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Seed and early plantlet structure of the Mediterranean seagrass *Posidonia oceanica*

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Abstract

Seeds from mature fruits of the Mediterranean seagrass *Posidonia oceanica* deposited in the intertidal zone by sea surface currents revealed an advanced state of embryo development. The fruit dehisces by three longitudinal openings, which originate from the base or point of fruit attachment. Within the fruit the seed is positioned with its radical end at the fruit base, and the apical or plumular end protected until the seed is completely released. Structural observations of the collected mature seeds suggest the possible onset of germination. The mature seed is characterized by an enlarged hypocotyl with abundant starch reserves, a well-defined vascular system with a predominant central vascular strand to mobilize those reserves, a well-developed plumule, and root system initials, which will assure anchorage to the sea floor. Thus, within the dispersal unit, the future plant organs and growing points are well established and the carbohydrate-rich endosperm will assure the availability of sufficient nutrient supplies for short-term development of the seedling.

Keywords: Seagrass; *Posidonia oceanica*; Fruit dehiscence; Seed anatomy; Germination

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1. Introduction

Posidonia oceanica (L.) Delile is the dominant seagrass species in the Mediterranean Sea, where it is endemic. This species forms extensive infra-littoral beds or meadows, which constitute one of the most important and productive coastal ecosystems in the Mediterranean (Pergent et al., 1994; Gaceau et al., 2004). In recent years, however, many populations of *P. oceanica* are declining due to both natural and anthropogenic disturbances (Marbá and Duarte, 1997; Occhipinti-Ambrogi and Savini, 2003) and efforts are being made for their protection (EEC, 1992) and restoration (Molenaar and Meinesz, 1995; Balestri et al., 1998; Procaccini and Piazzi, 2001).

The seagrass meadows of *P. oceanica* are maintained largely by vegetative propagation by horizontal rhizome growth from already-established patches (Meinesz et al., 1992). The occurrence of sexual reproduction is a rare event and the mechanisms involved are poorly understood, showing great variability both in frequency and intensity (Bay, 1984; Buia and Mazella, 1991; Balestri and Cinelli, 2003). Seed production, however, is thought to play an important role in colonizing new sites and assuring genetic variability in seagrass populations (Orth et al., 1994; Jover et al., 2003). Production of seeds in seagrasses has been a key topic of research interest due to its importance for conservation and restoration. Recently, *P. oceanica* seed production (Piazzi et al., 1999; Periano et al., 2000; Balestri and Cinelli, 2003) and seed germination (Balestri et al., 1998; Balestri and Bertini, 2003) have been studied, but information on the structure and mechanisms involved in fruit and seed dispersal remains scarce.

Seagrasses are monocotyledons of the subclass Helobiae, in which the endosperm is intermediate between cellular and nuclear types, but is later absent in the mature seed (Tomlinson, 1982). Studies of mature seeds of seagrass species other than *P. oceanica*, such as *Zostera marina* L. (Zosteraceae) (Taylor (1957a,b), *Halophila spinulosa* (R. Brown) Ascherson and *Halophila ovalis* (R. Brown) (Hydrocharitaceae) (Birch, 1981; Kuo and Kirkman, 1992), *Talassodendron pachyrhizum* den Hartog (Cymodoceae) (Kuo and Kirkman, 1987, 1990), *Amphibolis griffithii* (Black) den Hartog and *A. antartica* (Labill.) Sonder et Ascherson (Cymodoceae) (Kuo and Kirkman, 1990), *Phyllospadix iwatensis* Makino and *Phyllospadix japonicus* Makino (Zosteraceae) (Kuo et al., 1990), *Thalassia hemprichii* (Ehrenberg) Ascherson (Hydrocharitaceae) (Kuo et al., 1991), *Posidonia australis* Hooker, *Posidonia sinuosa* Cambridge and Kuo and *Posidonia coriacea* Cambridge and Kuo (Kuo and Kirkman, 1996), indicate wide morphological diversity. Within this diversity, however, many authors have found extensive tissues with large amounts of nutrient reserves (Kuo and Kirkman, 1992, 1996; Kuo et al., 1990, 1991).

The fruit of *P. oceanica* is ovoid, with a fleshy and spongy pericarp bearing a single seed. Once separated from the plant, the green-colored fruit floats freely on the sea surface for a few days until dehiscence occurs, and the negative buoyancy of the seed compels it to sink to the bottom where it is dragged and finally fixed (Tomlinson, 1982). The fruit dehiscence process was observed by Caye and Meinsz (1984); however, morphology and anatomy of the seed of *P. oceanica* have not been described in detail. The objective of the current study is to describe the mature seed and early plantlet structures by means of anatomical procedures.