanging iron in the trees; wrapping the branches with rags soaked in brimstone; driving nails in the trunk to give the trees an iron tonic; and 'physicking' the trees with calomel inserted beneath the bark. The award was not made, which speaks well for the intelligence of the society.

Peach yellows began to be troublesome late in the eighteenth century, and peach growers attributed it to an infection in the air. This is one orchard disease that growers then knew almost as much about, and controlled almost as well, as they do now, although its contagious nature was not known so well. The remedy—in 1800 as today—is to destroy the diseased trees as soon as the foliage begins to turn yellow.

Little could be done to control injurious insects until entomologists had studied their life histories and classified them. Not much was achieved in this field until after the Civil War, and spraying for insects and plant diseases has been practiced only during the lifetimes of many men now living. However, early fruit growers and gardeners were not so badly off in the matter of pests, since many of the most troublesome diseases and insects are of comparatively recent introduction. Moreover, faulty fruits made as good cider and brandy as perfect ones.

Nothing was known about the need of cross-pollination for fruits, although a good deal was said in the early publications about 'sterile trees.' 'Excessive growth of wood' was the cause commonly assigned to sterility. Why corn, cucurbits, flowers, and fruits 'mixed' was not well understood even as late as a hundred years ago, and many people doubted the existence of 'perfect' and 'imperfect' flowers in strawberries.

Common springtime visitors in all northern orchards were the itinerant tree grafters, who went from orchard to orchard grafting apples and pears, usually seedlings, often substituting grafts from unknown trees for named varieties. The matter of varieties, however, was of small importance, since most of the fruit grown was used for fermented or distilled drinks. An apple in a colonial orchard, and long after, was but an 'apple'; a pear, a 'pear'; a peach, a 'peach'; to most who planted orchards—a variety name meant nothing. As late as 1843, Patrick Barry, noted pomologist, wrote of the nursery business: 'It is hard to make a start because of the itinerant grafters who make it a business to peddle cions around the country.'

Yet as we have seen there were many European gardeners in America who knew how to bud and graft—the art was described by writers long before the time of Christ. As early as 1736, Peter Collinson was telling John Bartram to 'graft plums and nectarines on peach stocks.' [5] The matter had been under discussion before, for Collinson urges: 'Pray try; I have great opinion of its succeeding.' Ten years later, he writes impatiently: 'Though thou canst not see, yet I have told thee what inoculating a peach stock may do.' [6]

After the Revolution, budding and grafting became much more common. The Princes were the first nurserymen to advertise budded and grafted trees. In their catalogue for 1771 they offer 29 kinds of peaches, most of which appear to be types grown as seedlings rather than varieties. In 1791 they list 35 sorts, with the statement that 'all are inoculated.' John Kenrick, a nurseryman at Newton, Massachusetts, began business in 1790 by planting a quantity of peach pits, the trees from which he sold without budding. Four years later he had learned to bud and began to make a specialty of budded peach trees.

The practice during the colonial period of growing apples from seed had some advantages; in apple-growing states, thousands of seedlings were passed through the sieve of selection, and America by 1800 began to have a long list of good apples. At the opening of the nineteenth century, out of a hundred-odd varieties offered by nurseries, nearly all were of American origin, not a few of which are grown today. Among these one thinks at once of Baldwin, Ben Davis, Early Harvest, Esopus, Spitzenburg, Fall Pippin, Fameuse, Green Newton, Jonathan, Lady, Maiden Blush, Pomme Grise, Rhode Island Greening, Ribston Pippin,

[5] Darlington, p. 81.

[6] Ibid. p. 177.

Roxbury Russet, Swaar, Sweet Bough, Tompkin King, Wagener, Williams, Winesap, Yellow Bellflower, and York Imperial; of these 22, 19 are of American origin. Of the three European sorts, Lady and Pomme Grise came from France; Ribston Pippin from England.

In the century and a half since the colonial period ended, perhaps as many as 2000 varieties of apples have originated on this continent and at least 100 have been brought over from Europe; yet 10 of the 20 varieties originating by accident in the colonies are still standard commercial varieties, and the other 10 would stand in any collection of choice apples.

The pear did not reach so high estate as the apple in colonial America, and one somehow feels that a great opportunity was missed. French missionaries early planted pear seeds from Nova Scotia up the St. Lawrence to the Great Lakes; along the shores of Ontario and Erie to Detroit; and about the French trading posts in Ohio, Indiana, and Illinois, from which some of the oldest, largest, and most productive pear trees the world has ever known were grown. Moreover, the trees, some of which the author has seen, were free from blight and bore handsome pears of very good quality. Out of the thousands of these old French trees, no named variety arose, and probably all are now lost to cultivation.

Perhaps the reason for the neglect of these French pears was that they were superseded, none having been recognized by fruit growers as especially meritorious, by the very good new varieties introduced from Belgium and France in the first half of the nineteenth century. In *The Pears of New York*,[7] 2,929 varieties of pears are described, of which more than half have been grown in America. Of this number, only the 4 following sorts were under cultivation in 1800: Bartlett, Seckel, Tyson, and White Doyenne. Of the four, Seckel and Tyson originated in America. Bartlett and Seckel are still the most commonly planted pears on this continent. Had seedling pears been grown as commonly as seedling apples, we should have had more American varieties.

The quince, another pome fruit, was relatively more commonly planted in the colonies than the apple and pear. As far as can be

[7] Hedrick, *T[illegible]rs of New York.*

made out, the Orange Quince, which comes nearly true to seed and is therefore a group rather than a varietal name, was the only type of the quince known in America until the nineteenth century. This variety is now about the only one planted, and even so, unfortunately, the quince can hardly be found in modern American orchards. Quinces, then as now, were commonly grown from layers and suckers, with few seedlings from which new varieties might originate.

In no other part of the world, as has been said, does the peach grow and bear as well as in favored parts of North America. Wherever grown in the colonies, the peach came from seeds and there were few or no varieties. There seem to have been two very distinct types, and only two, in colonial America, whereas there are now at least six very different groups. The two were the small, woolly, round, streaked, or reddish Indian peach, poor in quality; and the large Melocoton of which the well-known Crawfords, best of all peaches in quality, are the type.

In the author's *Peaches of New York*,[8] 2181 varieties of peaches are described. Unlike any other fruit, almost none of the varieties grown now or in the colonies came from Europe, and only four of this vast number can have been known by old men of this generation; nearly all the others have originated since 1860. Heath Cling, Oldmixon Cling, Red Cheek Melocoton, and Yellow Rareripe are the four varieties, largely grown a hundred years ago, which might have been found in collections as late as 1900. It is doubtful if any could now be found. All originated in America. Unlike the apple, the peach profited little in the way of new varieties from the millions of seedling trees grown in the colonies.

At one time or another about several hundred varieties of plums have come under the eye of the author.[9] These varieties are of 15 species and sub-species, giving probably a greater diversity of fruits in size, color, taste, aroma, and texture than any other hardy tree fruit. Yet before 1800, only 2 species and some 10 or 12 varieties of plums were grown in North America that could by any chance now be found in our orchards. These are Black Bullace, a damson; German Prune, which goes back to the Crusades and is one of the oldest fruits known; Hand, grown

[8] Hedrick, *The Peaches of New York.*
[9] Hedrick, *The Plums of New York.*

by General Hand in Lancaster, Pennsylvania, in 1790; Hungarian, an old prune from Hungary; Imperial Gage, grown by the Princes in 1790; Italian Prune, from Italy; Peach, a European plum; Reine Claude, an old French variety; Shropshire, a damson from England in the seventeenth century, and one of the first plums to be brought to America; Washington, grown in 1790 from the same lot of seeds as Imperial Gage; and Yellow Egg, an old European variety still grown commercially. The plum profited little or not at all by being grown as a seedling fruit, of which, in comparison with the apple and peach, there were few trees.

In modern America, the apricot is grown only on the Pacific Coast, California having about five million trees. California furnishes America with practically all of its fresh apricots, and has a monopoly on the canned and dried products for the whole world. In the Atlantic States the apricot is now found only occasionally in some favored spot, though the tree is as hardy as that of the peach, and might, at least, be grown as an ornamental, for few trees are handsomer either in leaf or flower. It cannot be grown in the East commercially, chiefly because the varieties now known bloom so early that frost nearly every year destroys the crop. Yet the apricot seems to have been grown in colonial America wherever peaches were planted. Perhaps late frosts were less frequent in the more wooded country in these earlier years. The varieties mentioned by early gardeners, all of which came from Europe and can still be obtained, are Moorpack, Peach, and Royal.

So, too, the nectarine, now almost exclusively a Pacific Coast fruit, although of minor importance because the fruits have skins so delicate that they cannot be safely shipped, is little grown. There are occasional references to nectarines in notices of colonial gardens and in the advertisements of early nurserymen. The nectarine is a fuzzless peach, not more different in other respects than are groups of peaches among themselves. Were it not for the thin skin and the curculio, and had there been more work in breeding varieties, the nectarine would possibly have been as largely grown in America as the peach, for it is better liked. It is probable that the curculio was not so common in colonial orchards. Early Newington, Elruge, and Pitmaston Orange are

the three varieties that were offered by colonial nurserymen. All came from Europe.

Unlike the apple and the peach, and like the pear, the cherry is distinctively a European fruit in the origin of varieties. The author describes in *The Cherries of New York* [10] 1145 varieties of cherries, of which at least three-fourths came from Europe. Some of the kinds now grown are among the oldest of all hardy fruits, many of them having been brought to North America by the earliest European settlers. Black Heart was, according to Prince in 1832, more widely known than any other cherry in the country; Black Tartarian, still common in every sweet cherry orchard in the country, was brought to this country at the close of the eighteenth century; Carnation, first mentioned by Rea in 1676, was early brought to America; Early Richmond, the second most popular sour cherry in America, was brought to the lower St. Lawrence region as 'French,' and to Virginia before 1700, where it received its American name, its original English name being 'Kentish'; Late Kentish is the sour pie-cherry of early New England, propagated from seeds or sprouts; May Duke, a corruption of Medoc, was said by William Prince in 1832 to be 'among the first of the cherries introduced to America from Europe'; Montmorency, a group name for several cherries as a type, has been cultivated in France for several centuries and was early brought to Canada and New England; and Yellow Spanish, the Bigarreau of the French, goes back at least to the first century of the Christian Era; it was brought to America soon after the Revolution. Not one of these, nor of any other named cherry, originated in the American colonies.

