U. S. FOREST SERVICE RESEARCH NOTE NE-9

1963

Northeastern Forest Experiment Station

FOREST SERVICE, U.S. DEPT. OF AGRICULTURE, 102 MOTORS AVENUE, UPPER DARBY, PA.

EXCESSIVE EXPOSURE STIMULATES EPICORMIC BRANCHING IN YOUNG NORTHERN HARDWOODS

Sudden and excessive exposure of northern hardwood trees often causes growth responses that degrade tree quality, injuries that lead to tree deterioration, or both. The most sensitive and visible tree reaction to increased exposure is the formation of epicormic branches. Such branches may arise along the tree bole from either dormant or adventitious buds in response to some physiological stimulus. Often, but not necessarily always, they are associated with a decline in tree vigor. If they persist, knots develop and log and lumber quality are reduced.

Excessive exposure also may cause twig mortality and top dieback; it may lead to sunscald, snow-bending, glaze damage, and root mortality. In sensitive species such as yellow birch, many trees succumb completely after a few years. Epicormic branching may accompany or, in some cases, may be induced by these various forms of exposure damage (fig. 1).

Clearcutting in small patches (usually less than 1 acre each), which is gaining recognition as a silvicultural system in northern hardwoods for securing a high proportion of yellow and paper birch in the regeneration, has the drawback of suddenly exposing trees on the patch borders. The first patches in old-growth timber expose only mature trees, and epicormic branching here is not of serious concern. But patches cleared in the second and later cuttings adjoin previously cut patches and thus expose borders of young trees. Detrimental effects on these young trees are important because both future growth and timber quality may be impaired.

In a study of patch cuttings on the Bartlett Experimental Forest at Bartlett, N. H., we have become increasingly aware of undesirable after-effects of exposure. So in 1960 we began a small 1-year study of exposure

Figure 1. — Bent over by snow and afflicted by sun-scald, this 20-year-old sugar maple border tree has produced many epicormic branches.

Figure 2. — A typical border studied, as seen from a newly cut patch; 20-year-old trees on the left, 10-year-old trees on the right.

effects on 10- and 20-year-old border trees. We were concerned primarily with epicormic branches, but noted all manifestations of exposure damage except possible root mortality.

Study Methods

Four borders, each facing a different direction, were chosen in each age class. The borders consisted of the outermost trees growing in previously cut patches that were adjacent to new patches cut in 1960 (fig. 2). In addition to the border trees, unexposed trees were marked along a line 1 chain inside the stand and parallel to the south-facing borders. Five sample trees each of yellow birch, sugar maple, and beech were then chosen at random from each border and from each of the two interior lines. The condition of each sample tree was recorded soon after the cutting in 1960, and again 1 year later. A chi-square test was used to test significance, at the 5-percent level, of differences in numbers of epicormic branches among species, age classes, and exposures.

Most of the tags marking sample trees in the two east-facing borders were missing when the final observations were made, so the following results are based on 15 border trees in each age class instead of the original 20.

Results and Discussion

The exposed south-facing border trees produced significantly more epicormic branches in 1 year than did trees growing 1 chain inside the stands. For both age classes combined, about three times as many epicormic branches were produced by the border trees as by the interior ones.

Direction of exposure showed no consistent effect upon number of epicormic branches. However, direction undoubtedly influences intensity of exposure, and differences in exposure effects other than epicormic branch formation did show up.

Among species, striking differences were observed in the formation of epicormic branches. Yellow birch was by far the most prolific, producing a total of 66 branches among the 30 border trees in the final sample. The sugar maples produced 29 branches; the 30 beeches produced only 5. Expressed as a ratio, the three species rank 13 : 6 : 1 respectively in epicormic-branch production. These differences were significant by chi-square test. The tabulation below shows average numbers of branches per tree by species and age classes (rounded to nearest tenth):

	10-year	*20-year*	*Age classes combined*
Yellow birch	0.9	3.5	2.2
Sugar maple	.2	1.7	1.0
Beech	.3	.1	.2

As this tabulation shows, the 20-year-old birches and maples formed many more branches than the 10-year-old trees; and these differences are significant. However, the differences may not be entirely a physiological effect of age. The older trees, being larger, had more bole surface on which branches might originate, and this size factor in itself may be important. Size almost certainly would be important if the main source of branches was adventitious buds. Even if, as seems likely, the main source of branches is dormant buds, the number of branches might increase with tree size: larger trees offer more area to exposure and possible stimulus of dormant buds by light, heat, and other atmospheric factors; larger trees may have undergone more natural pruning, thus baring the boles and increasing their exposure; and larger trees may have more potentially active buds because of envelopment of more basal branch buds in addition to the original complement of stem buds. So, although tree age may well be a direct factor affecting the number of epicormic branches, it probably functions also as an indirect factor operating through tree size.

Some sun-scald and snow bending also occurred. Sun-scald was most prevalent on 20-year-old sugar maple and beech on the south-facing border. Here it caused extensive death of bark along the tree boles, followed by discoloration of the underlying wood. Three of the five sample trees of sugar maple and one of the five beeches on this border were severely damaged by sun-scald. No sun-scald was observed on yellow birch: the light-colored bark of this species, which would reflect much of the heat and light, possibly was a factor in its resistance to sun-scald damage.

