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Characterization of the Arboreal Flora of Two Provinces in South of Mozambique

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Abstract: This study was carried out in two provinces in the south of Mozambique to characterize the structure and the floristic composition of the arboreal flora. 134 plots of 100×20 m and 93 plots were a random sampling allocated in Gaza and Inhambane province, respectively. The tree with DBH equal or superior than 10 cm were identified and measured. The results in Gaza province shows that a total of 2593 trees were measured corresponding to 106 tree species, 25 botanical families and 54 genera. The most important species in this province were *Colophospermum mopane*, *Guibourtia conjugata*, *Androstachys johnsonii*, *Spirostachys africana*, *Acacia burkei*, *Combretum zeyheri*, *Combretum molle*, *Sclerocarya birrea*, *Strichynos madagascariensis* and *Terminalia sericea*. In Inhambane province, 2556 trees were measured distributed to 108 species, 30 botanical families and 58 genera. The most important species in this province were *Brachystegia spiciformis, Colophospermum mopane, Androstachys johnsonii*, *Spirotachys africana*, *Guibourtia conjugata*, *Acacia nigresscens*, *Sclerocarya birrea*, *Margaritaria discoidea*, *Brachystegia manga* and *Pteleopsis mytifolia*. The diversity of the Inhambane forest was larger than the one of the Gaza forest (index of Shannon = 3.36, Pielou index = 0.72 and 3.09, Pielou index = 0.66, respectively). The Index of Jaccard and Sorensen revealed low similarity among the two forests. The specificity of identified species in each province can be used to define restoration and conservation strategies of the south of Mozambique.

Key words: floristic composition, diversity, forest conservation

1. Introduction

Mozambique had an estimated forestry potential of 70% throughout the country [1]. Despite this potential, knowledge of the floristic composition and economic value of these ecosystems is still very limited, which makes it difficult to include the value of these resources in the planning and elaboration of management plans that aim at their sustainable use [2].

Forests in southern Mozambique have been experiencing strong anthropogenic pressure as sources of energy from biomass, timber and non-timber forest products, to supply domestic and foreign markets, and the last forest inventory update in this particular region was in 2007, without knowing the current forest potential of this region.

From the scarce studies on the floristic composition and phytosociology of the forest resources conducted in Mozambique covering larger areas, most of them were developed in conservation areas, and Ribeiro et al. (2008) [3], in the Niassa Forest Reserve and Williams et al. (2008) [4] in the Gorongosa National Park. For Regan et al. (2007), the lack of knowledge about the flora and its economic-ecological value, in general, makes many species unprotected, even when conservation units are created because of their conservation.

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Disordered exploitation of forest resources without scientific support regarding floristic composition, phytosociological structure, pattern of spatial distribution and species dynamism may have consequences for a particular community. For Rossi (1998) [5], the disorderly use of forest resources drastically modifies the environmental regime and the pattern of tree spacing, leading to influence on outcropping, fruiting and seed production.

Due to the increasing advancement and anthropogenic pressure on the natural landscape, studies that take into account the quantification, characterization forest resources present a great interest for humanity. Castro (1994) [6] and Felfili et al. (1993, 1994, 1997) [7-9] report that floristic and phytosociological surveys have provided important information for the understanding of the biogeographic patterns of native forests, contributing to the determination of priority areas for conservation, management and sustainable exploitation or rehabilitation.

Felfili (2005) [10] argues that researches on how biodiversity is organized and distributed in forest communities is necessary to assess their value and impacts from anthropic activities, to plan the creation of conservation units and to adopt conservation techniques. management. It is in this context that the present study aimed to characterize the forests of the provinces of Gaza and Inhambane, southern Mozambique, providing subsidies for the national economy and for the improvement of adaptive techniques of management and conservation of forests.