New Jersey cider continued to be the best America produced, as it had been in the colonial period. William Coxe, the pomologist, reported that in 1810 Essex County produced 198,000 barrels of cider and 307,310 gallons of cider spirits (applejack or apple brandy, it would be called now). Woodward reports that in 1812 one citizen 'made 200 barrels of cider daily, the products of six mills and twenty-three presses.' [11] According to the same

[10] Hedrick, *The Cherries of New York*.
[11] Woodward, p. 21.

authority the pomace was spread on the fields as a fertilizer. Cider and brandy making continued as leading horticultural products until the great temperance movement of the 1830's ruined the business, although, according to Woodward, as late as 1834, there were 388 cider distilleries in New Jersey.

To find out what fruits were being grown in the northern states in this period, what varieties of each, and who the nurserymen were, we must rely almost wholly on the newspapers of the day. There were no agricultural papers or books, and few writers of the time had much to say about horticulture. Happily, the newspapers, in Baltimore and Philadelphia especially, carried advertisements of several nurserymen, which give us some information. Possibly a search through the files of papers in smaller cities might give further information.

A rather wide range of nursery plants is offered in an advertisement in the *Maryland Journal and Baltimore Advertiser,* 1 August 1786. It should be noticed that the advertiser distinguishes European strawberries under the name 'Hautboys' from 'Strawberry Plants of different Kinds.' Just what the 'different Kinds' were would be hard to say. The advertisement reads:

> At Timonium, excellent Clover, Timothy and wild Grass Meadow-Pasturage, for Horses and Cattle, at the moderate Price of Seven Shillings and Six Pence each per Month. . .
>
> Likewise, all Kinds of Stocks for Grafting and inoculating, consisting of Apples, Pears, Quinces, Cherries, Plums, Damson's, wild Grapes, Rasberries, Gooseberries, Currants, Hautboys, and Strawberry Plants of different Kinds—Golden and Weeping Ozier, and Filbert Trees—a few bulbous Roots, warranted good of their Kind. Orders left at Mr. Armstrong's in South-Street, will be received and punctually attended to.

Probably none of the nine apples offered in the *Maryland Journal and Baltimore Advertiser* of 28 October 1788 could now be found in any nursery, but trees of six of them might be found in an occasional old orchard. Many older orchardists will remember House, and Hoop (synonym of Honey Sweet), Romanite, Rambo, Newtown Pippin, Spitzenburg, and Redstreak:

> For Sale, and now fit to be planted out in Orchards a Variety of grafted Apple-Trees, viz House-Apples, Hoop's, Romanites, Ramboes, English Russetens, Newton Pippins, Spitzenbergs, Redstreaks, and early Codlings. Orders sent in Two Weeks from this Date, mentioning the different Sorts and numbers of each, will be forwarded to the Nursery-man who will bring the Trees in all next month. The Price for those sent to Baltimore-Town, or any other Part of the country, is Ten-Pence a Piece, to be paid on Delivery.
>
> William Russell.

Philip Walten seems to have been the leading nurseryman and florist in Baltimore in the post-Revolutionary period. His advertisements appear in three of the several Baltimore papers published in the 1780's and 1790's. The following list of fruits probably includes about all that could be purchased from American nurserymen at the close of the eighteenth century. The advertisement appears in the *Maryland Gazette and Baltimore General Advertiser* of 7 November 1788:

> To Be Sold, by the Subscriber.
>
> A Quantity of Grafted and Inoculated Fruit Trees: Among which are the following kinds, viz.
>
> Apple-Trees—Price 1 s. each
>
> Newtown pipins
> Golden Ditto
> Orange Ditto
> Long Ditto
> English Redstreaks
> Black Ditto
> Priest Apple
> English Codlin
> English White Apple
> Bell Catlin
> Summer Pearmain
> Cathead Apple
> Robeson Apple
>
> Pears—Price 3 s.
>
> Summer Bergamot
> French Orange Ditto
> Ball Pear
> English Summer pound Ditto
> Green Chisel Ditto
>
> Cherries—Price 3 s.
>
> May-Duke
> Arch-Duke
> Carnation
> White Heart
> Ox Heart
> Bleeding Heart
> Kentish Cherry
> Spanish Heart
> French Cherry &c.
>
> Peaches—Price 1 s. 3 d.
>
> Old Newington
> New Newington

Peaches—Price 1 s. 3 d. (Cont.)
White Blossom
Early Purple
Scarlet Nutmeg
White Ditto
Green Ditto
Musketong Peach
Red Pine-apple
Green Catherine
October Peach
Rare Ripe Ditto, &c.
Dean or Heath Peach

Roman Apricots—Price 2 s.
Winter Clingstone
White Newington

Plumbs—Price 3 s.
Yellow Bonum Magnum
Green Gage
Prune Monsieur, &c.

Nectarines—Price 2 s.
Red Roman
Yellow Ditto

The above named trees are a small distance from town, and will be shewn to any person inclining to purchase, by applying to the subscriber, living in Sharp-street, near the Market-house, Howard's-hill. If any person should be wanting to send any of the Trees above mentioned, a great distance, great care will be taken to put them up so as to take no damage.

Philip Walten.

Another of Walten's advertisements appears two years later in the *Maryland Gazette,* 30 November 1790, in which an assortment of ornamentals and several other fruits are offered:

To be Sold, By the Subscriber

A number of enoculated and grafted Fruit-Trees, and others, Apples, Pear, Plumbs, Cherries, Peaches, Apricots, Nectarines, English Walnuts, of the best kind, Gooseberries, Currants, White Muscat Grape Vines, Monthly Roses, Honey Suckles, Catalpa flower Tree, Weeping Willow, Sena Tree, Bitter Almonds, White and Red Althea Fruit, Purple Ditto.

Philip Walten.

Evidently most of the trees offered south of New York were named varieties. In New England and New York seedlings predominated until 40 years later.

An early collector of fruit trees, a benefactor of pomology in his day, was a Mr. Gough, who offers his surplus trees to fellow fruit growers at 'Nine Pence a Tree.' His advertisement appears in the *Maryland Journal and Baltimore Advertiser,* 30 March 1790:

About Two Thousand Apple-Trees for Sale.

As Mr. Gough has transplanted as many Apple Trees from his Nursery at Perry-Hall, as he would wish, the Remainder will be disposed of, promiscuously, at Nine Pence a Tree.—Among them are some grafted and innoculated, so that it is possible a Purchaser may get a curious variety of good Fruit, that Mr. Gough has been carefully collecting, these Fifteen Years, from France, Philadelphia, and New York. As several large Orchards have been planted at Perry-Hall, from the Nursery, the Trees, now for SAle are, in general, not handsome. . . They are already divided into Bundles, containing Twenty-five each, and will be sold in that Situation. The money to be sent by the Persons who take the Trees away. Application to be made to John Norwood, at Perry-Hall.

A nursery in New Castle County, Delaware, was doing an interstate business in 1791. The stock was being grown in Delaware, but was advertised for sale in the *Maryland Gazette,* 18 September 1791. Some of the varieties listed were grown down to the end of the nineteenth century and 8 or 10 of the apples could be found in any one of the northern states today:

Fruit Trees

James Dixon, at his Nursery, in Mill Creek Hundred, New Castle County, Delaware, fourteen miles from Elkton, fifteen from New Castle, seven from Newport, and eight from Wilmington, Has for Sale, a large and general collection of Choice Grafted Trees, of early and late Fruits, now fit to Transplant, viz.

Among which are,

Apples and Pears
New-Town Pippin
Long Pippin
Cart-house Apple
Pennock
English Redstreaks
House Apple
Rambos
English Russet
Vandever
Priestly Apple
American Pippin
Winter-Queen
Gregg Apple
Late Blossom
Yellow Vandever
Sweet-Pine
Pound Apple
Green Roman Right
Virginia Crab
White Vandever
Black Vandever
Summer Queen
English Codlin
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APPENDIX A: REFERENCES

Sources of information on early orchards and varieties. Additional information is contained in the orchard management plan(*) and in this appendix for those markedwith an (+).

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Waugh, F.A. *The American Apple Orchard,* New York: Orange Judd Company. 1908. Contains information on distances for planting, cover crops, pruning techniques and harvesting methods.

F.C. Sears' *Apple Orcharding*:

- Chapter One - "Establishing an Apple Orchard"

  Tree spacing should not be less than 40 feet apart.

G.W. Johnson's *The Apple; its culture, uses, and history*:

- p. 36 "If [an apple orchard is] to be grazed, it is expensive and difficult to keep the trees protected from the cattle."
- Spacing of orchard trees is highly varied. Although spacing may be as little as 16 or 20 feet, the recommended distance is 15 yards (45 feet).
- "Culture as a Cider Fruit" includes information on cider production.

A.J. Downing's *The Fruit and Fruit Trees of America*:

- Information is provided on soil preferences, propagation, preparing, planting, cultivation, and the best uses for different varieties of apples.
- The origins of the apple varieties are outlined. (Baldwin and Roxbury Russet's origins are in Massachusettes.)
- Apples belong in an orchard except for a few choice varieties.
- p. 62 Spacing of apple trees should be 30 feet to devote the ground to the trees. However, if grass or grains are desired to grow in the understory a 50 - foot spacing appropriate. On average spacing distance is 45 feet.
- p. 69 Cider: apples are shaken from trees around November first by placing straw or hay under the trees to prevent bruising. In good weather the apples are stacked outside or in poor weather they are moved to airy ripening sheds.

