Journal of Ecology and the Natural Environment Vol. 3(3), pp. 95-103, 2011
Available online at http://www.academicjournals.org/jene
ISSN 2006- 9847

Full Length Research Paper

Structural characterization of the woody plants in *restinga* of Brazil

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Accepted 7 March, 2011

The structure of the woody component of in *restinga* (tropical coastal vegetation) of Brazil was surveyed in order to describe and examine the relationship between community structure, water table, and soil nutrients. The survey was undertaken between January and March 2005 in an area with a forest physiognomy, employing the point-center quarter method with 100 sampling points. Soil samples were collected for chemical and physical analysis. A total of 51 species, 36 genera, and 31 families were sampled. The *H'* was 3.508 nit.ind^{-1} and the species with the highest VI were *Manilkara salzmannii* (22.63), *Myrcia bergiana* (20.55), *Chamaecrista ensiformis* (19.82), *Sacoglottis mattogrossensis* (17.68), and *Coccoloba laevis* (15.18). The distribution of species was associated with certain soil nutrients (calcium, acidity, organic matter and cation exchange capacity). The species richness in Maracaípe Reserve was high in comparison to other coastal areas in the Brazilian northeast, indicates the need for conservation of this area. We may conclude that the present study indicated that soil nutrients were of greater importance for explaining the observed variations in the physiognomy and species distribution in the *restinga* area.

Key words: Pernambuco, physiognomies, resting, species distribution.

INTRODUCTION

Structural descriptions of forests are based on the relationships of abundance of the component plant populations and on the analysis of the bio-climatic factors that act upon them. In general, the plant population structure and the biodiversity observed in a given area reflect the conditions in the local micro-habitats and the variety of niches available (Richards, 1952).

The tropical coastal vegetation (*restinga*) is one of the ecosystems associated with the Brazilian Atlantic Forest (Scarano, 2002), and is composed of herbaceous, shrub, and arboreal physiognomic forms (Pereira et al., 2000). The different physiognomies encountered in *restinga* areas reflect the diversification of niches available there and the influence of the neighboring vegetation types (Scarano et al., 2005). These same authors also stresses the importance of detailed studies on the distribution of plant species in the *restinga*.

The majority of studies on *restinga* vegetation was carried out in the south and southeastern Brazil, with emphasis on floristic and phytosociological parameters (Sá, 1992; Pereira et al., 2001; Assis et al., 2004). Studies of *restinga* areas in the Brazilian northeast were undertaken during the 1990’s (Zickel et al., 2004). From this decade, studies on the structure of vegetation has contributed to the knowledge of the distribution of species of *restinga* in NE Brazil.

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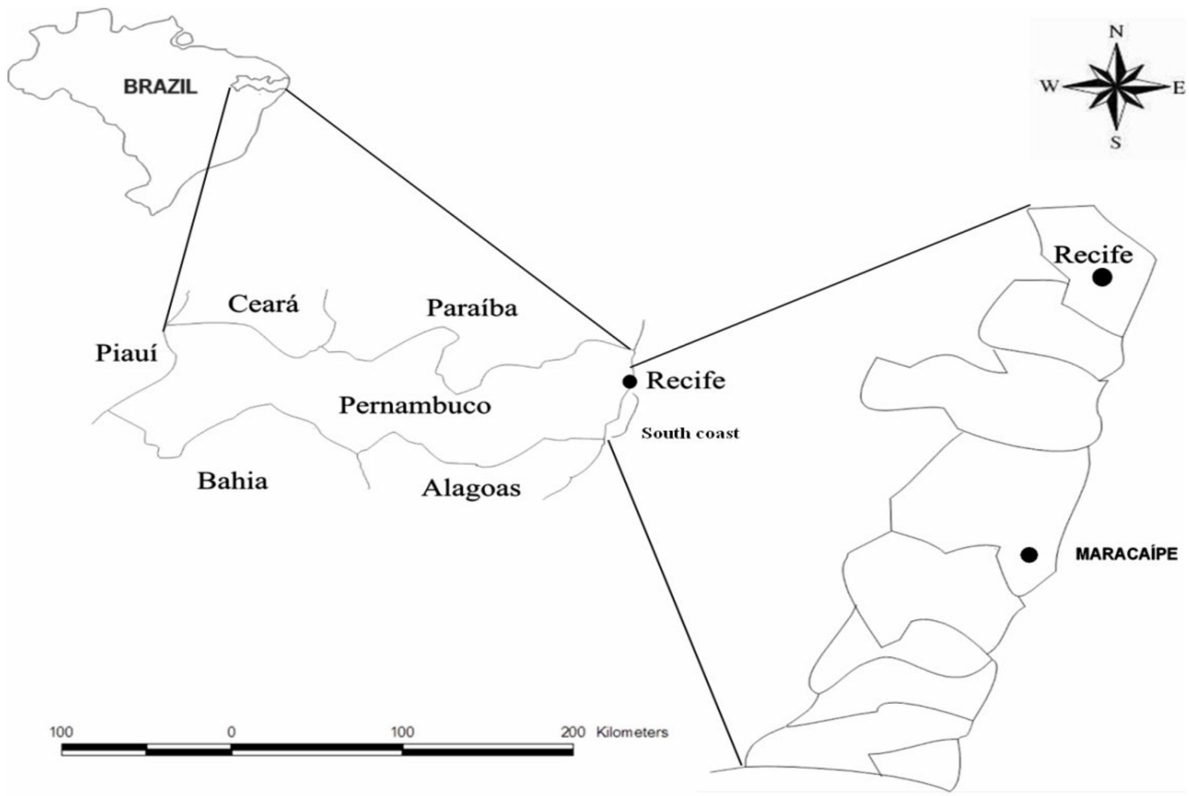

