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Orchid diversity at Cuetzalan del Progreso, Puebla, Mexico – anthropogenic threats and potential for organic production for conservation purposes

Introduction

The Puebla State, Mexico has not performed a comprehensive survey of the local orchid flora for a considerably long period. There are still fragments of tropical montane cloud forest and tropical rain forest in Puebla between the biogeographical provinces of the Sierra Madre Oriental and the Gulf of Mexico (Veracruz State border) which have not been totally explored. The current orchid species reported for the State can be attributed to random studies conducted in the past two decades.

Soto-Arenas (1988) recorded 127 species of orchids for Puebla and a decade later Espejo-Serna and López-Ferrari (1998a, 1998b) recorded 146 species. Recently, Pérez-Bravo et al. (2010) conducted collection of orchids in the pine-oak forest in the north-east part of Puebla in the Xochiapulco and Zacapoaxtla municipalities, recording 12 species that increased the total number of orchid members for the state to 158. Additionally, various taxonomic (e.g. Solano-Gómez, 1993; Soto-Arenas et al., 2007; Hágsater, Soto-Arenas, 2003, 2008) and floristic studies (e.g. Romero-Giordano, 2000) recorded through photographs and herbarium material another 14 species for the state, increasing the current number of species to 172.

The largest number of the species reported for Puebla is distributed mostly in the north-east and south-east parts of the state (Conabio, 2008), where the diversity of

the vegetation types of the Gulf of Mexico lowlands and the mountainous parts of the Sierra Madre Oriental makes these municipalities ecologically rich with high orchid diversity. This area is also considered as priority in conservation for its tropical montane cloud forest and tropical rain forest by the Comisión Nacional para el Conocimiento y el Uso de la Biodiversidad of Mexico (Conabio, 2008). However, no comprehensive study of the orchid flora of the region has been previously conducted to assess the number of orchid species and their conservation status in Cuetzalan del Progreso municipality.

Our objective has been to explore this habitat, collect and record with photographs different species of Orchidaceae and also to identify any anthropogenic factors impacting the survival and existence of the local orchids in this fragile and highly fragmented ecosystem. Furthermore, we were to establish a model for the sustainable management and to promote conservation action of species at some level of threat and in the restoration of areas with fragmented forests. A viable approach will be to allow the introduction of *in vitro* orchid germination program and organic production of orchids by local residents and forest fringe communities; that will improve the local economy, reduce their dependence on the scarce forest resources and prevent illegal harvesting and trafficking of wild orchids, and at the same time provide economic development for the local communities.

Materials and methods

Study area

Cuetzalan del Progreso is one of the municipalities of the State of Puebla in Mexico, that still has conserved fragments of tropical montane cloud forest (Fig. 1B) and tropical rain forest (Fig. 1C). This municipality is located in the north-eastern Puebla between the limits of the Eastern Sierra Madre and the Gulf of Mexico Provinces (Veracruz border) (Morrone, 2001, Fig. 2). This ecosystem is located at an altitude ranging between 180–1600 m, with semi-warm to warm humid climate and rainfall throughout the year (*Instituto Nacional de Estadística...*, 1987, 2009). The ecosystem also constitutes the pine-oak and tropical deciduous forests. However, these forests have been severely fragmented, unfortunately reducing them to minor fragments of vegetation due to drastic changes in land use pattern for cash rich coffee production and for establishing grazing areas for the local livestock and dairy herds (*Instituto Nacional de Estadística...*, 1985).

Botanical collections

As part of our study of the orchid flora of Mexico and as an effort to contribute to the knowledge of the flora of the Puebla and Cuetzalan del Progreso, photographic

documentations were made between December 2010 and November 2013. The specimens were photographed in their natural habitats. We have included the photos of the new records only (Appendix 1, Fig. 3–4). Some species were collected vegetatively and cultured in the Xoxoctic Botanical Garden in Cuetzalan del Progreso (20°2'22.63" N, 97°30'32.16" W) and when the plants later flowered, they were photographed and identified. The identification of specimens was made based on the digital catalog of the Orchids of Mexico (Soto-Arenas et al., 2007). The map of the study area was downloaded from the Free Relief Layers for Google Maps (2013) and edited with the Adobe Photoshop 6.0.1. (Adobe Systems Inc, San Jose, California). The line that divides the municipality into two biogeographic provinces is based on Morrone (2001) (Fig. 2).

