The Status of Flowering Dogwood in Five Long-term Forest Plots in Connecticut

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ABSTRACT

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Long-term forest plots were established by The Connecticut Agricultural Experiment Station in 1927 and were censused in 1937, 1957, 1967, 1977, and 1987. The number of native flowering dogwood trees declined slowly as the forests matured, going from a total of 661 in 1927 to a total of 603 in 1977. Between 1977 and 1987, the total number of living dogwood trees declined by 86% to 82, in marked contrast to the change in numbers of other species in the subcanopy. No "edge-effect" was found, with mortality higher in the forest than along forest edges as reported by others. The death of the dogwoods was not correlated with moisture class of the sites, or age or growth rate of the trees themselves.

Flowering dogwood trees, *Cornus florida* L. are a conspicuous part of the forest ecosystem in Connecticut. As hardwood forests progress toward climax, dogwood trees are expected to remain an important subcanopy species (4). A sudden decrease in the number of dogwoods was noted when long-term forest plots regularly censused by The Connecticut Agricultural Experiment Station were examined in 1987 (7). This sudden decrease is similar to that reported by Sherald et al. in their Catoctin Mountain Park site in Maryland (6). Sherald et al. also reported that there were 11 dead trees out of 35 in the forest, but only 17 dead out of 92 along a road (31 and 19% mortality, respectively). We have also examined the records kept on the census of long-term plots in Connecticut to see whether an "edge effect" is apparent in our data, and whether there are any correlations with site moisture, tree age, tree size, tree growth rate, or summer drought.

MATERIALS AND METHODS

The five long-term forest plots contain a total of 4.63 hectares in central and south-central Connecticut. All sites had previously been logged or farmed, and were reverting to forests when the study began in 1927. Data have been kept on all woody stems at least 1.3 cm in diameter at breast height (dbh), by site and moisture classes (7). Stems were censused in 1927, 1937, 1957, 1967, 1977, and 1987, and tree age was estimated from stand age for trees present in 1927, or determined from when the tree first appeared in the census records. A portion of one of the four original plots was burned in 1932, and this area was designated a new plot. Areas where there has been illegal cutting were excluded from this analysis. There have been four major insect defoliation events (1961, 1964, 1971, and 1981). The soils are acidic (pH 4.5 to 6.0), and are very stony to extremely stony, fine sandy loams derived from gneiss and schist glacial tills. Topography is gently rolling, with elevations ranging from 90 to 170 m. The area is in the northern temperate climate zone, with an average of 176 frost-free days per year. Mean monthly temperature ranges from –3.7°C in January to 23°C in July. Average annual precipitation is 112.8 cm per year evenly divided over all months. Rainfall data reported here are from Bradley Field in Hartford, CT (5).

Site histories, and stand composition were reported by Stephens and Ward (7). Soil moisture classes were those used by foresters: moist (very poorly drained and poorly drained), medium moist (imperfectly or somewhat poorly drained, moderately well drained, and well drained), and dry (somewhat excessively drained, and excessively drained).

Differences in mortality among classes for each period were tested with procedures previously described (10), which use a modified t test with a pooled estimator. For some data, Fisher's exact test was used.

To examine the edge effect discussed by Sherald et al. (6), our data were separated in the same manner, with "edge" trees being those within 10 m of a gravel road, or within 5 m of an unimproved road, and "forest" trees those in areas that were not near roads.

RESULTS

The number of *C. florida* dropped suddenly between the 1977 and 1987 censuses in all of the plots where dogwoods were found in substantial numbers (Table 1). The stems appeared to have been dead for some time when the 1987 census was made. When the data is separated by moisture class, no difference is seen in dogwood mortality on moist, medium moist, or dry sites during this period (Fig. 1). There was also no difference in mortality by diameter class (Fig. 2) ($P < 0.001$), or tree age (Fig. 3) ($P < 0.001$), with old and young, large and small trees dying at similar rates. During the period 1967 to 1977 mortality was higher for the trees that were growing more slowly ($P < 0.05$; fastest growing class not included because the number of trees was too low), but from 1977 to 1987 mortality was very high for dogwoods in all of the growth-rate classes (Fig. 4).

There was no evidence for "edge effect" mortality difference in these plots. In 1987, 87% of the "forest" dogwoods that were

Table 1. Number of *Cornus florida* found in the Connecticut long-term forest plots in each year that the plots were censused[a]

	Census year					
Site	**1927**	**1937**	**1957**	**1967**	**1977**	**1987**
Turkey Hill	257	212	173	151	137	13
Turkey Hill, burned (1932)	208	1	341	208	142	6
Cox	62	47	52	86	152	21
Reeves	85	71	60	81	151	31
Cabin	49	31	29	25	21	11
New dogwoods, all sites	...	61	476	103	204	14

[a] Part of the Turkey Hill plot was burned in 1932 (leaving one living dogwood) and this area was then designated a new plot. The total area analyzed here was 3.68 hectares. New dogwoods (those that had reached 1.3 cm in diameter at breast height by the time of census) were noted each decade as seedlings became established in the plots.

