

Growth and survival of rainforest seedlings in reforestation in lowland Costa Rica



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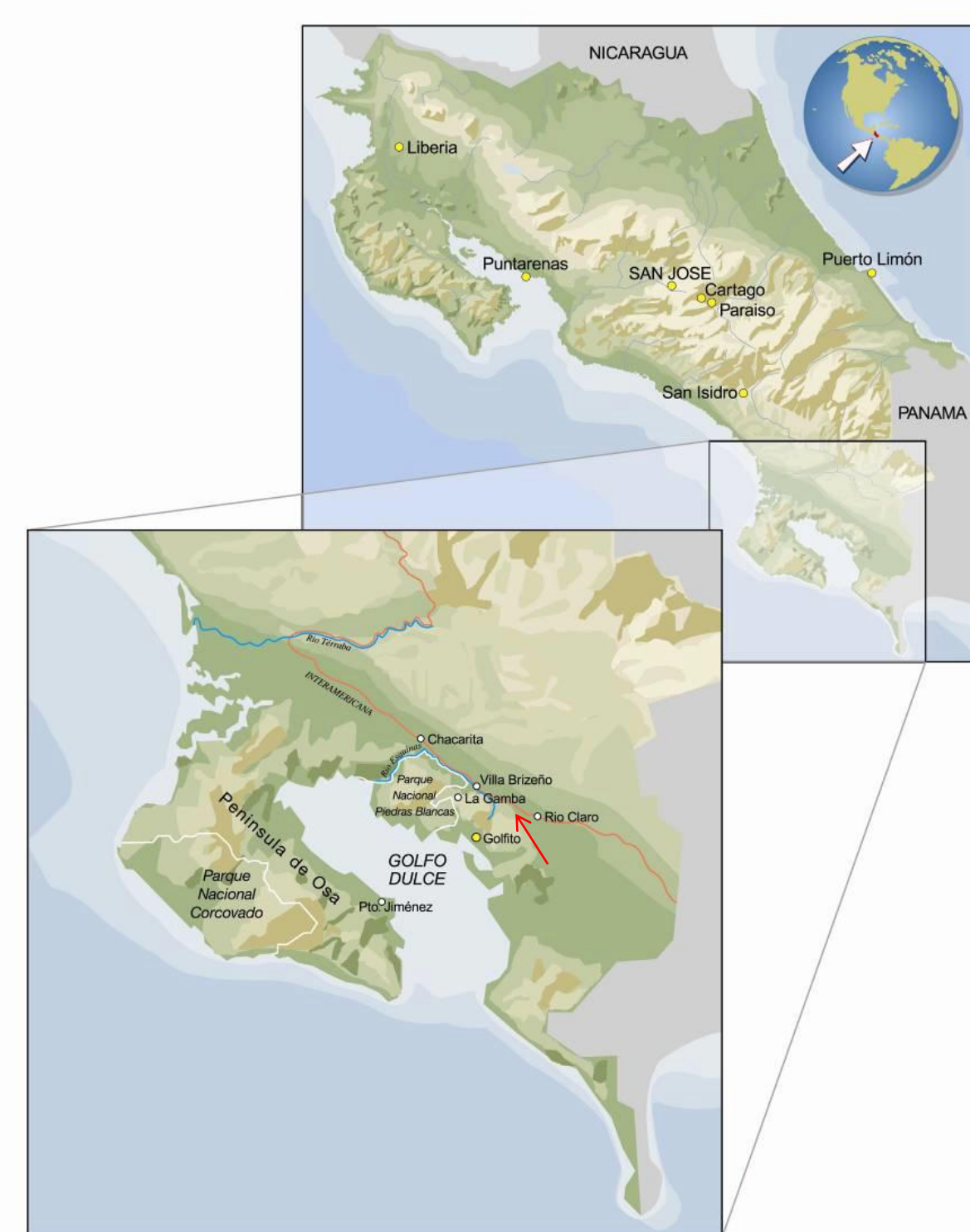
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Study area in La Gamba, Costa Rica, Golfo Dulce Region (map from Weissenhofer et al., 2008, modified)



