Cordia alliodora (Ruiz & Pav.) Oken

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BORAGINACEAE (BORAGE FAMILY)

C. gerascanthus Jacq. (not *C. gerascanthus* L.), *C. gerascanthus* var. *domingensis* Cham., *C. velutina* Mart., *C. alliodora* var. *glabra* DC., *C. gerascanthus* var. *subcanescens* DC., *C. gerascanthus* sensu Griseb., *C. gerascanthus* forma *martinicensis* Chodat, *C. gerascanthus* forma *micrantha* Chodat, *C. alliodora* var. *boliviana* Chodat & Vischer., *C. andina* Chodat, *C. chamissoniana* var. *complicata* R. & P. ex Chodat., *C. goudoti* Chodat., *C. macrantha* Chodat., *C. cerdana* (R. & P.) R. & S., *Cerdana alliodora* R. & P., *Varronia tuberosa* S. & M., *Lithocardium gerascanthus* var. *alliodorum* Kuntze, *Lithocardium alliodorum* (R. & P.) Kuntze, and *Lithocardium gerascanthus* var. *domingense* (Cham.) Kuntze.

Aguardientillo, ajahatsa (ahahsatsa), amapa, amapa asta (amapa hasta), amapa blanca, amapa bola, anallo caspi, arbol del ajo, asca, auxemma blanca, bohunlanza, bois cypre, bois de Rhodes, bois de roge, bois de rose, bois soumis, bojón, bolaina, botoncillo, brown silver balli, canalete, canalete de humo, capá, capá de olor, capá de sabana, capá prieto, cayly, chaquine, chêne caparo, chevel, chullachaqui blanco, cinchado, claraiba parda, corallilo, cyp, cypre, cypress, d'ou lemon, dze-uí, freijo (frejoes, freijorge), guacimilla, guacimo nogal, hochi, hormiguero, lapochillo, laurel, laurel blanco, laurel de monte, laurel de puna, laurel macho, laurel negro, laurel prieto, louro, louro amarello, mataatiyo, moho, momiguilla, muñeco, nogal, nogal cafetero, pardillo, partago, picana, picana negra, sabanero, salaam, salmwood, smokewood, solera, soleria (solerillo), solerito, Spanish elm, spruce, suchil, tacuraí, tama palo santo, tambor hormiguero, uruazeiro (uraseiro), utaatigo, uurushi numi (murushinim), vara de humo, varía, varía amarilla, varía colorada, varía prieta (Little and Wadsworth 1964)

Cordia alliodora is the most widespread of the 300 species in the genus. It grows naturally from northern Mexico, through Central America and South America, to Paraguay, southern Brazil, and northern Argentina (Greaves and McCarter 1990). *Cordia alliodora* is also found on most of the Caribbean Islands from Cuba to Trinidad but is probably not native to Jamaica (Johnston 1950). The most frequently used name is probably laurel.

In lowland, humid tropical, regions, *C. alliodora* is generally a tall, thin tree with a narrow, open crown, and shows minimal forking forming a single stem to 15 to 20 m. Trees may reach over 40 m in height and over 1 m d.b.h. at overmaturity. However, 50 cm d.b.h. is more common in mature trees (Somarriba and Beer 1987). In seasonally dry, deciduous, and semideciduous forests, the species is smaller and more poorly formed, rarely reaching more than 20 m in height and 30 cm d.b.h. Its range extends from flat coastal lowlands, with deep infertile sands and little organic matter (Entisols or Oxisols), to very dissected, mountainous uplands with deep, fertile, volcanic soils high in organic matter (Andepts). *Cordia alliodora* grows under a wide variety of ecological conditions, varying from very wet (as much as 6000 mm annual precipitation) to seasonally dry (as low as 600 mm annual precipitation and a 7-month dry season). The tree grows from sea level to 1400 m in Central America and to 2000 m at lower latitudes in Colombia. It grows best on well-drained, medium-textured soils where mean annual rainfall exceeds 2,000 mm and the mean annual temperature is about 24 °C. The species does not tolerate poor internal drainage or waterlogging. Although *C. alliodora* will survive under light shade, full overhead light on fertile sites produces vigorous trees capable of rapid early growth. A strong tap root is produced at an early stage but a spreading root system also develops (Schlönvoight 1993). Some suggest this root system allows the tree to withstand exposed conditions (Marshall 1930).

