Gaultheria procumbens at Pine Hills, Indiana —Its Measured Decline, 1951-1971

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Abstract

Perimeters of *Gaultheria procumbens* L. (Wintergreen) populations in Pine Hills Natural Area, Montgomery County, Indiana, were mapped at decade intervals from 1951 to 1971. Associated dominant trees were measured, and their date of "zero diameter" was calculated. *Gaultheria* densely covered an area of 204 m^2 in 1951, continued healthy with an area of 307 m^2 in 1961, and declined precipitously to 26.3 m^2 plus 23 separate plants in 1971. Suggestions are made that survival of *Gaultheria* at Pine Hills is associated with the formation of acid soils weathered from Borden sandstones and protected from calcareous leaching by a deeply meandered stream system, and that its near-disappearance by 1971 is accompanied by re-establishment of hemlock and pine. *Cornus rugosa* Lam. (Roundleaf Dogwood) on the adjacent cliffs of Borden sandstone remained nearly constant, with a population of 147.

Introduction

Gaultheria procumbens L., or Wintergreen, is a northern plant that ranges from Newfoundland to Manitoba and extends south in the Appalachians to northern Georgia and Alabama. In Indiana it is largely a post-glacial relict (3), known only in five countries south of the northern third of the state (2). In the first discovered (1) and perhaps the best known of these stations, a population in the Pine Hills Natural Area, Montgomery County, the species was observed, during a recent 20-year period, to be undergoing a rapid decline in numbers and vigor, suggesting that local extinction may be imminent.

The Pine Hills Natural Area, in southwestern Montgomery County, Indiana, is a region of steep cliffs, cool north-facing slopes, and well-leached acid ridges. The physiography has been described by Smith (8), the vegetation has been mapped by Friesner and Potzger (4), and the flora has been carefully inventoried by McCormick (6). Pine Hills is most noted for an impressive series of incised meanders of Indian Creek and the subsidiary Clifty Creek, tributaries of Sugar Creek, the principal drainage channel of the region. Pleistocene meltwaters deeply entrenched Sugar Creek in the glacial deposits and the underlying bedrock, and these tributary streams cut down to the same level, while still conforming to the meandering course that they had established in the mature pre-glacial topography. At seven places in the Pine Hills area these streams bend back upon themselves, or upon each other, to form steep sided ridges or "backbones" up to 70 m long and 33 m above the stream beds. In 1960 The Nature Conservancy completed purchase of Pine Hills, then presented it to the State of Indiana for maintenance in perpetuity as a wilderness (6). It was appropriately given a rating of "1" by Lindsey et al. (5), indicating the highest evaluation as a natural area.