Figure 1. Distribution into height classes of the woody species encountered in *restinga* vegetation in Ipojuca, Pernambuco State, Brazil.

Recent studies have indicated a number of different parameters that can influence the organization of the *restinga* communities and the distribution of the plant populations found there, with soil nutrient levels being especially important (Moreno and Schiavini, 2001; Botrel et al., 2002; Dalanesi et al., 2004; Resende et al., 2004). However, studies conducted in *restinga* areas in Pernambuco State, the analysis of soil nutrients did not affect the variations in physiognomic of these *restinga* (Cantarelli, 2003; Vicente et al., 2003).

This lack of any obvious correlation between the soil nutrient status and floristic composition within the distinct physiognomies of the *restinga* lead to examine other factors that could explain the functioning of this ecosystem. Sá (2002) hypothesized that the water table or groundwater stocks (associated with soil nutrient conditions) influenced plant distribution in the *restinga* areas of Rio de Janeiro, contributes to the physiognomic variation between the *restingas*, and depending on the region has geographical variations (Lacerda et al., 1984), with different ecological or historical anthropogenic origins.

Accordingly, this study aims to describe the structure of the woody component of the *restinga* vegetation and evaluate the effect of soil nutrients and water table levels on the structural arrangement of the woody community of *restinga*.

MATERIAL AND METHODS

Study area

The study was carried in the Private Nature Reservation (RPPN) Nossa Senhora do Outeiro de Maracaípe, in the municipality of Ipojuca (08°31'48''S, 35°01'05''W), located along the southern coast of Pernambuco State, Brazil (Figure 1). The reserve covers a total area of 130 ha, of which 76.2 ha is occupied by *restinga* vegetation. The *restinga* area is composed of three physiognomies: flooded and non-flooded open fields, as well as non-flooded forests. The forest physiognomy, the plants most representative is composed of trees that can reach 20 m tall, with a shrubby understory of about 4 to 5 m tall and few herbs (Almeida et al., 2009).

The *restinga* of Maracaípe is remaining vegetation well preserved in the Pernambuco State, according to Almeida et al. (2009). These same authors reported that the flora of this *restinga* comprises 187 species belonging to 71 families. Myrtaceae, Rubiaceae, Fabaceae, Mimosaceae, and Caesalpiniaceae families hold the greatest woody species richness in the area.

The local climate is defined as As' type by the Köppen (1948) classification system (rainy tropical climate with dry summers and less than 60 mm of rain in the driest month), and receives an annual rainfall of approximately 2000 mm (INMET, 2005) (Figure 2).

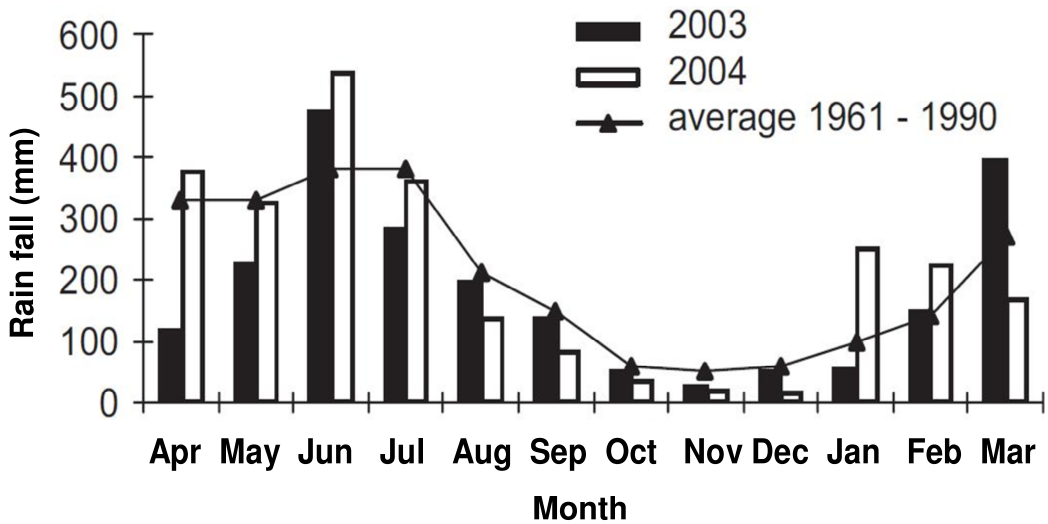

Figure 2. Mean annual rainfall (mm) from April 2003 to July 2004, and historical mean annual data from 1961 to 1990 of Ipojuca Municipality, Pernambuco State, Brazil. Source: INMET Recife (Curado).

