SUGAR MAPLE TREE PHENOLOGY MONITORING

by Sandra H. Wilmot, Vermont Dept. Forests, Parks & Recreation

Cooperators: H. Brenton Teillon, Thomas Simmons, and Cecilia Polansky, VT Dept. Forests, Parks & Recreation; and Bruce L. Parker, Margaret Skinner, Luke Curtis and Jim Boone, UVM Entomology Laboratory.

Introduction

Annual changes in the timing and duration of bud development in the spring, total leaf size, and timing and duration of leaf senescents and drop are important to understanding interactions between environmental stresses and forest ecosystems. Subtle changes in tree phenology may be an early indication of larger changes to be manifested in the future.

The objectives is to measure the phenology of sugar maple trees to establish the timing of developmental events and trends, especially as they relate to changes in weather or insect and disease occurrence.

BUD PHENOLOGY

Methods

Bud development is measured from dormancy through full leaf expansion and flower senescence on five sugar maple trees at the Proctor Maple Research Center [1360 ft (415 m) elevation] using a 45X spotting scope. Observations are made at least twice weekly, and more frequently when bud development rates increase. Bud development is categorized into 8 vegetative and 7 reproductive bud stages using the guide and protocols developed by Skinner and Parker (Skinner & Parker, 1991) [Table 1]. Data are analyzed as percent of buds in each stage on each sampling date (Figure 1).

Results

Bud swelling began on Julian date (JD) 95 (April 5) and by JD 98 the average vegetative bud stage was V1 (initial bud swell). Following JD 113 (April 23), the rate of bud development increased more rapdidly. Bud break (V4) occurred by JD 119 (April 29). Full leaf expansion was reached first by the regeneration (on JD 122-May 2), then the lower and upper canopies on JD 133 (May 13).

Individual tree differences in developmental rate are shown in Figures 2-6, and can be used as a baseline for monitoring changes in developmental rates over time.

Table 1. Stages of sugar maple bud development, as identified by Skinner & Parker (1991)[see guide for more detailed description of each stage].

Vegetative bud stage	Developmental event
V0	Dormant
V1	Initial bud swell
V2	Bud elongation
V3	Green tip stage
V4	Bud break
V5	Extended bud break
V6	Initial leaf development
V7	Initial leaf expansion
V8	Full leaf expansion

Flower bud stage	Developmental event
F0	Dormant
F1	Initial bud swell
F2	Bud elongation
F3	Green tip stage
F4	Bud break
F5	Initial flower expansion
F6	Full flower expansion
F7	Flower senescence and drop

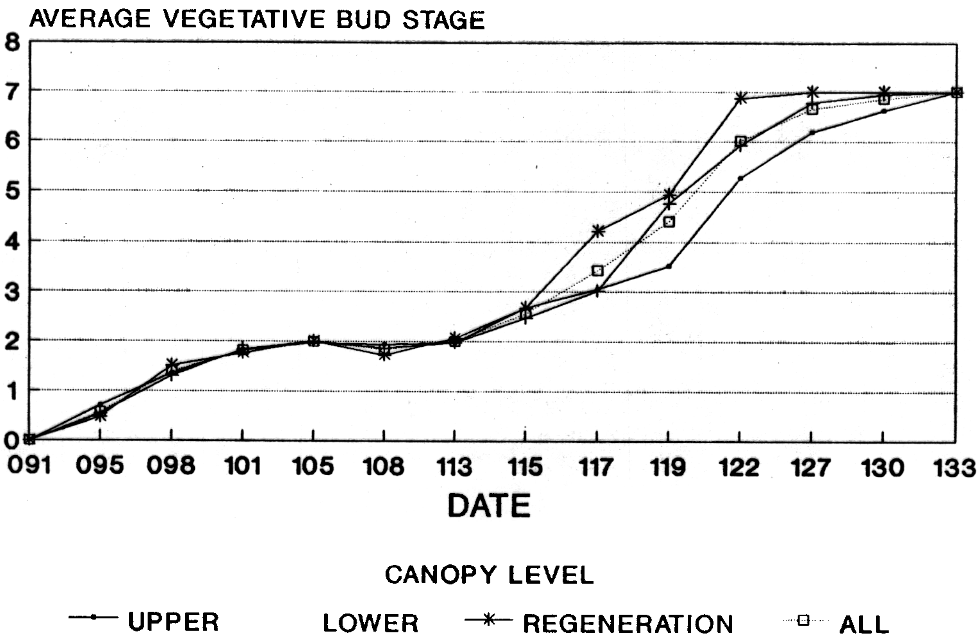


Figure 1. Sugar maple bud phenology. Average developmental rate for sugar maple buds at different levels in the canopy: upper canopy, lower canopy and regeneration. Proctor Maple Research Center, Mount Mansfield [1360 ft (415 m)], Vermont, 1991.

