Eco-genetic Variation of the Lithuanian *Quercus robur* L. Populations and Families and its Consequences on Gene Conservation

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The purpose of the investigation was to estimate among- and within population variation for juvenile growth and growth rhythm in halfsibs families of the Lithuanian populations of *Quercus robur* L..

Eight oak populations with an average of 10 halfsib families in each were studied in Lithuania. Assessments of height, presence of lammas shoot, number of stems and growth rhythm traits were done in nursery at juvenile age up to 4 years. Genetic correlations between these traits were calculated. Bud flushing of the part of mother trees was recorded as well. Variance components (for population and family effects) and the estimates of additive genetic coefficient of variation (CV_A) for growth rhythm traits and height at juvenile age of halfsib families were presented.

Strong parental effect and assortative mating might have influenced the estimates of correlation coefficients between family means and mother trees bud flushing which were 0.53 to 0.60 for oak in Lithuania. For gene conservation purposes a few large oak populations seems to be insufficient in Lithuania. One of the prerequisites for that is insufficient overlapping of populations in the range of values of adaptive traits. The high CV_A estimates for the adaptive traits studied mean that oak species have a potential to respond to strong environmental changes such as are predicted by global warming. The large CV_A estimates also mean that improvement by breeding is possible and it could be combined with gene conservation.

Key words: juvenile traits, genetic correlations, variance components, additive genetic coefficient of variation, *Quercus robur*, gene conservation

Introduction

The necessity for genetic information on Lithuanian *Quercus robur* L. stands is very actual for gene conservation and breeding programs. Up to date there is only 1 seed orchard (1.2 ha). Gene reserves of this species were singled out and approved based on information of environmental gradient, distribution and stands inventory data from the Lithuanian Forest Inventory Institute. The delineation of seed zones was based mainly on evaluation of permanent plots in mature oak stands and information on eco-climatic characteristics of eco-regions.

The purpose of the investigation was to estimate among- and within population variation for juvenile growth and growth rhythm in halfsib families of the Lithuanian populations of *Quercus robur*.

Results of research on the Lithuanian oak populations

Acorns collected in 1995 in natural oak stands were sown in spring 1996. The design of common-garden test in the nursery was incomplete randomized blocks with 8 tree linear plots. Each of 3 blocks had 1 to 6 replications. Spacing was 0.15x0.30 m.

The comparative time of bud flushing of 4-yr. old progenies (halfsib families from 11 populations) was stable from year to year. The comparison of two years bud flushing assessments (where the mean values of families were more or less similar) at individual level showed that ranking within the families was also stable. The estimated correlation coefficients of halfsib families (mean values) with mother trees bud flushing forms over years were 0.53-0.60. For some populations

it was 0.95. Strong parental effect and assortative mating might have influenced the estimates of correlation. One possible reason for differences among populations in coefficients could be improper time for assessments in mother stands.

The correlation coefficients between bud flushing means of progeny (made of family means of population or stand) and means of mother trees stands were 0.75 to 0.85 over years. That means that data even from 10 progeny families per stand (the distances between mother trees were 20-30 meters) gives possibility for a quite precise estimation of a given population phenotypic structure. Correlation analysis revealed strong parent-offspring relationship for bud flushing (Fig. 1). The parent-offspring relationships of the two most extreme oak stands are shown in lower case of Figure 1. The distribution of studied oak stands in Lithuania and their mean values of bud flushing are presented in Fig. 2.

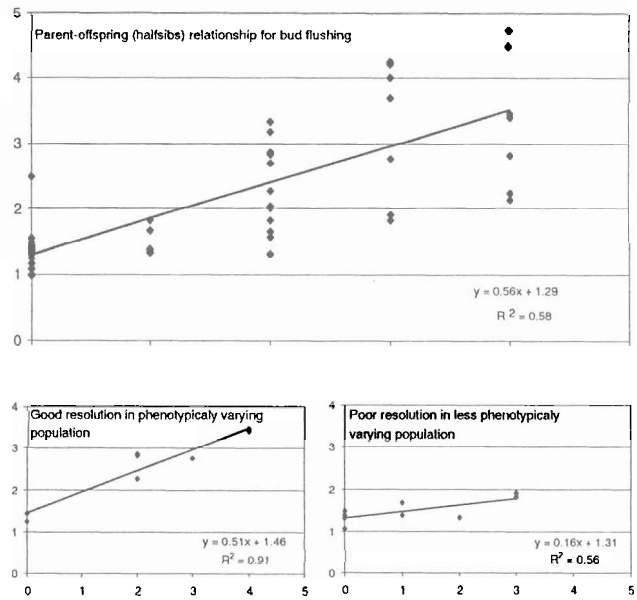

Figure 1. Parent-offspring (halfsibs) relationship for bud flushing. Mother tree values are given on the horizontal axis, progeny family mean values – on the vertical axis.

