may be possible to select fast growing trees with acceptable wood density. The influence of site, not only upon relative density, but also on the correlation between relative density and volume must be taken into consideration in the selection process, however. COOK (1988) has identified an end-product based approach for determining a cut-off point for minimum acceptable relative density levels in young trees, that may be valuable in deciding volume growth, relative density trade-offs.

MCKIMMY and CAMPBELL (1982) suggested that stem strength is a function of wood relative density and ring width, and that low relative density for a given mean ring width would result in weak trees susceptible to wind and snow damage. At each site, Hoh compares well with local sources assuming that wood relative density and bole diameter together determine stem strength. At Coal Harbour, Hoh and Jeune had similar mean diameters and relative densities. While Seymour's mean relative density was 6% higher than Hoh's at Coal Harbour, Hoh's diameter was 12% larger than Seymour's. Similarly, at Harrison Lake, where all provenances had high relative density and volume, the local source's relative density was 7% higher than Hoh's but Hoh's diameter was 10% larger. At Chilliwack, Hoh had higher mean relative density and diameter than the local source. Thus there is no evidence for maladaptation of the Hoh source in terms of stem strength in the three test environments.

Unless a provenance trial is continued for at least half a rotation length, results cannot be conclusive, but decisions must often be reached based on such evidence as is available at the time. If volume continues to be primary consideration, inclusion of parent trees from the Hoh region in the British Columbia coastal Douglas-fir breeding program, at least on an experimental basis seems advisable. Before doing this, however, it would be useful to obtain a larger wood sample for relative density analysis, including young trees growing in additional B.C. provenance trial locations as well as older plantation trees growing in the Hoh area to determine whether the low relative density is a result of seed movement.

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Short Note: Are Inferred Outcrossing Rates Affected by Germination Promptness?

By D. J. PERRY and P. KNOWLES

School of Forestry, Department of Biology,
Lakehead University, Thunder Bay, Ontario P7B 5E1,
Canada

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Summary

Outcrossing rates ($\hat{t}_m$) were estimated from allozymes of eastern white cedar seeds, sampled according to germination promptness. The proportion of selfed seed, on which selection might act, was high, but differences in $\hat{t}_m$ among early, intermediate and late germinants were not statistically significant.

Key words: mating system, outcrossing rate, germination rate, *Thuja occidentalis* L.

Introduction

Allozyme analysis has become a popular investigative tool in the study of forest tree mating systems. Procedures, based on the mixed mating model, have been developed to estimate mating-system parameters from allozyme data (*e. g.*, SHAW *et al.*, 1981; RITLAND and EL-KASSABY, 1985). One assumption of the mixed mating model is that selection does not occur prior to census (BROWN *et al.*, 1985). Violation of this assumption is likely common with conifers since, following selfing, embryos are more frequently aborted and filled seed germination is often reduced (FRANKLIN, 1970). However, there may be more subtle pre-census selection. Differential germination speed (*i.e.*, promptness) is one possibility (FRANKLIN, 1970) and could potentially affect the effective outcrossing rates inferred from mating system studies. If germination promptness is affected by inbreeding and families are not sampled equally, spurious heterogeneity of inferred outcrossing rates among families could conceivably result.

The purpose of this study was to determine whether inferred outcrossing rates of eastern white cedar (*Thuja occidentalis* L.) are affected by germination promptness. Wind pollinated seed of eastern white cedar contains more selfs than that of most other conifers (average 37% selfs inferred at viable embryo stage; PERRY and KNOWLES, 1990) so there is a large proportion of selfed seeds on which differential selective mechanisms might act. However, it is not known whether inbreeding affects germination speed in this species.

Methods

Ten trees were randomly selected from one eastern white cedar population and the following sampling procedure was followed for each tree. Approximately 100 wind-pollinated seeds were placed on moist filter paper in a petri dish and incubated at room temperature (*i. e.*, no stratification). When at least 20 seeds had germinated (after an average of 5.5 days, with a range among families of 4 to 7 days), all germinated seeds were removed and retained as *sample 1*, the early germinants. Similarly, after an average of 6.7 days (range 5 to 8 days), when at least 20 additional seeds had germinated, all germinated seeds were again removed and retained as *sample 2*, the intermediate germinants. This procedure was repeated after an average of 7.8 days (range 6 to 10 days) to obtain *sample 3*, the late germinants. Germinated seeds were stored at 4^0 C for up to one week until analysis. Germination trials of bulked seed from this same population have indicated high total germination (93% at 20 days) and 97% of this total germination occurred within the first 10 days (PERRY and KNOWLES, unpublished data).

Allozyme analysis was conducted on 20 seeds from each of the three samples from each tree giving a total of 200 seeds per sample group (*i. e.*, *sample 1*, *sample 2* or *sample 3*), 60 seeds per tree. Four polymorphic, unlinked loci (*Mdh-1*, *Me*, *6Pg-2* and *Pgm*) were scored in paired embryo and megagametophyte tissues with electrophoretic conditions as previously described (PERRY and KNOWLES, 1989). The paternal (pollen) contribution at a given locus was inferred by comparing the allozyme phenotype of the embryo to that of the corresponding megagametophyte.

Multilocus outcrossing rates ($\hat{t}_m$) and outcross pollen pool allele frequencies ($\underline{p}$) were estimated using the maximum likelihood procedures of RITLAND and EL-KASSABY (1985). Since the actual outcross pollen pool was the same for each sample group, $\underline{p}$ was estimated jointly with $\hat{t}_m$ using the combined data of all three sample groups and then held constant while $\hat{t}_m$ was estimated for each of the three sample groups. Heterogeneity of $\hat{t}_m$ among sample groups was assessed using a likelihood ratio test (RAO, 1973).

Results and Discussion

Overall estimates of $\hat{t}_m$ (±S.E.) were 0.594 (±0.061), 0.536 (±0.061) and 0.547 (±0.062) for the early, intermediate and late germinants respectively. These values are within the range of $\hat{t}_m$ found in a more detailed study of this species (PERRY and KNOWLES, 1990). Differences in outcrossing rates among the three sample groups were not statistically significant.

Since outcrossed conifer progeny are generally more vigorous than selfed progeny (FRANKLIN, 1970), we had anticipated that early germinating, presumably more vigorous progeny would be more highly outcrossed. However, such a trend is not made evident by our data. The germination conditions of this study may not have provided selective forces sufficient to allow fitness differences between inbred and outcrossed progeny to be discerned. Perhaps a more stressful germination environment would result in detectable differences among the sample groups. Nonetheless, the results do indicate that, at least for this species and these germination conditions, the selection of a nonrandom sample of germinants would likely have no effect on estimated outcrossing rates, even though the proportion of selfed embryos, on which selective forces might act, is high. We suspect that the use of samples which are not random with respect to germination promptness would have little or no effect on outcrossing rate estimates for other conifers in which the proportion of selfed embryos is less than that observed in eastern white cedar.

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