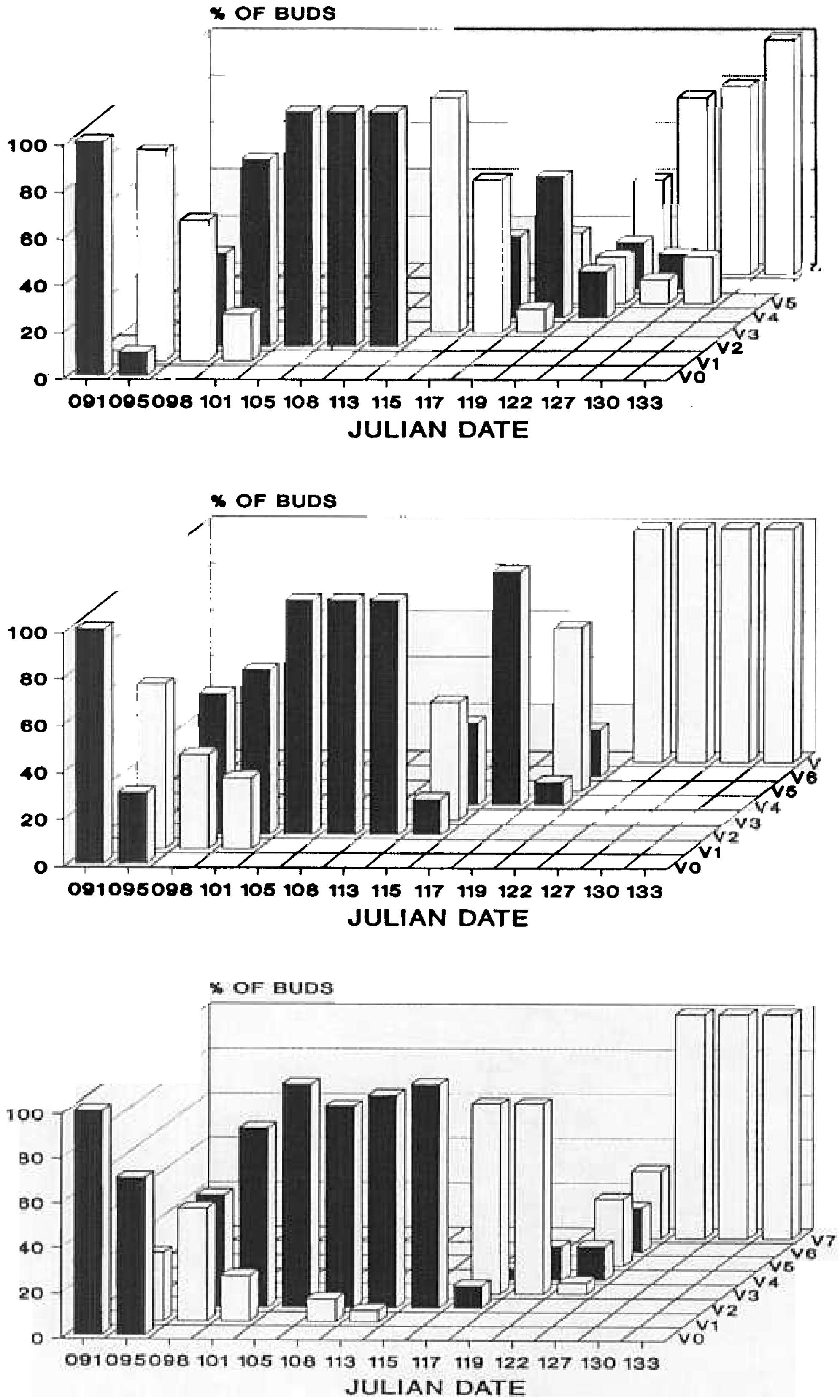


Figure 2a-c. Sugar maple tree 1, bud phenology. Developmental rate of upper canopy (2a), lower canopy (2b), and regeneration (2c) of tree 1, Proctor Maple Research Center, Mount Mansfield [1360 ft (415 m)], Vermont, 1991.

