TIME VARIATION OF ELECTRIC POTENTIAL DIFFERENCES ON TREE TRUNK

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Introduction

Bioelectric phenomena at tissue and organism levels are sometimes less known in plants than in animals, although the problem of plants seems to be simpler than that of animals or humans. In situ electrical measurements on plants especially on trees have proven to be very difficult. Investigation of bioelectric phenomena of trees became widespread in the last decades, but many question remained unanswered, e.g. the true relationship between life- functions of the tree and the measured electric signals. The effect of the environment on the electric signals is also not yet fully explained.

Measurements and some results

We started the first bioelectric experiments in 1995, primarily focusing on the measurements of electric potential differences (EPD) on the tree trunks. The EPDs were recorded continuously for four years (between 17.05.1997 and 28.02.2002) at the Széchenyi István Geophysical Observatory. As shown in Fig. 1 a–b, sixteen non-polarizing electrodes were inserted beneath the cambium into the sapwood of a turkey oak (Quercus cerris L.) at four height levels (at 0, 2, 4 and 6 m), and at each height level four electrodes (corresponding to S, W, N and E sides of the tree) were installed. The EPDs were measured between the trunk electrodes and a common ground. The sampling interval was kept as short as 1 sec. and 1 minute mean values were continuously recorded.

The electric potential differences on tree trunks change over time. The most noticeable variation is the regular daily fluctuation whose amplitude is a few tens of mV. The daily activity is most likely related to the transpirations daily rhythm. The amplitude of the daily fluctuations shows a characteristic seasonal variation as well, with two maxima. The first peak occurs at frondescence (due to the very intense transport processes within the tree), while the second one appears in early summer (Koppán et al. 2000). Beyond the temporal changes we investigated the spatial variations of EDPs, too (Koppán et al. 2005).

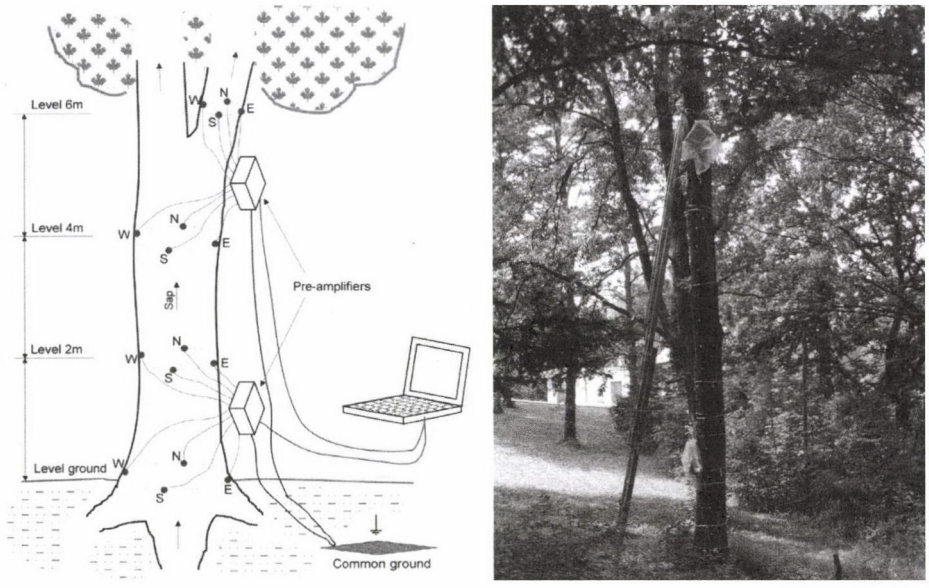

Fig. 1. The electric potential difference measuring system in the Nagycenk Observatory

After determining the variations of the electric potential differences and their characteristics the next step was to define which internal processes and environmental parameters might be the source for the formation and changes of the electric potential differences. The most important internal process is the axial water transport in the tree trunk. This fact is confirmed by the correlation analysis of the sap flow and electric potential difference data (Fig. 2.), which showed a close connection between the two data series. The sap flow was simultaneously recorded from July 1999 to December 1999 with Graniers radial flowmeter technique (Granier 1987) by using a four-channel (four thermocouples) system.

In order to understand the tree - environment interactions, it is important to study, which environmental factors could directly or indirectly affect the EPDs. We revealed relationships between the variations of the EPDs and various meteorological/geophysical parameters (recorded at the Observatory) by using a multivariate statistical analysis, although the assessment of the results is difficult due to the many unseparable external and internal factors, acting simultaneously. Such measurements are carried out nowadays in frame of a complex geoenvironmental project, in cooperation with the University of West-Hungary (Gribovszki et al. 2004).

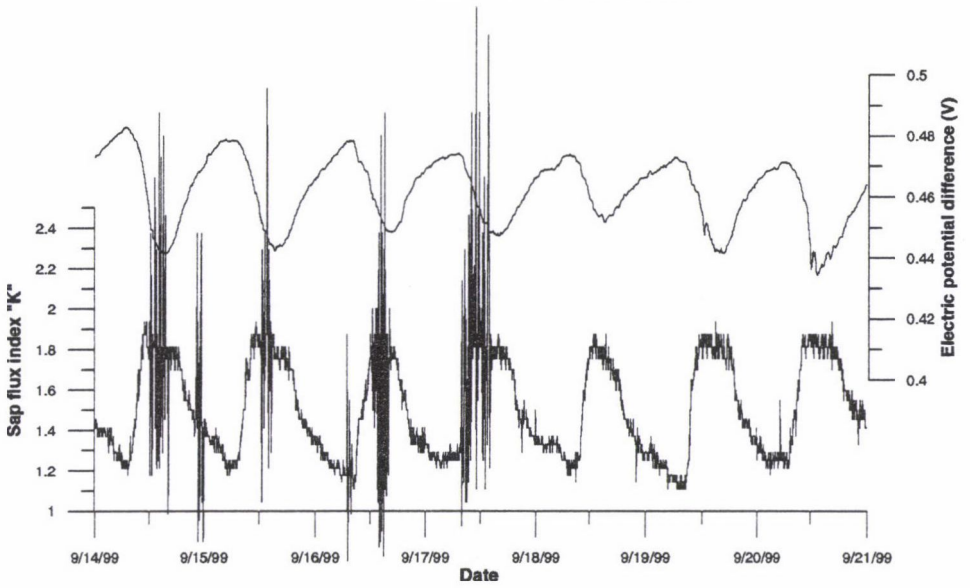

Fig. 2. Variation of electric potential differences (top) and the sap flux index "Kö (bottom) derived from Granier (1987) thermometric method (14–20 September 1999)

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