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Seed deposition in drift lines during an extreme flooding event — Evidence for hydrochorous dispersal?

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Summary

Extreme flooding events can be of major importance for dispersal processes in today's fragmented landscape. We studied long- and short-distance seed dispersal during an extraordinary flooding of the Elbe River in summer 2002. In addition we evaluated the effect of different species traits (seed buoyancy, dispersal type, Ellenberg moisture values) on dispersal and discussed the relevance of hydrochorous dispersal during extreme flooding events for nature conservation and restoration. Along a transect of 400 km of the Middle Elbe River (Eastern Germany) drift line material from three habitats (arable field, grassland, river bank) was collected at five locations. Its seed content was analysed and compared with vegetation communities of the same region with respect to species composition. One part of the drift line samples was scanned for seeds and seed fragments visually, while the other part was exposed for germination. A total of approximately 1500 seedlings of about 70 species emerged from the samples. The most frequent species were *Deschampsia cespitosa*, *Urtica dioica*, *Ranunculus repens* and *Lycopus europaeus*. Hand-sorting of drift-line material revealed that only 1.5% of the seeds occurring in the samples recruited in the germination trials. Although most seeds and seedlings from the drift line samples belonged to common species, some seeds of rare and endangered species were found. Species composition of the drift line samples differed only marginally between the studied habitats and locations, which is interpreted as evidence for short- and long-distance seed dispersal. In contrast, the vegetation of the analysed habitats differed significantly. The studied species traits did not differ between drift line material from different habitats, but rather between the differentiated vegetation communities. We conclude that seeds from different

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habitats and locations are transported together during heavy flooding and that these floodings might thus expand the usual dispersal ranges of plant species.

Zusammenfassung

Extreme Überflutungsereignisse können in unserer heutigen fragmentierten Landschaft von großer Bedeutung sein. Im Sommer 2002 haben wir nach Rückgang der ''Jahrhundert-Flut'' der Elbe hydrochore Nah- und Fernausbreitung pflanzlicher Diasporen untersucht. Zusätzlich wurde der Einfluss unterschiedlicher artspezifischer Charakteristika (Schwimmfähigkeit der Diasporen, Ausbreitungs-Typ, Ellenberg Feuchte-Werte) auf die Ausbreitung analysiert und die Relevanz hydrochorer Ausbreitung während extremer Überflutungen für den Naturschutz diskutiert. Entlang eines Transekts von insgesamt ca. 400 Flusskilometern der Mittleren Elbe (Ost-Deutschland) haben wir von jeweils drei Habitaten (Acker, Auen-Grünland, Flussufer der Elbe) an fünf Lokalitäten Spülsaummaterial entnommen. Wir untersuchten dessen Diasporengehalt und verglichen die Artenzusammensetzung des Spülsaums mit derjenigen charakteristischer Vegetationstypen derselben Region. Ein Teil der Spülsaumproben wurde visuell auf Diasporen durchsucht, während der übrige Teil zur Keimung ausgebracht wurde. Insgesamt liefen ca. 1500 Keimlinge von mehr als 70 Arten aus den Proben auf. Am häufigsten kamen *Deschampsia cespitosa*, *Urtica dioica*, *Ranunculus repens* und *Lycopus europaeus* vor. Das manuelle Sortieren des Spülsaummaterials ergab, dass nur ca. 1.5% der in den Proben enthaltenen Diasporen in den Keimungsuntersuchungen aufliefen. Obwohl die meisten Diasporen und Keimlinge aus den Spülsaumproben zu weit verbreiteten Arten gehörten, wurden einige Diasporen seltener und gefährdeter Arten gefunden. Die Artenzusammensetzung der Spülsaumproben unterschied sich nur geringfügig zwischen den untersuchten Habitaten und Lokalitäten, was als Hinweis sowohl auf Nah- als auch Fernausbreitungsprozesse gewertet wird. Im Gegensatz dazu unterschied sich die Vegetation der untersuchten Habitate signifikant. Die analysierten artspezifischen Charakteristika unterschieden sich nicht signifikant zwischen Spülsaummaterial verschiedener Habitate wohl aber zwischen den betrachteten Vegetationstypen. Wir schließen aus den Ergebnissen, dass während extremer Überflutungen Diasporen von Arten unterschiedlicher Habitate und Lokalitäten zusammen transportiert werden und dass derartige Überflutungen den normalen Ausbreitungsradius von Pflanzenarten ausweiten können.

Introduction

Although seed dispersal via running water is known as an important factor for plant populations occurring near rivers (e.g. Andersson, Nilsson, & Johansson, 2000; Goodson, Gurnell, Angold, & Morrissey, 2001) it is usually confined to the river bed and the nearby surroundings. However, Schwabe (1991) found seedlings of plant species which are usually absent from floodplains in samples of freshly deposited riverbank sediments following an extreme flooding event. These species came from arable fields, grasslands and other habitats near the floodplains. Also Hughes and Cass (1997) found more than 20 herbaceous species in flood debris which did not occur in their studied habitat. Thus, hydrochory can give even terrestrial plant species an opportunity to expand their range rapidly, providing that safe sites are reached (e.g. Pyšek & Prach, 1994 for invasive species Boedeltje, Bakker, Bekker, Van Groenendael, & Soesbergen, 2003).

Today, almost all of Europe's large floodplains are altered due to river straightening and the construction of dykes. These landscape changes have reduced the area of characteristic floodplain plant communities during the last decades and have led to an increasing level of fragmentation of the remaining habitats. As dykes prevent water-born seeds from dispersing beyond their walls, hydrochorous seeds cannot disperse among these fragmented habitats during regular flooding events. Extremely rare events of extraordinary floods causing breaching of dykes may increase the chances of seed dispersal by flooding water between otherwise fragmented habitats (compare Nilsson, Reidy, Dynesius, & Revenga, 2005). Following major floods, water-borne seed dispersal may