LANKESTERIANA 25(1): 43–56. 2025. doi: http://dx.doi.org/10.15517/lank.v25i1.64730

ANALYSIS OF TRADITIONAL KNOWLEDGE ON EPIPHYTIC ORCHIDS IN RURAL COMMUNITIES OF A PROTECTED NATURAL AREA FROM NORTHEASTERN MEXICO

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Abstract. Orchids are in high ethnobiological demand worldwide and are often illegally collected in large quantities, impacting their wild populations. Understanding how rural communities use these species is a relevant cultural element that should be preserved for future generations. We evaluated the traditional uses of epiphytic orchids in three communities within the "El Cielo" Biosphere Reserve (RBEC) through 98 surveys. The communities were Alta Cima, Gómez Farías and San José. Our findings indicated that the community members utilized 10 species of epiphytic orchids mostly for ornamental purposes, accounting for 78% of the uses. Notably, woman contributed to 68% of these mentions. Our study revealed that both gender and community influenced the number of orchids used in the RBEC, with gender showing the highest contribution (21.4% of the variability). San José reported the highest number of uses for orchids (four uses), followed by Gómez Farías (three uses) and Alta Cima (two uses). Lastly, Mexican laws identified three species of orchids in one protection category. Recognizing the traditional knowledge these communities possess about orchids is crucial, as it represents a fundamental part of their cultural identity and can aid in developing sustainable management and conservation strategies.

Resumen. Las orquídeas tienen una alta demanda etnobiológica alrededor del mundo, son recolectadas ilegalmente en cantidades masivas, alterando sus poblaciones silvestres. El conocimiento sobre los usos de las especies es un elemento cultural relevante de las comunidades rurales, que debe ser preservado para las generaciones futuras. Se evaluaron los usos tradicionales de orquídeas epífitas en tres comunidades de la Reserva de la Biosfera "El Cielo" (RBEC) a través de 98 encuestas. Las comunidades fueron Alta Cima, Gómez Farías y San José. Los datos muestran que los miembros de las comunidades utilizan 10 especies de orquídeas epífitas, donde el uso ornamental fue el más mencionado con 78%. Notablemente, las mujeres contribuyeron con el 68% de estas menciones. El género y la comunidad influyeron en el uso de las orquídeas en el RBEC, donde el género tuvo la mayor contribución (21.4% de la variabilidad). En San José se reportó el mayor número de usos de orquídeas (cuatro usos), seguida de Gómez Farías (tres usos) y Alta Cima (dos usos). Finalmente, se identificaron tres especies de orquídeas en una categoría de protección en las leyes Mexicanas. Reconocer el conocimiento tradicional que estas comunidades poseen sobre las orquídeas es crucial, ya que representa una parte fundamental de su identidad cultural y puede ayudar a desarrollar estrategias de gestión y conservación sostenibles.

Keywords / Palabras clave: área natural protegida, conservación, conservation, epiphytes, epífitas, "El Cielo", medicinal use, natural protected area, ornamental use, uso medicinal, uso ornamental

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Received 27 January 2025; accepted for publication 18 March 2025. First published online: 10 April 2025.

Introduction. Orchids represent the largest family of flowering plants, with approximately 30,000 species (Chase *et al*., 2015). They grow in a wide range of habitats worldwide, mainly in tropical and subtropical regions and at elevations ranging from sea level up to 3000 m (Chase *et al*., 2003; Djordjević *et al*., 2022). This diversity and broad distribution have allowed orchids to play a significant role in various cultures throughout history, being used for medicinal, food, ornamental and ceremonial purposes (Cox-Tamay, 2013; Fonge *et al*., 2019; Góngora-Chin *et al*., 2016; Ibarra-Contreras *et al*., 2021; Lawler, 1984; Ossenbach, 2009; Rosete-Blandariz *et al*., 2019; Teoh, 2019). Despite the vast number of orchid species, a significant portion is lost each year due to the over-collection of specimens. This has led to a decline in wild populations, species extinction, and habitat degradation (Zhao *et al*., 2021).

Orchids are one of the most used groups of plants in Mexico (Cox-Tamay *et al*., 2016; Espinoza-Pérez *et al*., 2018; Jiménez-López *et al*., 2019), with around 1315 species and 170 genera, of which around 40% of which are endemic to the country (Castillo-Pérez *et al*., 2018; Gutiérrez-Rodríguez *et al*., 2022; Hágsater *et al*., 2005). Some orchids, such as *Laelia autumnalis* (Lex.) Lindl. and *Oncidium sphacelatum* Lindl., are frequently used as ornamental plants regularly incorporated into garlands, ornaments, and crafts for religious festivities in communities within the states of Veracruz and Guanajuato (Martínez-Morales *et al*., 2020). This has led to the excessive collection of these species, with reports indicating that more than 60,000 plants or parts of plants may be collected each year, depending on the species (Ticktin *et al*., 2023). Unfortunately, this collection often occurs without proper management or regulation (Espejo-Cruz *et al*., 2023). Another widely used orchid is *Vanilla planifolia* Andrews, from which vanillin is extracted for use as a flavoring and aromatic agent in the culinary industry. In addition, its flowers are in demand in the craft market, with *V. planifolia* being an important source of income for the rural communities of Mexico (Herrera-Cabrera *et al*., 2022; Luis-Rojas *et al*., 2020). The traditional uses and knowledge of orchids within these communities significantly shape their cultural identity. This knowledge is passed down through generations both within and between communities (Hernández-Mejía *et al*., 2024).

Understanding how different demographic groups value and utilize orchids is essential, as ethnobotanical knowledge can vary significantly among generations. Older individuals often possess a deeper, more traditional understanding of medicinal and edible plants, while younger individuals may be more influenced by globalization. Additionally, the appropriation of knowledge is affected by various multicultural factors (Kumar *et al*., 2021).

"El Cielo" Biosphere Reserve is a protected natural area located in the northeast of the country, renowned for its diverse ecosystems, including semideciduous forests, tropical montane cloud forests, pine-oak forests and submontane scrub (Sánchez-Ramos *et al*., 2005). The epiphytic orchids found in this reserve are particularly valuable for nature conservation because they are restricted to a limited number of habitats, showcasing a high degree of heterogeneity. They have the northernmost distribution in the Mexican transition zone, where the environments range from warm subhumid to dry climates (de la Rosa-Manzano *et al*., 2019).

Research conducted in this reserve has focused on describing the diversity patterns of epiphytic orchids within each type of vegetation. The studies indicate that the semideciduous forest and the tropical montane cloud forest host the highest diversity of epiphytic orchids (Lacaille-Múzquiz, 2005; de la Rosa-Manzano *et al*., 2019). Additionally, investigations into the traditional uses of orchids in family gardens by local communities have identified several species, including *Isochilus linearis* (Jacq.) R.Br., *Lycaste aromatica* (Graham) Lindl., *Prosthechea cochleata* (L.) W.E.Higgins and *Stanhopea tigrina* Bateman ex. Lindl., that are valued for their ornamental qualities. These studies also shed light on the processes of acquisition, transmission, and socialization of ethnobotanical knowledge within these communities (González-Romo & Gispert, 2005). Given the diversity of epiphytic orchids in the RBEC (de la Rosa-Manzano *et al*., 2017; de la Rosa-Manzano *et al*., 2019), we propose conducting a systematic analysis of the ethnobotanical significance of these orchids. Our goal is to obtain an updated overview of their use within local communities and to assess whether any species fall under a protection category. This information will serve as a baseline for imple-

