Genetic Diversity of Plant Species in Glacier National Park: Implications for Management

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Glacier National Park (GNP) is responsible for the management and preservation of biological diversity in the natural populations of plants and animals occurring within its boundaries. Information on existing levels of genetic variation within and among populations is a prerequisite for developing management strategies to maintain genetic diversity and to perform revegetation activities. We are using two methods to assess levels of genetic diversity and differentiation among populations: quantitative genetic analysis and isozyme (electrophoresis) analysis. To examine whether patterns of genetic variation and adaptation to local environments require that sites be revegetated with plants collected from nearby natural populations, or alternatively, whether transplants could be obtained from other sources; we are focussing on three experimental areas:

1. quantitative genetics,
2. electrophoresis, and
3. natural selection.

Quantitative Genetics

Quantitative genetic analysis uses measurements of traits that are important to the fitness of individuals in natural populations. This involves assessing morphologic and life history characters of related individuals (e.g., one plant and its runners (runner = clone)). Sixty transplants were collected randomly from each of 12 populations of strawberries *(Fragaria virginiana)* Duchesne in GNP during June 5-21, 1990 (Table 1). These 12 populations represent variability present at points along the diverse environmental and geographic gradients in GNP. Transplants were planted in a randomized complete block design on 24 June into Diettert Experimental Gardens at the University of Montana, Missoula. Plants established well and produced an average of three runners per plant.

Electrophoresis

Initial electrophoretic analyses will identify

1. procedures necessary for resolving enzyme systems and
2. polymorphic loci.

During October 7-8, 1990, the youngest leaves present on the 720 maternal plants in the Diettert Experimental Gardens were harvested for use in electrophoresis screening. Leaves were placed randomly in four grinding buffers:

1. PO_4-PVP,
2. Tris-Maleate-PVP,
3. Tris-HCl-PVP, and
4. distilled

Table 1. Locations of *Fragaria virginiana* populations in Glacier National Park used for quantitative genetics experiment.

Many Glacier Area				
*Populationion	1	Wilbur Ck	elev. 1585 m	S-facing slope,15%
Population	2	Apikuni Ck	elev. 1521 m	flat
Two-Medicine Area				
*Population	3	W end of Lower Two-Medicine Lakeel	elev. 1511 m	flat
Population	7	E side of Dry Fork Ck, Running Eagle Falls	elev. 1511 m	flat
North Fort Flathead River				
Population	4	South of Bowman Lake, 1 mile	elev. 1268 m,	flat
*Population	10	Big Prairie	elev. 1122 m	SW-facing slope, 15%, burned in 1988
St. Mary's Area				
Population	5	Two Dog Flats	elev. 1487 m	E-facing slope, 20%
*Population		Siyeh Ck	elev. 1804 m	SW-facing slope, 15%
Middle Fork Flathead River				
Population	8	Park Ck	elev. 1146 m	flat, gravel flood plain
*Population	9	Belton Hills	elev. 975 m	flat
Continental Divide				
Population	11	1967 Fire Pullout, Going-to-the-Sun Hwy, 396 m W from Haystack Ck	elev. 1536 m	SW facing slope, 60%
*Population	12	Logan Pass	elev. 2060 m	S-facing slope, 20%

*Populations used in Natural Selection Experiment

H_2O. These leaves were ground and stored at -40°C until used in enzyme analyses.

Chromosome counting is necessary to ascertain the ploidal level of *(F. virginiana)* in GNP. This is essential information for interpreting enzyme banding patterns. Roottips for chromosome squashes were taken from the plants in Diettert Experimental Gardens on October 25, 1990 and fixed in Farmer's solution (Love and Love 1975).

Six study populations of mountain brome *(Bromus carinatus)* Hook. and Arn. were located to maximize diversity present in samples of the environmental and geographic parameters in GNP (Table 2). Two hundred panicles from each population were collected from August 19-23, 1990. Seeds will be germinated and used for 1) ascertaining population chromosome numbers and 2) genetic diversity assessments by enzyme electrophoresis screening.

