

BRIEF COMMUNICATION

Stomatal Oscillations in Adult Forest Trees in Natural Environment

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Abstract. Conductance of abaxial epidermis was measured in leaves of *Acer campestre*, *Carpinus betulus*, *Quercus cerris* and *Q. petraea* sample trees growing in an oak-hornbeam forest. Measurements were performed on several summer days during morning and midday hours. Stomata tended to oscillations only in *Q. cerris*. The occurrence of stomatal oscillations was controlled by environmental conditions, e.g. weather.

Stomatal oscillations were observed by many investigators in several plant species under controlled conditions (*see* review of BARRS 1971) and several models of oscillations were proposed (*e.g.* COWAN 1972, SHERIFF 1974, SHIRAZI *et al.* 1976). However, stomatal oscillations were found very rarely under natural field conditions (TEOH and PALMER 1971, LEVY and KAUFMANN 1976, MAOTANI and MACHIDA 1977). The aim of this paper has been to find out whether oscillations in stomatal conductance occur in adult forest trees growing in natural habitat.

Mature sample trees of *Acer campestre* L. (18 m high), *Carpinus betulus* L. (18 m), *Quercus cerris* L. (21 m) and *Q. petraea* LIEBL. (20 m) have been grown in a natural stand of the oak-hornbeam forest in I.B.P. Forest Research Area at Báb, SW. Slovakia, Czechoslovakia. Field measurements of stomatal conductance were made from 22 m high steel tower on fully exposed sunlit foliage within a small region of the crown (about 1 m²) in the upper part of the forest canopy (the heights 16 to 17 m), during several clear summer days in July 1977.

Conductance of abaxial epidermis of the hypostomatic leaves was measured with a Lambda diffusion porometer, LI-60, similar in design to that of KANEMASU *et al.* (1969). Micrometeorological factors were measured above the

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forest canopy, at heights of 25 or 19 m above the ground, and registered by the UM-type data logging system in 10-minutes intervals at Báb's meteorological station (cf. SMOLEN 1970). Soil moisture content was determined by the thermogravimetric method at the depths of 10 to 80 cm and expressed in weight percentage (dry mass).

Fig. 1 illustrates a day when no or negligible fluctuations in stomatal conductance were observed. Maximum conductance of stomata in morning hours and the decline of conductance towards midday were frequently observed in *Quercus petraea* and *Acer campestre* (cf. ELIÁŠ 1977a, b), but also in other plant species growing in the field.

Fig. 2 was chosen to illustrate the oscillations in stomatal conductance in forest large trees *in situ*. They were more apparent in *Quercus cerris* than in *Acer campestre*. Rapid decline in stomatal conductance after 10 h a.m. was caused by clouds which decrease illumination intensity. The same stomatal responses to clouds were observed in *Quercus alba* L. (HINCKLEY *et al.* 1974). Clouds can cause significant changes in plant water status in a short time as demonstrated by STANSELL *et al.* (1973).

The results of our field measurements of stomatal conductance indicate

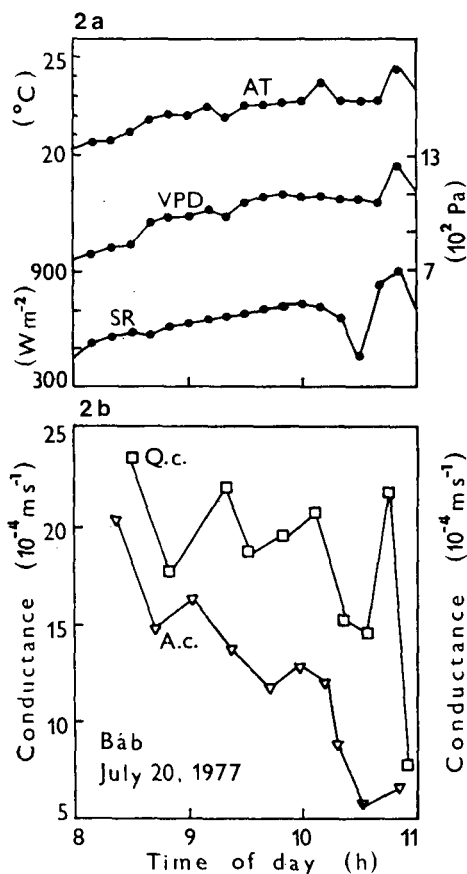
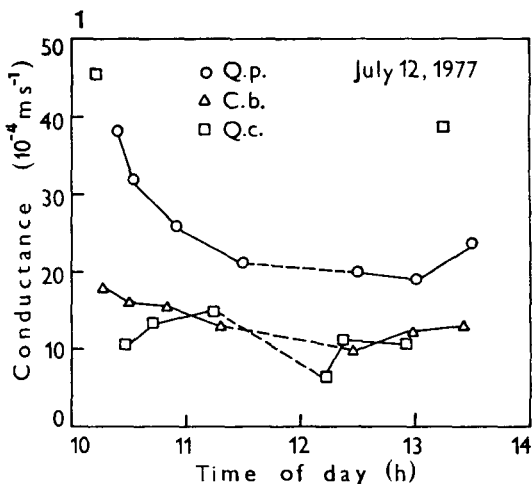


