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Taxus globosa Schltdl. (Taxaceae). Distribution and Diagnosis of an Endangered Yew

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Abstract: After prospecting the vast majority of the populations and consulting herbarium collections and literature, data of distribution and demography of the Mexican populations of *Taxus globosa* is presented. Besides, the global distribution as the status of the species and its ecology is reviewed. Some populations are well preserved, however most of the prospected populations are under risk of anthropogenic disturbances. No real direct use of the species is performed, but other activities put pressure in their very small populations. With the data compiled, a preliminary diagnosis of its natural state is exposed towards the management and conservation of the species.

Keywords: Anthropogenic Disturbances, Conservation Ecology, Global Distribution, Mesoamerica, Mexican Yew, *T. globosa*

1. Introduction

The genus *Taxus* L. (*Taxaceae*) is distributed almost entirely throughout the northern hemisphere. The existence of four *Taxus* species is widely recognized in the American continent [1]. In the northernmost area of North America, *T. Canadensis* inhabits the Atlantic Coast of USA and Canada, while *T. brevifolia* is on the Pacific coast. *T. floridana* or *T. globosa* var. *floridana sensu* Spjut [2] - is located in the Apalachicola River Basin, a species displaying very restricted distribution at specific locations within the State of Florida [3]. Finally, the species considered as the subject of this work, *T. globosa* Schltdl. is one of the least studied species that inhabits the southernmost area, specifically in cloud forests located in Mexico and to the north of Central America [4].

This species, more widely known as Mexican Yew, has a disjoint distribution in Mexico along the length of the Sierra Madre Oriental (in the States of Nuevo León, Tamaulipas and San Luis Potosí, Querétaro, Hidalgo, Puebla and Veracruz) and the Juarez Sierra in Oaxaca and the sierras of Chiapas. Knowledge about the actual distribution of Mexican Yew is more diffuse and the size of its populations is much smaller in the Neotropical biogeographic region. There are numerous records with as little as 30-40 individuals per population in Sierra Juárez in Oaxaca. *T. globosa* herbarium specimens have been found in cloud forests belonging to Los Altos de Chiapas [5]. This yew also lives in Guatemala´s humid montane forests [6, 7] located at Las Minas Biosphere Reserve, Sierra de los Cuchumatanes and the Volcanic Chain. In El Salvador, very small nuclei are residually located in remote areas near to the top of Cerro del Pital [8] at 2,670 m (ASL). A few kilometres away towards the west, in Honduras, the species lives in Santa Bárbara National Park, in addition to several locations inside the Celaque National Park, a place considered as the southernmost limit of its global distribution [22].

2. Morphological and Autoecological Nature

T. globosa is a tree that does not exceed 15 m in height and 60 cm in trunk diameter; so, it is a smaller species than *T. baccata,* and more related to the rest of the American species along the Eastern seaboard, such as the shrub-like *T. canadensis*. For the American plant, the needles are more shiny, elongated and acuminate at the apex, with a more visible dark green colour along the middle nerve areas and underside margins. The aril and seed are the *T. globosa* hallmark, these are more rounded and compressed; this is why, in 1838, Diederichvon Schlechtendal described it as *Taxus baccata* var. *globosa* [9]. The species grows preferably on well drained, acidic soils, rich in inorganic matter. The altitudinal range of distribution fluctuates from1,100 to 2,960 m (ASL). The highest altitude is found in the cloud forests of Oaxaca exceeding 2,600 m (ASL) which is the maximum altitude reached by *T. baccata* in the High Atlas of Morocco [10, 11].

