Heterospecific tree density and environmental factors affect *Afzelia africana* Sm. population structure in the Pendjari Biosphere Reserve, West Africa: Implications for management and restoration

Justin A. Atanasso[1] , Sylvanus Mensah[1] , Akomian F. Azihou[2] , Bruno A. Djossa[3] , Romain Glele Kakaï [1] and Achille E. Assogbadjo[2]
Laboratory of Biomathematics and Forest Estimations, Faculty of Agronomic Sciences, University of Abomey-Calavi, 04 BP 1525, Cotonou, Benin

1.The Problem

There are still knowledge gaps on how local environmental factors and co-occurent species density shape *Afzelia africana* populations structure

2.The Research Hypothesis (RH)

There are some degrees of correlation between soil topography, terrain slope, termite mounds, heterospecific trees density and *A. africana* population structures.

3. How we addressed the RH

Sampling and data collection

Studied stands of *A. africana*	Plots size per stand	Species indexed	Recruit stages indexed	Parameters collected
Stand of Batia (17ha) Stand of Bondjagou (27ha) Stand of Bali (8ha)	▪ 4ha plot / stand ▪10 rectangular 0.4ha subplots / 4ha plot	*Afzelia africana* 24 heterospecific co-occuring trees	Early stages plants: dbh < 10 cm (seedlings, saplings, juveniles) and adults dbh ≥ 10 cm (small adults, large adults and very large adults) 5 cm ≥ dbh Juveniles >10 cm, and adults (dbh ≥ 10 cm)	**Response variables:** tree density, mean diameter, basal area, Lorey height, regeneration density **Explicative variables:** sol type, mound density, slope, heterospecific tree density

4.The main Results and Conclusions

Figure 1. The lower densities of *A. africana* individuals in the 10-20 cm diameter class, as compared to the individuals of < 10 cm, 20-30 and 30-40 cm classes, suggest a recruitment bottleneck at the juvenile stage, leading to low recruitment potential, despite higher seedlings and saplings densities (A, B). Similar observations were made by Venter and Witkowski (2010) on the African baobab *Adansonia digitata* L., across different habitats

