

THE SUCCESS OF ALIEN ANGIOSPERM SPECIES IN CHICKAMAUGA BATTLEFIELD

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ABSTRACT

Observations were made from 1972-1975 at Chickamauga Battlefield in northwest Georgia, an area which had been severely disturbed for an extended period of time. The U. S. Park Service has made an effort to restore the previous vegetation in most of the study area but a certain portion has been repeatedly disturbed by mowing. The objectives of this study are (1) to determine the relative success of alien plant species in the various habitats, and (2) to determine which families and genera have the largest percentage of alien species. There are 368 species of vascular plants currently reproducing in the flora and 23.6% of these are not native. The alien species are primarily found in the fields and to a lesser extent in cedar glades and other habitats. The families with the largest number of alien species are Poaceae, Asteraceae, Brassicaceae, and Fabaceae. The larger families with the greatest percentage of alien species are Brassicaceae, Caryophyllaceae, Fabaceae, and Scrophulariaceae. The great majority of the alien species are from Europe and/or eastern Asia.

INTRODUCTION

As man continues to clear away native vegetation and at the same time show increasing awareness for the need to protect the environment, it is of interest to document what can be done to restore greatly disturbed areas to their previous state. One area where restoration has been attempted is Chickamauga Battlefield. This is one of the major sections of Chickamauga and Chattanooga National Military Park, which is in Catoosa and Walker Counties of northwest Georgia. The Battlefield encompasses 2,268 ha and the elevation ranges from 109 to 229 m above sea level.

The results presented in this paper are based on a four-year study (1972-1975) of the vascular plant flora of Chickamauga Battlefield (Van Horn, unpublished). The objectives were (1) to determine the relative success of alien plant species in the various habitats and (2) to determine which families and genera have the largest percentage of alien species. Since, in many cases, it was impossible to determine whether or not a species had been introduced to the area on purpose and/or accidentally, the term "alien" is used for any species not native to the general area.

Chickamauga Battlefield is an ideal site to study the success of alien plants and the restoration of native plant species since the area was severely disturbed for an extended period. In the late 1820's and early 1830's

the first settlers clearcut portions of the deciduous forest and farmed them. Then, in 1863, this was a major battlefield of the Civil War and much of the vegetation was destroyed during the fighting. Between 1863 and 1890, when a bill was passed authorizing establishment of the site as a National Military Park, the area was under cultivation. In later years, 1898 to 1945, a portion of Chickamauga Battlefield was used as a U. S. Army Post, and at one time 71,000 men and 8,400 horses and mules were stationed there. Furthermore, an airfield was located in the Park from about 1917 to 1920. Extensive disturbance is indicated in an Annual Report (1900-1916) by the following quotation: "Large tracts of the reservation are now in luxuriant growth. This, with the still more extensive sowing of grass and clover seed through the feeding of animals in every camp during the mobilization of the war with Spain, and the subsequent occupation by the cavalry and artillery, has turned the entire reservation into excellent pasture." It should be noted that natural disturbances have also occurred, such as a tornado in 1909 that destroyed many large trees.

In addition to the many alien plant species that were introduced accidentally due to human activities, many plant species were purposely introduced. These included exotics and cultivars. There were at least two nurseries on the reservation that were used primarily to reforest the cleared areas. In 1900 an examination was made of the 61 ha that had been cleared since the battle to plan for reforestation. In 1901 a large number of tree seeds were planted as well as over 1,000 trees and shrubs. These were virtually all alien species. Seeds of many alien herbaceous species were also planted. However, over 7,000 trees were planted of species typically found in that area. In 1905 12,223 trees were planted, almost all native species (Annual Report, 1900-1916).

In keeping with the concept that the Park should be maintained in a condition similar to that at the time of the battle of 1863, various fields are now mowed several times per year. These fields end abruptly at the point where they are adjacent to forest. Today, 202 ha (8.9%) of the Battlefield is mown. The remainder of the Park is not disturbed except for trails. The undisturbed portion consists of deciduous forest, small areas that are predominately pine, and several cedar glades. The alien species have had several types of habitat available to them and some species very likely have had about 150 years to become established in the natural plant communities.