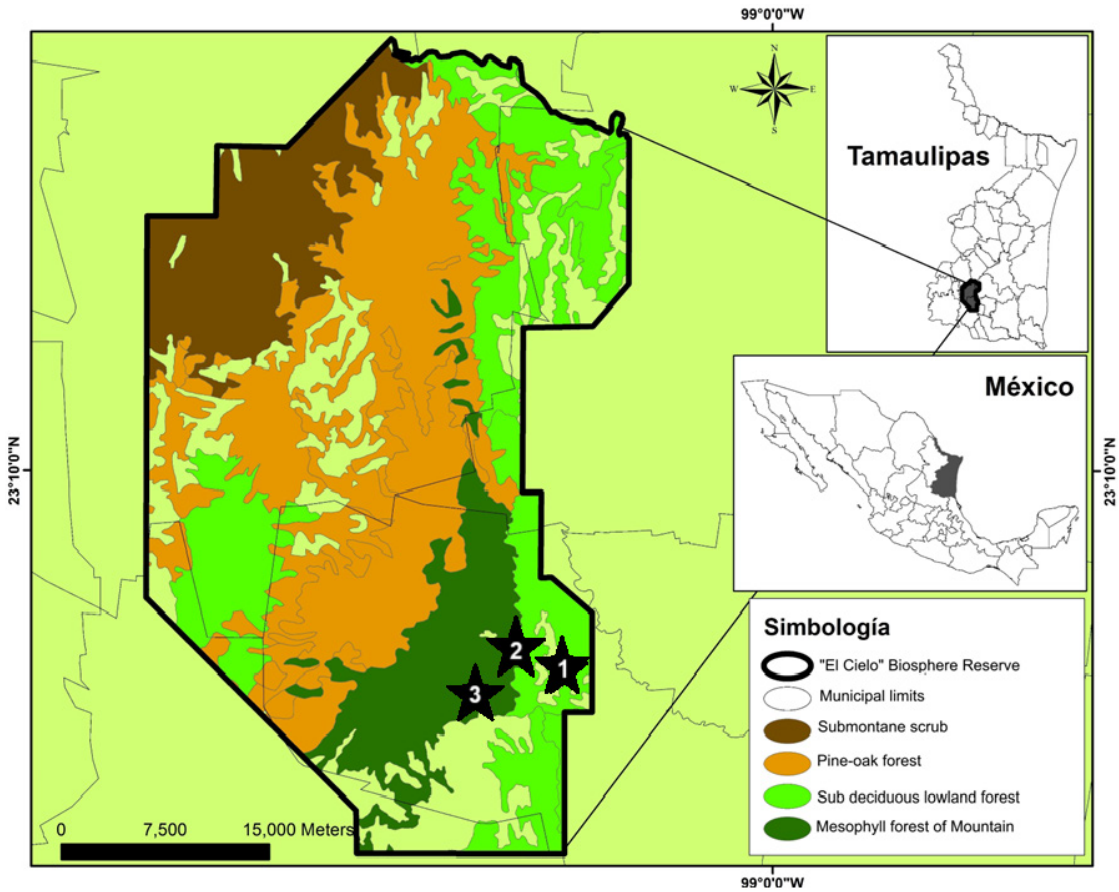

Figure 1. Location of the "El Cielo" Biosphere Reserve, Mexico. The three communities evaluated are indicated: 1. Gómez Farías, 2. Alta Cima and 3. San José. Map prepared by Vanoye Eligio V.

menting management and conservation strategies in collaboration with the communities (Menchaca-García *et al*., 2012).

We plan to (i) evaluate the traditional uses of epiphytic orchids in three RBEC communities, (ii) assess local perceptions regarding the importance of conserving these orchids, and (iii) identify any orchid species in the study area that are classified as protected.

We anticipate that if community members are aware of the richness of epiphytic orchids and have direct contact with the natural resources of the RBEC, they will attribute various uses to these orchids. These uses may differ based on gender and age. Additionally, if traditional knowledge is identified and shared among residents, we expect that interest in conserving the most valued species of epiphytic orchids in the study area will grow.

Materials and methods. *Study area*.— The "El Cielo" Biosphere Reserve (RBEC) is the most significant protected natural area in northeastern Mexico, celebrated for its diverse flora, wildlife, and ecosystems. It is located in the Sierra Madre Oriental, specifically in the regions known as Sierra de Cucharas and Sierra de Guatemala, covering an elevation range from 200 to 2200 m (Fig. 1). The study was conducted in three communities within the reserve: Alta Cima, Gómez Farías, and San José. Alta Cima has a population of 142 residents, comprising 47.9% women and 52.1% men, distributed across 38 families. Gómez Farías is the largest community, with a population of 854 residents (49.4% women and 50.6% men) living in 246 families. San José, the smallest community, has 66 residents, with 45.5% women and 54.5% men, residing in 21 families (INEGI, 2020). The levels of urbanization vary among the three

communities. Gómez Farías is the most urbanized, with access to electricity, piped water, drainage, and the internet. Alta Cima is less urbanized, while San José is the least urbanized, relying on solar-powered electricity and having limited access to piped water (INEGI, 2020).

Ethnobotanical research.— In the Alta Cima community, a survey was conducted with 20 families (52.6% of the response rate), in San José with 21 families (100% response rate), and in Gómez Farías with 57 families (32% response rate) (INEGI, 2020, Fig. 1). The ethnobotanical survey focused on the community´s knowledge, management and use of epiphytic orchids and involved one family member per household, with no age restrictions for participants. Informed consent was obtained and all responses were kept confidential.

The survey included four sections (see Appendix 1): 1) Information about the interviewee, 2) General information about the plant, 3) Ethnobotanical information about orchids, and 4) Local perceptions regarding the conservation status of epiphytic orchids in the Reserve. The survey was validated using the expert panel validation method (INEE, 2019). Age categories were defined into five groups, ranging from 20 to 60+ years, with ten-year intervals. The data collected were compiled to create a database for further analysis.

Ethnobotanical data analysis.— The following ethnobotanical indices were determined according to Hussain *et al*. (2023):

Relative Frequency Citation (RFC): This is used to calculate the relative frequency of citations, using the local importance of each plant species (Birjees *et al*., 2022). It was calculated using the following formula:

$$RFC = FC/N$$

Where FC is the proportion of informants who mentioned the use of a particular species. N represents the total number of informants. This index theoretically varies from 0, when no one refers to the plant as useful, to 1 in the unlikely case that all informants mention the use of the species.

Use value (UV): This index is used to find the relative importance of each species used locally. It combines the frequency of the species mentioned with the number of uses mentioned per species and is often used to highlight notable species of interest (Zenderland *et al*., 2019). It is calculated according to the following formula (Jan *et al*., 2021; Phillips *et al*., 1994):

$$UV = \sum U/n$$

Where $\sum U$ is the number of uses each informant mentions for each species mentioned. It is higher when more uses of a species are reported and lower when fewer uses of a species are reported; n is the total number of informants interviewed for each particular species.

Informant Agreement Ratio (IAR): A metric used to evaluate how suitable specific plants are for each use category. It was determined using the following formula:

$$IAR = (Nur - Nt) / (Nur-1)$$

Where Nur is the number of mentions in each use category and Nt is the number of species mentioned in each category. The values range from 0 to 1.

Plant Part Value (PPV): The method proposed by Chaachuay *et al*. (2019) was used to find the relative value of the different sections of the specimens. The following formula was used:

$$PPV = RU/Rupp$$

Where RU represents the total number of plant uses (including all parts) specified by the informant, while Rupp represents the total number of uses for each given portion.

Analysis of data.— R software version 4.3.3 was used for statistical analyses. The Pearson Chi-square test (χ^2) was applied to find possible differences between (i) gender of the informants in each community and among communities, and (ii) among age range of the informants of RBEC.

