Abstract

The timing and duration of budbreak of forest trees may be affected by biotic and abiotic factors. This manual provides a visual method for monitoring bud development of mature trees of sugar maple, *Acer saccharum* Marsh., from the ground. A spotting scope with a 15-45x zoom lens was used for bud rating. The user is supplied with close-up photographs and a brief description of each bud stage. Sample data sheets are also provided. This protocol is currently used in the Vermont Forest Health Monitoring Program.

Acknowledgments

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Field Guide for Monitoring Sugar Maple Bud Development

by

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Introduction

The timing and duration of budbreak of forest trees may be affected by biotic and abiotic factors. Variation in bud phenology from year to year may render a tree's foliage more or less prone to insect injury. For example, the severity of damage to the foliage of sugar maple, *Acer saccharum* Marsh., by pear thrips, *Taeniothrips inconsequens* (Uzel), is believed to be greater when budbreak is delayed or prolonged. To facilitate evaluation of these types of relationships, we developed a visual method to monitor bud development from the ground in sapling and mature sugar maple trees, using a spotting scope with a 15-45x zoom lens, mounted on a tripod. It serves as a standard procedure which can be amended to accommodate specific research or management objectives.

For two years, flower and vegetative buds were collected from the canopy of mature maple trees in Vermont and photographed to determine visually-detectable differences in development. Each bud stage was coded and described.

This manual is designed for field use and supplies foresters or researchers with a systematic protocol, including close-up photos and a brief description of each maple bud stage, and sample data sheets. This protocol has been field tested, and is currently used in the Vermont Forest Health Monitoring Program for long-term assessment of tree health.

Monitoring Protocol

This protocol was designed to take a minimum of time to complete while still providing adequate replication to account for between- and within-tree variation. The tree sample size was selected based on the time we had available, mindful of statistical considerations. This method has not been tested statistically to determine its reliability relative to an entire forest. However, we observed that variation in bud development was greater between than within trees, and the tree and bud sample sizes reflect this.

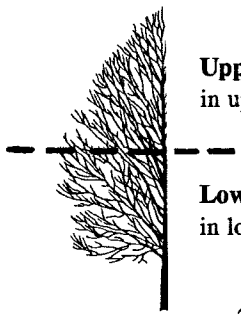
Sample Population

▸ *Trees to evaluate*

Five: dominant or co-dominant sugar maple trees per site or habitat.

Five: sugar maple saplings per site or habitat (spotting scope is not needed). These trees should be monitored, as bud development in saplings can differ significantly from that in mature trees.

▸ *Location in trees*



Upper canopy: branches in upper half of the crown.

Lower canopy: branches in lower half of the crown.

▸ *Bud types to evaluate*

Terminal buds only:

Vegetative buds
Flower buds

Equipment

Spotting scope with 15-45x zoom lens and tripod

Bud Assessment Method

A sample tree should be selected that is representative of other trees in the forest, i.e., without obvious signs of decline or poor health. However, the specific characteristics of the sample trees depend upon the goals of the study. If monitoring will be repeated for several years, sample trees should be marked so that they can be located each year.

After a sample tree is selected, the site for positioning the spotting scope and tripod should be found that allows a full, unobstructed view of the sample tree. This location must be marked to allow reposition of the scope in the same place for each monitoring event. The spotting scope should be positioned to allow multiple sightings around the canopy and so that the viewer is as comfortable as possible during the assessment process. The distance from the sample tree (usually 15-20 m) will vary based on the denseness of the forest. It may be best to stand, kneel or sit in a chair, on a stump or on the ground. Each viewer must find his/her own best method (Fig. 1.).

Figure 1. Field position for monitoring of bud development.

Twenty vegetative buds at each canopy level are assessed for development with the spotting scope, using the accompanying rating guide. The specific number of buds to evaluate depends on the level of accuracy desired. Because bud development may vary in different parts of the canopy, five buds from each of four different areas within each canopy level (a-d on data sheet) are rated. These buds are selected at random.

Prior to selecting buds for assessment, the canopy should be scanned for about one minute with the scope to calibrate the eye to the general bud status and to confirm that the correct tree is in view. It is useful to locate specific aspects of each tree which can be used to identify the sample tree from others nearby. After scanning, the scope should be held stationary and the buds within view should be randomly selected for evaluation. This method should be used for all areas within each canopy level.