2. Material and Methods

The present research was conducted in the natural forests of Gaza and Inhambane provinces, located in the southern region of Mozambique (Fig. 1). Gaza province is situated between the parallels 21°19' and 25°23' south latitude, 31°30' and 35°41' east longitude, with an estimated area of 75,334 km². Inhambane province lies between south latitudes 20 ° 57', longitudes 35°41' and has an estimated area of 68,775 km^2.

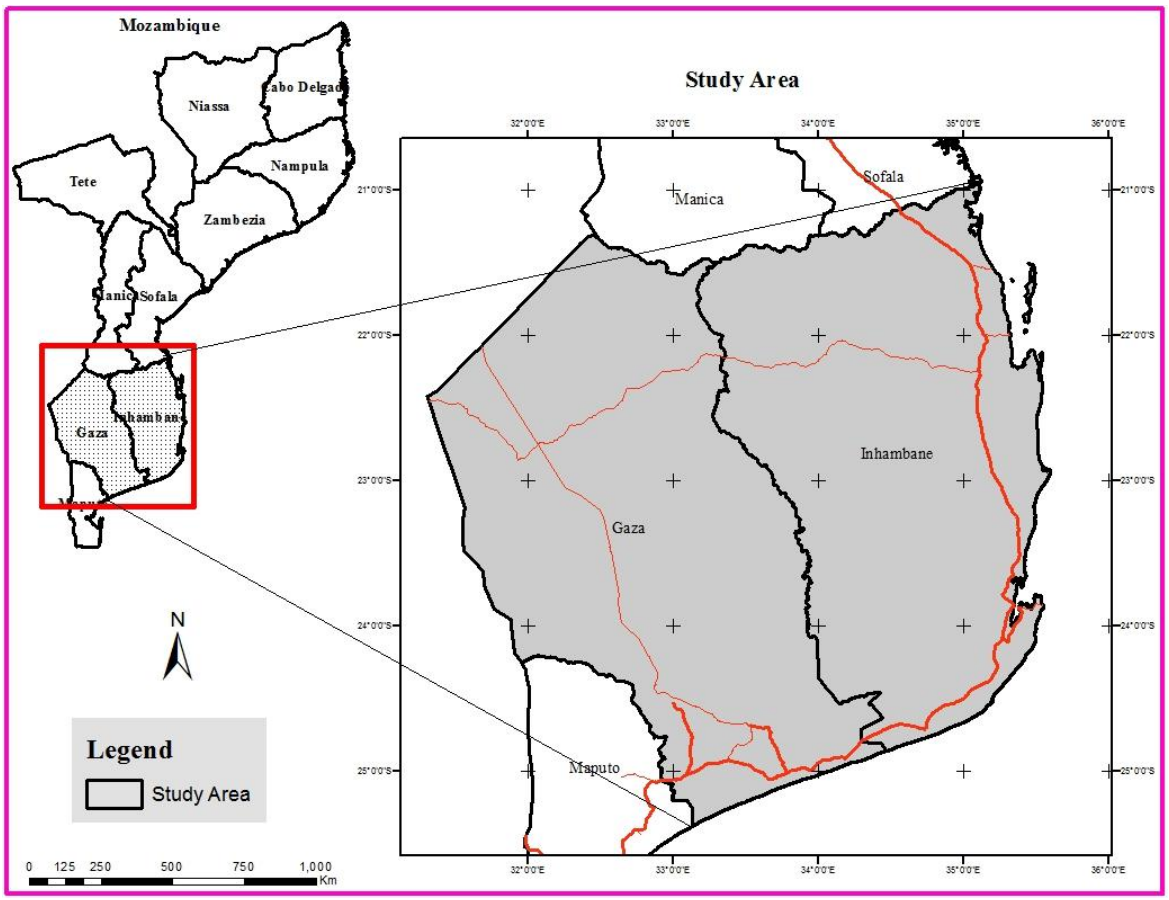

Fig. 1 Localization of study area.