One of the most notable autecological features of Mexican Yew is its distinctly nemoral nature. *T. globosa* occurs exclusively in sheltered and shady bottoms of canyons that shows permanent or seasonal standing water; the species presence depends on the canopy above filtering out a large amount of the direct solar radiation. The species needs an annual rainfall over 800 mm but which can exceed 2,500 mm. For example, in forests of the State of Hidalgo, where we detected a recent expansion of the species, yew inhabits a temperate and sub-humid climate under a canopy of *Abies religiosa* (Kunth) Schltdl. & Cham. This protective cover significantly reduces evapotranspiration rates inside the forest. In this area, rainfall ranges from 1,000 to 1,200 mm excluding horizontal precipitation that should increase considerably the total amount. The average annual temperature in those well preserved forests is 14° C [4].

3. *T. globosa* Habitat

The Mexican yew woods are characterized by their distribution within a broad and discontinuous latitudinal gradient. They are isolated by lower and warmer areas including semi-desert areas. Usually, these formations record a high orographic precipitation, mild climate and high floristic complexity that varies even between nearby sites [12]. For example, Luna-Vega*et al*. [13] describes these forests as typical vegetal communities that exist in temperate zones, where there is a subordinated floristic element of subtropical nature. Structural formations coexisting with yew in Mexico are mixed pine-oak forests: *Pinus pseudostrobus, P. ayacahuite, P. patula, Arbutus xalapensis, Quercus crassifolia, Q. germana, Q. rysophylla, Q. laurina* and *Tilia mexicana* among many others and fir forests *(Abies religiosa* and *A. vejarii).* The yew also occurs in cloud forests alongside species belonging to this type of formations such as *Ostrya virginiana, Liquidambar styraciflua, Cornus disciflora* to name some widely distributed species [9, 13, 14]. In Mesoamerican montane forests (located at southern Mexico, Guatemala, Honduras and El Salvador), the species is typically associated with *Pinus ayacahuite* and *Abies guatemalensis* [7].

Figure 1. *Global distribution of T. globosa.*

4. Methodology

After reviewing herbarium collections, analysing related literature, and several interviews in local communities, a complete census of *T. globosa* in Mexico is achieved. In 29 of these populations we made a survey and *in situ* characterization, gathering data about number of individuals, geographic location, altitude, regeneration recruitment and other parameters. With this information the conservation value of each location (classified as favourable, inadequate and unfavourable) was created following a model already tested for *T. baccata* [33]. After this, an analysis of the data collected was performed in order to offer a wide view from ecological aspects and the conservation of the species and its habitat. Further, geographic data was gathered to create a map of the natural distribution of *T. globosa* including the localization of the species in Guatemala, Honduras and El Salvador (Figure 1).

5. Results and Discussions

To date, in the Mexican territory, a total of 75 populations of *T. globosa* have been located in Mexico (Table 1). The vast majority of these nuclei contain less than 100 adult individuals. From the 29 characterized and inventoried populations, only 11 of them showed spontaneous regeneration and its overall proportion of male/female individuals is approximately 1/1.3 [15]. 12 of these characterized populations were considered under favourable condition, 12 unfavourable and 5 with inadequate information (Table 2). Consequently, we can say that demographic bottlenecks, that require a more detailed and specific study, are frequent. However, there are a few yew stands that currently exhibit a remarkable regeneration due to diminished human intervention and their difficult access. These are roughly focused in at least two large areas: one is located in the central and southern area of Nuevo León in north-eastern Mexico, including many nuclei within the municipalities of Zaragoza and Santiago. Here there are *T. globosa* populations with many individuals registered in a census: Las Tinajas with 3,035 individuals and Potrero Redondo with 3,460 [14]. These same authors conducted a demographic study in several northern populations that included a classification by forest mensuration with class intervals (height-diameter) that allows inference of the inter-annual evaluation of the recruitment dynamics, as well as disturbance changes that occurred in a spatio-temporal scale for the studied yew populations. The second zone is located hundreds of miles towards the south and represents what might constitute a set of meta-populations distributed in the headwaters of the deepest valleys that define El Chico National Park in Hidalgo. This zone is located in the central-eastern area of Mexico and includes populations showing abundant regeneration such as those located in two ravines: “Cañada Los Ayacahuites“and “Pueblo Nuevo Canyon”, each of them with next to 150 mature trees in a very well preserved area.