Ten flower buds at each canopy level should also be assessed, using the flower bud rating guide. Buds for evaluation should be randomly selected from at least two different areas within each level (A and B on data sheet). Flower buds may be less abundant than vegetative buds, requiring more time to look for them. They are commonly found in the upper canopy so the scope should be focused there. Early in the season differences between flower and vegetative buds are difficult to detect. In general flower buds are more rounded and develop faster than vegetative buds.

The percentage of flower buds should also be estimated. Because this may vary within the canopy, estimate the percentage of flower buds in two areas of each canopy level (upper and lower). The abundance of flowers varies greatly from year to year; in some years no flower buds are present.

In addition to rating the buds for development, comments on other aspects of development should be noted, including the general status of the buds on the tree and the extent of dieback.

We recommend a standardized sequence of rating the lower canopy vegetative and flower buds first, followed by evaluation of the upper canopy flower buds and finally the upper canopy vegetative buds. We also suggest that trees be assessed in different order on different days to make sure that no one tree is always viewed first.

Ten buds from each sapling should be selected at random and assessed using the same rating guide. It is not necessary to use the spotting scope for this.

Timing of Evaluation

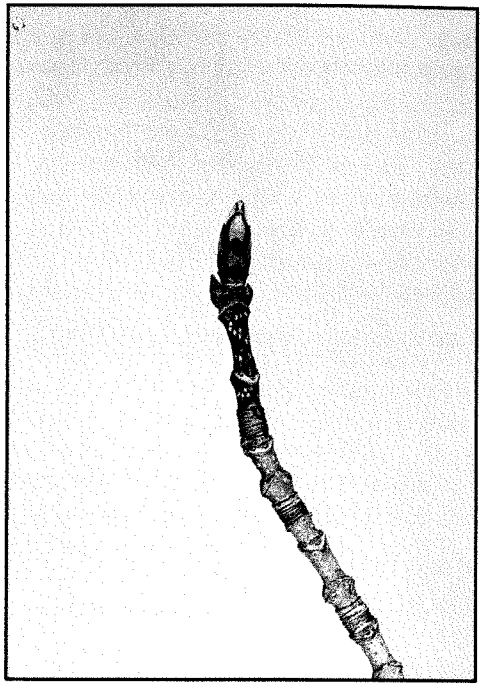
Monitoring should begin prior to any sign of bud development in the spring. In Vermont that is around 27 March. Observations should be made every 3-5 days until buds begin to swell (bud stage V1 or F1), usually for 1-2 weeks depending on weather conditions (cool temperatures slow down development). When bud swell begins, observations should be made often, at least every 2-3 days or daily if possible. The period between bud elongation and leaf expansion can be very rapid--2-4 days in some years.

Bud rating with the spotting scope is easiest to do on calm, sunny days. Even a little breeze makes it very difficult to keep the buds in focus for assessment. It is easier for two people to do the bud evaluation; one to look through the scope and the other to record data.

Using the Bud Rating Guide

The photos for this manual were selected based on bud development, irrespective of collection date or location in the canopy. They should be used as a guide for rating bud development for all canopy locations. Though more than one bud may be shown in a photo, only the terminal bud should be used as a guide for rating purposes. The term bud scale, used throughout this manual, refers to the tough brown flaps that encase each bud, and are pushed apart and ultimately shed during bud expansion.

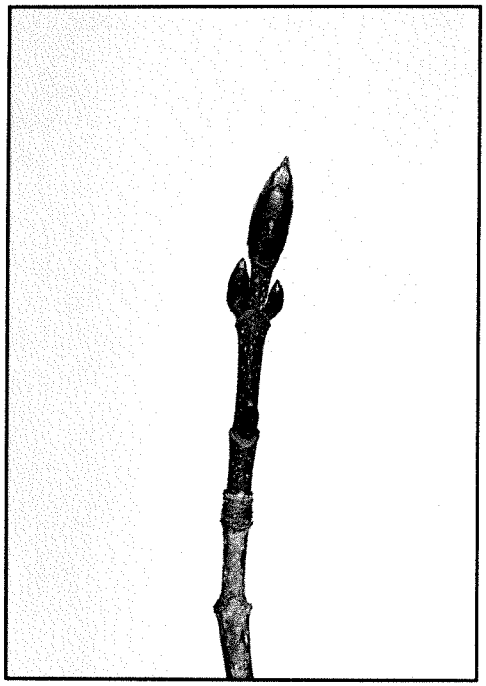
Bud Rating Guide



V0

Bud dormancy

No sign of swelling or enlargement. It is impossible at this stage to distinguish between vegetative and flower buds.



