CORRELATION BETWEEN STAND PHOTOSYNTHESIS AND COMPOSITION AT MICRO-SCALE IN LOESS GRASSLAND

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Introduction
Compositional and functional patterns and trends in micro-scale, that of the organization of grassland communities, are more difficult to explain than phenomena of the population or macro ecological level (Lawton 1999). To observe rules and forces, mechanisms that govern them, selection of appropriate scales is necessary (Bartha 2000, Elmore 1980).

Small-scale spatial heterogeneity of CO$_2$ gas exchange in grasslands partly depends on plant community compositional traits. Species richness, species composition, horizontal and vertical structure and green leaf area index (LAI) of grasslands are diverse in space, and affect net ecosystem CO$_2$ exchange through its components (gross photosynthesis, soil respiration etc.). Study of the rapport of diversity and productivity has long history. LAI and NDVI, considered here with reference to compositional richness (Csillag et al. 2001, Kertész et al. 2001) are usually related to photosynthetic performance. Papers published on the relationships of the CO$_2$ exchange and diversity (Craine et al. 2001, Spehn et al. 2000, Stocker et al. 1999) report that diverse ecosystems perform better both above- and below-ground, than monocultures, other articles on the topic of photosynthesis and species dominance or cover (LeCain et al. 2002, McAllister et al. 1998) emphasize that dominant species with high cover are more effective in their gas exchange, than rare species, but these studies mainly refer to leaf level photosynthesis and CO$_2$ enrichment experiences.

We investigated the effect of species richness and surface cover on photosynthesis at the same spatial scale: stand-level gross photosynthesis and composition of the measured stand patches have been compared to: (i) find the relationships between photosynthesis and vegetation cover, (ii) reveal the rapport between species number and photosynthesis and the importance of the dominant species.

Methods
Gas exchange and air temperature measurements were made by using portable photosynthesis system (LICOR 6200, Li-Cor, Lincoln, NE, USA) sampling the air from closed, cylinder-shaped plexi chambers, 70 cm high of each. 60 cm diameter
chamber was used to a wide functional description of three different facies of the *Salvio-Festucetum rupicolae* community near Isaszeg (47.34N 19.2E, 230 m a.s.l.) in Hungary in September 2000. The grassland is highly productive, vertically well structured, the soil is chernozem type loess soil. 90 replicates in each type were measured. Five gas exchange chambers (sizes doubling from 15 to 240 cm of diameter) were used to detect the dependence of photosynthesis on the measured area. 72 replicates at each size were measured on 13th, 15th and 25th of June 2001. Surface cover of each species of each plot has been recorded. PAR values were recorded using ceptometer (Decagon).

To evaluate the rapport of functional and compositional traits, data were filtered by PAR (>1000) and air temperature (>35°C). Only groups of gas exchange data with statistically not significant differences between the groups (between types of grassland or different chamber sizes) were used in the above analysis.

**Results and discussion**

Net ecosystem exchange (NEE, μmol CO₂m⁻²s⁻¹) and surface cover (%) of the vegetation showed statistically significant positive correlation both in the case of summer (r²=0.13, p<0.025) and autumn (r²=0.05, p<0.1) measurements (Fig. 1.). The larger the cover, the gross photosynthesis was also greater, and this was true for the whole summer dataset, and for different chamber sizes in summer measurements (not shown here). The range of cover values was much wider in summer, than in autumn, and this is only partly due to the different sample plot sizes.

Figure 1.: Correlation between photosynthesis and vegetation cover from autumn 2000 and summer 2001 datasets on loess grassland, Hungary. Different symbols represent measurements and estimated cover values from different chamber sizes, or different seasons.
Considering the relationships between number of species, (that is the most obvious numerical representation of the diversity of the community) in the measured plots, and NEE, Fig 2. shows that in autumn, while number of functioning species was relatively low, positive correlation was found ($r^2=0.13$, $p<0.01$). However in summer, with wider range of species numbers, the trend was not so clear, non-significant $r$ squared values were 0.05 and 0.03 for less, than 10 and more than 10 species, respectively.

Figure 2.: Rapport between species number and photosynthesis from autumn 2000 and summer 2001 datasets on loess grassland, Hungary.

These results are supported by the significant increase of the number of dominant, (that is "most effective") species in the case of autumn dataset (Fig. 3., $r^2=0.13$, $p<0.025$), while the correlation is not significant considering summer data. Moreover, in autumn, larger part of the total cover is represented by dominant species, than in summer (Figs. 1 and 3.).
Figure 3.: Importance of the number of dominant species in NEE of loess grassland, Hungary (autumn 2000).

Conclusions
Increasing aerial cover, number of species, and even the number of dominant species showed positive correlations with NEE at the same micro-scale in the loess grassland stands. The first relationship was more pronounced in summer, while the latter two in autumn. Rare species didn’t seem to play important role in autumn, when senescence touches differently the functioning species present, while in summer, they could affect results by their greater mass and cover.

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References