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Floristic survey of the Caatinga in areas with different grazing intensities, Pernambuco, Northeast Brazil

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ABSTRACT

A floristic survey was conducted in eighteen areas in the municipalities of Itacuruba and Floresta, Pernambuco, northeast Brazil. The objective was to investigate if the species richness of terrestrial plant species of the Caatinga is affected by grazing intensity. Eighteen 20 × 20 m² plot were established in areas of low grazing intensity (9), and areas with high grazing intensity (9). We recorded 136 species belonging to 97 genera and 43 families. The most species-rich families were Poaceae (14), Fabaceae (13), and Asteraceae (11). The most species-rich genera were *Aristida* (Poaceae), *Sida* (Malvaceae) and *Ipomoea* (Convolvulaceae). The number of species in each study area (Itacuruba and Floresta) varied according to the distribution of the precipitation, the soil types, and the actual land-use. Areas with a low grazing pressure show a higher species richness of plant species than areas with a higher grazing intensity.

Keywords: anthropic pressure, land-use history, plant species richness, semiarid region.

Introduction

Brazil is the country with the largest area of tropical forests in the world. It also exhibits the highest biodiversity and with 43.902 species comprises the highest number of plant species of the world (Ribeiro & Walter, 1998; Barbosa & Peixoto, 2003; Forzza et al., 2012). Otherwise, the literature shows that in the tropical regions, rainforests have been more widely studied than dry forests, even though approximately 42% of tropical forests around the world are dry tropical ones (Murphy & Lugo, 1986; Miles et al., 2006; Quesada et al., 2009; Espírito-Santo et al., 2009; Santos et al., 2011).

The largest tropical dry forest of South America can be found in the northeast of Brazil. It is called Caatinga and covers about 70% of the northeast with an area of approximately 844.453 km² (MMA, 2014). The mean annual precipitation varies between 380 and 800 mm (Araújo et al., 2007). The Caatinga is characterized by shrubby and tree species, forming different assemblages of which many are practically unknown from an ecological point of view (Pereira et al., 2001). The vegetation of this region occurs to be non-continuous due to the high spatial and temporal variability of rain events. In general, the vegetation is characterized by xerophytic species as deciduous trees and shrubs of short stature, which often

exhibit thorns and spines and small leaves (Prado, 2003; Maracajá & Benevides, 2006). Giullieti et al. (2002) state that the Caatinga exhibits a high biodiversity and shows a considerable number of endemic species: 596 woody species are already recorded of which 180 are endemic to the Caatinga. Including the herbaceous species, this number will be much higher (EMBRAPA, 2005). Herbaceous species are annual and strongly depend on the rainy season (Silva et al., 2012; MMA, 2014). According to Silva et al. (2009), 587 herbaceous species can be registered only for the semiarid area of Pernambuco.

Many tree and herb species, which can be found in the Caatinga, are already studied regarding their economic value (Lucena et al., 2006). The tree species are important for the supply of timber and are used in the pharmaceutical and cosmetics industry. The herbs play a very important ecologic and economic role as they are used for medical purposes, apiculture and as livestock fodder.

In contrast to studies carried out in other vegetation types of Brazil, only recently the flora of the Caatinga was studied regarding the effect of grazing pressure (Schulz et al., 2016). However, studies about the effect of grazing show that goat breeding is one of the main reasons for degradation in the arid areas of the world (Oba, 1998; Carmel & Kadmon, 1999). Rook & Tailowin (2003) affirm that grazing has an important impact on the dynamic of this vegetation type. The herbivory, mainly of domestic and wild ungulates, is known to influence vegetation (Huntly, 1991; Milchunas & Lauenrith, 1993; Vavra et al., 2007) due to processes related to competitive abilities, which change density and frequency of the plants involved (Dias Filho et al., 2008).

The effect of herbivory on the vegetation may be both direct and indirect. The direct effects are caused by the consumption of plant biomass.

Immediately as a consequence of reduced leaf area and mass of leaves and roots, the rate of CO_2 sequestration and the absorption of water and nutrients decrease. The indirect effects are a result of the change in the soil properties, the microclimate, nutrient cycles and competition between plants.

Santos et al. (2014) highlight the importance of carrying out more studies to understand the influence of climatic changes on Caatinga vegetation and ecosystem services to better manage the resources by implementing socioenvironmental policies, engaging the local population and providing subsidies for life wealth improvement. These are key aspects of a long-term recovery and conservation of the Brazilian dry tropical forest.

