Strong spatial and temporal limitation in seed arrival as complementary mechanisms for species coexistence in a tropical Atlantic coastal forest

Leticia B. Zimback, Paulo I. Prado, Marcelo P. Pansonato, Geraldo A. D. C. Franco, Adriana M. Z. Martini

Supplementary Information

In this appendix we report the coefficients of the selected models (ΔAIC ≤ 2) to describe spatial seed limitation (*SSL*, equation 1 in Methods in the main paper) and temporal seed limitation (*TSL*, equation 2). We also provide the AIC values for each model and the coefficients for the average model, obtained from the selected models.

The set of competing models have as linear predictors all combinations of the following fixed effects and their interactions (see methods in the main paper for details):

Log seed mass : logarithm dry seed mass average of each plant species

Adult maximum height : maximum tree height recorded in the study site [1].

Frequency of adults : proportion of the sampling plots in which adults of each species was recorded [1].

All these fixed-effect variables were standardized as z-values, to ease convergence fo the mixed-effect models, and also to allow comparison of the coefficients for each effect. We thus refer the coefficients as "standardized coefficients" in the tables below.

We evaluated two response variables to express SSL: (i) the proportion of seed traps where seeds of each species were not recorded each year, and (ii) the proportion of traps where seeds of each species were never recorded in any of the three sampling years. Accordingly, TSL was also assessed by two response variables: (i) proportion of sampling occasions (months) when seeds of each species were not recorded in some trap, and (ii) proportion of the twelve months of the year when seeds of each species were not recorded over the three sampling years. As all response variables are proportions, we used generalized binomial models.

Response variables (i) have three values for each species, which correspond to the proportions of unoccupied traps or unnocupied occasions each sampling year. We thus included in the model for these responses a random effect for plant species. Plots with the values of these responses and values predicted by the models are in the main text. For response variables (ii) we used linear models only with the fixed effects, as there is no repeated responses for each plant species. Figures S-1 and S-2 show the values of the responses (ii) and the values predicted by the models.

References

[1] Marcelo Petratti Pansonato, Renato Augusto Ferreira de Lima, Alexandre Adalardo de Oliveira, Ricardo Bertoncello, and Adriana Maria Zanforlin Martini. Community structure and species composition of a periodically flooded restinga forest in caraguatatuba, são paulo, brazil. *Biota Neotropica*, 19, 2018.

Table S-1: Mixed-effect models for the spatial seed limation. For each model is shown standardized coefficients and standard error (brackets). Also shown the estimated standard deviation for the random effects (SD), the AICc value for each selected model, and the coefficients of the average model.

	8	16	7	24	32	6	Average
Adult Frequency	−0.410	−0.303		−0.445	−0.334	−0.618	−0.341
	(0.226)	(0.231)		(0.224)	(0.227)	(0.218)	(0.270)
Adult height	−0.478	−0.542	−0.659	−0.467	−0.536		−0.473
	(0.231)	(0.227)	(0.217)	(0.226)	(0.221)		(0.277)
Log seed mass	1.018	1.024	0.975	1.003	1.009	1.029	1.010
	(0.205)	(0.197)	(0.214)	(0.201)	(0.192)	(0.220)	(0.205)
Frequency:Height		−0.320			−0.335		−0.106
		(0.234)			(0.228)		(0.202)
Frequency:Mass				0.257	0.268		0.074
				(0.224)	(0.214)		(0.166)
SD (Intercept)	1.022	0.979	1.085	1.002	0.952	1.113	
SD (Observations)	1.000	1.000	1.000	1.000	1.000	1.000	
AICc	489.753	490.276	490.645	490.769	491.099	491.440	

Table S-2: Mixed-effect models for the temporal seed limation. For each model is shown standardized coefficients and standard error (brackets). Also shown the estimated standard deviation for the random effects (SD), the AICc value for each selected model, and the coefficients of the average model.