Fig. 1. Changes in conductance of abaxial epidermis in leaves of large *Quercus petraea* (Q. p., crown aspect: E), *Carpinus betulus* (C. b., NE), and *Quercus cerris* (Q. c., W) sample trees between 10 h a.m. and 2 h p.m. (12 July 1977) under natural conditions of the Báb forest. Each point is the mean of 3 to 7 leaves. Soil moisture content within the soil layer 10 to 60 cm thick was 15.46 per cent.

Fig. 2a, b. Changes in conductance of abaxial epidermis of *Quercus cerris* (Q. c., crown aspect: E) and *Acer campestre* (A. c., SW) under natural forest conditions. Above: AT — air temperature at 19 m, VPD — vapour pressure deficit at 19 m, SR — solar radiation at 25 m above the ground. Soil moisture content within the soil layer 10 to 60 cm thick was 14.85 per cent.



that oscillations in stomatal aperture do not occur in all investigated tree species and that stomata of *Quercus cerris* tended to the oscillations more apparently. Environmental conditions appear to play important role in the occurrence of oscillations. LEVY and KAUFMANN (1976) observed differences in oscillations between plants growing at different root temperatures. MAOTANI and MACHIDA (1977) found that the amplitude of oscillations in leaf diffusion resistance of *Citrus unshiu* MARC. became larger with non-irrigated trees than with those irrigated. SHERIFF and SINCLAIR (1973) did not observe oscillations in stomata aperture in certain cases, although they measured fluctuations in sap fluxes.

The oscillations are not usually synchronous in leaves of one shoot of *Citrus unshiu* (MAOTANI and MACHIDA 1977) or in individual stems of one plant of *Gossypium areisianum* (SHERIFF 1973). In the later case, there should be a time lag in the transmission of oscillations in sap flux along a stem. Oscillations in stomatal conductance in leaves were not synchronized in our materials either. Therefore in Figs. 1 and 2 only average values obtained from measurements of the sample groups of leaves measured at a given time are introduced. Each sample group was formed by the same leaves which were usually measured in the same sequence. This way may in some cases lead to masking the oscillations, but it was considered as convenient because of a large variability of stomatal conductance in individual leaves.

KUČERA *et al.* (1977) recorded fast changes in the transpiration flow rate in the trunk bases of full-grown *Quercus sessilis* EHRH. and *Betula alba* L. during a day of unstable weather conditions. These oscillations are not always caused by the oscillations in stomatal aperture (SHERIFF and SINCLAIR 1973, SHERIFF 1973). The correlation between stomatal conductance and transpiration flow rate is not linear, except for stomata closing at midday and in the afternoon (*cf.* ELIÁŠ 1976, 1977b). Short-time fluctuations in transpiration flow rate may be caused by changes in hydraulic properties of the flow system, including changes in root resistance. SHERIFF and SINCLAIR (1973) suggested that the short-time fluctuations (1 to 10 min) are apparently not caused by changes in stomatal aperture.

The results of our preliminary measurements indicate that the oscillations in stomatal conductance of some species may occur also in natural environment and in this case they may be a natural phenomenon. But the oscillations have not been observed in the same species under all environmental conditions and far more investigations are needed for definitive conclusions.

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