A total of 93 plots of 100×20 m (2,000 m²) was a random sampling allocated in Inhambane province and 134 in Gaza province, making up a sampled area of 18.6 ha in Inhambane province and 26.8 ha in Gaza province. All trees and shrubs present in the plot, which presented DBH ≥ 10 cm were measured [11, 12]. Identification of the botanical material on the species, genus and family name was initially performed on the field whenever possible by the field teams, based on the dendrological aspects of the species. The floristic list generated was organized according to the classification system of the Angiosperm Phylogeny Group II [13].

The floristic diversity and relative abundance of species were analysed using the following indexes: Shannon-Weaver (H') [14], Pielou (J) equitability [15], Jaccard's similarity [16] and Sorensen [17] (Table 1). The characterization of the horizontal structure of the shrub-arborea community was estimated by means of the phytosociological parameters of frequency, density, dominance and importance indexes of each species sampled.

3. Results and Discussion

In Inhambane province, 2568 individuals were found, distributed in 108 species of 30 families, belonging to 58 genera. On the other hand, in the province of Gaza, 2593 individuals of 106 species, belonging to 25 families and 54 genera, were found. For the province of Inhambane, the families that most stood out in species richness were Fabaceae (33), Combretaceae (10), Anacardiaceae (6), Burseraceae (4) and Celastraceae, Euphorbiaceae and Phyllanthaceae (3). The other families had two or one species. For Gaza Province, the families that stood out were Fabaceae (34), Combretaceae (10), Sterculiaceae and Burseraceae (4), Anacardiaceae, Capparaceae, Euphorbiaceae, Loganiaceae and Sapotaceae (3). In

this forest, the other families presented two or one species.

Table 1 Parameters and formulas used in the study.

Parameters	Formula
Shannon-Weaner Index	$H' = -\sum p_i \ln(p_i)$
Pielou Index	$C = \frac{H'}{\ln(S)}$
Jaccard Index	$C_j = \frac{a}{a+b+c}$
Sorensen Index	$C_s = \frac{2a}{2a+b+c}$
Importance Value Index	IVI (%) = relative frequency +relative abundance + relative dominance

The species present in the study area are cited in previous studies in the region, indicating little regional floristic variation. In order to determine floristic composition, diversity and miombo structure by random sampling in 71.6 hectares, in the district of Mocuba, central Mozambique, Hofiço and Fleig (2015) [11] identified 31 families, 83 genera and 124 species. that the family Fabaceae was the one that presented the greatest species richness, located in the order of 48 species, followed by the family Euphorbiaceae with 11 species. Bila and Mabjaia (2012) [12], in their study on the growth and phytosociology of a forest with *Colophospermum mopane*, in Mabalane, province of Gaza, southern Mozambique, have verified the occurrence of 11 botanical families and 15 forest species, considering that families with largest number of species were Fabaceae, Loganiaceae and Capparaceae.

According to Souza et al. (2010) [18], the predominance of the Fabaceae family in the study region is attributed to its biological capacity of nitrogen fixation and ability to grow in degraded and low fertility soils. For Gentry and Dodson (1987) [19], the majority concentration of species in some families reflects the specialization of these families to the local environment where they naturally occur.

The values of the Importance Value Indexes (IVI) of the main species by province are presented in Table 2.

Table 2 shows that the species with the highest Importance Value Index (IVI%) were *Acacia nigrescens*, *Colophospermum mopane*, *Lannea anthiscorbutia* and *Brachystegia spiciformis* (in Inhambane forest) and *Sclerocarya birrea*, *Acacia burkei*, *Colophospermum mopane* and *Androstachys johnsonii* (in Gaza forest). On the other hand, there is a predominance of *Brachystegia spiciformis* species in the Inhambane forest and *Colophospermum mopane*, in the forest of Gaza.

Table 2 Importance Value Indexes (IVI) of the main species of the forest of Gaza and Inhambane.