Data collection of species of plants illegally traded in tianguis of Cuetzalan del Progreso

The "*tianguis*" in Cuetzalan del Progreso are informal markets that are established on the major streets of the town on Saturdays and Sundays between 7 am to 5 pm. Throughout 2013 we conducted weekly visits to record and identify species of orchids that are being sold there.

Results and discussion

Floristic inventory, new records of orchids for Puebla, conservation status and illegally trade

A total of 93 species were recorded in Cuetzalan del Progreso and it is quite exciting to report that 25 of these species are new reports for the Puebla flora (Appendix 1, Fig. 3–4). With our latest findings the number of orchid species in this specific habitat has now increased to 197. It is noteworthy that about half (47%) of the species present in Puebla (3 430 600 ha) are in the Cuetzalan del Progreso (13 522 ha), which demonstrates the wide diversity of Orchidaceae of this municipality.

Nine species are listed in the NOM-059-SEMARNAT-2010 (Semarnat, 2010) and one in documents of International Union for the Conservation of Nature (*IUCN Red list*, 2016) (Appendix 1). Of the new records, two species are listed as subject to special protection and one as threatened. The habitats where those species were photographed are quite close (ca. 500–1000 m of distance) to the surrounding human settlements and have been found to be severely deforested for indiscriminate agricultural activities and/or illegal timber collection of firewood by the local settlers.

While the survey identified 25 new records from the region, it also identified potential pitfalls in the efforts for the conservation of the rich biodiversity of the region, including the spectacular orchid species biodiversity for the first time. The species are extremely vulnerable to exploitation by local and indigenous populations. Irregular and

Fig. 1. Cuetzalan del Progreso, Puebla, Mexico. a – Mountains of the Eastern Sierra Madre, B – Tropical montane cloud forest, C – Tropical rain forest (Photo. R. Alvarez-Mora)

repeated harvesting of the species by local populations for illegal nursery trade could result in serious depletion of several species in the long term if careful attention is not paid immediately (Cetzal-Ix et al., 2014). The other threats for the orchid species are: lack of monitoring and increased encroachments in the forested areas over the decades

