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Temporal Variation of Membracidae (Hemiptera: Auchenorrhyncha) Composition in Areas of Caatinga with Different Vegetation Structures

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Abstract

The present study investigated the diversity of membracids in different Caatinga vegetation structures (preserved, intermediate and degraded) during dry and rainy seasons in 2006. We recorded 1,107 individuals, belonging to 13 species, mostly during the rainy season (693). *Melusinella nervosa*, *Enchenopa gracilis* and *E. eunicea* were the most abundant species, although this pattern varied in the three areas. *M. nervosa* and *E. gracilis* were the most abundant during the rainy and dry seasons, respectively. *Thrasymedes pallescens* was the species least affected by seasonality, with 51.3% and 48.7% of the specimens collected in the rainy and dry seasons, respectively. A cluster analysis showed that membracids from preserved areas in the dry season were more related to the ones from rainy season. Seasonality of membracids seems to be related to seasonal ecology and phenology of their host plants. Furthermore, preserved areas are very important for maintenance of membracids diversity during the dry season.

Introduction

The Caatinga, an exclusively Brazilian biome, is one of the largest seasonal savannas in the world, comprising about 800,000 km^2, and is represented by multiple types of forests, whose plants exhibit many structures adapted to the predominate climatic conditions (Sampaio, 1995; Prado, 2003). The Caatinga is among the most degraded and least studied ecosystems in Brazil. The causes of degradation are numerous; however, the most common include exploitation of wood for fuel and substitution of native vegetation with agricultural practices that have been inappropriate for hundreds of years (Velloso et al., 2002). Only about 30% of the Caatinga is considered a non-altered region, and this area is a sum of islands dispersed throughout the interior of the biome (MMA, 2002).

Striking weather patterns between seasons, mainly influenced by changes in rainfall and humidity, determine strong seasonality in the Caatinga. Rainfall varies from 240 mm to 1,500 mm with 50 to 70% of the total rain concentrated in three consecutive months (Prado, 2003). During the rainy season there is a substantial increase in plant biomass that provides resources for many different groups of insects such as the Hemiptera-Auchenorrhyncha, which become abundant under these conditions (Vasconcellos et al., 2010).

Phytophagous insects form bonds with their host plants (using them as site for reproduction, egg laying and food source) which are particularly vulnerable to fluctuations in variables such as humidity, nutrient availability, and plant cycle (Lawton, 1983). Changes in insect abundance indicate an increase or decrease in its primary resources or an alteration in habitat, or even in its natural enemies (Brown, 1997). Faunal diversity studies in the tropics and particularly for insects in the Caatinga have indicated that taxa reach higher indicators of diversity in environments with more complex vegetation structure (Lawton, 1983; Leal, 2003). Insect communities respond in different manners when inhabiting gradients of different proportions of

pioneer plants, different physiognomies of the same vegetation and/or different special verticality limits (Humphrey et al., 1999; Leal, 2003).

Membracids are phytophagous insects found on the softer parts of plants, and parts with the most exposure to sunlight, such as branches, inflorescences and fruits (Wood, 1993). From these parts, they suck plant sap and release honeydew, which attracts ants, with which they establish biological associations (Moreira & Del-Claro, 2005; Fagundes et al., 2013). They have varying degrees of host selectivity (Creão-Duarte et al., 2012), and some species have gregarious habits, and may form colonies with a significant number of nymphs and adults (Wood, 1993). However, in general, in most degraded environments there are changes in abundance status, marked by strong dominance of a few species (Lopes, 1995; Creão-Duarte et al., 2012).

Neotropical membracids have been predominantly studied from the taxonomic perspective and from the perspective of hymenopteras' mutualistic relationships (Moreira & Del-Claro, 2005; Fagundes et al., 2013). However, in studies surveying entomofauna they are always present (Yamamoto & Gravena, 2000; Hickel et al., 2001; Favretto et al., 2013). Colonial species are less active and easy to collect, their life cycles are closely related to the host plant, and they have a stable classification. These conditions make them potentially useful for conservation and monitoring of neotropical forests (Wood, 1993; Brown, 1997).