Natural Selection

Measurement of quantitative characters on individuals in natural populations in GNP will indicate which traits are influenced by natural selection. Survival and reproduction are two parts of the complex suite of processes that comprise individual fitness. In each of six *F. virginiana* populations in GNP, 200 individuals were labeled with 1 x 3 inch aluminum tags (Table 1). Characters were measured twice during the growing season, June 1-6 and September 4-10 (Table 3). These data will be used to estimate which characters are subject to natural selection, and if there

are temporal or spatial differences in natural selection in populations throughout GNP.

✦ Proposed Work

November 1, 1990 to May 31, 1991

During the remainder of this first year in a three year study, experiments to characterize genetic variation in natural populations in GNP will continue:

1. quantitative genetics,
2. electrophoresis, and
3 natural selection.

The development of long-term management plans for genetic diversity and for revegetation programs requires information on levels and patterns of genetic divergence within GNP.

Quantitative Genetics

This experiment provides information on the genetic differentiation and local adaptation of *F. virginiana* populations. Population transplants in Diettert Experimental Gardens will be monitored for runner production. Fifteen runners from each of the 60 maternal plants (15 x 60 x 6 GNP populations = 5400 total clones) will be needed for transplant into common gardens at GNP. Total number of clonal propagules will depend on levels of reproduction and mortality. It may require the 1991 growing season to produce this number of clones. These clones will be transplanted into three common gardens (low elevation west side, continental divide, and low elevation east side), five clones from each maternal plant per garden. Transplant times will be July-September 1991,

Table 3. Characters measured on *Fragaria virginiana* innatural selection experiment.

1. number of leaves per plant
2. number of stolons
3. number of peduncles
4. number of flowers and flower buds
5. number of hermaphroditic flowers
6. number of pistillate flowers
7. number of staminate flowers
8. number of fruits
9. length of largest leaflet
10. width of largest leaflet
11. length of longest stolon
12. number of stolon nodes
13. number of leaves on runner on the longest stolon

Table 2. Population locations of *Bromus carinatus* in Glacier National Park used for electrophoresis experiment.

Population 1	Big Prairie, North Fork Flathead River, 183 m N of *Fragaria virginiana* Population 10, elev. 1122 m, flat, population extends along W edge of *Populus tremuloides* stand
Population 2	W of Apikuni Falls parking lot 396 m, 183 m S of trail to Redgap Pass, elev.1536 m, population extends along W edge of *Populus tremuloides* stand
Population 3	Two Dog Flats, E of Two-Dog Ck, elev. 1438 m, SE-facing slope, 10%, population extends along WSW edge of *Populus tremuloides* stand
Population 4	Two-Medicine Area, 137 m W of GNP boundary, elev. 1511 m, SW facing slope, 20%
Population 5	1967 Fire Pull-out, Going-to-the-Sun Hwy, 183 m W of Haystack Ck, elev. 1536 m, SW-facing slope, 60%
Population 6	Siyeh Ck, elev. 1804 m, SW-facing slope, 15%

depending on clone-producing success. Quantitative characters that are important for survival, reproduction, and revegetation success (Table 3) will be measured after clones are established.

Electrophoresis

Both species, *F. virginiana* and *B. carinatus*, will be screened on electrode/gel buffer systems for polymorphic enzyme systems. *Bromus carinatus* seed (Accession 9054510) will be obtained from the Plant Materials Center, Bridger, MT (BPMC) for a comparison of polymorphic loci. This is seed that was collected in 1987 from GNP and has been propagated at BPMC during the past three years. Electrophoretic data will provide information on feasibility of using off-site propagation to maintain genetic diversity in revegetation stocks. Analysis of all electrophoretic data will use measures of genetic distance and F-statistics (Nei 1987). Tests of statistical significance will use parametric (Sokal and Rohlf 1981) and nonparametric techniques (Mitchell-Olds 1986).

Natural Selection

First-year data from the six populations of *F. virginiana* will be analyzed using regression with parametric or jackknife significance tests to estimate the effects of various characters on fitness components (Mitchell-Olds 1986, Mitchell-Olds and Bergelson 1990). These analyses will help to identify the factors that determine variation in *F. virginiana* fitness and, therefore, on revegetation success.

✦ Conclusions

This research will provide information on genetic variation within and among populations of *F. virginiana* and *B. carinatus* in GNP. Final results from this three year study will facilitate the development of effective management strategies for preservation of existing genetic integrity in natural populations and the revegetation of disturbed GNP lands.

✦ Literature Cited

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