At very juvenile age bud flushing and leaf fall of oak offspring were weakly correlated (-0.19±0.04) giving some indication that the earlier the bud flushing the later the growth cessation. Bud flushing stages were strongly correlated with late spring frost damage. The correlation coefficient between bud flushing and frost damage during one year was 0.95. If frost occurs at the stage of the intensive leaves development it causes serious damage of leaves and for rebuilding of lateral

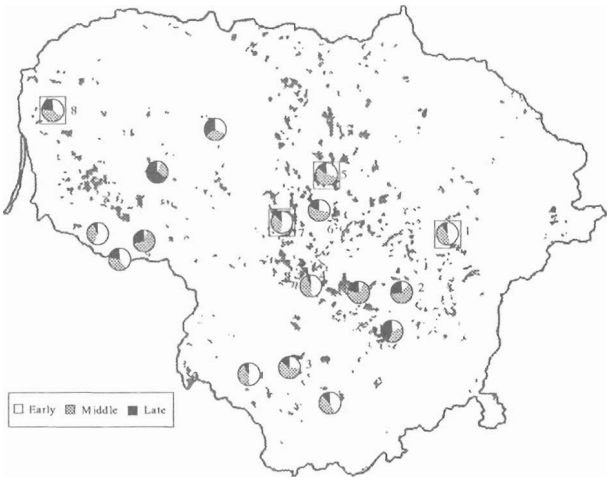

Figure 2. Composition of oak trees with different time of bud flushing in permanent plots of oak stands. The patches indicate stands where oak comprises more than 10 % in stand tree composition.

and leader shoot approximately a 2-week period is needed. Additional coefficients of genetic correlations between growth rhythm and quantitative traits are shown in Table 1.

Table 1. Genetic correlations between growth rhythm and some other traits.

Trait, at age	Height, 1	Presence of lammas shoot, 2	Number of stems
Bud flushing, 3	-0.08±0.03	-0.12±0.06	0.25±0.07
Autumn leaf colouring, 4	0.34± 0.05	0.17±0.08	-0.26±0.11

Figure 3 illustrates the variability of oak populations and families within population in growth rhythm traits and height (Baliuckas & Pliūra 2001). If we compare Lithuanian oak populations with Swedish ones, it could be seen much steeper slopes formed of family mean values of adaptive traits in Lithuanian populations (unpublished data on Swedish material). That probably indicates greater genetic diversity as well.

The large CV_{Λ} estimates of the oak populations for growth rhythm traits and strong population differentiation in variance components indicate that comparatively more populations (maybe at a cost of family number) have to be selected for oak gene conservation.

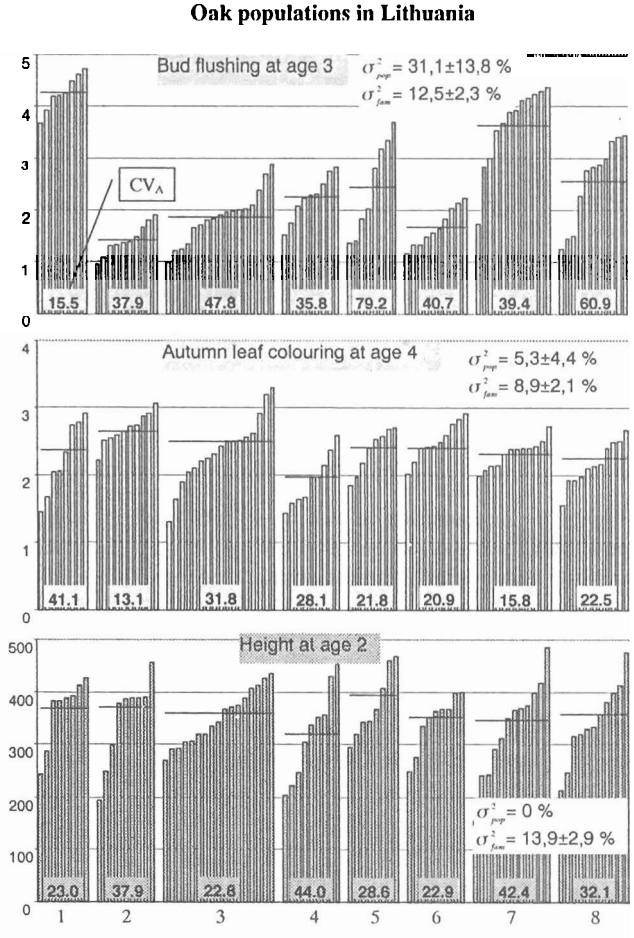

Figure 3. The estimates of population and family variance components and CV_A (%) of growth rhythm traits and height of progenies from studied Lithuanian oak populations. Populations numbers increase with a decrease of climate continentality (see Fig. 2).

Output from Lithuanian oak studies

• Bud flushing as one of growth rhythm traits is highly heritable (on population, family and individual level) and stable during ontogenesis of trees;

• Strong paternal effect and assortative matting might have influenced the estimates of genetic correlations and heritability;

• The differences in phenotypic composition of a number of populations indicate that it is problematic to build a prognosis on the population structure relying only on assessment in randomly selected stands, a more detailed and sophisticated analysis is needed for that;

• The significant differences in time of bud flushing of rather closely situated oak populations in Lithuania indicate that for gene conservation a few large populations seem to be insufficient;

• The large CV_A estimates for the adaptive traits studied mean that oak populations have a potential to respond to strong environmental changes such as are predicted by global warming;

• The large CV_A estimates also mean that improvement by breeding is possible and it could be combined with gene conservation.

References

Baliuckas V., Pliūra A. 2001. Lietuvos paprastojo ąžuolo populiacijų pusiausibų šeimų požymių genetinis kintamumas genetinių išteklių dinaminio išsaugojimo kontekste. [Genetic variation in halfsib families and populations of pedunculate oak (*Quercus robur* L.) in Lithuania and the implications for dynamic gene conservation]. Miškininkystė [Forestry] (in press). (in Lithuanian)

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