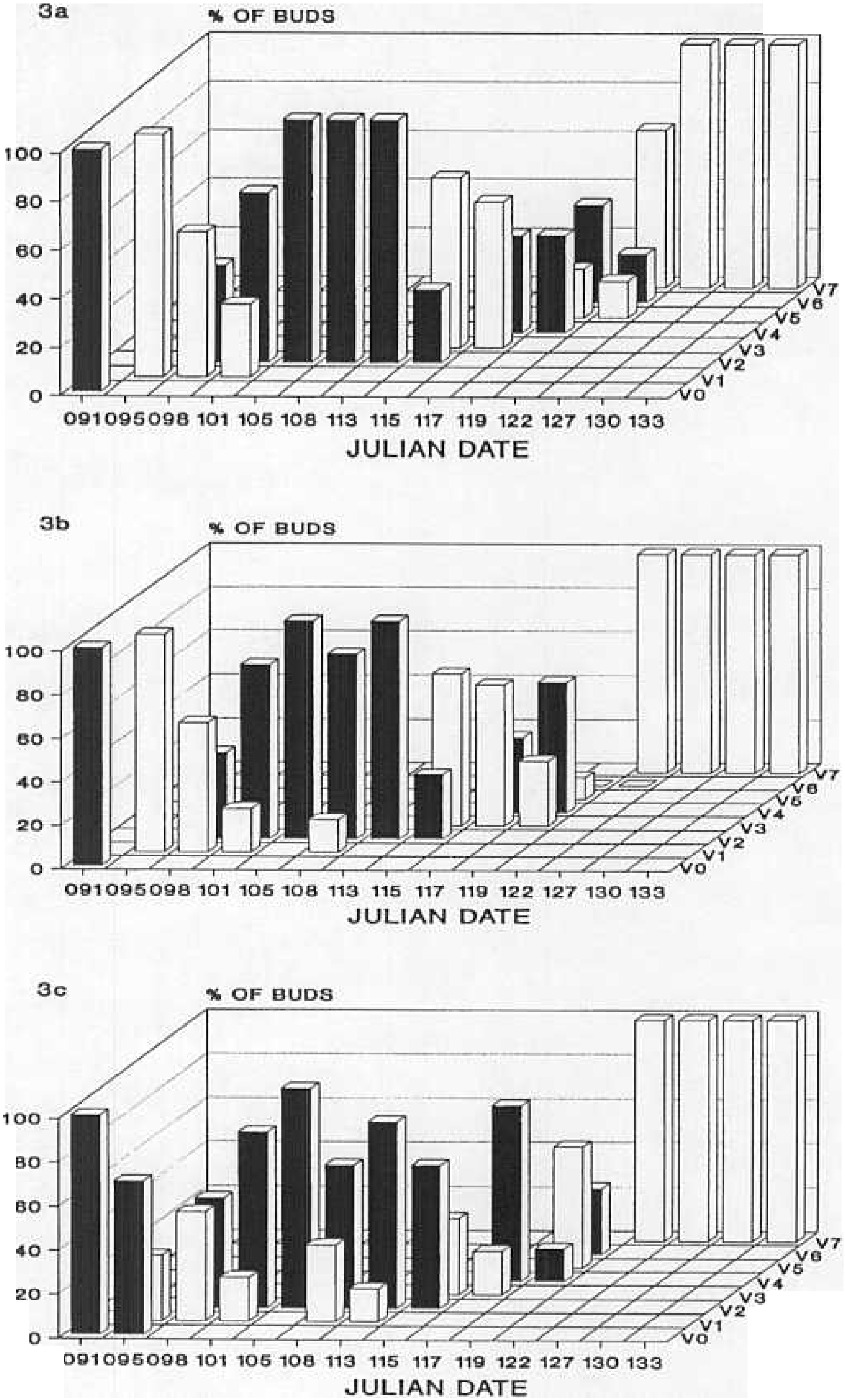


Figure 3a-c. Sugar maple tree 2, bud phenology. Developmental rate of upper canopy (3a), lower canopy (3b), and regeneration (3c) of tree 2, Proctor Maple Research Center, Mount Mansfield [1360 ft (415 m)], Vermont, 1991.

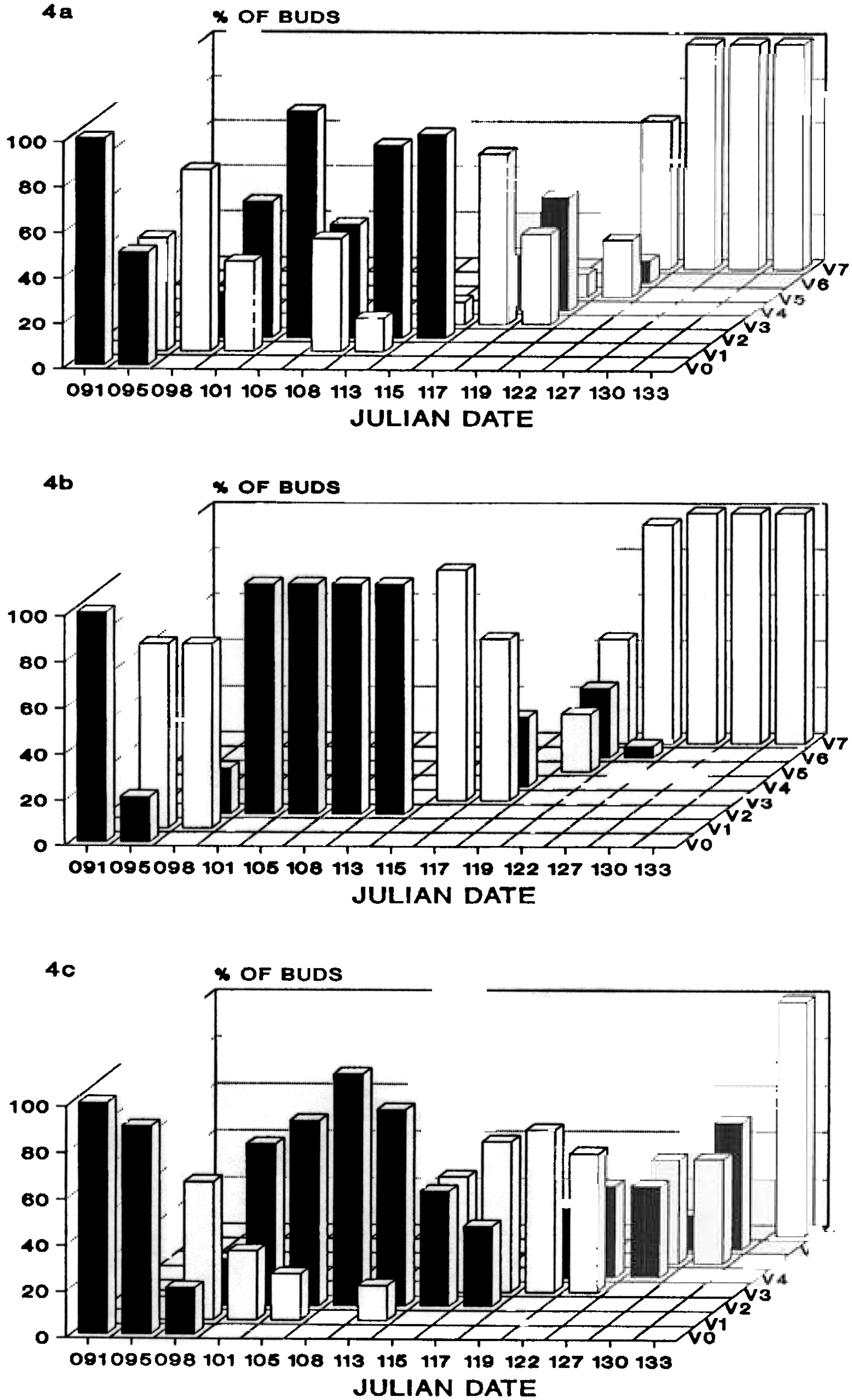


Figure 4a-c. Sugar maple tree 3, bud phenology. Developmental rate of upper canopy (4a), lower canopy (4b), and regeneration (4c) of tree 3, Proctor Maple Research Center, Mount Mansfield [1360 ft (415 m)], Vermont, 1991.