METHODS

The field notes taken from 1972-1975 were analyzed for this study. No attempt was made to include the cultivated plants near the various buildings in this study. Various sources were used to determine the geographic region of origin for each species (Bailey, 1971; Correll and Johnston, 1970; Fernald, 1950; Gleason, 1963; Hitchcock and Chase, 1950; Radford, Ahles, and Bell, 1973).

RESULTS

Chickamauga Battlefield has 368 known species of vascular plants that are currently reproducing. Undoubtedly, some of the species were in gardens many years ago since they are now only found near old foundations, but they have been able to maintain themselves in areas that are disturbed by mowing. Of this number, 23.6% (87 species) are not native to this area. As would be expected, the percentage of alien species in the Battlefield is high. Comparative figures for the percentage of alien species in other areas are: Britain, over 25% (highest in Europe); Holland, 20%; Germany, 14-18%; France, 12-13%; central and northeastern United States and Canada, 20% (Fernald, 1950; Webb, 1978).

TABLE I: Larger families of the Battlefield with their number of alien and native species. The last column is from Fernald (1950).

Family	Total taxa: Battlefield	Percentage of alien species: Battlefield	Percentage of alien species: northeastern U.S.
Cyperaceae	15	0	4.6
Liliaceae	24	12.5	22.7
Poaceae	49	24.0	20.1
Apiaceae	12	16.7	22.4
Asclepiadaceae	10	0	8.1
Asteraceae	75	12.0	19.8
Brassicaceae	11	72.7	51.7
Caprifoliaceae	9	22.2	32.6
Caryophyllaceae	9	44.5	44.0
Ericaceae	10	0	7.9
Fabaceae	43	37.2	29.1
Fagaceae	15	6.7	3.2
Lamiaceae	17	29.4	42.2
Ranunculaceae	19	15.8	14.6
Rosaceae	32	21.9	11.2
Rubiaceae	10	10.0	24.1
Scrophulariaceae	16	37.5	26.3
Violaceae	9	0	7.5

Ten alien species are not reproducing or are reproducing extremely slowly, as suggested by the very few individuals found. Seven of these species considered as not reproducing are trees or shrubs. Three are species of *Narcissus*, all of which are together in a small group in a cedar glade, and they appear to be reproducing slowly by vegetative methods. These ten species are not considered in the data presented here.

Of the plant families with a comparatively large number of species present in the Battlefield, several have a

comparatively high percentage of alien species (Table 1). Some of the families (Cyperaceae, Asclepiadaceae, Ericaceae, Violaceae) lack any alien representatives. For comparison, figures from Fernald (1950) for the northeastern United States are also cited.

TABLE II: Genera with four or more species present with a high percentage of alien species. The last column is from Fernald (1950).

Genus	Numbers of Species: Battlefield	Percentage of alien species: Battlefield	Percentage of alien species: northeastern U.S.
<i>Cardamine</i>	4	25	25
<i>Geranium</i>	4	50	62
<i>Lespedeza</i>	5	40	28
<i>Lonicera</i>	4	50	35
<i>Plantago</i>	5	40	41
<i>Poa</i>	5	40	12
<i>Potentilla</i>	4	25	21
<i>Prunus</i>	7	29	25
<i>Ranunculus</i>	7	29	17
<i>Trifolium</i>	5	100	76
<i>Vicia</i>	4	75	73

Certain plant families have a large number of genera with species that are aliens. The families with the largest number of genera with alien species are Poaceae (9 genera), Brassicaceae (7), Fabaceae (6), Asteraaceae (5), and Caryophyllaceae (4).

Some genera found in the Park have a fairly high percentage of alien species. Genera that have only two or three species in the Park may lack any native representatives. These include *Barbarea*, *Lamium*, *Melilotus*, *Rumex*, *Spiraea*, and *Veronica*. Genera with four or more species present and with a high percentage of alien species are listed in Table 2. The percentage of alien species for each genus cited by Fernald (1950) is also given.

TABLE III: Collection sites of reproducing alien species.

Habitat	Numbers of species	Percentage
Forest	6	7
Fields	53	63
Margins ¹	7	8
Cedar Glade	16	19
Stream	2	3
	84	100

¹ Includes margins of forest with fields, cedar glades, or trails.

Many alien species have had ample opportunity to spread into the more undisturbed areas but apparently have not been able to compete with the native vegetation. Moreover, they were probably established throughout most of the Park and have been displaced by the native species as the Park was restored. They survive today only because of the mowing.

