Phenotypic variation in Lychnis flos-cuculi

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SUMMARY

The aim of this thesis was to provide insight into factors that contribute to the generation of size-differences among individuals within natural plant populations. Plant size is often closely related to reproduction and fitness of an individual. Hence, strong selection on traits that contribute to large plant size in a particular environment is expected. Traits that are considered in this thesis are seed size, germination rate, and relative growth rate (RGR).

A genetic response to selection requires that variation in these traits has a genetic basis. Environmental heterogeneity within a population, and genotype-environment interactions may result in differential ranking of genotypes with respect to plant size in different micro-habitats and contribute to the maintenance of genetic variation for plant size within a population.

The presence of such heterogeneous selection on size-related traits and the genetic basis of these traits were investigated in the perennial, rosette-forming, hay-meadow species *Lychnis flos-cuculi L.* (ragged robin). To study the genetic basis of variation in these traits, a set of diallel crosses was performed between genotypes sampled from a single population. Progeny were analyzed in a greenhouse and sown in four sites along a natural production gradient, enabling assessment of both phenotypic selection on size-related traits and changes in the frequency of progeny-groups.

Analysis of these progeny groups (chapter 3,5) revealed that seed size, germination characteristics, and seedling size were strongly determined by maternal genotype. If plants were grown individually, maternal genotype effects decreased over time, and additive genetic effects explained a significant part of the variance in plant size four weeks after germination. However, in the field sites, maternal genotype effects on plant size persisted until the end of the growing season (chapter 4). As a consequence, a genetic response to selection on plant size is expected to be slow.

Strong inbreeding depression for plant size was observed in this predominantly outcrossing species. Selfed progeny, sown in different sites along the production gradient were 65 % smaller than progeny from outcrossed parents after one year of growth (chapter 4). Initial seed weight and seedling size of selfed progeny were 10 and 18 % lower, respectively, and their potential relative growth rate was reduced by 4 % due to a lower leaf area production (chapter 6). Size differences between progeny obtained from selfing and outcrossing thus increased over time. Differences were most pronounced in the most productive site. This may indicate that the initial size disadvantage in the seedling stage was most strongly enhanced in conditions where competition for light presumably was most intense.

Greenhouse studies (chapter 6) showed significant differences in relative growth rate (RGR) and its components among families obtained from within-population crosses under both nutrient-rich and nutrient-poor conditions. Differences in plasticity for these traits among families were small. For instance, families producing a larger leaf area per unit biomass (one of the components of RGR) under nutrient-rich conditions, did so on nutrient poor conditions as well. The specific combination of traits that resulted in large plant size differed among sites (chapter 4,7). In the least productive site of the gradient, families with an inherently low investment in leaf area per unit plant biomass produced significantly larger plants, despite the fact that they had a lower potential relative growth rate. In the most productive site however, families with an inherenly higher investment in leaf area and a higher potential RGR tended to produce relatively larger plants. Likewise, the relative importance of early emergence for attaining larger plant size increased with site productivity, while the relative importance of seed size decreased (chapter 7). These differences can thus partly explain why families that attain a relatively large plant size in one part of the gradient, produce relatively small plants in another part (chapter 4). As larger rosette size resulted in higher reproduction in the succeeding year in each of the sites (chapter 5), such family x site interactions may contribute to the maintenance of genetic variation for plant size within a population. The results support the hypothesis that under adverse environmental conditions, the components of RGR,that are more closely related to specific mechanisms of resource capture, rather than RGR itself are the target of natural selection.