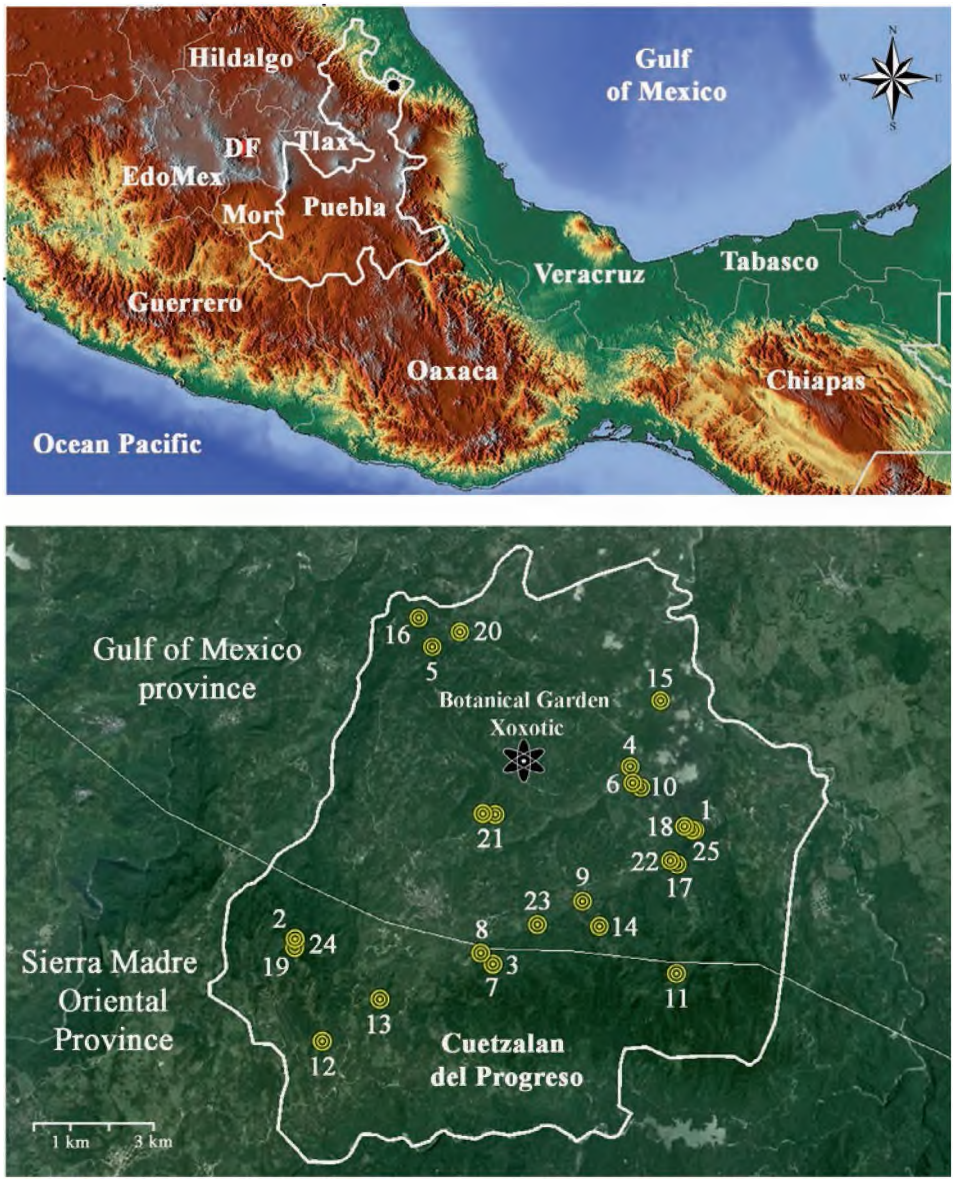

Fig. 2. Study area and distribution of new records in Cuetzalan del Progreso, Puebla, Mexico. 1 – *Acianthera angustifolia*, 2 – *Anathallis abbreviata*, 3 – *Aspydogyne querceticola*, 4 – *Campylocentrum micranthum*, 5 – *Chysis bractescens*, 6 – *Corymborchis forcipigera*, 7 – *Dichaea trichocarpa*, 8 – *Encyclia gravida*, 9 – *Epidendrum diffusum*, 10 – *Erycina pusilla*, 11 – *Gongora truncata*, 12 – *Habenaria floribunda*, 13 – *Heterotaxis maleolens*, 14 – *Jacquiniella equitantifolia*, 15 – *Leochilus labiatus*, 16 – *Lophiaris lurida*, 17 – *Ornithocephalus inflexus*, 18 – *Polystachya lineata*, 19 – *Prescottia stachyodes*, 20 – *Sacoila lanceolata*, 21 – *Scaphyglottis fasciculata*, 22 – *Scaphyglottis lindeniana*, 23 – *Specklinia alata*, 24 – *Stelis rubens*, 25 – *Vanilla planifolia*

Fig. 3. Study area and locations of new records of Orchidaceae species in Cuetzalan del Progreso, Puebla, Mexico; a – *Acianthera angustifolia*, b – *Anathallis abbreviata*, c – *Aspydogyne querceticola*, d – *Campylocentrum micranthum*, e – *Chysis bractescens*, f – *Corymborchis forcipigera*, g – *Dichaea trichocarpa*, h – *Encyclia gravida*, i – *Epidendrum diffusum*, j – *Erycina pusilla*, k – *Gongora truncata*, l – *Habenaria floribunda*, m – *Heterotaxis maleolens*, n – *Jacquiniella equitantifolia*, o – *Leochilus labiatus*, p – *Lophiaris lurida* (Photo. R. Alvarez-Mora)