Description of Mill Cut Backbone

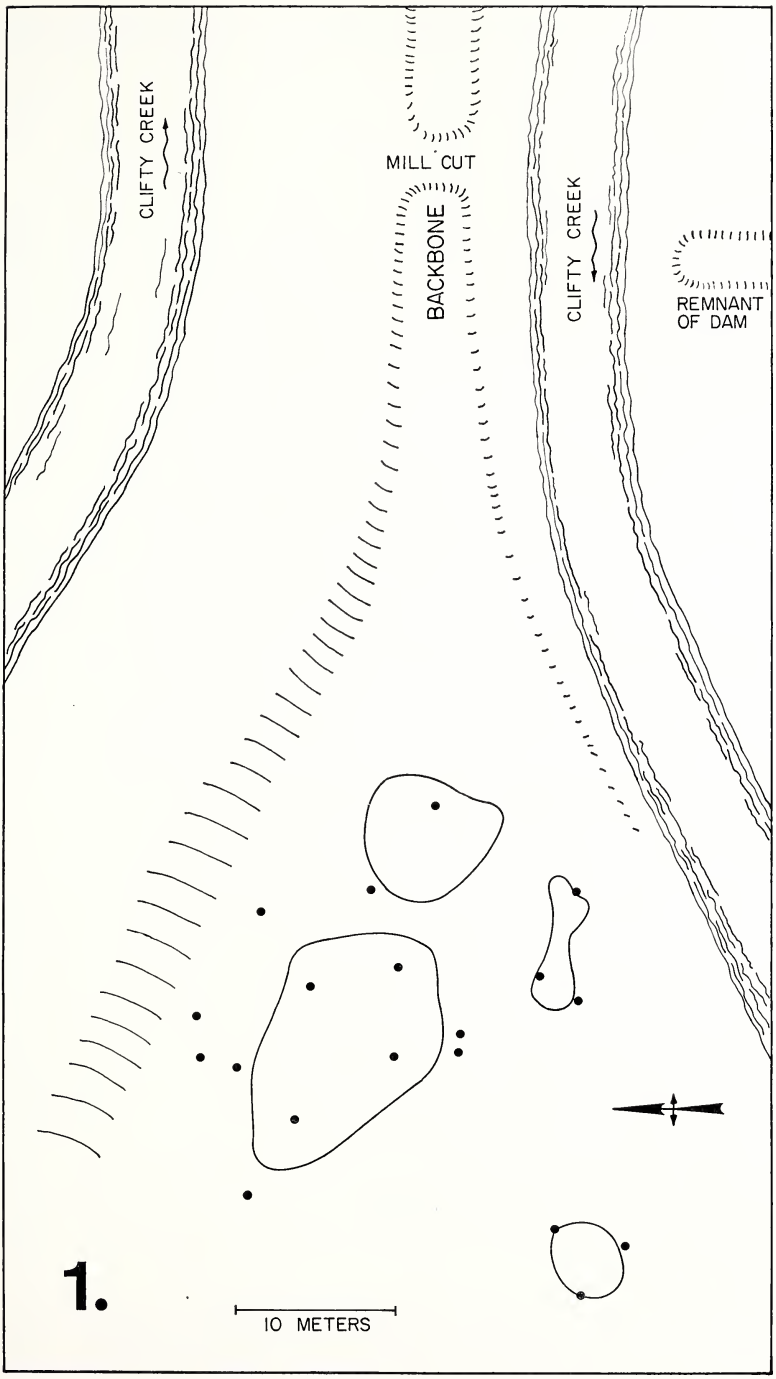
The backbone known as "Mill Cut" is formed by a looping bend of Clifty Creek (Fig. 1). Clifty Creek, in its headwaters flowing generally northward, abruptly changes direction to the west, circles widely to the north and east, and approaches the course of its westward channel before again turning northward. The westward and eastward legs of the creek thus flow in opposite directions but in close proximity. They are separated by a ridge or wall of Borden sandstone (8) closely approached on the southern exposure by the west-flowing channel and somewhat less closely on the north by the east-flowing lower course of the stream. This wall has been formed by the progressive and relatively rapid erosion of the sandstone by the flowing stream, aided by the winter freeze-and-thaw spalling of large stone plates parallel to the exposed surface, a distinctive property of the Borden formation. This erosion, no doubt much accentuated in times of glacial run-off, has produced a channel that varies in depth from about 9 or 10 m at the lowest point of the backbone to over 20 m at the east and where the backbone merges with the adjacent upland.

The millcut, a man-made square notch through the narrowest and lowest portion of the backbone, is about 6 m deep and 3 m wide. It lacks 3 m of reaching the bed of the west-flowing channel (Fig. 1). The cut was made in 1868 to supply water power to a small woolen mill on the terrace of Clifty Creek just north of the Mill Cut Backbone (6). A crib dam of hemlock logs, filled with rock rubble, was built across Clifty Creek on its westward leg just downstream from the cut; a low mound outlining this dam was still discernible in 1971. Water impounded by this dam passed through the cut, along a wooden flume, to an overshot wheel in the mill. The mill was discontinued and the equipment removed in 1873. Except for the millcut, traces of the dam, and a remnant of the access road up the slope to the south of the backbone, the only present indications of human disturbance are in subtle features of plant distribution.

