



Effect of mother plant age on germination and size of seeds and seedlings in the perennial sedge *Carex secalina* (Cyperaceae)

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ABSTRACT

The performance of seeds and seedlings in relation to the age of the mother plant was studied in *Carex secalina*. Seeds of this sedge can differ substantially in size. We planted 100 *C. secalina* individuals from three populations in a common garden and followed them for four years. We found that mean seed mass varied with plant age, but the pattern of variation was population-specific, with only one population showing significant reduction in seed mass with age. Similarly, germination frequency changed with age differently in different populations. The relationship between the age of the mother plant and the height of emerged seedlings did not differ between populations. In spite of the fact that plant size and mean seed mass exhibited similar patterns of variation within populations, there was no correlation between these two variables at the level of individuals. This means that the size of *C. secalina* tufts does not determine how big the seeds will be. Moreover, there was no relationship between mean seed mass and the height of seedlings. Presumably, factors intrinsic to each plant determine the production of either small or large seeds in a population-specific way.

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Introduction

Cyperaceae is a large, cosmopolitan group of plants that dominates many habitats including those that are essential to humans (pastures, grasslands, etc.). In studies of seed germination in sedges, the most common approach is to analyze the effects of environmental, physiological and morphological factors. Correlations have been demonstrated between seed germination and temperature (e.g., Kettenring and Galatowitsch, 2007; Schütz, 2000), light (e.g., Schütz, 1999), cold stratification (e.g., Brändel and Schütz, 2005), leaf litter (Vellend et al., 2000) and a seed bank (Schütz, 2002).

Germination of seeds may not only depend on external factors (temperature, light, etc.) but also on the amount of resources accumulated by a plant in the year of seed production and its pattern of resource allocation. Seeds of a perennial plant in successive periods of reproduction can be characterized by progressively lower germination rates, resulting from changes in resource allocation. The resources of a plant must be divided among various processes essential for individual survival (growth, protection), while resources allocated toward reproduction must be appropriately divided between the production of generative shoots, flowers and seeds. Clonal plants additionally allocate resources to vegetative reproduction (Karlsson and Méndez, 2005). In accordance with accepted models of plant resource allocation, perennials such as sedges, unlike annuals, allocate different amounts of available resources in successive years. This allocation results from differential availability of these resources and the varying needs of an individual over its lifetime (Kozłowski, 1992). Due to this, studies of seed germination should involve individuals of known age. However, in many investigations, the collected seed samples originate from randomly selected individuals of unknown age (e.g., Kettenring and Galatowitsch, 2007; Schütz, 1999), a fact that may obscure the results.

In the case of perennials, an effective way of obtaining individuals of known age is to examine the plant's life history traits in uniform garden conditions. Such studies of individual life history traits eliminate the influence of different sampling-plot environments and allow the observation of hereditary traits (Stearns, 1992). Differing from the majority of other approaches, in studies on the early life stages of *Carex secalina* involving seeds and seedlings, we took special care to sample seeds only from mother plants of known age. Usually, examination of seed germination in Cyperaceae is carried out in Petri dishes after a period of stratification, with seeds collected from mature individuals of advanced age (e.g., Baskin et al., 1996; Brändel and Schütz, 2005; Leck and Schütz, 2005; Schütz, 1999). However, these methods do not take into consideration the life history traits of individuals that affect the expression of the initial stages of plant development. Our controlled

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Table 1

Characteristics of localities and populations of *Carex secalina* that provided seeds for the garden experiment. All localities are in the vicinity of Inowrocław, Kujawy-Pomerania region, Poland (prepared from data in Lembicz et al., 2009).

Locality	Dulsk (A)	Turzany (B)	Jacewo (C)
Location (GPS)	N 52° 45' 19.72" E 18° 20' 31.05"	N 52° 47' 20.90" E 18° 20' 16.58"	N 52° 48' 02.88" E 18° 17' 50.78"
Area of population (m ²)	4	20	17
Maximal number of individuals between 2001–2008	20	73	38
Type of habitat	Pasture	Pasture (fringes of watering place)	Former pasture, currently under sporadic recreational pressure
Intensity of grazing	Small (one cow)	High (20 heads of cattle)	None
Number of species per m ²	10	5	8

garden experiment allowed us to observe the effect of mother plant age on seed and seedling development. The aim of the present study was to answer whether seed size, germination frequency or seedling size are related to an individual's age or to the source population.

