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Variability of leaf growth characteristics in the canopy of sessile oak and Austrian oak

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ABSTRACT In this study the variability of leaf growth traits was investigated within the canopy of the two dominant tree species of *Quercetum petraeae-cerris* forest community, covering 30 % of the present forested area in Hungary. The investigation were performed in the "Sikfőkut Project" LTER site (Jakucs 1985). We compared the present leaf growth traits of species with those reported by Virágh (1985) for years of 1973-1975 before the decline of sessile oak in the site. After bud break leaves of the two canopy layers exhibited different rate in the increase of leaf area (La) and leaf mass (Lm). In spring shade leaves showed more intense increase in leaf area than in leaf mass. This resulted in a transitional large reduction of SLM in the shade leaves. In case of sessile oak the full leaf size was achieved within the same period in 2003 and 2004 but the area of mature leaves were larger in both canopy layers in 2004 than in 2003. In case of sessile oak the area of mature leaves in growing seasons of 2003 and 2004 increased significantly as compared to the period before the forest decline (Virágh 1985). In the upper canopy layer of Austrian oak the leaf area and leaf mass did not differ significantly from those reported for the period before the forest decline. In the lower layer of the canopy, however, the increase of leaf area was observed but the leaf mass exhibited similar values. In 2004 the loss of leaf area in the sun layer was 17% and in the shade layer 6 % as a consequnce of photophagous damages. In case of Austrian oak the loss of leaf area was smaller and amounted only to 1-5%.
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KEY WORDS
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Function of forests, the most complex terrestrial ecosystems, primarily depends on the organic matter production taking place in the canopy of trees. The efficiency of organic matter production is influenced by many plant and environmental factors among which the area and mass relations of assimilating leaves are determinant. During the development leaves of trees are going through a series of functional and morphological specialization processes and in the meantime they are forced to maintain their physiological balance and to adjust the spatial and temporal fluctuations of environmental factors. Beside these the fine differences and fluctuations in the light and temperature conditons due to the place of leaves within the tree canopy influence the growth parameters and the whole physiology of leaves. As a consequence leaves in the upper and outside surface of the tree canopy (sun layer, sun leaves) exhibit distinct anatomical, morphological and physiological traits from those developing in the the inside of canopy (shade layer, and shade leaves). Sun and shade leaves have different significances in the overall physiology of the tree (Kozlowski 1971; Roderick 1982; Ülo and Kalevi 1994).

In this study we investigated the variability of leaf growth traits within the canopy of the two dominant tree species of *Quercetum petraeae-cerris* forest community, covering 30% of the present forested area in Hungary. The investigation were performed in the Sikfőkut Project long-term ecological research site (LTER; Jakucs 1985). The influence of the changes in stand structure due to the decline of sessile oak appeared nationwide in the 80 ies (Mészáros et al. 1993) on the alteration of leaf growth were evaluated by comparing our results with those reported by Virágh (1985) for years of 1973-1975. The influence of phytophagous insects on the leaf growth traits of the two species was also studied.

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Materials and Methods

The "Sikfőkut Project" experimental site is situated at 320-340 m a.s.l. in the Bükk mountains in the North-Hungarian Central Range. The geographic, climatic, soil conditions and vegetation of the site and the adjacent area are described by Jakucs (1985). The site is covered by a 85-90 years old stand of the climate-zonal sessile oak-Austrian oak community (*Quercetum petraeae-cerris*). The decline of sessile oak occurred in Europe in the 80 ies seriously influenced the structure and compostion of the forest stand of the site (Jakucs et al. 1986; Mészáros et al. 1993). Opening of canopy layer and formation of canopy gaps as a concomitant with the 60% decline of sessile oak influenced the microclimatic conditions and the dominance relations of the vegetation layers (Mészáros et al. 1993).

