IS THE TAMANU LOSING TURF? DISTRIBUTION AND PROPOGATION OF THE ECONOMICALLY IMPORTANT *CALOPHYLLUM INOPHYLLUM OF MOOREA*

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Abstract. French Polynesia's indigenous tamanu Tree (*Calophyllum inophyllum)* is an important natural resource harvested for lumber, resin, and oil. Being a marine-seed dispersed species it self-propagates and can be found growing along the coastline of Moorea. Development and harvest patterns on Moorea may be slowing the natural reproductive rate of the species. Fifty years ago it was recommended as a species to include in management programs as it had been noted to be in decline due to its slow growth and high use rates. Interviews with elders, carvers and healers indicated that the range has indeed diminished. A total island survey was performed and the resulting map of *C. Inophyllum's* distribution indicates that the range is healthy- but it will continue to compete with human development for the diminishing resource of coastal terrain.

Key words: Tamanu; Calophyllum inophyllum; *Moorea, French Polynesia; ethnobotony*

INTRODUCTION

Calophyllum inophyllum, known to Tahitians as "tamanu", or, "Beware" when the strong wood is discussed, or "Poro Ati" when referring to its beautiful "perfectly round ball" shaped fruit, is an evergreen member of the family Clusiacea. Highly valued by the native culture for its lumber and medicinal values, and also for its pleasing beach canopy, it is distributed along rocky coastline throughout French Polynesia. Economically promising for its' anti-microbial, anti-viral, anti-cancerous and anti HIV-1 (Ishikawa 2000) action, researchers in French Polynesia are keen to make use of new chemical analysis which will allow for developing standardized therapeutic uses (Laure 2005). Construction of tikis, canoes, bowls, furniture, musical instruments and houses (Whistler 1992) as well as production of traditional medicines for curing eye infections, skin infections and even broken bones, however, attracts many harvesters who gather up the reproductive nuts, remove nearly girdling squares of bark or outright chop the tree down. And then there's the loss of its preferred coastal habitat: Self-propagated by marine seed dispersal, like the coconut, this is one of the first trees to colonize newly formed islands in the pacific region (Gunn 1976), yet it has been suggested for more than fifty years that due to impact of wild harvesting and competition for turf, it is necessary to undertake appropriate management measures to insure the tamanu will remain an important potential source of revenue for French Polynesia (Petard 1985). Seeing that the tamanu was recently red-listed by the International Union for the Conservation of Natural Resources as a threatened species (Stephens 1998) I was compelled to investigate the robustness of the population on Moorea.

METHODS

Study site

The island of Moorea is located 17 kilometers northwest of Tahiti and is a typical "high island" with mountains punching upwards in the center and sloping downward on all sides with watershed valleys giving out onto a ring of white coralline sandy beaches. It is on these beaches that the tamanu and other marine – seed dispersed seedlings mark their arrival, and to a large extent, where they stay- due to heavy nature of floating fruits which wouldn't easily be carried inland by scavengers or birds (Gunn, 1976). Moorea has 62 kilometers of this littoral as natural habitat for *C. inophyllum* and I chose, due to its manageable size, to walk the entire periphery making GIS waypoints of every specimen on the island- a complete census-taking data on the location, dimensions, substrate, fruit presence, and evidence of impact by harvesters along the way. With this data I plan to test the hypothesis that tamanu is evenly distributed around the island.

Interviews

Knowing that the tamanu was once sacred and guarded by taboo, planted around ceremonial sites and reserved for the use only of religious and political leaders, I wished also to learn of any interior sites which might host tamanu trees growing in areas of former or current human plantation. To this end I conducted a series of interviews with elders, woodworkers, agro-foresters and healers for clues as to what the former range of the species might have been. Mr. Pierre Nardi arrived just over fifty years ago to the island of Moorea where he found a sparsely populated island with plenty of opportunity for farming. In addition to introducing modern pineapple culturing methods, he bought land and set to work planting hardwoods teak and mahogany. "Tamanu was everywhere back then. Nowadays there are none left of the old plantations in the hills and there are none of the giants left anywhere on the island." Mr. Nardi indicated to me that the

last ocean-going vessel to be made of tamanu on Moorea, "The Maire", was sourced from Vaiare from land belonging to Monique Donasson- Princess Pomare.