This study has the main goal to compare how the vegetation structure changes under different pressure of herbivory in areas with high and low grazing intensities at Caatinga.

Material and Methods

Study area

The floristic inventory was carried out on eighteen areas divided in nine areas with high and nine with low grazing intensity, located in the two municipalities of Floresta and Itacuruba. The grazing pressure was classified according to the farm owner information of the number of domestic animals (goats, sheep, cows, and donkeys) present in the area.

The study area is located in the mesoregion of São Francisco at Pernambuco, adjacent to the Itaparica Reservoir. The altitude asl. ranges between 300 and 1.050 m. According to the classification of Köppen (1948), the study area belongs to the climate type BSs'h', with mean annual temperatures of 25,8°C and monthly temperature up to 33,9°C (Fig 1). The mean annual precipitation is 623 mm (Embrapa, 2001).

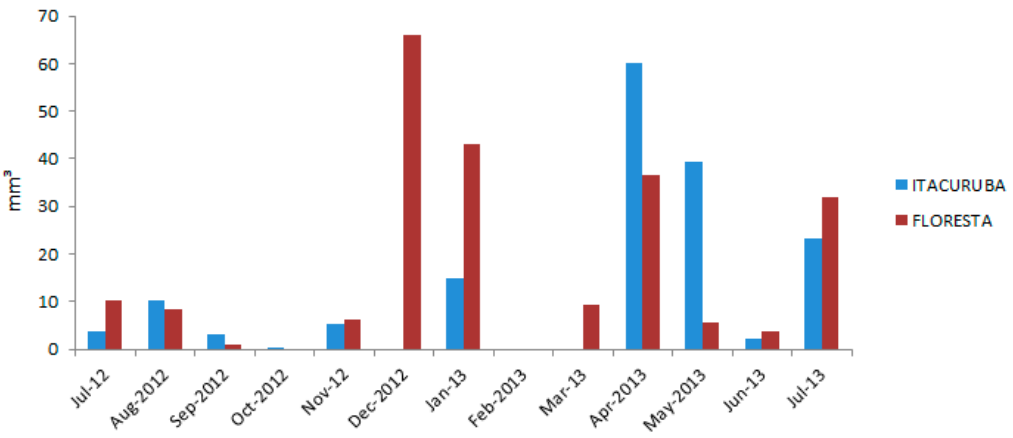

Figure 1. Monthly rainfall precipitations in 2012 and 2013. The months highlighted represent the period of sampling of herbaceous species in the study areas in the municipalities of Forest and Itacuruba.

Inventory of woody species, bromeliads, cacti, and herbs

A permanent plot measuring 20 m × 20 m was established in each of the eighteen areas. On each plot, plant diversity was assessed by carrying out vegetation relevés according to the methodology of Braun-Blanquet. Fertile branches, flowers, and leaf material were collected for plant identification. Plant identification was carried out in cooperation with the herbarium Dardano de Andrade of the Instituto Agronômico de Pernambuco (IPA), Recife, and followed Cronquist (1988) and APG III classification. The voucher material is deposited at the herbarium Dárdano de Andrade Lima (IPA) and Technische Universität Berlin. Some species did not have sufficient material to proceed the identification, probably caused by a huge drought in the years of the studies.

Table 1. The list of species classified as woody species (W), bromeliads (B), cactus (C) and herbs (H) harvested at high (HP) and low pressure (LP) of livestock herbivory in areas with different land use at de Floresta e Itacuruba, Pernambuco.

