EFFECT OF FLOODING ON ANNUAL DORMANCY CYCLES IN BURIED SEEDS OF TWO WETLAND CAREX SPECIES

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Abstract: Buried seeds of Carex comosa and C. stricta were exposed to nonflooded and flooded conditions and natural seasonal temperature changes for 30.5 and 33 mo, respectively. At 1-, 2- or 6-mo intervals, exhumed seeds were tested for germination in light and darkness over a range of daily thermoperiods. Freshly-matured seeds of both species were conditionally dormant; maximum germination was at 35/20°C, in light. Dormancy decreased in nonflooded and flooded seeds of C. comosa during late autumn and winter, but the decrease was greater in flooded than in nonflooded seeds. Nonflooded and flooded seeds of C. stricta gained the ability to germinate in light during the first summer of burial and in darkness during the following winter. Seeds of neither species germinated while they were buried in pots of soil under either nonflooded or flooded conditions in the nonheated greenhouse. Nonflooded and flooded seeds of both species incubated in light and flooded seeds of C. comosa incubated in darkness had an annual conditional dormancy/nondormancy cycle, being conditionally dormant in summer and autumn and nondormant in spring. However, nonflooded seeds of C. comosa incubated in darkness remained dormant, germinating to only 1%. Most nonflooded and flooded seeds of C. stricta incubated in darkness had an annual dormancy/nondormancy cycle, being dormant in summer and nondormant in spring. Thus, flooding influenced the annual changes in dormancy states of buried seeds of C. comosa, but it had no effect on seeds of C. stricta.

Key Words: Cyperaceae, Carex, seed dormancy, burial, flooding, temperature requirements, germination

INTRODUCTION

In temperate regions of the world, buried seeds exposed to seasonal temperature changes may cycle between dormancy and nondormancy (Baskin and Baskin 1985) or between conditional dormancy and nondormancy (Baskin et al. 1989, Baskin et al. 1993a), or they may come out of dormancy and remain nondormant (Baskin et al. 1989). By definition, dormant seeds do not germinate under any temperature or light:dark conditions. As seeds come out of dormancy, they first enter conditional dormancy, during which time they germinate only over a narrow range of conditions. During the progression of dormancy loss, this range widens until seeds eventually germinate over the maximum set of conditions possible for the species or ecotype, at which point they are nondormant (Baskin and Baskin 1985). Thus, an understanding of the timing of germination in a species requires information about environmental conditions as well as the dormancy state of seeds at various times of the year.

Data on the temperature and light:dark requirements for germination throughout the year are available for buried seeds of only ten wetland species (Baskin et al. 1989, Baskin et al. 1993a,b, 1994). Buried seeds of seven of the ten species have an annual conditional dormancy/nondormancy cycle, while those of the other two species remain nondormant after their initial dormancy is broken. Six of the ten wetland species are members of the Cyperaceae, and buried seeds (achenes) of five of them, including Cyperus erythrotrhizos Muhl., C. flavidomus Michx., Fimbristylis autumnalis (L.) R. & S., F. vahlii (Lam.) Link (Baskin et al. 1993a) and Scirpus lineatus Michx. (Baskin et al. 1989), have an annual conditional dormancy/nondormancy cycle. Buried seeds of C. odoratus L. were conditionally dormant at maturity in autumn, but after this dormancy was lost during winter, seeds remained nondormant throughout the year (Baskin et al. 1989). Only two of the six species (C. odoratus and S. lineatus) are perennials; the others are summer annuals. No studies have been conducted on the germination re-
requirements for wetland species of Carex following various periods of burial under natural seasonal temperature cycles.

Moreover, little is known about the effects of flooding on seasonal changes in dormancy states of buried seeds. Short-term flooding had no effect on the dormancy state of buried seeds of the summer annuals Cyperus erythrorhizos, C. flavicomus, Fimbristylis autumnalis, and F. vahtii. Dormant or conditionally dormant seeds of these species flooded from October to April or May came out of dormancy, and nondormant seeds flooded from February to August did not re-enter dormancy (Baskin et al. 1993a). However, flooding in winter prevented dormancy break in seeds of Leucospora multifida (Michx.) Nutt., and flooding in summer prevented induction of nondormant seeds into conditional dormancy (Baskin et al. 1994). The purpose of this study was to determine the effects of flooding on seasonal changes in dormancy states of buried seeds of two wetland perennial carices. Information on how flooding affects the annual dormancy cycle of seeds would allow managers of wetlands to manipulate water levels to regulate germination.

MATERIALS AND METHODS


Ripe seeds were collected from plants of C. comosa growing in a swamp in Stewart County, Tennessee, USA (87°55'50"W and 36°30'30"N) on 16 August 1990 and from plants of C. stricta growing in a marsh in Stewart County, Tennessee (87°59'10"W and 36°30'38"N) on 13 May 1991. Seeds were allowed to dry at room temperatures for 1 week prior to initiation of germination studies.

Approximately 3,000 seeds were placed in each of 52 fine-mesh polyester bags for C. comosa and in each of 28 bags for C. stricta. Each bag was buried to a depth of 7 cm in soil (3:1 volume/volume mixture of limestone-derived top soil and river sand) in 15-cm-diameter plastic pots with drainage holes. The pots were placed in a greenhouse in Lexington, Kentucky that had no heat or air conditioning and windows were open all year. Mean daily maximum and minimum monthly air temperatures for the duration of the study were calculated from continuous thermograph records (Figure 1).

Half of the pots of seeds for each species was placed in a pool (1.4-m in diameter and 0.25-m deep) of water in the greenhouse and kept continuously flooded. The second half of the pots of seeds for each species was watered to field capacity once each week during summer (1 May-31 August) and daily during the remainder of the year, except on some winter days when frozen. These watering regimes simulate soil moisture conditions that could occur in the field in nonflooded sites throughout the year.

Germination tests were performed on freshly-matured seeds and on those exhumed on the first day of the months shown in figures in the Results section. Incubators were set on 12/12 h daily thermoperiods of 15/6, 20/10, 25/15, 30/15, and 35/20°C, which approximate mean daily maximum and minimum air temperatures for each month of the growing season in Stewart County, Tennessee (Wallis 1977): March and November, 15/6; April and October, 20/10; May, 25/15; June and September, 30/15; and July and August, 35/20°C. At each thermoperiod, seeds were incubated in light (14 h daily photoperiod of ca. 20 μmol m⁻² s⁻¹, 400-700 nm, cool white fluorescent light) and in darkness (continuous darkness for duration of germination test). At each thermoperiod, the photoperiod extended from 1 h before to 1 h after the high temperature period.

Seeds were incubated on white quartz sand moistened with distilled water in 5.5 cm Petri dishes. All

![Figure 1. Mean daily maximum and minimum monthly air temperatures that seeds were exposed to in the nontemperature-controlled greenhouse in Lexington, Kentucky, USA during the study period.](image-url)