Henri Jones, longtime resident of Temae beach which was hit by an enormous hurricane in 1985, indicated that the exposed beach was once dense with tamanu where there are now young coconuts and even younger noni trees.

An elder of the community, Papa Mita, communicated to me through a translator that there are fewer trees than before but a stand of about ten could possibly remain surrounding an ancient, undiscovered ceremonial terrace known as a marae, in an inaccessible valley behind Mt. Rotui.

I also spoke with an expert on traditional resources, culture and medicine, Hinano Murphy, and learned that the tamanu trees which once provided her afternoon labor (gathering the seeds to place in the fire to keep mosquitoes at bay) have been reduced in numbers in the region of Afareaitu by roughly 80%. At the Agricultural vocational school on the island, which is very much concerned with conservation of useful plant resources, I was shown the stumps of two very large *C. inophyllum* which had fallen prey to negligence, were burned near the base by a bar-b-que and cut down due to their dangerous proximity to school buildings.

I learned from Gerard Brigant,, a tamanu product manufacturer in Papeete, who buys his seeds from Bora Bora, and chemist Jean-Pierre Bianchini of the University of French Polynesia that while tamanu harvesting might benefit the economy, Tahiti and Moorea do not have adequate supply of the resource to fulfill manufacturing needs.

Woodcarvers however, remarked to me that the Society for Rural Development had undertaken the propagation of tamanu at a site near the hospital in Afareaitu and that there was a plantation of trees behind the soccer field in Pao Pao.

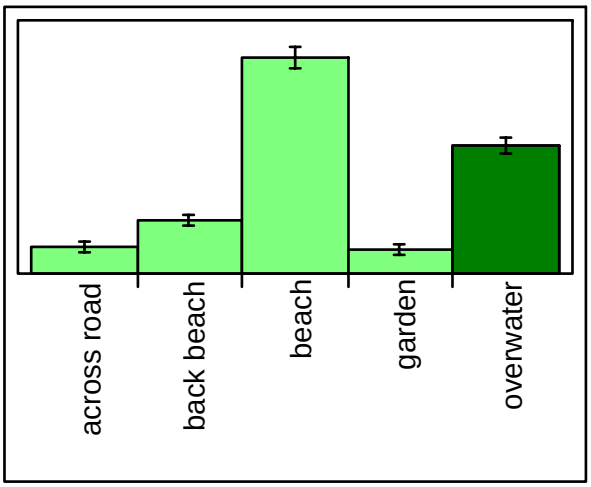

Fig. 4 Distribution of tamanu trees by location

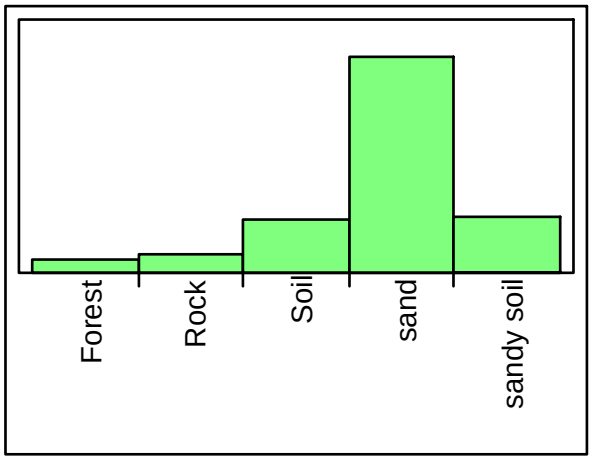

Fig. 2 Distribution by habitat

Germination

C. inophyllum propagates by conveyance of buoyant salt-water tolerant seeds on ocean currents. Seeds prefer to germinate in coralline salt-saturated soils (Elevitch) so beaches are sites of first colonization of the species. I also undertook a small germination study to compare known germination rates available in the scientific literature with local seeds and conditions. One study found average germination times of 22 days for seeds fully shelled, 38 days for seeds in cracked shells and 57 days for seeds still in their shells (Parras). To mimic this experiment I planted the nuts in three states: Whole fruit, seed with endocarp, and naked seed in beach matrix/ soil mixture. Six seeds each were sown.