Fig. 4. Study area and locations of new records of Orchidaceae species in Cuetzalan del Progreso, Puebla, Mexico; a – *Ornithocephalus inflexus*, b – *Polystachya lineata*, c – *Prescottia stachyodes*, d – *Sacoila lanceolata*, e – *Scaphyglottis fasciculata*, f – *Scaphyglottis lindeniana*, g – *Specklinia alata*, h – *Stelis rubens*, i – *Vanilla planifolia* (Photo. R. Alvarez-Mora)

by local populations; cattle and livestock grazing in sensitive habitats; collection of food, fuel, fodder and fertiliser resources from the forests are adding serious anthropogenic interferences within the sensitive and extremely fragile ecosystem due to absence of any legal restrictions and comprehensive forest management policy.

Many species of orchids present in Puebla state are confiscated from *tianguis* and private collections by the Federal Attorney for Environmental Protection (PROFEPA – Procuraduría Federal de Protección al Ambiente) (*UNIÓN*, 2013). In 2013, species rescued by PROFEPA from illegal trade estimated to over 1000 specimens

of orchids in Puebla alone (Islas, 2014). In this sense, 37 out of 93 species present in Cuetzalan del Progreso were recorded from *tianguis* of this municipality, involved in illegal trade of wild orchids (Appendix 1). Surprisingly, four new records presented here were observed on sale in different *tianguis* of Cuetzalan del Progreso (*Chysis bractescens*, *Dichaea trichocarpa*, *Encyclia gravida* and *Epidendrum diffusum*). Also, five taxa under the category of "threatened" (*Camaridium densum*, *Chysis bractescens*, *Mormodes maculata* var. *unicolor*, *Oncidium incurvum*, *Stanhopea oculata* and *Stanhopea tigrina*) and two species subject to "special protection" (*Prosthechea vitellina* and *Vanilla planifolia*) were also recorded from there (Appendix 1). Those species were sold for between 250–280 pesos (approximately US$ 18.85–21.11) (Barragán, 2013).

Organic production of local orchids

Based on our study, the risks of commercial exploitation of the local orchid species, as well as illegal harvesting and trade on them by the local human populations have been substantial. The average annual income of the majority of the family groups living around those biodiversity hotspots has been quite minimal in economic terms, barely sufficient to support them and to respond to their daily needs. As a consequence such remote rural residents and fringe forest dwellers have become increasingly dependent on whatever local forest resources are available for their sustenance. Slowly and steadily they have been encroaching illegally into the protected forested zones out of poverty and due to absence of any viable alternative sources of income. They are also getting involved in illegal trade and theft of forest resources (with local orchids becoming a primary target for ruthless exploitation) and slowly turning into an impending danger towards the destruction of the orchid biodiversity of this region.

We sincerely believe that the situation will not improve unless a sustainable approach is adapted to cater for the economic needs of the local resident populations in the region from a humanitarian perspective. If alternative sources of income, education, and health care are introduced in a timely fashion for those helpless communities, the benefits would come directly in the form of effective conservation of the local orchids and other floral and faunal biodiversity of the Puebla ecoregion. We humbly suggest the introduction of *in vitro* orchid germination program and organic production of local orchids in the small community run cooperative nurseries and development of small *in vitro* and plant tissue culture laboratories in the region. The local administration, the forest, and social services departments must cooperate to train enthusiastic residents into *in vitro* germination programme and organic production of orchids in those proposed cooperatives. Some interested and enthusiastic local and international non-government organizations (NGOs) dedicated to the cause of biodiversity conservation and helping remote rural communities in becoming self-suf-

ficient and economically sustainable could be included as important stakeholders for further facilitating of the process.

The plants, cut flowers and seeds generated in those government and/or NGO monitored cooperatives could be bought back by the forest department and they could be easily sold to bigger commercial nurseries in the nearby cities that have high demand for orchids. The plants and the seeds could be used in replenishing the reduced stocks of several populations of threatened orchid species in the local forests, thereby supporting the effort towards conservation of the local orchid biodiversity. Because there is a high demand for the local orchids, the factor can be rather explored to provide alternative employment for the needy local communities, as well as useful for conservation and biodiversity management too. If successful, the project could be extended to other local floral groups available in the local forests, for which there is high demand. Furthermore, as local communities are traditionally and predominantly agrarian societies, it would be easier to teach them the practices of organic production of orchids rather than trades of modern agriculture heavily tilted towards over application of agro-chemicals.