Because there is an imbalance in the number of interviews conducted in each community, a subsampling of the majority variable, "community" was performed. Specifically, 20 observations were randomly selected from the Gómez Farías community to match the number of observations in the minority group, creating a balanced model. Additionally, since the food and medicinal categories each recorded less than six observations, they were combined into the "other"

category, resulting in two levels for the response variable: "other" and "ornamental". A binomial logistic regression model with logit link function was used to evaluate the association between the response variable and the predictors "gender", "community" and "age range" (20–30, 30–40, 40–50, 50–60 and 60+ ages). The model was fitted using the glm function of the "Stats" package of the R software version 4.3.3. In the Alta Cima variable, women and 20–30 age range were not present as coefficients because they were taken as reference points, as well as ornamental use. The statistical significance of the predictors was evaluated by Likelihood Ratio Test, considering a significance level of $\alpha = 0.05$. The ratio was obtained as the percentage of the predictor's deviance with respect to null deviance.

Results. Of the total informants, 64% were women and 36% men ($\chi^2 = 8$, d.f = 1, $P < 0.05$). Comparing the three communities, Gómez Farías had both the highest number of women interviewed (52%, 33 informants; $\chi^2 = 10.6$, d.f = 2, $P < 0.05$), and the highest number of men interviewed (68%, 24 informants; $\chi^2 = 20.6$, d.f = 2, $P < 0.05$). According to age range, RBEC informants between 50 and 60 years of age was highest with 33% (33 informants), followed by those who were between 30 and 40 years of age with 19% (18 informants), and both ranges of 20 to 30 and 40 to 50 with 16% (16 informants each); particularly, the smallest number of informants was the 60+ age range (15%, 15 informants) ($\chi^2 = 11.7$, d.f = 4, $P < 0.05$).

Uses of epiphytic orchids by communities.— We found that inhabitants of the RBEC used ten epiphyte orchid species (Fig. 2) for purposes such as ornamental, food, medicinal, and others (inspiration and tourism, which were considered as uses of orchids provided to society according to ecosystem service classification; Hernández-Mejía *et al*., 2024) (Table 1). The ornamental use of orchids stood out with 78% (80 informants), followed by other uses with 12% (10 informants), food with 6% (6 informants) and medicinal with 2% (2 informants) (Fig. 3A). In the analysis by community, Alta Cima stood out for ornamental use, which was 90%, and for other uses (inspiration/tourism) with 10% (Fig. 3B); in Gómez Farías the category of ornamental use was 85%, and other uses with 15% (Fig. 3C). Finally, in San José, four uses of epiphytic orchids stood out: ornamental with 60%, other uses with 28%, food with 7%, and medicinal with 5% (Fig. 3D).

Gender and community influenced the use of orchids in the RBEC (Table 2). Gender contributed the most to the model, explaining 21.4% of the variability, followed by community (18.9%) and age range (6.37%). The male gender showed a 23 times higher probability of using orchids in the "other" category (medicinal, food, inspiration/tourism) compared to the female gender (Odds ratio = 23.19, P = 0.0001; Table 3). For the community variable, a trend was observed in the probability of using orchids in the "other" category in the community of San José compared to Alta Cima. Conversely, Gómez Farías community showed a lower probability of using orchids in the "other" category compared to those from Alta Cima, who are most likely to use orchids as ornamentals. However, these differences were marginally statistically significant (P = 0.05; Table 3). Finally, individuals in the age ranges of 30–40, 50–60, and 60+ showed a lower probability of using orchids in the "other" category. In contrast, the probability of this type of use increased among individuals aged 40–50, although these values were not statistically significant (Table 3).

Ethnobotanical indices.— Relative Frequency Citation (RFC): The RFC ranged from 0.01 to 0.19 in the RBEC. *Laelia anceps* Lindl., presented the highest value with 0.19. For its part, *Isochilus unilateralis* B.L.Rob., *Lycaste aromatica* and *Cohniella ascendens* (Lindl.) Christenson showed values below 0.05.

Use value index (UV): The values found for this index were from 0.01 to 0.04, where *S. tigrina* had the highest use value, which was 0.04; species like *Encyclia parviflora* (Regel) Withner*, I. unilateralis,* and *C. ascendens,* had the lowest use value (0.01) and were mentioned in just one category of use.

Informant agreement index (IAR): The IAR applied to orchid species yielded the maximum value of 0.80 for the ornamental use category. The other uses, include touristic purposes and inspiration/creativity, were in second place with a value of 0.40.

Plant Part Value (PPV): The highest proportion of the PPV was for using the racemose inflorescence with 57, while using the complete plant was 43.

FIGURE 2. Total species reported in the study. **A**. *Catasetum integerrimum* Hook. **B**. *Cohniella ascendens* (Lindl.) Christenson. **C**. *Encyclia parviflora* (Regel) Withner. **D**. *Isochilus unilateralis* B.L.Rob. **E**. *Laelia anceps* Lindl. **F**. *Laelia speciosa* (Kunth) Schltr. **G**. *Lycaste aromatica* (Graham) Lindl. **H**. *Prosthechea cochleata* (L.) W.E.Higgins. **I**. *Prosthechea mariae* (Ames) W.E.Higgins. **J**. *Stanhopea tigrina* Bateman. Photo credit: Diederick Antoni (A), Julieta Hernández (C & H), Edilia de la Rosa (B, D & G), Wilfrido Rodríguez Pérez (J), Antonio Guerra (E & F). Illustration assembled by Julieta Hernández.

Communities' perception of orchid conservation.— Regarding the importance of conserving orchids in the RBEC, 52% of those surveyed considered that the conservation of orchids is very important, 30% mentioned that it is important, 15% that it is somewhat important and 3% considered it unimportant.

Orchids used by the RBEC communities include species under protection status according to the Mexican law NOM-059-SEMARNAT-2010 (SERMANAT, 2010); including *Laelia speciosa* (Kunth) Schltr. as under special protection, and both *Prosthechea mariae* (Ames) W.E.Higgins and *S. tigrina* as threatened (Table 1, Fig. 2). Under international listings such as the IUCN Red List of Threatened Species (IUCN 2024), the species reported in this study are still not evaluated according to the list criteria.

Discussion. Orchids play an essential role in the daily lives of the inhabitants of the RBEC, who take advantage of this resource using it for purposes such as ornamental, food, and medicinal, which coincides with our proposal. The use of 10 epiphytic orchid species in this study is low compared to other studies. For instance, 62 Mexican orchid species with anti-inflammatory, vasorelaxant, antinociceptive, antioxidant, and spasmolytic properties have been reported (Castillo-Pérez *et al*., 2024). Similarly, 53 orchid species in Costa Rica are utilized as a tourist resource (Kirby, 2003). These comparisons highlight the need for further research that allows the conservation and maintenance of the species in order to obtain ethnobotanical information on those that have potential medicinal use and have not been evaluated in the study area.

Ornamental use was the most prominent in the three communities, contributing with more than 60% of the uses in each. Generally, the inhabitants of the RBEC collect orchid plants and have one or more species of orchids as part of the family garden, where the main interest is for them to reach the flowering stage to appreciate and decorate their gardens. The ornamental use of orchids has been well documented (Beltrán-Rodríguez *et al*., 2012; Hinsley *et al*., 2018; Ibarra-Contreras *et al*., 2021; Martínez-Morales *et al*., 2020; Nurfadilah, 2020); they are a key element in various religious events and festivities in other places, as in the case of *Laelia autumnalis*, which is used on the Day of the Dead, when its inflorescences are collected for the arrangement of altars that are placed both in homes and cemeteries in the state of Guanajuato, Mexico (Beltrán-Rodríguez *et al*., 2012).

