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Photochemical efficiency of amphibious plants in an intermittent lake

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Abstract

During the six month dry period in the intermittent lake Cerknica in 2003, fluorescence parameters in 14 amphibious plants were measured to estimate the possible disturbance to photosystem II. Environmental changes due to intermittence caused no evident irreversible damage, since the potential photochemical efficiency of the majority of species and forms remained close to the optimal value at 0.83. Actual photochemical efficiency varied, showing different levels of temporary stress. Sudden submergence of aerial forms caused little disturbance to PS II. The results revealed the acclimation of plants thriving in intermittent habitats that enabled continuous harvesting of solar energy.

Keywords: Intermittent lake; Photochemical efficiency; PS II; Amphibious plant

1. Introduction

On areas, where floods alternate with periods of drought, many plant species exhibit an amphibious character (Cronk and Fennessy, 2001). Morphological and biochemical features and reproduction strategies enable them continuous physiological functioning over the environmental gradient from open water to dry land (Gaberščik, 1993; Boulton and Brock, 2001; Germ and Gaberščik, 2003). Some amphibious plants develop differently

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shaped leaves (heterophylly) or growth forms (Hutchinson, 1975; Cronk and Fennessy, 2001), while others survive with no visible changes. The ability to photosynthesise under contrasting conditions (Germ and Gaberščik, 2003) presents a competitive advantage over submerged or emerged macrophytes, which have a low tolerance of variable water regime (Cronk and Fennessy, 2001).

Fluorescence techniques provide an indication of plant stress. Drought induces a decline of photochemical efficiency of PS II that is indicative of photoinhibition (Colom and Vazzana, 2003). Interspecies differences in fluorescence parameters and responses of plants exposed to variable water regime in the field may provide useful information on the ability of amphibious plants to tolerate extreme situations. Water level fluctuations in the intermittent Lake Cerknica influence the abiotic and biotic components of the ecosystem (Gaberščik and Urbanc-Berčič, 2002; Gaberščik et al., 2003). Prolonged dry period, accompanied by high temperatures, marked the whole vegetation period 2003. Outstanding conditions favoured the growth and development of plants with an amphibious character (Urbanc-Berčič et al., 2005). The objective of this study was to examine, to which extent the fluorescence characteristics and thus electron flow through PS II of amphibious plants were affected by drought or submergence.

2. Materials and methods

2.1. Area description

The study was carried out during dry period in 2003 at Lake Cerknica (45°45′N, 14°20′E). Lake Cerknica is *locus typicus* for intermittent lakes, appearing at the bottom of the karst field, Cerkniško polje. The closed depression of Cerkniško polje extends over 38 km^2 and a surface of 25 km^2 is flooded when the polje changes into a lake. Usually, twice a year (in spring and late autumn to early winter), the water reaches its normal level of 500 m a.s.l. The normal floods last on average 260 days. The dry period usually starts at the beginning of summer (Kranjc, 2002) while in year 2003 it began in May and it lasted till October. The precipitation was scarce and temperatures high in comparison to average summer period (Zupančič, 2002).

2.2. Plant species studied

The measurements were conducted on plants, exhibiting an amphibious character, that are abundant at Lake Cerknica (Urbanc-Berčič et al., 2005; Martinčič, 2002). In most cases aquatic, aerial and transitional growth or leaf forms were examined. Three out of 14 plant species were homophyllus (*Mentha aquatica* L., *Myosotis scorpioides* L., *Teucrium scordium* L.) and 11 were heterophyllus or developed an aerial growth form (*Alisma plantago-aquatica* L., *Glyceria fluitans* L., *Hippuris vulgaris* L., *Myriophyllum spicatum* L., *Nuphar luteum* (L.) Sibith. & Sm., *Oenanthe fistulosa* (L.) Poir., *Polygonum amphibium* L., *Ranunculus trichophyllus* Chaix, *Sagittaria sagittifolia* L., *Sium latifolium* L., *Sparganium erectum* L.). In *N. luteum* and *P. amphibium* natant leaves were considered as aquatic.