Commercial organic productions are suggested to avoid using excessive agro-chemicals in the production system that may in turn cause contamination and pollution of the locality, and hence indirectly impact the local forests, as well as to keep the production costs under control. The benefits of sustainable organic production will be higher economic returns for the community cooperatives, as well as reduced chances of undesirable pollution of the local environment. Another important concern and factor favoring the use of organic production of orchids by local cooperatives in this proposed model is that the adult plants and seedlings used as stocking and replenishment populations for conservation purposes in the remote forests are completely free of any external chemicals. The precaution is essential to avoid contaminating the local forest ecosystem as less as possible. All cares must be taken so that it does not transmit to other floral and faunal communities in the forest via food chains and food webs thorough the process of biomagnification, particularly by means of any biological pollinators.

Although the initial cost of establishing training centers, nurseries, greenhouses, and offices will be covered, in the end, if the project runs successfully, it could well turn out into a successful model that can be extended to other parts of Mexico and Latin America with similar and related anthropogenic threats for both economic benefits of the local communities, as well as conservation of local biodiversity. It will be extremely important to note that in the initial or founding years complete monitoring and surveillance of the production system will be absolutely essential. Strong government support, initiatives, training, funding, as well as political willingness and determination at the beginning to carry the project forward would be important in making the organic production of local orchids sustainable, viable and successful.

According to our humble evaluation, the first step in establishing this proposed model and platform will be to reach the local residents with empathy and patience, communicate with them through friendly dialogues, explain them the issues in simple terms and in the next stage slowly make them participants and stakeholders in the entire process. As they will realize and understand the benefits of the project, they will also reciprocally become respectful towards their local environment and they are expected to become partners in the conservation process in the long term. Based on this proposed model we sincerely believe that the promotion of commercial production of local orchids in the cooperative nurseries developed for the local rural communities and fringe dwellers could make significant sustainable changes both in the life of the resident communities and in the conservation of local orchid biodiversity.

Conclusions

We anticipate that if proper measures are not adopted by the local administration and by the forest department, several of the majestic species of orchids existing in the region will soon be threatened with extinction. Since we consider orchids to be flagship plant species highlighting the rich biodiversity of this unique ecosystem, the loss of the orchids from the region will also indicate indirect loss of several other key species from this sensitive and fragile ecosystem. Climate change and global warming are causing widespread impact on the survival of several plant species including orchids and their primary and secondary pollinators (Hegland et al., 2009). Similar impacts are also possibly affecting the orchid species at Puebla. In addition, the excessive anthropogenic stress in the region could have severe long-term impact on the survival and natural propagation of the orchid species of this region.

The majority of the new records reported here are also found to be distributed in Veracruz and in some cases in other states of south-eastern Mexico, such as Oaxaca and Chiapas. However, they represent an important contribution to the knowledge of the biodiversity of Puebla and even more when you consider the degree of fragmentation the forests of the State are now exposed too. It also suggests the importance of botanical explorations in this municipality and in other boundaries of the Sierra Madre Oriental and the Gulf of Mexico to the north-western portion of Puebla. This will possibly help to increase the existing number of taxa for orchids, as well as other plant groups present within this area and should be considered a conservation priority for its tropical montane cloud forest and tropical rain forest by the Comisión Nacional para el Conocimiento y el Uso de la Biodiversidad (Arriaga et al., 2009).