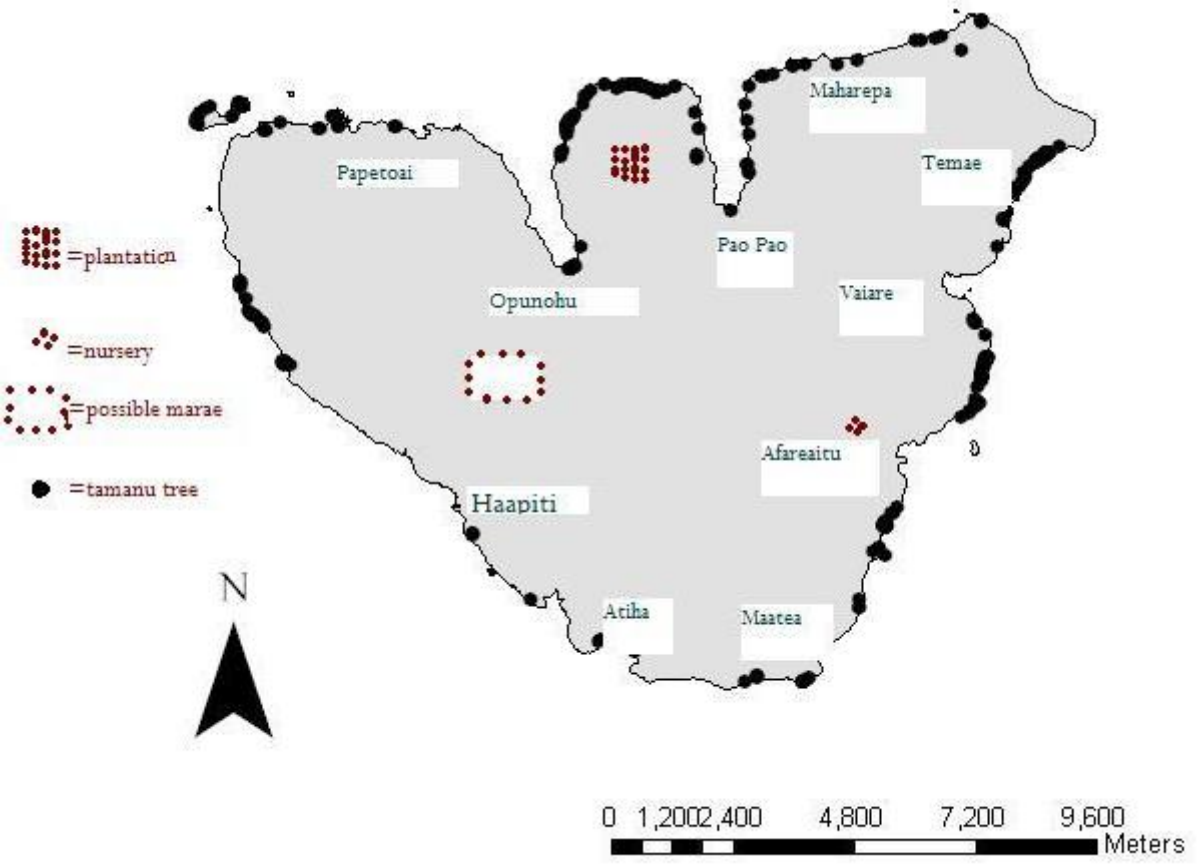

Fig. 1 Distribution of *Calophyllum inophyllum* around the island of Moorea, French Polynesia

RESULTS

Distributional survey

As can plainly be seen in figure one, I discovered more than 400 tamanu trees distributed fairly evenly around the entire island and all of the locations exposed in the interview process as being former strongholds of tamanu; Afareaitu, Vaiare, PaoPao. The oldest and grandest grove of the former princess is on protected land and has plenty of sprouts coming up in its' shade. Motu (Tahitian for island) Fareone and Tiahura which appear of the coast of Papetoai also had presence of tamanu, which is consistent with the known former range (Burford), however, on Fareone the were all lined up in a border fence strung with barbed wire creating cutting across the center of the island. On Motu Tiahura they were found growing in more natural positions ringing the island where there were no rock walls.

