

# Ecological Interactions in Epiphytic Orchids in the Archaeological Zone “El Tajín”, Papantla, Veracruz

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**Abstract:** Protected natural areas, as well as archeological zones are reservoirs of a region’s biodiversity, and the latter represent a legacy of local culture. In this sense, knowledge of the species present is essential to highlight their importance and ensure their conservation. We studied the diversity and ecological interactions of orchids (Orchidaceae) epiphytes in the archaeological zone “El Tajín”, municipality of Papantla, Veracruz, Mexico. From January 2015 to February 2016, the orchids species present their floral visitors, their phorophytes (hosts) as well as their vertical location in the trees were recorded. There were 202 colonies of *Lophiaris cosymbephorum*, 25 of *Oncidium sphacelatum* and eight of *Catasetum integerrimum*, distributed in 11 species of phorophytes. *L. cosymbephorum* was distributed in the five vertical strata, although with greater abundance in the outer part of the crown, on the contrary, *Catasetum integerrimum* was more frequent in the basal part of the trunk. Floral visitors were: crickets (Gryllidae), beetles (Curculionidae: Baridinae) and ants (Formicidae: Lasius niger), the latter with the highest number of visits. No pollinators were recorded, possibly due to anthropogenic disturbances around the archaeological zone.

**Key words:** floral visitors, phorophytes, lophiaris cosymbephorum, vertical stratification

## 1. Introduction

Epiphytes are plants that grow on trees (phorophytes) attached to trunks and branches. Among the most representative epiphytic families are Orchidaceae, Araceae, Piperaceae and Bromeliaceae [1]. The family Orchidaceae comprises about 30,000 species, in Mexico 1300 species are reported [2]. The seeds of the orchids are very small and light-weight which allows them to disperse long distances from their parent plants through the wind [3]. The orchids have aerial roots which have a special fabric (velamen) that captures rainwater, and during droughts this root is filled with air which acts as an insulator against heat and drying [4].

Orchids develop in a network of biological relationships which can be beneficial, antagonistic, or neutral to the individuals they interact with, thus they are related through ecological interactions [5]. Plant-insect interactions can be affected by anthropogenic disturbances which cause habitat loss, affecting the richness and abundance of various pollinators [6]. Under conditions of anthropic disturbance, protected natural areas serve as refuges because they are home to different species of flora and fauna. These areas are subject to special regimes of protection, conservation, restoration and development. Since archaeological zones are under protection, they are also considered fundamental for the conservation of different species of flora and fauna.

The Archaeological Zone of “El Tajín” served as a ceremonial center where the Totonaca culture

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developed. It stands out for being the largest ancient settlement on the northern coast of the Gulf of Mexico, which was discovered in 1785 [7]. Among the most important buildings in this area is the pyramid of the Niches which has 365 of them, so it has been associated with the solar calendar [8]. However, before being declared World Heritage in 1992 by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the archaeological zone of El Tajín and its surroundings (relics of Semievergreen forest) were disturbed by the inhabitants who settled there for housing purposes, using land for agriculture and livestock, in addition to extracting flora and fauna, and cutting down trees. After it was declared Cultural Patrimony of Humanity, a reforestation program was carried out in the gardens of the archaeological zone, these trees have been colonized by epiphytic plants.

Currently, the archaeological constructions of El Tajín are under the protection of the National Institute of Anthropology and History (INAH), while protecting the natural resources that are housed there. However, human settlements in its surroundings generate disturbances, impacting the scarce relics of Semievergreen forest and acahuales (secondary growth forest). Among the most affected flora are orchids, which are a fundamental element in the composition, structure and functionality of ecosystems. For example, the population of *Oncidium sphacelatum* has been affected since it is extracted for use in a traditional religious celebration. For this reason, the contribution made by the Archaeological Zone of El Tajín to the conservation of biodiversity is of great importance. This paper studied the diversity and ecological interactions in epiphytic orchids (Orchidaceae) in the “El Tajín” archaeological zone.