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FINAL REPORT

INVENTORY AND CONSERVATION OF GENETIC RESOURCES IN THE FORM OF HISTORICALLY SIGNIFICANT FRUIT AND NUT TREES IN THE NATIONAL PARK SYSTEM

DECEMBER, 1992

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THIS PROJECT WAS CONDUCTED UNDER A COOPERATIVE AGREEMENT BETWEEN THE UNIVERSITY OF MASSACHUSETTS, AMHERST, AND THE UNITED STATES DEPARTMENT OF THE INTERIOR, NATIONAL PARK SERVICE

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            b. INDIANA DUNES NATIONAL LAKESHORE
            c. ISLE ROYALE NP
            d. SLEEPING BEAR DUNES NL

e. SAINT CROIX NSR
f. EFFIGY MOUNDS NM
vi. ROCKY MOUNTAIN REGION
a. ZION NP
vii. SOUTHWEST REGION
a. FORT DAVIS NHS
b. CARLSBAD CAVERNS NP
c. GUADALUPE MOUNTAINS NP
d. BANDELIER NM
e. LYNDON B. JOHNSON NHP
f. CANYON DE CHELLY NM
g. HUBBELL TRADING POST NHS
viii. WESTERN REGION
a. CHIRACAHUA NM
ix. PACIFIC NORTHWEST REGION
a. OLYMPIC NP
b. SAN JUAN ISLAND NHP
c. NORTH CASCADES NP
d. COULEE DAM NRA
e. NEZ PERCE NHP
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I. EXECUTIVE SUMMARY

A survey instrument was designed and administered to 341 NPS sites in order to indentify those containing historic fruit or nut plantings. Survey results revealed a much larger number of historic orchards than had been anticipated. The culture of tree fruits and nuts is a common factor to sites as diverse culturally as Canyon de Chelly NM, Booker T. Washington NHS, and St. Gaudens NHS. Some areas, such as the Great Smokey Mountains National Park and Shenandoah National Park, contain many abandoned home sites, some with hundreds of trees.

Data from the survey were confirmed from 337 units, with 210 responding negatively, and 127 positively. Historic plantings were identified in each of the NPS regions, with the Southeast having the largest number (22), and the National Capitol having the fewest (7). Virtually every temperate, and several tropical or semi tropical, cultivated fruit or nut were reported in the NPS system, including: apple, apricot, avocado, cherry, coconut, fig, grapefruit, lime, olive, orange, noni, paw paw, peach, pear, pecan, persimmon, pomegranate, and walnut. At the project outset, most sites had little or no information on the varieties, ages, and in some cases, the locations of existing trees. Although not all positive sites reported original trees, site dates ranged from as early as 1752 (Wick Farm Orchard at Morristown NHP) to as recent as 1963 (Lyndon B Johnson NHS), and span the complete period during which fruit trees were introduced and spread throughout the North American Continent.

The survey indicated that many sites had not conducted a complete tree inventory, or were not sure which varieties were present or if trees dated to the historic period for the site. Site management of trees also varied widely, from active removal of trees, to no management, to commercial operation or lease.

The survey also demonstrated the urgency of this research, since some unidentified fruit and nut trees had already been lost, and some were currently threatened. In many sites, maturing second growth forest had overgrown old, abandoned orchards and homesite trees. In other areas, park practices, such as using old orchards as sites for parking lots or other park facilities, had resulted in removal of unidentified trees. Finally, many trees were dying due simply to old age, accelerated by disease and other pest infestations in unmanaged orchards.

In general, fruit trees in the NPS system receive little or no maintenance, the exceptions being sites such as Adams NHS, Morristown NHP, Oxon Hill Farm, and Fort Vancouver, where trees are an important component of site interpretation. As a consequence of low maintenance, condition of trees in the majority of sites visited is poor to fair. Commonly seen pests attacking the tree are: Vertebrates, wood rotting fungi, apple scab, black rot, cedar apple rust, internal borers, white apple leafhopper, apple leafminers, and aphids. Commonly seen pests attacking fruit were: apple scab, codling moth, apple maggot, leafrollers, fruitworms and plum curculio.

A total of 139 sites in 44 parks were visited by investigators during the conduct of the study. As of this report, we have classified 33.8% of these sites as Historic, 13.7% as Cultural, and 52.5% as Other. Budget and time limitations made it impossible to visit a significant number

of parks reporting historic fruit and nut trees on the original survey. Based on site documents we have obtained, a number of sites not visited clearly have trees which date to the primary period. An example is olive grove remnants dating from the plantation period at Dungeness, Cumberland Island National Seashore (Zeichner, 1988).

Other sites which submitted positive replies whose status has not yet been confirmed by site visits include: Biscayne NP (only lime grove in the NPS system); Fort Frederica (fruits and nuts of unkown cultivar and age); Canaveral NS (Oranges, grapefruit of unknown cultivar and age); Pea Ridge NMP (large potentially historic pecan); Glacier NP (remnant orchards at a number of sites); Grand Canyon NP (remnant fruit trees at historic ranch in canyon); Hawaii volcanoes NP (6 pre-1940's apples); Eugene O'Neill NHS (historic orchard, oranges, limes, almonds); and Great Basin NP (historic orchard remnants), to name a few. In addition, sites such as great Smokey Mountains (Remnant orchards, Cherokee orchards, 'Shockley' apple), which was not visited, and Shenandoah NP, only part of which was inventoried, require additional effort to completely identify tress with genetic or historic significance.

In most cases, attempts to quantify tree age by collecting increment cores from NPS trees was not possible; the largest, presumably the oldest, trees typically yielded very small intact cores. Due to twisting and breaking of some cores, and presence of dry rot in others, many readings could not be considered reliable.

Based on dendrochronometer readings of tree cores, the oldest confirmed trees in the NPS system were the 23" caliper pear (115 years), and a second pear (83 years) at San Juan Island, Hoffmeister site. The age of the larger tree puts it and several other comparable trees at the same location within the primary period for the park. The surviving pear at Hampton NHS was also estimated as 83 years old, although the specimen was noted as being of "very poor" quality, with "low reliability because of extensive breakage and twisting." Hence, its age could be substantially greater than determined by the dendrochromometer reading.

Based on their large caliper, the potentially oldest trees identified to date on NPS land are in Delaware Water Gap NRA, on the Roberts Farm site in New Jersey. The largest tree at this site is in excess of 40 inch caliper, and could approach 200 years of age. Several other large trees can also be found at Roberts Farm, and other comparably large specimens have been located and measured in the Minisink District of DEWA. The Noah Brooks Tavern and the Hartwell Tavern in Minuteman NHS also had relatively large trees, up to 30.25" caliper, which could not be cored due to internal rot. I estimate that these trees date at least to the early to mid 19th century.

The positive identification to cultivar of fruit trees in the national park system proved to be a daunting problem for a number of reasons. Principal among these was the lack of fruit, or poor fruit condition due to lack of tree maintenance and/or pest management. In addition, although budding and grafting of fruit trees pre-date settlement of North America, many NPS trees are likely to be reproductively produced "own-rooted" seedlings.

Nonetheless, with the assistance of experts at the New York Agricultural Experiement

Station, Geneva, NY, and elsewhere, a number of tentative or conclusive identifications were made of specimens collected from the study. An example is the apple collected from the Ransom site on Isle Royale which, due to its distinctive shape, is likely related to the old cultivar 'Black Gilliflower'. In this case, the apple shape is so distinctive, as to be diagnostic, a relatively unique occurence.

A potentially important contribution to genetic diversity is the location at the Moses Cone Estate in Blue Ridge Parkway NHP of the cultivar 'Gragg'. The successful identification by Dr. Elwood Fisher of an apple which is not in the USDA Clonal Germplasm Repository or in personal collections, was largely possible due to the extensive orchard maps done for the site early in this century.

NPS should continue to make available to interested staff, the educational information needed to pursue improved management strategies, and to carry out enhanced management for significant sites or trees (e.g. Moses Cone Estate, Saint-Gaudens NHS, Hampton NHS, John Day Fossil Beds NM, etc.). NPS staff training in cultural practices relevant to fruit and nut trees, in Integrated Pest Management, and in proper tree pruning and training are critical if existing or newly planted trees are to survive.

NPS administration should consider the establishment of regional sites within the NPS system where unusual (or unknown) fruit or nut specimens could be propagated, screened, and maintained or discarded. Maintaining potentially valuable specimens off site would serve the twin goals of conservation and removal of exotics from wilderness parks, and would consolidate resource management needs at fewer sites.

Known rare cultivars or otherwise unusual germplasm (e.g. Canyon de Chelly peaches, Moses Cone Estate apples, etc.) should be made available to USDA for inclusion in the appropriate repository.

Exclusive of any contribution NPS fruit or nut trees may make to genetic diversity at this time, a strong case can be made for conservation of NPS fruit and nut tree resources due to their cultural or interpretive value. We strongly concur with arguments offerred by others (Melnick, 1984; Firth, 1989) that rural cultural landscapes are an often overlooked factor in evaluating and registering "historic districts" in the National Register, and believe that many of the cultural landscapes we have visited, with their associated fruit and nut trees, are suitable candidates for inclusion in submissions to the National Register. Consequently, we believe that NPS sites should retain all original trees for propagation as replacements where appropriate, or until NPS addresses issues and recommendations made in this report.

NPS should provide special project funds to appropriate sites (e.g. John Day Fossil Beds, Buckner homestead, Bandelier, Zion, etc.) to rehabilitate historic irrigation systems or arrange for other mechanisms to provide adequate water to trees. Funding for nutrient analyses, and required fertilization should also be provided to sites which intend to enhance maintenance of historic or culturally-significant fruit or nut trees.

Prime among the NPS policy issues which should be addressed at the regional or national level is to resolve whether fruit trees are undesirable exotics, or important contributors to site interpretation and/or wildlife. NPS should address this question on a servicewide basis, taking into consideration both natural resource and cultural resource management factors.

From the survey and from site visits, we noted a variety of past and present dispersal practices of potentially rare and/or commercially valuable germplasm. NPS administration should develop a clear servicewide policy regarding collections and propagation of fruit and nut germplasm from national park lands.

The authors believe that fruit and trees are a significant resource in the NPS system, justifying at least one full time position to complete the servicewide inventory, coordinate staff training, plan enhanced amanagement, develop regional repositories, and add to USDA germplasm repositories when approporiate.

Eleven trees were seen, with the largest having a caliper of 16 inches. Some have grown up near buildings. Trees were all overgrown and unsightly and in poor to fair condition, with evident dead wood, and limited terminal growth. None showed signs of a graft union. All showed signs of diseases and insect damage.