Slope at La Bolsa with bordering secondary forest

Calophyllum brasiliense grows well in partial shade

Schizolobium parahyba grow fast but with a mortality of c. 40%



Dicranopteris invades eroded soil on sun-exposed sites

Growth is often poor on ridges and upper slopes

Competing grasses have to be cut during the first years

At the border of the Piedras Blancas National Park, close to the „Tropical Station La Gamba“, the project „Biological Corridor La Gamba“ (COBIGA) aims to enhance connectivity between montane and lowland forests outside the Piedras Blancas National Park, close to the „Tropical Station La Gamba“ by reforesting some agricultural areas. In 2010 the former pasture of Finca La Bolsa (13 ha) was reforested by planting c. 4700 seedlings of 83 native species that had been pre-grown in a nursery from seeds and seedlings collected from the local forest.

Objectives of research were the initial performance of plants and reforestation success. Tree survival and size were evaluated to identify suitable species for reforestation. Micro-environmental factors such as light and topography were taken into consideration to determine the conditions that may have supported or reduced seedling survival and growth.

Site conditions

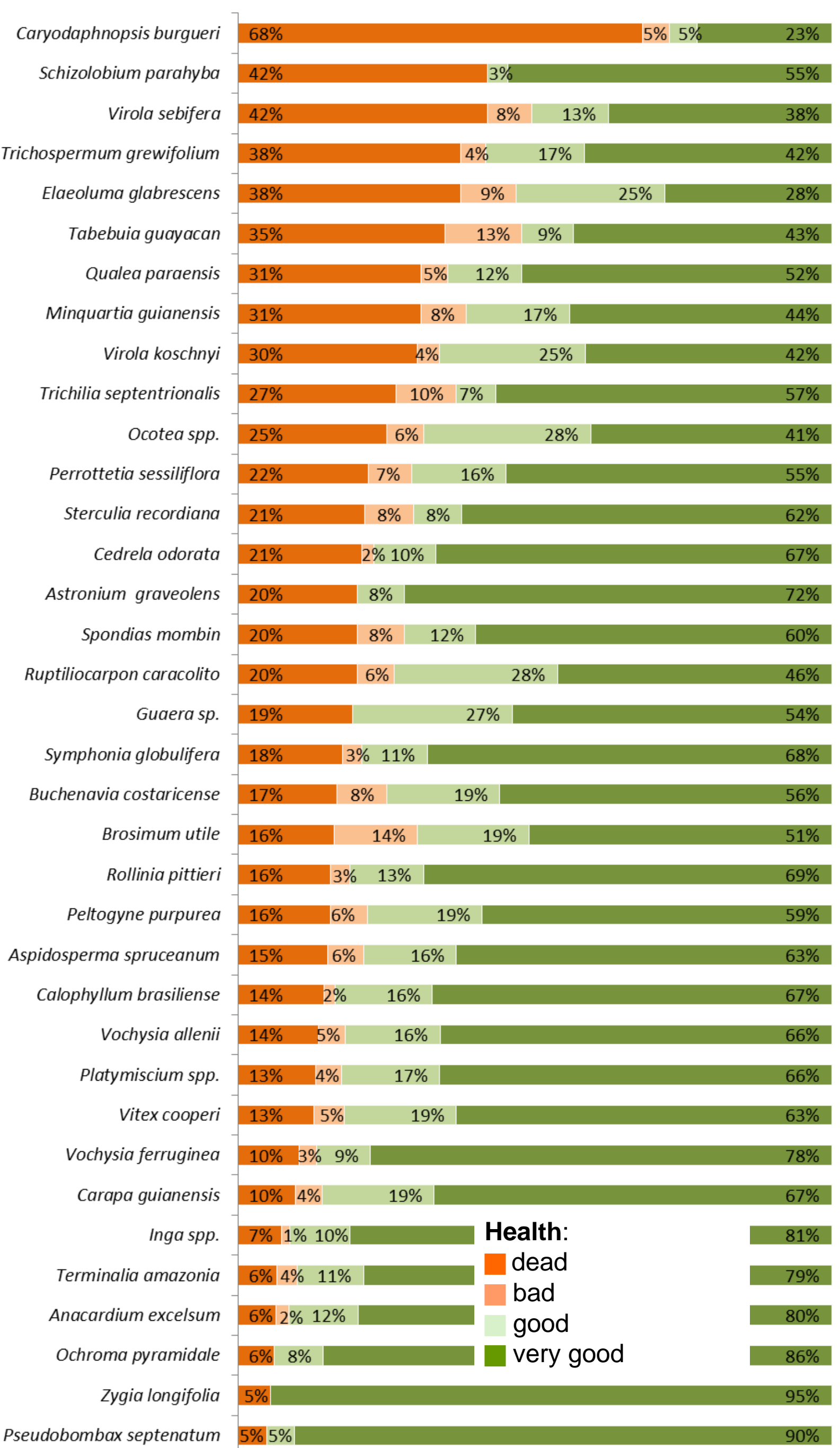
Mean annual precipitation is 5836 mm. La Bolsa is a small valley with very heterogeneous terrain, from flat areas to slopes (inclinations up to 60°) and dry ridges. Soils are also heterogeneous, generally acid with low nutrient availability. As predominant soil types Typic Hapludult and Andic Dystrudept were identified where plant growth can be limited by high aluminium-saturations (Pamperl, 2001). Light conditions range from full sun to shaded similar to closed forests.