The timber of *C. alliodora* is highly valued and used extensively throughout its natural range. Specific gravity varies from 0.38 to 0.73 (Greaves and McCarter 1990), with

densities higher on seasonally dry sites and in provenances from seasonally dry zones (Boshier and Henson 1997). The wood is usually straight-grained and easily seasoned and worked. It is used widely for construction, furniture, flooring, veneer, turnery, and carving. Although it marks easily, the heartwood is moderately to highly resistant to termites and to both brown and white-rot fungi (Greaves and McCarter 1990). In Mexico a decoction of leaves was used as a tonic and stimulant in cases of catarrh and lung infections. In the West Indies pulverized seeds were used in treating cutaneous diseases (Standley 1924). The flowers are considered a major source of nectar by beekeepers in the Caribbean (Crane and others 1984).

The white flowers of *C. alliodora* are hermaphrodite, unspecialized, about 1 cm in length, and occur in large auxiliary or terminal inflorescences with 50 to 3,000 flowers. *Cordia alliodora* may begin flowering at 2 years (Greaves and McCarter 1990), but trees usually reach sexual maturity at approximately 4 to 5 years and do not produce large quantities of seeds until later. One tree produces many flowers daily for 8 to 9 weeks. A large canopy tree may produce as many as 10 million flowers and 1 million seeds in 1 year (Boshier and Lamb 1997). The ovary contains four ovules, but generally only one embryo develops per fruit (Miller 1985). The calyx does not continue to grow after pollination, and the mature fruit is shed complete with calyx and persistent corolla. The latter acts as a parachute aiding dispersal by wind. Several indicators of mature fruit (ripe seed) have been reported: at 2 to 3 weeks before natural seedfall; when flower inflorescences turn brown; when the swollen, protruding seed turns brown; and when the embryo is hard.

Seeds should be collected no less than 2 weeks after the last flowers have opened on a tree. Optimal seed collection time is approximately 7 weeks from the period when flowers have opened and the petals are white. In Costa Rica, seed collected at the beginning of March gave germination of less than 10 percent, rising to over 70 percent by the end of April (Boshier and Lamb 1997). Fallen seeds may be collected from the ground (Marshall 1939), mature seeds may be shaken from the branches onto sheets spread on the ground (Stead 1980), or inflorescences may be cut from trees (Boshier and Lamb 1997). Seeds collected from the ground have low viability. The presence of wind and the location of trees above coffee or cacao often render the shaking of seeds onto sheets impractical. Moreover, shaking branches is no more effective in collecting high-viability seeds than is cutting inflorescences.

Seed yields range from about 0.5 to 2 kg per tree (Jara and Valle 1997, Salazar and Boshier 1989), although in some large-crowned trees they may be as high as 5 kg. Better-formed trees usually have smaller crowns and consequently lower seed yields. Collection costs from well-formed trees in natural stands are high, with yields of 1 to 4 kg of seed per man-day (Cortéz 1990, Jara and Valle 1997).

The initial moisture content of mature *C. alliodora* seeds is around 40 percent (Trino Triviño and others 1990) and must be promptly reduced to below 10 percent. Moisture content can be reduced by drying in the shade or in a drying room. Seeds dried in the sun are cooked, which reduces initial germination rate (Boshier and Lamb 1997). Shade drying reduced the moisture content to 6 to 7 percent in 4 to 6 days, while artificial drying achieved the same reductions in 2.5 days (Samaniego and others 1997a, Trino Triviño and others 1990). During drying, the wings (persistent corolla) can be removed by rubbing seeds between the hands. After drying, seeds can be cleaned by winnowing using the hand or aspirator. The aspirator also removes some empty and immature seeds. *Cordia alliodora* seeds average 40,000 to 100,000 per kg, with high levels of purity (more than 95 percent) possible after processing (Greaves and McCarter 1990, Jara and Valle 1997, Samaniego and others 1997b, Trino Triviño and others 1990).

In Costa Rica, seed storage was the most effective at low temperatures (less than 5 ^{o}C) and in hermetically sealed containers that effectively maintained low moisture content (Boshier and Lamb 1997). In Colombia, hermetically sealed aluminium bags allowed only small fluctuations in the moisture content of stored seeds over 15 months. Polyethylene bags allowed the moisture content of seeds to rise from 7 to 13 percent over the same period; germination of these seeds was relatively poor (Trino Triviño and others 1990). Similarly, seed lots collected for provenance trials and stored for 7 to 8 years, with an initial moisture content below 10 percent, maintained their high initial germination rates (generally over 50 percent and some around 90 percent); one lot with a moisture content around 12 percent showed the initial germination rate (11 percent) declining to 1 percent after 8 years (McCarter 1986). In laboratory tests over a range of temperatures germination was found to be optimum at 28 to 30 ^{o}C, but all pregermination treatments tested resulted in germination inferior to the untreated control (Samaniego and others 1997b).