Management and Conservation recommendations - All trees are most likely seedlings resulting from either previous landfilling or casual discard of apple cores. Site management plans do not call for maintaining the fruit trees, and certain trees (near the walkways) are considered a hazard because they draw geese who soil the area with their droppings. At certain times of the year, ripening fruit would be expected to draw yellow jackets. Although trees would contribute to wildlife habitat, they have little or no value to genetic diversity or site interpretation. I recommend removing all trees near historic buildings, leaving trees near filled area to remain as is for wildlife benefit.

f. Minuteman NHS

At Minuteman, I have met on several occasions with Dan Datillio, Matt Pool, Larry Gall, Blaise Davi, and others. Much of the park which is now wooded, was cleared and in agriculture at the time of the battle. At that time, there was an orchard at the site of the Hartwell Tavern as well as at a number of other locations. There is a good deal of historic information concerning the use of apples to make cider, and the history of tax changes which led to the abandonment of many of the cider trees.

Noah Brooks Tavern

This site had substantial remnant orchards on both sides of Rt. 2A. The fields in which the trees were growing have been kept mowed, but the area immediately around each tree has not. Hence, each tree stood in a thicket of brush, typically covered with poison ivy, making calipering and coring very difficult.

Immediately east of the tavern was a large tree that calipered 24.5" (at 36"), showing terminal growth of 2-4 inches. Some fruit were present in the top of the tree, with pulm curculio damage visible from the ground. Foliage consisted of large, shiny leaves, showing evidence of leafroller injury. Immediately south of that tree was another with a few fruit and a caliper of 28" (at 36"). The former superintendent, Bob Nash, reports seeing photographs showing this site as an orchard in the 1920's and 1930's, and that it may have been abandoned around WWII due to tax law changes.

Continuing south further into the field, 75-100 yds. from the tavern, we noted an apple tree with a caliper of 30.25" appearing to have a rotten center. All of the trees found in this area (@ 12) were quite large, comparable in size to the last one noted. Most had fruit and all were badly overgrown and showing terminal growth of no more than 8".

Immediately behind the tavern and the barn was a cluster of pear trees, with a few fruit scattered among them. All were in poor overall condition, although foliar quality of some trees was good. Caliper of the first pear was 14"; a second to the east of the first was 18". Trees were very hard to approach because of the poison ivy. This area also had native Crataegus.

Behind the block of pears were many more apple trees with estimated calipers of >24", all on the same overgrown condition noted earlier. Some of these showed severe leaf curling from aphids, and black rot lesions on the leaves. All fruit were about 1-1¼" diameter at the time of the visit. The last apple calipered, behind the Rogers house and near a newly constructed home, was 29".

The trees on the opposite side of the road in the maple woods, were not as big so were not visited. Other trees were seen along Rt. 2A south of the Battle Road Visitors Center, just east of the cranberry bog. All were overgrown and fruit showed plum curculio and sawfly injury. One tree calipered 17". These are clearly younger than the ones at Noah Brooks and most likely date to the 20th Century.

Hartwell Tavern

A site visit was made to the Hartwell Tavern area to look for fruit tree remnants at a site shown on Malcom's map as having been an orchard surrounded by a stone wall. Thick brush made careful examination of the site impossible. One tree of estimated 30"+ caliper was alive, with fruit like 'Duchess of Oldenberg', 'Gravenstein', or 'Ben Davis'. One large blown-down dead apple tree was estimated as caliper 30".

Management and conservation recommendations - All of the larger trees at Noah Brooks are likely in excess of 100 years old, and they could date to the mid 19th century, given their caliper. The single remnant at Hartwell Tavern could be of a similar age or older, given the size of surrounding new growth forest. I recommend that trees at both sites be cleared of brush and surrounding forest and fertilized/limed according to soil and leaf analysis. The tree at Hartwell should be propagated from immediately, if possible. Trees at Noah Brooks should be pruned of dead wood initially, with eventual rejuvenative pruning by trained individuals.

Both sites are suitable for enhanced interpretation of the historical role of orchards at the time of the battle and over time. The Hartwell site would require a larger resource investment in order to rehabilitate as an orchard, but presents the better interpretive opportunity because of the presence of old stone walls, and since the building is open to the public. I would support plans to replant an orchard at Hartwell Tavern.

g. Morristown NHP

The park was one of three initially worked with prior to the onset of the servicewide inventory. Detailed reports on activity at the three sites in 1986 and 1987 are contained in Appendix H. and I. of this report.

Wick Farm

The orchard covered about 8 acres behind the farmhouse. At the time of an initial site visit the site contained about 160 trees, 100 of which were NPS planted and less than 5 years old. Most trees were in poor condition, especially the older ones, some of which could exceed 50 years of age. Only one tree, completely rotten in the center, could be more than 100 years old. Recent managment had been

Written text: In addition to the mapped data, the landscape and the forces that shaped is described in a written report. This data will be used to identify historic character for each of the historic periods and show how the landscape evolved through time.

Next, the existing cultural landscape features are mapped. The data needed for cultural landscape identification are as follows:

Land Use: Open fields and agricultural land use are mapped because they help describe the spatial organization needed to analyze the cultural landscape (McClelland, 1991). Land use data is compiled by Massachusetts Geographic Information Systems (Mass/GIS) through aerial photographs or detailed field surveys by the Massachusetts Natural Heritage Program.

Hydrology: Spatial organization is further defined by mapping wetlands which may either be open (emergent wetlands and wet meadows) or forested (deciduous wetlands, coniferous wetlands, sapling swamp, and shrub swamps).

Vegetation: Forest cover is mapped in order to define spatial organization as well. Categories include: deciduous forest, coniferous forest and mixed deciduous/coniferous forest.

Buildings, Structures and Objects: These important character-defining features are mapped including farmhouses and barns.

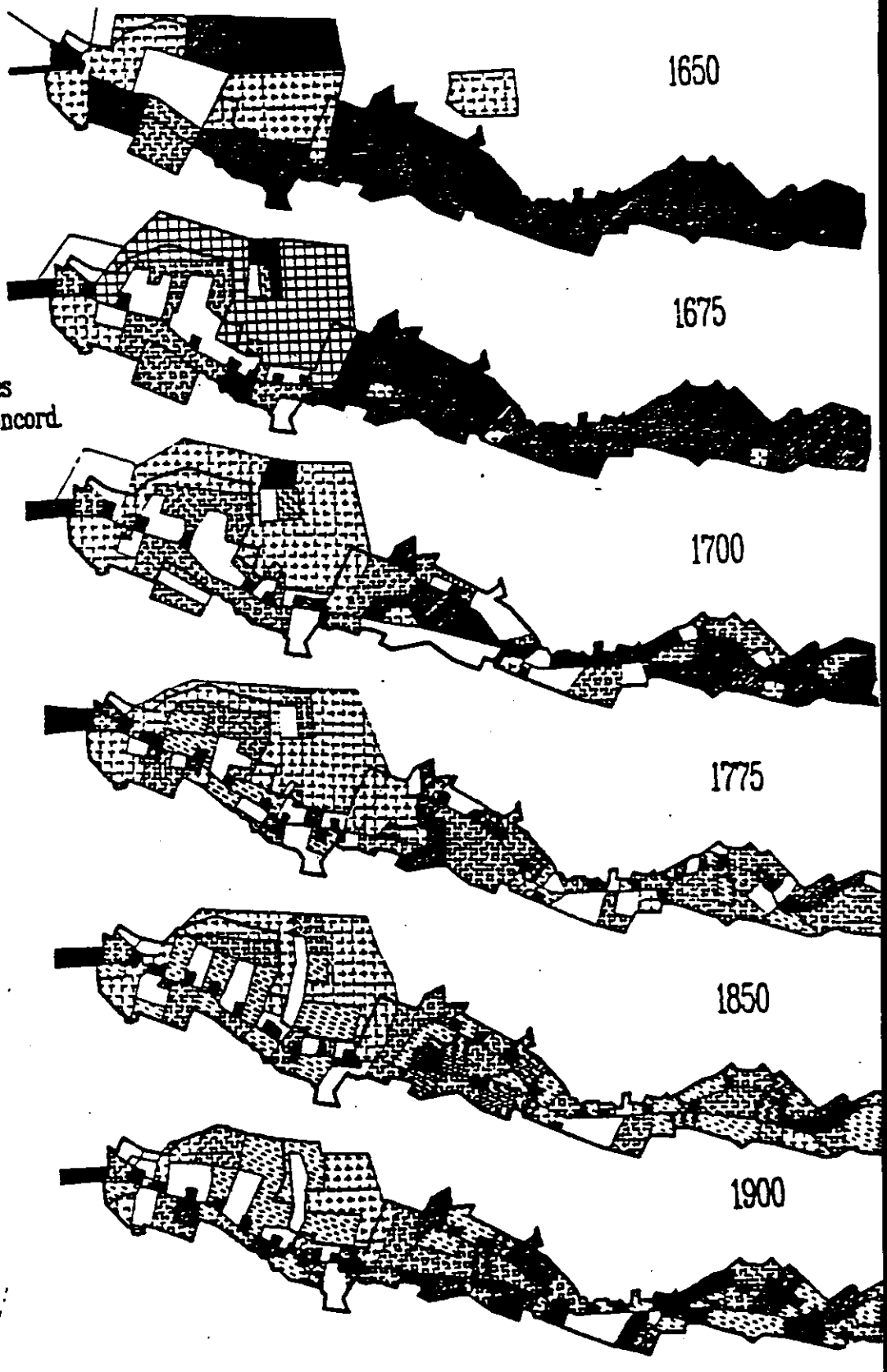
Circulation networks: Paths, roads, streams or canals, highways, railways and waterways are mapped as part of the circulation networks (McClelland, 1991). The data is compiled by Mass/GIS from aerial photographs.

Stone Walls: Stone walls are an important small-scale character-defining feature listed in Bulletin #30 (McClelland, 1991). The data is developed through interpretation of aerial photography as well as field surveys.

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Typical Land Use 1650 - 19(



Note: Maps are conceptual representations of land uses typical for the Town of Concord. They were developed using tax records and deeds.