A histogram showing that more trees grow where retaining walls are absent (Fig. 2) demonstrates that that is indeed the case consistently around the island. This iimportant because, as you can see in Fig. 3 that the tamanu trees preferred habitat is by far the beach. The second preferred habitat is also the beach, closer to the water, with branches hanging over the high water line. From these two positions the fruit of the tree could drop into the water and float away for possible germination elsewhere. Corroborating habitat preferences is another histogram spread sorting the trees by which substrate on which they were growing. You can see in Fig. 4 that of 379 trees found (excluding the plantation and nursery sites which are unnatural locations perturbing the data) 227 were found growing in sand.

Island wide there were not many *C. inophyllum* seedlings found. The majority of

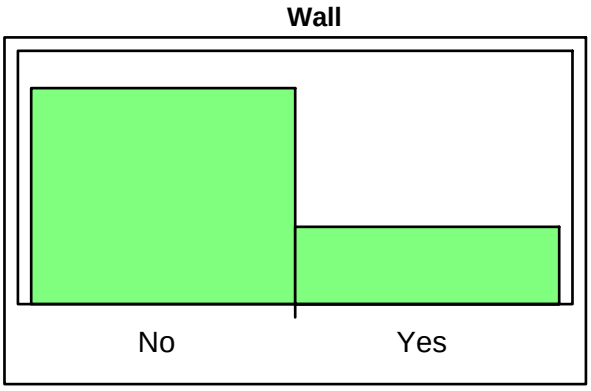

Fig. 2 The majority of Tamanu trees on Moorea grow where there is no retaining seawall- suggesting it is easier to germinate where there is no wall capturing the coast.

trees had no sprouts around them (Fig. 5) In Fig. 6 and 7 it is clear that most sprouts were found growing in the forest, on rock, or even on sandy soil. With a significant P value of .0199 you can see that sprouts are not found growing in sand or, less significant (P.4188), on the beach.
It is on the back beach, in a garden, or even across the coastal road that one would finsprouts. The likely explanation for this apparent contradiction has to do with the observation that Mooreans regularly clean their beachfronts of debris and even rake the tamanu almonds into piles and remove them from the environment for personal use. It is on rocky or grassy substrate that the locals don't rake away the seeds- potential sprouts.

An analysis of where one can find seeds confirms this. Most trees, in fact, were found with no nuts in trees and no nuts on ground (Fig. 8 and 9). In Fig. 10, a one way analysis of where one does find most nuts, indicates a with a highly significant P value of .0005, that, once again as was with the sprouts, it is on rocks in the forest or even sandy soil, but not sand (Fig. 11). Again, I believe this to be due to human activity- the nuts being removed diligently and daily from beachOne can clearly see in Fig. 12 (significant P value of .0109) that the larger, therefore older, trees as determined by diameter at breast height, can be found growing on sand. In Fig. 13, less significant (P value of .8683) but showing a trend, there are more larger trees growing on the beach and over the water than in any other location.

As for the health of the population. Fig. 14, a distribution of trees by diameter, shows that the mean diameter was 62 cm (with a standard deviation of 49.3) with a few individuals topping the scale near 400 cm. These larger individuals often had several large trunks diverging from each other at ground level and sprouting nuts wedged into crevices in the aging bark. The trees appeared to overall healthy with no pests or indications of disease of any kind. The only
stress observed was that caused, again by human activity, with 36 individuals (nearly ten per cent of trees) having had portions of their bark harvested for medicinal use (see photo next page).

Germination

Fig. X Tanamu germination experiment

The seeds in my germination study sprouted at a rate consistent with past findings. However, there was not enough time to see if seeds in cracked shells and seeds still in their shells would sprout, also, at consistent rates. Incidentally, seeds sprouted for study were planted at Atatia

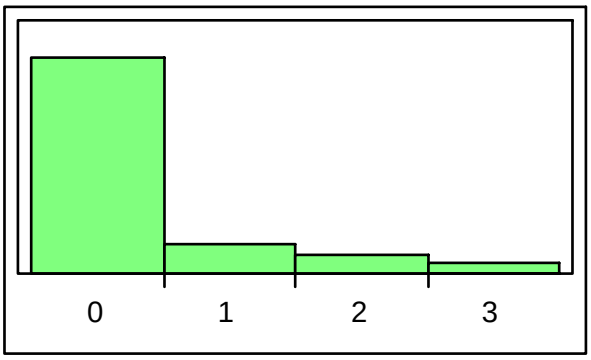

Fig. X. Distribution of numbers of sprouts around Tamanu trees. 1 corresponds to less than 5 sprouts. 2 corresponds to between 5 and 10 and 3 corresponds to greater than ten srpouts.

cultural center by students from the Agricultural vocation high school.