Seeds can be sowed (approximately 40 to 50 g per m^2; Carpanezzi and others 1982) in germination beds under shade and covered to a depth of about 0.5 cm. First germination occurs within 10 to 20 days, and seedlings are transplanted when the first true leaves appear (Boshier 1984). Planting stock is generally produced as stumps from plants raised in beds or as seedlings in bags. Stumped plants, which must remain in the nursery longer than bagged stock, are less sensitive to adverse conditions during transport and storage and to drought immediately after planting (Greaves and McCarter 1990).

ADDITIONAL INFORMATION

Cordia alliodora has often been cited as *C. alliodora* (R. & P.) Cham., a combination made by De Candolle in 1845. Oken, however, made the combination at an earlier date and should be cited as the authority (Johnston 1950).

Some confusion exists over two common names used in a number of countries: laurel negro and laurel blanco. The author feels the terms are used in two different circumstances. In some cases, they are used to distinguish two different species of standing trees because the heartwood color, the bark color, or both, differ. In other cases, the terms refer to a difference in the heartwood color of the sawn timber of *C. alliodora*. In some countries, such as Costa Rica, the terms are used both ways. This confusion has led some to oppose distinguishing the two types as standing trees (Greaves and McCarter 1990).

Although frequently described as a straight tree (e.g., Greaves and McCarter 1990, Stead 1980), this is rarely the case over most of *C. alliodora's* range, and natural regeneration shows great variation in form characteristics (Boshier and Mesén 1987). The bark is light grey/brown in color and smooth, although in drier regions it tends to be more fissured. Buttressing is generally limited to larger trees and is not pronounced, although it may extend 1 to 1.5 m up the bole on shallow soils. The tree is self-pruned even in open conditions, but the degree of pruning is variable. Some trees have pronounced nodal swellings where branches have been shed. Mature trees are deciduous, even in aseasonal climates, losing their leaves for 1 to 2 months following seed production.

Within the genus, *C. alliodora* is unique in having swollen domatia at the tips of shoot nodes (Miller 1985), which are usually occupied by ants.

Cordia alliodora is a prolific seeder and regenerates easily; it is often found in pure stands after forest clearance. Moderately fire resistant, it also competes in dry forests where crown competition and species diversity are more restricted.

Claims that the first seeds to fall have low viability (Marshall 1930) undoubtedly reflect the fact that initial falls consist mainly of unfertilized flowers. A number of indicators of seed ripeness have been reported. Tschinkel (1967) and Vega (1977) suggest that good seeds can be collected 2 to 3 weeks before natural seeds fall. However, they gave no indication of how to observe this period. Salas and Valencia (1979) describe the time to collect ripe and viable seeds as the period when flower inflorescences turn from white to brown without appearing burnt. Because the color change of the corolla to brown occurs approximately 3 days after pollination, part of an inflorescence may be brown while other flowers on the same inflorescence have not opened. Similarly, inflorescences on the same tree may be simultaneously at different developmental stages. Stead (1980) states that, in the latter stages of development, the seed swells and protrudes out of the enclosing calyx and, in drying, turns from green to brown. To examine the color, seeds must be collected. If seeds are collected, the best way to determine seed ripeness is to remove the embryo and squeeze: it is ripe if hard like a grain of rice, but immature if still soft and translucent.

A variety of seed abnormalities can be found at low frequencies. These include seeds with three cotyledons, fused cotyledons, no radicle, or two to three seeds per fruit when more than one ovule in the flower has been fertilized (Boshier 1992). Seeds are despoiled before dispersal by bruchid beetles (*Amblycerus* spp.), with up to 50 percent of the seeds killed (Opler and Janzen 1983). However, levels of attack vary among trees and years. The larva eats the developing seed embryo and the emerging adult beetle leaves a round hole in the calyx. Although adult beetles emerge during the drying process, a small proportion of live adults and larvae remain inside. Damaged seeds and beetles can be removed in the winnowing process. If the level of attack is high or seeds are for export, a persistent grain storage insecticide can be used to kill late-emerging beetles.

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