Figure 27: Typical Land Use Maps: 1650 - 1900 showing the evolution of the agricultural landscape over a 250 year period. These maps also illustrate the dynamic nature of the landscape, especially in terms of forest clearing.

1775:

During the mid-18th century, an integrated system of land use in towns such as Concord and Lexington reached its fullest development. Although farmers did have some connections with Boston markets for commodities such as ship timber, live cattle and barreled beef, overall the agrarian economy was overwhelmingly subsistence oriented. This does not mean that every homestead provided for itself: there was very lively local exchange of goods and services. Many farmers also practiced a trade, and women were involved in economic networks as well, making dairy products, spinning and weaving wool and linen cloth, and practicing as midwives.

Every part of the environment was involved in this system of local production and consumption. Tillage was used to its fullest capacity as farmers grew their own subsistence grains of corn and rye; there would never again be as much land in tillage in these towns as there was in 1775. Cider was the local beverage , and small orchards had proliferated across the landscape. Meadows were fully utilized, and farmers had just begun the process of expanding their hay production by converting some of their drier meadows to higher quality "English hay". Pastures that provided grazing for cattle were the most prominent agricultural feature of the uplands. Cattle tied this agrarian economy together, providing butter, cheese, meat, tallow, hides, locomotion , and manure. There was scope to clear more pasture, but only if more hay could be grown for winter fodder, and only at the expense of forest. Forest was also essential, providing not only fuel, fencing and building timber, but also material for crafts and trades such as staves for cooperage and bark for tanning leather (Donahue, 1992, Appendix C).

1850:

After the Revolutionary war, farmers began to alter their practices in response to the limitations they had encountered in their subsistence system, and to take advantage of increasing commercial opportunities. Among the complex of changes they made over a period of more than half a century was a decrease in subsistence production of grain, and an increase in market production of beef and dairy cattle.

The historic land use data also show that as the landscape was cleared, it was then farmed, and this continuity of land use is an important aspect of the landscape history. These types of agriculture fluctuated somewhat in terms of their percentage of the overall mix as shown in Figure 29, however, through time, there was a general continuity of agricultural land use.

From the landscape descriptions of the five historic periods as well as the identification of aspects of continuity, the following important points are made concerning the appearance of the historic cultural landscape:

- A high proportion of the land (well over 50% at most times) was open and farmed. Forest land was comparatively restricted compared to today. What forest remained was frequently cut.
- A high proportion of this open agricultural land (again wall over 50% at most times) was in grass - either pasture, meadow, or mowing. This grassland was often in a scruffy, rundown condition.
- Livestock, particularly cattle, were economically central and prevalent.
- Apple orchards were common, first for "hard cider" then for desert apples.
- The landscape was intricately divided by lanes, walls, fences and ditches into rather small (typically less than 10 acres), intermixed parcels with different uses; rather than lying in large, uniform blocks.
- Houses and barns tended to be found very close to the road (often on opposite sides), with their farms extending back behind them on both sides, often in several detached parcels interspersed with parcels belonging to neighbors. Other scattered pieces lay up to a mile away (woodlots and meadows especially). Compact, nucleated farms were not as common.[9]

[9] From an unpublished report entitled, Battle Road Historical Research Areas - 11/23/1992 by Brian Donahue. pg. 1.

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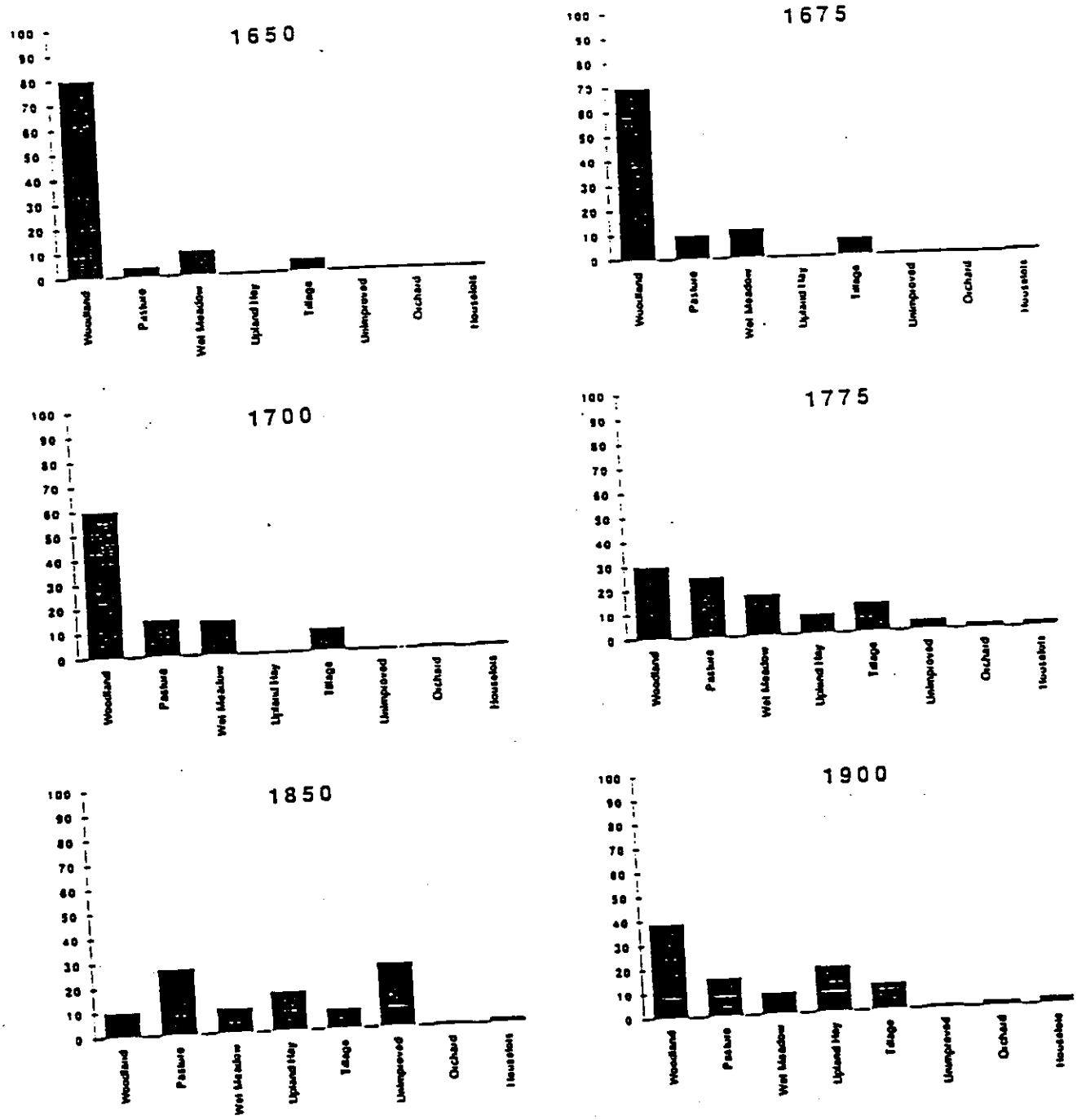


Figure 29: Land Use Categories 1650 - 1900 showing continuity of agricultural land use.

predominantly agricultural. As the
was generally open and field sizes averaged from 2-12 acres. There was continuity through time of the circulation pattern, although the experience from the road became more uniform, with less contrast between the open, agricultural fields and alternating forest. The most important small-scale features were the stone walls which outlined a field pattern or network that changed very little through time. The field pattern was in place by 1675. Therefore historic character in this landscape consists of open, agricultural fields bounded by stone walls or hedgerows. These fields are generally small, between 2 and 12 acres. An important point in analyzing the historic character (based on available data) is that there is a great deal of continuity in its appearance.

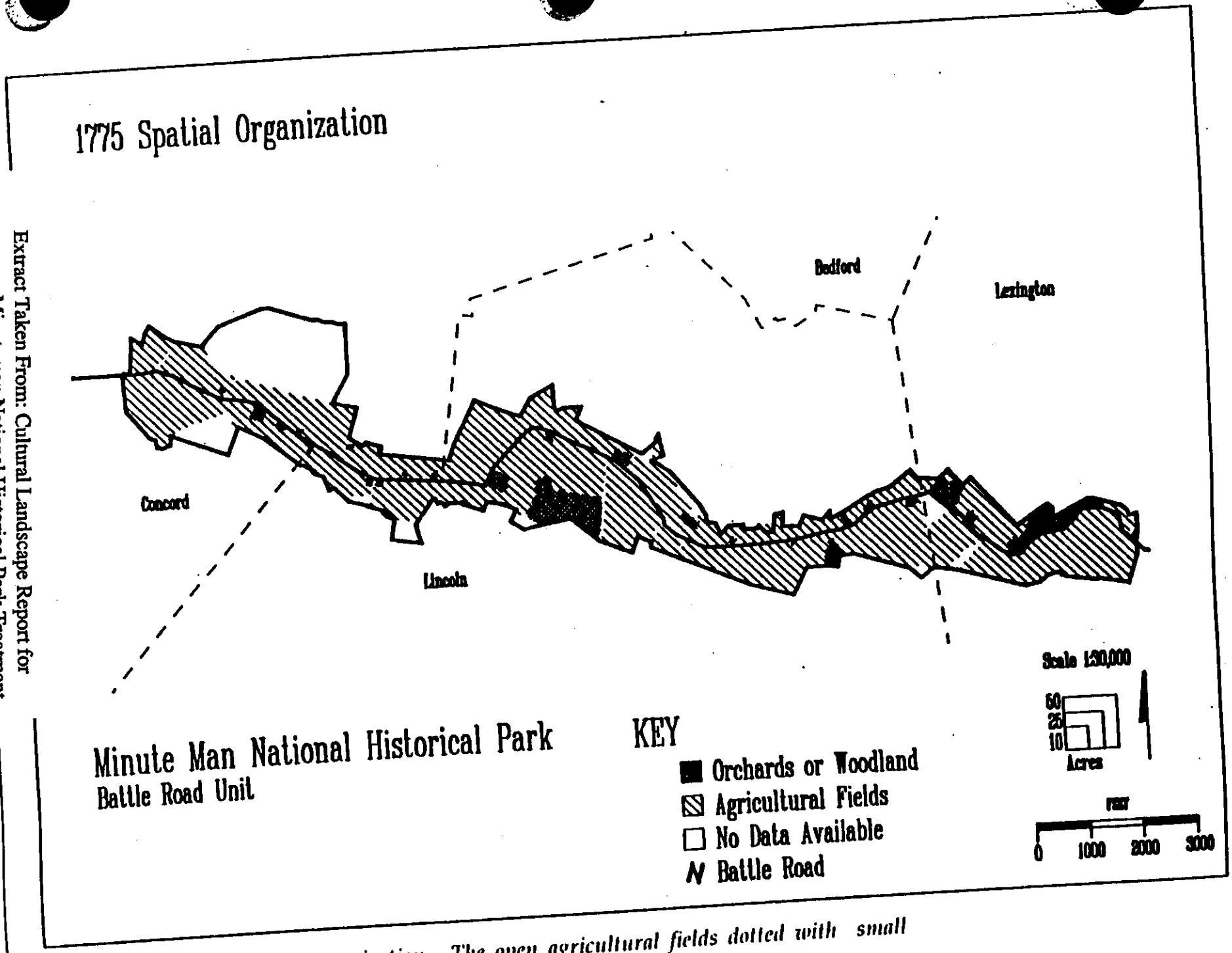
It was also found that there was also a general continuity in the Park's circulation pattern. There were references to the Battle Road, or "Concord Road" since 1636 when the first division of Concord's town land took place. Though the exact right of way "varied considerably" (Malcolm, 1985, p. xii) it was found that the Battle Road followed generally the same path as it does today. The ownership boundary maps were used to analyze the circulation pattern, and they showed a continuity of road location through time.