5.1. Key Mechanisms of Ecological Interaction

Once some of the more "healthy" Mexican Yew stands in ideal situations were pinpointed, one wonders, what could be the factors involved in the success of its establishment? The average production of fruits per tree for *T. globosa* is very limited: 40-50 seeds/adult female per year [16]. This fact was subsequently confirmed from seed collection from multiple locations and across years. Mast year occurred every two and three year, and some trees do not have any seed in a year. This circumstance may be due to the purely shade-tolerant nature (sciophilous) of the species in the sense of [32] who detected that lack of light causes a decreasing production of flowers in some European yew populations. Seed viability has been investigated using the tetrazolium test to analyze the seed viability from different populations [15, 17] and those obtained in 2011 for the present work. The maximum percentages of viable seed obtained globally were 98%, 75% and just 21% respectively. Further, germination capacity is very low especially in the stands from central Mexico [17]. Thus, in these vigorous yew stands, a successful recruitment of new individuals, having so little seed rain and fluctuating viability values, is a fact that catches the eye, especially when it is compared to European species that easily reach seed production averaging several thousand seeds per individual per year.

Table 1. *Located populations of* Taxus globosa *in Mexico.*

Nº	Population	State	Latitude	Longitude	Height (msnm)
1	La Ciénega	Nuevo León	25º 22' 35"	100º 13' 15"	1460
2	El Manzano	Nuevo León	25º 22' 29"	100º 12' 39"	1460
3	El Manzano-VitroParque	Nuevo León	25º 22' 27"	100º 13' 05"	1470
4	El Cilantrillo	Nuevo León	25º 21' 15"	100º 20' 00"	1890
5	San Isidro	Nuevo León	25º 20' 50"	100º 18' 15"	2055
6	El Tejocote	Nuevo León	25º 19' 20"	100º 15' 30"	1970
7	La Camotera	Nuevo León	25º 16' 45"	100º 15' 10"	1760
8	Cañada La Trinidad	Nuevo León	25º 14' 49"	100º 09' 20"	1361
9	La Trinidad	Nuevo León	25º 14' 00"	100º 08' 30"	1400
10	El Butano	Nuevo León	25º 10' 50"	100º 08' 00"	2000
11	Cañada Agua Fría	Nuevo León	24º 02' 20"	99º 42' 50"	1890
12	Cañada La Era	Nuevo León	24º 02' 15"	99º 44' 05"	2350
13	Cerro El Viejo	Nuevo León	23º 59' 10"	99º 44' 30"	2 375
14	La Yerbabuena	Nuevo León	23º 55' 31"	99º 47' 58"	2100
15	La Encantada	Nuevo León	23º 55' 20"	99º 48' 20"	2385
16	La Tinaja (Cañada)	Nuevo León	23º 53' 25"	99º 47' 29"	2650
17	Puerto Purificación	Tamaulipas	23º 55' 20"	99º 28' 18"	1300
18	Galindo	Tamaulipas	23º 54' 00"	99º 27' 00"	2300
19	Los Caballos-Puerto Purificación	Tamaulipas	24° 04' 00"	99° 27' 00"	1 245
20	Reserva “El Cielo” N	Tamaulipas	23º 12' 25"	99º 13' 35"	1550
21	Reserva “El Cielo” S	Tamaulipas	23º 11' 46"	99º 13' 43"	1620
22	Joya de Salas	Tamaulipas	23° 10' 48"	99° 16' 26"	1 650