In this context, the present study investigated the diversity and abundance exhibited by membracid assemblies in different types of semi-arid vegetation structures in the Caatinga, during the dry and rainy seasons. We asked: (1) Do membracids seasonally explore host plants in this environment? (2) How abundant and diverse were the membracids throughout preserved, intermediate and degraded areas?

Material and Methods

This study was conducted in the Private Reserve for the Environmental Inheritance "Fazenda Almas", with an area of 3,500 ha in the municipality of São José dos Cordeiros, Paraíba, Brazil (7°28'45" S; 36°54'18" W). The reserve is located in the ecoregion "Depressão Sertaneja Setentrional", one of the areas most impacted by anthropic actions and characterized by irregular rainfall (historical average of 350 mm/year in the "Cariri Paraibano") (Velloso et al., 2002). The vegetation varies from open to dense arboreal Caatinga, with a strong deciduous characteristic during the dry season. The soil is sandy and arid with irregular topography, with inselbergs and rocky outcrops (Vasconcellos et al., 2010).

Three vegetation structures (preserved, intermediate and degraded) were defined for insect collection with bases on a phytosociological analysis of three 100 m^2 plots located nearly 1 km from each other. *Preserved*: N of trees = 23; height = 20.3±12.5 m; height at beginning of canopy = 5.2±1.8 m and canopy diameter = 2.7±1.2 m. *Intermediate*: N of trees = 5.5; height = 12.4±5.4 m; height at beginning of canopy = 3.4±1.9 m and canopy diameter = 2.9±2.1 m. *Degraded*: N of trees = 4.5; height = 2.8±0.3 m; height at beginning of canopy = 2.8±0.3 m and canopy diameter = 1.5±0.3 m.

Two collections were conducted within each vegetation structure, one during the rainy period (April 2006) and the other during the dry period (September 2006), with a significant variation in rainfall (Fig 1), totaling six collections. The method of active collection (both sweeping and direct collection into collection bottle) was used to capture adults. Random walking and observation of host plants parts (leaves, branches, inflorescences and fruits) were conducted for 6 hours per area during each period (rainy and dry), totaling 36 hours of observation. For species already represented within the collections we only registered the species and number of individuals. The collected membracids were incorporated into the Entomological Collection of the Department of Ecology and Systematics (DSEC) of the Federal University of Paraíba (UFPB).

The cluster analysis calculates the abundance data for each species per area per period using UPGMA method, as well as Bray-Curtis similarity index, with the software PAST (Hammer et al., 2001).

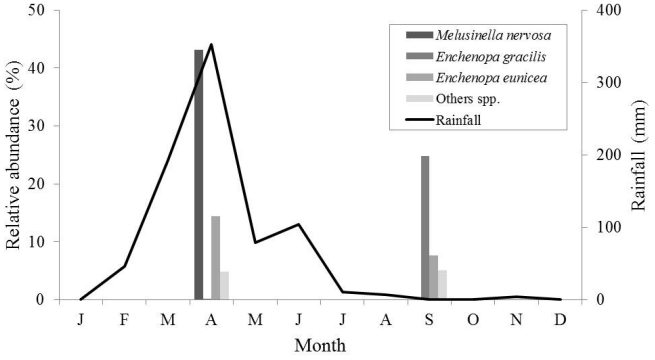

Fig 1. Monthly rainfall variation (mm) and relative membracid abundance (%) collected in São José dos Cordeiros, Paraíba in 2006 (Source: AESA).

