Ethnobotany and notes on conservation for *Tillandsia imperialis* (Bromeliaceae) in Huayacocotla (Veracruz, Mexico), a species in a risk category

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Notes on Ethnobotany

Abstract

Background: Easter is an important celebration in Huayacocotla municipality, Veracruz. The residents traditionally decorate the streets with representations of the Viacrucis, using plants for biocultural traditions.

Methods: The study took place in Huayacocotla municipality in Veracruz (Mexico) at Easter. We register plant species used in 11 floral arches and religious decorations. Some semi-structured interviews with people involved in the decorations and their perceptions are reported. We calculate IUCN categories based on species distribution.

Results: Every Good Friday, the local community includes several plants as *Dasylirion* sp. and bromeliads, for the decoration of arches and streets. Four tillandsias have been reported as being employed for these religious celebrations: *Tillandsia usneoides, T. deppeana* and principally *T. imperialis*, and recently *T. botterii. Tillandsia imperialis* is the main species used (at least 230 individuals) and it appears in the list of Mexican protected species in the NOM-059-SEMARNAT- 2010. Photographs of the biocultural process and suggestions for species conservation are included to promote species protection and implement strategies to continue using these plants, but with less impact on the wild population.

Conclusions: This study provides ceremonial plants data with current conservation status in Huayacocotla, Veracruz. We propose strategies that could be implemented by the authorities and addressed to the residents who can help to preserve cultural rituals while conserving the species.

Key words: Floral arch, NOM-059-Semarnat-2010, threatened species, IUCN, conservation, traditional knowledge.

Background

Bromeliads are an important component of the tropical montane cloud forest (TMCF), known in Mexico as montane mesophyll forest, as well as for their ethnobotany (Bennet, 2000; Benzing, 2000; Hornung-Leoni, 2011 a,b; Jiménez-López et al., 2018; Mondragon & Ticktin, 2011; Solano-Gómez *et al*., 2010).

The ethnobotany explored in this study is based on the traditional knowledge of the community, describing the ceremonial rituals and use of the plants in the locality, and provides the registration and description of the species used in arches, the conservation status of the most used species, and their tradition-environment relationship in the community. *Tillandsia* L. species are frequently used in ceremonial acts and have an important ornamental use in all Latin America. It has been estimated that more than 22 species of the genus have been used for ceremonial purposes, in most cases associated with traditions and particular dates, to decorate altars, streets and churches as is the case of *T. eizii*, *T. lucida*, *T. punctulata*, *T. multicualis* and *T. guatemaltensis* among others (Solano-Gómez *et al.*, 2010; Hornung-Leoni, 2011; Jiménez-López *et al.* 2019).

Tillandsia imperialis E.Morren ex Roezl is considered endemic to Mexico according to Espejo-Serna (2012) and is included in the NOM-059-SEMARNAT (henceforth NOM-059), an official list of endangered species, in the A category "at risk", which corresponds to “threatened” in the above-mentioned list (Semarnat, 2010). Its conservation status in the IUCN has not been estimated previously to this study. However, other sources indicate a wider distribution that includes Guatemala, Honduras and El Salvador (CONAP, 2010).

Actually, several *Tillandsia* species are used in ceremonial festivities and sold in markets in Mexico (Flores-Palacios & Valencia-Díaz, 2007; Haeckel, 2008; Hornung-Leoni, 2011 a, b); these plants are mainly extracted from forests without any management that can ensure their availability. However, more studies are necessary to better understand their relationship with humans (Haeckel, 2008). *Tillandsia* is a large genus that includes around 422 species (Espejo-Serna & López-Ferrari, 2018) that have been used for food, fiber, ceremonies, medicine and ornamental plants in many cultures like Aztecs and Mayas (Mexico), Incas and Quechuas (Peru), and Yanomami (Venezuela) (Bennett, 2000; Pierce, 2000; Rondón, 2003). In Latin America 33 species of *Tillandsia* have been reported as used in ceremonial events (e.g. Bolivia, Mexico, Peru, and Venezuela) (Hornung-Leoni, 2011b).