Other species such as *Laelia albida* Bateman ex Lindl., *L. furfuracea* Lindl., and *Prosthechea karwinskii* (Mart.) J.M.H.Shaw also have a high ornamental

Table 1. Ethnobotanical data of epiphytic orchids mentioned in the surveys carried out in the "El Cielo" Biosphere Reserve.

Scientific name	Local name	Used part	Ethnobotanical use in RBEC	Other reported uses outside the study area
Catasetum integerrimum Hook.	Monjito	Complete plant	Orn, Other	Pseudobulbs used to cure tumors; treatment of kidney, gastrointestinal diseases and diabetes mellitus (Castillo-Pérez, 2023; Herbario CICY, 2010; Hernández-Bautista & Martínez-Espinoza, 2019; López-Puc & Herrrera-Cool, 2022).
Cohniella ascendens (Lindl.) Christenson.	Lápiz	Complete plant	Orn	Inflammation caused by splinter; "Limpia" (a ritual to prevent, diagnose, or cure a disease set); headaches; toothaches; stomach aches; kidney diseases. (Cano-Asseleih *et al.*, 2015; Rodríguez-Castro, 2009).
Encyclia parviflora (Regel) Withner.	Rocío	Complete plant	Orn	-
Isochilus unilateralis B.L.Rob.	Marcianita	Complete plant	Orn	-
Laelia anceps Lindl.	Calaverita	Racemose inflorescence	Orn, Other	Religious offerings; to treat pain and inflammation (Menchaca-García & Morales-Ruiz, 2016; Vergara-Galicia *et al.*, 2013).
Laelia speciosa (Kunth) Schltr.	Lirio morado	Racemose inflorescence	Orn, Other	Cough and inflamed blows (Vergara-Galicia *et al.*, 2013).
Lycaste aromatica (Graham) Lindl.	Lirio amarillo	Complete plant	Orn, Other	-
Prosthechea cochleata (L.) W.E.Higgins.	Pulpito	Single flower	Orn, Other	An adhesive mucilage is obtained from the pseudobulbs (Royal Botanic Gardens, 2024).
Prosthechea mariae (Ames) W.E.Higgins.	Lirio blanco	Complete plant	Orn, Other	-
Stanhopea tigrina Bateman.	Torito, cabeza de perro, tigre	Single flower	Food, Med, Orn, Other	Against heatstroke and weakness; renal disorders, and mental disorders (del Carmen Díaz-Torres, 2019; Teoh, 2019).

*Ethnobotanical use in RBEC: Food, (Med) Medicinal, (Orn) Ornamental, Other (including tourism, inspiration and appreciation).

value, and their commercialization is increasing in Oaxaca, Mexico (Ibarra-Contreras *et al*., 2021; Solano-Gómez *et al*., 2010). It is important to consider that orchids and community traditions are a key part of cultural identity, so strategies must be developed to mitigate the damage from over-collecting plants and ensure that their use is sustainable (Ticktin *et al*., 2023).

As expected, responses from informants using orchids in the RBEC across age ranges were different; however, this variable was not significant in the model. The number of mentions from informants between 51 and 60 years old (34%) was the highest, and older people represented the guardians of traditional knowledge. During the interview, participants pointed out that young people from Gómez Farías (between 20 and 30 years old, 62.5% of the total) know and use orchid species such as *P. cochleata* "pulpito" or *C. ascendens* "lápiz" from the tropical dry forest that surrounds the community, but have no interest in cultural knowledge, nor have the tradition of continuing to transmit this knowledge to new generations. In fact, individuals of this community showed a lower probability of using orchids in the "other" category than those from Alta Cima. This could be related to the young people of Gómez Farías having more access to technology compared to the other two populations who are without even an internet signal, probably causing a lack of interest in traditional knowledge and represent-

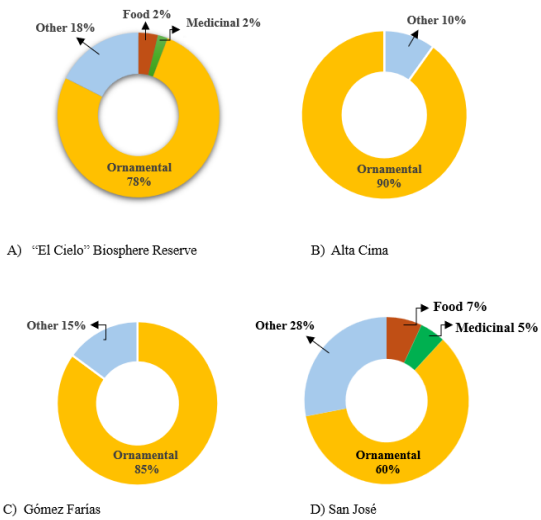

FIGURE 3. Percentages of uses of epiphytic orchids per inhabitant from the "El Cielo" Biosphere Reserve (A); and the three communities evaluated: Alta Cima (B), Gómez Farías (C) and San José (D).

ing a concern for the preservation of the ethnobotanical use of orchids. In addition, community residents mention in the survey that young people often migrate to large cities in search of life opportunities, which could affect interest in the vital role played by orchids and their conservation in the communities of the RBEC. Contrarily, Beltrán-Rodríguez *et al*. (2012), found that the knowledge and customs required to carry out the processes of collection, marketing and use practices of *L. autumnalis* are instilled from parents to children, favoring the preservation and transmission of local traditions. It is important to recognize that residents, particularly those who are older and have more knowledge about epiphytic orchids, can become part of future proposals for the development of conservation strategies, since they have the experience, practices and potential to carry out successful conservation of both the species and the ecosystem (Hussain *et al*., 2023). Proposals such as environmental education workshops and scientific dissemination fairs on the uses and management of orchids in the study area will allow the knowledge of the residents of the RBEC to be transmitted and remain in future generations (Velázquez-Juárez, 2019).

The gender of people who use orchids in the RBEC was a significant factor, as expected. Recent studies on gender bias in ethnobotanical knowledge show that not

TABLE 2. Analysis of variance of the binomial logistic regression model. The table reports likelihood-ratio (LR), Chi-squared, degrees of freedom (Df), and associated p-values. These results evaluate the statistical significance of each predictor (age range, gender and community) in explaining variation in the binary response variable.

	LR Chisq	Df	Pr(>Chisq)
Age range	6.3201	4	0.1765
Gender	21.2273	1	4.08E-06 ***
Community	18.8425	2	8.10E-05 ***

everyone in a community has the same level of knowledge, and one gender is generally held to be the one with the most knowledge (Dan-Guimbo *et al*., 2011; Laleye *et al*., 2015; Müller *et al*., 2015). According to our model, ornamental use of epiphytic orchids in the RBEC was most probably by women, who are mostly housewives (Beltrán-Rodríguez *et al*., 2012) and have learned to take advantage of these plants as inspiration to make souvenirs to sell to tourists, providing an economic income for their families. The implementation of training programs for the propagation of plants destined for sustainable and legal commercialization could be successful, as in Costa Rica (Gutiérrez, 2008), where the Union of Associations of Rural Women Producers of the Western Central Sector and Rambla produce and export orchids, establishing sales stands at exhibitions, supermarkets or on private orders. They also export mainly to Panama and the USA. This program has reduced the over-collection of wild specimens (Gutiérrez, 2008).