Results

A total of 1,107 membracids were recorded, distributed into 11 genera and 13 species (Table 1). *Melusinella nervosa* (Fairmaire, 1846) (43.18%), *Enchenopa gracilis* (Germar, 1821) (24.84%) and *Enchenopa euniceae* Rothéa & Creão-Duarte, 2006 (22.04%) were the most abundant species, while the other species together amounted to only 9.94% of the total (Table 1, Fig 1). The number of individuals collected during the rainy season (N=693 from 10 species) was 67.4% greater than the number of individuals collected during the dry period (N=414 from 8 species).

M. nervosa and *E. gracilis* showed strong seasonality, the first more present during the rainy season and the second during the dry season. *Trasymedes pallescens* (Stål, 1896) was the species less subjected to seasonality with 51% and 49% of individuals collected during the rainy and dry period, respectively. *E. euniceae* was well represented in almost all

Table 1. Membracids collected in three areas with different vegetation structures in the Caatinga (P, preserved; I, intermediate; D, degraded) during the rainy and dry periods of 2006 in São José dos Cordeiros, Paraíba, Brazil.

Species	Rainy Period				Dry Period				Total	
	P	I	D	Total	P	I	D	Total	N	%
Melusinella nervosa	167	234	77	478	-	-	-	-	478	43.18
Enchenopa gracilis	1	-	-	1	3	150	121	274	275	24.84
Enchenopa euniceae	11	117	32	160	31	51	2	84	244	22.04
Thrasymedes pallescens	20	13	6	39	37	-	-	37	76	6.87
Enchenopa minuta	2	-	-	2	4	11	-	15	17	1.54
Sundarion flavum	2	-	3	5	1	-	-	1	6	0.54
Erosne parvula	-	2	2	4	-	-	-	-	4	0.36
Micrutalis binaria	-	-	2	2	-	-	-	-	2	0.18
Ceresa ustulata	-	-	-	-	-	-	1	1	1	0.09
Darnis olivacea	-	1	-	1	-	-	-	-	1	0.09
Tolania sp.	-	-	-	-	1	-	-	1	1	0.09
Amastris sp.	-	-	-	-	-	-	1	1	1	0.09
Phylia sp.	1	-	-	1	-	-	-	-	1	0.09
Individuals/area	204	367	122	693	77	212	125	414	1,107	100
Species/area	7	5	6	10	6	3	4	8		

areas during both seasons; the exception was in the degraded area during the dry season. *Melusinella nervosa* was found in large quantities in the three vegetation profiles during the rainy season. On the other hand, *E. gracilis* was associated in large quantities only to intermediate and degraded areas during the dry season.

According the cluster analysis, during the rainy season membracids from different vegetation structures are relatively similar (more than 60% similarity); on the other hand, during the dry season they are different, where the Degraded and Intermediate areas during this period have a very low similarity when compared with others (Fig 2).

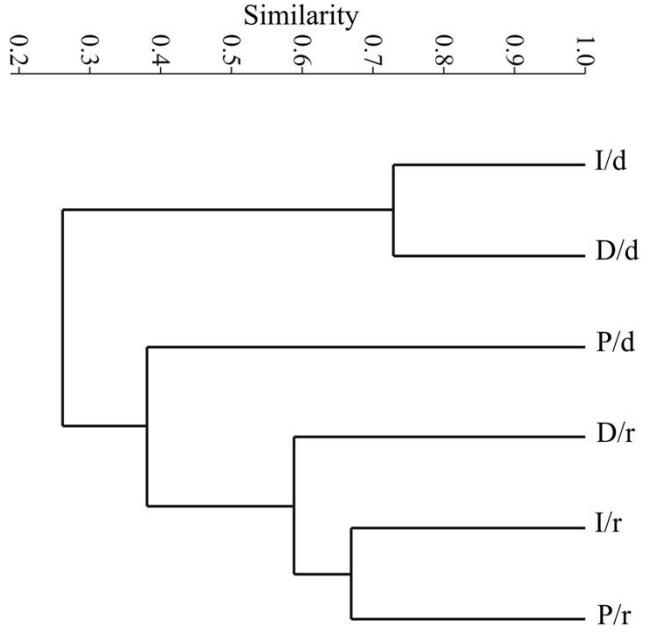

Fig 2. Similarity between areas/periods in function of the collected membracids in São José dos Cordeiros, Paraíba in 2006 (area: P, preserved; I, intermediate; D, degraded; period: r, rainy; d, dry).