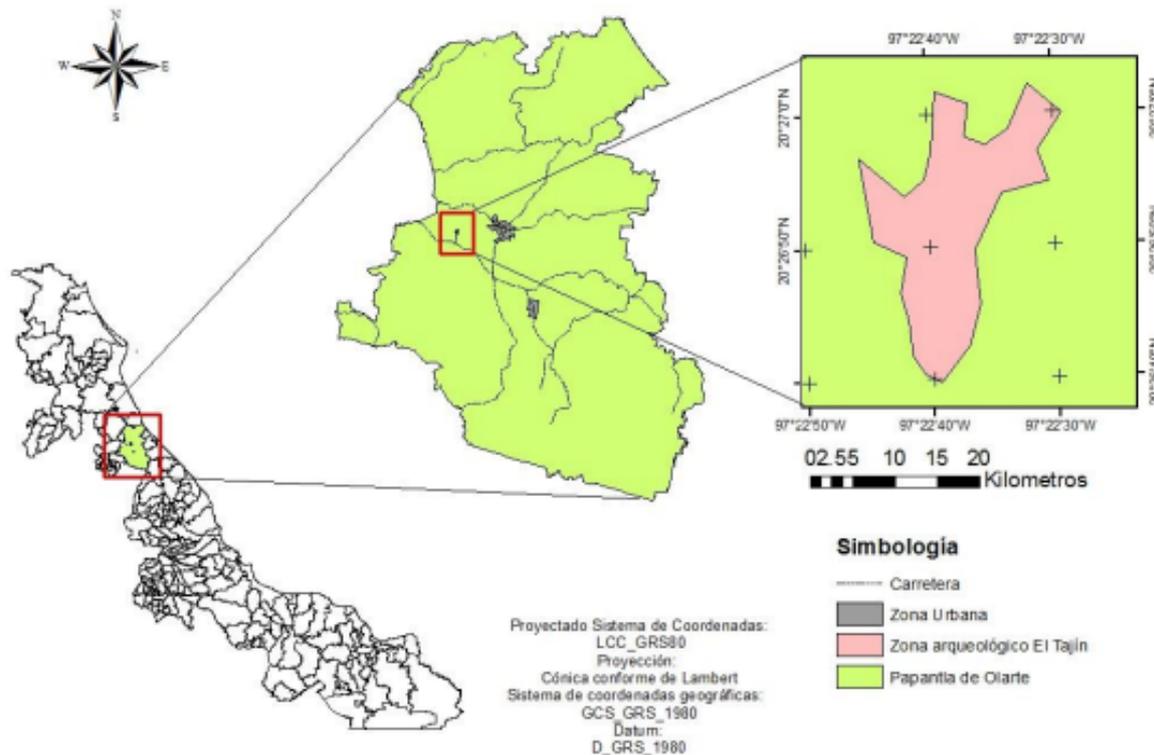


Fig. 1 “El Tajín” Archaeological Zone, Papantla, Veracruz, Mexico.

## 2. Materials and Methods

In the city of Papantla, Veracruz (Mexico) is located the ceremonial center El Tajín, area in which the

Totonaca culture was developed, and is considered one of the most important archaeological settlements in Mesoamerica. This zone has 168 buildings, distributed

in architectural complexes and constructions classified as ceremonial temples, ball games, and houses.

The first routes to identify orchid phorophytes were made in April 2015, the trees were located using a global positioning system (GPS). Phorophyte species were identified based on Niembro et al. [9]. Orchid specimens were later collected and deposited in the herbarium of the Mexican Association of Orchidology (AMO).

In order to analyze the distribution of the orchids over the phorophytes, each phorophyte with orchid presence was subdivided into the five vertical zones proposed by Johansson [10], and the number of colonies present for each orchid species was counted.

Observations of floral visitors were made on the species *Lophiaris cosymbephorum*, which was the most frequent species, with the highest number of reproductive individuals. We selected six orchids located in *Crescentia cujete*, the most abundant phorophyte and with most of the orchids in bloom. The observations were made in periods of 20 minutes each hour from 08:00 to 17:00, from November 2015 to February 2016. The following data were recorded in a field record: floral visitors, number of visits to the flower, duration of the visit and visitor behavior. Floral visitors were photographed and videotaped during their activity. Finally, two individuals were collected that were herborized and deposited in the AMO herbarium as a reference.

Revision of the species of orchids epiphytes between the archaeological zone and the surrounding vegetation.

A bibliographic investigation was carried out on the available information on the vegetation surrounding the Natural Protected Area El Tajín [11], in order to identify if the orchid species found in the study area are the same as those described in the management programs. Subsequently, to corroborate this information, 10 transects (10 × 5 m) were made in the surrounding vegetation (east acahual and west acahual) to record the orchid species present and compared the

species composition between the study area and the two secondary growth forests (acahuales).

### 3. Results and Discussion

#### 3.1 Phorophytes Associated with the Species of Orchids Epiphytes in the Area

In the present study we found 37 phorophytes with the presence of orchids (Table 1). The phorophyte with the highest orchid abundance was *Parmentiera edulis* with 63 colonies of *L. cosymbephorum*, unlike *Manilkara zapota* and *Bauhinia divaricata* with one individual each. A previous study “The environment of El Tajín” [11], reported the tree species *Parmentiera edulis*, *Swietenia macrophylla*, *Manilkara zapota*, *Guazuma ulmifolia*, *Spondias purpurea*, *Crescentia cujete* to mention a few. And for the acahuales (surrounding area) *Guazuma ulmifolia*, *Pimienta dioica*, *Bauhinia divaricata* and *Sabal mexicana*. However, that study did not report the existence of associated orchids on these trees.