Family	**Species**	**HP**	**LP**	
Alismataceae	*Echinodorus lanceolatus* Rataj	X	-	H
Amarantaceae	*Alternanhtera tenella* Colla	-	X	H
	Amaranthus viridis L.	-	X	H
	Froelichia humboldtiana (Roem. & Schult.) Seub.	-	X	H
	Gomphrena demissa Mart.	X	X	H
Anacardiaceae	*Astronium urundeuva* Engl.	-	X	W
	Commiphora leptoploeos (Mart.) J. B. Gillett	-	X	W
Apocynaceae	*Aspidosperma pyrifolium* Mart.	X	X	W
Asteraceae	*Bidens pilosa* L.	-	X	H
	Blainvillea acmella (L.) Philipson	-	X	H
	Centratherum punctatum Caas.	X	X	H
	Eclipta prostrata (L.) L.	X	X	H
	Emilia forbergii Nicolson	X	-	H
	Emilia sonchifolia (L.) DC. ex Wight	X	-	H
	Lagascea mollis Cav.	X	X	H
	Pectis linifolia L.	X	X	H
	Pectis oligocephala (Gardner) Sch.Bip.	-	X	H
	Solidago chilensis Mexer	-	X	H
	Tridax procumbens L.	X	X	H
Boraginaceae	*Cordia leucocephala* Moric	X	X	W
	Heliotropium procumbens Mill.	-	X	H/W
	Heliotropium ternatum Vahl.	-	X	W
Bromeliaceae	*Bromelia laciniosa* Mart. Ex. Schultes f.	X	-	B
	Encholirium spectabile Martius ex Schultes & Schultes f	X	X	B
	Neoglaziovia variegata (Arruda) Mez.	X	X	B
Cactaceae	*Cereus jamacaru* DC.	X	X	C/W
	Melocactus bahiensis (Britton & Rose) Luetzelb.*	-	X	C
	Melocactus zehntneride Britton & Rose	-	X	C
	Opuntia palmadora Britton & Rose	-	X	C
	Pilosocereus chrysostele (Vaupel) Byles & Gdrowley	X	-	C/W
	Pilosocereus gounellei F.A.C.Weber	X	X	C/W
	Tacinga inamoena Backeb	X	X	C
	Tacinga palmadora (Britton & Rose) N.P.Taylor & Stuppy	X	X	C
Capparaceae	*Cleome guianensis* Aubl.	-	X	H
	Cleome lanceolata (Mart. & Zucc.) Iltis	-	X	H

Celastraceae	*Maytenus rigida* Mart.	X	-	W
Commelinaceae	*Commelina erecta* L.	-	X	H
	Commelina obliqua Valh.	-	X	H
Convovulaceae	*Evolvulus frankenioides* Moric.	X	X	H
	Evolvulus glomeratus Nees & C. Mart.	X	X	H
	Ipomoea asarifolia Roem. & Schult.	-	X	H
	Ipomoea brasiliana Meisn	X	X	H
	Ipomoea longeramosa Choisy	-	X	H
	Ipomoea subrevoluta Choisy	X	-	H
	Jacquemontia evolvuloides (Moric.) Meisn	X	X	H
	Jacquemontia racemosa Meisn	X	-	H
Cyperaceae	*Cyperus odoratus* L.	X	X	H
	Cyperus surinamensis Rottb.	X	X	H
	Lipocarpha micrantha (Vahl.) G. C. Tucker	X	X	H
Gentianaceae	*Schultesia guianensis* (Aubl.) Malme	-	X	H
Euphorbiaceae	*Chamaesyce hirta* (L.) Millsp.	X	X	H
	Chamaesyce thymifolia (L.) Millsp.	X	X	H
	Cnidoscolus quercifolius Pohl	X	X	W
	Croton cordiifolius Baill.	-	X	W
	Croton heliotropiifolius Kunth.	-	X	W
	Croton hirtus L.	-	X	H
	Jatropha mollissima (Pohl) Baill.	X	X	W
	Jatropha ribifolia (Pohl) Baill.	-	X	W
Fabaceae	*Anadenanthera colubrina* var. *cebil* (Griseb.) Altschul.	-	X	W
	Bauhinia cheilantha (Bong.) Steud.	X	-	W
	Caesalpinia ferrea C. Mart.	X	-	W
	Caesalpinia microphylla G. Don.	X	-	W
	Indigofera suffruticosa Mill.	X	X	H/W
	Mimosa tenuiflora (Willd.) Poir.	X	X	W
	Neptunia plena (L.) Benth	X	X	H
	Phyllanthus heteradenius Müll. Arg	X	-	H
	Poincianella pyramidalis Tul.	X	X	W
	Prosopis juliflora (Sw.) DC.	X	X	W
	Senna obtusifolia (L.) H.S.Irwin & Barneby	-	X	H
	Stylosanthes scabra Vogel	X	-	H/W
	Zornia brasiliensis Vogel	X	-	H
Hydroleaceae	*Hydrolea spinosa* L.	-	X	H
Lamiaceae	*Hyptis suaveolens* (L.) Poit	X	-	H/W
	Marsypianthes chamaedry (Vahl) Kuntze	-	X	H
	Ocimum campechianum Mill.	-	X	H
Loganiaceae	*Spigelia polystachya* Klotzsch ex Prog.	-	X	H
Lytraceae	*Ammannia auriculata* Willd	X	X	H
	Cuphea campestres (Mart.) Koehne	-	X	H/W
Malvaceae	*Herissantia tiubae* (K. Schum.) Brit.	X	-	W
	Pavonia cancellata (L.) Cav.	-	X	H/W
	Sida cordifolia L.	X	X	H/W