The soil is sandy (sand content 98 to 100%), being classified as Quaternary Neossoils, according to the classification system used by Company Brazilian Agricultural Research - EMBRAPA (1999).

Data collection

We made a phytosociological survey between January and March 2005, using the quadrant method (Cottam and Curtis, 1956). Ten 100 m transects were laid perpendicular to the coast out in the non-flooded forest area, each composed of ten survey points, spaced at 10 m apart, summing 100 survey points (Killeen et al., 1998; Rodal et al., 1998; Medeiros et al., 2010), that is an area of sample 0.651 ha. All woody individuals with the perimeter at soil level (PSL) ≥ 10 cm, had height and circumference of the stem measured, and the plants permanently marked. Multi-stemmed plants were tallied when at least one of the shoots had PSL ≥ 10 cm. The other shoots of each individual were also measured and computed for calculating the plant diameter. Voucher specimens were collected, identified according to the APG III (2009), and are deposited in the Herbarium IPA ("Dárdano de Andrade Lima").

Ten soil samples were collected at a depth of 20 cm, in each transect, following the techniques recommended by EMBRAPA (1997). The soil samples were then randomly collected and subsequently, mixed to provide a single combined sample. Analysis were performed for hydrogen (H), phosphorus (P), calcium (Ca), potassium (K), aluminum (Al), carbon (C), sodium (Na), manganese (Mn), magnesium (Mg), iron (Fe), cuprum (Cu), zinc (Zn), pH, total acidity (H±Al), organic material (O. M.), exchangeable sodium percentage (PST), cation exchange capacity (T), total bases (S), base saturation (V), and aluminum saturation (m), according to the criteria of Oleynik (1980).

In order to examine any possible relationships between forest physiognomy and water table movements, ground water levels were measured throughout the dry and rainy seasons. Ground water levels were measured in three bore holes located 400 apart and fitted with 3 m long 40 mm diameter PVC tubes that were perforated along their entire length and wrapped in nylon mesh to exclude sand but allow water to percolate in. Once placed in the ground, the upper ends of the tubes were sealed prevent the entrance of rain water. The levels were measured once a month in each of the three bore holes for 17 months (March 2004 to July 2005).

Dates of analyses

The phytosociological parameters of basal area (BA), relative density (RD), relative frequency (RF), relative dominance (RDo), importance value (IV), and cover value (CV), the Shannon diversity index, and the Pielou equitability index for species and families were calculated using the FITOPAC 2.0 software package (Shepherd, 1995). Histograms were prepared showing the numbers of individuals within the different height (1 m intervals) and diameters classes (10 cm intervals).

The Kolmogorov-Smirnov test was used to verify the normality of the data referent to the soils samples and the water table level, and the non-parametric Mann-Whitney test, alfa = 0.05, was used to examine whether there is significant difference in the values of soil nutrients and water level (Zar, 1999).

RESULTS

We identified 51 species, 36 genera and 31 families; of the total, three were identified as morphospecies (Table 1). The families with the greatest species richness: Myrtaceae (11 species), Fabaceae (6),Polygonaceae (3), Anacardiaceae, Apocynaceae, Euphorbiaceae, Lauraceae, and Nyctaginaceae (2).

Myrcia bergiana was the most abundant, followed by *Sacoglottis mattogrossensis*, *Manilkara salzmannii*, *Chamaecrista ensiformis*, *Casearia javitensis*, *Coccoloba laevis*, *Himatanthus phagedaenicus*, *Tapirira guianensis*, *Guettarda platypoda*, *Anacardium occidentale*, *Ocotea duckei*, *Myrcia guianensis* and *Marlierea regeliana* whose sum corresponded to 60.5% of all individuals sampled.

Table 1. Phytosociological parameters of the species samples in the forest physiognomy of *restinga*, Maracaípe, Ipojuca, PE. N= number of individuals samples, RF= relative frequency, RD= relative density, RDo= relative dominance, IV= importance value, CV= cover value, BA= basal area (Organized by IV).