	Gaza province		Inhambane province	
Order	Scientific name	IVI (%)	Scientific name	IVI (%)
1	*Colophospermum mopane*	28.88	*Brachystegia spiciformis*	27.59
2	*Andostachys johnsonii*	20.58	*Sclerocarya birrea*	12.68
3	*Guibourtia conjugata*	20.48	*Spirotachys africana*	9.83
4	*Spirostachys africana*	10.76	*Androstachys johnsonii*	9.49
5	*Acacia burkei*	8.11	*Colophospermum mopane*	9.32
6	*Combretum zeyheri*	6.79	Unidentified	9.16
7	*Combretum molle*	6.01	Unidentified	9.16
8	*Strichynos madagascariensis*	5.74	*Deinbollia oblongifolia*	8.65
9	*Antidesma venosum*	5.67	*Acacia nigresscens*	8.38
10	Unidentified	5.67	*Guibourtia conjugata*	8.33
	Others	181.31	Others	187.41
	Total	300.00	Total	300.00

The species found in Gaza province forest corroborate [1] as being those that define the mopane formation, since the species *Colophospermum mopane, Androstachys jonhsonii, Acacia nigrescens, Spirostachys africana, Guibourtia conjugata, Swartzia madagascariensis* and *Combretum spp*. Chidumayo (1997) [20] and Giliba (2011) assert that genera that typify miombo formation may also occur outside miombo. Scholes and Walker (1993) [21] point out that the distribution of species at the local level is influenced by the variables that govern the dynamics of savanna forests, the state of coexistence grazing and trees, which is perpetuated by disturbances such as herbivory, burning and drought.

The Shannon diversity indexes were H' = 3.09 and H' = 3.36 in the forests of Gaza and Inhambane, respectively, indicating high diversity between the two provinces.

The Shannon diversity indexes and the Pielou equability found in this study are similar to the values obtained by Hofiço and Fleig (2015) [11], which found Shannon indices between 3.03 and 3.64 in the miombo forest in the central region of Mozambique; and with Mohamed (2008) [22], on a forest reserve in Tanzania. However, under similar conditions Williams et al. (2008) [4] and Shirima (2011) [23] revealed low Shannon index values of 1.25 and 1.05; in Mozambique and Tanzania, respectively.

In the case of the genus Combretum [3], these differences are related to the probable disturbance in the forest, which may have allowed greater regeneration of light-tolerant species. For Marangon et al. (2007) [24], the variation in values of diversity indexes may be related mainly to differences in succession stages, together with discrepancies in sampling methodologies, inclusion levels, taxonomic effort, and, of course, floristic dissimilarities in different communities. Although, at the region level, the diversity values found in this study are within expected ranges, they are below the range expected for tropical forests [25].

The Pielou equability values (J = 0.66 and J = 0.72, for Inhambane and Gaza) can be considered low and within the standard, compared to other studies in the region, where values are between 0 [4]. In the present study, it is possible to determine the relationship between the two variables. Low or moderate equability can be attributed to a few species that occurred with a high number of individuals, especially *Colophospermum mopane*, in the Gaza rainforest and *Brachystegia spiciformis*, in the Inhambane forest.

The forests of Inhambane and Gaza showed 41.53% similarity by the Sorensen index. This floristic similarity can be considered low, since it is below 50%. The Jaccard index presented 26.21% similarity between the two forests, indicating that the two forests do not belong to the same plant community [10].

4. Conclusions

Fabaceae and Combretaceae are the families that present the largest number of shrub-arboreal species in the study area;

Shannon diversity indexes and Pielou equability were H' = 3.09, J' = 0.66 and H' = 3.36, J' = 0.72 in the forests of Gaza province and Inhambane respectively, indicating a relatively high diversity pattern, low similarity between the two communities, being more expressive in Inhambane forest; and

The two areas presented a low similarity by Jaccard (26.21%) and Sorensen (41.53%), below 50%, indicating that they do not belong to the same plant community.

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