DISCUSSION

It is evident at a glance of the distributional map of Moorea that the tamanu's preferred habitat on Moorea is its coastline. Undeveloped coastline on Moorea is becoming ever more scarce. An examination by researchers from University of California at Berkeley's Environmental Planning Department found that historic growth and development patterns on the island confirmed that most of the land along Moorea's coastline was built upon, with development creeping inland up river valleys. And furthermore, at the observed rate of development, since 1986, Moorea may reach build-out in 50 years (Timothy Duane 2006). It is clear that since development follows the coastline in a high island setting, all native coastal species will be feeling the pressure from human activity. Chiefly valued today for its wood and medicinal products, the tamanu is also a valuable native coastal stabilizer. The tamanu tree is an excellent urban forestry tree for large spaces in coastal environments.

The tree's large spreading crown and horizontal branches make it a good shade tree and focal point for parks and other open areas (Friday, 2006). Since the tree is adapted to shallow, often flooded, salty and windy environments, it is highly recommended to be planted as a coastal species windbreak. Where *Calophyllum inophyllum* was not represented in great numbers on the coastline there were in its place planted single- row windbreaks of ironwood (Casuarnia spp.). New development on the island, namely at the golf course in Temae, has removed all coastal vegetation whatsoever and replaced it with four non-native species- including two which are on Tahiti's own list of invasive plants forbidden to be planted and sited for removal. This includes the octopus or chenille tree and the tulip tree. But Moorea's communes own land use management "best management practices" recommends using native species and specifically calls for the leaving of rough wild vegetation in all new coastal development and to establish buffer strips along wetland perimeter. It is also specifically called for to discourage the constructions of rock walls on beaches. Analysis of Moorea's terrestrial zoning plan (PGA) policies reveal that current planning regulations for tourism zones are inconsistent with the goals of the Marine Management Plan (PGEM) as they encourage large scale tourism development in the vicinity of important marine protected areas (MPAs) and fail to control inputs from reaching the marine environment that potentially could cause signifcant harm to marine ecosystems (Duane 2006).

In this study I found that there is a healthy population of tamanu trees on Moorea, but their preferred habitat is the coastal areas which are diminishing. It germinates well when humans don't disrupt their natural propagation and does not seem to grow as often where there are rock walls. Because it is a species highly recommended to be included in Moorea's coastal plans for protection from cyclones and capture of coastal runoff, it is hoped that consideration will be made in future developments to leave existing tamanu trees were they grow and encourage the dissemination of young trees being grown for the public at the

native plant nursery run by the Society of Rural Development.

