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Comparison of the seed germination of native and non-native winter annual Apiaceae in North America, with particular focus on *Cyclospermum leptophyllum* naturalized from South America

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Abstract

To increase our knowledge of the seed dormancy breaking and germination requirements of native and non-native winter annual Apiaceae in temperate eastern North America, a study was conducted on seeds of *Cyclospermum (Apium) leptophyllum*, which is native to South America, but naturalized in North America and elsewhere. A high percentage of fresh seeds germinated over a narrow range of temperatures, but the range increased when seeds were incubated continuously in light or buried in soil at high summer temperatures, indicating the presence of conditional physiological dormancy (PD). Embryos grew from approximately 0.3 to 1.25 mm (316% increase in length) inside the seeds before the radicle emerged; thus, seeds had morphological dormancy (MD) as well as PD, that is, morphophysiological dormancy (MPD). Embryo growth did not occur during summer in seeds exposed to natural temperatures, but embryos did grow in autumn. For seeds sown in the field in June, both embryo growth and germination occurred in autumn. Thus, seeds have non-deep simple MPD, with PD being broken in summer and MD in autumn. A comparison of *C. leptophyllum* with native and non-native winter annual Apiaceae in the region reveals that all species have MD, but the proportion of fresh seeds that also has PD (thus, MPD) varies between species. A combination of factors, including PD, an inability to germinate at high summer temperatures, a relatively low temperature requirement for embryo growth and a lack of dispersal until autumn (in two non-natives), delays germination of both natives and non-natives until autumn, when conditions are favorable for both germination and seedling establishment.

Keywords: Apiaceae, germination phenology, morphological seed dormancy, morphophysiological seed dormancy, winter annual.

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Introduction

The flora of temperate eastern North America includes 15 genera and 24 species of winter annual Apiaceae (Radford

et al. 1968; Gleason & Cronquist 1991). Six genera (*Chaerophyllum*, *Cynosciadium*, *Daucus*, *Ptilimnium*, *Spermolepis* and *Trepocarpus*) are native to the region, and 10 (*Aethusa*, *Anethum*, *Amni*, *Anthriscus*, *Apium*, *Bupleurum*, *Cyclospermum*, *Coriandrum*, *Scandix* and *Torilis*) are not native. All species from the non-native genera, except *Cyclospermum leptophyllum* (Pers.) Sprague ex Britton & P. Wilson, are native to Europe or Eurasia (Radford *et al.* 1968; Gleason & Cronquist 1991). *Cyclospermum leptophyllum* is native to South America, and it is widely naturalized as a weed in

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