V1

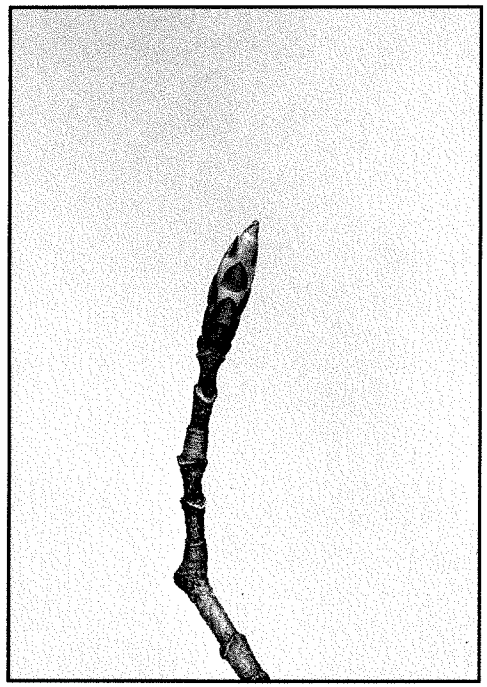
Initial bud swell

First noticeable bud enlargement. Bud scales are beginning to shift slightly, giving a reddish tinge to the buds.

V2

Bud elongation

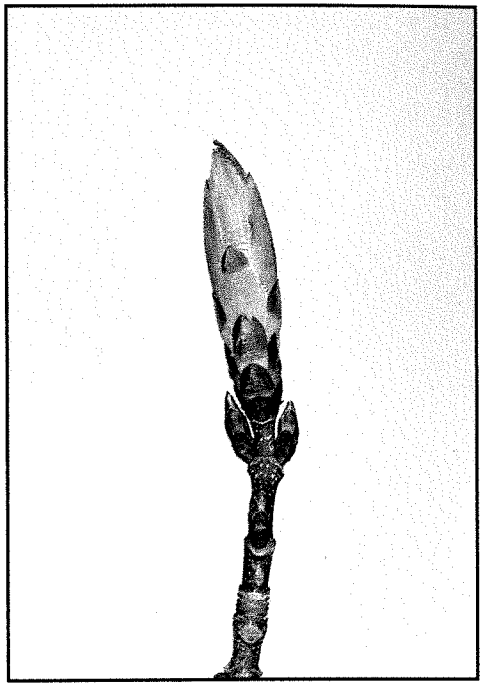
Bud lengthening, making tip more pointed than round. A light yellowish color is visible between the bud scales.



V3

Green tip stage

Bud tip and area between the scales are light green. The bud is not yet open at the tip.



V4

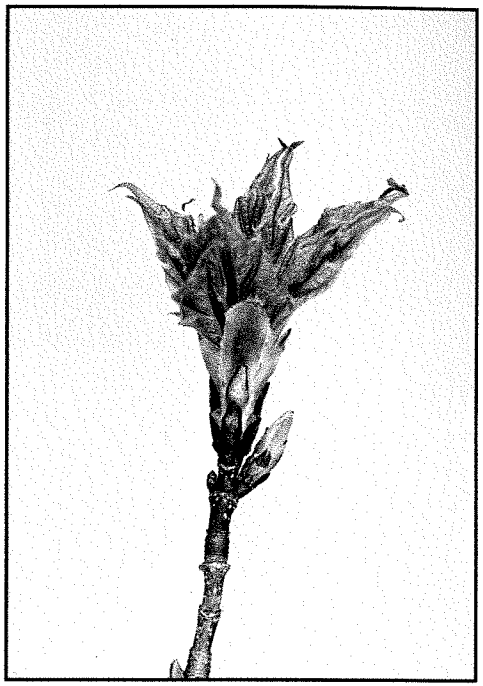
Budbreak

Leaf tips just barely visible expanding beyond the bud tip. The bud scales are loosened enough to allow entry of small insects, such as thrips.