Nº	Population	State	Latitude	Longitude	Height (msnm)
23	Los Tres Cerritos	Tamaulipas	23° 07' 10"	99° 12' 00"	1350
24	Rancho El Cielo	Tamaulipas	23° 07' 00"	99° 12' 00"	1450
25	Ojo de Agua del Indio	Tamaulipas	23° 05' 45"	99° 12' 40"	1430
26	Sierra de Guatemala	Tamaulipas	23° 09' 00"	99° 18' 00"	1550
27	San José	Tamaulipas	23° 04' 48"	99° 13' 40"	1340
28	Casa de Piedra	Tamaulipas	23° 02' 48"	99° 14' 50"	1400
29	Arroyo del Tepaxtle	San Luis Potosí	21º 55' 40"	100º 16' 40"	2000
30	Cañada de las Avispas	Querétaro	21º 27' 26"	99º 07' 48"	1980
31	Cerro Grande	Querétaro	21º 25' 00"	99º 07' 00"	2300
32	Llano Chiquito	Querétaro	21º 24' 30	99º 07'30"	2120
33	El Salto	Querétaro	21º 14' 50"	99º 38' 30"	2 200
34	La Joya del Hielo	Querétaro	21º 13' 30"	99º 09' 35"	1 900
35	Cañada Los Granadillos	Querétaro	21º 12' 40"	99º 41' 00"	2400
36	Barranca El Bosque	Querétaro	21º 09' 40"	99º 40' 44"	2.600
37	Cañada de Agua Fría	Querétaro	21º 08' 14"	99º 41' 06"	2620
38	Agua Blanca Cerro	Hidalgo	20°22'01"	98°20'22"	2260
39	El Remudadero	Hidalgo	20º 22' 00"	98º 19' 00"	2250
40	Cañada Los Zorrillos	Hidalgo	20° 13' 16"	98° 43' 08"	2400
41	Cañada Los Ayacahuites	Hidalgo	20° 12' 25"	98° 43' 10"	2.630
42	Los Corrales-El Chico	Hidalgo	20° 12' 13"	98° 43' 33"	2550
43	El Conejo	Hidalgo	20°12'11"	98°43'28"	2500
44	Pueblo Nuevo	Hidalgo	20º 11' 04"	98º 40' 42"	2.530
45	Cuyamalolla	Hidalgo	20º 05' 23"	98º 32' 04"	2650
46	Barranca Rio Seco	Hidalgo			2 630
47	Estación de Honey	Puebla	20º 15' 00"	98° 12' 00"	2000
48	El Salto, Helechales,	Veracruz	20º 36' 00"	98° 26' 20"	1720
49	Viborillas	Veracruz	20° 29' 00"	98° 29' 20"	2 200
50	Buenavista	Veracruz	19º 44' 00"	96° 49'00"	2150
51	Cerro La Tolva	Veracruz	19° 39'00"	97° 08' 00"	2000
52	Pueblo Viejo	Veracruz	19º 31' 55"	97º 03' 15"	2140
53	El Encinal II	Veracruz	19º 31' 16"	97º 03' 08"	2500
54	Rancho Las Golondrinas	Veracruz	19º 30' 53"	97º 03' 33"	2649
55	Oxtlapa	Veracruz	19º 25' 20"	97º 06' 15"	2140
56	El Rincón Atotonilco	Veracruz	19° 09' 00"	97° 14' 00"	2 500
57	Cerro Mirador (C. Hueso)	Oaxaca	17° 40' 29"	96° 33' 54"	2 400
58	Río Perfume-Oeste	Oaxaca	17° 39' 00"	96° 32' 00"	2660
59	Río Perfume	Oaxaca	17° 38' 49"	96° 32' 26"	2 800
60	Puerto La Soledad	Oaxaca	17° 35' 15"	96° 34' 40"	2 500
61	Mirador	Oaxaca	17° 34' 43"	96° 29' 51"	2 800
62	Cerro Humo Chico	Oaxaca	17° 33' 00"	96° 30' 10"	2 800
63	Parte alta de la brecha	Oaxaca	17° 30' 00"	96° 30' 20"	2 950
64	El Carrizal	Oaxaca	17° 29' 20"	96° 41' 30"	2540
65	Llano Verde	Oaxaca	17° 29' 15"	96° 24' 00"	2200
66	Cruz de la Raya	Oaxaca	17° 18' 00"	96° 19' 00"	2460
67	Tepitongo	Oaxaca	17° 18'00"	96° 02'00"	1700
68	La Natividad	Oaxaca	17° 17' 40"	96° 26' 00"	2.500
69	El Quelite	Oaxaca	17° 17' 15"	96° 26' 30"	2 372
70	Capulalpa-Llano Verde	Oaxaca	17° 11' 30"	96° 22' 44"	2 400
71	Cañada de Torres	Oaxaca	17º 11' 03"	96° 22' 44"	2700
72	Cumbres de los Frailes	Oaxaca	17º 11' 00"	96° 24' 00"	2 500
73	Coapilla	Chiapas	17º 10' 00"	93° 10' 00"	1750
74	Tenalchen	Chiapas	16º 37' 00"	93° 20' 00"	2200
75	Jocosic	Chiapas	16º 50' 00"	92° 30' 00"	2 300