Species	Families	N	RF (%)	RD (%)	RDo (%)	IV	CV (%)	BA (m^2 ha^{-1})
Manilkara salzmannii (A. DC.) H.J. Lam	Sapotaceae	20	3.09	5.00	14.54	22.63	9.77	2.2815
Myrcia bergiana O. Berg	Myrtaceae	49	4.64	12.25	3.67	20.55	7.96	0.5753
Chamaecrista ensiformis (Vell.) H.S. Irwin and Barneby	Fabaceae	20	3.61	5.00	11.21	19.82	8.10	1.7601
Saccoglotis mattogrossensis Malme	Humiriaceae	32	4.64	8.00	5.04	17.68	6.52	0.7905
Coccoloba laevis Casar.	Polygonaceae	18	3.61	4.50	7.07	15.18	5.78	1.1096
Guapira nítida (Schmidt) Lundell	Nyctaginaceae	9	3.09	2.25	6.66	12.00	4.45	1.0447
Andira nitida Mart. ex Benth.	Fabaceae	8	2.58	2.00	7.12	11.70	4.56	1.1182
Anacardium occidentale L.	Anacardiaceae	11	2.58	2.75	5.64	10.97	4.19	0.8849
Tapirira guianensis Aubl.	Anacardiaceae	13	3.09	3.25	3.72	10.07	3.48	0.5844
Casearia javitensis Kunth	Salicaceae	20	3.09	5.00	1.90	10.00	3.45	0.2989
Guettarda platypoda DC.	Rubiaceae	13	3.61	3.25	0.64	7.50	1.94	0.1008
Sloanea guianensis (Aubl.) Benth.	Elaeocarpaceae	3	1.55	0.75	5.20	7.50	2.97	0.8159
Abarema filamentosa (Benth.) Pittier	Fabaceae	8	2.58	2.00	2.63	7.21	2.31	0.4134
Ocotea duckei Vattimo	Lauraceae	11	2.58	2.75	1.72	7.04	2.23	0.2692
Himatanthus phagedaenicus (Mart.) Woodson	Apocynaceae	14	2.58	3.50	0.67	6.75	2.08	0.1050
Inga capitata Desv.	Fabaceae	7	2.58	1.75	2.38	6.70	2.06	0.3730
Myrcia guianensis (Aubl.) DC.	Myrtaceae	11	3.09	2.75	0.68	6.53	1.71	0.1073
Eugenia sp 1	Myrtaceae	8	2.58	2.00	1.66	6.24	1.83	0.2607
Protium heptaphyllum (Aubl.) Marchand	Burseraceae	8	3.61	2.00	0.17	5.77	1.08	0.0261
Marlierea regeliana O. Berg.	Myrtaceae	10	2.58	2.50	0.61	5.68	1.55	0.0950
Ocotea gardneri (Meisn.) Mez	Lauraceae	7	3.09	1.75	0.78	5.62	1.26	0.1220
Buchenavia capitata (Vahl.) Eichler	Combretaceae	3	1.03	0.75	3.45	5.23	2.10	0.5414
Rollinia pickelli Mart.	Annonaceae	6	2.58	1.50	1.12	5.19	1.31	0.1751
unidentified species	Myrtaceae	4	2.06	1.00	1.99	5.05	1.49	0.3126
Erythroxylum passerinum Mart.	Erythroxylaceae	4	2.06	1.00	1.97	5.04	1.48	0.3099
Byrsonima riparia W. R. Anderson	Malpighiaceae	8	2,58	2.00	0.29	4.86	1.14	0.0450
Eugenia hirta O. Berg	Myrtaceae	6	1.55	1.50	1.04	4.09	1.27	0.1637
Marlierea sp 1	Myrtaceae	7	1.55	1.75	0.56	3.86	1.15	0.0885
Ouratea fieldingiana (Gardner) Engl.	Ochnaceae	6	1.55	1.50	0.34	3.39	0.92	0.0539
unidentified species	Unidentified	5	1.55	1.25	0.45	3.25	0.85	0.0706
Eugenia excelsa O. Berg.	Myrtaceae	5	1.55	1.25	0.35	3.14	0.80	0.0543
Cupania racemosa (Vell.) Radlk.	Sapindaceae	5	1.55	1.25	0.22	3.02	0.73	0.0352
Maytenus distichophylla Mart.	Celastraceae	4	1.55	1.00	0.41	2.95	0.70	0.0637
Calophyllum brasiliensis Cambess.	Calophyllaceae	4	1.55	1.00	0.40	2.95	0.70	0.0633
Coccoloba confusa How	Polygonaceae	2	1.03	0.50	1.27	2.80	0.88	0.1996
Inga flageliformis (Vell.) Mart.	Fabaceae	3	1.55	0.75	0.29	2.59	0.52	0.0458
Capparis flexuosa (L.) L.	Capparaceae	3	1.55	0.75	0.19	2.48	0.47	0.0296
Rapanea guianensis Aubl.	Myrsinaceae	3	1.03	0.75	0.19	1.97	0.47	0.0305
Couepia impressa Prance	Chrysobalanaceae	2	1.03	0.50	0.30	1.84	0.40	0.0478
Eugenia punicifolia (Kunth) DC.	Myrtaceae	3	1.03	0.75	0.03	1.81	0.39	0.0044
unidentified species	Myrtaceae	3	0.52	0.75	0.43	1.70	0.59	0.0676
Andira fraxinifolia Benth.	Fabaceae	3	0.52	0.75	0.09	1.35	0.42	0.0138
Cecropia pachystachya Trécul	Urticaceae	2	0.52	0.50	0.25	1.27	0.37	0.0399
Coccoloba scandens Casar.	Polygonaceae	1	0.52	0.25	0.44	1.20	0.34	0.0688
Cyphomandra fragrans (Hook.) Sendtn.	Solanaceae	2	0.52	0.50	0.01	1.03	0.25	0.0019
Hancornia speciosa Gomes	Apocynaceae	1	0.52	0.25	0.09	0.85	0.17	0.0140

Table 1 (Cont'd).