Tillandsia imperialis has a tank with a central inflorescence around 35–70 cm long, with 10–20 spikes per inflorescence. In Mexico, it has been reported from Hidalgo, Oaxaca, Puebla, Querétaro and Veracruz (Espejo-Serna & López-Ferrari, 2018). *Tillandsia deppeana* Steud. endemic to Mexico, has a pink inflorescence and is found in many regions, from Guanajuato, Hidalgo, Puebla, Querétaro, San Luis Potosí, Tamaulipas to Veracruz (Espejo-Serna & López-Ferrari, 2018). *Tillandsia botterii* E. Morren in Baker, endemic to Veracruz, has spikes two-colored spikes, red at the base and green at the apex. *Tillandsia usneoides* (L.) L. is the species with the widest distribution from southern Florida to Argentina (Benzing, 2000), mostly used in ceremonial events and to obtain fiber (Hornung-Leoni, 2011b).

The main objective of this study was to report the uses of *Tillandsia* species, focusing mainly on *T. imperialis*, during the religious festivities of Huayacocotla (Veracruz-Mexico), where they are used by the community to adorn the traditional arches. In addition to it, we intended to find out the number of rosettes used for the Viacrucis and to report their risk status. For us, it was also relevant to know the perception of the villagers about the plants used for their religious ceremonies, and present proposals for the preservation of both their cultural traditions and the plants employed in them.

In order to reach this purpose, we evaluated the conservation status under IUCN categories and provided information to promote a better use of the resources.

Materials and Methods

Study area

Huayacocotla is located in the northeastern part of the State of Veracruz, in the central eastern part of Mexico. Huayacocotla is a municipality well-known for its timber resources, mainly pine and oak species.

Field data

We observed that *Tillandsia* spp. was used during Good Friday celebrations (Easter week), April 14, 2017. We had already noticed its presence during several fieldworks from 2016 to 2018 and could confirm its use in streets and arches decorations in 2022 (Figure 1).