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alive in 1977 were dead, and 84% of the "edge" dogwoods that were alive in 1977 were dead (368 dead "forest" dogwoods out of 424 alive in 1977, and 31 dead dogwoods along roads out of 37 alive in 1977). These mortality levels are not significantly different from each other (Fisher's exact test, $P \leq 0.5$).

New dogwood trees have been found each decade in the long-term plots (Table 1), but in the 1987 census there were only 14 new trees (trees that reached our measurement threshold of 1.3 cm dbh), compared with 204 in the 1977 census. Even though seedling survival is expected to be low (4), overall numbers of new trees were significantly lower in the 1987 census than in the 1977 census.

DISCUSSION

Ward and Stephens (9) noted that shade-intolerant woody species declined slowly in number in these plots as the forests matured, and the canopy closed. However, since other shade-tolerant understory trees did not suddenly decline in numbers during the decade 1977 to 1987 (9), it is unlikely that competition alone caused the dogwood mortality increase. There was also no clear association of high mortality with moisture levels of the sites, diameter class, tree age, or tree growth rate.

Dogwood mortality was high both in the forest and along the edges of roads (87 and 84%, respectively), but these levels are very different from the 31% (forest) and 19% (edge) reported by Sherald et al. (6). Chellemi and Britton (1) had also noted higher disease incidence and greater severity in interior forest areas where the lowest evaporative potential was found.

Hibben and Daughtrey (3) found dogwood anthracnose between 1977 and 1983 in southwestern Connecticut in their study of dogwood mortality. Even though Daughtrey et al. (2) reported that the U.S. Forest Service survey found dogwood anthracnose in all of Connecticut, Walton (8) was unable to find any evidence of the dogwood anthracnose fungus, *Discula destructiva* Redlin, in his samples of central Connecticut dogwoods begun in the early 1980s.

Walton (8) concluded that the dogwoods he observed were dying of drought, dogwood borers, and lawn mower damage. Cumulative rainfall for April to September, 1977 to 1987, is shown in Figure 5A, and no serious moisture deficit can be invoked to explain the sudden dogwood mortality in our long-term forest plots. Moisture deficits were actually greater between 1957 and 1967, a period of low dogwood mortality (Fig. 5B).

We have seen no dogwood mortality in Connecticut in the last 5 years that we can attribute to *D. destructiva*. It is possible that *D. destructiva* caused a major epidemic in Connecticut in the late 1970s and populations of the fungus then quickly declined, or the virulence of strains here became suddenly reduced. The fact that something happened to forest dogwood trees in Connecticut between 1977 and 1987 raises interesting questions for future

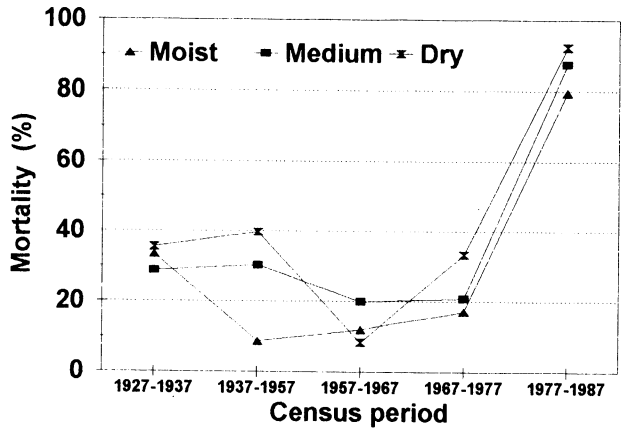

Fig. 1. Flowering dogwood data from the long-term forest plots in Connecticut separated by moisture class of the sites, with percent mortality at each census on moist, medium moist, or dry sites. The second census included 20 years of mortality, while the others were 10 years.

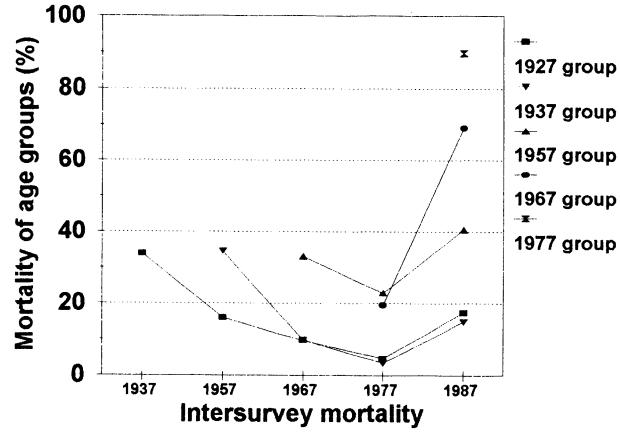

Fig. 3. Flowering dogwood mortality (percent) from the long-term forest plots in Connecticut separated by age groups of trees. The 1957 mortality of the cohorts of trees first censused in 1927 and 1937 was divided by two because the 1957 census was after a 20-year period instead of a 10-year period.

