



Mesofaunal arthropod diversity in shrub mangrove litter of Cozumel Island, Quintana Roo, México



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ABSTRACT

We studied the mesofaunal arthropod diversity in a shrub mangrove in the Punta Sur area within the National Park Reefs of Cozumel Island in the South of Mexico. Two mangrove areas were selected for sampling, dominated by *Rhizophora mangle* and *Avicennia nitida*, respectively. Four sampling periods, two during the dry season and two during the rainy season, and 25 random litter samples of litter (225 cm²) per site and date led to a total of 200 samples. Spatial and temporal variation of arthropod diversity was analyzed at the order/suborder level. A total of 90,680 arthropods belonging to 30 taxa were recorded during the study, Oribatida being most abundant with 61.8%, followed by springtails (14%). Densities of arthropods were higher in the rainy season than in the dry season, showing a strong positive correlation with humidity. Highest abundance was found in the *R. mangle* mangrove in the rainy season, and highest diversity was found in the *A. nitida* mangrove in the dry season. Seasonal distribution of litter fauna in two mangroves are related with the particular characteristics shown in each one.

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1. Introduction

Mangroves are ecosystems at the transition from the terrestrial to the marine habitat, characterized by strong spatial and temporal variations of factors such as inundation, salinity, temperature and oxygen. Compared to other environments, for example rain forests, mangroves show high productivity and low species richness (Duke et al., 1998), the latter because of the extreme fluctuations of environmental factors that require special adaptations of the species (Field et al., 1998; Whittaker et al., 2001). Only few plant families, e.g. Rhizophoraceae, Avicenniaceae and Combretaceae have developed physiological and structural adaptations, comprising about 50–70 species only, depending on different classifications (FAO, 2007). These trees are used as refuge for fungi (Kathiresan and Bingham, 2001), bacteria (Twilley et al., 1996), plants and animals

(Meades et al., 2002) with terrestrial, aquatic and/or semiaquatic habits. Fauna and flora in the mangroves are organized in complex trophic webs with interactions among aquatic (fishes), terrestrial (birds, mammals, reptiles, arthropods; Nagelkerken et al., 2008), and amphibiotic biota (crabs; Smith et al., 1991; insects, Moreno-Casasola and Infante, 2009; amphibians, reptiles; Nagelkerken et al., 2008; mollusks; Kathiresan and Bingham, 2001). Furthermore, the temporal and spatial variations of environmental factors are reflected in the temporal and spatial distribution of species, as it has been documented in ants of mangroves (Nielsen, 2011).

Throughout the world, about 10,000–240,000 km² of the tropical and subtropical littoral belt are mangroves (Moreno-Casasola and Infante, 2009; Giri et al., 2011), but these ecosystems are seriously endangered. In Mexico, according to data from 2008, there are 655,667 ha of mangroves, 55% of them located in the Yucatán Peninsula, and 16% alone in Quintana Roo State (Comisión Nacional de Biodiversidad, CONABIO, 2009). Here ca. 20% of this ecosystem have been destroyed in only 15 years, from 1986 to 2001, due to human population growth and the increase of tourism industry, ca. 20% of this ecosystem has been destroyed in Quintana Roo State in only 15 years, from 1986 to 2001 (Moreno-Casasola and Infante, 2009). The area has recently been recognized as a priority for conservation by the CONABIO, the Mexican National Commission of

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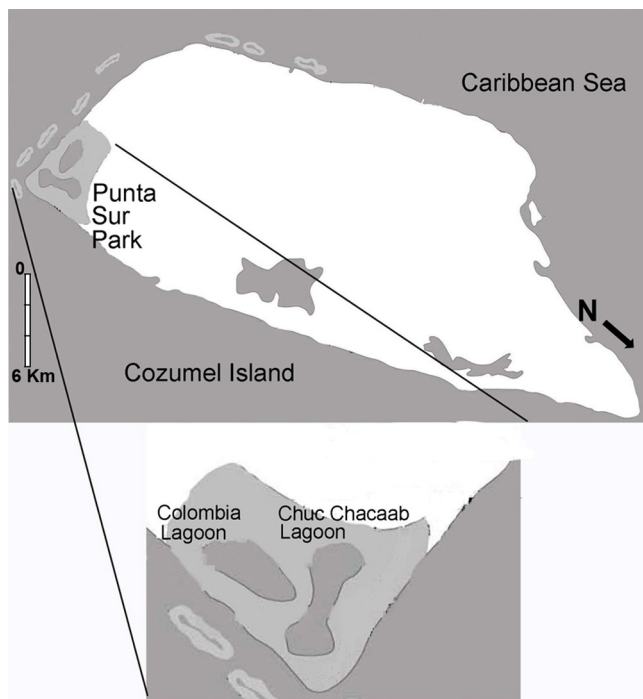


Fig. 1. Localization of studied lagoons at Punta Sur Park, Cozumel, México.

Biodiversity (CONABIO, 2009), nevertheless mangroves continue to be affected and reduced, even in protected areas such as Punta Sur, Cozumel.