V5

Extended budbreak

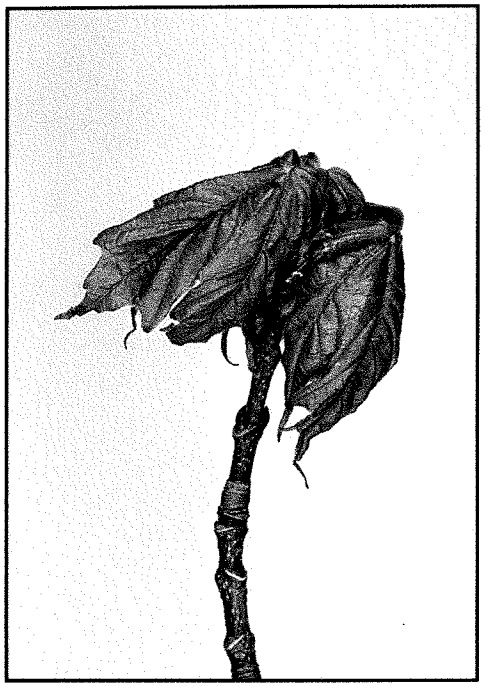
Continued expansion of the leaf bundle beyond the bud scales. The leaves have not yet separated or spread apart.



V6

Initial leaf emergence

Appearance of leaves in recognizable form. The leaves are beginning to expand perpendicular to the base of the bud.

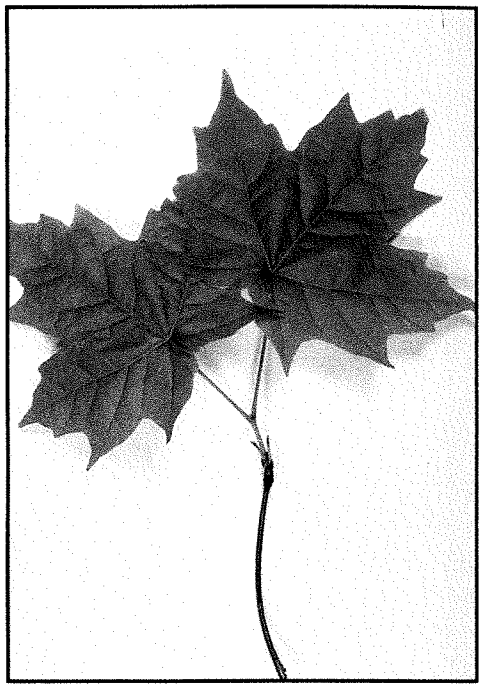


V7

Initial leaf expansion

Leaves fully unfolded, showing each individual leaf. The leaves are light green, small, and slightly wrinkled. They are curled over the base of the bud and their development is not yet complete.

Vegetative Buds

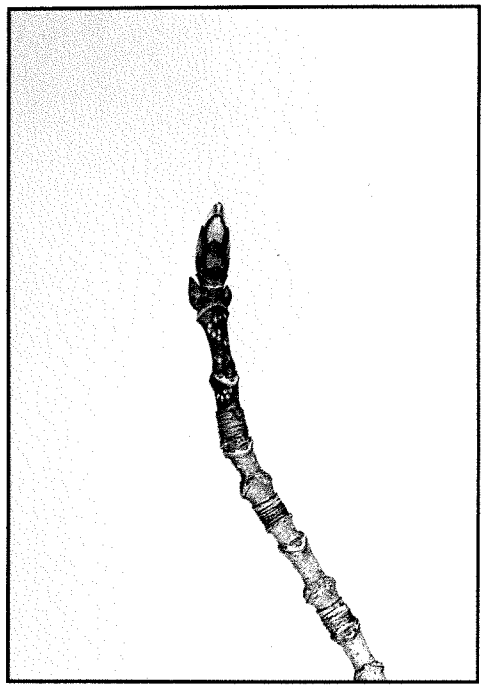


V8

Full leaf expansion

Leaves flattened and fully expanded. The leaves are dark green with a relatively smooth surface. They are larger than V7, though may not yet have reached their full size. They are spread out in their final orientation position.