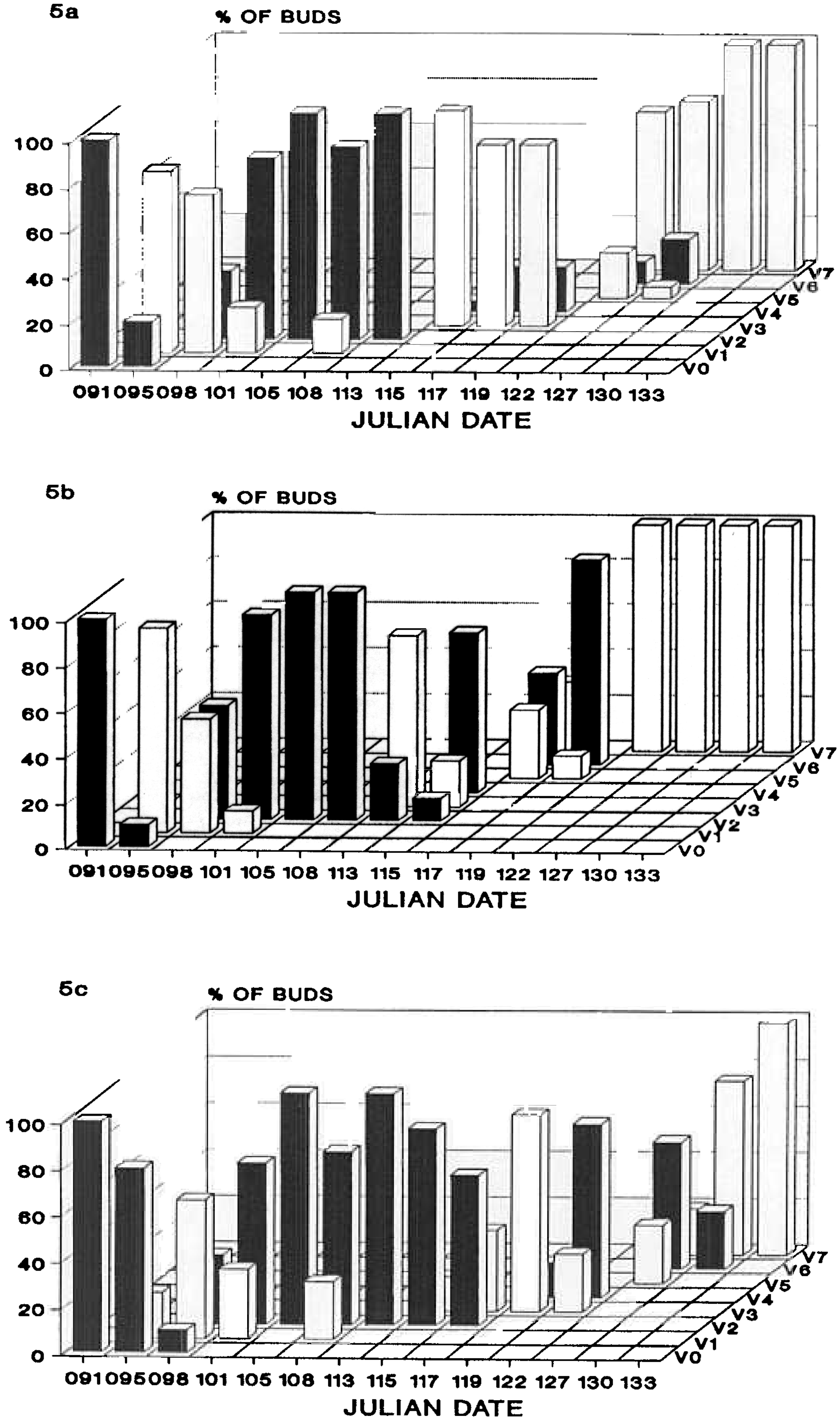


Figure 5a-c. Sugar maple tree 4, bud phenology. Developmental rate of upper canopy (5a), lower canopy (5b), and regeneration (5c) of tree 4, Proctor Maple Research Center, Mount Mansfield [1360 ft (415 m)], Vermont, 1991.