Materials and methods

Species and populations

Carex secalina Wild. ex Wahlenb. 1803 is one of three species of sedges belonging to the section Secalinae (O. Lang) Kük. 1909 of the subgenus *Carex*, family Cyperaceae (Egorova, 1999). It is a peren-

nial, monoecious plant with a tussock habit and iterative growth. It propagates exclusively from seeds. Individuals of this species enter the reproductive phase in their second year of life (Żukowski et al., 2005). Usually, two or three male spikes are situated at shoot apices, below which are single female spikes. *C. secalina* is a halophyte with a Euro-Siberian, Irano-Turanian distribution of small, isolated populations. In the European part of its range, numerous localities of *Carex secalina* are found in southern Germany, Austria, Hungary and southern Ukraine and Russia – at the outlets of the Dnieper River to the Black Sea and of the Volga river to the Caspian Sea. The Asian part of the range consists of isolated populations scattered from the southern Ural Mountains in the west through Kazakhstan and up to Lake Baikal in the east (Egorova, 1999; Meusel et al.,

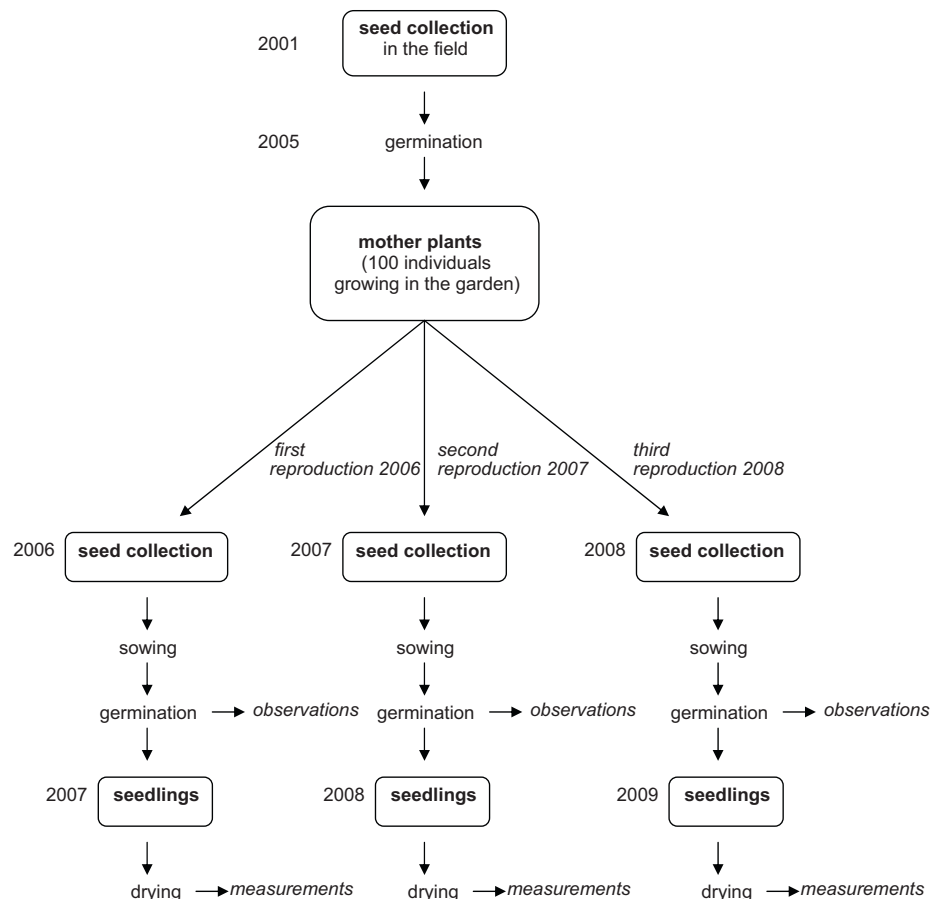


Fig. 1. Schematic presentation of the experiment. In 2001, seeds from three natural populations were collected. They were sown in the garden in 2004. In 2005, the seedlings germinated and 100 were selected as mother plants for further experiments. For three consecutive years, their aboveground biomass and seed mass were measured. Each year, seeds from the mother plants were collected and sown, their germination ability was estimated and seedling size was measured.

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