Table 2. *Number of trees and conservation condition of* T. globosa *in Mexico.*

Nº	Population	Mature trees	Condition
1	La Ciénega	27	inadequate
2	El Manzano	9	unfavorable
3	El Manzano-VitroParque	162	favorable
4	El Tejocote	436	favorable
5	La Camotera	100	inadequate
6	Cañada La Trinidad	208	favorable
7	La Trinidad	106	favorable
8	Potrero redondo	3460	favorable
9	Cañada La Era	657	favorable
10	La Yerbabuena	357	favorable
11	La Encantada	543	favorable
12	La Tinaja (Cañada)	3,035	favorable
13	Reserva "El Cielo"	100	inadequate
14	Mesas de San Isidro	123	unfavorable
15	Cañada de las Avispas	330	favorable
16	La Joya del Hielo	2	unfavorable
17	Cañada Los Granadillos	120	inadequate
18	Barranca El Bosque	4	unfavorable
19	Cañada de Agua Fría	55	unfavorable
20	Los Corrales-El Chico	57	unfavorable
21	Cañada Los Zorrillos	41	inadequate
22	Cañada Los Ayacahuites	153	favorable

Nº	Population	Mature trees	Condition
23	Pueblo Nuevo	166	favorable
24	El Remudadero	10	unfavorable
25	Cuyamalolla	110	unfavorable
26	El Encinal II	90	unfavorable
27	Barranca de la Funda	5	unfavorable
28	Capulalpa	11	unfavorable
29	Cañada de Torres	45	unfavorable

As noted above, the environments inhabited by *T. globosa* are characterized as moist microhabitats covered by an upper canopy formed by other species of larger size. This protecting cover could also serve as a bird perch accounting for the large number of yew juveniles thriving vigorously at short distances from adults of spruce, oak, pine, true fir (Figure 2) and to a lesser extent, from the existing yew adult individuals as seen in different species by other authors [18, 19]. Before the creation of new seedlings, the action of different dispersants is needed to make a decisive contribution to effective aril dispersal [20]. This means that the use as food of the few available arils could lead to the observed high recruitment rates. Thus, well-preserved, Mexican temperate forests are ecosystems with considerable capacity to shelter both forest-resident birds and bird species migrating through the Americas. From observations at Las Tinajas Mountain, Bluebirds (*Sialia currucoides*) eating yew arils during the fall have been detected (pers.obs.), which is likely complemented by the presence of other *Turdidae* birds - a very important family for yew dispersal – such as the Aztec Thrush (*Ridgwayia pinicola*), the Brown-backed Solitaire (*Myadestes occidentalis*), the Black Thrush (*Turdus infuscatus*) and the Clay-colored Trush (*Turdus grayi*) which are present in northern forestland communities of the Sierra Madre Oriental [21]. It is unknown whether there is some involvement in *T. globosa* dispersal by terrestrial mammals (foxes, badgers, weasels, etc.). On the other hand, hydrochory dispersal events should not be ruled out, due to the sub-riparian character of the species. We have not detected mechanical protection systems provided by other species (plant-plant mutualistic interactions) acting over young yew seedlings existing in the prospected area *sensu* García & Obeso [18].