As described in the Methods Chapter, a detailed analysis was done for the 1775 landscape because there is the most data available for this time. The 1775 land use is shown in Figure 31 shows a predominantly agricultural landscape, with the largest area in pasture, interspersed with smaller tilled fields and meadows. Small (1-2) acre orchards punctuate the fields. Figure 32 shows the spatial organization in terms of woodlands and orchards, contrasting with open agricultural fields. Neither the orchards nor woodlands define the edges of the fields, so the spatial organization could be characterized as generally open in nature. Figure 33 combines the circulation, stone walls and structures in the 1775 landscape. It highlights the location of the Battle Road as a main spine through this landscape, with narrow lanes and secondary roads leading off from it. There is also a strong relationship between the stonewalls and the circulation system. The Battle Road is lined almost continuously by walls in the central and eastern parts of the Park. The fewer walls in the western end of the Park may be attributed to the better soils located there, so there were fewer rocks to pull out before the soil could be farmed. Rock walls were also used to outline the

Figure 31: 1775 Land Use Map showing a predominantly agricultural landscape made up of pasture interspersed with tilled fields, meadows, orchards, woodlands

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Figure 32: 1775 Spatial Organization. The open agricultural fields dotted with small [illegible] characterize this open agricultural landscape.

The land cover data are summarized in their report, entitled "Ecological Reconnaissance of the Minuteman National Historical Park" (August, LaBash and Keniski, 1993, pp. 11-12). 100' buffers were placed around the 31 historic structures for future archaeological investigations.

Substep 5: Place-oriented information -- At this stage, place-oriented information from local experts was added. Place-oriented information, or non-factor based information, is either non-spatial or of a generalized spatial nature. Place-oriented information can also be anecdotal in nature, and is therefore not readily mappable. The information can include relationships between specific combinations of landscape features that vary with specific combinations or over time.

Place-oriented information was identified by pomologist and Agricultural Extension Specialist Dr. William Coli and Landscape Historian Brian Donahue. Additional place information was identified in a public workshop, held on February 18, 1993, at the Concord Town House (see Appendix H for more details). Figure 46, the middle section of Minute Man NHP, is representative of the type of place-oriented information identified for the whole cultural landscape.

Through the history of the landscape, agricultural activities and values changed, as did the types of land used for agriculture. For example, as the demand for hard cider increased, forested land was cleared for apple orchards, which could be grown on steep, stony, marginal soils. The National Park Service would like to rehabilitate these orchards to assist in interpreting the cultural landsape, although these areas may not be attractive for leasing (Ahern, et. al., 1993).

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Extract by: The National Park Service

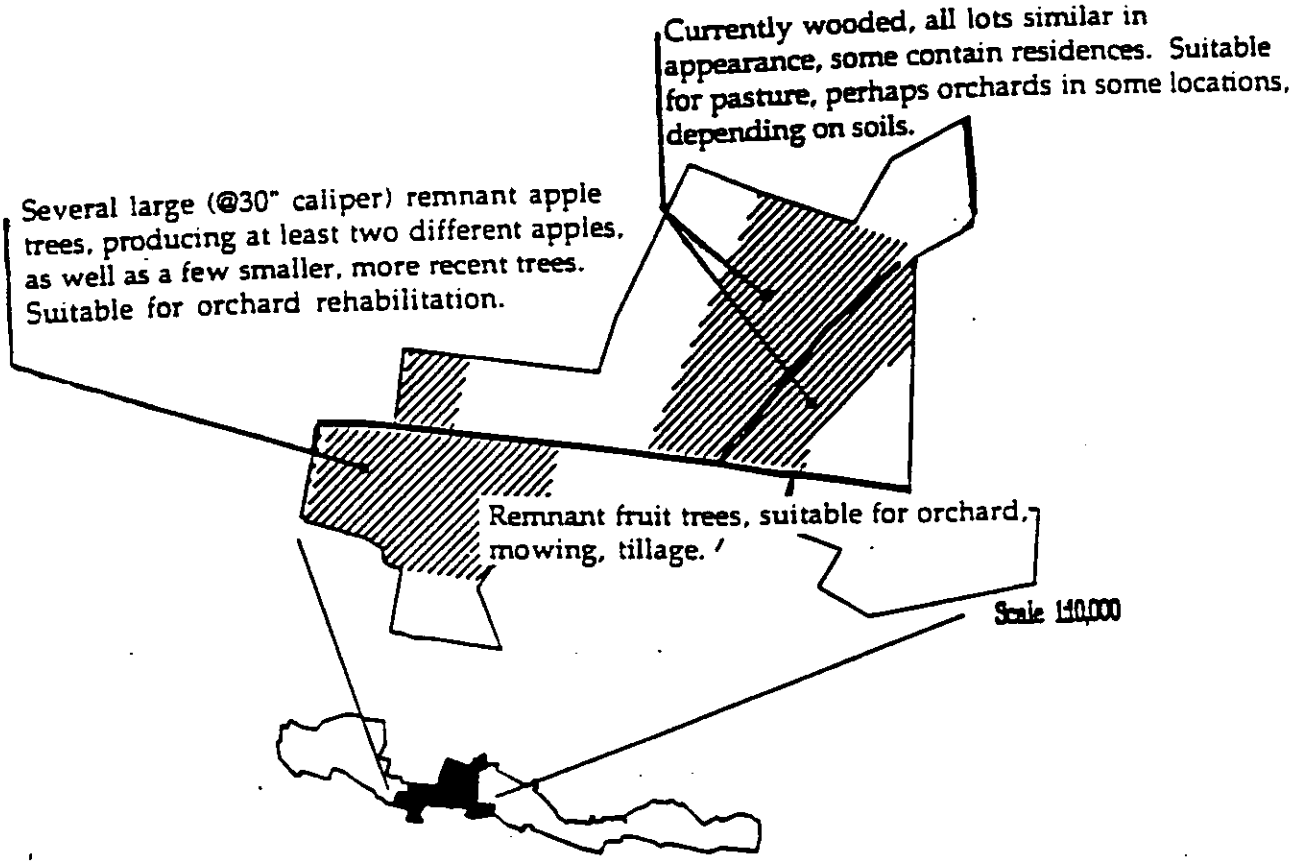


Figure 46: Place Oriented Information. This is an example of agricultural resource information that is added by local experts, information that is not available from traditional sources of information, such as the Soil Conservation Service.

Step Two: Assessment

Step Two of the agricultural resource procedure first determined which land was unsuitable for farming, and was therefore eliminated. Potential fields, after being delineated by existing physical constraints such as roads and topography, were assessed for soil capability class rating and present land use/land cover.

Substep 1: Eliminative Procedure -- Wooded wetlands and their 100' buffers, 100' buffers of ponds, rivers and streams, and other sensitive areas in which farming should not take place were eliminated from consideration as

However, this still left the older towns feeling diminished. Most men aspired to the status of patriarches that their fathers and grandfathers had achieved, as comfortable farmers with their children well established on farms near by. Now, many children were leaving town, and it was difficult for most parents to find the means to give all their children a good start in life. Many children were sinking to a lower status on inadequate subsistence holdings, scraping for a living in poorly paying trades or as laborers. Most historians feel that while colonial society was not in crisis, it wasn't really prospering either: it was stagnating. Economic growth was slow at best.[2]

Along the Battle Road, we can find examples of these conditions in the dispersal of Joshua Brook's children throughout New England, and in the presence of families like that of Joseph Mason, working as a currier and occupying a very small farm between the Hartwells and the Brooks.

This condition of stagnation was not immediately improved by the Revolution: indeed, for a time, things continued to get worse. The 50 year period from 1775 to 1825 was one of difficult and painful transition. However, the Revolution did help create conditions that led to a new approach to farming, including the development of a domestic manufacturing economy, government that was responsive to entrepreneurs, and a sense of political and economic independence. Farmers needed to involve themselves more in the cash economy to get the means to give children a start. They gradually learned to substitute imported resources such as wheat and coal for local subsistence production of some crops, and to specialize their own production in other crops for the market. Along with this economic transition to "commercialism" went a social transformation toward aspirations to be middle class, and materially prosperous. Tied in with this was deliberately limited family size, women's desire to escape the grinding drudgery they had endured under the traditional patriarchal system, and temperance and a more rational, "managed" approach to farming and trades.[3]

Although some prospered in taking up these new ways, others failed. Along the Battle Road, these changes can be seen in the expansion of commercial livestock and dairy farming, and the appearance of larger, more prosperous houses and barns, often painted white, with front yards and trees;[4] but at the same time in the decline of orchards, and the failure of old trades such as the tannery.