Most studies on mesofauna of mangroves have focused on groups such as ants, larvae of dipterans and beetles (Twilley et al., 1996), copepods, mites, termites and springtails (Procheş et al., 2001; Nagelkerken et al., 2008). Very few ecological studies in Mexican mangroves are available (Dejean et al., 2003). The Quintana Roo mangroves in Chetumal have been investigated regarding physical and environmental aspects, α and β diversity of biota, and environmental protection (Espinoza-Ávalos et al., 2009), descriptions of new species of springtails (Thibaud and Palacios-Vargas, 2001), new records of springtails (Cutz-Pool and Vázquez-González, 2012), and records of ants and termites (Moreno-Casasola and Infante, 2009). Currently 28 species of springtails are known from mangroves in Cozumel (Cutz-Pool and Vázquez-González, 2012).

In the present study we analyze the seasonal and spatial variations in diversity of invertebrates in litter of mangroves from Cozumel Island. We compared two areas with different species of mangrove, one characterized by *Rhizophora mangle* (red mangrove) as the dominant trees species, the other characterized by *Avicennia nitida*, a species that on Cozumel Island replaces *Avicennia germinans* (black mangrove), usually present in Quintana Roo (Moreno-Casasola and Infante, 2009). Being a preliminary study we considered higher taxa levels. Studies focusing on conservation suggest that the higher taxon approach can be applied for conservation purposes in order to predict species richness (Gaston and Williams, 1993).

2. Materials and methods

2.1. Study area

Cozumel Island (20°30'N and 86°57'W) is located at the North-east of the Yucatán Peninsula. We studied two lagoons (Fig. 1) at the South of the Island, in the Punta Sur Ecological Park. The Colombia Lagoon (20°18.27'43"N, 87°00.43'47"W) to the east is dominated by *Rhizophora mangle* L.; the Chun Chacaab Lagoon to

Table 1

Characteristics between lagoons from Punta Sur, Cozumel.

	Colombia Lagoon	Chuc Chacaab Lagoon
Localization	20°18.27'43"N, 87°00.43'47"W	20°18.01'47"N, 87°00.39'71"W
Dominant tree	<i>Rhizophora mangle</i>	<i>Avicennia nitida</i>
Distance to the sea	20–25 m	45–50 m
Altitude	0.5–2.5	2–4
Dunes	Without	Several more than to 10 m high

the west (20°18.01'47"N, 87°00.39'71"W) is dominated by *A. nitida* Jacq. (Arriaga et al., 2000).

The area is colonized by dwarf mangrove (Moreno-Casasola and Infante, 2009). The limited growth of the mangrove trees is possibly due to the karstic bedrock which leads to low exchange rates of the water body (in terms of tidal influence and fresh water input) and produces calcium saturated water with few nutrients and shallow soils (López and Ezcurra, 2002). Each lagoon has particular characteristics, shown in Table 1. During the rainy season (June–December), both lagoons are connected; there are frequent hurricanes in the area with strong winds. In the dry season (January to May), Colombia Lagoon shows little influence of wave motion and the area is almost dry, while Chun Chacaab Lagoon shows a natural opening (between dunes) where the ocean water comes in and preserves the humidity in the area during the dry months. There is no sand in both lagoons, dunes in the East area excepted, and roots and pneumatophores of mangroves are on karstic rocks; only in the rainy season there is stagnant water. The dunes are a natural barrier to the entrance of marine water. The tidal range in the area is considered microtidal with a typical range of less than 20 cm (Kjerfve, 1981). There are no data about the pH in the studied area, but in wells of the urban zone of Cozumel, levels ranged from 7.5 to 8.7 (Coronado-Álvarez et al., 2011). Merino and Otero (1983) reported salinities at Puerto Morelos in the range of 36.8–32.3‰.

2.2. Sampling

Four expeditions were performed to Cozumel Island, in April, September and November 2011 and in March 2012. In each lagoon we selected five sites, and five samples of litter were taken per site. Each sampled surface was 225 cm². The depth of litter was about 2 cm in the area, accumulated between pneumatophores and the soil surface. Litter samples were stored in plastic boxes 10.5 cm × 10.5 cm × 5 cm (551 cm³). Sampling points were selected in one transect of 20 m, and by random number sampling points were obtained. A total of 25 samples were taken in each lagoon on each occasion, resulting in a total of 200 samples for the whole study. Data of temperature, relative humidity and CO₂ content were taken in each sampling point using a multimeter (IAQ-CALC 8760-M-NP).

Samples were carried to the Laboratorio de Ecología y Sistemática de Microartrópodos at Science Faculty, UNAM, and processed by Berlese funnels during six days, first three with natural light and the last three with a heat source (60 W bulb). The fauna obtained was fixed in 75% ethanol, counted and identified to the order and suborder level using a stereo-microscope. Specimens were identified to morphospecies level, however, the analysis presented here confines to order/suborder level. Further results concerning the species level will be presented elsewhere.

2.3. Statistical analyses

Shannon diversity index was calculated for site and sampling data, and comparisons were made by "t" student test and

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