5. DYNAMICS OF DOMINANT PLANT POPULATIONS AND RELATIONS TO MANAGEMENT

5.1. ADAPTATIONS OF DOMINANT PLANT POPULATIONS TO FLOODPLAIN ENVIRONMENT: AN INTRODUCTION

Leoš Klimeš

Plants living in floodplains with natural water regimes (i.e. which experience flooding) have to cope with considerable fluctuations of water level. Organisms living there possess special adaptations to survive, grow and reproduce in those stressful environments (Jackson & Drew 1984).

There are three basic strategies by which species adjust to a fluctuating water environment where periods of perturbance alternate with periods of recovery. Organisms may avoid severe periods (i) by escaping from the affected area, (ii) by surviving in inactive states (e.g. dormant seeds), or (iii) they may develop adaptations which enable toleration of the adverse conditions (e.g. aerenchyma formation and ethylene-induced etiolization in plants, see Blom *et al.* 1990; Voesenek *et al.* 1990). It is difficult for plant species living in flooded areas to avoid flood episodes, as the majority are perennial and the floods are unpredictable both in time and duration (Chapter 3.3). Therefore, most of them respond to flooding by incorporating structural changes in their tissues which help to ensure survival in such times of stress.

From the point of view of the plant, flooding is a complex phenomenon. Besides the direct disturbance caused by the flood episodes themselves and by the material introduced and removed from the system by the water flow, the flood indirectly affects the vegetation by virtue of the remarkable changes in oxygen availability in the soil, by hydrochemical change, and through generally lowered illumination of the floodplain surface. The plant species living in flooded areas are well differentiated according to their adaptability to anaerobic conditions. Those living in oxbows and water pools possess numerous adaptations which enable them to live in (nearly) permanently flooded environments (*Carex gracilis* is an important representative of this group in the studied area, see Chapter 5.2). Other plants may survive better in flowing water than in water pools (e.g. *Phalaris arundinacea*) because of the better supply by oxygen. On the other hand, numerous plants cannot survive in flooded areas as they will not tolerate even short periods of oxygen deprivation (Crawford 1989). The length of individual floods affecting mesic sites on the floodplain of the Lužnice River is between six and ten days on average (Fig. 5.1a). However, the maximum length of floodings is between 30 and 50 days in these habitats. As the plants living in the floodplain may also suffer from fast changes in water levels resulting in a post-anoxic injury and mortality in non-adapted plants (Drew 1983) the length of the period without floods is also important, as many plant species regenerate during this drier period. In the section of floodplain subjected to detailed investigation as part of this project, mesic localities were observed to be not flooded for between 70 to 140 days (as averaged over the entire 10-year study period) and between 51 to 70 days during the growth season of April to Sep-

Floodplain Ecology and Management, pp. 125–129
ed. by K. Prach, J. Jeník and A.R.G. Large