Myrciaria floribunda (H. West ex Willd.) O. Berg	Myrtaceae	1	0.52	0.25	0.06	0.82	0.15	0.0087
Simaba cuneata A. St.-Hil. and Tul.	Simaroubaceae	1	0.52	0.25	0.02	0.79	0.13	0.0035
Pera glabrata (Schott) Poepp. ex Baill.	Euphorbiaceae	1	0.52	0.25	0.02	0.79	0.13	0.0032
Guapira pernambucensis (Casar.) Lundell	Nyctaginaceae	1	0.52	0.25	0.01	0.77	0.13	0.0008
Croton sellowii Baill.	Euphorbiaceae	1	0.52	0.25	0.01	0.77	0.13	0.0008

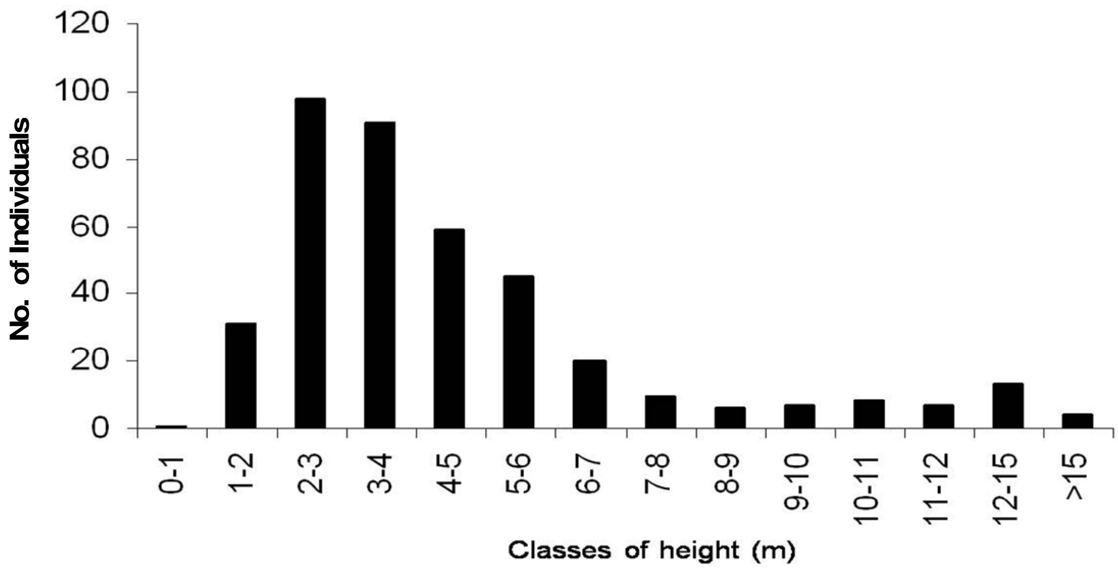

Figure 3. Distribution into height classes of the woody species encountered in *resting* vegetation in Ipojuca, Pernambuco State, Brazil.

The most frequent species were *M. bergiana*, *S. mattogrossensis*, *Coccoloba laevis*, *Protium heptaphyllum*, *C. ensiformis*, and *G. platypoda* (Table 1), of which the first three were well represented throughout the forest. *M. salzmannii*, *C. ensiformis*, *Andira nitida*, *C. laevis*, and *Guapira nitida* had the highest dominance levels.

Manilkara salzmannii, *M. bergiana*, *C. ensiformis*, *S. mattogrossensis*, and *Coccoloba laevis* had the highest importance values (IV) (Table 1), while *Guapira pernambucensis*, *Myrciaria floribunda*, *Pera glabrata*, *Cyphomandra fragrans*, and *Simaba cuneata* were the rarest species in the area. Total woody plant density was estimated at 614.89 $ind.ha^{-1}$, with an average distance of 4 m between individuals and a total basal area of 15.695 $m^2.ha^{-1}$. The Shannon diversity index (*H'*) was 3.508 $nit.ind^{-1}$ and the equitability (*J'*) was 0.892.

The woody vegetation had an average height of 4.9 (± 3.2 m), with a maximum height of 25 m. The highest concentration of individuals was observed between the second and fifth height classes (Figure 3), with the former comprising the largest number of individuals.

The first vegetation layer of this forest physiognomy contained individuals up to 5 m tall, such as *Myrcia bergiana*, *Marlierea regeliana*, *Ouratea fieldingiana*, *Rapanea guianensis*, *Abarema filamentosa*, *Byrsonima riparia*, and *Coccoloba laevis*.