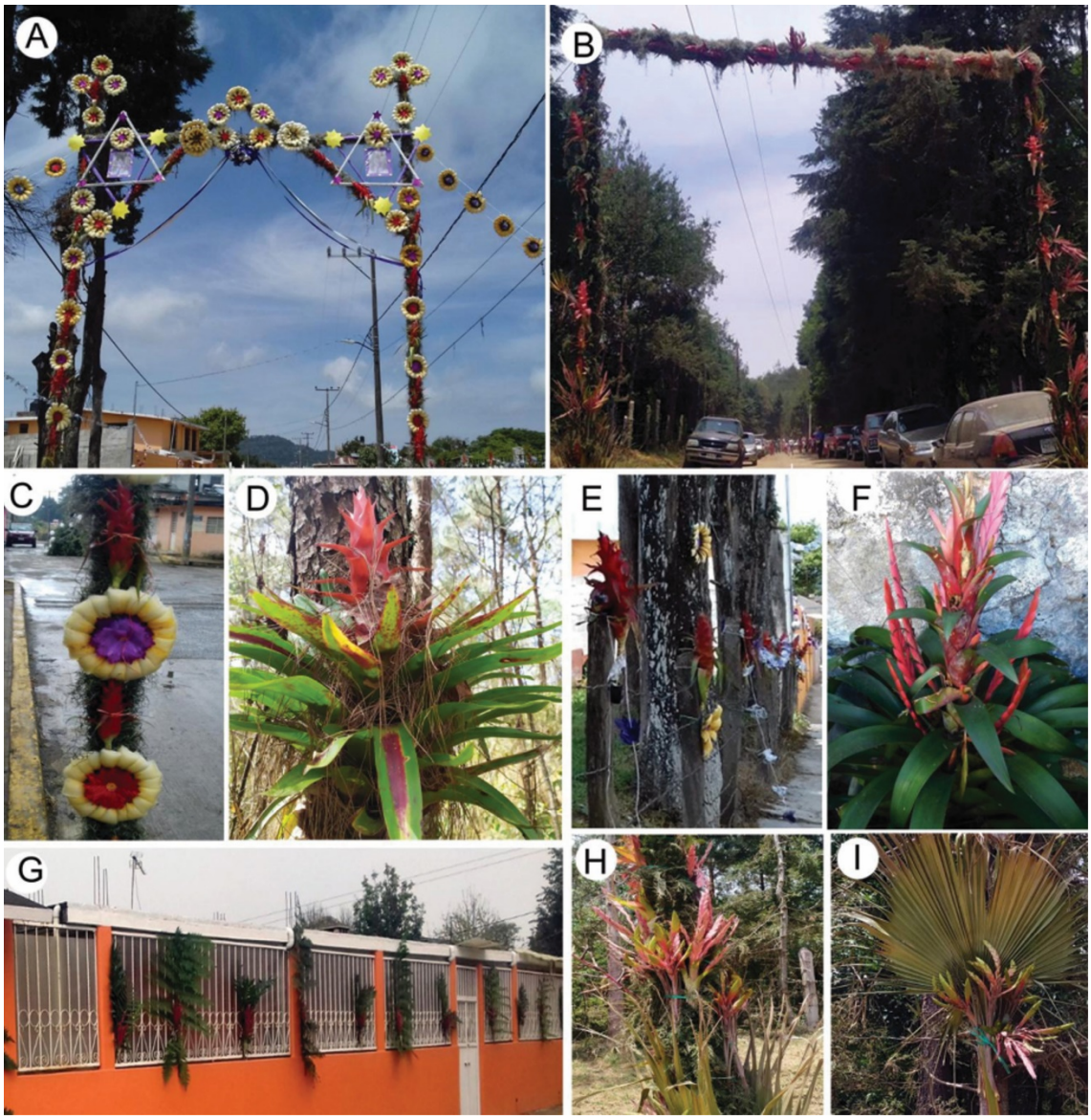

Figure 1. Arches in Huayacocotla: A) arches in 2017; B) arches in 2022; C) detail with *T. imperialis*, *Dasylirion* and *T. usneoides*; D) *Tillandsia imperialis* in habitat, E, G) street decorations with *T. imperialis* (2017); F) *T. deppeana*; H, I) *T. botterii* (2022). Photography ©Pérez-González.

In 2017 we prepared a semi-structured interview to get information about the parts of the plants the village people would use for the ceremonies, the place they extracted them from, other non-ceremonial uses as well as information about the interviewee (age, sex and village).

People keep their tradition of Viacrucis building arches and decorating the streets of the village (Figure 2).

Many people collaborate in the decoration of 11 arches, each led by a foreman. We noticed that only four of the arches used *T. imperialis* (Table 1), therefore merely their leaders, representing the whole group, were interviewed (Table 2).

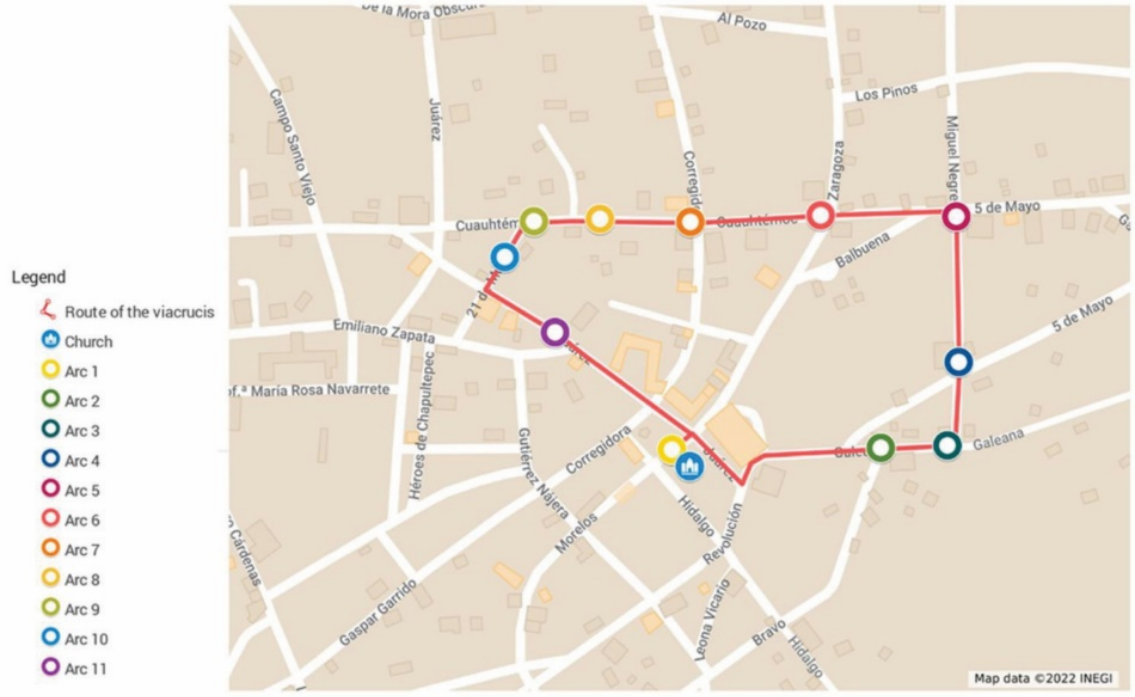

Figure 2. Route of the Viacrucis procession in Huayacocotla, Veracruz. The locations of the eleven arches are indicated.