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Appendix 1

List of Orchidaceae species of Cuetzalan del Progreso, Puebla State, Mexico. Growth form: E – epiphytic, T – terrestrial, L – litophytic. Vegetation type: TMCF – tropical montane cloud forests, TRF – tropical rain forest, POF – pine–oak forest. Photographer: RAM: Raúl Alvarez-Mora; Conservation status: according to Nom-059-SEMARNAT-2010: a – threatened, Pr – subject to special protection; IUCN Red List (2016): LC – least concern. New records for the state (*). Species plants illegally traded in "*tiangui*" of Cuetzalan del Progreso, Puebla (†)

No.	Species	Characteristics
1.	*Acianthera angustifolia* (Lindl.) Luer	(E; TRF; 272 m; *RAM 2* Photo) (*)
2.	*Anathallis abbreviata* (Schltr.) Pridgeon & M.W. Chase	(E; TMCF; 886 m; *RAM 3* Photo) Pr (*)
3.	*A. sertularioides* (Sw.) Pridgeon & M.W. Chase	(E; TRF; 272 m; *RAM 93* Photo)
4.	*Aspydogyne querceticola* (Lindl.) Meneguzzo	(T; TRF; 1600 m; J. Santana et al. 10 UAMIZ)(*)
5.	*Bletia purpurea* (Lam.) DC.	(T; TMCF; 1381 m; *RAM 26* Photo) (†)
6.	*Brassia verrucosa* Bateman ex Lindl.	(E; TRF; 690 m; *RAM 27* Photo) LC
7.	*Camaridium cucullatum* (Lindl.) M.A. Blanco	(E; TRF; 557 m; *RAM 28* Photo) (†)
8.	*C. densum* (Lindl.) M.A. Blanco	(E; TRF; 713 m; *RAM 29* Photo) a (†)
9.	*C. meleagris* (Lindl.) M.A. Blanco	(E; TMCF; 1187 m; *RAM 30* Photo)
10.	*Campylocentrum micranthum* (Lindl.) Rolfe	(E; TRF; 389 m; *RAM 4* Photo) (*)
11.	*Catasetum integerrimum* Hook.	(E; TRF; 466 m; *RAM 31* Photo) (†)
12.	*Chysis bractescens* Lindl.	(E; TRF; 256 m; *RAM 1* Photo) a (*) (†)
13.	*C. laevis* Lindl.	(E; TMCF; 1377 m; *RAM 32* Photo) (†)
14.	*Coelia macrosthachya* Lindl.	(L; POF; 1429 m; *RAM 33* Photo) (†)
15.	*C. triptera* (Sm.) G. Don ex Steud.	(L; TMCF; 901 m; *RAM 34* Photo) (†)
16.	*Corymborchis forcipigera* (Rchb.f. & Warsz.) L.O. Williams	(E; TRF; 379 m; *RAM 5* Photo) (*)
17.	*Cyclopogon comosus* (Rchb.f.) Burns-Bal. & E.W. Greenw.	(T; POF; 1533 m; *RAM 35* Photo)
18.	*C. luteo-albus* (A. Rich. & Galeotti) Schltr.	(T; POF; 1552 m; *RAM 36* Photo)
19.	*Dichaea glauca* (Sw.) Lindl.	(E; TRF; 594 m; *RAM 37* Photo) (†)
20.	*D. intermedia* Ames & Corell	(E; TMCF; 1029 m; *RAM 38* Photo)
21.	*D. muricatoides* Hamer & Garay	(E; TRF; 688 m; *RAM 39* Photo) (†)
22.	*D. trichocarpa* (Sw.) Lindl.	(E; TMCF; 1068 m; *RAM 6* Photo) (*) (†)
23.	*Dinema polybulbon* (Sw.) Lindl.	(E; TRF; 929 m; *RAM 40* Photo)
24.	*Elleanthus cynarocephalus* (Rchb.f.) Rchb.f.	(E, L; TMCF; 1079 m; *RAM 41* Photo)
25.	*Encyclia candollei* (Lindl.) Schltr.	(E; TMCF; 1385 m; *RAM 42* Photo) (†)

