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1. INTRODUCTION

The influence of plants on each other is usually considered to be negative, and competition is supposed to be the most important interaction between them. Species-rich habitats thus intrigue ecologists, as the ability of numerous species to coexist in a small scale seems to contradict the importance of competition.

Several theories have been formulated to explain this contradiction. Coexistence is explained by the avoidance of competition by niche differentiation or, by absence of competitive equilibrium. The differing habitat requirements obviously cannot sufficiently explain high numbers of coexisting plant species, and elaborated models of the niche have been developed to increase the possibilities for variation. GRUBB (1977) divides a plant's niche into habitat-, life form-, phenology- and regeneration niche, emphasizing especially the significance of the last one. TILMAN (1982, 1988) suggests that various competitive abilities at different ratios of available nutrients and light together with spatial heterogeneity of these factors enable coexistence. Selection towards equal competitive abilities of the species is proposed by AARSSEN (1983) as a mechanism of coexistence.

Natural communities are subject to continuous changes and environmental fluctuations. Already HUTCHINSON (1941, 1961) questioned the significance of the exclusion of inferior competitors at competitive equilibrium, but only during the last two decades have a number of theories explaining coexistence in non-equilibrium systems been formulated (for a review see CHESSON and CASE 1986). Equilibrium may be prevented by disturbance (CONNELL 1978, WHITE 1979, PICKETT 1980, SOUSA 1984), which leads to a mosaic-like patchy structure of non-equilibrium communities with increased species richness (LEVIN 1974, WHITTAKER and LEVIN 1977). The character of a patch is determined by random initial events such as colonization pattern. The dynamics of patches of different successional stages allows the reproduction or growth of different species (PICKETT 1980), but also patchiness per se increases the species diversity. Plants themselves may increase the spatial heterogeneity by microsite differentiation; thus homogeneous environments may become heterogeneous and heterogeneous environments even more so (LEVIN 1974, GIGON 1981).

The combined effects of disturbance and low productivity most effectively limit competitive dominance, and the highest species densities may be achieved at low levels of productivity and intermediate levels of disturbance (GRIME

1979, HUSTON 1979). Spatial and temporal mass effects by immigration of propagules from neighbouring communities or by yearly fluctuation of environmental conditions may further increase species density (SHMIDA and ELLNER 1984).

In central Europe limestone grasslands are among the most species-rich plant communities. Infertility and regular management either by grazing or mowing are important factors for the maintenance of their high species density (DURING and WILLEMS 1984). Considering the theories reviewed above, regeneration of the species is likely to be an important aspect of the maintenance of species richness. Many species occurring in limestone grasslands are dependent on a regular regeneration by seed. They must have safe sites for germination and favourable microsites for establishment to be able to survive in the community. As the influence of vegetation is usually considered as being detrimental to seedling establishment, attention has been focused on the role of gaps as such safe sites (GRUBB 1976, RUSCH 1988, SILVERTOWN 1981). They seem to be important for the regeneration of short lived species, but considering the very high species density in small scale, which is possible in calcareous grasslands - up to 10 species per dm² on average (VAN DER MAAREL 1988 and pers. obs.) - it is difficult to imagine gaps as the only possibility for seedling establishment.

The aim of the present work was to assess the influence of neighbouring plants on seedling establishment in a species-rich infertile limestone grassland. The following aspects were regarded:

- Does competition by the established vegetation limit the establishment of new seedlings or are they able to survive also in a closed canopy?
- Do different species influence seedling establishment in their neighbourhood differently?
- Special interest was paid on the possible existence of positive influences (GIGON and RYSER 1986) of vegetation on establishment, as indicated by the works of HILLIER (1984) and SCHENKEVELD and VERKAAR (1984).

For that purpose seeds of six dicotyledonous species were sown in microsites with a different degree of influence of three different species of neighbouring plants. The survival of the emerged seedlings in the different microsites was recorded during two years. Further, the influence of moss cover on establishment was studied on separate plots.

Seedling establishment is often defined as the stage when seedlings become independent of seed reserves and are able to live with their own photosynthetic activity (e.g. HARPER 1977). As the distinction is difficult to make in the

field and the growth of the seedlings is very slow in a nutrient poor limestone grassland, in the present work seedlings surviving the first growth period are regarded as established.

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