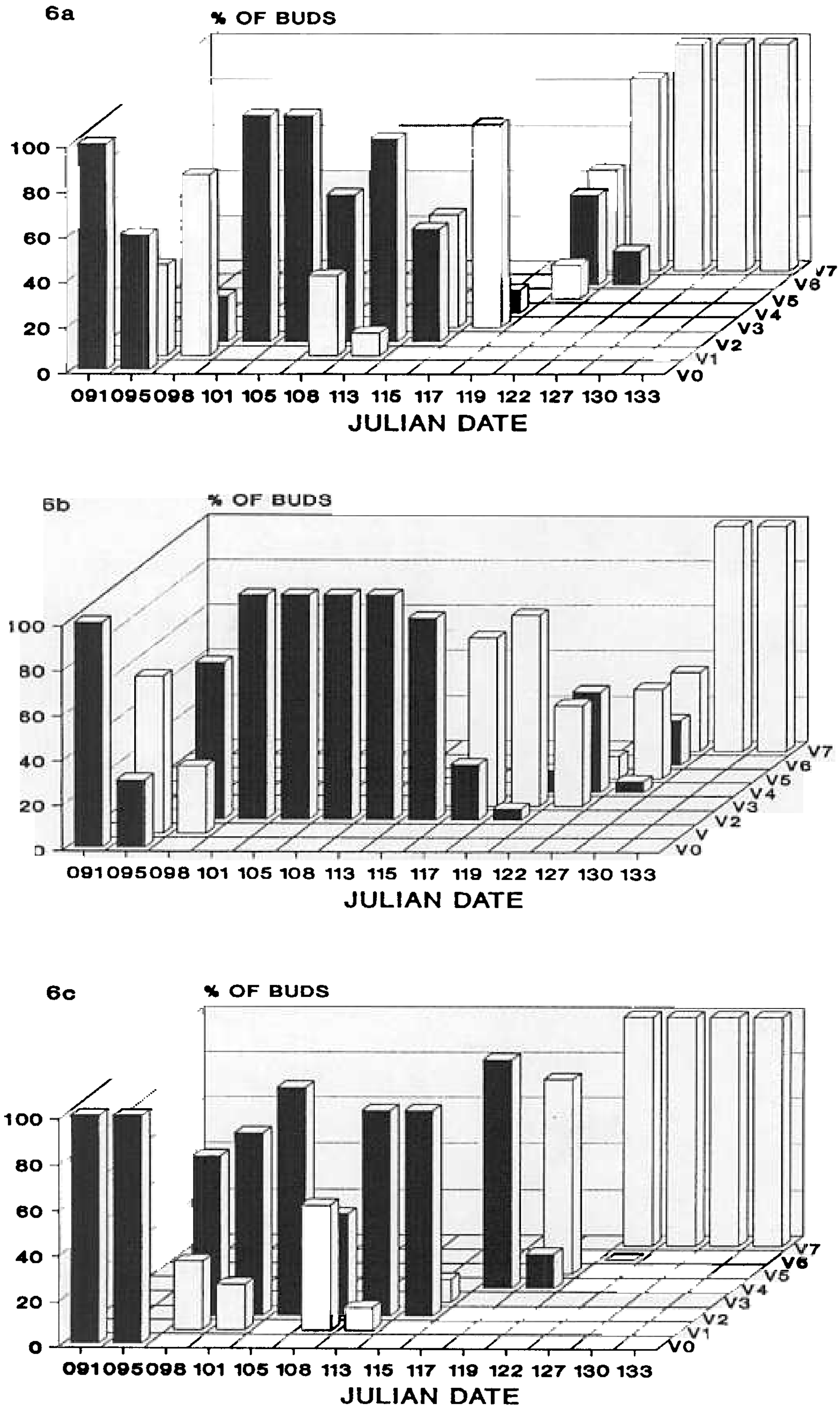


Figure 6a-c. Sugar maple tree 5, bud phenology. Developmental rate of upper canopy (6a), lower canopy (6b), and regeneration (6c) of tree 5, Proctor Maple Research Center, Mount Mansfield [1360 ft (415 m)], Vermont, 1991.

Discussion

Since budbreak is an important event in terms of insect pest activity, among others, it is interesting to note that although the average vegetative stage on JD 119 was V4, only the regeneration and lower canopy buds were at this stage. The upper canopy did not reach budbreak until 3 days later when the average bud stage had actually moved beyond this to the extended bud break stage (V5). In general, the upper canopy lagged behind the regeneration and lower canopy in timing of development.

Context

Bud phenology of sugar maple trees is being conducted at other locations in Vermont by the UVM Entomology Laboratory (B.L. Parker et al) in the context of understanding the relationship between insect populations (pear thrips) and bud phenology.

LEAF SIZE

Methods

Mid-canopy leaf samples were taken from the same 5 sugar maple trees used for bud phenology monitoring, 5 times throughout the growing season. Each sample consisted of 20 leaves collected from 4 sides of each tree. Leaves were pressed, dried and leaf surface area measured using both a leaf area meter and a modified swath kit (a computerized system developed for measurement of spray droplets used in insect pest suppression projects).

Results

Both the leaf area meter and the swath kit yielded the same results for each leaf measured, so results reflect both measurement types (Figure 7). Maximum leaf size was obtained on Julian date (JD) 165 (June 14), and was 44.21 cm^2. A decrease in leaf size occurred on the subsequent collections, probably due to defoliation from the maple leaf cutter, which was present at the site.

Discussion

This year was a good year for gaining baseline information on leaf size, since field observations found growing conditions to be favorable for early season leaf growth, generally low seed production and light insect activity.

Variation between collection dates could also have be affected by the presence of small, immature leaves, that persisted throughout the field season. As much as possible, leaves were collected in an unbiased manner, taking all leaves from a cluster of 3-5 leaves. But it is easy to see how these small leaves, ca. one-quarter the size of other leaves, could have changed average leaf

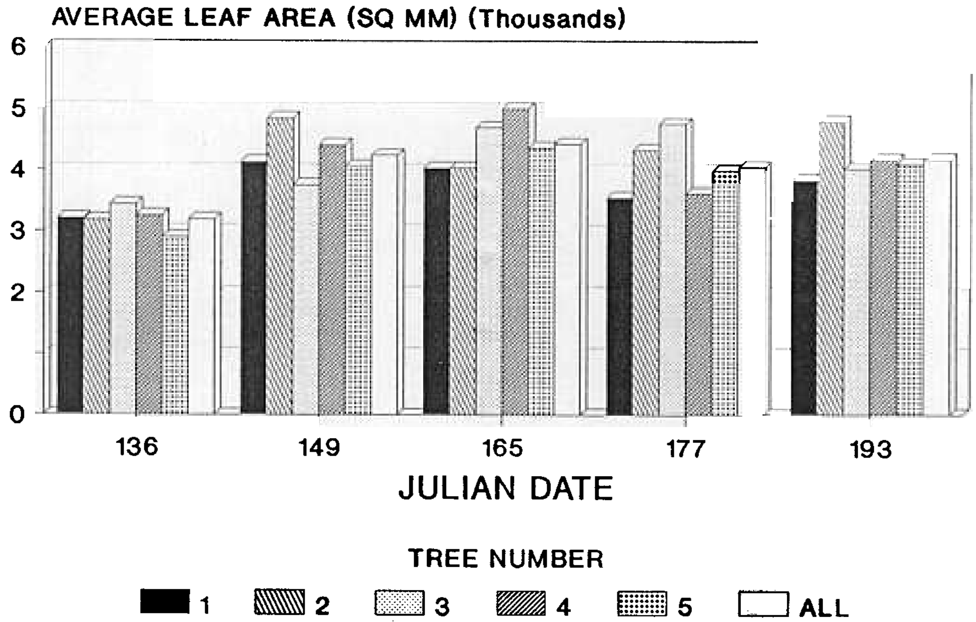


Figure 7. Sugar maple leaf size. Timing of full leaf expansion and average leaf surface area (mm^2), expressed in thousands, of sugar maple leaves collected from 5 mature trees at the Proctor Maple Research Center, Mount Mansfield [1360 ft (415 m)], Vermont, 1991.

size. The range of variation in calculating size was 7.85 to 13.57 %.

