The effects of seed size and pericarp on seedling recruitment and biomass in *Cryptocarya alba* (Lauraceae) under two contrasting moisture regimes

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Accepted 7 February 2000

**Key words:** Desiccation, Probability of recruitment, Recalcitrant seeds, Seedling biomass, Wet and dry year regime

**Abstract**

Establishment success of plants derived from large seeds has been proposed to be greater than that of those derived from smaller ones, particularly under unfavourable conditions of moisture. Therefore, the advantages conferred by large seeds in terms of seedling performance may be modulated by abiotic conditions. The effect of seed size on *Cryptocarya alba* seedling performance (as determined by seedling recruitment and seedling size) was evaluated under two contrasting rainfall regimes (wet and dry year regime), simulated in the laboratory. It was also determined whether the presence of a pericarp, which had been shown to reduce germination, decreases desiccation and if this counterbalances the greater recruitment of seeds without a pericarp, especially under unfavourable conditions of moisture. Large seeds had a greater probability of recruitment and their seedlings attained a greater biomass, independently of the amount of water applied. In the simulated wet year regime, seeds with a pericarp showed a greater probability of recruitment than those lacking a pericarp. However, seedlings derived from both seed types attained a similar biomass. Under the dry year regime, seeds with and without a pericarp showed similar recruitment probabilities and their seedlings had similar biomasses. These results do not support the assumption that under favourable conditions of moisture, individual differences in seed size would not matter in term of seedling performance. A possible explanation in this case, is the presence of recalcitrant seeds in *C. alba*, which determines a very short time period for germination following dispersal. Therefore, any attribute that increases germination (e.g., large seeds) would be advantageous, independently of the prevailing abiotic conditions.

**Introduction**

Seed size is a morphological trait that may affect the fitness of the parent plants as well as the population regeneration process (Harper 1977; Fenner 1985; Silver town 1989). At the intraspecific level, large seeds have been shown to enhance germination (Schaal 1980; Weis 1980; Zimmermann & Weis 1982; Dolan 1984; Stanton 1984; Morse & Schmitt 1985; Winn 1988; Tripathi & Khan 1990; Vera 1997; Chacón, Bustamante & Henríquez 1998), shoot growth rates (Weiss 1980; Zimmermann & Weis 1982; Bonfil 1998; Chacón et al. 1998), seedling biomass (Weis 1980; Howe & Richter 1982; Dolan 1984; Stanton 1984; Morse & Schmitt 1895; Hendrix et al. 1991; Bonfil 1998; Chacón et al. 1998), and seedling survival (Schaal 1980; Morse & Schmitt 1985; Wulff 1986; Tripathi & Khan 1990; Vera 1997). As a result, seedlings originated from large seeds may have a competitive advantage in comparison to those originated from small seeds (Salisbury 1942). Nevertheless, it has been suggested that these advantages are modulated by abiotic conditions: the establishment success of plants derived from large seeds should be greater relative to those derived from smaller ones only under unfavourable conditions of moisture (Venable & Brown 1988). In contrast, under favourable moisture conditions, these phenotypic variations would be irrelevant.

*Cryptocarya alba* (Mol.) Looser (Lauraceae) is a shade tolerant tree, dominant on south-facing slopes and in humid ravines in the Mediterranean climate.
region of central Chile (Armesto & Martínez 1978). This zone is characterized by high inter-annual rainfall variability (Espinoza & Hajek 1988), causing the regeneration of *C. alba* to be episodic and concentrated during wet years (Fuentes et al. 1984). Fruits are red to pink, one-seeded drupes with a thin pericarp. Seeds vary widely in size, ranging from 0.1 to 3.3 g (1.0 g ± 0.02, 2 SE) (Chacón 1998). Laboratory evidence indicates that large seeds germinate in greater numbers compared to medium-sized and small seeds; and seedlings derived from large seeds develop longer shoots, have a greater probability of producing leaves and of attaining a greater biomass (Chacón et al. 1998). Fruits of *C. alba* are dispersed by vertebrates (e.g., birds and foxes), that remove and consume the pericarp, although an important proportion of fruits fall passively beneath parent plants with the pericarp intact (Bustamante et al. 1996). Although the removal of the pericarp by dispersers significantly increases the rate and percentage of seed germination (Bustamante et al. 1993), the presence of a pericarp should reduce desiccation, especially during dry years (Bustamante et al. 1996).

In this study, the following questions were addressed: (1) if large seeds recruit in greater numbers and produce larger seedlings than smaller seeds (Chacón et al. 1998), are these differences intensified under unfavourable moisture conditions, (2) does the presence of pericarp reduce seed desiccation?, and (3) if the pericarp protects seeds against desiccation but reduces germination (Bustamante et al. 1993, 1996), does its presence counterbalance the greater recruitment of seeds without a pericarp, especially under unfavourable moisture conditions?. In order to answer these questions, the probability of recruitment and seedling biomass were evaluated as a function of moisture conditions, seed size and presence or absence of a pericarp, in a laboratory experiment, in which two contrasting rainfall regimes were simulated.

**Materials and methods**

*Seed size distribution*

Seeds with their pericarp intact (i.e., whole fruits) and lacking their pericarp (i.e., vertebrate dispersed seeds) were collected from three populations of *C. alba* (Granizo, Ocoa and Curacavi), located in central Chile between 32°47’ S and 33°23’ S. Both types of seeds from the three populations were pooled in order to have an adequate sample size for the experiment. Each fresh seed was weighed to the nearest 0.01 g. The weight of the pericarp was subtracted from the total weight of the fruits in order to determine the weight of the seeds alone. For this, a sample of 150 fruits was weighed individually, peeled manually and weighed again. These seeds were not used in the subsequent experiment.

The seed size distribution curves (Figures 1a and 1b) were used to define small and large seeds. These two size classes were determined from the two extremes of the observed distribution: below and above percentile 10% and 90%, respectively. Seeds with a pericarp ranged in weight from 0.12 to 3.22 g (Figure 1a), while seeds lacking a pericarp varied between 0.19 and 2.14 g (Figure 1b). Mean seed weight was 1.04 g ± 0.02 (2 SE) and 0.95 g ± 0.01, respectively. The contribution of the pericarp to total fruit weight was 18.21% ± 0.68 (2 SE). For seeds lacking