Commented List of the Orchids of the El Cometa Lagoon,

Tabasco, México

Derio Antonio Jiménez López
Instituto de Ciencias Biológicas, Universidad de Ciencias y Artes de Chiapas. Libramiento norte poniente 1150, Col. Lajas Maciel, 29039, Tuxtla Gutiérrez, Chiapas, México. derio.a@hotmail.com

Marco Antonio Domínguez Vázquez
Instituto de Ciencias Biológicas, Universidad de Ciencias y Artes de Chiapas. Libramiento norte poniente 1150, Col. Lajas Maciel, 29039, Tuxtla Gutiérrez, Chiapas, México.

Summary: We present a list of orchids for the El Cometa lagoon, a *mangal* area of great biological and economic importance, but that has been scarcely studied. The purpose of this work is to contribute to the knowledge of the richness of orchids in this region of Tabasco, Mexico. The list was drawn from field work trips realized between 2014 and 2016. A list of eight genera and nine species was obtained, most of which are widely distributed in the neotropics. The richness of orchids is low compared to other types of vegetation. Knowledge of floristic listings in mangrove ecosystems is important for their conservation and rational use.

Key words: biodiversity, floristic, Pantanos de Centla Biosphere Reserve, mangroves; Orchidaceae

Introduction

The Orchidaceae family is one of the most diverse groups of angiosperms in the world, reaching around 28,000 species (Chase *et al.*, 2015, Christenhusz and Byng, 2016). In Mexico there are 1266 species distributed in 166 genera, of which 60% are epiphytes (Soto-Arenas *et al.*, 2007), and the third family with the highest species richness, surpassed by the families Asteraceae and Fabaceae (Villaseñor, 2016). For the state of Tabasco, the knowledge of the orchid flora comes basically from the floristic listings of Guadarrama-Olivera and Ortiz-Gil (2000), Diaz-Jiménez (2010) and Noguera-Savelli and Cetzal-Ix (2014), in which 58 genera, 109 species and one variety are reported. Of the total number of species, eight are distributed in the mangrove ecosystem (Noguera-Savelli and Cetzal-Ix, 2014).

The *mangal* is characterized by a vegetation type where high salinity conditions are present, dominated by low dissolved oxygen content that limits the permanence of other plant families, as is the case of epiphytic orchids, uncommon in the mangrove ecosystems (Rodríguez-Zúñiga *et al.*, 2013). In Mexico, 14 families, 51 genera and 146 species of vascular epiphytes are reported in mangroves (Carmona-Díaz and Hernández-Carmona, 2015).

However, there have been no studies specifically aimed at determining the orchid richness in the mangroves of the Pantanos de Centla Biosphere Reserve and, therefore, the diversity and distribution of the orchids in this place is little known. The objective of this study is to document the richness of orchids found in the El Cometa lagoon in the state of Tabasco, in order to contribute to the orchidological knowledge of this unexplored area.

Materials and methods

Study area

The work was carried out in the Laguna El Cometa (Figure 1), located within the Pantanos de Centla Biosphere Reserve, in the northeastern state of Tabasco, Mexico, which covers an area of 302,706 hectares. The lagoon is between the coordinates 17 ° 57′ and 18 ° 39′N and 92 ° 06′ and 92 ° 47′W (INE, 2000). It is located in the Grijalva-Usumacinta hydrological region (Bautista-Jiménez *et al.*, 2000). Rainfall in the region is 1693 mm per year, with most falling during the months of June to October. The average annual temperature is 27 ° C (Kauffman *et al.*, 2016). The dominant vegetation type in this ecosystem is mangrove or *mangal* Tomlinson (2016), dominated by *Rhizophora mangle* L., mixed with medium subperennifolia forest of *Bucida buceras* or pukteal (Miranda and Hernández X, 1963). For this study we refer to mangrove as the ecosystem of tropical trees restricted to intertidal communities, adjacent or subject to indirect influence of tides, and "*mangal*" as a term for the community or vegetation containing mangrove plants (Tomlinson, 2016).

Field work

Three field trips were made, two in 2014, seven and ten days respectively. The second, in 2016 was 23 days. During that time, 20 plots of 50 × 25 mt (1250 m2) were established with a minimum distance of at least 100 mt between collection sites, randomly distributed around the lagoon (modified by Flores-Palacios and García-Franco, 2006, 2008).

Individuals were collected from trees (phorophytes) that had a DAB (diameter at breast height) ≥10 cm due to a correlation between phorophytes size and epiphyte richness (modified from Cach-Pérez *et al.* , 2013). We collected from one to three individuals with a reproductive structure - flower or fruit - and thus have sufficient material for their identification, taking into account that in most cases the identification at the species level in the Orchidaceae family is based

on their reproductive system structures. Without these, their determination may be imprecise (Hagsater *et al.*, 1996; Cano-Busquets, 2012). When the orchids did not present these structures, alive specimens were collected, which were kept in nursery conditions until they reached flowering, for later identification and preparation for herbarium. In addition, individuals were photographed in their habitat during the flowering season. This allowed us to count on photographic material of the majority of the species (Pérez-Bravo *et al.*, 2010).