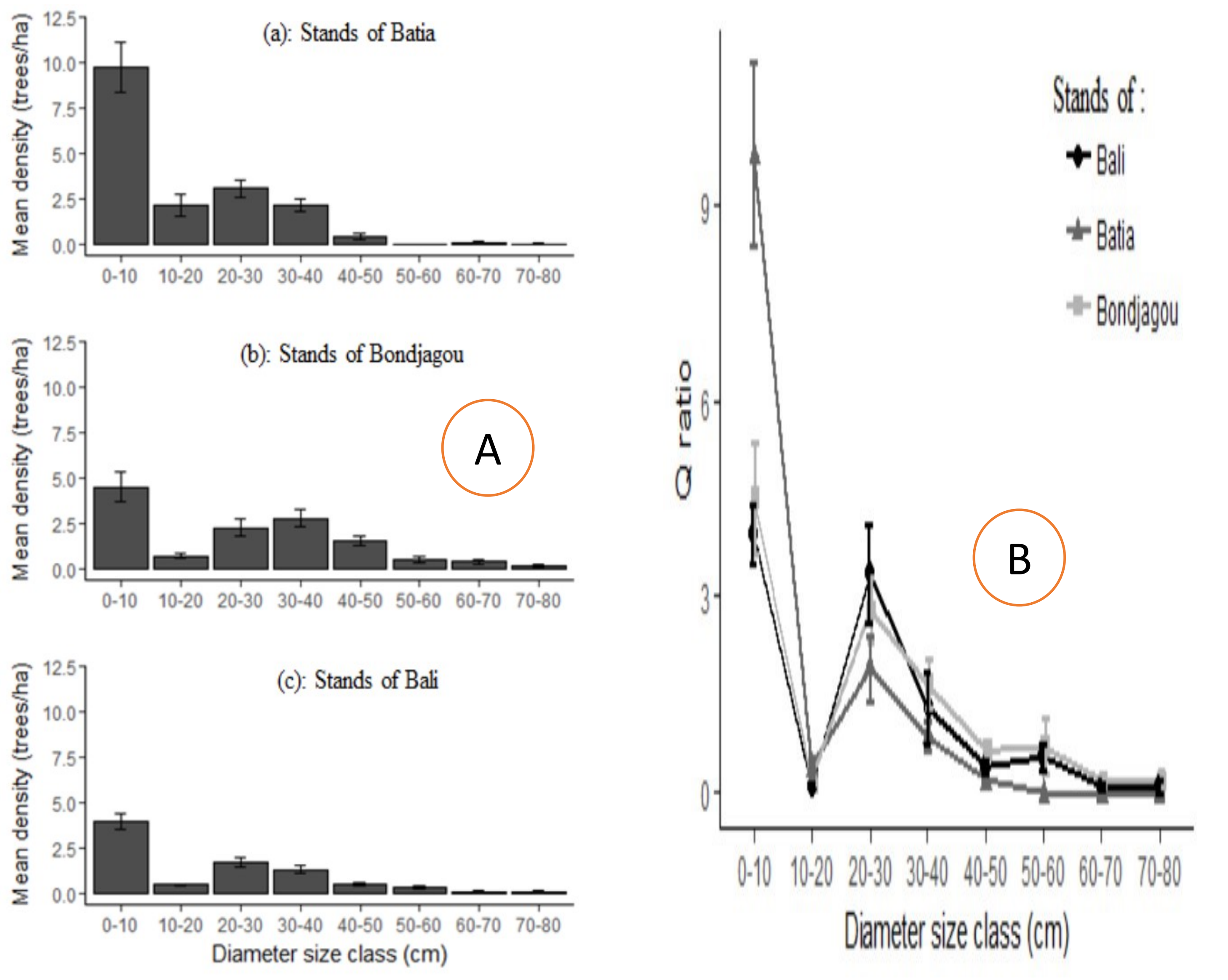

Figure 1. Diameter size class distribution (trees / ha) (A) of three *A. africana* stands and Quotients between successive classes (B)

Table 1. Linear models showing the effects of the topographic factors and heterospecific tree density on *A. africana* stands structure. Est: estimate; se: standard error; SS: sand-silt soils (vs rock outcrop soils ROC)

Variables	Est. (β)	se	T	p (>|t|)	R^2 (%)
Tree density					
(Intercept)	27.99	12.65	2.21	0.036	
Soil type : SS	14.15	9.90	1.43	0.165	
Density of mound	-0.82	0.66	-1.26	0.221	25.50
Slope	0.22	0.39	0.57	0.574	
Density of heterospecific trees	2.00	0.88	2.27	0.032	
Mean diameter					
(Intercept)	11.82	0.76	15.54	0.001	
Soil type : SS	-0.83	0.59	-1.40	0.173	
Density of mound	0.03	0.04	0.82	0.418	28.29
Slope	0.02	0.02	0.90	0.377	
Density of heterospecific trees	-0.15	0.05	-2.92	0.007	
Basal area (m²/ha)					
(Intercept)	7.40	1.50	4.99	0.001	
Soil type : SS	-5.00	1.20	-4.31	0.001	
Density of mound	0.10	0.10	1.79	0.085	59.14
Slope	0.10	0.00	2.29	0.031	
Density of heterospecific trees	-0.30	0.10	-2.56	0.017	
Lorey height					
(Intercept)	12.52	1.02	12.17	0.001	
Soil type : SS	-0.95	0.81	-1.18	0.247	
Density of mound	0.04	0.05	0.78	0.443	19.96
Slope	0.03	0.03	0.81	0.424	
Density of heterospecific trees	-0.16	0.07	-2.25	0.033	
Regeneration density					
(Intercept)	3.62	0.37	9.74	0.001	
Soil type : SS	-0.86	0.27	-3.12	0.005	
Density of mound	-0.00	0.01	-0.10	0.924	46.71
Slope	-0.00	0.01	-0.10	0.920	
Density of heterospecific trees	0.00	0.02	0.17	0.864	

Figures 2. Results of the Multidimensional Scaling (A) of heterospecific trees of the stand of Batia and Bondjagou were associated and showed similar individuals and were together separated from individuals of the stand of Bali. Surprisingly, this stand of Bali showed together of the stand of Bondjagou, to which it was associated, similar heterospecific tree individuals and both were separated from the stand of Batia. The three stands were then relatively similar in terms of co-occurring species within the three stands (see ANOSIM result R = 0.61; p = 0.001) and the IVI (B) with the ten most important heterospecific species for each stand as *Vitallaria paradoxa*, *Lannea acida, Pterocarpus erinaceus, Detarium microcarpum etc* (see also Yaoitcha *et al.,* 2016)