The highest number of uses reported for epiphytic orchids was in the community of San José (Fig. 2D), despite having the smallest number of inhabitants compared to Alta Cima and Gómez Farías. San José is the least urbanized community and does not have essential services. However, it is surrounded by tropical mountain cloud forest (González-Medrano, 2005), which houses ~60% of the epiphytic orchid species in Mexico (Espejo-Serna *et al*., 2021), being highly recognized and appreciated for their high nutritional, medicinal, ornamental value, among others (Şen *et al*., 2018; Bozyel & Merdamert-Bozyel, 2020). In this community, *S. tigrina* has different uses, including the use of its flowers as food. Similarly, Teoh (2019) reported that *S. tigrina* has been used against heatstroke and loss of strength

Table 3. Coefficients, standard errors and odds ratios of the binomial logistic regression model, where the variable community (Gomez Farías and San José), male gender and age range (30-40, 40-50, 50-60, and 60+) were evaluated. Variable Alta Cima, women and 20-30 age range are not presented as coefficients because they were taken as reference points, as well as ornamental use. Significance level, * (0.01), ** (0.001), *** (0.05).

	Estimate	Std.error	z value	P.value	Odds_ratio	Lower	Upper
Intercept	-2.376	1.166	-2.037	0.042	0.093	0.009	0.914*
30–40	-0.452	1.308	-0.345	0.730	0.636	0.049	8.267
40–50	1.784	1.178	1.514	0.130	5.951	0.591	59.884
50–60	-0.799	1.022	-0.782	0.434	0.450	0.061	3.336
60+	-0.064	1.110	-0.057	0.954	0.938	0.107	8.261
Male	3.144	0.813	3.866	0.000	23.187	4.710	114.141**
Gómez Farías	-2.051	1.049	-1.955	0.050	0.129	0.016	1.006***
San José	1.607	0.998	1.611	0.107	4.987	0.706	35.230

since the post-Hispanic period; in addition, Moreno-Martínez and Menchaca-García (2007) highlight the use of the flowers of this species in the preparation of tortillas so that they acquire a pleasant aroma since this orchid flower has molecules of phenylmethyl acetate, cinnamyl acetate, indole, benzyl acetate, and methyl salicylate, which give it its intense, sweet and aromatic aroma (Castillo-Pérez *et al*., 2021; Gerlach, 2010).

Alta Cima was the community where the inhabitants used the largest number of orchid species and where orchids are most likely used as ornamental, compared to the other two communities. Alta Cima is a community with a low urbanization level but does have basic services and an elementary school. Here, the male inhabitants use orchid species from the area for tourism and recognize the ornamental value of orchids, exploiting them along the guided routes and trails through the RBEC, where they obtain economic income. In this community, *L. anceps* is well recognized as an ornamental species for the size of its flowers (6.25 to 12.5 cm), and its striking pink color (Fig. 2E), as well as being easily propagated (Halbinger & Soto-Arenas, 1997). Although this species does not show declining populations in Mexico, it is prone to over-collection of specimens for illegal sale and decoration in festivities, in addition to the degradation of its habitat (Solano-Gómez *et al*., 2010; Cox-Tamay & Cervantes-Uribe, 2016). It is necessary to promote its protection to conserve and its habitats and prevent it from becoming threatened due to its ornamental value (Cox-Tamay & Cervantes-Uribe, 2016; Vera-Aguilar *et al*., 2022).

Some epiphytic orchids named in NOM-059-SEMARNAT-2010 include *L. speciosa*, *P. mariae* and *S. tigrina*. Particularly, *L. speciosa* is also used by residents of the RBEC who are dedicated to ecotourism mainly as a visual attraction within the tours they provide. It is reported as a species subject to special protection, so its populations are not strongly affected (Campos-Rojas & Muñoz-Pérez, 2018). The *L. speciosa* population is a conservation priority in our region because it has one of the most northerly distributions of the species (Halbinger & Soto-Arenas, 1997). Community participation, therefore, is essential to conservation and management programs since they have the closest relationship with this resource. The main threat it faces is massive looting to form decorations for the Corpus Christi festival in some towns in Michoacán, Mexico, so it is necessary to promote studies on the biology, ecology and reproduction of species for their effective conservation (Vera-Aguilar *et al*., 2022).

Both *P. mariae* and *S. tigrina* are endemic species to Mexico and are listed as threatened (SEMARNAT, 2010). *P. mariae* is appreciated for its unique appearance and white flowers (Fig. 2I) and for its ornamental and horticultural uses (Alanís-Méndez *et al*., 2024). However, its populations are threatened due to the fragmentation and loss of its natural habitat (Alanís-Méndez *et al*., 2024; Rocha-Gutiérrez & Duque-Sánchez, 2017). Meanwhile, *S. tigrina*, due to its floristic attractiveness and characteristic fragrance (Gerlach, 2010; Castillo-Pérez *et al*., 2021), is the object of looting for illegal trade, while problems with its germina-

tion and propagation have been reported, which makes it a vulnerable species in the face of so many threats (Zamora-Cortez, 2021).

In conclusion, this study emphasizes the importance of traditional knowledge and the conservation of epiphytic orchid species, highlighting their ornamental, medicinal, and cultural values. It notes that gender differences play a role in the utilization of orchids, with women primarily leading ornamental and economic activities. However, factors such as overharvesting and habitat degradation pose significant threats to numerous orchid species, particularly those that are endemic or protected, such as *L. speciosa*, *P. mariae*, and *S. tigrina*.

To address these threats, strategies such as establishing nurseries, creating germplasm banks, and promoting environmental education should be implemented to reduce the overexploitation of orchid species and encourage their conservation. By documenting and preserving cultural practices, this research contributes to biodiversity protection while ensuring the transmission of traditional knowledge amidst globalization and evolving rural lifestyles.

Acknowledgements. JAHM was recipient of a Ph.D. fellowship by Consejo Nacional de Humanidades, Ciencias y Tecnologías (CONAHCYT) (54784). Special thanks to the inhabitants of the "El Cielo" Biosphere Reserve for their interest, cooperation and kindness in providing us with their knowledge about the orchid group. We are grateful to two anonymous reviewers and editors for comments that improved the manuscript.

Author contribution. Conceptualization, J.A.H.M. and E.R.M.; Methodology, J.A.H.M. and E.R.M.; Formal Analysis, J.A.H.M. and E.R.M.; Writing – Original Draft Preparation, J.A.H.M. and E.R.M.; Review & Editing, E.R.M., J.A.H.M., P.D.S. and V.V.E.

Funding. This research was funded by Universidad Autónoma de Tamaulipas UAT/SIP/INV/2022/012

Conflict of interest. The authors declare no conflicts of interest.

Literature cited

Alanís-Méndez, J. L., Soto, V., & Limón-Salvador, F. (2024). Effects of climate change on the distribution of *Prosthechea mariae* (Orchidaceae) and within protected areas in Mexico. *Plants*, *13*(6), 839.

Beltrán-Rodríguez, L. A., Martínez Rivera, B., & Paulo Maya, A. (2012). Etnoecología de la flor de Catarina - *Laelia autumnalis* (La Llave & Lex.) Lindl. - (Orchidaceae) en una comunidad campesina al sur del estado de Morelos, México: Conservando un recurso y preservando saberes populares. *Etnobiología*, *10*(1), 1–17.

Birjees, M., Ahmad, M., Zafar, M., Nawaz, S., Jehanzeb, S., Ullah, F., & Zaman, W. (2022). Traditional knowledge of wild medicinal plants used by the inhabitants of Garam Chashma valley, district Chitral, Pakistan. *Acta Ecologica Sinica, 42*(2), 19–33. https://doi.org/10.1016/j.chnaes.2020.12.006.

Bozyel, M. E., & Merdamert-Bozyel, E. (2020). Ethnomedicinal uses of Orchidaceae Taxa in Turkish traditional medicine. *International Research Journal of Biological Sciences*, *9*(3), 52–63.

Campos-Rojas, E., & Muñóz-Pérez, R. (2018). Flor de mayo (*Laelia speciosa* (Kunth) Schltr), la estrella de Belén. *Agro Productividad***,** *5*(3), 3–10.