Taxonomic identification
The collected material was prepared for herbarium conservation according to conventional techniques (Lot and Chiang, 1986) and deposited in the herbarium (HEM) of the University of Sciences and Arts of Chiapas. The taxonomic determination of the specimens was carried out using dichotomous keys of the orchids of Mexico, specialized literature and consultations to specialists. The species list presented is generally adjusted to the system proposed by Chase *et al.* (2015) and follows the synonymy proposed in tropicos.org (http://www.topicos.org).

Sampling effort
A curve of species accumulation was developed (Gotelli and Colwell, 2001), based on the theoretical assumption that the collection effort performed for each sampling unit was the maximum (Yandi *et al.*, 2016). To predict the richness of each plot, we calculated the estimated richness with the non-parametric estimators Jacknife 1 and Chao 1. The first estimator is based on the number of species found only in one sample and does not assume environmental homogeneity, while Chao 1 estimator considers the number of rare species in the sample and takes into account the abundance by species (Carvajal-Cogollo and Urbina-Cardona, 2008), the StimateS version 9.1 program was used for these analyzes (Colwell, 2013).

Relative abundance
The relative abundance of phorophytes and epiphytic orchids was characterized by the proportion representing the number of individuals of each species relative to the total of individuals of all species. According to the following formula: Ar = (Ai / ΣA), where Ar is the relative abundance, Ai is the absolute abundance of the species i and ΣA is the total abundance of the species (modified by Uslar *et al.*, 2004).

Results

There were a total of 830 phorophytes, distributed in 12 species. Of these, only 66.5% showed epiphytic orchids. The most abundant phorophytes were *Rhizophora mangle* (316 individuals), followed by *Bucida buceras* (242) and *Pachira aquatica* (136). It was observed a low equity in the relative abundances of the species of phorophytes since only two species were highly abundant, followed by two that presented intermediate abundance, and four species low abundance (table 1).

Table 1. Species of Phorophytes with the presence of Orchids in the *mangal* of the laguna El Cometa, Tabasco, México.

Common Name	Specie	Abundance	Relative Abundance	Family
Puckté	*Bucida buceras* L.	242	0.29	Combretaceae
Icaco	*Chrysobalanus icaco* L.	4	0.005	Chrysobalanaceae

Common Name	Specie	Abundance	Relative Abundance	Family
Mangle blanco	*Laguncularia racemosa* L.	3	0.004	Combretaceae
Gusano de agua	*Lonchocarpus hondurensis* Benth.	116	0.14	Fabaceae
Zapote de agua	*Pachira aquatica* Aubl.	136	0.16	Malvaceae
Sin datos	*Pithecellobium longifolium* (Humb. & Bonpl. ex Willd.) Standl.	7	0.008	Fabaceae
Mangle rojo	*Rhizophora mangle* L.	316	0.38	Rhizophoraceae
Tabebuia	*Tabebuia rosea* (Bertol.) DC.	1	0.001	Bignoniaceae
Total		825		

A total of 282 individuals were registered, belonging to eight genera and nine species of orchids. *Trichocentrum* Poepp. & Endl. was the most diverse genus with two species (*Trichocentrum cosymbephorum and Trichocentrum sp*.). The remaining seven genera were represented by a single species. The most abundant species was *Myrmecophila tibicinis* (63 individuals), followed by *Trichocentrum cosymbephorum* (61) and *Notylia barkeri* (46). Like the phorophytes, there was a low equity in the relative abundances of orchid species; only four species were highly abundant, each representing more than twice the abundance of the other five species, which presented low abundance (Figure 2). Photographic material was obtained from six of the nine species found (Figure 3).

The species accumulation curve (spliced with the Chao 1 line) indicates that the sampling effort was adequate since the asymptote was reached. Two hundred eighty two (282) individuals distributed in nine species were recorded in 20 sampling plots. The representativeness of the inventory for species found was between 46% and 94% for the study area, according to the estimators used. The Jackknife 1 wealth estimator predicts 0.95 more species with the sampling effort performed, while the Chao 1 estimator does not predict more species, which would indicate that 99.05% of the assemblage was sampled. (Figure 4).

Discussion

Of the 20 plots analyzed (2.5 ha), the presence of epiphytic orchids was observed in only 10.48% of phorophytes, partially confirming the hypothesis about the low diversity of epiphytes in mangrove ecosystems compared to other types of vegetation. Lowland rainforest between 58-69 species in two plots of 0.15 ha (Hietz-Seifert *et al.*, 1996) and in mountain mesophilic forests (cloud forest) with 88-93 species in 0.32 ha in Veracruz (Krömer *Et al.*, 2014). However, comparing them with the two species in Yucatan mangroves, the epiphytes of the El Cometa lagoon are much more diverse. The main

difference with the study of Cach-Pérez *et al.* (2013) for Yucatan, is the size of trees sampled -1.5 mt maximum height- and in El Cometa trees reach an average of >17 mt, indicating the importance of high canopy cover to cushion the great variability of climatic conditions (Cach-Pérez *et al.*, 2013).