	Sida galheirensis Ulbr.	X	X	H/W
	Sida harleyi Krapov	-	X	H/W
	Sida spinosa L.	-	X	H
Molluginaceae	*Mollugo verticillata* L.	X	X	H
Nyctaginaceae	*Boerhavia diffusa* L.	X	X	H
Onagraceae	*Ludwigia octovalvis* (Jacq.) P.H. Raven	-	X	H
Phytolaccaceae	*Microtea paniculata* Moq	X	X	H
Poaceae	*Anthephora hermaphrodita* (L.) Kuntze	X	X	H
	Aristida adscensionis L.	X	X	H
	Aristida elliptica (Nees) Kunth	X	X	H
	Aristida longifolia Trin.	X	X	H
	Aristida megapotamica Spreng.	X	X	H
	Aristida setifolia Kunth	X	X	H
	Eragrostis amabilis (L.) Wight & Arn	X	X	H
	Eragrostis ciliaris (L.) R. Br.	X	X	H
	Eragrostis pilosa (L.) P. Beauv	X	X	H
	Melinis repens (Willd.) Zizka	X	X	H
	Neesiochloa barbata (Nees) Pilger	X	X	H
	Paspalum sp.1	-	X	H
	Paspalum sp.2	X	-	H
	Tragus berteronianus Schult	X	X	H
Polygalaceae	*Polygala brizoides* A. St.-Hil. & Moq.	X	X	H
Portulacaceae	*Portulaca elatior* Mart.	X	X	H
	Portulaca oleracea L.	-	X	H
Plumbaginaceae	*Plumbago scandens* L.	-	X	W
Rhamnaceae	*Crumenaria decumbens* Mart.	-	X	H/W
	Ziziphus joazeiro Mart.	-	X	W
Rubiaceae	*Borreria scabiosoides* Cham. & Schltdl	X	X	W
	Diodia apiculata (Willd. ex Roem. & Schult.) K.Schum.	X	X	H/W
	Diodia teres Walt.	X	X	H/W
	Mitracarpus longicalyx E.B.Souza & M.F.Sales	-	X	H/W
	Richardia grandiflora (Cham. & Schltdl.) Steud.	-	X	H
	Staelia aurea K. Schum.	X	X	H
Sapotaceae	*Sideroxylon obtusifolium* (Roem. & Schult.) T.D.Penn.	X	-	W
Selaginellaceae	*Selaginella convoluta* (Arn.) Spring	X	X	H
	Selaginella sellowii Hier	X	-	H
Schrophulariaceae	*Angelonia campestris* Nees & Mart.	-	X	H/W
	Angelonia gardneri Hook.	-	X	H/W
	Scoparia ducis L.	X	-	H
	Stemodia foliosa Benth.	-	X	W
	Stemodia maritima L.	X	-	H
Solanaceae	*Datura stramonium* L.	-	X	H/W
	Nicotiana glauca R. Grah	-	X	W
	Physalis angulata L.	-	X	H
	Physalis neesiana Sendtn.	-	X	H
Sterculiaceae	*Waltheria cf. indica* L.	X	X	H
	Waltheria rotundifolia Schrank	X	X	H

Tiliaceae	*Corchorus hirtus* L.	-	X	H
Turneraceae	*Piriqueta cistoides* (L.) Griseb.	X	X	H
	Piriqueta guianensis N.E.Br.	X	X	H
	Turnera pumilea Poir.	X	X	H
	Turnera subulata Sm.	X	X	H
Verbenaceae	*Lantana camara* L.	X	X	W
	Stachytarpheta sanguinea Mart. ex Schauer	-	X	H
Violaceae	*Hybanthus arenarius* Ule	-	X	H
	Hybanthus calciolaria (L.) Oken	X	-	H
Zygophilaceae	*Tribulus terrestris* L.	X	-	H

Results

The floristic inventory of woody species, cacti, bromeliads, and herbs registered 43 families, 97 genera, and 136 species in the studies areas at municipalities of Itacuruba and Floresta (Table 1). The most species-rich families were Poaceae (14), Fabaceae (13), Asteraceae (11), Euphorbiaceae (8) and Convolvulaceae (8). The most species-rich genera were: *Aristida* (Poaceae) with five species, followed by *Sida* (Malvaceae) and *Ipomoea* (Convolvulaceae) with four species each and *Eragrostis* (Poaceae) with three species.