Snow damage was more prevalent on all of the borders than sun-scald, but was not so injurious to the individual trees. Most noticeable on the 20-year-old borders, snow-damaged trees usually were bent over in an arc or in a pronounced lean toward the center of the clearcut patch, no doubt because the mechanical support of adjoining trees on that side had been removed. Most trees damaged by snow seemed likely to recover.

Little top dieback or twig mortality had occurred on these 10- and 20-year-old trees. Though some foliage was discolored, serious crown damage, if it appears at all, probably will not show up until after several growing seasons. Because of the youth and vigor of most of the sample trees, they may adjust to the changed environment without appreciable dieback in the crowns.

Origin of Epicormic Branches

The study afforded an excellent opportunity to explore the origin of epicormic branches. Theoretically, epicormic branches can develop from either dormant or adventitious buds. By definition, a dormant bud is connected to the pith and primary xylem of the parent stem or branch by a strand or trace of pith and primary xylem tissue. As the parent stem or branch grows in diameter, the strand elongates and the bud continues to lie just under the bark. Upon receiving a suitable stimulus, the dormant bud may become active and produce a branch. An adventitious bud, on the other hand, originates in place, usually from the cambium as a result of injury or other stimulus; it has no strand connecting it with the center of the parent stem.

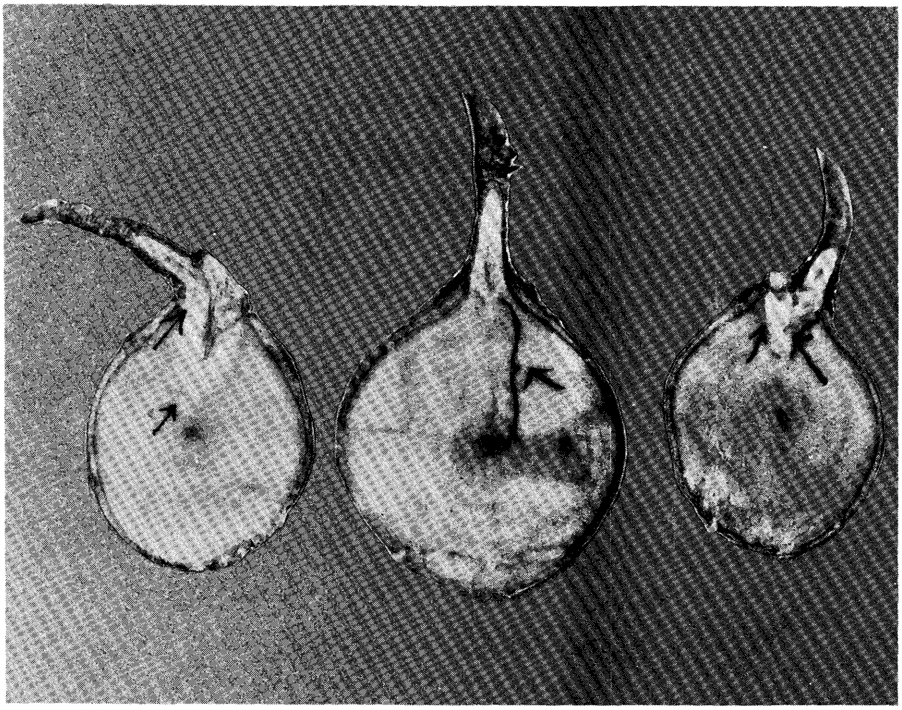

Figure 3. — Cross-sections of yellow birch saplings showing bud strands connecting with epicormic branches. The center section shows a strand originating at the pith of the tree; those on either side show strands originating from old branch knots.

About 30 epicormic branches from several sugar maple and yellow birch saplings from the borders were dissected to determine branch origin. In all cases, including one with cambial injury (sun-scald), the branch was connected to a typical strand extending back into the underlying wood, which confirmed its origin from a previously dormant bud.

However, not all of the bud strands could be traced back to the pith of the parent tree. Particularly in yellow birch, the bud strands of many of the epicormic branches appeared to begin along old branch knots some distance from the pith of the main stem (fig. 3). We could not definitely follow these strands all the way to their origins; presumably they led to old leaf axils at the base of the primary branches that had given rise to the knots. The lower primary branches now were dead and mostly broken off, and the old leaf-axil sites had been enveloped by growth of the main stem, but the axillary buds apparently had maintained their identity and had moved outward as the main stem grew in diameter.

These observations invite a few questions. Does the potential of a tree to form epicormic branches from dormant buds increase with the number of old branch stubs within the tree? Can the number of dormant buds be limited to a significant degree by the early artificial pruning of live limbs? Does the persistence of dormant buds from old branch bases in itself mean that larger trees will produce more epicormic branches than smaller trees?

If all epicormic branches came from dormant buds that had originated on the main stem, the potential of a tree to form such branches would be essentially the same throughout its life. By the same token, if such branches came from adventitious buds or a combination of dormant and adventitious buds, the epicormic-branch-forming potential of a tree would theoretically increase with an increase in the surface area of the tree. If, as our observations indicate, dormant buds from old branch bases persist, the feathering-out potential of a tree may be related to the number of branch stubs within the tree bole. Further study on the origin of epicormic branches should provide some answers to these questions.

—BARTON M. BLUM

Research Forester
Northeastern Forest Experiment Station
Forest Service, U. S. Dept. Agriculture
Laconia, N. H.