	7	6	5	8	Average
Adult Frequency		−0.295		−0.174	−0.097
		(0.195)		(0.211)	(0.179)
Adult height	−0.355			−0.278	−0.180
	(0.194)			(0.213)	(0.223)
Log seed mass	0.971	1.000	0.963	0.992	0.979
	(0.197)	(0.201)	(0.206)	(0.197)	(0.200)
SD (Intercept)	0.919	0.936	0.981	0.905	
SD (Observations)	1.000	1.000	1.000	1.000	
AICc	356.252	357.240	357.249	357.819	

Table S-3: Fixed effects models for the spatial seed limitation pooled over years (see text for details). For each model is shown standardized coefficients and standard error (brackets). Also shown the QAICc value for each selected model, and the coefficients of the average model.

	8	16	7	6	Average
Adult Frequency	−0.363	−0.164		−0.538	−0.257
	(0.203)	(0.241)		(0.198)	(0.269)
Adult height	−0.432	−0.528	−0.597		−0.413
	(0.227)	(0.238)	(0.210)		(0.293)
Log seed mass	0.836	0.851	0.771	0.849	0.826
	(0.206)	(0.198)	(0.199)	(0.224)	(0.208)
Frequency:Height		−0.395			−0.100
		(0.237)			(0.209)
QAICc	56.540	56.920	56.965	57.439	

Table S-4: Fixed effects models for the temporal seed limitation pooled over years (see text for details). For each model is shown standardized coefficients and standard error (brackets). Also shown the QAICc value for each selected model, and the coefficients of the average model.

	5	7	6	Average
Adult Frequency			−0.198	−0.045
			(0.182)	(0.120)
Adult height		−0.224		−0.059
		(0.185)		(0.137)
Log seed mass	0.628	0.639	0.661	0.638
	(0.193)	(0.194)	(0.198)	(0.194)
QAICc	62.212	63.548	63.812	