Method

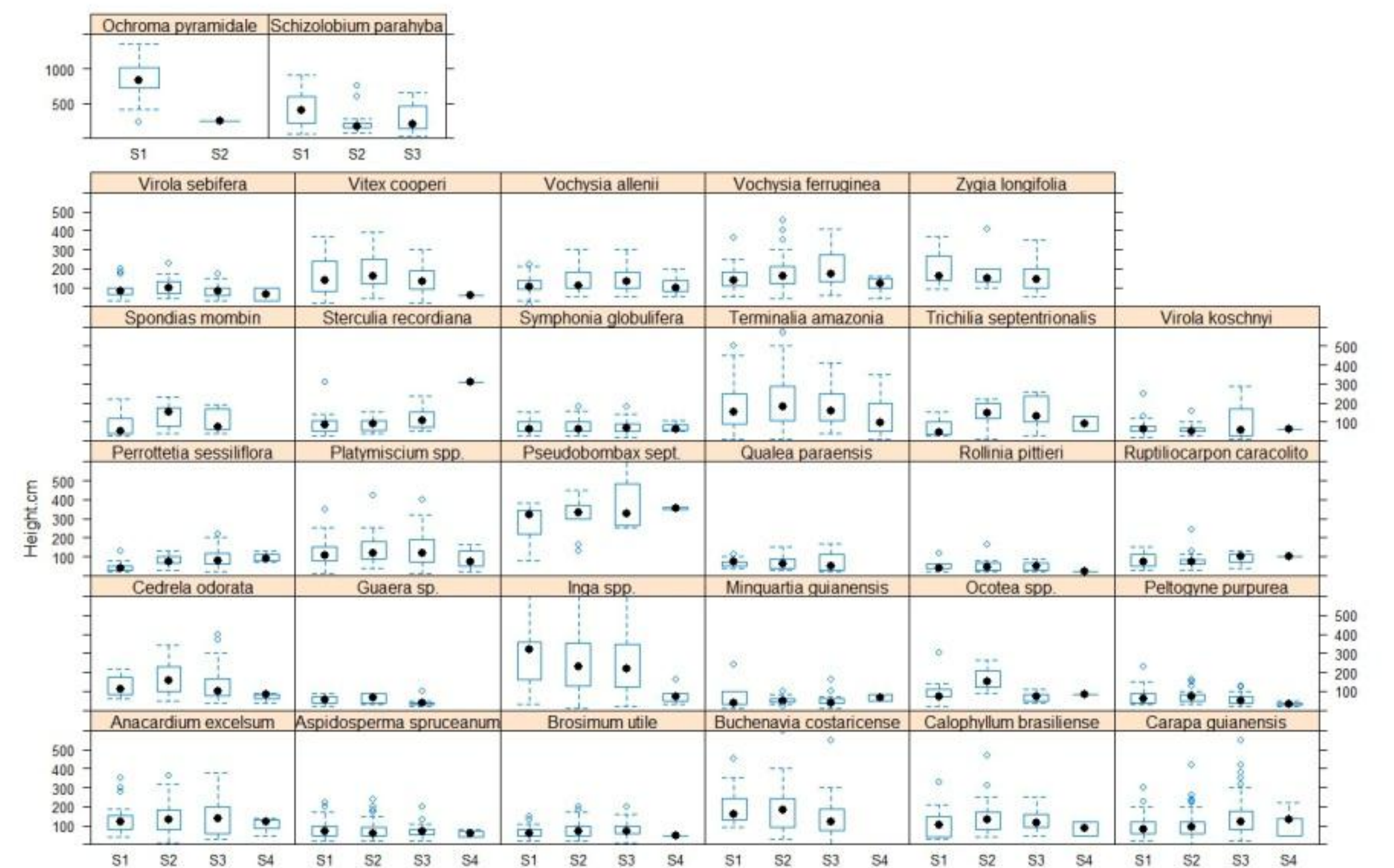
Two years after planting, tree health and size (height, diameter at 0.5 m and in 1.3 m) were assessed and evaluated in combination with the semi-qualitative factors light (~ canopy closure), topography, slope, herbivory and competing neighbouring plants. Significance of factors was tested with one-way ANOVAs.