The *Gaultheria* Population

The only *Gaultheria* in the Pine Hills region grows in the loop formed by the circling Clifty Creek, just west of the millcut. As the creek entrenched itself in the Borden formation it swung ever wider in the westward portion of its bend. It left a knoll at the west end of the backbone, the north side of which was continuous with the backbone's north face, although less sheer and more vegetation covered, with the south side sloping gradually to a low bench just above the west-flowing leg of the stream. It is on this gradual south-facing slope that the *Gaultheria* has survived.

FIGURE 1. *Map, showing Mill Cut Backbone, Pine Hills, and associated stands of* Gaultheria *in 1951. Clifty Creek flows from the upper right, downward along the south face of the Backbone, then circles widely (off the plate) to reappear on the north face of the Backbone. Within this loop of Clifty Creek a knoll (indicated by hatch lines) extends eastward to a cut where a millrace was once located. The* Gaultheria *occurs in four separate colonies (represented by the solid lines). Major trees are indicated by dots.*


CLIFTY CREEK
MILL CUT
BACKBONE
CLIFTY CREEK
REMNANT OF DAM
1.
10 METERS

The slope is sparsely covered with mature but somewhat stunted trees. Toward the crest, northern red oak (*Quercus borealis*), black oak (*Q. velutina*), and a few large hemlock (*Tsuga canadensis*) predominate, while lower down white oak (*Q. alba*) and white pine (*Pinus strobus*) appear. Beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum)* are on the bench near the stream. Linden *(Tilia americana*), tulip-tree (*Liriodendron tulipifera*), redbud (*Cercis canadensis*), and blue-beech (*Carpinus caroliniana*) occur only at the stream edge, below the *Gaultheria* population. The crest of the slope bears a rich understory, containing black gum (*Nyssa sylvatica*), flowering dogwood (*Cornus florida*), red cedar (*Juniperus virginiana*), witchhazel (*Hamamelis virginiana*), and wild hydrangea (*Hydrangea arborescens*). These are replaced lower on the slope by shadblow (*Amelanchier arborea*), ironwood (*Ostrya virginiana*), red maple (*Acer rubrum*), maple-leaf viburnum (*Viburnum acerifolium*), sassafras (*Sassafras albidum*), partridgeberry (*Mitchella repens*), and running euonymus (*Euonymus obovatus*). Wintergreen (*Gaultheria procumbens*) occurs only on this slope, below the crest and extending to the stream bench.

Circumference measurements of the larger trees of the *Gaultheria* slope give a degree of insight to the earlier appearance of the area. Sixteen individuals were measured for the entire 20-year period, several others dying in the interim. Perhaps the most meaningful statistic derived from these measurements, in light of the need to understand the earlier vegetational history of the slope, is the date of "zero diameter," a calendar date obtained by extrapolating backward the tree's growth in diameter as measured over the last 20 years. This figure is understandably problematical, but places less stress on the specimen trees than increment borings, and is the only approach available in a protected forest.

The only measured hemlock in the area of the *Gaultheria* population, of several large individuals along the crest of the knoll, gave a zero diameter date of 1671, a compelling statement of its presence throughout historic times. Four white pines gave less conclusive dates of 1812, 1838, 1895, and 1927. The two black oaks with full data gave dates of 1854 and 1858; larger individuals present in 1951 died before 1971. Six white oaks yielded 1704, 1815, 1821, 1832, 1887, and 1901. A solitary beech and a sugar maple showed little growth during the study period.

The aspect of the *Gaultheria* slope changed markedly during the 20 years it was under observation. It was first sunny and open, with *Gaultheria* forming dense green mats that were vigorous and sharply delimited. The slope became progressively more thickly covered with sapling hemlocks (most of them becoming 2-4 m tall with 1-3 cm basal diameters) plus a smaller number of young white pines. At the final survey no more than 5-15% of the soil surface was exposed to the noonday sun. The surviving *Gaultheria* plants were scattered in this dense thicket.

In June, 1951, in 1961, and in 1971, the *Gaultheria* population was carefully mapped. Larger trees served as reference points, and their diameters were measured on each occasion. The perimeters of the

Gaultheria colonies were recorded, a simple task on the open slope of 1951, but less easily achieved in the young hemlock and pine thicket of 1961. By 1971 the colonies had fragmented, with a meaningful perimeter no longer persisting; in this situation individual plants were located and marked only with difficulty.