Figure 2. *Juvenile yew growing beside an* Abies religiosa*. Promotion of hanger effect by the canopy individuals is very common in order to facilitate the recruitment of new plants.*

The other location was chosen because it contains burgeoning yew stands situated at Los Ayacahuites Gully within El Chico National Park. This fact represents an *a priori* major figure of protection. This territory has vast formations of *Abies religiosa* and several pine species in the lower levels and is one of the oldest forest reserves in Mexico. Also, particularly characteristic, the park's managers have a special awareness of Mexican Yew. In addition, for years, it has been the preferred area for the study of the species [15, 16, 17]. However, the Protected Natural Areas do not cover or guarantee the protection of *T. globosa* and its associated ecosystems across its distribution [22]. In addition, even in areas where the Mexican yew has been until recently regarded as abundant, the species may now be suffering a reversal or at least a collapse in regeneration dynamics within its populations. This is the case of some nuclei present in the Sierra Gorda Biosphere Reserve in Queretaro (Figure 3), where we observed an aging population in Los Granadillos

Gully and Agua Fría Gully, for example; this is due to increased livestock pressure and the cutting down of dozens of adult individuals. Paradoxically, some kilometres away, in Las Avispas Gully, there is an important yew nucleus-area managed by another communal group, different than that above, where the owner is aware of the environmental value of their surroundings.

Figure 3. *Female tree of* T. globosa *characterized in Sierra Gorda. Queretaro. Mexico.*

5.2. Importance of the Local Communities Implication

An obvious and predictable fact is that to promote optimal stability dynamics of this valuable yew stands needs the indispensable involvement of the existing human communities for conservation of the natural environment. In La Encantada Communal Land in Nuevo León - where, among others, the burgeoning yew population of Las Tinajas occurs - it is revealing to observe the management of the existing forest resources, which includes major logging of pines and oak species. However, this management is far less widespread throughout the whole territory; despite forest management by the community being a deeply-rooted custom, the reality of Mexican forests managed by local people is uneven and complex [23]. It has been highlighted that many human customs are the main limiting factor for the effective regeneration of the species. Consequently, most populations consist of adult specimens roughly dispersed in areas generally affected by disturbances such as timber extraction and excessive pressure by domestic cattle.

There are many voices warning about increased disappearance of these ecosystems in the American biogeographic and trans-frontier region known as Mega-Mexico, which is one of the global hotspots of biodiversity [24]. In recent decades, the deforestation problem has done nothing but worsen alarmingly: the area occupied by these cloud-forest formations has fallen by at least, 50% according to the National Commission for Knowledge and Use of Biodiversity-Conabio. Anthropic causes are clandestine and uncontrolled clear-cutting for wood extraction, recurrent forest fires and land-use changes generally for agriculture and livestock purposes [23]. To date, this increasing level of threat has been the major cause of decline of this unknown yew. Local extinction of the species has likely happened in the State of Mexico, where there are herbarium yew samples from the mid-20th century [9]. Recent disappearance of already isolated and fragmented populations has been noticed near to the northern El Cielo Reserve in Tamaulipas, in addition to the loss of a large number of individuals - only stumps remain - within some forests of Veracruz and Hidalgo. Both these previously mentioned Mexican States contain a high level of biodiversity; and in this sense, they are significantly affected by the relentless deforestation. A study of Contreras-Medina*et al.* [25] has analyzed, through predictive modelling, habitats housing yews in a macro-territorial way: since a few decades ago, the potential niche of *T. globosa* has probably disappeared by up to 80% in the last forty years.