FALL PHENOLOGY

Methods

Leaf senescence and drop was measured on the same 5 sugar maple trees as bud phenology and leaf size studies. Visual crown ratings were taken from JD 207 (July 26) through JD 289 (October 16) [the time when all leaves on all trees had turned color] once every two weeks, with weekly ratings done when the rate of color change and leaf drop increased (JD 276-289, October 3-16). The visual crown rating system used is that used by the National Forest Health Monitoring Program (Conkling and Byers, 1992), where leaf discoloration (DS) measurement was used to measure change in coloration, and foliage transparency (TR) and crown dieback (DK) were used to measure change in leaf drop. All ratings were taken in 5 % classes.

Results

Data were analyzed as percent of leaves turning color or dropping (Figures 8-13). Initial ratings show the baseline ratings of each tree for this year. Significant coloration did not begin until JD 276 (October 3), when the average coloration was 62 %. There was a slight increase in leaf drop on this date, but leaf drop did not exceed 50 % until JD 289 (October 16).

Discussion

Although this crown rating system was not developed for this use, it worked well for this application. At the onset, we did not know whether to use TR or DK as an indication of leaf drop. Since some trees lost leaves from twig tips first, the DK rating served to indicated leaf drop. Other trees leaf loss was evenly distributed throughout the crown, and the TR rating better represented these individuals. For future applications, we will continue to take both measurements as an indication of the timing of leaf drop.

Future Plans

In 1992, we plan to add 2 additional species to this tree phenology study. In addition, the 3 species would be monitored at both the Proctor Maple Research Center and an additional site at a higher elevation on Mount Mansfield.

Funding Sources

This project was partially funded through the VMC grant from the USDA Forest Service. Additional support for leaf area measurements was provided by the UVM Entomology and the St. Albans Correctional Facility.

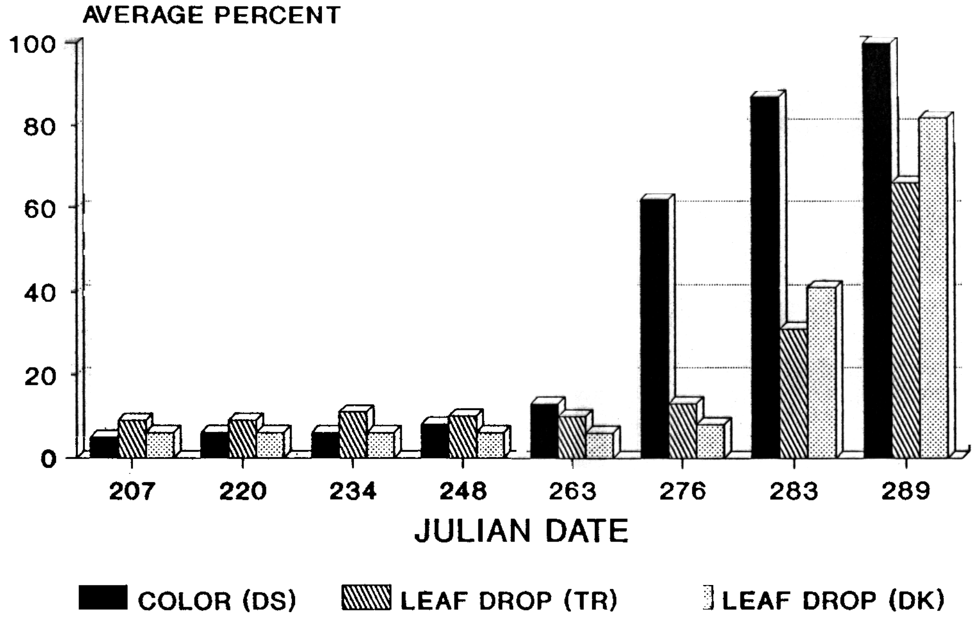


Figure 8. Sugar maple fall phenology. Average rate of fall leaf coloration and drop for 5 mature sugar maple trees, Proctor Maple Research Center, Mount Mansfield [1360 ft (415 m)], Vermont, 1991. Rating system is according to North American Maple Project protocols for foliage discoloration (DS), dieback (DK) and transparency (TR), expressed in a 12-class percentage rating system (Millers et al).