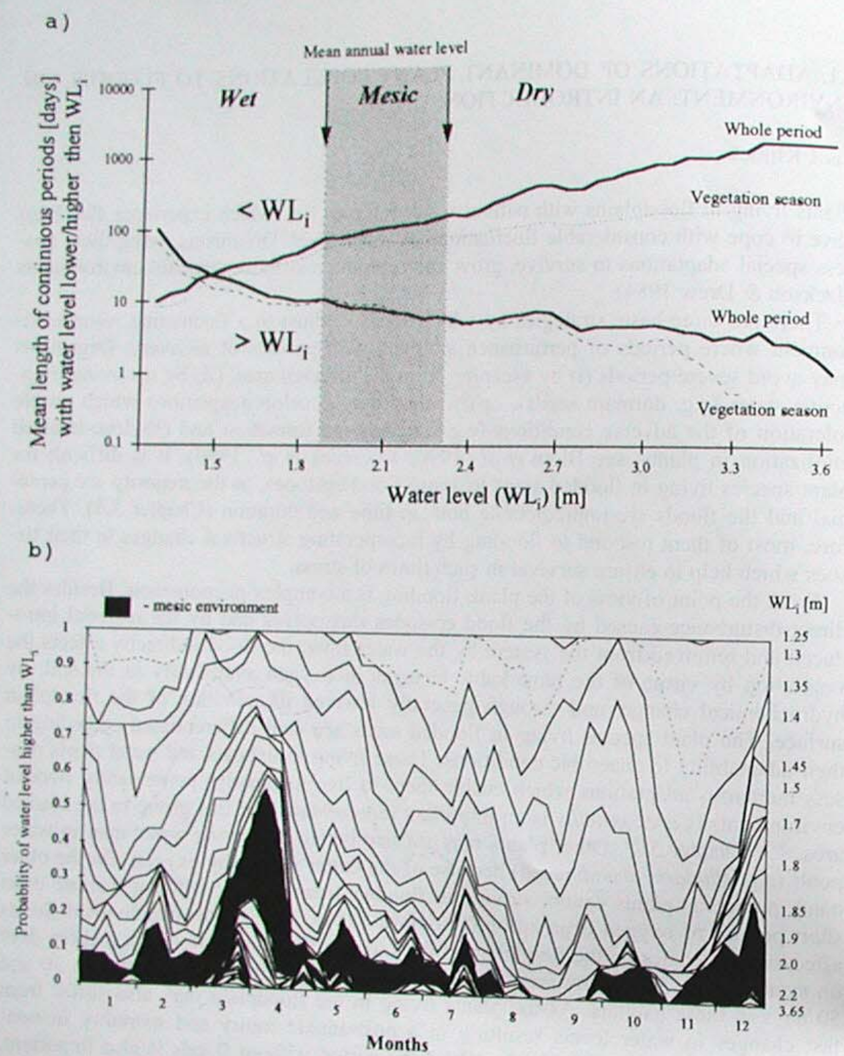

Fig. 5.1. (a) Mean length of continuous periods with water level (WL) lower or higher than the level given on x-axis (WL_i, mesured to nearest 5 cm, ranging between WL_1 = 1.25 and WL_{49} = 3.65 m). Based on daily discharge measurements ($m^3 \cdot s^{-1}$) recorded at the Pila station between November 1979 and October 1990. WL (m) was calculated as $WL = [-0.000584*D^2 + 0.075835*D + 1.2392]$ ($R^2 = 0.99$). The results are presented for the whole 10-year monitoring period and for growth seasons (April-September). The "mesic" environment was defined as a range of mean annual WL at which more then one plant of *Rumex obtusifolius* occurs per 10^2 m (see Klimeš 1989). "Dry" and "Wet" environments were defined as those with lower and higher mean WLs respectively.
(b) The water regime in the Lužnice River floodplain. The probabilities of water levels higher than WL_i are shown.

tember (Fig. 5.1a). This period is hardly long enough for all plants to complete their life cycle.

The mean length of the periods with water levels less than WL_i (defined as water level at Pilař Station measured to the nearest 5cm) was seen to increase linearly with WL_i. Values ranged between WL_1 = 1.25 m and WL_{49} = 3.65 m during the period November 1979 to October 1990. In contrast, the mean length of periods with water levels above WL_i decreases more quickly for low values of WL_i. At higher WL_i values, the decrease is much slower (Fig. 5.1a). This implies that, over a ten-year period, the probability of a flood with a given intensity decreases predictably with this intensity whereas the length of the flood is less dependent on its intensity. However, if floods within vegetation seasons are considered, then for high water levels the length of periods with a given water level increases more slowly (Fig. 5.1a).

Flood events are relatively unpredictable in their occurrence throughout the year. Except for the end of August and the beginning of September, mesic environments in the floodplain may be inundated during any month, with the highest probability of inundation being at the beginning of April, i.e. at the time of rapid growth of most plants (Fig. 5.1b). This leads to problems for many plant species inhabiting the Lužnice floodplain study area. The driest month was seen to be November, when floods rarely occurred and the highest probabilities of the lowest water levels were recorded (Fig. 5.1b).

The main plant dominants in grasslands of the Lužnice River floodplain are adapted to different water regimes (Prach 1992; Chapter 4.1.3.; Table 5.1). *Alopecurus pratensis, Urtica dioica* and *Rumex obtusifoius* are relatively sensitive species to oxygen deficiency (Klimešová 1995; Chapters 5.2, 5.3), whereas *Carex gracilis* tolerates high water levels and associated oxygen deprivation quite effectively. In standing water bodies on the floodplain without throughflow, oxygen deficiencies are further enhanced by the high organic matter content in the soil (Chapter 5.2).

There is little differentiation between the main species in respect to temperature, soil pH and light requirements. However, the species were observed to vary markedly in their response to nutrients and mowing (Table 5.1). *Urtica dioica* is a species particularly sensitive to mowing (Šrůtek 1993; Klimešová 1995; Chapter 5.3). Other dominant species have either lower nutrient demands and are moderately sensitive to mowing, or regenerate vigorously and fast after cutting with few signs of lasting damage (Table 5.1). In the Lužnice River floodplain study area, fertilisers are usually applied where two harvests a year are expected. However, there are also large areas with either unpredictable or no management (Part 8). Regular management regimes with high doses of fertiliser applied several times a year and regular mowing twice a year are dominant in the northern part of the floodplain where floods are infrequent. More irregular management without fertilisation is seen to occur in areas where the harvest is often lost due to flood episodes. In recent years, these floodplain areas have often been abandoned (Chapter 8.1). Most plant assemblages limited to oligotrophic conditions have disappeared from the study area in the past decades (compare Blažková 1973; Prach 1993, 1994). Still, there is a marked differentiation in nutrient demands among herbaceous species dominating in the floodplain (Table 5.1). Under conditions of high nutrient levels *Carex gracilis* is replaced by *Phalaris arundinacea* and even *Urtica dioica* (Šrůtek 1993; Klimešová 1995; Chapter 4.1.2). *Rumex obtusifolius* is another species which can efficiently utilise high levels of nutrients (Chapter 5.3).