Cano-Asseleih, L. M., Menchaca-García, R. A., & Ruiz-Cruz, J. Y. S. (2015). Ethnobotany, pharmacology and chemistry of medicinal orchids from Veracruz. *Journal of Agricultural Science and Technology*, *5*, 745–754. https://doi.org/10.17265/2161-6256%2F2015.09.006

Castillo-Pérez, L. J. (2023). Study of the ethnopharmacological potential of *Catasetum integerrimum* Hook. In the Huasteca Potosina. PhD thesis. Universidad Autónoma de San Luis Potosí.

Castillo-Pérez, L. J., Martínez-Soto, D., Fortanelli-Martínez, J., & Carranza-Álvarez, C. (2021). Asymbiotic seed germination, *in vitro* seedling development, and symbiotic acclimatization of the Mexican threatened orchid *Stanhopea tigrina*. *Plant Cell, Tissue, and Organ Culture*, *146*, 249–257. https://doi.org/10.1007/s11240-021-02064-9.

Castillo-Pérez, L. J., Martínez-Soto, D., Maldonado-Miranda, J. J., Alonso-Castro, A. J., & Carranza-Álvarez, C. (2018). The endemic orchids of Mexico: a review. *Biologia*, *74*, 1–13. https://doi.org/10.2478/s11756-018-0147-x

Castillo-Pérez, L. J., Ponce-Hernández, A., Alonso-Castro, A. J., Solano, R., Fortanelli-Martínez, J., Lagunez-Rivera, L., & Carranza-Álvarez, C. (2024). Medicinal Orchids of Mexico: A Review. *Pharmaceuticals*, *17*(7), 907. https://doi.org/10.3390/ph17070907

Chaachouay, N., Benkhnigue, O., Fadli, M., El Ibaoui, H., & Zidane L. (2019). Ethnobotanical and ethnopharmacological

studies of medicinal and aromatic plants used in the treatment of metabolic diseases in the Moroccan Rif. *Heliyon, 5*(10), e02191. https://doi.org/10.1016/j.heliyon.2019.e02191.

Chase, M. W., Cameron, K. M., Barrett, R. L., & Freudenstein, J. V. (2003). DNA data and Orchidaceae systematics: A new phylogenetic classification. In: K. W. Dixon, S. P. Kell, R.L. Barrett, & P. J Cribb (Eds.), *Orchid conservation* (pp. 69–89). Kota Kinabalu, Malaysia: Natural History Publications.

Chase, M. W., Cameron, K. M., Freudenstein, J. V., Pridgeon, A. M., Salazar, G., van den Berg, C., & Schuiteman, A. (2015). An updated classification of Orchidaceae. *Botanical Journal of the Linnean Society, 177*, 151–174. https://doi.org/10.1111/boj.12234

Cox-Tamay, L. D. (2013). Orquídeas: Importancia y uso en México. *Bioagrociencias*, *6*(2), 4–7.

Cox-Tamay, L. D., & Cervantes-Uribe, J. S. (2016). Laelias: Flores mágicas y ceremoniales. *Desde el Herbario CICY*, *8*, 122–127.

Cox-Tamay, L. D., Ruiz Cruz, J. Y. S., & Pérez García, E. A. (2016). Diversidad y uso de las orquídeas. *Bioagrociencias*, *9*(1), 1–6.

Dan-Guimbo, I., Mueller, J. G., & Larwanou, M. (2011). Ethnobotanical Knowledge of Men, Women and Children in Rural Niger: A mixed-methods approach. *Ethnobotany Research and Applications*, *9*, 235–242.

de la Rosa-Manzano, E., Guerra-Pérez, A., Mendieta-Leiva, G., Mora-Olivo, A., Martínez-Ávalos, J. G., & Arellano-Méndez, L. U. (2017). Vascular epiphyte diversity in two forest types of the "El Cielo" Biosphere Reserve, Mexico. *Botany*, *95*(6), 599–610. https://doi.org/10.1139/cjb-2016-0184

de la Rosa Manzano, E., Mendieta Leiva, G., Guerra Pérez, A., Aguilar Dorantes, K. M., Arellano Méndez, L. U., & Torres Castillo, J. A. (2019). Vascular epiphytic diversity in a neotropical transition zone is driven by environmental and structural heterogeneity. *Tropical Conservation Science, 12*, 1–16. https://doi.org/10.1177/1940082919882203

del Carmen Díaz-Torres, R., Yáñez-Barrientos, E., Montes-Rocha, J. Á., Morales-Tirado, D. J., Alba-Betancourt, C., Gasca-Martínez, D., González-Rivera, M. L., del Carmen Juárez-Vázquez, M., Deveze-Álvarez, M. A., Isiordia-Espinoza, M. A., Carranza-Álvarez, C., & Alonso-Castro, A. J. (2024). Estudio etnomedicinal y evaluación de los efectos ansiolíticos y diuréticos de la orquídea *Stanhopea tigrina* Bateman ex Lindl—(Orchidaceae). *Productos farmacéuticos*, *17*(5), 588. https://doi.org/10.3390/ph17050588

Djordjević, V., Tsiftsis, S., Kindlmann, P. & Stevanović, V. (2022). Orchid diversity along an altitudinal gradient in the central Balkans. *Frontiers in Ecology and Evolution*, *10,* 1–15. https://doi.org/10.3389/fevo.2022.929266

Espejo-Cruz, A. D. C., Espejo-Martínez, A., Chávez-Ángeles, M. G., Lagunez-Rivera, L., & Solano, R. (2023). Deficiencies in compliance with environmental regulation for orchid trade via social networks in Mexico. *Botanical Sciences*, *101*(2), 400–416. https://doi.org/10.17129/botsci.3159

Espejo-Serna, A., López-Ferrari, A. R., Mendoza-Ruiz, A., García-Cruz, J., Ceja-Romero, J., & Pérez-García, B. (2021). Mexican vascular epiphytes: richness and distribution. *Phytotaxa, 503*(1), 1–124. https://doi.org/10.11646/phytotaxa.503.1.1

Espinoza-Pérez, J., Herrera-Cabrera, B. E., Zizumbo-Villarreal, D., Delgado-Alvarado, A., & Salazar-Rojas, V. M. (2018). Perfil de productor por intensidad de manejo sobre vainilla (*Vanilla planifolia* Jacks. ex Andrews) en la región Totonacapan, México. *Agroproductividad*, *11*(3), 58–63.

Fonge, B. A., Essomo, S. E., Bechem, T. E., Tabot, P. T., Arrey, B. D., Afanga, Y., & Assoua, E. M. (2019). Market trends and ethnobotany of orchids of Mount Cameroon. *Journal of Ethnobiology and Ethnomedicine*, *15*(29). https://doi.org/10.1186/s13002-019-0308-1

Gerlach, G. (2010). Stanhopeinae Mesoamericanae, V. El aroma floral de las Stanhopeas de Mexico. *Lankesteriana*, *9*(3), 431–442. https://doi.org/10.15517/lank.v0i0.12105

Góngora-Chin, R. E., Flores-Guido, S., Ruenes-Morales, M. D. R., Aguilar-Cordero, W. D. J., & García-López, J. E. (2016). Uso tradicional de la flora y fauna en los huertos familiares mayas en el municipio de Campeche, Campeche, México. *Ecosistemas y Recursos Agropecuarios*, *3*(9), 379–389.

González-Medrano, F. (2005). La vegetación. In: G. Sánchez-Ramos, P. Reyes, & R. Dirzo (Eds.), *Historia natural de la reserva de la biosfera El Cielo, Tamaulipas, México* (pp. 88–105). Universidad Autónoma de Tamaulipas.