Twenty-five tree species were recorded out of twelve families. Fifty-two herb species were recorded in the studies areas of Floresta, that represents 38,3% of the total species number collected during the survey. Cacti were represented by five generea and eight species, and bromeliads by three genera and three species: *Bromelia laciniosa* (a species endemic to the Caatinga); *Encholirium spectabile* and *Neoglaziovia variegata.* Two fern species of the Selaginellaceae family were harvested. (Table 1).

Fifty-five species were found in both municipalities, which represents 41,9% of all herbaceous species. Twenty-seven herbaceous species were found in the areas located at municipality of Itacuruba, which represents 19,9%.

In the visited areas, twenty-three species were found in areas with high grazing pressure. Fifty-three species were found in the areas with a low grazing intensity. Sixty species were found in both grazing classes.

Discussion

Previously floristic survey was done by Souza et al. (2010) at the municipality of Floresta. The authors identified seventy-eight species, distributed within thirty-nine families. The most abundant families were Fabaceae (with thirteen genera and thirteen species), Euphorbiaceae (with six genera and eight species) and Asteraceae (with seven genera and seven species). The most abundant species were herbs with 43,6% of all recorded species, followed by trees (17,95%), subshrubs and shrubs (15,38%), vines (5,12%), hemiparasites (1,28%), and one rosette plant (1,28%).

Similar results were gained during this study, where most species were herbs (86%) and woody species represented 14%.

Accordingly, the highest richness was observed in herbs species when comparing woody and non-woody species, corroborating previously studies done in different land use (Barbosa et al., 2003; Araújo et al., 2005; Rodal et al., 2005).

Silva et al. (2009) found ninety-five herbaceous species belonging to seventy-five genera and thirty-nine families on crystalline and sedimentary soils in Petrolândia, Pernambuco. The species of the families Poaceae, Euphorbiaceae, Asteraceae, Capparaceae, Convolvulaceae, Cyperaceae, Fabaceae, and Malvaceae were found in areas with sedimentary soils. The families Poaceae, Euphorbiaceae, Convolvulaceae, Portulacaceae, Bromeliaceae, Malvaceae, and Rubiaceae were found in areas with crystalline soils. Together they accounted for 49% of the total species number. These results are similar to the results found in our study. However, results differ for the families Fabaceae, Capparaceae, Portulacaceae, Bromeliaceae and Cyperaceae which in our study were present with two to three species. We may have distinguished species of the families Poaceae, Euphorbiaceae, Asteraceae, Capparaceae, Convolvulaceae, Cyperaceae, Fabaceae, Malvaceae as commonly occurring at the sedimentary soil region, from species of the families: Poaceae, Euphorbiaceae, Convolvulaceae, Portulacaceae, Bromeliaceae, Malvaceae, and Rubiaceae occurring at the crystalline soil region. Those species represent 49% of all species found by Silva et al. (2009). These results are very similar to our studies.

The floristic survey conducted by Silva et al. (2012) was carried out in an area of Caatinga, Crioulas, Ceará. The farmland involved is grazed by goats. Within a period of six months, thirty

herbaceous species were found, belonging to fifteen families. Benevides et al. (2007), studying two areas, one was characterized by anthropogenic use, the second one was preserved to some extent. In the used area, they found thirty-two herbaceous species belonging to sixteen families. In the preserved area they found twenty-seven species belonging to twenty families. In contrast to the study conducted by Benevides et al. (2007), we found a higher number of species in the area with low grazing pressure.

Areas with low grazing intensity were only found in the municipality of Floresta. When we compare high and low herbivory pressure area, we found a higher species richness in low grazing intensity areas. One explanation could be the effects of soil degradation by the animal which may add to the pasture effects. Accordingly, Schulz et al. (2016) showed that grazing at high intensities significantly reduced soil carbon stocks of the upper soil horizons. Further, goats are the most common livestock in this region, and this animal has a generalist habit, eating different parts of the plant from different species, even those presenting chemical and/or mechanical defenses as spines.

Conclusion

The number of species in each study area (Itacuruba and Floresta) varied according to the distribution of the precipitation, the soil types, and the actual land-use. Areas with a low grazing pressure showed a higher species richness of plant species than areas with a higher grazing intensity. This implies that an intense grazing may leads to a decrease in species number, and thus directly changes the composition of the herbaceous species community.

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