Discussion

The seasonality of *M. nervosa* and *E. gracilis* was due to seasonal ecology and phenology of the species primary host plants, respectively, *Sida galheirensis* Ulbr. and *Indigofera suffruticosa* Mill. (Creão-Duarte et al., 2012), but also probably due to the reproductive cycle of the membracids (Wallace & Maloney, 2010). On the other hand, *T. pallescens* was the species less subjected because it is found exclusively on *Caesalpinia pyramidalis* Tul., arboreal plant that can remain green during periods of less rigorous droughts (Creão-Duarte et al., 2012). Similarly, *E. euniceae* was well represented in both seasons due to the perenniality of its main host plants *Mimosa tenuiflora* (Wild.) Poir. and *Mimosa ophthalmocentra* Mart. ex Benth. (Creão-Duarte et al., 2012).

The increase in plant biomass during the rainy season represents an increase in resources for many insects in the Caatinga (Vasconcellos et al., 2010). During these periods, plant diversity in the intermediate and degraded areas increases with the emergence of numerous herbaceous species within the open spaces (Reis et al., 2006; Santos et al., 2013) and, thus, increases the resource supply to be exploited by the membracid community. The effects of seasonality on entomofauna, principally rainfall and humidity as the main predictors of abundance has already been observed in Isoptera (Moura et al., 2006), Diptera (Alves et al., 2014), Coleoptera (Santos et al., 2014a), Hymenoptera (Santos et al. 2014b), Lepidoptera (Gusmão & Creão-Duarte, 2004) and other orders (Vasconcellos et al., 2010). However, for membracids this pattern has not been directly observed since they heavily rely on the cycle of their host plants (Wood, 1993; Creão-Duarte et al., 2012).

The cluster analysis allows us to deduce that the climate is primarily responsible for the difference between the

assemblies of the various areas. However, it is interesting to note that the climate did not affect the preserved area as much, since membracids in this area during the dry season appear more related to those of the rainy season. Thus, underscoring the importance of preserved areas for the conservation of membracid species (especially *T. pallescens*) during the dry period, which is a limiting factor for those assemblies in the semiarid region.

During the dry season plants from intermediate and degraded areas suffer climate effects earlier, since the vegetation structure is composed mostly of herbaceous plants that soon lose their leaves and cease to house their guests, membracids. Where as in the preserved areas plants are larger and take longer to relay the effects of the drought, and thus can accommodate membracids for a longer period of time (Lima & Rodal, 2010; Creão-Duarte et al., 2012).

Brown (1997) includes the Membracidae in the group of insects that are potential indicators for conservation and monitoring, in order to promote sustainable use of tropical forests due to the strong association of membracids with their host plants (Wood, 1993). These floras respond to environmental disturbances (Andrade et al., 2005), as well as climate change (Reis et al., 2006; Lima & Rodal, 2010). Diversity analysis of these insects, as observed, can provide answers strongly related to the environment in the Brazilian semiarid region. In this context, *E. gracilis* can be a good indicator of disturbance, since its main host plant, *I. suffruticosa*, is an invasive species with little demands that sprouts in any type of soil, and may also be common in dry and disturbed areas in Northeastern Brazil (Salvador et al., 2010; Creão-Duarte et al., 2012).

In conclusion, seasonality of membracids in Caatinga seems to be closely related to seasonal life cycle of their host plants. Furthermore, preserved areas kept a great richness during the dry season, highlighting the importance of these areas for maintenance of diversity of membracids.

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