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APPENDIX

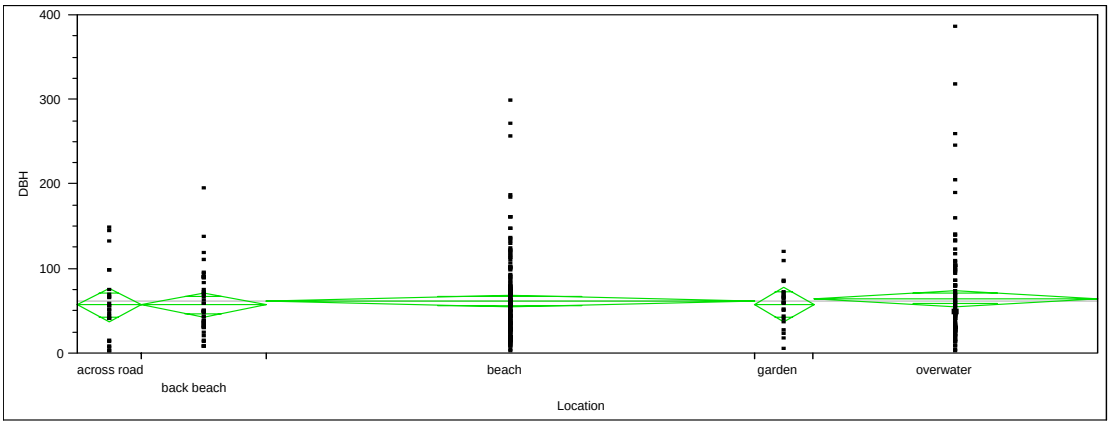

Fig. 1 Analysis of tree size (diameter at breast height) By Location

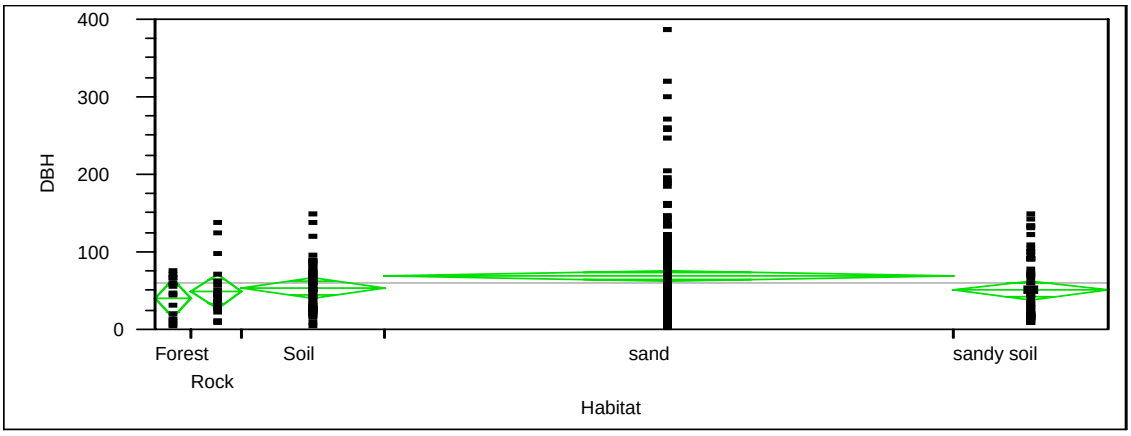

Fig. 2 Analysis of tree size (diameter at breast height) By Habitat

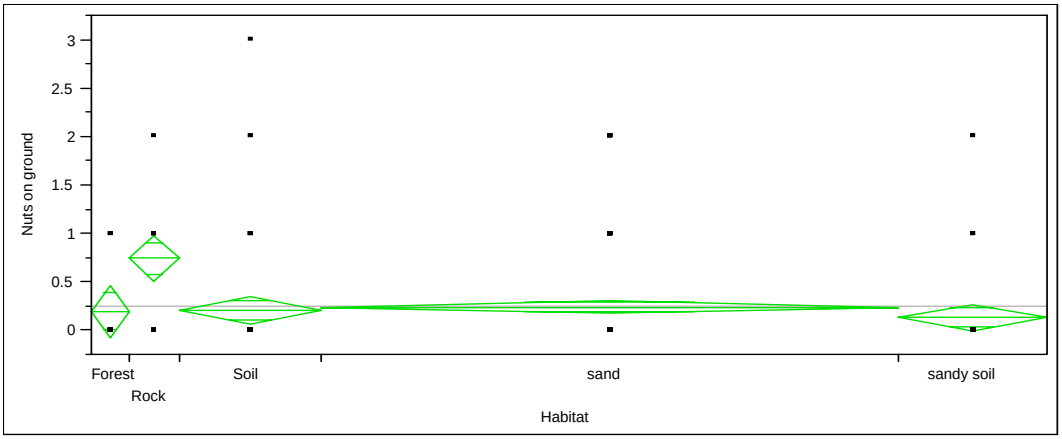

Fig. 3 Analysis of Nuts on ground By Habitat

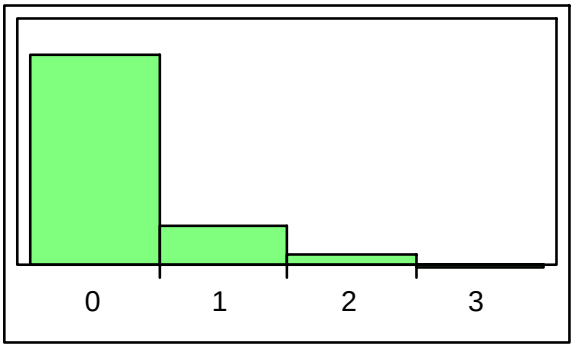

Fig. 4. Distribution of trees with fallen nuts on the ground.

