

Reforestation in Ecuador's Dry Forest

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Introduction

The country of Ecuador conjures images of the Amazon headwaters, pristine rain forests, giant land tortoises, and Darwin's Finches. But less often recognized are Ecuador's regions of tropical dry forests and the organisms that inhabit them. Tropical dry forests are characterized by a very pronounced rainless season of four to six months and a wet season often receiving less than 2000 millimeters of rainfall each year (Janzen, 1988). Dry forest trees are often deciduous and other organisms are forced to deal with desert-like conditions for part of the year and rain forest like conditions for the rest. Sadly, because tropical dry forest soils are among the most arable, they have been decimated to less than two percent of the original amount worldwide; Ecuador has virtually no tropical dry forest left.

In May of 1994, I embarked on a three month journey to Ecuador's dry forest regions along the coast, west of the economic and commercial center, Guayaquil. In a small village called Manglaralto (meaning tall mangroves) I worked with an agroforestry and reforestation project.

Background

Western Ecuador's fertile soils are of alluvial and volcanic origin and they have been cultivated for thousands of years (Dodson and Gentry, 1991). This lowland region falls into two of the "Holdridge" life zones: Premontane thorn scrub and very dry tropical forest (Dodson and Gentry, 1991; Holdridge, 1967). Thornwood is another general term used to describe this type of land and vegetation cover. Further historical and site descriptions are provided by Svenson (1946), Gentry (1976), and Meyers (1988). Although precipitation records do not exist for the area, the Ecuadorian coastal region below one degree south of the equator generally receives less than 1000 millimeters of rainfall annually (Dodson and Gentry 1991).

Almost all of the trees in this environment have been cut within the past 50 years. Near the coast the only species that are older are the occasional Kapok trees (*Ceiba trichistandra* and *C. pentandra*), whose magnificent green contorted trunks tower over the land. Kapok trees produce copious amounts of silky fibers around their seeds which are often used in mattresses and pillows. The tragic but obvious reason for their continued persistence is that the wood is useless to humans. Secondary growth amongst the Kapok trees include scat-

tered *Prosopis juliflora*, *Cordia lutea*, *Jacquinia* spp., and other scrub.

The conservation needs of western Ecuador have been well defined by Conservation International's Rapid Assessment Program (Parker and Carr, 1992; Dodson and Gentry, 1991). An astounding 20 percent of the flora of these dry regions are reported to be endemic (of an estimated 5-6,000 vascular plant species) and many are threatened by extinction.

The Project

The Proyecto Eduardo Aspiazu Estrada (PEAE) was formed in 1992 to conserve the remnants of tropical dry forest in the Cordillera Chongon-Colonche (a range of hills) in southwestern Ecuador. Due to the area's communal ownership, the project was later transformed into a program to provide a means for reforestation, environmental education, development, and alternative sustainable income sources. This project is funded directly by Fundacion Natura (Ecuador), La Cemento Nacional (Ecuador), and the German government.

The project's ultimate goal is to increase the standard of living as well as the ecological awareness of the villagers. Under this program villagers are paid to reforest their private land, taught natural history and the value of biodiversity, aided in water extraction and sanitation and introduced to alternative income sources such as apiculture. In the comuna (small village) Salanguillo, approximately 640 hectares per year are reforested with 150-500 plants per hectare, depending on the species. Some plots have a diversity of native species, while others have predominantly trees for wood and soil development. Efforts have been made to increase within plot species variation and to establish both restricted use plots (to allow for regeneration of native species) and heavy use plots (where harvesting and grazing is permitted). Seeds are collected by nurserymen from all over the region and stored at the seed bank in Manglaralto. Each comuna has its own nursery, and the nurserymen frequently meet together with forest engineers to exchange ideas and tips.

One central part of the project is expanding knowledge of the biology of the trees to be planted. Especially important is information on seed collection, storage, and germination. Below I describe two studies I conducted on the natural history and seed biology of two species used in the project: *Prosopis juliflora*, which is valued for its wood and natural products and *Loxopterygium guasango*, which is a native species in danger of extinction.

Prosopis juliflora

Commonly known as "Algarrobo" in Ecuador and "Mesquite" in the United States, *Prosopis juliflora* is a fast growing and drought tolerant legume (Leguminosae: Mimosoideae). The wood of *P. juliflora* is used for production of cooking charcoal, house construction, fence posts, and animal fodder in many developing countries (Hughes and Styles, 1987; Jain et al., 1989).

Prosopis juliflora is native from Mexico to northern South America and has been introduced and become "well naturalized" in other parts of the world. Requiring only 600 millimeters of water annually, this species is suited to arid and semi-arid environments in Central and South America, Africa, southwestern United States, and southeast Asia (Webber and Stoney, 1986). In addition to the above mentioned direct uses, *P. juliflora* has well developed lateral and tap roots which decrease soil erosion (Hughes and Styles, 1987) and contributes nitrogen, potassium, phosphorus, sulfur, and other nutrients to soil development under the canopy (Tiedemann and Klemmedson, 1973; Virginia, 1986; Hughes and Styles, 1987).