The average plant diameter was 15.3 cm, with a maximum of 106.3 cm and a minimum of 3.2 cm. This maximum value was due to stem ramification of *Coccoloba laevis*; other scrubs individuals of *M. bergiana*, *G. platypoda*, *S. mattogrossensis*, and *Casearia javitensis* also demonstrated similar ramification. Additionally, the shoots observed on arboreal individuals of *Manilkara salzmannii*, *Ocotea gardneri*, *Chamaecrista ensiformis*, and *Sloanea guianensis* were the result of cutting and ramification of stem these plants.

Ramification of stem was observed in 31.25% of the individuals in this plant community. The first three diameter classes had the largest numbers of plants (Figure 4), with many young plants, mainly individuals of *M. bergiana*, *S. mattogrossensis*, *Tapirira guianensis*, *C. javitensis*, and *Protium heptaphyllum*. The last three species also had many large individuals in the

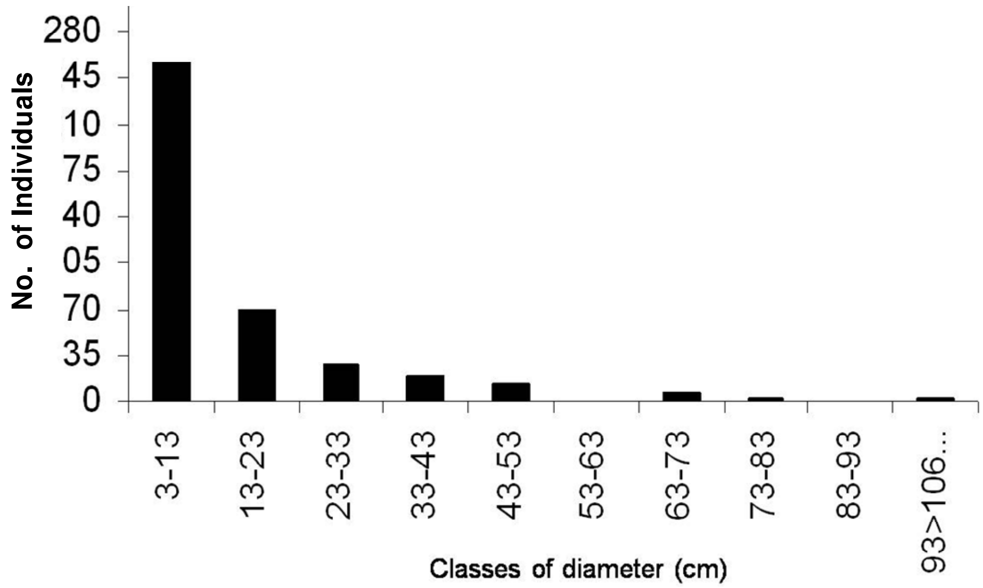

Figure 4. Distribution into diameter classes of the woody species encountered in *resting* vegetation in Ipojuca, Pernambuco State, Brazil.

forest area surveyed. *M. bergiana*, and *S. mattogrossensis* had individuals in all diameter classes, suggesting regularity in recruitment among these species. As the main species were represented in the various diameter classes, we can suggest that this community, under current conditions, presents good potential for regeneration.

The pH varied between 3.7 and 5.4 (average 4.52 ±0.64), while organic material composed between 9.27 and 44.04% of the soil (average 28.86 ±15.54) (Table 2). The concentrations of magnesium, phosphorous, and sodium considered low. In the analysis of nutrients, the highest values O.M., H ± Al and T contributed to occurrence of *Croton sellowii*, *Simaba cuneata*, *Cecropia pachystachya*, and *Guapira pernambucensis*. Species *Andira fraxinifolia* and *Hancornia speciosa*, were recorded in areas with higher levels of Ca and S (total bases).

The level of the water table did not differ significantly during the survey months ($p > 0.05$), indicating that this variable did not influence the distribution of the species in the forest physiognomy (Figure 5). However, it was observed that the samples L2 and L3 presented largest movement of the water column in the rainy period (between the months of June and September). Differently the L1 point where it was recorded low water level during the rainy season.

DISCUSSION

The families with the largest numbers of species (Myrtaceae, Sapotaceae, Mimosaceae, Fabaceae, and Lauraceae) are also typical of other *restinga* areas in the states of Pernambuco, Paraíba, and Rio Grande do Norte in NE Brazil (Zickel et al., 2004). Among these families, Myrtaceae and Leguminosae also have high species richness in *restinga* areas of Rio de Janeiro (Pereira et al., 2001). Sapotaceae is also a characteristic of *restinga* due to the frequency of species (Peixoto and Gentry, 1990). They are amongst the main neotropical families (Gentry, 1988), and have also great representation in the Atlantic Coastal Forest (Mori et al., 1983; Salimon and Negrelle, 2001).