Tables 1. Number of floral arches and number of samples in which *Tillandsia imperialis* was used in ceremonies in 2017.

Number of individuals used in arch	Arch number	Number in fences of houses
32	1	0
22	2	18
92	3	34
32	4	0
Total: 178	**Total: 4/11**	**Total: 52**

Table 2. Information compiled from the semi-structured interviews in the arches. Out of a total of 11 arches, the 4 opinions of arch foremen are included.

Age of interviewee (years)	Gender	Origin of the interviewer	Other uses of the interviewer (different to ceremonial)	Extraction from	Distance from the town of Huayacocotla to the collection site (in km)
60	♂	Huayacocotla	none	Zilacatipan	15
51	♂	Huayacocotla	Ornamental	La Paloma Boca del Perro	18.5 7.5
25	♂	La Selva	Ornamental	Helechales Los Ocotes Tzitzabí	 12.5
40	♂	Los Parajes	Ornamental	La selva La mina vieja El zorrillo	6.4

The streets decoration had no responsible leader. The number of individual plants of *T. imperialis* used in the floral arches was counted in the streets of the locality to realize the quantity of species extracted during a single week, and the

consequences this implies in species population. In 2022, information and pictures of the "*Fiesta de la Santa Cruz*" (Holy Cross Festival) in May was documented (Figure 1 H, I).

Botanical specimens

We only collected in Mexico, in Veracruz state. Bromeliads vouchers were deposited in HGOM herbarium (UAEH) for the following species: *Tillandsia imperialis* (Y. Pérez #12, 18), *T. deppeana* (Y. Pérez #23, 33), *T. botterii* (Y. **Pérez** #25, 36) and *T. usneoides* (Y. Pérez #43). Species names are standardized according to World Flora Online (WFO, 2022).

Data analyses

The IUCN category for *T. imperialis* data was determined from herbarium collections in Mexico (HGOM, MEXU), and information from databases (Gbif) including the complete distribution of the species was included.
IUCN criterion B (geographic distribution) was used to establish the risk category: sub-criteria B1 (extent of occurrence, EOO) and B2 (area of occupancy, AOO) were calculated using GEOCAT (Bachmann *et al.*, 2011), and field observations were also included to complement information on the status of specimens in the field.

Results

According to information gathered locally, the *Tillandsia* plants were picked in the forests around the municipality. The Viacrucis celebration is very important for local residents, and their tradition requires to decorate the streets with floral arches. They remarked that this tradition had existed for at least 50 years and affirmed that the plants were mainly collected from the woods or purchased at local street markets.

Species

In general, although residents consider that many epiphytes are a plague or parasitic plants, they do not have any detailed information about the species they commented that each year they must go deeper into the forest in order to find them. The species mostly used during the yearly celebrations is *T. imperialis,* called "**tecolote**". In 2017, we could identify 178 individual plants on 4 arches and about 52 additional plants decorating fences and railings, for a total of 230. The number of specimens of *T. imperialis* was also very high in 2017 as shown in this study (Table 1). The route of the Viacrucis procession and the location of the decorated arches can be seen in Figure 2.

Other species used in this festival, even if in a lower proportion than *T. imperialis,* were *T. usneoides,* called "**heno**" by the villagers, and *T. deppeana* (also known as "**tecolote**") (Figure 1). Other plant species included in arrangements were *Dasylirion*, *Dryopteris*, *Brahea*, *Juniperus*, and some Asteraceae.

Floral arches were also made during the first days of May, celebrating the Holy Cross. In 2022, the floral arches had fewer specimens of *T. imperialis* and we documented the use of *T. botterii*, which apparently had not been used previously.