26.	*E. gravida* (Lindl.) Schltr.	(E; TMCF; 948 m; *RAM 7* Photo) (*)
27.	*Epidendrum atroscriptum* Hágsater	(L; TMCF; 1028 m; *RAM 44* Photo) (†)
28.	*E. cardiophorum* Schltr.	(E; TRF; 549 m; *RAM 43* Photo)
29.	*E. diffusum* Sw.	(E; TRF; 663 m; *RAM 8* Photo) (*) (†)
30.	*E. eustirum* Ames, F.T. Hubb. & C. Schweinf.	(E; TRF; 1034 m; *RAM 46* Photo)
31.	*E. longipetalum* A. Rich. & Galeotti	(E; TMCF; 1390 m; *RAM 47* Photo) (†)
32.	*E. melistagum* Hágster	(E; TRF; 732 m; *RAM 48* Photo)
33.	*E. polyanthum* Lindl.	(E; TMCF; 1073 m; *RAM 49* Photo) (†)
34.	*E. ramosum* Jacq.	(E; TRF; 735 m; *RAM 50* Photo)
35.	*E. tuxtlense* Hágsater, García-Cruz & L. Sánchez	(L; TMCF; 616 m; *RAM 51* Photo) (†)
36.	*E. veroscriptum* Hágsater	(E; TRF; 1092 m; *RAM 52* Photo) (†)
37.	*Erycina pusilla* (L.) N.H. Williams & M.W. Chase	(E; TRF; 377 m; *RAM 9* Photo) (*)
38.	*Eulophia alta* (L.) Fawc. & Rendl	(T; TRF; 330 m; *RAM 53* Photo)
39.	*Gongora galeata* (Lindl.) Rchb. f.	(E; TRF; 738 m; *RAM 54* Photo)
40.	*G. truncata* Lindl.	(E; TMCF; 1065 m; *RAM 10* Photo) (*)
41.	*Habenaria floribunda* Lindl.	(T; TMCF; 1429 m; *RAM 11* Photo) (*)
42.	*Heterotaxis maleolens* (Schltr.) Ojeda & Carnevali	(E; TMCF; 1199 m; *RAM 12* Photo) (*)
43.	*H. sessilis* (Sw.) F. Barros	(E; TMCF; 1199 m; *RAM 56* Photo)
44.	*Isochilus latibracteatus* A. Rich. & Galeotti	(E; TRF; 726 m; *RAM 57* Photo) (†)
45.	*I. major* Schltdl. & Cham.	(E; TMCF; 991 m; *RAM 58* Photo) (†)
46.	*Jacquiniella equitantifolia* (Ames) Dressler	(E; TRF; 814 m; *RAM 13* Photo) (*)
47.	*J. teretifolia* (Sw.) Britton & P. Wilson	(E; TMCF; 949 m; *RAM 59* Photo)
48.	*Leochilus labiatus* (Sw.) Kuntze	(E; TRF; 417 m; *RAM 14* Photo) (*)
49.	*Lophiaris lurida* (Lindl.) Braem	(E; TRF; 211 m; *RAM 15* Photo) (*)
50.	*Lycaste aromatica* (Graham) Lindl.	(E; TRF; 846 m; *RAM 60* Photo) (†)
51.	*L. deppei* (Lodd.) Lindl.	(E; TMCF; 1435 m; *RAM 61* Photo) (†)
52.	*Malaxis excavata* (Lindl.) Kuntze	(T; POF; 1517 m; *RAM 62* Photo)
53.	*Masdevallia floribunda* Lindl.	(E; TRF; 592 m; *RAM 63* Photo)
54.	*Maxillariella tenuifolia* (Lindl.) M.A.Blanco & Carnevali	(E; TRF; 731 m; *RAM 64* Photo)
55.	*M. variabilis* (Bateman ex Lindl.) M.A. Blanco & Carnevali	(E; TMCF; 1080 m; *RAM 65* Photo) (†)
56.	*Mormodes maculata* var. *unicolor* (Hook.) L.O. Williams	(E; TMCF; 1205 m; *RAM 66* Photo) a (†)
57.	*Nidema boothii* (Lindl.) Schltr.	(E; TRF; 864 m; *RAM 67* Photo) (†)
58.	*Notylia barkeri* Lindl.	(E; TRF; 903 m; *RAM 68, 16* Photo)
59.	*Oncidium incurvum* Barker ex Lindl.	(E; TMCF; 1222 m; *RAM 69* Photo) a (†)
60.	*O. sphacelatum* Lindl.	(E; TRF; 489 m; *RAM 70* Photo) (†)
61.	*Ornithocephalus inflexus* Lindl.	(E; TRF; 545 m; *RAM 17* Photo) (*)
62.	*O. iridifolius* Rchb.f.	(E; TRF; 386 m; *RAM 94* Photo)
63.	*Platystele stenostachya* (Rchb.f.) Garay	(E; TRF; 735 m; *RAM 71* Photo)
64.	*Pleurothallis cardiothallis* Rchb.f.	(E; TRF; 763 m; *RAM 72* Photo)