The 1951 observations recorded *Gaultheria* in four wholly distinct and sharply demarked colonies (Fig. 1). These ranged in area from 130 m^2, to 16 m^2 and together covered 204 m^2. The horizontal stems were closely entangled, with numerous forkings and abundant evergreen foliage. They were estimated to have the capability of extending the colony about 10 cm in a single year, a figure smaller than that indicated by later measurement.

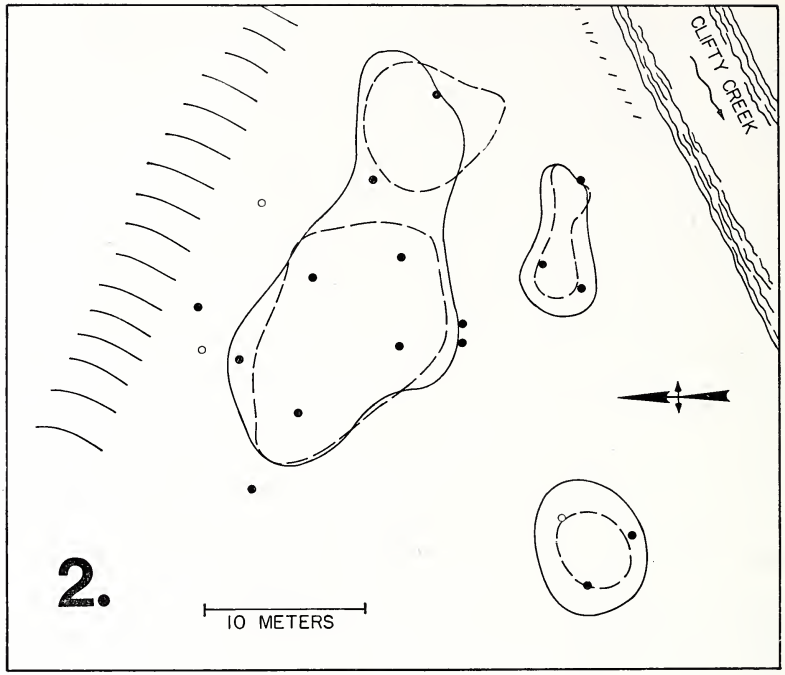
The 1961 observation yielded a similar pattern (Fig. 2). Each of the four colonies was slightly enlarged, two of them having met and become one. The total area covered was 307 m^2. The maximum distance *Gaultheria* was found outside the 1951 perimeter was approximately 150 cm, suggesting an annual rate of spread of 15 cm. The colonies remained dense, in some locations very much so, but a future decline was adumbrated by the disappearance of *Gaultheria* from part of the easternmost portion of the population.

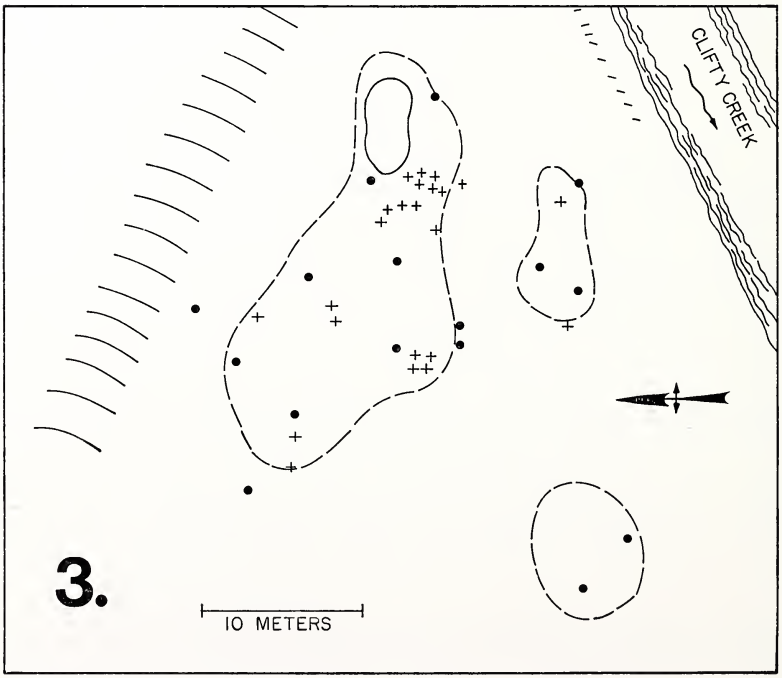
By 1971 the situation had changed markedly (Fig. 3). The *Gaultheria* colonies had lost their discrete outlines, and in most of the area the plants had disappeared. No *Gaultheria* was found on the site of the previously smallest colony and only two plants survived of the other smaller colony. The formerly extensive merged colony was reduced to a small area of 16.3 m^2, containing no more than 5 to 10 leaf-bearing stems/m^2, plus some 21 scattered plants. No plants were found more than insignificant distances outside the 1961 perimeter.