Cattle, donkeys, goats and other livestock in Ecuador readily consume *Prosopis juliflora* pods. The germination of their hard, water impermeable seeds often benefits from the digestive processing (scarification) of mammalian browsers. And although some suggest that this species could get too weedy, this fast growing, multi-purpose species has proven to be a nearly ideal tree for cultivation, increasing soil productivity, and for reduction of the need to harvest wood from the remaining forested areas in dry regions.

In southwestern Ecuador, *Prosopis juliflora* is evergreen, replacing most of its leaves early in the dry season (June-July). Flowering and seed production takes place twice annually. The first flowers appear in January, with most seeds maturing through May. There is a second wave of flowers in August with seed production continuing through November. *P. juliflora* is insect pollinated, largely by bees. In nature, the seeds are long lived and are generally dormant until the pods are weathered or consumed by grazing animals (Haas et al., 1973).

Because it is always in demand by the tree planters, my research on *Prosopis juliflora* focused on how to improve the quality and efficiency of seed germination. This involved two aspects: 1) decreasing the proportion of seeds lost to predation, and 2) improving seed processing methods. I found that many of the seeds were inviable because they were infested by bruchid beetles. This family of beetles specializes on seed feeding. Adult bruchids lay eggs on the pods of developing seeds and the larvae burrow in and consume the entire contents. The beetles can reproduce and have multiple generations in one year, and thus they thrive in seed storage facilities. Contact pesticides are often not effective because the beetles are inside the seed coats. I determined that there would be great benefit to using fresh seeds as often as possible (fruiting trees are available at least six months of the year).

With regard to seed processing methods, each seed has a very hard seed coat and is held in a waxy compartment called a septum. Ten to twenty septa, each with a seed, form a bean-like pod. Although it is more time consuming, removing the septum more than doubles the probability of germination. Furthermore, a treatment with boiling water often releases the seeds from dormancy and significantly increases the probability and speed of germination. In conclusion, with so many

seed predators present, the best method for planting *Prosopis juliflora* seeds is to clean the seeds of their septa, treat them with boiling water, and plant immediately.

Loxopterygium guasango

Loxopterygium guasango (Anacardiaceae) is a deciduous tropical dry forest tree that grows in patches in coastal southwestern Ecuador (mainly on the Santa Elena Peninsula) and northwestern Peru (Gentry, 1993). This native species occurs in groves of 10-20 individuals, often mixed in with *Prosopis* spp. and other scattered scrubby vegetation. Many of the groves are found less than 100 meters away from the ocean growing in soil that is nearly all sand.

The biogeographic distribution of *Loxopterygium guasango* is not known, however it probably is endemic to coastal northwestern South America (Gentry, 1993; De Elao, 1993). The intense exploitation of this durable timber for house pillars coupled with the explosion of coastal shrimp laboratories and farms in the last 15 years are most likely the causes of the decimation of *L. guasango* populations. In a report from the Natural Resources University of Guayaquil (Ecuador), *L. guasango* is listed as being in danger of extinction in Ecuador (De Elao, 1993).

Loxopterygium guasango is being promoted for reforestation not only because of its threatened status, but because it is hearty, drought tolerant, and repels browsing animals. Like many plants in the Anacardiaceae (poison ivy, mango), *L. guasango* can cause skin irritation. Most of the leaves fall off early in the dry season (June-August) and the plant stays leafless until the rains come in January. The flowers are small and numerous, producing single winged, wind dispersed fruits at the time of leaf fall. Although *L. guasango* can be vegetatively propagated from small branch cuttings, it is most desirable to use seeds for reforestation. Each seed is a new genotype produced by sexual reproduction and genetic recombination which increases genetic variability in the population.

My research on *Loxopterygium guasango* focused on improving seed germination. I found that seeds had very poor germination (less than ten percent) and that this was not improved by several treatments including a water soak, boiling water, and desiccation. Although there was no sign of an insect pest that was consuming the seeds, viability of the seeds decreased with time from harvest. After a bit of experimentation, my main hypothesis was that *L. guasango* seeds were being killed by over desiccation in the sun. The trees currently exist in groves that are open and sunny and it is likely that the regimes of temperature, sun exposure, and precipitation have been severely altered since the tropical dry forest canopy was removed (Dodson and Gentry, 1991; Svenson, 1946). My recommendation was to harvest seeds as soon as they mature and attempt to store them a cool dry room.

Conclusion

The coastal regions of Ecuador that were once clothed in tropical dry forests are now heavily degraded and highly altered environments. If the countless endemic species are to be preserved through the efforts of community based environmental projects, we must continue to support local reforestation and basic research that makes the projects successful. In addition to saving the endangered plants and animals, we must invest in knowledge about highly productive multipurpose tree species that will support people and hopefully reduce pressure on regenerating native species. It is important to note that recommendations for these various efforts are likely to differ. For agroforestry the focus may need to be on storing and germinating large quantities of seed. Reforestation requires the ability to produce high quality seed as well as knowledge of seedling biology. For conservation and ultimately preservation, the priority must be maintenance of low-use and regenerating areas. It is essential that all of these efforts have an educational component. Only with local research and input will values change, and only then will endangered habitats such as Ecuador's tropical dry forest have a chance to survive.

For more information about Proyecto Eduardo Aspiazu Estrada please contact the Director at: Oficina Fundacion Natura - Manglaralto (Santa Elena - Guayas) Ecuador, South America. Phone/Fax 593-4-901-203.

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