Genetic differentiation and phenotypic plasticity in Plantago species

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SUMMARY

Survival of plant populations depends upon the genetic composition of the population and the phenotypic plasticity of the individual plant, the latter also being genetically determined. In this thesis I define plasticity as all intragenotypic variation. In physiological experiments it is often hard to see, whether a plastic response will contribute to a more adaptive attitude of the plant to the environment, or it will reduce its fitness.

After preliminary experiments on the appearance of phenotypic plasticity, a subdivision could be made within the genus Plantago; a group of plastic responding species, Plantago lanceolata L., Plantago media L. and Plantago coronopus L. and a group of non-responding species; Plantago major L.and Plantago maritima. L.

From both groups one species was chosen for further study and the following hypothesises were formulated:
Plantago major L. is characterized by genotypic specialization and a low degree of individual plasticity.
Plantago lanceolata L. has a high degree of phenotypic plasticity, which is essential for adaptation.

Two experimental approaches for a test of the hypothesis about P. major were set up. On one hand I used four inbred lines, since P. major is highly inbred and self pollinating for about 90% (chapter, 3, 4 and 5). On the other hand I collected two genotypes from the field, one originating from a shaded and one from an exposed habitat (chapter, 7 and 8). Plants of the inbred lines were submitted to alterations in a single environment factor, the level of mineral nutrition, the nitrogen source or salt. The responses of growth, root respiration, dark respiration, photosynthesis and enzyme activity (root ATPase, and shoot and root nitrate reductase) were followed during the experiments. From the results it is concluded, that genetic specialization is present within P. major. A fast growing inbred line also showed high respiration rates and enzyme activities. Besides this high metabolic activity a fine regulation of growth and development was present: obviously this inbred line, belonging to ssp pleiosperma showed adaptive plastic responses to environmental changes. In the other lines, belonging to ssp major and ssp pleiosperma, a decreasing growth rate and metabolic activity was accompanied by a lower degree of phenotypic plasticity. Experiments with genotypes from the field confirmed the results of the study on inbred lines: genotypic specialization to light and a low degree of phenotypic adaptive plasticity, which was restricted to seedling stage.

From three populations of Plantago lanceolata each eight randomly taken samples were collected (chapter, 9). All these samples were grown up seperately, and submitted to alterations in mineral nutrition. The responses of growth, root respiration and root ATPase activity were followed during the experiment. Plants of P. lanceolata also showed correlations between growth, root respiration and root ATPase activity. " Genetic differentiation ", on the population level, could be distinguished. Shortage of water and/or minerals, as present in our locality Westduinen exerted selective pressure for reduced dry matter accumulation, and plasticity served in the supply of water and minerals. In other populations, Heteren and Merrevliet, the impact of vege-

tation height improved selection for fast growing genotypes of P. lanceolata and in these genotypes plasticity was involved in competition for light.

In chapter 10, I propose three physiological models, for the mechanism of phenotypic plasticity. Both the irradiance and the mineral nutrition are used as stimulus in these models. Mineral nutrition will affect synthesis of cytokinins and adeninenucleotide pool, which in their turn affect protein synthesis and energy capacity. Phytochrome will mediate the light stimulus and affect protein synthesis, adeninenucleotide pool and sugar production in the shoot.