Flower Buds



F0

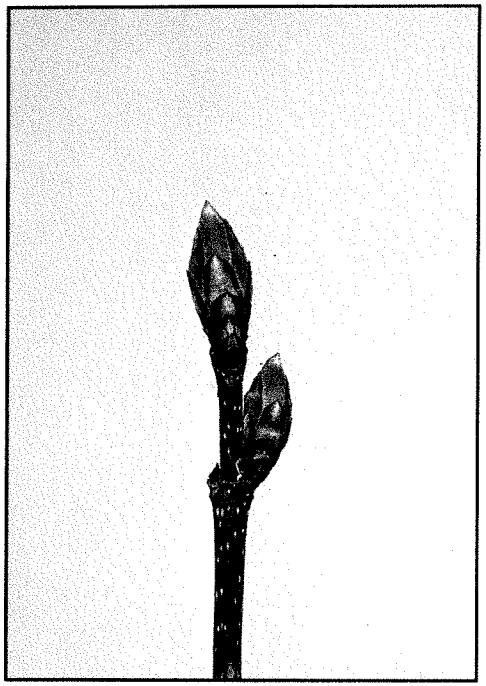
Bud dormancy

No sign of swelling or enlargement. It is impossible at this stage to distinguish between vegetative and flower buds.

F1

Initial bud swell

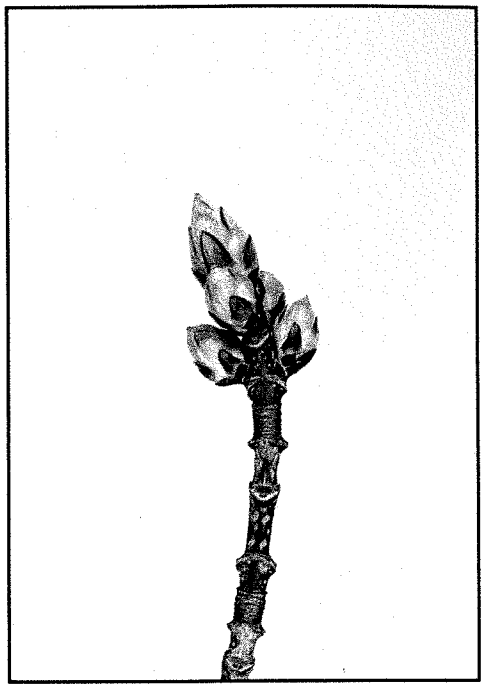
First noticeable bud enlargement. Bud scales are beginning to shift slightly, giving a reddish tinge to the buds. Flower buds are more rounded than vegetative buds at this stage.



F2

Bud elongation

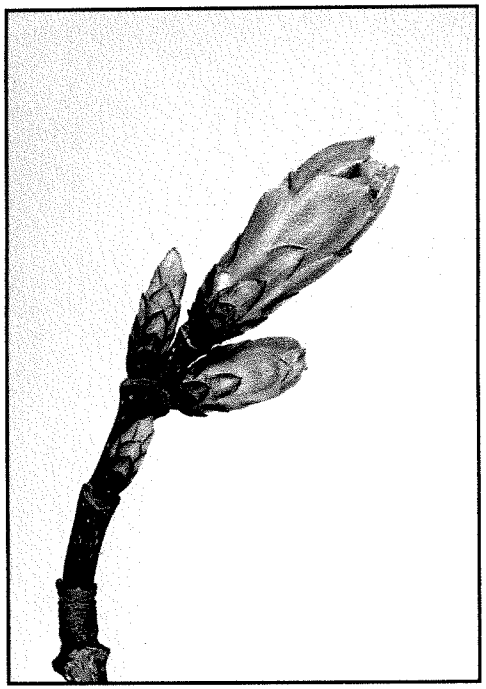
Bud lengthening, making tip more pointed than round. A light yellowish color is visible between the bud scales.



F3

Green tip stage

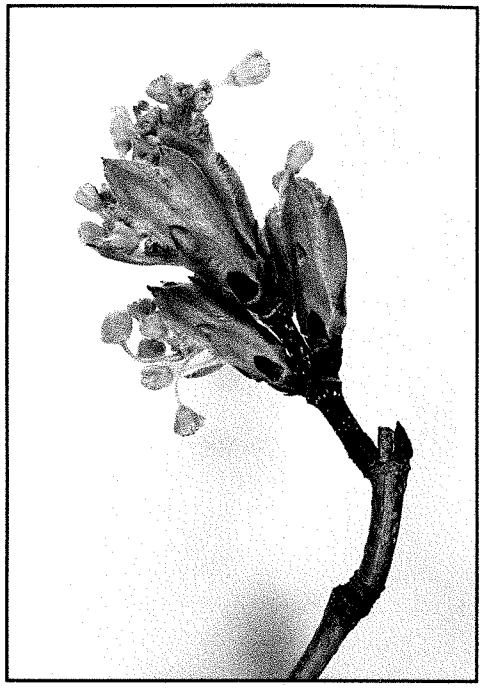
Bud tip and area between the scales are light green. The bud is not yet open at the tip.