The diversity of vascular epiphytes in *mangales* of El Cometa lagoon may be negatively influenced by a hypersaline aquatic environment, which creates adverse conditions for the establishment of this group of plants (Villalobos-Zapata and Mendoza-Vega, 2010; Ong and Gong, 2013), high temperatures that generate high mortality of epiphytes in the canopy parts (Cach-Pérez *et al.*, 2013). On the other hand, the positive influence is evident because the epiphytic species that grow in this type of vegetation are highly tolerant to drought and resistant to the direct exposure of light, because of the height of the trees and consequently the canopy, that could be generating mortality in the upper parts but microclimatic benefits in the lower parts of the phorophytes (Giesen *et al.*, 2007, Krömer *et al.*, 2007, Cach-Pérez *et al.*, 2013). All this could explain its high diversity compared to other mangroves in Mexico.

The orchid diversity recorded for the study area represents 9% of the mangrove orchids of Mexico (Carmona-Díaz and Hernández-Carmona, 2015), 13.8% of the genera and 8.2% of the species of orchid flora of the state of Tabasco (Noguera-Savelli and Cetzal-Ix, 2014). The orchid flora of the El Cometa lagoon consists of species of wide distribution for the neotropics, only *Trichocentrum cosymbephorum* is endemic to Mexico, while the others are distributed in Central America and South America. Some of them, such as *Brassavola nodosa*, *Encyclia alata* and *Prosthechea boothiana* are also distributed in the Antilles, the latter also for North America. However, they are not restricted only to this type of vegetation, in Mexico they are distributed in dry tropical rainforests - deciduous tropical forest, thorn forest, tropical rainforests - evergreen tropical forest - and oak forests (see Rzedowski, 1978; 2005) at altitudes between <500 and >2000 masl, whereby they could have evolved to adapt to conditions of water stress in the lower parts, and excessive water and humidity in the upper parts. Some modifications are the pseudobulbs, the succulent leaves and the velamen (special epidermal cells that surround the root areas) that help to retain the accumulation of water in excessive water conditions and to absorb the greater amount under water stress conditions (Benzing, 1986 Petter *et al.*, 2016, Joca *et al.*, 2017).

Our first observations on the presence of epiphytic orchids indicate a greater succulence in leaves due to the high percentage of humidity and the high salinity present and also a myrmecophilic type association with several species of ants for protection from possible predators (Dejean and Olmsted, 1997).

Currently ca. 12.5 km2 of the studied area is covered with original vegetation, and although there is change of land use in the surroundings of the study area, in recent years it has decreased. The Puckté and red mangrove that are extracted for firewood and coal are the indirect factors that could be explaining some degree of diminution of the vascular epiphyte populations (Guerra-Martínez and Ochoa-Gaona, 2008). The fact is that villagers close to the study area rarely venture into the vegetation for the extraction of epiphytes in general, and specifically they do so to place the traps for shrimp extraction, suggesting that the local diversity of orchids are stable. Since the lagoon is within the Pantanos de Centla Biosphere Reserve, it could be inferred that it is little vulnerable to the anthropogenic effects of habitat modification or extraction (INE, 2000).

Thus, the risk factors for orchids are due to the loss and / or transformation of their habitat and the extraction of wild specimens for their trade for ceremonial purposes (Solano-Gómez *et al.*, 2007; Flores-Palacios and García -Franco, 2008,

Cruz-García *et al.*, 2015), which were not observed during the field collections.

Conclusions

Nine orchid species were found, most of which are widely distributed in the neotropics and found in other vegetation types. The characteristics of the mangrove ecosystem - hypersalinity, high humidity and insolation, and flooded soils most of the year - greatly diminish the diversity of orchids compared to other types of vegetation, but El Cometa hosts a great diversity of orchids among different types of mangroves in Mexico. Studies on the ecology of epiphyte groups are recommended to understand the dynamics of these in this type of ecosystem.

Acknowledgements: This study was supported by the Center for Global Change and Sustainability of the Southeast (CCGSS), through the project Challenges for Sustainability in the Usumacinta River Basin, Ecosystems, Climate Change and Social Response (FOMIX-TAB-2012-C28-194316). To Candelario Peralta-Carreta, Gerardo Cervantes, Jonathan Solórzano, Jorge Navarro-Ramos, Matías Hernández, Rubí Muñoz-Vázquez, Rene Roblero-Velasco and Edgar Shirma for their help in the field. To Alberto Gallardo Cruz for confiding and taking us to the Pantanos de Centla. To Marcos Alberto Escobar-Castellanos for providing the location map.

BIBLIOGRAPHIC REFERENCES AND PHOTO CREDIT

See spanish version.