#### 3.2 Orchids Epiphytes Established in the Archaeological Zone of El Tajín

Three species of orchids were found in the study area: *Lophiaris cosymbephorum* with 202 colonies, *Oncidium sphacelatum* with 25 colonies and *Catasetum integerrimum* with eight colonies. The genus *Oncidium* has a wide distribution in tropical ecosystems, and has also been recorded in the archeological zones of Calakmul and Chicanná in Campeche, México [13].

#### 3.3 Vertical Distribution of Orchids on the Phorophytes

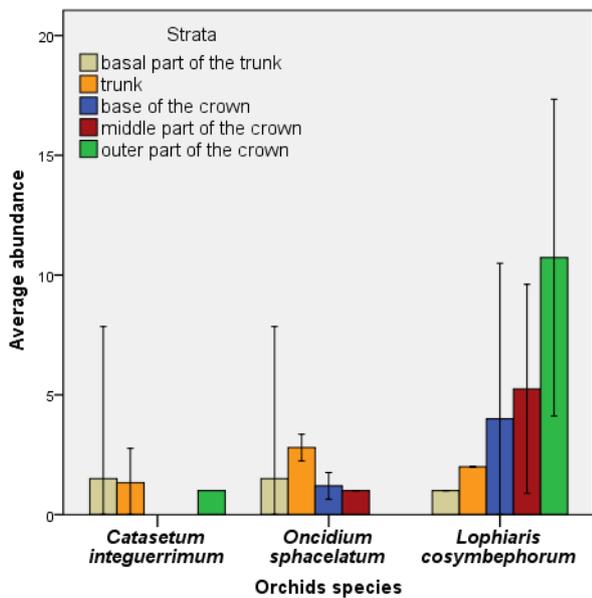
According to Johansson’s vertical stratification [10], although *L. cosymbephorum* was distributed in the five strata, it was more abundant on the outside of the crown (Fig. 2). *O. sphacelatum* was distributed in four strata, of which it was more frequent in the trunk, while *C. integerrimum* was distributed in three strata. In this sense, Morales [13] reported *C. integerrimum*, at the

base of the crown (in cocoa agroecosystems), according to his study, this species is of rare and

indefinite distribution so it can be established from the trunk to the crown.

**Table 1** Distribution of orchids by host tree species.

Phorophyte species (local common name)	Number of phorophytes	Orchid Species	Number of orchids
<i>Bauhinia divaricata</i> (pata de cabra)	1	<i>L. cosymbephorum</i>	2
<i>Bernardia interrupta</i>	5	<i>L. cosymbephorum</i>	9
<i>Crescentia cujete</i> (jicaro)	2	<i>L. cosymbephorum</i>	52
		<i>O. sphacelatum</i>	1
<i>Guazuma ulmifolia</i> (guácima)	9	<i>L. cosymbephorum</i>	56
		<i>C. integerrimum</i>	1
<i>Mangifera indica</i> (mango)	1	<i>O. sphacelatum</i>	3
<i>Manilkara zapota</i> (chicozapote)	1	<i>O. sphacelatum</i>	1
<i>Parmentiera edulis</i> (chote)	7	<i>L. cosymbephorum</i>	62
		<i>O. sphacelatum</i>	3
<i>Sabal mexicana</i> (palmito mexicano)	5	<i>C. integerrimum</i>	7
<i>Spondias purpurea</i> (ciruela)	2	<i>O. sphacelatum</i>	2
<i>Swietenia macrophylla</i> (caoba)	5	<i>O. sphacelatum</i>	13
<i>Tamarindus indica</i> (tamarindo)	1	<i>L. cosymbephorum</i>	5
		<i>O. sphacelatum</i>	2



**Fig. 2** Average abundance (+C.I.) of vertical stratum orchids in the phorophytes present in the El Tajín archaeological zone in Papantla, Veracruz. The classification of the strata (or sections in trees) follows Johansson’s classification (1974).

**3.4 Floral Visitors of the Orchids Species in the Archaeological Zone**

The six individuals of the *Lophiaris cosymbephorum*

orchid selected presented a total of 49 flowers (Table 2). The flowering time of the six individuals was between 10 and 35 days, and the longest flowering was 35 days.

The registered floral visitors were: Gryllidae (crickets), Curculionidae: Baridinae (beetles) and Formicidae: *Lasius niger* (ants) (Table 3), the latter with the highest number of visits. No pollinators were recorded, so there was no formation of *L. cosymbephorum* capsules. This may be due to various factors such as the absence of pollinating insects as the archaeological zone is surrounded by communities and lands used for citrus, maize, vanilla and livestock introduction.