F4

Budbreak

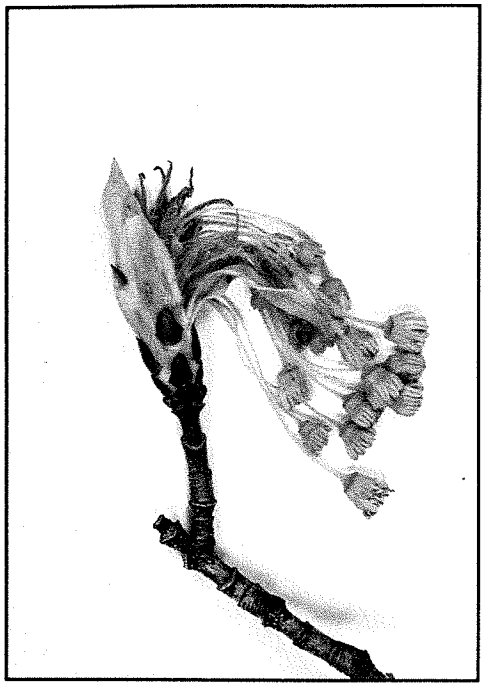
Flower tips just barely visible expanding beyond the end of the bud. The bud scales are loosened enough to allow entry of small insects, such as thrips.



F5

Initial flower expansion

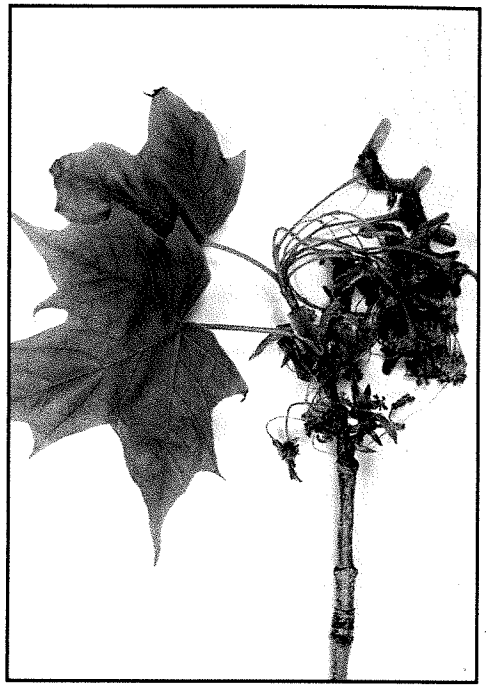
Flower bundle expanded beyond the scales. Individual flowers are visible but are held vertically within the bud scales.



F6

Full flower expansion and pollen dispersal

Full expansion and separation of the flower bundle. The individual flowers droop downward over the bud, and yellow pollen at the flower tips may be visible.

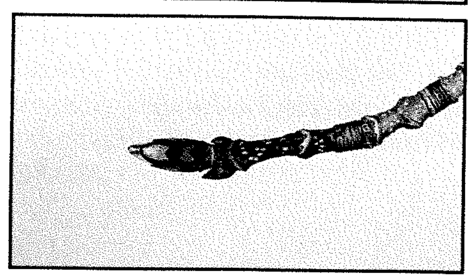


F7

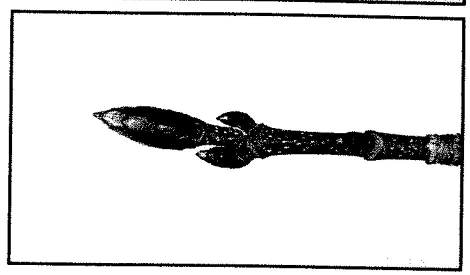
Flower senescence and seed formation

Flowers brown and shriveled and dropping off, while small seeds form. Seeds will continue to grow until reaching their full size.