Discussion

Speculation as to the causes of disappearance of a plant species is usually difficult because of the absence of time-coupled quantitative records. In this instance, with population data spanning 20 years, some degree of credibility may perhaps be attached to suppositions drawn from historic events, although the full causative factors remain elusive.

It may be assumed, from the absence of *Gaultheria procumbens* elsewhere in the Pine Hills region, that this boreal species has persisted on the south-facing slope at the west end of the Mill Cut Backbone since the glacial recession. With decomposition, the Borden sandstones yield an acid soil which appears a necessary factor for the persistence of white pine, hemlock, and very possibly *Gaultheria*. Hemlock and pine seedlings are known to prefer soil of high acidity. At Pine Hills, Potzger and Friesner (7) found hemlock reproduction to be most vigorous on soils with pH near 4.5. The predominance of hemlock and pine on the slopes of the various backbones of the Pine Hills, and particularly on the knolls which rise at the ends of these backbones within the loop of the encircling stream, a distribution which has been excellently mapped and portrayed by Friesner and Potzger (4), may be accentuated by the absence of calcareous seepage from the overlying soils


CLIFTY CREEK
2.
10 METERS


CLIFTY CREEK
3.
10 METERS

of glacial origin on the surrounding uplands. The meandering streams with their deeply entrenched channels effectively isolate these backbones and their knolls from sources of non-acid influence.

The presence of *Gaultheria*, a northern plant, on a south-facing slope is thus not an anomaly of distribution. The species may have a requirement for acid soil that is more critical for its survival than is the coolness and moisture of other sites in the Pine Hills area.

Almost surely the slope where the *Gaultheria* now grows was until historic times forested predominantly with hemlock, as presently are similar sites near the other backbones. In pioneer days the low worth of hemlock timber and the difficult terrain, and in more recent times a series of protective landowners, have preserved the forest cover of the Pine Hills. The absence of mature hemlock from the *Gaultheria* slope at the west end of Mill Cut Backbone seems associated with the commercial exploitation of the site during construction of the woolen mill in 1868. Although the millcut did not disturb the *Gaultheria* and the mill itself was on the opposite side of the backbone from the slope on which it grows, the construction of the log crib dam must have had significant impact.

Beyond the statement that the dam was once about 4.6 m tall (6), there is no basis for calculation of the volume of timber required for an effective barrier to the flow of Clifty Creek. Nor is there an estimate for the quantity of hemlock that once stood on the slope just downstream from the dam site. But there seems little reason to doubt that the most convenient source of materials for the dam would have been the immediately available easily-worked softwoods on the *Gaultheria* slope. It is a comfortable speculation that this slope was shorn of its hemlock and pine in 1868, with the task completed before reaching the few large hemlocks now standing on the crest. The age of the other trees suggest that some individuals were a minor component of the original hemlock forest, while others, and perhaps all of the black oak, came in at or soon after the time of disturbance.