The present study site at Maracaípe has one of the best preserved areas of *restinga*, with a continuous vegetation cover and distinct vegetation layers, different from the *restinga* of Guadalupe and Ariquindá that have lower vegetation statures (Cantarelli, 2003).

The *restinga* of Guadalupe (29%) and Ariquindá (40%) had greater percentages of plants with branched stems (Cantarelli, 2003). Sá (2002) observed that it is relatively common to encounter trees with multiple trunks in *restinga* forest areas. These multiple-trunk individuals may be related to previous cutting of these forests or may represent a natural characteristic of some species (Dunphy et al., 2000) with an innate sprouting capacity (Sá, 2002). Sztutman and Rodrigues (2002) reported the occurrence of multiple-sprouting as a characteristic of forests growing under stressful edaphic conditions. As such, the number of plants with branched stems individuals should not considered in isolation in evaluating the level of anthropogenic influence in these areas.

The shrubs encountered in the *restinga* at Maracaípe

Table 2. Chemical variables in the six soil samples from the closed forest physiognomy of a non-flooded area of *restinga* vegetation in Maracaípe, Ipojuca, Pernambuco State, Brazil.

Chemical variables	Mean ± standard deviation
pH (H_2O)	4.52 ± 0.64
P (mg/dm3)	3.70 ± 1.12
O.M. - organic material (g/kg)	28.86 ± 15.54
Ca ($cmol_c/dm^3$)	0.93 ± 0.63
C (g/Kg)	16.74 ± 9.01
Na ($cmol_c/dm^3$)	0.07 ± 0.03
H ± Al ($cmol_c/dm^3$)	3.31 ± 2.55
Al ($cmol_c/dm^3$)	0.37 ± 0.56
Mn ($cmol_c/dm^3$)	1.92 ± 1.86
K ($cmol_c/dm^3$)	0.07 ± 0.05
Mg ($cmol_c/dm^3$)	0.50 ± 0.37
Fe ($cmol_c/dm^3$)	3.23 ± 0.47
Cu ($cmol_c/dm^3$)	0.00
Zn ($cmol_c/dm^3$)	5.52 ± 7.85
S ($cmol_c/dm^3$)	1.57 ± 0.62
T - Cation exchange capacity ($cmol_c/dm^3$)	4.88 ± 2.86
m - Aluminum saturation (%)	15.01 ± 16.68
V - Base saturation (%)	35.96 ± 12.14
PST - Exchangeable sodium percentage (%)	1.91 ± 1.13

Values are averages ± standard deviation.

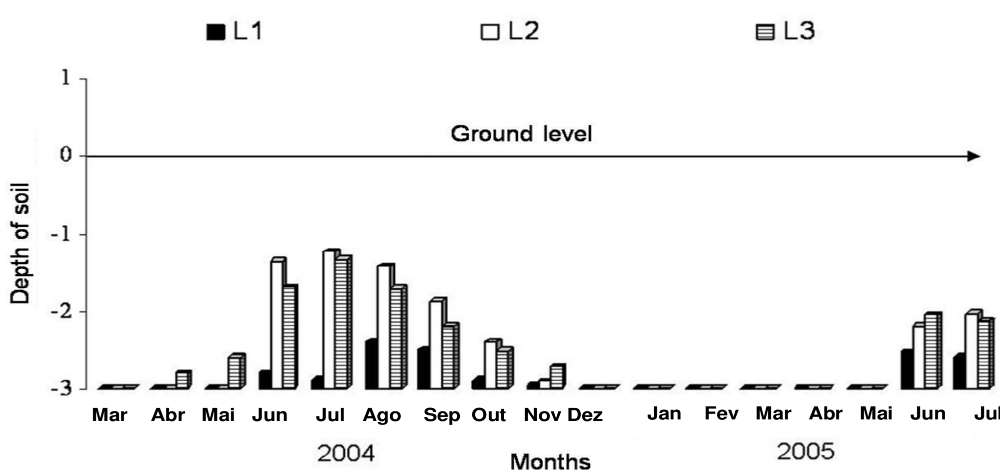

Figure 5. Variation of the level water table in meters of the four pools (L1 the L3) in the months between 2004 and 2005 in *restinga* vegetation in Ipojuca, Pernambuco State, Brazil.

are larger and have greater diameters than those observed in either the Guadalupe or Ariquindá sites. According to Jutras et al. (2006), the height of a tropical forest is influenced by the quantity and regularity of the rainfall, as well as temperature, drainage, and soil nutrient levels. The different proportions of available nutrients, allied to low anthropogenic influences and rare incidences of burning have contributed, likely, to the distinct physiognomy of the Maracaípe *restinga* in relation to other *restinga* areas examined in Pernambuco State.