The investigations were prformed in the growing seasons of 2003 and 2004. The two years were completely different in weather conditons especially in the distribution and the amount of rainfall. Spring was very dry in 2003 and wet in 2004. Leaves were collected regularly from the upper and lower canopy layers of 3 trees of sessile oak and Austrian oak from the metorological tower from the bud break until the end of summer. Leaves were samled in three shoots of every layer. The leaf area (La) was determined by means of AeaScope 5 v1 leaf area measuring system developed in the Department of Botany, Debrecen University. Parallel to the La measurements, leaf length, leaf width and damaged leaf area were also determined. Dry mass of individual leaves (Lm) were weighted after drying at 85°C for 48 hours. Specific leaf mass (SLM, g dm^{-2}) was calculated as the ratio of Lm to La. Relative Leaf mass Growth Rate (RLmGR) was calculated as $(\ln Lm_2 - \ln Lm_1)/(t_2 - t_1)$ (g g^{-1} day^{-1})

Results and Discussion

In 2003 the number of sessile oak trees was less with 67% in the stand as compared the number before the forest decline. There were only 21% decrease in the number of Austrian oak trees. The vertical projection of the tree canopy was used for evaluating the change in the canopy size and responses of individual trees to the structural loosening of the stand. This parameter of the remained sessile oak trees increased with 14%. The canopy size of the Austrian oak increased more significantly (34%).

In spring the increase of leaf area (Lm) was more intense in the shade layer of the canopy in both species than in the sun layer. This resulted in a transitional large reduction of SLM in the shade leaves from the the starting high values measured after bud break. In case of sun leaves the starting phase of development of La and Lm was more balanced than in shade leaves. However shade leaves reaches the full area development earlier than sun leaves. In the lower layer of trees leaves can avoid the later shading influences of the upper canopy with this strategy.

In case of sessile oak the full leaf size was achieved within the same period in 2003 and 2004 but the area of mature leaves were larger in both canopy layers in 2004 than in 2003. This is due to the differences in the rainfall conditions in the period of the logaritmic phase of the leaf development in the two growing seasons. This suggests that springtime drought primarily influence the potential size of assimilating leaf area of sessile oak. The increase of leaf mass was very similar in the sun and shade layers of sessile in spring. The mass of shade leaves reached the maximum than tha of sun leaves. In 2004 the mass of fully developed sun leaves was significantly larger than in 2003. This is due to the compensation in leaf mass as a consequence of phytophagous damages. The loss of leaf area int he upper canopy layer was 16%. In case of sessile oak the springtime increase of leaf mass was very similar in the sun and shade layers. Shade leaves finishes the development of leaf mass earlier and exhibit significantly smaller leaf mass than sun leaves.

In sessile oak the area of mature leaves in growing seasons of 2003 and 2004 increased significantly as compared to the period before the forest decline (Virágh 1985). This suggests that the loosening of stand structure may have large influence on the canopy size and the development of shade and layers of individual trees. The horizontal increase of canopy resulted in deeper shade in the lower layer of trees. In case of sessile oak the leaf mass of mature sun and shade leaves was significantly larger in 2003 and 2004 than in the period before the forest decline (Virágh 1985).

In the upper canopy layer of Austrian oak the leaf area and leaf mass did not differ significantly from those reported before the forest decline. In the lower layer of the canoy, however, the increase of leaf area was observed but the leaf mass exhibited similar values.

The SLM of mature leaves was larger in the sun layer than in the shade layer. The maximum values of RLmGR was observed in spring and did differ significantly from those reported for the period before the forest decline. The maximum value of RLmGR appeared 45-50 days later in case of the thermophyllous Austrian oak than in case of sessile oak. However the logaritmic phase of leaf development of Austran oak is shorter than in sessile oak. In 2004 there was a 17% loss of leaf area in the sun layer and 6% loss of leaf area in the shade layer as a consequnce of photophagous damages. In case of Austrian oak the loss of leaf area was smaller and amounted only to 1-5%.

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