**Table 2** Number of flowers and time of flowering of individuals of *Lophiaris cosymbephorum*.

Individual	Total Open Flowers	Total days in Flowering
1	10	35
2	4	21
3	2	15
4	15	16
5	12	24
6	6	11

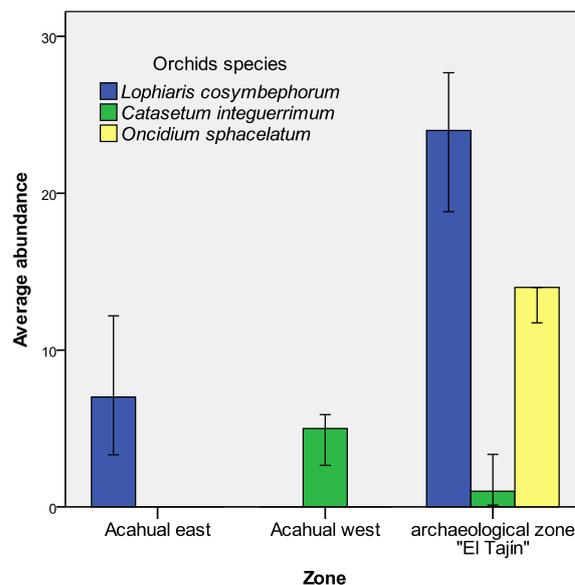
**Table 3** Floral visitors of *Lophiaris cosymbephorum*.

Organism	Number of visits to <i>L. cosymbephorum</i>
<i>Lasius niger</i> ( Formicidae)	350
Barinidae (Coleoptera)	27
Gryllidae (Orthoptera)	10

In these activities, owners close to the area use herbicides, pesticides and insecticides that could generally affect insects and possible pollinators of orchids. However, although there is no formation of capsules (fruits), orchid colonies continue to grow vegetatively. But by having sexual reproduction and not producing seeds, a future risk is generated for the population of this species as its genetic variability is reduced. The archeological zone, being a guarded area, allows the conservation of the present species, since they thrive there and the looting of orchids is not allowed.

### 3.5 Comparison of Epiphytic Orchid Species Present in the Archaeological Zone with Species of Surrounding Vegetation (Acahuals)

The acahuals are found on the sides of the archeological zone. The acahual of the east side with woody species of *Bernardia interrupta* and *Bahuinia divaricata* to mention a few, and the presence of 26 individuals of the orchid *Lophiaris cosymbephorum*. In the acahual on the west side, the predominant species was *Sabal mexicana*, where seven individuals of *Catasetum integerrimum* were recorded (Fig. 3). According to the secretary of the Environment in the management program, around El Tajín, the following species were reported within the archeological zone: *Parmentiera edulis*, *Swietenia macrophylla*, *Manilkara zapota*, *Guazuma ulmifolia*, *Spondias purpurea*, *Crescentia cujete* among others, and for the acahuals (surrounding area) species such as *Guazuma ulmifolia*, *Pimienta dioica*, *Bahuinia divaricata* and *Sabal mexicana*; which agree with those recorded in this study. As for orchids, SEDEMA [11] reported *Epidendrum cochleatum*, *Vanilla fragans* and *Vanilla planifolia*. These species were not found in the present



**Fig. 3** Average Abundance ( $\pm$ C.I.) of three species of orchids per zone: Archaeological zone, acahual East and Acahual West. Forms of life and the various epiphytes.

study. This may be due to the fact that the SEDAM study focused more on the description of tree species, leaving other life forms and diverse epiphytes in the background.

## 4. Conclusion

Three species of orchids were recorded, and *Lophiaris cosymbephorum* was more abundant, followed by *Oncidium sphacelatum* and *Catasetum integerrimum*. The orchids were distributed in 37 phorophytes, of which *P. edulis* and *C. cujete* presented greater abundance and richness of orchids.

The average abundance of orchids per stratum according to Johansson's classification, *L. cosymbephorum* was distributed in the five vertical strata of the trees, being the external part of the crown where it was more abundant, unlike *C. integerrimum* that presented more in the basal part of the trunk.

*Lophiaris cosymbephorum* flourished in November 2015, ending in February 2016, and although ants of the species *Lasius niger*, an organism of the family Gryllidae and beetles of the subfamily Baridinae were recorded as floral visitors, no pollinator visits were recorded.

In the vicinity of the study zone, no orchid species were recorded from the archaeological zone, thus highlighting the importance of archaeological zones as sites for biodiversity conservation.

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Supplementary 1 *Lophiaris cosymbephorum* with its floral visitors: *Lasius niger* and Curculionidae.



Supplementary 2 *Lophiaris cosymbephorum*.