5.3. Therapeutic Properties. Taxanes and T. globosa

As is known, yew is a potent anticancer agent. In the last two decades, studies of its biomedical properties have been extended to the Mesoamerican species [26]. Paradoxically, beginning forty years ago, this therapeutic attribute is reducing the populations of different species from the *Taxus* genus throughout North America; also, more recently, the Asian yew is decreasing even more dramatically in a pressing manner [27].

In Mexico, *T. globosa* populations do not seem to be currently significantly affected by this type of exploitation, except in El Tejocotal town, in Nuevo Leon (perhaps due to its easy access and its proximity to Monterrey City). However, this is possibly changing due to the growing demand for taxol intended for the global pharmaceutical industry. In other regions, there have been reports of selective extraction of yew in some Guatemalan forests [7]. Detailed and updated studies of the demographic situation of the species in the three Central American countries (Guatemala, Honduras and El Salvador) show high rates of deforestation and loss of biodiversity are happening. In our opinion, given the small size of the populations and their restricted global distribution, the commercial exploitation of the species will lead to rapid extinction in the short term. In this regard, *T. globosa* is included in the Official Mexican Norm (NOM-59-ECOL-2010) under its "in special protection" category [27]; and, in Guatemala, it appears in Conap [29] within the list of species requiring an environmental impact study before its possible use (included in Category 2 of the Red List of forest species). However, the economic incentive that will encourage plant extraction by certain members of local communities with high levels of marginality could be the trigger of illegal and uncontrolled exploitation, as is widespread in Asia [31].

6. Conclusions

In the 29 populations characterized in Mexico, 15 had a favourable conservation status, two an inadequate state and 12 populations are in unfavourable conditions. The region where *T. globosa* is best represented and best preserved is the Mexican state of Nuevo León followed by Hidalgo. In this sense, biggest problems of threat such as fragmentation and habitat degradation, low number of breeding individuals, and land use change is observed in a north-south gradient. Different authors confirm this spatial trend in the remaining populations of Guatemala, El Salvador and Honduras [7, 9]. The poor fruit production suggests that the species may be subject to both inter-annual pulses of regeneration and there is a population requirement for a minimum number of adult individuals with an adequate sex ratio in order to achieve effective pollination and minimum fructification rates. This phenomenon has been confirmed in studies conducted in *T. baccata* [34]. A deeper and specific research on autoecology of *T. globosa* is needed.

In summary, our preliminary diagnosis suggests that well-preserved Mexican Yew could match the following pattern: i) a need for a strong contingent of reproductive individuals to counteract the low fruit production per adult individual due to innate abiotic factors of its autecology, ii) the existence of a protective canopy against direct sunlight that also provides the perch effect of other tree species, iii) the need of positive interactions with frugivore dispersing birds and low pressure by herbivore species. Therefore, for satisfactory renewal of *T. globosa* formations, the existence of a heterogeneous, fully structured and minimally altered ecosystem is essential.

In order to mitigate the human pressure, a possible solution to boost preservation of some of the most vulnerable and accessible yew stands could be the setting up of green pathways which could serve both as touristic attractions and to bring sustainable income to the local communities currently managing these areas, as can be observed in the population of Las Viborillas (Veracruz).

Different strategies to improve the knowledge of ecological behaviour are needed. The main objective is to mitigate - or avoid in the best of cases - the threats described above; so that, multifunctional action planning includes the *in situ* characterization and conservation of existing populations, the active promotion of genetic diversity by creating living collections and *ex situ* seed sources for reproduction, and the progress in biomedical research in order to reduce provisioning problem by exploiting the wild yew. Multidisciplinary collab oration between institutions and working groups are becoming increasingly necessary. In the case of *T. globosa*, this cooperation has allowed the use of some of the techniques successfully applied in the active conservation of *T. baccata* in the Mediterranean area [30], because although large distances exist between the two species, the reality and necessity of conservation is the same.

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