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Ecological Botanical Garden
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Water, wind and willows:

Dispersal timing, seed germination & distribution of seedlings

Fig.1: Fructifying *Salix purpurea*.

Introduction

The vegetation of river meadows is characterized by flooding dynamics. The success of Salicaceae and especially the genus *Salix* (willow) in these disturbance-intensive habitats is based on different properties, especially:

- Large quantities of small, anemochorous distributed seeds,
- fast germination of seeds,
- fast growing seedlings.

The aim of the present study was to investigate if different time of seed dispersal leeds to spatial differentiation of willow seedlings in their habitat.

Therefore we investigated time of seed dispersal of several alluvial willow species, germination characteristics and the spatial distribution of seedlings.

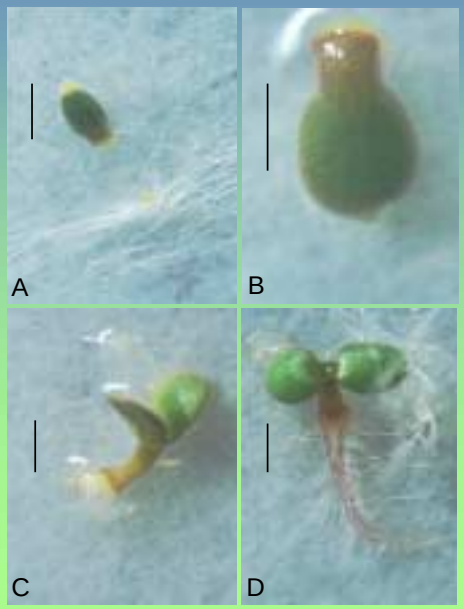

Fig. 2: Germination of *Salix fragilis*. Scale = 1 mm. A: Seed, B: swollen seed after 5 hours on moist filter paper, C: 1-day-old seedling, testa stripped off, hairs at the base of hypocotyl visible, D: 3-days-old seedling, radicle with hairs, horizontal arrangement of cotyledones.

Tab. 1: Influence of seed age on germination rates (%) in continuous light. Shown are means and standard deviations, significant lower germination rates during storage compared with the germination rate of fresh seeds within one species (Friedman's ANOVA, Wilcoxon-Wilcox-test) are marked red.
= alluvial species

		Seed germination [%] after storage for						
		0 weeks	1 week	2 weeks	3 weeks	4 weeks	6 weeks	8 weeks
Salix caprea	♂	95,3	96,5	93,8	90,0	64,5	47,8	0
	SD	4,1	4,3	7,1	10,0	25,0	28,0	/
Salix cinerea	♂	99,5	88,3	53,0	16,0	13,0	0	0
	SD	1,5	16,7	28,1	12,7	19,3	/	/
Salix purpurea	♂	79,0	47,9	29,7	1,3	0,3	0	0
	SD	21,3	35,4	25,4	2,8	1,1	/	/
Salix viminalis	♂	82,3	60,0	40,0	2,8	1,0	0	0
	SD	17,9	35,7	34,6	6,8	2,1	/	/
Salix fragilis s.l.	♂	93,0	35,3	17,3	4,3	0	0	0
	SD	19,5	28,2	18,0	5,8	/	/	/
Salix triandra	♂	99,5	69,0	12,3	2,8	0	0	0
	SD	1,5	30,2	8,4	4,4	/	/	/

Fig. 3: Study site *Marktzeuln* at the river *Rodach* (Germany, Bavaria, Upper Franconia). Sample areas I and II were located on this river bank.

Germination characteristics

On moist filter paper in light, germination rates of all species were at least 80 % (Tab. 1). All species except the non–alluvial *S. caprea* showed significantly reduced germination rates after two weeks. All alluvial willow species lost germination ability after four weeks.

Dispersal timing, water level and colonized area

The investigated species can be divided into early dispersers (*Salix viminalis and S. purpurea*) and late dispersers (*S. alba, S. fragilis* s. l. *and S. triandra*). The water level during the time of early seed dispersal was significant higher than during the time of late dispersal (Fig. 5).

Therefore, the distribution of seedlings among the relief differed significantly between both groups. Early dispersers occured in higher altitudes and farther from the water shore than late dispersers (Figs. 4, 5). Establishment of seedlings only took place in the range of water level fluctuations during the time of seed dispersal or a few centimeters higher.

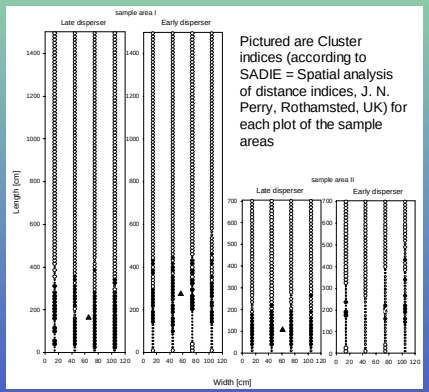

Fig. 4: Spatial distribution of seedlings on two sample areas at the first recording date in June 2000 for early and late seed dispersers. X-axis at y = 0 complies to the waterline at mean summer water level. Open circles: cluster index < 0, filled circles: cluster index > 0. Big open circles belong to a gap of seedlings (cluster index < -1,5), big filled circles belong to a patch of seedlings (cluster index > 1,5). The triangle markes the spatial mean of seedling distribution .

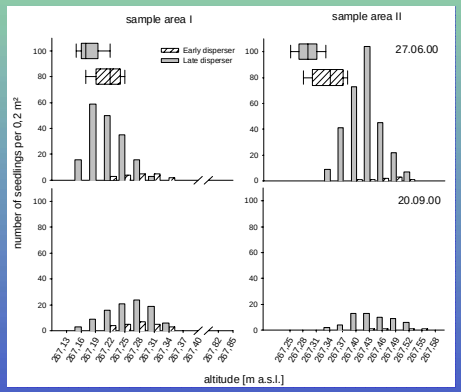

Fig. 5: Distribution of seedlings of early and late dispersers (differentiated into first and last recording date 2000 and sample areas I and II) according to the relief. Number of individuals are combined to relief categories of 3 cm.
Water levels during the time of seed dispersal for both species groups are shown as box plots (Median, 10th, 25th, 75th and 90th percentiles shown as boxes with error bars).

Conclusions

These results suggest that optimal germination conditions must be available during the time of seed dispersal due to the short period of germination ability. Sufficient germination conditions are provided primarily in the zone of water level fluctuations. Thereby, time of seed dispersal and distribution by wind (and water?) in combination with water level fluctuations result in different spatial distribution of the two dispersal groups. This seems to be an important factor to avoid interspecific competition, to ensure establishment of seedlings on a preferably large area and to support the high diversity of *Salix* species in alluvial habitats.

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