González-Romo, C., & Gispert, M. (2005). Etnobotánica de los solares. In: G. Sánchez-Ramos, P. Reyes, & R. Dirzo (Eds.), *Historia natural de la reserva de la biosfera El Cielo, Tamaulipas, México* (pp. 88–105). Universidad Autónoma de Tamaulipas.

Gutiérrez, K. (2008). *La comercialización y exportación de orquídeas cultivadas por mujeres en Costa Rica.* (Master thesis). Universidad Latinoamericana de Ciencia y Tecnología.

Gutiérrez-Rodríguez, B. E., Vásquez-Cruz, M., & Sosa, V. (2022). Areas of endemism of the orchids of Megamexico:

functional attributes and elevation. *Plant Diversity*, *44*, 351–359. https://doi.org/10.1016/j.pld.2022.03.004

Hágsater, E., Soto Arenas, M. A., Salazar, G. A., Jiménez Machorro, R., López Rosas, M., & Dressler, R. (2005). *Las orquídeas de México.* México: Instituto Chinoín.

Halbinger, F., & Soto-Arenas, M. A. (1997). *Laelias of Mexico*. Orquídea (Méx.). 15, 1–160.

Herbario CICY (2010). Unidad de Recursos Naturales - Flora de la Península de Yucatán.

Hernández-Bautista, E., & Martínez-Espinoza, L. A. F. (2019). Aspectos ecológicos, etnobotánicos, análisis fitoquímico y cultivo *in vitro* de *Catasetum integerrimun* Hook. (Orchidaceae). (PhD thesis). Instituto Tecnológico de Huejutla, Hidalgo, México.

Hernández-Mejía, J. A., de la Rosa-Manzano, E., & Delgado-Sánchez, P. (2024). Ecosystem services provided by orchids: a global analysis. *Botanical Sciences*, *102*(3), 671–685. https://doi.org/10.17129/botsci.3478

Herrera-Cabrera, B. E., Salgado-Garciglia, R., Barrales-Cureño, H. J., Alvarado Delgado, A., Montiel-Montoya, J., Díaz-Bautista, M., Almorin Albino, R., Reyes, C., & Ocaño-Higuera, V. M. (2022). Producción y caracterización de vainilla (*Vanilla planifolia*) en función de la concentración de vainillina. *Revista Iberoamericana de Ciencias*, *9*(2), 46–62.

Hinsley, A., De Boer, H. J., Fay, M. F., Gale, S. W., Gardiner, L. M., Gunasekara, R. S., Kumar, P., Masters, S., Metusala, D., Roberts, D. L., Veldman, S., Wong, S., & Phelps, J. (2018). A review of the trade in orchids and its implications for conservation. *Botanical Journal of the Linnean Society*, *186*(4), 435–455. https://doi.org/10.1093/botlinnean/box083

Hussain, K., Ejaz Ul Islam Dar, M., Mehmood, A., Sabir, S., Shakeel Awan, M., Shafique Ahmad, K., & Bussmann, R. W. (2023). Ethnomedicinal uses and conservation status of medicinal orchids from Western Himalayas of Azad Jammu & Kashmir, Pakistan. *Ethnobotany Research and Applications, 26*,1–13. https://dx.doi.org/10.32859/era.26.1.1-13

Ibarra-Contreras, C. A., Solano, R., Paz-Cruz, L., Pérez-Domínguez, C., & Lagunez-Rivera, L. (2021). Orquídeas de los municipios de Santo Domingo Yanhuitlán y San Pedro y San Pablo Teposcolula, Oaxaca. *Polibotánica*, *51*, 17–41. https://doi.org10.18387/polibotanica.51.2

INEE. (2019). Cuadernillo técnico de evaluación educativa: Desarrollo de instrumentos de evaluación: cuestionarios. Instituto Nacional para la Evlauación de la Educación, México. Retrieved from https://www.inee.edu.mx/publicaciones/desarrollo-de-instrumentos-de-evaluacion-cuestionarios/ [Accessed 11 January 2024].

INEGI. (2020). Espacio y Datos de México. Instituto Nacional de Estadística y Geografía (INEGI). Retrieved from https://www.inegi.org.mx/app/mapa/espacioydatos/default.aspx?ag=28 [Accessed 11 January 2024].

Jan, H. A., Wali, S., Ahmad, L., Jan, S., Ahmad, N., & Ullah, N. (2021). Ethnomedicinal survey of medicinal plants of Chinglai valley, Buner district, Pakistan. *European Journal of Integrative Medicine, 13*, 64–74. https://doi.org/10.1016/j.eujim.2017.06.007

Jiménez-López, D. A., Pérez-García, E. A., Martínez-Meléndez, N., & Solano, R. (2019). Orquídeas silvestres comercializadas en un mercado tradicional de Chiapas, México. *Botanical Sciences*, *97*(4), 691–700. https:/doi.org/10.17129/botsci.2209

Kirby, S. (2003). Neotropical orchid eco-tourism: educational experience of an orchid neophyte at the Bosque de Paz Biological Preserve, Central Volcanic Range, Costa Rica. *Lankesteriana, 7*, 121–124.

Kumar, A., Kumar, S., Komal., Ramchiary, N., & Singh, P. (2021). Role of traditional ethnobotanical knowledge and indigenous communities in achieving sustainable development goals. *Sustainability*, *13*(6), 3062. https://doi.org/10.3390/su13063062

Lacaille-Múzquiz, J. L. (2005). Orquídeas. In: G. Sánchez-Ramos, P. Reyes-Castillo & R. Dirzo (Eds.), *Historia natural de la reserva de la biosfera El Cielo, Tamaulipas* (pp. 235–243). Universidad Autónoma de Tamaulipas.

Laleye, F. O. A., Mensah, S., Assogbadjo, A. E., & Ahissou, H. (2015). Diversity, knowledge, and use of plants in traditional treatment of diabetes in the Republic of Benin. *Ethnobotany Research and Applications*, *14*, 231–257.

Lawler, L. J. (1984). Ethnobotany of the Orchidaceae. In: Arditti, J. (Ed.), *Orchid Biology: Review and Perspectives-3* (27–149). Cornell University Press, Ithaca.

López-Puc, G., & Herrera-Cool, G. J. (2022). Asymbiotic germination, *in vitro* conservation, and regeneration of *Catasetum integerrimum*. *Polibotánica*, (53), 135–149.

Luis-Rojas, S., Ramírez Valverde, B., Díaz Bautista, M., Pizano Calderón, J., & Rodríguez López, C. (2020). La producción de vainilla (*Vanilla planifolia)* en México: análisis y pronóstico. *Revista Mexicana de Ciencias Agrícolas*, *11*(1), 175–187. https://doi.org/10.29312/remexca.v11i1.2065

Martínez-Morales, A., Pérez Olvera, M. A., Ortíz Medel, M., Hernández Pérez, M. L., & Rojas Moguel, A. (2020). Usos, festividades religiosas y conocimiento de las orquídeas *Laelia autumnalis* y *Oncidium sphacelatum*. *Ra Ximbai*, *16*(4), 251–272. https://doi.org/10.35197/rx.16.04.2020.12.am

Menchaca-García, R. & Morales-Ruiz, V. (2016). Lirio de Todos Santos. Universidad Veracruzana.

Menchaca-García, R. A., Lozano Rodríguez, M. A., & Sánchez Morales, L. (2012). Estrategias para el aprovechamiento sustentable de las orquídeas de México. *Revista Mexicana de Ciencias Forestales*, *3*(13), 9–16.

Moreno-Martínez, D., & Menchaca García, R. A. (2007). Efecto de los compuestos orgánicos en la propagación in vitro de *Stanhopea tigrina* Bateman (Orchidaceae). *Foresta Veracruzana*, *9*(2), 27–32.