Considering the whole distribution (Mexico, Guatemala, El Salvador and Honduras), our analyses show the EOO is 478,584 km^2, within the threshold for "LC" (Least Concern) status under subcriterion B1 (occurrence) whereas the AOO is estimated at 576,000 km^2 (subcriterion B2, occupancy) which is below "Vulnerable" status under subcriterion B2. According to the IUCN, the category that should be assigned in similar cases is that of the Vulnerable [VU B1ab(iii)+2ab(iii)]. Furthermore, in Mexico, the specimens are restricted to TMCF, and some of its populations are subject to the effects of habitat fragmentation due to deforestation.

Discussion

As previously reported, some bromeliads were used in religious ceremonies in Mexico (Bennet, 2000; Haeckel, 2008; Hornung-Leoni, 2011b) such as *T. multicaulis, T. punctulata,* and *T. usneoides,* among other species (Hornung-Leoni, 2011b; Sandoval-Bucio *et al.*, 2004; Villavicencio & Pérez 2005). The species most used in ceremonies in Hidalgo is *T. imperialis* (Hornung-Leoni, 2011b), and in this study we report that the four species of *Tillandsia (T. usneoides, T. deppeana, T. botterii* and *T. imperialis)* are used in ceremonial festivities every year in Huayacocotla, being the latter the most used in the locality.

Although the community in general uses *Tillandsia imperialis* and *T. deppeana* for ceremonial purposes, they mentioned that, even if they do not know the reason, that they have been using it for many years and up to now. This is not surprising because, due to its colors, it is considered a striking plant for ceremonies, as it occurs in other cultures we mentioned above.

In Huayacocotla, people define the structure of this plant (inflorescence and bracts) as a “large and colorful flower that lasts”. Therefore, despite being exposed to the sun and without water, it is considered the ideal species for their purpose.

It should be pointed out that the ceremonial use does not imply a spiritual meaning of the plant and that its use in arches and religious festivities complies with the community desire of decorating the streets and main points of the Viacrucis with beauty and colorful designs. It is worthwhile to remember that this region used to have an abundant population of this species, that is considered representative of the area.

The plants are taken from their habitat by the villagers mainly for festivities. On some special occasions when they know that tourists may come or for Christmas, they extract some plants to sell them. On these occasions, you can see stalls where this species, that is considered an orchid, is sold for an approximate cost of about $ 50 MXN. Usually, the same people who arrange the arches for the events, go and extract the plants from their habitat or pay someone to extract them, they almost never buy them at the market.

The residents commented that to find *T. imperialis* they had to go every year deeper into the forest. Consequently, we could infer that people are conscious that the resources are not infinite, even if they do not seem to recognize the importance of this species nor what they can do to obtain more plants. We do not know if this is the reason why they included *T. botterii* in arches decoration in 2022. This situation, not previously observed, could possibly be due to the difficulty of finding reproductive individuals of *T. imperalis.* Nevertheless, steady monitoring in following years is highly recommended.

Our qualitative field observations in the area suggest that this forest, considered as a timber resource, has been threatened causing that epiphytes growing on trees are consequently affected by habitat extraction. We do not have much data on the threats to epiphytes throughout its distribution, however it can be stated that areas of timber exploitation such as Huayacocotla, as well as in TMCF where epiphytes generally inhabit, are in great risk in Mexico (Gual-Díaz & Rendón-Correa, 2017). The extraction of its host can, in this way, provoke the extinction of epiphytes. Considering these observations, including the possibility of declining habitat quality and deforestation, and with the results of the IUCN category analysis, we assigned a preliminary VU status to *T. imperialis*.

We consider that Huayacocotla residents and the local authorities need to be trained to recognize species at risk and how to use them without affecting *Tillandsia* populations. Therefore, ample demographic studies are suggested to demonstrate the status of the species populations. We also informed residents and municipal authorities about our study and suggested short courses on the species conservation and propagation to reduce the impact on plant populations because of their use during the festivities. We consider that this information should reach both the community and authorities, if we want to preserve biodiversity in the region.

Suggestions and strategies to preserve species and festivals

The reason why the bromeliads were extracted without management measures seems to be related to the lack of knowledge. Most villagers do not know that plants should be processed nor that they are species at risk. Since they consider these plants as “parasites”, they are not conscious that they can affect them. Actually, there is no training program on the use and conservation of plants or traditions related to the use of non-timber resources. Both the lack of support to the municipality and the lack of knowledge and culture of environmental care convert *T. imperialis* into vulnerable species.