9a

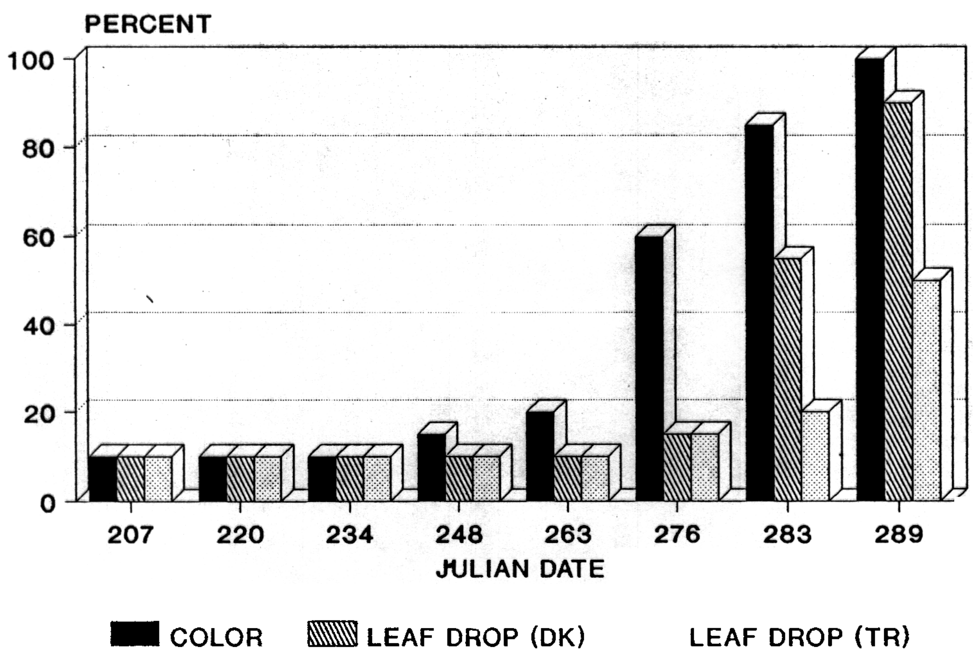
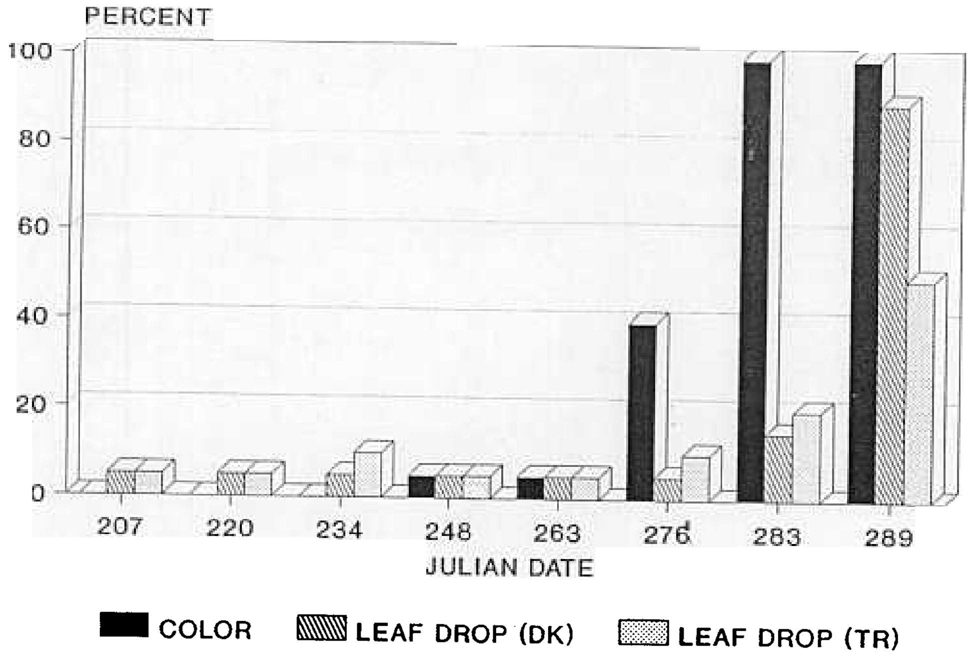
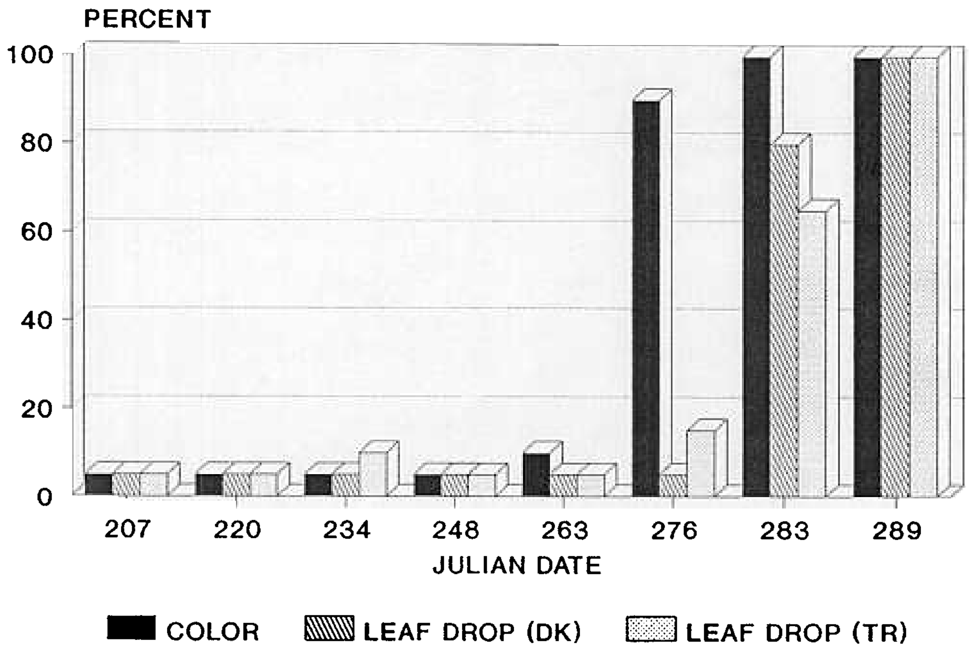


Figure 9a-e. Sugar maple fall phenology. Rate of fall leaf coloration and drop for 5 mature sugar maple trees [Tree 1 (9a), Tree 2 (9b), Tree 3 (9c), Tree 4 (9d) and Tree 5 (9e)], Proctor Maple Research Center, Mount Mansfield [1360 ft (415 m)], Vermont, 1991. Rating system is according to North American Maple Project protocols for foliage discoloration (DS), dieback (DK) and transparency (TR), expressed in a 12-class percentage rating system (Millers et al).