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2 James A. Henretta, "Wealth and Social Structure," in Jack P. Greene & J.R. Pole, eds, *Colonial British America: Essays in the New History of the Early Modern Era*, Baltimore: Johns Hopkins, 1984.

3 Richard L. Bushman, "Opening the American Countryside," James Henretta et al, eds, *The Transformation of Early American History*, New York: Knopf, 1991. Also, Henretta, "The Transition to Capitalism in America," same volume.

4 Thomas C. Hubka, *Big House, Little House, Back House, Barn: The Connected Farm Buildings of New England*, Hanover: Univ. Press of New England, 1984.

cleared land along the road backed by woodlands in the distance would mimic (in a somewhat concentrated form) the actual colonial landscape of the area.

Very little (or none) of the land in this area would be considered suitable for row crop cultivation today, although parts of it were pressed into cultivation in the colonial period. However, we could break up a few acres of pasture every year in the course of renovation and reseeding, and take a low maintenance crop such as pumpkins. Following pumpkin harvest, winter rye (along with hairy vetch) could be planted, and allowed to mature early the following summer. This is bad farming but would add the visual element of ripening small grains to our landscape. After mowing and disking the rye (and perhaps harvesting a small portion for demonstration purposes), we could plant pasture with a nurse crop of oats. The maturing oats will provide the small grain aspect again, and then winter kill. The following year the land would return to grazing for a decade or so. Growing corn with modern equipment on any of this upland is problematic, but again every year a small area of half an acre or so could perhaps be done the old way (in hills) for demonstration purposes.

Two crafts were practiced in this part of the Park which have great interpretive potential. The first is cider making, which was universal, but is perhaps best interpreted at the Hartwell Tavern. They produced lots of cider at the Hartwell place - Ephraim Hartwell reported 40 barrels of cider in 1749. Cider vinegar also appears in a later Hartwell inventory. Cider was being made in Concord already during the 17th century, but during the 18th century it became the leading beverage throughout rural New England, replacing beer. This allowed more efficient use of land, because apples could be grown on marginal upland soils less suitable for grain. It also improved seasonal labor distribution, because cider is made in the fall after harvest. Cider is also interesting because by the late 18th century routine heavy alcohol consumption was a significant social problem. Sweet cider, cider vinegar, and cider jelly could be produced by an entrepreneur and marketed at the Hartwell Tavern, putting visitors in touch with this colonial tradition. Peddling hard cider is a bit more problematic, but perhaps not totally out of the question.

The second local industry of great interpretive interest was the Brooks tannery at Elm Brook. The tannery operated from the late 17th century into the 19th century. The Brooks also ran a slaughterhouse, and during the early part of this period they apparently also had a small sawmill a bit further upstream. These small scale industries illustrate how forest and farm resources were processed for use in the local economy. Lumber was sawed for building, obviously, while leather was used in shoes, harness, work aprons, and a host of other products. The tanning process required oak bark from the local forest, ground at a bark mill.

Unfortunately I have found no good accounts of any of these enterprises. The Brooks sawmill is shadowy, just a few references in later deeds to a lane that formerly led to it and a dam that formerly fed it. There was an interesting case involving the theft of [illegible] Brooks by some erstwhile

1900 Map

Samuel Hartwell: Orchards and Market Gardening

During the second half of the 19th century and into the 20th, farmers in the region concentrated on commercial markets. The influx of cheap meat and grain from the Midwest led local farmers to specialize in market gardening, orchards, and dairy. Western grain actually provided cheap high-protein feed for cows. Agriculture boomed economically, but began to contract geographically onto the better soils, and to rely less on local resources. Worn out upland pastures reverted to pine.

The highly specialized, professional form of agriculture that emerged in the late 19th C was exemplified by Samuel Hartwell. Samuel grew up on one of the old Hartwell family farms up the hill. In 1857 he acquired the Noah Brooks Tavern Farm, along with more land across the road, and established a thriving orchard and market garden. By 1880 he had 10 acres of apples and 5 of peaches. His census returns show that he had both a higher gross income, and higher expenses than his neighbors - hiring more labor, and purchasing far more fertilizer.

Interpreting this farm will depend on what is done with the land in this part of the Park. If the Brooks area is used for a small scale commercial orchard operation, it would be a continuation of Samuel Hartwell's farm, and could be interpreted in that way. Further research can be done in tax records to flesh out Hartwell's land use, and there may be papers and memories in the Rogers family to help with this reconstruction.

McHugh & Dee: Assimilation of Irish Farmers

As farmers commercialized in the 19th century, they began hiring more wage laborers. These laborers were Yankees, Nova Scotians, and increasingly after 1840, Irish immigrants. The Irish arrived during the construction of the Fitchburg Railroad, and some of them stayed on in the area, working as domestics and farm laborers. This is an interesting rural aspect of the Irish immigrant experience in America, which was usually urban. There was of course a great deal of social tension between Yankees and Irish, but there was social intimacy as well: census data reveal that many Yankee farmers had several Irish laborers and domestics living with them under the same roof.

By the second half of the 19th century, a few Irish farm laborers were able to purchase farms of their own - generally, although not always, smaller and more marginal enterprises than their better capitalized Yankee neighbors. During the 1870s, the McHugh and Dee families acquired the old Hartwell homesteads on Virginia Road, and carried on dairy and orchard operations.

This era provides an insight into the social relationships between Yankees and Irish and the role of immigrant laborers in the commercialization of agriculture, and into the willingness of poorer immigrants to try to make a go of marginal land that was being abandoned by Yankee farmers. Interpreting it would give visitors whose ancestors did not arrive on the Mayflower another way of identifying with the agricultural history of the Park. Since US Census agricultural data for individuals is not available after 1880, I have not yet attempted to follow the story of the McHughs and Dees in any detail. This might be done using tax data, and oral histories.

1950 Map

Palumbo: 20th Century Market Gardening
Agricultural Abandonment and Suburban Development
Rogers Farm: Orchards

After the First World War, more changes came to the agricultural landscape of the region. The major marketed crops came under increasing competitive pressure. Vegetables and fruits were undercut by refrigerated shipment from other parts of the country where production was on a larger scale. Dairy shifted to larger, mechanized operations on cheaper land upcountry. The hay market declined with the advent of the automobile. At the same time, the automobile made possible suburban residential and commercial development, driving up the price of land. As a result, agriculture steadily shrank, while the landscape came to be dominated by forests, residences and roads.

Commercial agriculture has survived in a few places on the best soils. The Palumbos are typical of the Italian immigrant framers who have played a major role in keeping agriculture alive in this region during the 20th century. In a manner similar to the Irish before them, these later immigrants typically began as gardeners on estates, and then acquired land and went into market gardening for themselves. This is an important story that again will give more visitors an opportunity to identify with the living history of land in the Park.

The Samuel Hartwell farm descended to the Rogers around the turn of the century and remained in orchards for many years - these trees, although no longer maintained in production, are still an important feature of this part of the Park landscape. Meanwhile, agriculture over the uplands, such as in the old Hartwell Tavern farm area taken over by the McHughs and Dees, succumbed completely to forest and development (including Hanscom Field) by the middle of the century.

These stories are best "interpreted" by the continuation and revival of productive agriculture that the Park hopes to encourage. Along with this, some sort of tribute should be paid to those who have kept farming going by telling their stories for visitors. Additional research for this would consist primarily of oral histories.

APPENDIX D: HISTORIC LANDSCAPE PERIODS

by Brian Donahue
Landscape Historian and Consultant to the METLAND Team

Period	Date	Description
Common Field System	1635-1670's	Houses clustered in village center. Large common fields divided into 3-5 acre individual strips. Strips of river and brook meadow divided among colonists for hay (a key crop for colonial farmers). 50% of landscape forested. 15-20% of town was fresh meadow (wild grasses growing along rivers and streams).
Individual Ownership	1670's-1790	20-25% of landscape was forest. Farms moved away from the center of town. Uplands were farmed as tilled fields and pasture. Hay production limited farm size because farmers could not grow enough hay to feed the animals that in turn fertilized the tilled fields. Land became progressively more stressed and unproductive. Cider orchards planted (by 1725 cider replaced beer as the primary drink). 75% of the landscape was clear, 40% of the land was "ragged pasture". Land holdings became more fragmented as farms were divided among sons. A typical subsistence farm was approx. 50 acres. Mainly subsistence farming.
Commercial Farming	1790's-1860's	Commercial farming expanded, farms consolidated. Market oriented produce. Cider orchards disappeared because of Temperance movement. Dessert orchards planted on a small scale (expanded later). "Beautification Movement" resulted in tree plantings along roadsides and around town commons. Hay was planted on the uplands (timothy & clover), and farmers could feed it to their

Area 4: Brooks

1) Generational Land Divisions, Settlement and Farm Formation - Material exists to follow the early development of farms in this area, beginning about 1675. A series of generational "snapshot" maps taken every 25 years could show land distribution in the family, and the absorption of land originally granted to other families. This story is much too involved to even summarize here. The actual land-use layout within these farms could be done in a speculative way.

Such maps would have the most impact if they dealt with the entire Brooks clan, and this might be the eventual goal. I will be able to produce smaller samples dealing with the Hugh/Job and Noah/Joshua branches of the family for this phase.

2) Late Colonial Land Use - A fortuitous set of estate inventories and tax valuations makes it possible to produce a very detailed picture of the Job/Asa, Joshua, and Thomas/Noah Brooks farms in the closing decades of the 18th C. A complete presentation is beyond the scope of this phase of investigation, particularly because of outlying, detached parcels of land lying north of Old Bedford Road in Lincoln. However, I can produce a map of contiguous holdings largely within the Park or immediately adjacent.

Orchards, tilled fields, and even an area of "wood pasture" can be located with some precision. Following changes in these parcels through the 19th C looks difficult in spots, because of a disappointing scarcity of tax valuation data in Lincoln.

3) The Brooks Tannery - I have not yet found any material that sheds any light on the operation of the tannery. It existed from the late 17th C into the early 19th. Finding anything really illuminating is a long shot. However, the story on the importance of tanning and leather in the local economy can be filled in from secondary sources. The demise of the tannery in the early 19th C as the economy changed is equally interesting.