Local uses represent the transmission of knowledge to later generations, as well as an important cultural heritage; but it is necessary to equilibrate the use of natural resources to preserve culture and species. *Tillandsia* species can be conserved *in situ*. For these festivities, only the red inflorescences are important to the people, and one option could be to only cut the inflorescences and avoid cutting or damaging the rosettes. Even in the case the entire plant had been removed, people must know that it could be put back on the tree and continue to be alive, but only if the vegetative part had not been damaged. Due to the biology of the species, after the blooming period, the mother plant dies, but in many cases two or more vegetative shoots are generated at the base (Hornung pers. obs.), so it is very important that the rosette is not destroyed. In this way, even if the inflorescence is pruned or removed and the vegetative part is preserved, the plant can survive and produce an inflorescence in subsequent years. We consider important to discuss this technique with the collectors.

We also suggest that leaving some clusters of individuals with reproductive rosettes without extracting their inflorescences, will facilitate reproductive exchange and complete the cycle; in this way, new seeds propagation will be produced to preserve the healthy genetic diversity of this population. Thereby, we can protect tradition and bromeliad species populations as well,

promoting both reproduction types (vegetative and reproductive), taking care of rosettes and not extracting all individuals in the same area. In fact, generally people only look for fertile plants without any specific dynamics.

Another strategy is to promote collection of individuals fallen in the forest to be cultivated *in situ* or in greenhouses (*ex situ*). Cultivated plants can produce another clone in the following years (Hornung per. obs.), while if the plant remains in the soil, it can dry out and die within a few months.

All these strategies could be implemented for all species (bromeliads and others) used in festivals, because even if only one species is included in NOM-059, many species are continuously extracted from their natural environment in important proportions.

Even if *T. usneoides* is the most widely distributed species, it is one of the most used in Latin America for various purposes (Hornung-Leoni, 2011b). It is continuously extracted and considered as a plague, so it is important to regulate the quantity of the extraction of this species in its habitat.

According to the IUCN criteria, this study determines the preliminary status of "Vulnerable" for *T. imperialis.* Although this species is recorded not only in Mexico, it is also important to note that in this type of vegetation, there are risk factors (Gual-Díaz & Rendón-Correa, 2017), such as deforestation and impact on the TMCF in which it grows, as well as its overexploitation for events such as the one described in this work. Furthermore, bromeliads require several years to reach the reproductive stage (Benzing, 2000), so that in species with low abundance in the field, the extraction rate usually exceeds reproduction and flowering.

Another option would be to propose an "Unidades de Manejo para la Conservación de Vida Silvestre" (UMA), that is an environmental management unit to preserve several species at risk such as bromeliads and/or epiphytes as well as other families that are more commonly used, to promote a protection area that could minimize the effect of the forestry activities in the area. This would require an environmental management plan, registration at the proper organism ("Secretaría del Medio Ambiente y Recursos Naturales": SEMARNAT) and the support of the communities, as well as the consent of the landowners. *Ex situ* conservation can be carried out with a cultivation plan, using both seeds and vegetative propagation. In addition, some of the rosettes can be recovered from the soil and cultivated for propagation.

In fact, Easter is not the only occasion when Huayacocotla people used bromeliads. We documented that they were also used for decoration for the town's patron saint festivals (2017 and 2018), which are held a week before the beginning of Lent, as well as in the celebration of the Holy Cross in May (2022).

Conclusions

Four species of *Tillandsia* (*T. usneoides, T. deppeana, T. imperialis*, and recently *T. botterii*) were used in floral arches during religious ceremonies in Huayacocotla. The main species was *T. imperialis* (A category (NOM-059) which, based on distribution data, was classified as Vulnerable (IUCN) and consequently more in need to be protected. Strategies need to be implemented to preserve species and the traditional celebrations as well. In order to achieve both goals, we recommend that the local people actively participate in the protection of their own environment.

Declarations

Ethics approval and consent to participate: All participant gave their prior informed consent. Residents were informed about the study and their approval was sought to include (anonymously) the interview information.
Consent for publication: Not applicable.
Availability of data and materials: All the data obtained from informants during the study are included in the manuscript.
Competing interest: the authors declare that they have no conflicts of interest.
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Author contributions: YPG obtained the field data, conducted the interviews and reviewed the manuscript; CTHL managed the project, drafted and edited the manuscript and images, and calculated the IUCN category.

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