Seedbanks in fluvial pioneer habitats and their role in colonization of newly created habitats – an example from the middle Loire River (France)

Banques de graines des habitats pionniers fluviatiles et leur rôle dans la colonisation d'habitats neufs – un exemple de la Loire Moyenne (France)

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RÉSUMÉ

Les habitats pionniers des plaines alluviales sont colonisés par des communautés végétales qui comprennent typiquement une grande part de thérophytes, ce qui suggère que le recrutement à partir de la banque de graines joue un rôle majeur dans les processus de colonisation.
L'étude présentée vise (i) à étudier les banques de graines à travers une série d'habitats typique des plaines alluviales (bancs de sable à forêts matures), (ii) d'évaluer l'importance des graines allochtones dans la colonisation de bancs de sable récents et (iii) d'identifier le vecteur majeur de transport de diaspores (eau ou sédiments).
L'étude a été réalisée sur un ensemble d'îlots fluviatiles dont l'une a été arasée en septembre 2012 est qui est en reconstitution depuis. Les bancs de graines et la végétation établie ont été échantillonnés avant travaux et le processus de colonisation de l'îlot en cours de reconstitution a été suivi. Les résultats suggèrent que la formation de banques de graines est un processus lent, et que la production locale de graines à partir de quelques individus rares et arrivés aléatoirement pourrait être plus important que des graines arrivés directement d'autres sites.

ABSTRACT

Fluvial pioneer habitats are colonized by pioneer plant communities that generally comprise a large part of therophytes, suggesting that recruitment from seeds plays a major role in the colonization process.
The present study aims (i) to study seedbanks across a range of floodplain habitats (sandbanks to mature forest), (ii) to investigate the part played by allochthonous seeds in the colonization process of new sandbanks and (iii) to identify the major vector of propagule transport (water or sediments).
The study took place on a group of fluvial islands with one of them having been removed in September 2012 and that is reforming since then. Seedbanks and established vegetation were sampled prior to island removal and the colonization process of the reforming island was monitored.The results suggests that seedbank build up rather slowly, and that local seed production from some rare and stochastically arrived individuals may be more important for colonization than seeds arriving directly from other sites.

KEYWORDS

Floodplain, hydrochory, Loire River, Seedbank, propagules, succession

1 INTRODUCTION

The colonization of bare sand and gravel banks by pioneer vegetation in great river floodplains is the first step in succession, but also in the stabilization processes of sediments. The intensity and velocity of sediment stabilization will depend, among others, on the type of plant species that colonize, and on the velocity of the colonization process. Many seeds may arrive from upstream locations by hydrochory (floating) or as part of the deposited sediments. Another possibility for colonization is given by vegetative propagules that may be deposited especially after summer floods and along the waterline. Colonizing plant communities typically comprise a large part of therophytes, suggesting that recruitment from seeds plays a major role in the colonization process. Despite the potentially great impact of species- and trait composition within colonizing plant communities on sedimentation processes, little is known concerning seedbank densities and composition, and the process of seedbank formation across floodplain habitats.

The present study aims to address this question. It takes place prior and after the removal of a riverine island within the middle Loire River. The study compares the seedbank across floodplain habitats prior the works, and documents the colonization process and propagule origin of the re-forming island and its seedbank. The specific questions are: (i) which similarity of seedbanks and established vegetation prior to the island removal? (ii) which pathways and amplitude for propagule arrival and seedbank formation? (iii) which selection of plant traits for vegetation establishment one year after the works?

2 METHODS

2.1 Study site

The study took place on a group of fluvial islands in the middle Loire River (Mareau-aux-Prés). One of the islands has been removed in September 2012 within the framework of fluvial maintenance works and is reforming since then. The re-formation process of the island as well as its colonization by several taxonomic groups are monitored within a large research project (see Villar et al. IS Rivers 2015).

2.2 Vegetation and seedbank sampling

Prior to the island removal, established vegetation of five major habitat types (sandbanks, *Populus nigra* shrubs, *Elytrigia campestris*-dominated grassland, softwood forest, transition/hardwood forests) was monitored and underlaying seedbanks were sampled. Vegetation relevés and seedbank sampling took place on 5m * 5m plots in August 2012, with three replicates per vegetation type. Seedbank sampling comprised the upper 6 cm substrate layer.

Sampling after the island removal took place on the re-forming island. 5m * 5m plots were established on three elevation levels (Low, Intermediate, High). Vegetation on the plots was monitored in July 2013. Seedbanks were sampled on each plot, differentiating surficial sediments (upper 2 cm) and deeper sediments (2 to 6 cm) in order to distinguish propagules likely to be arrived by floating from propagules likely to have travelled among sediments.

Deposited plant material along the water lines were sampled at three dates in summer 2013 on three different zones (sampling of the upper 2 cm). Plant fragments were counted and determined, the propagule bank was sampled in regular intervals.

2.3 Seedbank study

Sediments sampled in September 2012 were kept to overwinter under a waterlayer of 4°C until April 2013 in order to mimic field conditions. Seedbanks were then studied according to the “seedling emergence method” (Simpson et al. 1998). Sediments were spread out in the laboratory on 18cm x 24cm x 9 cm trays on a 3.5 cm layer of heat-sterilized sand. Each sample was submitted to (i) a permanently flooded treatment and (ii) a permanently humid treatment, favoring respectively the development of aquatic species and wetland/terrestrial species.

Sediments sampled in July 2013 were submitted to the flooded/humid treatments immediately after their arrival to the laboratory. Since germination seemed very sparse in the 2013 samples, all

sediment samples were screened for remaining seeds in summer 2014, those seeds were determined according to Cappers, Bekker & Jans (2012).

2.4 Data treatment

Statistical treatment comprised ordination of vegetation plots using Principal Component Analysis and comparison of seedbank densities using Mann-Whitney tests. Composition of seedbank and established vegetation was investigated through the Sørensen similarity index.

3 RESULTS

3.1 Seedbanks prior to island removal

In samples from 2012, densities of germinated seeds were comprised between 0.3 * 10^{-2} cm^{-3} and 17.9 * 10^{-2} cm^{-3} .Both values concerned the sandbank habitat, in which variability was significantly higher than in any other habitat type. Similarity between established vegetation and seed bank composition did not differ according to habitat type. The most represented species among seedlings were two invasifs, *Lindernia dubia* and *Cyperus esculentus*. Both were present over the whole habitat range within the seedbank, but only rarely observed in the established vegetation.

3.2 Propagule arrival and seedbanks after island removal

Fragments of 20 taxa have been identified in the deposits of the waterline, most of them aquatic macrophyte or amphiphytes. None of them was observed to establish. Seed density in sediments was about ten times lower than in sandbank habitats prior to the island removal. No differences were observed between superficial and deeper sediments or between different elevations.

4 MAIN CONCLUSIONS

One year after island removal, the new sandbank presents only a very scarce vegetation cover. The results of this study reveal that this is not due to unsuitable conditions for vegetation establishment but can be explained by very low seed densities. No major pathway for seed arrival could be revealed. The results suggest that despite of high sediment dynamics, frequent erosion of existing pioneer habitats and export of sediments and seedbanks in the floodplain, the arrival of seeds and other plant propagules on new spots is a stochastic and rather rare event, and the formation of a local seed bank a slow process. Local seed production from some rare individuals may be more important for colonization than seeds that arrive directly from other sites.

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