The principal dominants in the floodplain are clonal plants. However, the role of clonality and generative reproduction differs between the species. A regular generative reproduction is not critical for most of these species because of their longevity

Table 5.1. The basic characteristics of the plants dominating grasslands in the floodplain study area. Clonal growth: TG - turf graminoids; ES - long-living epigeotropic stems < 10 cm in length; HS - long-living hypogeotropic stems: HSa - < 10 cm, HSb - > 10 cm in length. Grime's strategy: C - competitive; CS - competitive-stress tolerant. Life form: h - hemicryptophytes; g - geophytes; a - hydrophytes. Data from Frank & Klotz 1990 and unpubl. (clonal growth and the effect of mowing).

Species	Family	Clonal growth	Effect of mowing in the floodplain	Ellenberg's indicator values					Grime's strategy	Life form
				Light	Temperature	Soil moisture	Soil pH	Nitrogen		
Alopecurus pratensis	Poaceae	HSa	Weak	6	-	6	6	7	C	h
Carex gracilis	Cyperaceae	HSb	Moderate	7	4	9	6	4	CS	ga
Deschampsia cespitosa	Poaceae	TG	Weak	6	-	7	-	3	C	h
Phalaris arundinacea	Poaceae	HSb	Moderate	7	-	8	7	7	C	gh
Rumex obtusifolius	Polygonaceae	ES	Weak	7	5	6	-	9	C	h
Urtica dioica	Urticaceae	HSb	Strong	-	-	6	6	8	C	h

(*Alopecurus pratensis, Carex gracilis, Deschampsia cespitosa*) or intensive vegetative multiplication (*Phalaris arundinacea, Urtica dioica*). However, their abundance is determined by rates of establishment in space and time (Klimešová 1995; Chapter 5.2). *Rumex obtusifolius* is a short-living plant which has to rely on generative reproduction and a high competitive ability (Chapter 5.4).

The dominant species play a prominent role in the floodplain not only because of their contribution to biomass production and nutrient cycling (Chapter 6.1), but due to the fact that they can influence vegetation succession through time. A canopy of *Urtica* and *Phalaris* (the two species dominating abandoned floodplain areas) prevents establishment of shrubs and trees. In addition, a thick layer of litter which undergoes little decomposition over the period of a year makes seedling establishment nearly impossible in the subsequent growth season. Therefore, even after a long period without regular management, the herbaceous assemblage will not be replaced by woody vegetation species. In this way, the plants dominating the floodplain contribute to the maintenance of the entire area in a herbaceous species-dominated state.

References

Blažková, D. 1973. Pflanzensoziologische Studie über die Wiesen der Südbohmischen Becken. Academia, Praha.

Blom, C.W.P.M., Bogemann, G.M., Laan P., van der Sman, A.J.M., van de Steeg, H.M. & Voesenek, L.A.C.J. 1990. Adaptations to flooding in plants from river areas. Aquat. Bot. 38: 29-47.

Crawford, R.M.M. 1989. Studies in plant survival: Ecological case histories of plant adaptation to adversity. Blackwell Scientific, Oxford, 296 pp.

Drew, M.C. 1983. Plant injury and adaptation to oxygen deficiency in the root environment: A review. Plant & Soil 75: 179-199.

Frank, D. & Klotz, S. 1990. Biological-ecological data to flora of GDR. Wiss. Beitr. Martin Luther Univ. Halle-Wittemberg 32: 1-167.

Jackson, M.B. & Drew, M.C. 1984. Effects of flooding on growth and metabolism of herbaceous plants. In: Kozlowski, T.T. (ed.), Flooding and plant growth, pp. 47-128. Academic Press, Orlando.

Klimeš, L. 1989. Distribution and ecological differentiation of broad-leaved clocks (Rumex L.) in the floodplain of the Lužnice River, South Bohemia, Czechoslovakia (in Czech with English summary). Preslia 61: 129-144.

Klimešová, J. 1995. Population dynamics of Phalaris arundinacea L. and Urtica dioica L. in a floodplain during a dry period. Wetlands Ecol. Manage. 3:79-85.

Prach, K. 1992. Vegetation, microtopography and water table in the Lužnice River floodplain, South Bohemia, Czechoslovakia. Preslia 64: 357-367.

Prach, K. 1993. Vegetational changes in a wet meadow complex, South Bohemia, Czech Republic. Folia Geobot. Phytotax. 28: 1-13.

Prach, K. 1994. Vegetation changes in wet meadows in the Třeboň Biosphere Reserve (in Czech with English summary). Příroda, Praha, 1: 97-105.

Šrůtek, M. 1993. Distribution of the stands with Urtica dioica L. along the Lužnice River floodplain on the border between Austria and Czechoslovakia and land management. Vegetatio 106: 73-87.

Voesenek, L.A.C.J., Perik, P.J.M., Blom, C.W.P.M. & Sassen, M.M.A. 1990. Petiole elongation in Rumex species during submergence and ethylene exposure: the relative contribution of cell division and cell expansion. J. Plant Growth Regul. 9: 13-17.