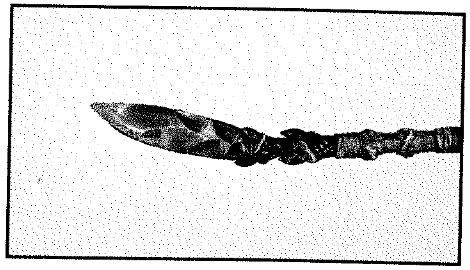
Bud Rating Quick Reference Guide



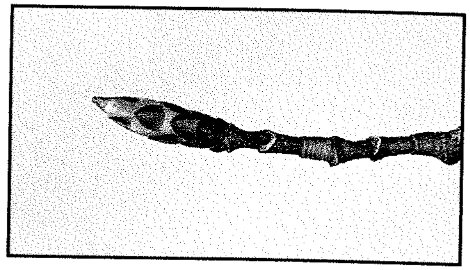
V0



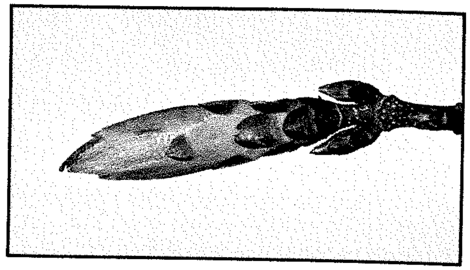
V1



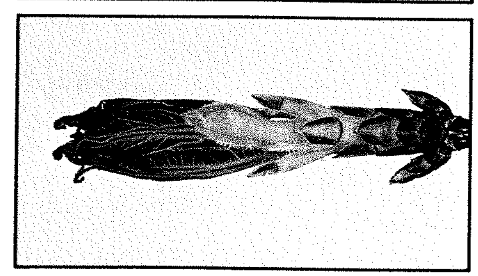
V2



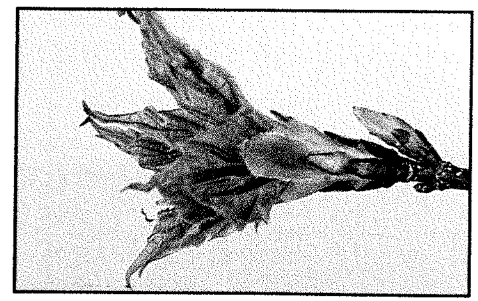
V3



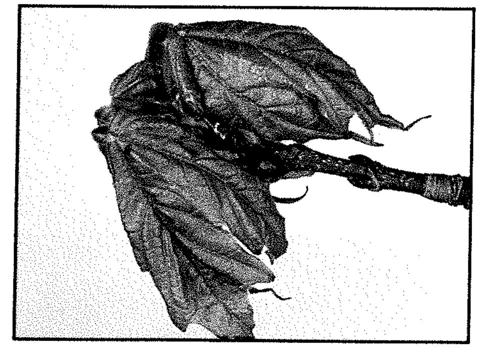
V4



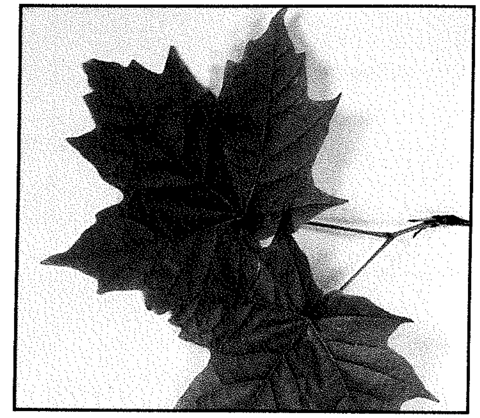
V5



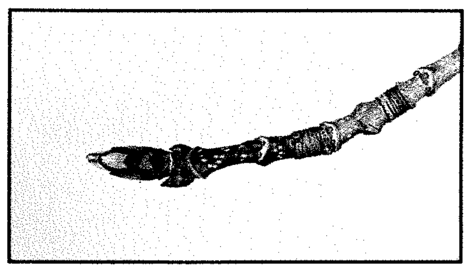
V6



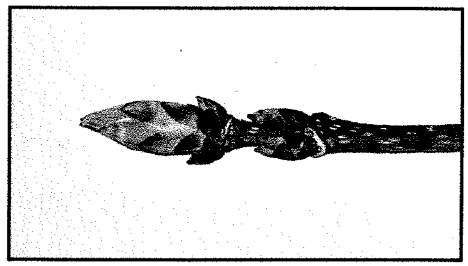
V7



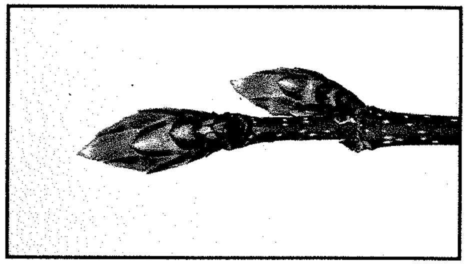
V8



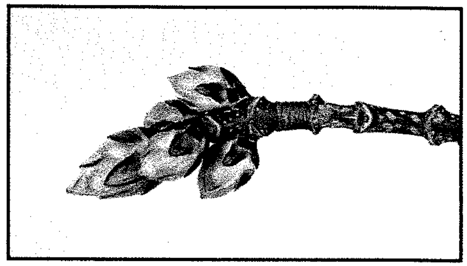
F0



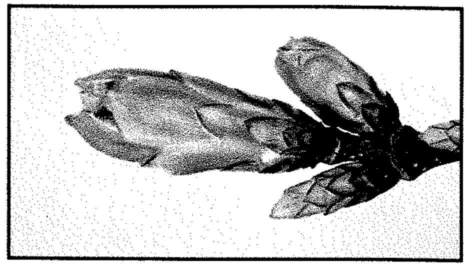
F1



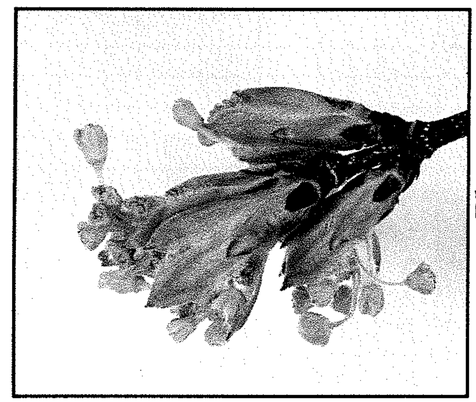
F2



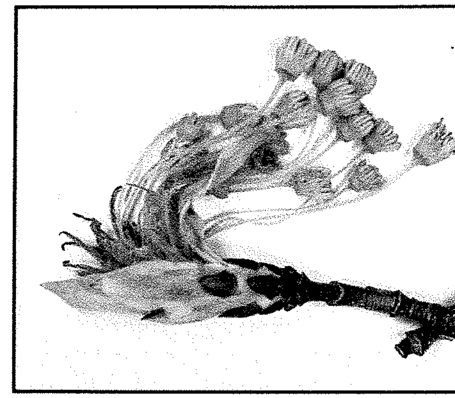
F3



F4



F5



F6

F7

Sample Data Sheet

Sugar Maple Phenology
Ground Observation of Upper Canopy

Observer: _____ Date: _____

Site: _____ Tree #: _____