Müller, J. G., Boubacar, R., & Dan Guimbo, I. (2015). The "how" and "why" of including gender and age in ethnobotanical research and community-based resource management. *Ambio*, *44*(1), 67–78. https://doi.org/10.1007/s13280-014-0517-8

Nurfadilah, S. (2020). Utilization of orchids of Wallacea region and implication for conservation. *IOP Conference Series: Earth and Environmental Science*, *473*, 012063. https://doi.org/10.1088/1755-1315/473/1/012063

Ossenbach, C. (2009). Orchids and orchidology in Central America. 500 years of history. *Lankesteriana International Journal on Orchidology*, *9*(1-2), 1–228.

Phillips, O., Gentry A. H., Reynel, C., Wilkin, P., & Gálvez-Durand, B. C. (1994). Quantitative ethnobotany and Amazonian conservation. *Conservation Biology, 8*(1), 225–248. https://doi.org/10.1046/j.1523-1739.1994.08010225.x

Rocha-Gutiérrez, O., & Duque-Sánchez, J. A. (2017). Unidades de manejo para la conservación de la visa silvestre con enfoque en orquídeas (Orchidaceae). *Agroproductividad, 10*(6), 62–65.

Rodríguez-Castro, E. C. (2009). Las Plantas Medicinales Mayas. Un Estudio de los Factores de Riesgo Ambientales y Sociales en Maxcanú, Yucatán. Master thesis. Centro de Investigación y de Estudios Avanzados Unidad Mérida, Mérida, Mexico.

Rosete-Blandariz, S., Sáenz Véliz, R. S., Jiménez González, A., & Pin Figueroa, F. E. (2019). Fitorecursos de interés para el turismo en los bosques secos de la región costa, Jipijapa, Manabí, Ecuador. *Revista Cubana de Ciencias Forestales*, *14*(2), 240–262.

Royal Botanic Gardens: Plants of the World Online. (2024). https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:1001247-1/general-information.

Sánchez-Ramos, G., Reyes-Castillo, P., & Dirzo, R. (2005). *Historia natural de la reserva de la biosfera EI Cielo, Tamaulipas, México.* Universidad Autónoma de Tamaulipas. México.

Şen, M. A., Palabiyik, I., & Kurultay, Ş. (2018). Composition, viscosity and solubility of saleps from twenty different orchid (Orchidaceae) species. *Journal of Food Measurement and Characterization*, *12*, 1334–1339. https://doi.org/10.1007/s11694-018-9747-y

SEMARNAT. (2010). NOM-059-SEMARNAT-2010. Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo.

Solano Gómez, R., Cruz Lustre, G., Martínez Feria, A., & Lagunez Rivera, L. (2010). Plantas utilizadas en la celebración de la Semana Santa en Zaachila, Oaxaca, México. *Polibotánica*, *29*(29), 263–279.

Teoh, E. S. (2019). *Orchids as aphrodisiac, medicine or food.* Springer Cham. ISBN: 978-3-030-18255-7.

Ticktin, T., Charitonidou, M., Douglas, J., Halley, J. M., Hernández-Apolinar, M., Liu, H., Mondragón, D., Pérez-García, E. A., Tremblay, R. L., & Phelps, J. (2023). Wild orchids: A framework for identifying and improving sustainable harvest. *Biological Conservation*, *277*, 109816. https://doi.org/10.1016/j.biocon.2022.109816

Velázquez Juárez, Z. B. (2019). *Propuesta de una estrategia de conservación de las orquídeas silvestres comercializadas en el mercado Isabel Díaz de Castilla en Tenango de las Flores, Puebla.* (Master thesis). Facultad de Ciencias Biológicas y Agropecuarias. Universidad Veracruzana. Tuxpan, Veracruz, México.

Vera-Aguilar, A., Ramírez-Mosqueda, M., Lee, H., Llarena-Hernández, R., Rodríguez-Deméneghi, M. V., & Murguía-González, J. (2022). Efficient protocol for *in vitro* propagation of *Laelia anceps* ssp. *anceps* white variant from asymbiotic seed germination. *South African Journal of Botany*, *149*, 376–380. https://doi.org/10.1016/j.sajb.2022.06.013

Vergara-Galicia, J., Castillo-España, P., Villalobos-Molina, R. & Estrada-Soto, S. (2013). Vasorelaxant effect of *Laelia speciosa* and *Laelia anceps*: Two orchids as potential sources for the isolation of bioactive molecules. *Journal of Applied Pharmaceutical Science*, 3(7), 34–37. https://doi.org/10.7324/JAPS.2013.3707

Zamora-Cortez, S. (2021). *Efecto del tamaño del explante en la propagación in vitro de Stanhopea tigrina* (Orchidaceae). (Bachelor thesis). Facultad de Ciencias, Universidad Nacional Autónoma de México.

Zenderland, J., Hart, R., Bussmann, R. W., Paniagua, N. Y., Sikharulidze, S., Kikvidze, Z., Kikodze, D., Tchelidze, D., Khutsishvili M., & Batsatsashvili, K. (2019). The use of "Use Value": quantifying importance in ethnobotany. *Economic Botany, 73*(1), 293–303. https://doi.org/10.1007/s12231-019-09480-1

Zhao, D. K., Selosse, M. A., Wu, L., Luo, Y., Shao, S. C., & Ruan, Y. L. (2021). Orchid reintroduction based on seed germination-promoting mycorrhizal fungi derived from protocorms or seedlings. *Frontiers in Plant Science*, *12*, 701152. https://doi.org/10.3389/fpls.2021.701152

Appendix 1. Survey to determine the perception and knowledge of orchids by residents of the communities of the "El Cielo" Biosphere Reserve as part of the development of the project titled "Community participation in the conservation of epiphytic orchids in the "El Cielo" Biosphere Reserve".

Interview date:_____

1. Interviewee information

Name: _____

Age:_____ Gender: _____ Ocupation: _____ Scholarship:_____

Are you originally from the community? Yes_____ No_____

2. General plant information

Have you heard about orchids? Yes_____ No_____

If yes, can you name some examples? _____

3. Ethnobotanical information about orchids

Do you use these plants in any way? Yes_____ No_____

What are the most common uses for these plants? Food_____ Spiritual _____ Medicinal_____ Ornamental_____ Religious_____ Other (inspiration/creativity, tourism)_____

What parts do you use the most? Root_____ Leaf_____ Stem (bulb) _____Flower_____Whole plant_____

Where do you usually find the plants? Trees/Branches_____ Thrown on the ground_____ Growing on stones/rocks_____

When you need a plant, who participates in obtaining it?_____

What time of year do you usually find them?
Dry season_____ Rainy season_____ All year_____

Do you have orchid plants in your home? If so, how many different species do you have _____

4. Local perception of the conservation status of orchids in the Reserve

Do you consider orchids to be important within the "El Cielo" Biosphere Reserve? Very important_____ Important_____ A little_____ Not important _____

Why do you think so?_____

Have you noticed that these plants are becoming scarce?
Yes_____ No_____

Since when?_____

How did you notice it? (you no longer find the plant as easily as before; you have to go further to find it) _____

What would you do if this species ended up in the Reserve?_____

Would you be interested in learning about the care and propagation of these plants as a way to conserve them? Yes_____ A little bit_____ No_____

How did you acquire knowledge about the use of orchids?
Own experience_____ By studies_____ By family tradition_____ By hobby_____

With whom do you share the knowledge you have about the uses and information of this group of plants?
Parents_____ Children_____ Siblings_____ Uncles_____ Nephews _____ Neighbors_____

Do you think that the knowledge that the communities of the Reserve have about orchids is being lost? Yes_____ No_____

What do you consider to be the main reasons why this traditional knowledge about orchids is lost?_____