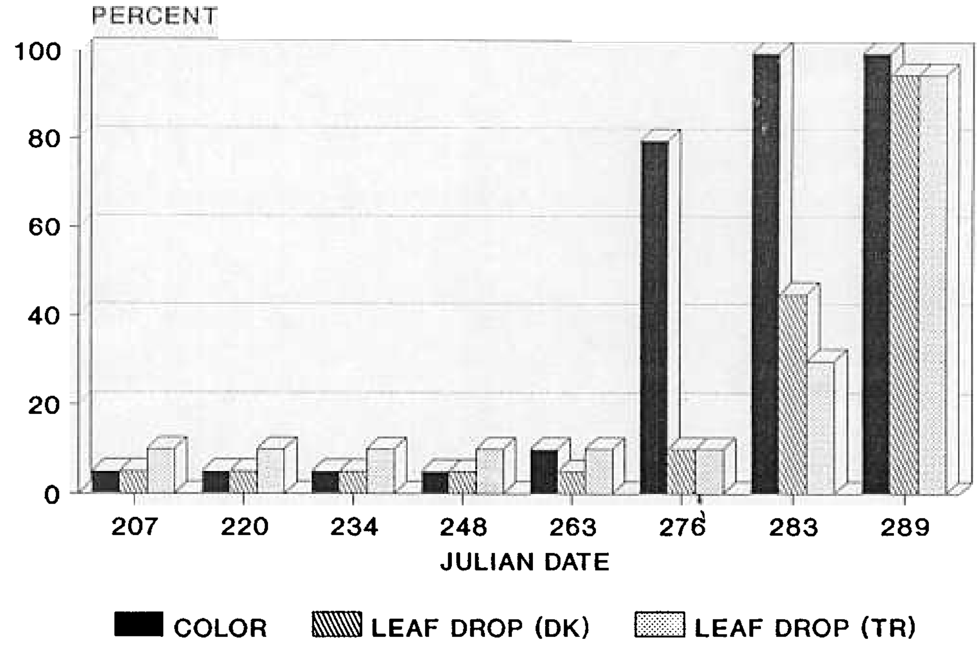
9b


PERCENT
100
80
60
40
20
0
207
220
234
248
263
276
283
289
JULIAN DATE
COLOR
LEAF DROP (DK)
LEAF DROP (TR)

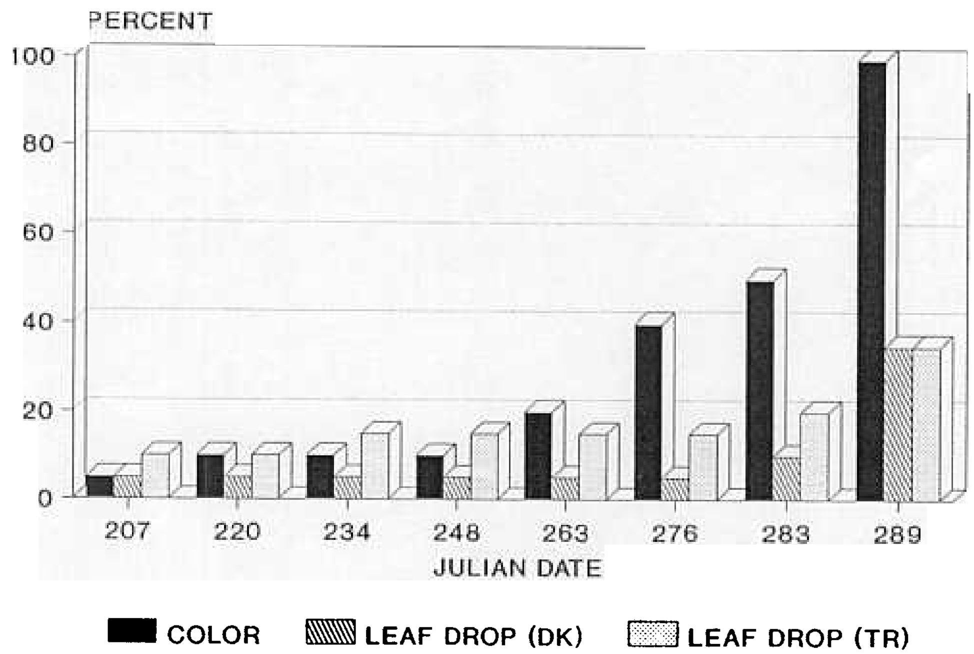
9c


PERCENT
100
80
60
40
20
0
207
220
234
248
263
276
283
289
JULIAN DATE
COLOR
LEAF DROP (DK)
LEAF DROP (TR)

9d


PERCENT
100
80
60
40
20
0
207
220
234
248
263
276
283
289
JULIAN DATE
COLOR
LEAF DROP (DK)
LEAF DROP (TR)

9e


PERCENT
100
80
60
40
20
0
207
220
234
248
263
276
283
289
JULIAN DATE
COLOR
LEAF DROP (DK)
LEAF DROP (TR)

References

Conkling, B. B. and G. E. Byers (eds.). 1992. Forest Health Monitoring Field Methods Guide. Internal Report. U. S. Environmental Protection Agency, Las Vegas, NV.

Millers, I., D. Lachance, W. Burkman & D. Allen. 1991. North American Sugar Maple Decline Project: organization and field methods. Gen. Tech. Rep NE-154. Radnor, PA: U.S. Dept. of Agr., Forest Service, Northeastern Forest Experiment Sta. 26 p.

Skinner, M. and B. L. Parker. 1991. Sugar Maple Bud Phenology Ground Monitoring Protocol (April 1991 draft). Entomology Research Lab, 655B Spear St., So. Burlington, VT 05403.