Results & discussion

Average survival of 31 species with each >19 individuals (n= 3693 trees) was 83.3%, which is a similar result as in a reforestation project in Panama (Breugel et al. 2011). Average height ranged between 8m for *Ochroma pyramidale* to 37cm for *Elaeoloma glabrescens*.



References
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Breugel, M. V., J. S. Hall, D. J. Craven, T. G. Gregoire, A. Park, D. H. Dent, M. H. Wishnie, E. Mariscal, J. Deago, D. Ibarra, N. Cedeño and M. S. Ashton (2011). "Early growth and survival of 49 tropical tree species across sites differing in soil fertility and rainfall in Panama." Forest Ecology and Management 261(10): 1580-1589.

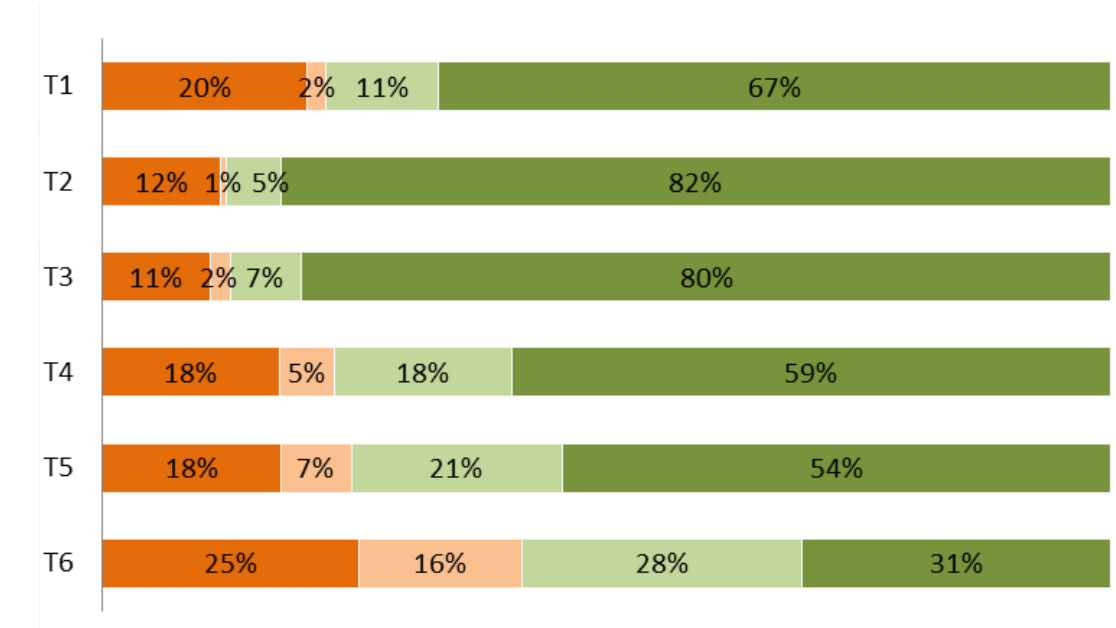


Height by light levels (S1: canopy closure < 10%, S2: <30%, S3: <70%, S4: >70%)