The Brooks sawmill is even less visible. My impression is that there were many small sawmills in Concord in the early days. I was pleased to discover 40 tons of ship timber sitting in the Asa Brooks' "Moon Lot" in 1816, showing Concord farmers were still cutting white oak for this market into the 19th C.

4) Early Meadow Development - Brooks family members had many neighboring meadow lots in Elm Brook meadow north of the highway. Several unusual deeds detailing exchanges of meadows and agreements about ditching give a glimpse into the development of this resource through the management of water flow in the 17th and 18th centuries. With careful

rocky and marginal to find a commercial niche. By the late 19th C much of it had already returned to forest.

7) Late 19th C Market Farming - In 1857 the Tavern Farm was acquired by Samuel, a scion of the Hartwell family up the hill. Samuel established a thriving orchard and market garden. By 1880 he had 10 acres of apples and 5 of peaches. His census returns show that he had both a higher gross income, and higher expenses than his neighbors - hiring more labor, and purchasing far more fertilizer. Hartwell's operation appears to exemplify the highly specialized, professional form of agriculture that emerged in the late 19th C.

Area 5: Hartwell

1) Farm Formation on the Uplands - The Hartwell homestead on Virginia Road illustrates very well the process by which farming spread to new areas away from Concord center. William Hartwell settled in Concord's East Quarter in 1636, and received land grants throughout the general fields and meadows, and later 2nd Division lands on Elm Brook Hill and near the Cambridge line. William's older son John was established with a houselot near his father, while his younger son Samuel inherited his father's homestead after William died in 1690.

Samuel eventually passed the original homestead to his youngest son Jonathan in 1709. He was 64 years old, and lived on with his son until 1725. Meanwhile, it was his eldest son Samuel Jr who established a new farm in the hills of what would become Lincoln, sometime before 1694. The original house lot may not have been on Virginia Road, but further east on the better tillage land by the Cambridge line.

Samuel set his son Ephraim up with a new farm on Virginia Road by 1733. Both Samuel and Ephraim went about buying and selling land with neighbors until the Hartwell farm was assembled. Ephraim afforded his own son Samuel, the clockmaker, with a smaller farm next door, and this was the situation in 1775.

In the Hartwell family we see again and again the archetypical colonial pattern of farm inheritance, in which the older children establish farms on fresh ground, while the youngest son inherits the homestead and cares for the aged parents. We also get a very nice picture of how outlying 2nd Division holdings were taken up and assembled into working farms. The way in which Samuel and Ephraim Hartwell put together the Hartwell homestead in Lincoln could be very effectively mapped, although the the exact origin of some land acquisitions would be speculative.

financial ground for later in 1771 they mortgaged their farm to William's father, who owned it until his death in 1783. Soon after his move to Lincoln, Smith assumed a prominent role in organizing Lincoln resistance to the British, persuading some historians that this may have been his purpose in moving to Lincoln.[16] In the early hours of April 19, 1775, Mary Hartwell is supposed to have brought Smith news of the British advance whereupon he galloped to Lincoln Center to raise the alarm and assembled his men for the trip to Concord.

Smith's fierce patriotism may have been commendable but other aspects of his behavior left much to be desired. In 1780 his father took the Lincoln farm out of his control. Smith became captain of marines on the privateer Tartar, which was captured. After his release, he failed to return to his family and from 1783 until his death in 1787 lived apart from his wife and children. Catherine Louisa and her children, however, remained on the Lincoln farm.

We can be certain of the bounds of the 120-acre Smith farm and, thanks largely to early Whittemore inventories, fairly confident about their use. The property included a house, two barns, plowland, mowing, pasture, and woodland as well as an old orchard. The boundaries of the 120 acre farm north of the road were:

> East by the farm formerly Ebenezer Lamson's at Concord Road north to a maple tree
> Northwest to a white oak tree upon a ditch bank between the land formerly Lamson's and that formerly Whittemore's
> North in line between Lamson and Whittemore land until it comes to Ephraim Hartwell's land [later Samuel Hartwell's farm]
> South upon Hartwell till it comes to Concord Road and upon said road to the first mentioned bounds.[17]

In addition to the farm north of the road, in 1774 William Smith rented and later bought three additional parcels south of the road from his father-in-law. These were:

1) 40 acres, the "Hill Pasture" between Bedford Road and Bedford Lane bounded:

> North by Concord Road
> West partly by E. Hartwell, the highway and Thomas Brooks
> East by Aaron Brooks & E. Hartwell
> South by Thomas and Aaron Brooks.

2) 1-acre west of Bedford R

Extract Taken From: The Scene of the Battle. Historic Grounds Report, Minuteman National Historical Park.
Extract By: The National Park Service.

East by Josiah Nelson
North by Josiah Nelson
South by Josiah Nelson
West by Ephraim Hartwell's land.

A third parcel of 3 1/2 acres and 25 rods was also south of the road and, according to the 1779 survey, was bounded:

East by a private way to Aaron Brooks land
South by land of Aaron Brooks and William Dodge
West by Bedford Road
North by Concord Road.

There is no description of the use to which these 3 1/2 acres were put. In 1766 Samuel had bought 3 acres 91 rods from Edmund Wheeler on the southern side of Concord Road outside the park, and in 1771 he bought 4 acres of woodland that bordered Flint's Pond on the west, again outside park boundaries.

The Lincoln tax of 1774 indicates that Samuel's farm contained 5 acres of tillage, almost certainly on the 6-acre parcel of plowland his father had given him south of Concord Road. He also was taxed for 5 acres of mowing land and 5 acres of pasture. Mowing was probably the use to which the swampy land to the rear of his houselot was put. Part of the pasture was probably also on the homelot, the rest on the 3 1/2-acre parcel at the corner of Bedford and Concord Roads. Samuel was not, of course, taxed for his 4 acres of woodland, and had no orchard. His stock consisted of a horse, 3 cows, 6 sheep, and 2 swine. Despite his 6 acres of tillage (or 5 according to the tax roll) he had no oxen but presumably used his father's teams. Indeed Ephraim Hartwell could certainly spare a team as he had six oxen, three times the average. In Samuel's own will of 1829 his widow is to be supplied with provisions of corn, rye, barley, white beans, cider apples and winter apples, pork and beef, and she is to get some of the bees and the hives. In 1775 he had no apples of his own, or at least no full-sized orchard, but the other crops may have been grown on his farm at that time.

The man-made structures on the Samuel Hartwell farm were all situated on Samuel's homelot and comprised his house, barn, and the old blacksmith shop near the road bordering his father's homelot. His will of 1829 mentions as part of the house a cheeseroom and sink (smoke?) room but there is no evidence that these refinements existed nearly fifty years earlier. In fact, the house Samuel was given may have been the house his grandfather had lived in, and if so it would have been built either century or very early in the eighte his grandfather's barn was still st

Extract Taken From: The Scene of the Battle. Historic Grounds Report, Minuteman National Historical Park.
Extract By: The National Park Service.

South and East of Concord Road

The parcel at the peak of the angle formed by present-day Old Bedford and Virginia Roads was owned in 1775 by Joshua Brooks.[2] It consisted of ten acres described as orchard, mowing, pasture, and woodland. Of this some 4 acres was orchard and mowing land; 6 acres was woodland and pasture.[3] The woodland seems to have been in the more southern portion of the plot. The property was bounded:

West and North by Concord Road
East by land of Ephraim Hartwell
South by Joshua Brooks' own property.

As we descend the hill moving south and west, the next parcel bordering the road also belonged to Joshua Brooks. It was a plot of 13 acres called the Top of the Hill Pasture bounded:

West by Concord Road
North by Joshua Brooks' land
East by Ephraim Hartwell's land
South by Thomas Brooks' land.

Southeast of the hill pasture was Thomas Brooks' two acre Barren Orchard. A barren orchard was a young orchard not yet capable of bearing fruit. The orchard bounds were:

West by Concord Road
North by Joshua Brooks' land
East by Joshua Brooks' land
South by the Holt Pasture.

At the point where the Concord Road turns west Thomas Brooks had a three acre parcel called the Little Pasture. It was bounded:

North by Concord Road and the Barren Orchard
East by Barren Orchard and Holt Pasture
South by land of Joshua Brooks
West by the Hog Pasture.

Joshua Brooks owned the one-acre Hog Pasture west of Thomas Brooks' Little Pasture. Despite its name, the Hog Pasture included a garden. It was bounded:

North by Concord Road
East and South by land of Thomas Brooks
West by Joshua Brooks' house lo

Extract Taken From: The Scene of the Battle. Historic Grounds Report, Minuteman National Historical Park.
Extract By: The National Park Service.

Joshua Brooks' houselot consisted of a two acre parcel south of Concord Road containing his house, barn, corn barn, and several outbuildings. It was bounded:

North by Concord Road
East by the Hog Pasture
South by the private way running from Thomas Brooks' house to Elm Brook Meadow
West by Thomas Brooks' land.

Thomas Brooks' homelot bordered Joshua's on the west. It was a larger tract, some thirteen acres, bounded:

North by Concord Road
East by Deacon Joshua Brooks
South by Eleazer Brooks
West by Samuel Brooks.

Samuel Brooks, whose house was north of Concord Road in the town of Concord, owned a fourteen acre parcel of land just west of Thomas Brooks' homelot. There was a wall between their properties and Samuel's land extended west to Brooks Road. In 1735 Brooks Road began four rods from the northwest corner of Samuel Brooks' stone wall.

North and West of Concord Road

Just below the peak of the hill, at the junction of Old Bedford and Virginia Roads and bordering the western side of the Battle Road, was a long pasture known as the Tanyard Meadow because Joshua Brooks' tanyard was situated at the foot of the hill. It belonged to Thomas Brooks and comprised 10 acres 126 rods of pastureland bounded:

West by land of Joshua Brooks
South by the town way to Bedford for 35 rods
Southeast by the way to Bedford for 54 rods to the corner of a stone wall
Northeast by land of Ephraim Hartwell 31 1/4 rods by 1 angle as the stone wall stands
Northwest by land of Joshua Brooks as the stone wall stands 76 1/4 rods to the corner first mentioned.

At the bottom of the hill where the Concord Road has