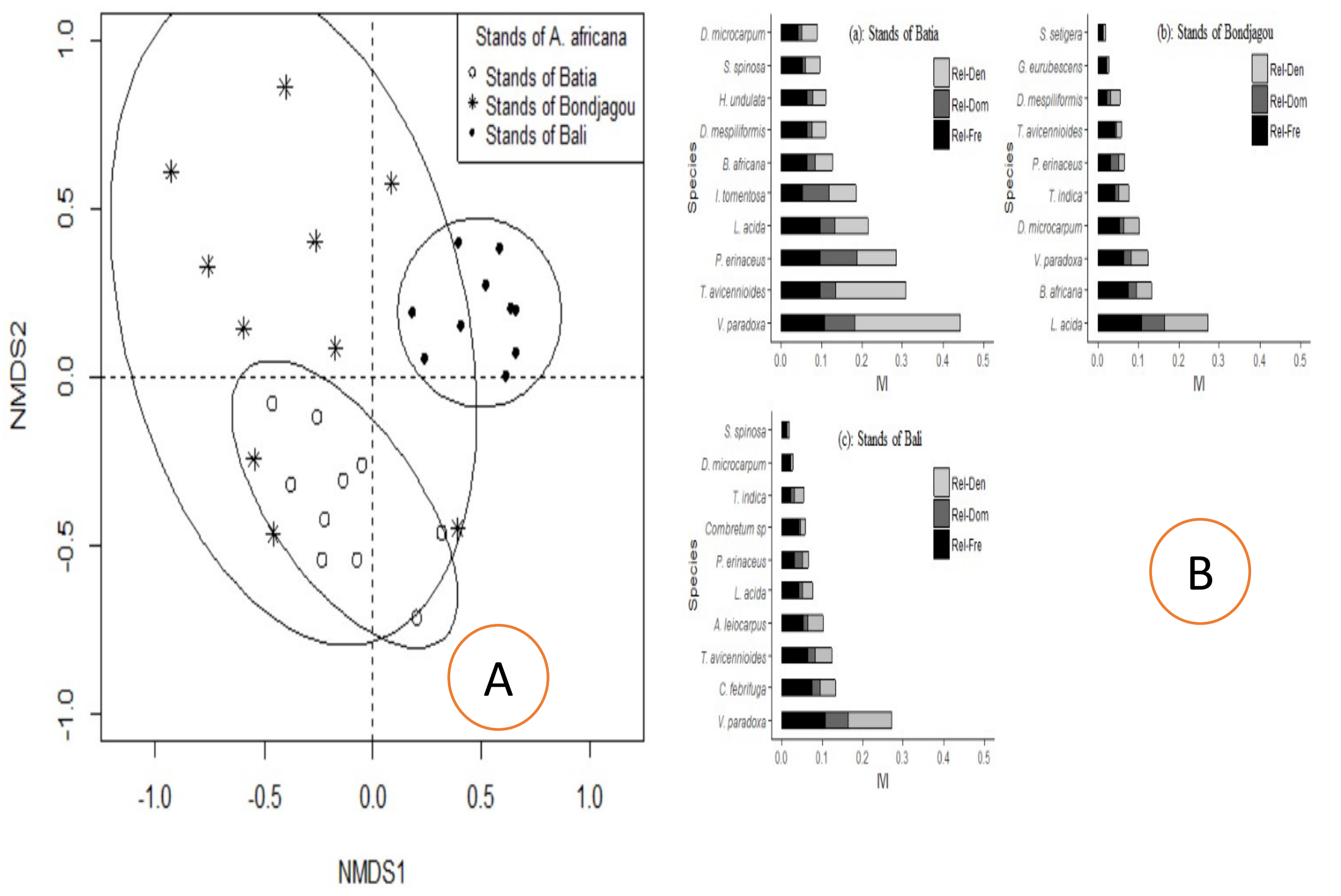

Figure 2. Multidimensional scaling (A) and Importance value Index (IVI) (B) in the stands

Table 1. Results from linear models showed significant influence of heterospecific tree density, soil type and slope on stands of *A. africana* structure. Consistently, heterospecific tree density was positively associated with tree density (β = 2.00; p = 0.032), but negatively related to mean diameter (β = -0.15; p = 0.007), basal area (β = -0.30; p = 0.017) and Lorey height (β = 0.16; p = 0.033). Soil type significantly influenced basal area and regeneration density only (p <0.01). Soil type effects were shown by significantly higher values of basal area and regeneration density on rock outcrop soils. On the other hand, only basal area was significantly affected by terrain slope, with higher values on steeper sites (β = 0.10; p = 0.031). We found no significant influence of mound density on stands of *A. africana* structure (p > 0.05). (Goldberg and Barton, 1992; Donh *et al* ., 2017; Gonçalves *et al.,* 2013; Mensah *et al* 2018a).

Implications for conservation: The topographic factors as soil type, soil slope and the other environnemental factors in the Pendjari Biosphere Reserve explain the dynamism and behavior of *A. africana* recruitment patterns with a key recruitment phenomenon bottleneck at small adult level while seedlings density was too high. This is an important tool to develop further management and sylvicultural strategies for the restoration of this endangered useful species.

Selected references:
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