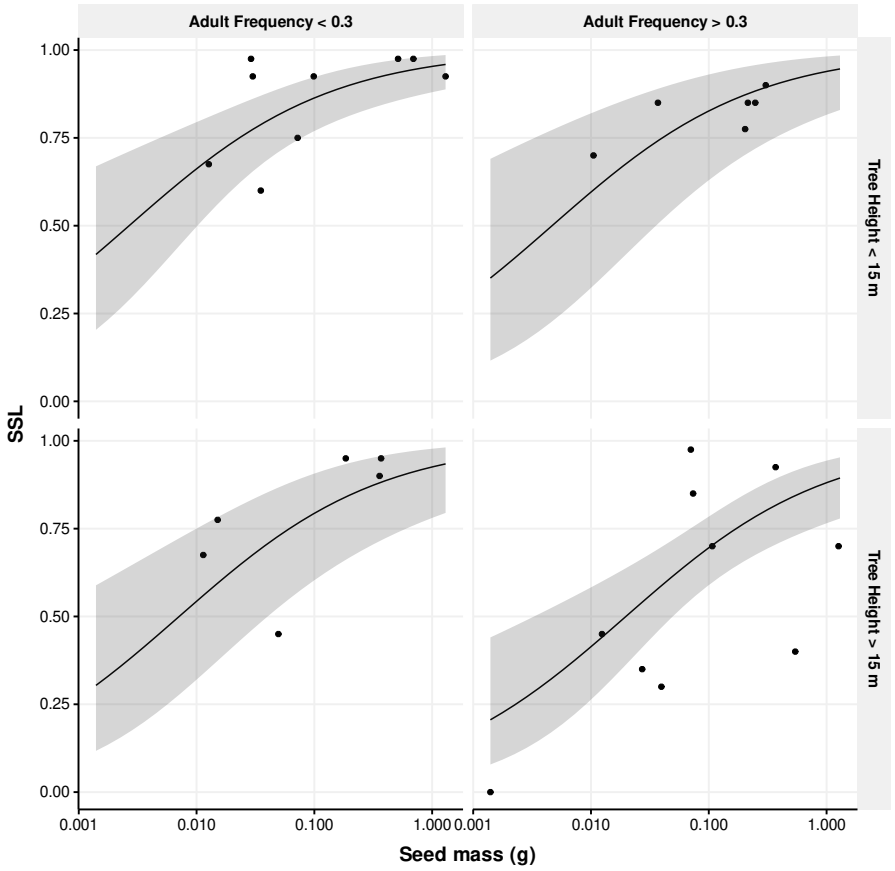

Figure S-1: Relationship among spatial seed limitation pooled over years (SSL), seed mass, tree height, and frequency of adults, as predicted by the glm average model (Table S-3). For species with frequency lower than median value (0.3) the relationship is showed in graphs in the left column, and for those with greater frequency, in the right column. For species with tree height lower than median value (15 m) the relationship is showed in upper graphs, and for those with greater height in bottom graphs. Regression lines are predicted values by the average model using the midpoint of the height and frequency class in each panel. Gray shadows are 95% prediction interval of the average model. Points are observed values of SSL (pooled over the 3 years) and seed mass for each species. Note the log scale for seed mass.

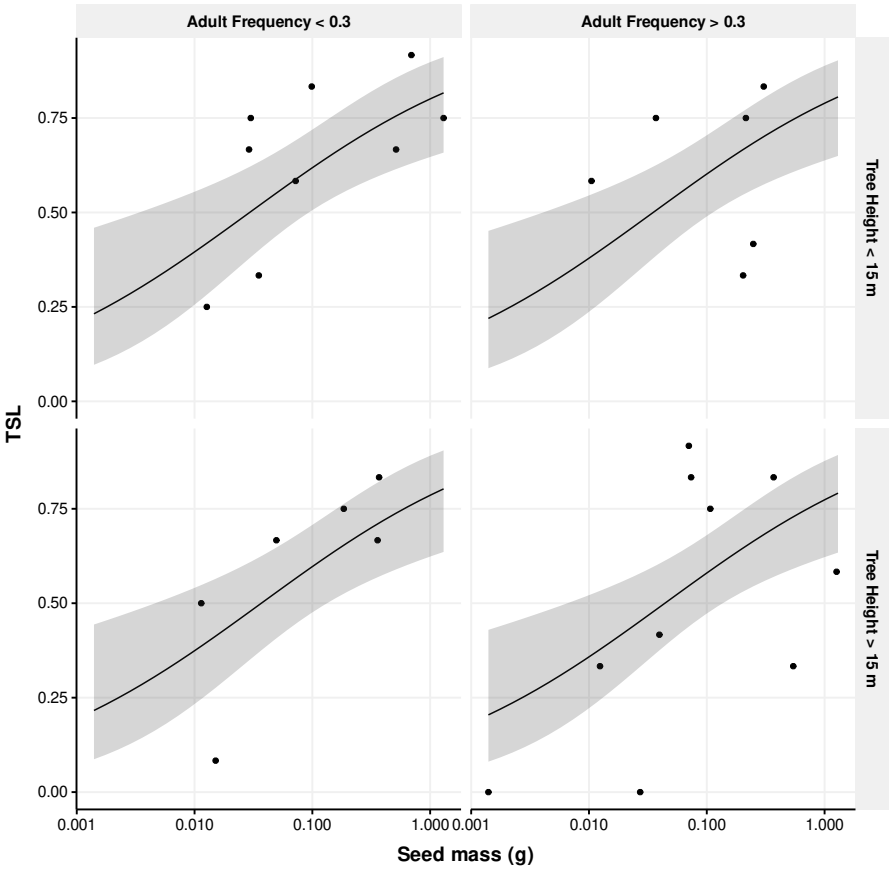

Figure S-2: Relationship among temporal seed limitation pooled over years (TSL), seed mass, tree height, and frequency of adults, as predicted by the glm average model (Table S-4). For species with frequency lower than median value (0.3) the relationship is showed in graphs in the left column, and for those with greater frequency, in the right column. For species with tree height lower than median value (15 m) the relationship is showed in upper graphs, and for those with greater height in bottom graphs. Regression lines are predicted values by the average model using the midpoint of the height and frequency class in each panel. Gray shadows are 95% prediction interval of the average model. Points are observed values of SSL (pooled over the 3 years) and seed mass for each species. Note the log scale for seed mass.