The species diversity encountered in Maracaípe (3.508 nit.ind-1) was higher than other *restinga* areas in Pernambuco (Guadalupe, 2.649 and Ariquindá, 2.85 nit.ind^{-1}) and Piauí (Luiz Correia, 2.180, Ilha Grande, 2.227 and Parnaíba, 2.446 nit.ind^{-1}) in the northern coast of the NE Brazil (Santos-Filho, 2009). Similar to other *restinga* forest formations which varied from 3 to 3.7 nit.ind^{-1} (Trindade, 1991; Silva et al., 1993; Assis et al., 2004; Medeiros et al., 2010). These results place the Maracaípe site as one of the most diverse *restinga* areas in NE Brazil. However, in spite of the typically low levels of nutrients encountered in the present *restinga* study area the diversity and equitability (0.892) were high, as were the number of single species genus.

It is worth mentioning that the Brazilian coast presents distinct geological formations. The *restinga* south of the country presents a different geomorphology of the Barreiras Formation that is found from the Espirito Santo coast, from south to north, northeast and north along the Brazilian coast. The coastal vegetation of south and southeast occur in soil of Precambrian origin (Precambrian Crystalline Complex) and the occurrence of rocky cliffs and narrow beaches. Thus, the geological structure also influences the floristic composition of the *restinga* (Pereira and Araújo 2000; Matias and Nunes 2001). The distribution curve of individuals by diameter classes demonstrated an inverted “J” form, suggesting a regular distribution of those individuals (especially shrub species) and thus regular and continuous recruitment in the Maracaípe *restinga* area. The arboreal species *M. salzmannii*, *Tapirira guianensis*, *C. ensiformis*, *Guapira nitida*, *B. capitata*, and *Sloanea guianensis* were also present in almost all of the diameter classes, likewise indicating regular recruitment into their populations. Vicente et al. (2003) registered the presence of large individuals of *M. salzmannii*, *Anacardium occidentale*, *Byrsonima gardneriana* and *Protium bahianum* in the Ariquindá *restinga*, but with significant gaps in the diameter classes, possibly indicating environmental degradation.

Manilkara salzmannii (Sapotaceae) and *Protium heptaphyllum* (Burseraceae) were capable of developing large populations in these low fertility soils, a characteristic previously noted by Hay and Lacerda (1984). *Chamaecrista ensiformis*, one of the five species with the largest IV, dominance, and frequency, is frequently encountered in coastal areas from Maranhão to São Paulo, and also occurs in areas of *cerrado* vegetation (Irwin and Barneby, 1977).

The results of the soil analyses performed in *restinga* areas at Guadalupe (Cantarelli, 2003) and Ariquindá (Vicente et al., 2003) were similar and did not indicate the source of the difference between sites’ physiognomies, according to Cantarelli (2003). However, Lathwell and Grove (1986) observed that the chemical and physical characteristics of the soil are important in the selectivity of species, for interfering in the growth of plant parts. Lathwell and Grove (1986) highlighted the aluminum as it restricts the root growth and water use efficiency, interfering with the occupation of the species in some areas. Almeida et al. (2009), in a study of the flora and physiognomy of the phanerograms in the Maracaípe *restinga*, identified soil nutrients that were associated with different physiognomies. Thus, soils where there is an accumulation of water (marshy) tend to be more acidic (pH <7), which favors the development of a particular group of plants (Mohr Van Baren 1959). The release of ions Al, Fe and Mn, acids in soils, makes the soil with a low proportion of ions $Ca^{2\pm}$, $Mg^{2\pm}$, $K^{\pm}$ and PO_4^{-3} (Oleynik, 1980), as verified in Maracaípe *restinga* area. The unbalanced proportion of ions ($Ca^{2\pm}$, $Mg^{2\pm}$), in *restinga* area, can affect plant growth (Rosolem et al., 1984), contributing to a lower height of vegetation.

Silva and Somner (1984) found that woody plants thrive in areas with higher proportion of organic matter. Cestaro and Soares (2004) highlighted fertility, aluminum and water regime of soils as important elements to determine the differences floristic and structural vegetation. These data agree with this study, which indicated the organic material (O.M.) as one of the factors that contributed to the provision of tree species in forest physiognomy.

Studies indicate that water table contributes a factor of separating faces of the *restinga* (Sá, 1992; Almeida et al., 2009). However, for the community structure of the *restinga* Maracaípe, has not registered the influence of water table in the arrangement of plant populations.

The set of information obtained in this study suggests that certain soil nutrients had greater influence on the *restinga* forest to explain the changes observed in this community studied. However, further studies are needed to explain the distribution of species in relation to soil nutrients, and more analysis regarding the influence of water table in the population structure of *restingas*.

ACKNOWLEDGEMENTS

The authors would like to thank the CNPq for the grant awarded to the first author and for financing the project “Floristic, Anatomical and Ecological Aspects of *restinga* Vegetation in the *restinga* of the RPPN Nossa Senhora do Outeiro de Maracaípe, Ipojuca, Pernambuco”, process number 473974/03-2, coordinated by Dr. Carmen S. Zickel. The Licenciatura em Ciências Biológicas Group 2004.2 of the UFRPE, and especially Murielle Olivo, Patrícia Lima, Liliane Lima, Hellen White, and Natan Messias for their aid in the phytosociological survey.

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