From Forest Nursery Notes, Winter 2012

56. © Reproductive ecology of black mangrove (*Avicennia germinans*) along the Louisiana coast: propagule production cycles, dispersal limitations, and establishment elevations. Alleman, L. K. and Hester, M. W. Estuaries and Coasts 34:1068-1077. 2011.

Estuaries and Coasts (2011) 34:1068–1077
DOI 10.1007/s12237-011-9404-8

Reproductive Ecology of Black Mangrove (*Avicennia germinans*) Along the Louisiana Coast: Propagule Production Cycles, Dispersal Limitations, and Establishment Elevations

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Received: 30 April 2010 / Revised: 29 October 2010 / Accepted: 11 April 2011 / Published online: 3 May 2011

Abstract Black mangrove (*Avicennia germinans*) reproduces by producing propagules through the process of cryptovivipary, which requires a significant energy investment. We conducted a series of field and greenhouse studies to track propagule production in years of high and low disturbances (i.e., hurricanes), the effects of time and salinity on propagule dispersal potential, and the relationship between hydrology and propagule establishment elevations. Trees tended to produce greater numbers of propagules in years after hurricanes, and individual trees alternated the amount of energy they invested in reproduction in consecutive years. In the greenhouse, propagule buoyancy was affected by salinity with propagules in 36 remaining buoyant for over 110 days and establishment success decreasing with dispersal period length. Finally, a field survey across five sites in southeastern Louisiana revealed that the 2009 cohort of propagules established at significantly lower elevations than mature trees occurred. These findings elucidate some salient features of black mangrove reproductive biology in the northern portion of its North American distribution.

Keywords *Avicennia germinans* · Propagule dispersal · Louisiana · Elevation · Reproduction

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Introduction

The range expansion of *Avicennia germinans* throughout the Gulf of Mexico and along the coasts of Central and South America is thought to be the result of long-distance dispersal events as evidenced by low genetic differentiation between West African and western Atlantic mangroves (Nettel and Dodd 2007). The propagules of *A. germinans* are cryptoviviparous, buoyant, and salt-tolerant which allow for long-distance dispersal events. It is hypothesized that vivipary evolved as a reproductive strategy to facilitate the colonization of high-energy environments, whereby the embryo does not undergo a period of dormancy but rather germinates and develops while remaining attached to the parent tree, thus reducing the time to establishment (Farnsworth 2000). Supplied with maternal carbohydrates and nutrients during development, the cotyledons contain sufficient reserves for long dispersal periods (Farnsworth 2000). When *A. germinans* propagules reach maturity and are abscised from the parent tree, they undergo an "obligate dispersal period" (Rabinowitz 1978) during which they develop roots while floating on tidal currents until they arrive at suitable exposed substrate and establish. The process of vivipary is common among mangrove genera but not requisite (Tomlinson 1986; Saenger 2002).

It has been suggested by Sousa et al. (2007) that "supply-side ecology" (Lewin 1986) may be as influential as abiotic factors or biotic interactions in determining the zonation, abundance, and composition of a mangrove community. As such, the arrival of large numbers of propagules at a site may initially outweigh other establishment factors, such as physiological tolerances or competition (Sousa et al. 2007). However, once dispersed to a site, abiotic and biotic factors influence propagule stranding, successful establishment (Delgado et al. 2001), the "main-