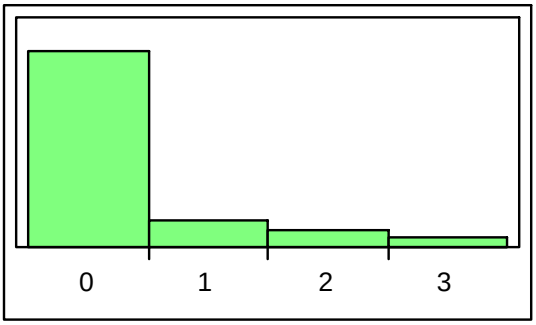

Fig. 6 Island trees without sprouts outnumber those with many.

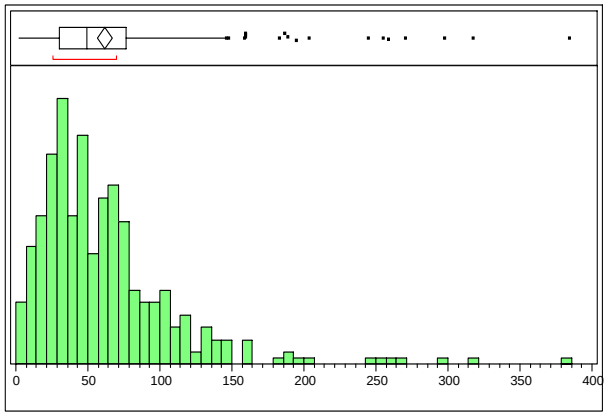

Fig. 5. Distribution of tree size by DBH in centimeters.

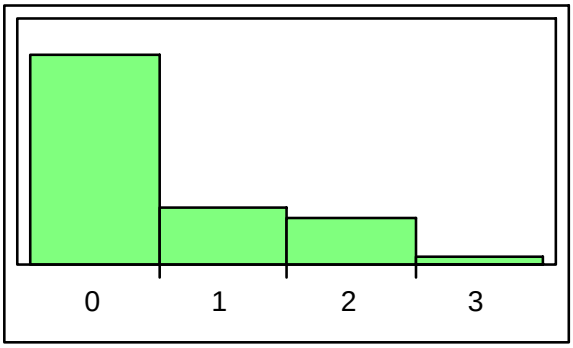

Fig. 7 Distribution of fruiting trees (nuts on branches).

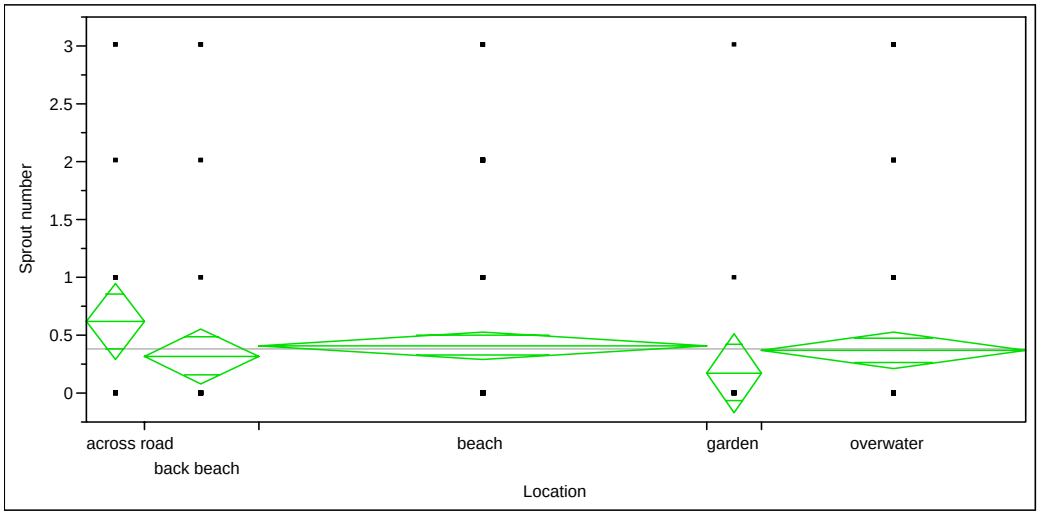

Fig. 8. Analysis of seedling quantity by Location (not significant)