Level	Bud #	Type	Rate	Comments
a	1	V		
a	2	V		
a	3	V		
a	4	V		
a	5	V		
b	6	V		
b	7	V		
b	8	V		
b	9	V		
b	10	V		
c	11	V		
c	12	V		
c	13	V		
c	14	V		
c	15	V		
d	16	V		
d	17	V		
d	18	V		
d	19	V		
d	20	V		
A	1	F		
A	2	F		
A	3	F		
A	4	F		
A	5	F		
B	6	F		
B	7	F		
B	8	F		
B	9	F		
B	10	F		

Percentage of flower buds: upper: _____ lower: _____

Sample Data Sheet

Sugar Maple Phenology
Ground Observation of Lower Canopy

Observer: _____ Date: _____

Site: _____ Tree #: _____

Level	Bud #	Type	Rate	Comments
a	1	V		
a	2	V		
a	3	V		
a	4	V		
a	5	V		
b	6	V		
b	7	V		
b	8	V		
b	9	V		
b	10	V		
c	11	V		
c	12	V		
c	13	V		
c	14	V		
c	15	V		
d	16	V		
d	17	V		
d	18	V		
d	19	V		
d	20	V		
A	1	F		
A	2	F		
A	3	F		
A	4	F		
A	5	F		
B	6	F		
B	7	F		
B	8	F		
B	9	F		
B	10	F		

Percentage of flower buds: upper: _____ lower: _____

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