Light conditions affected growth in many species with significant light x species interactions, i.e. species performance depends on their light preferences. We classified species based on growth, survival and the effect of shading, into groups suitable for reforestation under different conditions (table below).

Table: Species performance related to light conditions and mean height

Category and recommendation for reforestation	Species with survival > 80%	mean height [m] + SD
A: require not shading → planted in open reforestation sites, could serve as nurse trees.	<i>Aspidosperma spruceanum</i> <i>Buchenavia costaricensis</i> <i>Inga spp.</i> <i>Ochroma pyramidale</i> <i>Zygia longifolia</i>	0.7 ± 0.4 2.1 ± 1.6 2.5 ± 1.5 8.0 ± 3.4 1.9 ± 1.0
B: initial shading preferable (sorted by light demand (i(much)> ii > iii) → to be used in (semi-)open reforestation sites. Will grow also without shade, but slower and with reduced quality.	i.) <i>Vitex cooperi</i> ii.) <i>Calophyllum brasiliense</i> <i>Platymiscium spp.</i> <i>Terminalia amazonia</i> iii.) <i>Anacardium excelsum</i> <i>Vochysia ferruginea</i> <i>Vochysia allenii</i> <i>Brosimum utile</i>	1.6 ± 0.9 1.3 ± 0.8 1.3 ± 0.7 1.9 ± 1.2 1.4 ± 0.9 1.7 ± 0.8 1.3 ± 0.5 0.8 ± 0.3
C: initial shading necessary → not recommended for open sites	<i>Perrottetia sessiliflora</i> <i>Carapa guianensis</i> <i>Pseudobombax septenatum</i>	0.8 ± 0.4 1.1 ± 0.7 3.2 ± 1.2
D: no clear preference → no specific recommendation	<i>Symphonia globulifera</i> <i>Peltogyne purpurea</i> <i>Rollinia pittieri</i>	0.7 ± 0.3 0.7 ± 0.4 0.8 ± 0.4
	Species with survival < 80%	
B: initial shading preferable	i) <i>Virola sebifera</i> <i>Ocotea spp.</i> ii) <i>Cedrela odorata</i> <i>Spondias mombin</i>	0.9 ± 0.5 1.0 ± 0.7 1.5 ± 0.9 1.1 ± 0.7
C: initial shading necessary	<i>Trichilia septentrionalis</i> <i>Qualea paraensis</i> <i>Virola koschnyi</i> <i>Rupiliocarpon caracolito</i> <i>Sterculia recordiana</i>	1.3 ± 0.8 0.8 ± 0.6 0.8 ± 0.6 0.8 ± 0.4 1.1 ± 0.6



T1 = ditch
T2 = flat area
T3 = lower slope
T4 = middle slope
T5 = upper slope
T6 = ridge
Q1 = very good cond.
Q2 = good condition
Q3 = bad condition
Q0 = dead

Influence of Topography on growth

The highest mortality was recorded on ridges (25%) and in ditches (20%). Most trees observed in very good quality were situated in flat areas (82%) and slope bottom (80%). While most species grow worse on ridges and upper slopes with poorer soil conditions, species with high tolerance for conditions at unfavourable sites include *Vochysia ferruginea*, *Symphonia globulifera*, and *Aspidosperma spruceanum* (also naturally occurring on ridges in the area).

Conclusions

Evaluating performance under field conditions permitted us to identify suitable species and their micro-site preferences. In addition to species performance, the final choice of species will also depend on other objectives including diversity, protecting endangered species or ecosystem functions.