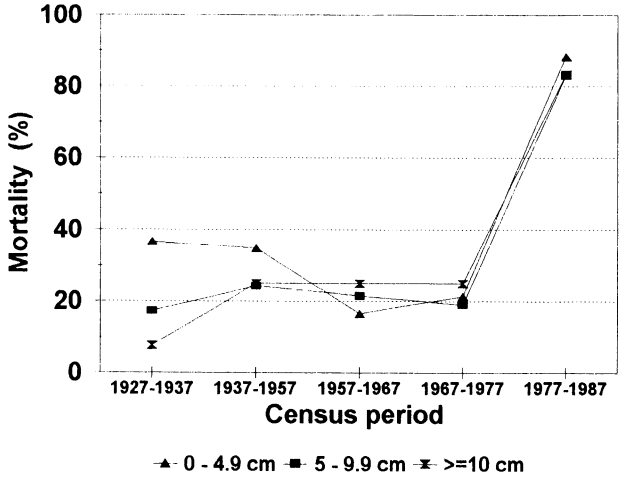

Fig. 2. Flowering dogwood mortality (percent) from the long-term forest plots in Connecticut separated by stem size (diameter at breast height in cm) for each census period.

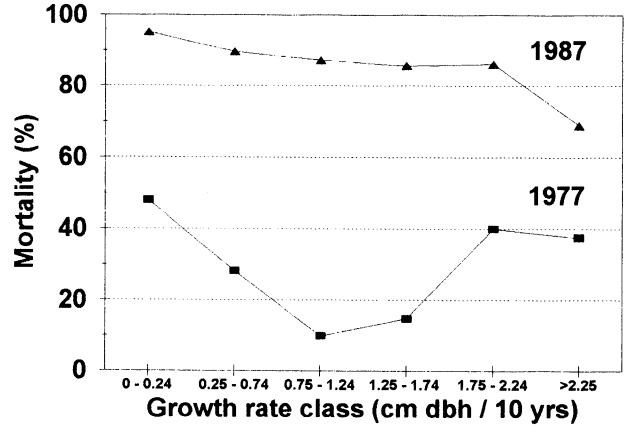

Fig. 4. Flowering dogwood mortality (percent) from the long-term forest plots in Connecticut separated by growth rate class (diameter at breast height in cm / 10 years) for the 1977 and 1987 censuses.

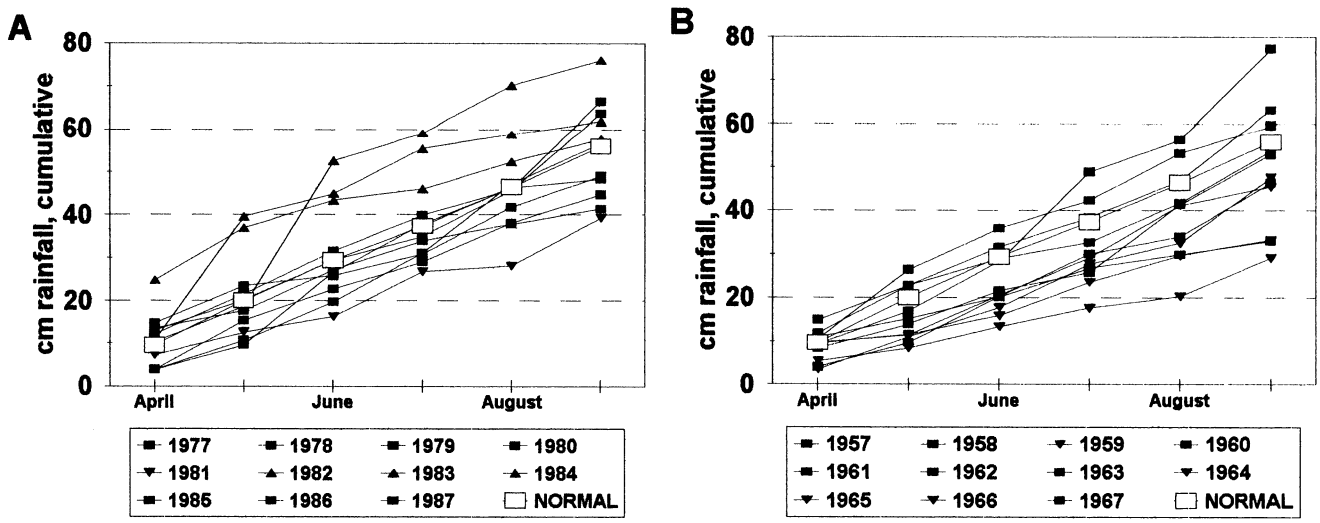

Fig. 5. Rainfall (precipitation, water equivalent) in Hartford, CT, from **(A)** April to September in 1977 to 1987 and from **(B)** April to September in 1957 to 1967, with "normal" included for comparison. All data are from the National Oceanic and Atmospheric Administration records, U.S. Dept. of Commerce (5).

studies on the resistance of the remaining dogwoods, and the virulence of the remaining fungus.

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