A possibility exists that removal of the hemlock from the slope at the west end of the millcut, rather than accelerating the decline of the *Gaultheria*, may indeed have been the agent that prolonged its survival into the present century. When first measured in 1951, the *Gaultheria* was growing vigorously in sharply delimited colonies, scarcely the pattern to be anticipated in a static or declining situation. Nor could such a vigorous condition be of long duration, for with the plants capable of spreading at the rate of 10 to 15 cm per year, no more than one or two centuries would have been required for it to become an omnipresent groundcover on the Mill Cut knoll. Since no point in the 1951 colonies was more than 4.9 m from the periphery, by the smaller estimate of

FIGURE 2. *Map, showing status of* Gaultheria *population in 1961. The previous colonies have now expanded somewhat over the 1951 perimeters (represented by dashed lines). Trees dead since 1951 are indicated by hollow dots.*

FIGURE 3. *Map, showing status of* Gaultheria *population in 1971. The stand remains dense in only one area (enclosed by solid line); elsewhere, solitary surviving plants are represented by crosses (+).*

10 cm per year, approximately 50 years would have been sufficient for development of the largest colony. This figure may be within permissible limits of error of the 83 years that had elapsed since construction of the dam and probable logging of the *Gaultheria* slope.

If the *Gaultheria* on the Mill Cut knoll in 1868 was in a condition of decline, or at the verge of extinction, for reasons that were associated with the hemlock overstory, the removal of this timber may have been a reprive in its population trend. The *Gaultheria* plants surviving in 1868 would have undergone a resurgence that led to the vital colonies observed in 1951. Although these colonies may have been formed by the merger of smaller clones, it may be that in 1868 *Gaultheria* in the Pine Hills was reduced to as few as four surviving plants. Had the millcut not been built, and the hemlock timber removed, the present century might well have never known *Gaultheria* from Montgomery County, Indiana.

The re-establishment in the last quarter century of a vigorous young hemlock and pine forest on the slope of the Mill Cut knoll has reversed, once again, the population trends of the *Gaultheria*. Although the Wintergreen colonies were clearly vigorous in 1951, and appeared to continue so until 1961, the following decade saw an abrupt crash that coincided with the development of the conifer thicket. A continuation of this most recent trend for no more than a few years must result in the extinction of *Gaultheria* in the Pine Hills.

A Second Relict, *Cornus rugosa*

An additional plant of the Mill Cut Backbone, similarly a relict of cooler post-glacial climates, is *Cornus rugosa* Lam., the Roundleaf Dogwood. Deam (2) recorded this shrub in Indiana only in five counties along the northern edge of the state, and in Montgomery County at the Pine Hills station. It is thus even rarer in Indiana than *Gaultheria*, and proportionately more precarious in retaining its place among the subboreal vegetation of central Indiana.

At Pine Hills this *Cornus* is known only on the bare rock cliffs and dry crest of the Mill Cut Backbone, just east of the wooded slope on which the *Gaultheria* occurs. In June, 1951, an approximate tally was made of the number of plants to be seen on this limited habitat, east and west of the millcut itself, as follows: west, on north side—61 plants; on south side—38 plants; east, on north side—26 plants; on south side—0 plants. An additional 22 plants were seen on top of the backbone, yielding a total population number of 147. A count in September, 1971, gave somewhat smaller but perhaps not significantly different results, implying that *Cornus rugosa* during the two intervening decades has resisted the downward population trend of its northern associate, the *Gaultheria*.

The exposed rocks of the Mill Cut backbone are all shaley sandstones of the Borden formation (8). The southern exposure, other than for the bisection provided by the millcut, appears uniform; yet, while *Cornus* is frequent west of the cut, it is wholly absent east. A tentative explanation may lie in the location of the mill dam, just west of the

cut, which would have flooded the lower portion of the cliff upstream, with capillary seepage changing the habitat of the bluff immediately above. Although the mill was removed in 1873 (6), and doubtless maintenance of the dam terminated at that time, the century since elapsed has not seen re-establishment of *Cornus* on the denuded cliff face.

Acknowledgments

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