In spite of the fact that the native vegetation of

Chickamauga Battlefield has been greatly disturbed for an extended period of time, few alien species are present in the forest now (Table 3). The vast majority (63%) of the alien species are present in the fields that are mowed several times per year. Cedar glades, which are undisturbed at present as is the forest, have more alien species than the forest. The margins of the various areas would be expected to have a higher percentage of the alien species if it were not for the fact that the margins in the Battlefield are very abrupt, being maintained by man.

Of the few alien species that are found in the wooded areas, many are displacing native species. *Vinca minor* L. can form such a dense population that very few native herbaceous species can coexist. The establishment of trees even appears to be inhibited where the *Vinca* is most dense. A much greater threat is *Lonicera japonica* Thunb., which is rapidly displacing native species in many areas.

The alien species growing in the cedar glades are not necessarily in an unstable area. The only areas in the cedar glades that are disturbed are the edges of the trails that pass through them. Plants able to grow in such areas do not have the reduced light and competition with trees for water that is present in a wooded situation, although of course there are other environmental problems to be overcome such as the shallow, alkaline soil. Of the 30 alien species not in the mowed fields, 16 (53%) grow in the undisturbed portion of the cedar glades.

It is obvious that alien species can be a threat to native species when one observes the destruction on a large scale by such species as *Pueraria lobata* (Willd.) Ohwi throughout much of the southeastern states. Of a more subtle nature is the gradual invasion of alien species into undisturbed habitats such as woods or cedar glades. Not all of the alien species grow in the disturbed areas of cedar glades so some native species are being reduced in numbers by direct competition. Naturally, reduction in numbers makes a species much more susceptible to local extermination.

TABLE IV: Geographic regions of origin for the alien species in the Battlefield.

Geographic Region	Numbers of species	Percentage
Europe	33	41
Eastern Asia	12	15
Eurasia	30	38
Midwestern United States	4	5
South America	1	3
	80	100

Some plant species, such as *Barbarea verna* (Mill.) Aschers, and *Nasturtium officinale* R. Brown which are growing in a stream, appear to be invading open niches. Perhaps some of the alien species in the wooded situations are also growing in previously open niches. However, without a more intensive study on a species by species basis it would be difficult to say which species might be filling previously unoccupied niches. The difficulty of determining the presence of an open niche has been noted by Simpson (1964).

Aggressive species such as *Pueraria lobata* merely cover and kill other plants. However, for most introduced species it is likely that there has to be enough of an opening or disturbance in the native vegetation so that a few individuals can reach maturity. From that point the species apparently must be adapted enough to the area so they can compete for some niche. Naturally, if a species is fairly well adapted to the climate and competition, the process of ecesis would not take very long, depending on the type of breeding system and generation rate. The more successful of the introduced species probably do not have to undergo any change in gene frequency to compete in wooded situations. It would be interesting to determine if a change in gene frequency had occurred between a population that has been competing successfully for about 50 years in an area that is basically undisturbed with its parent population in another country.

TABLE V: Geographic regions of origin for the alien species found away from the mowed fields.

Geographic Region	Numbers of species	Percentage
Europe	13	44
Eastern Asia	9	30
Eurasia	7	23
Midwestern United States	1	3
	30	100

Europe is the most common geographic region of origin of the alien species (Table 4). If the alien species located away from the mowed fields are analyzed as to their geographic region of origin Europe still has the largest number but those species coming from eastern Asia increase while those from the larger region of Eurasia decrease (Table 5). Since most authors separate Europe and eastern Asia from Eurasia when listing the geographic region of origin for species that convention is followed here.

CONCLUSIONS

Observations made at Chickamauga Battlefield indicate that native species will replace most alien species even after severe disturbance over many years, and that this varies with the habitat. Nonetheless, some alien species will replace native species even with no disturbance. The introduction of alien species to cedar glades may pose a threat to native species. The most successful alien species in the forest appear to be woody vines such as *Lonicera japonica*. Other species, such as *Vinca minor* and *Hedera helix* L. will also displace native species, but at a slower rate. The chances of restoring an area to its previous species composition will depend to a great extent on the presence of such species as *Lonicera japonica*.

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