65.	*Polystachya lineata* Rchb.f.	(E; TRF; 365 m; *RAM 18* Photo) (*)
66.	*Ponera juncifolia* Lindl.	(E; POF; 1434 m; *RAM 73* Photo)
67.	*Prescottia stachyodes* (Sw.) Lindl.	(T; TMCF; 1069 m; *RAM 19* Photo) (*)
68.	*Prosthechea cochleata* (L.) W.E. Higgins	(E, L; TRF; 963 m; *RAM 74* Photo) (†)
69.	*P. ochracea* (Lindl.) W.E. Higgins	(E; TRF; 706 m; *RAM 75* Photo)
70.	*P. pseudopygmaea* (Finet) W.E. Higgins	(E; TRF; 1050 m; *RAM 76* Photo)
71.	*P. pygmaea* (Hook.) W.E. Higgins	(E; TMCF; 816 m; *RAM 77* Photo)
72.	*P. radiata* (Lindl.) W.E. Higgins	(E; TRF; 777 m; *RAM 78* Photo) (†)
73.	*P. rhynchophora* (A. Rich. & Galeotti) W.E. Higgins	(E; TRF; 611 m; *RAM 79* Photo)
74.	*P. vitellina* (Lindl.) W.E. Higgins	(E; TMCF; 1340 m; *RAM 80* Photo) Pr (†)
75.	*Sacoila lanceolata* (Aubl.) Garay	(T; TRF; 385 m; *RAM 20* Photo) (*)
76.	*Scaphyglottis fasciculata* Hook.	(E; TRF; 886 m; *RAM 21* Photo) (*)
77.	*S. lindeniana* (A. Rich. & Galeotti) L.O. Williams	(E; TRF; 517 m; *RAM 22* Photo) (*)
78.	*Sobralia macrantha* Lindl.	(E, L; TMCF; 1077 m; *RAM 81* Photo) (†)
79.	*Specklinia alata* (A. Rich. & Galeotti) Soto Arenas	(E; TRF; 753 m; *RAM 23* Photo) (*)
80.	*Stanhopea oculata* (G. Lodd.) Lindl.	(E; TMCF; 1419 m; *RAM 82* Photo) a (†)
81.	*S. ruckeri* Lindl.	(E; TMCF; 997 m; *RAM 83* Photo) (†)
82.	*S. tigrina* Bateman ex Lindl.	(E; TMCF; 909 m; *RAM 84* Photo) a (†)
83.	*Stelis emarginata* (Lindl.) Soto Arenas & R. Solano	(E; TRF; 736 m; *RAM 85* Photo) (†)
84.	*S. nagelii* Solano	(E; TRF; 882 m; *A. Espejo 7173* UAMIZ)
85.	*S. ornata* (Rchb.f.) Pridgeon & M.W. Chase	(E; TMCF; 1476 m; *RAM 86* Photo)
86.	*S. pachyglossa* (Lindl.) Pridgeon & M.W. Chase	(E; TMCF; 961 m; *RAM 87* Photo)
87.	*S. platystylis* (Schltr.) Solano & Soto Arenas	(E; TMCF; 961 m; *RAM 88* Photo)
88.	*S. rubens* Schltr.	(E; TMCF; 1002 m; *RAM 24* Photo) (*)
89.	*S. veracrucensis* Solano	(E; TRF; 667 m; *RAM 89* Photo) (†)
90.	*Stenorrhynchos speciosum* (Jacq.) Rich. ex Spreng.	(E; POF; 1431 m; *RAM 90* Photo)
91.	*Trichocentrum candidum* Lindl.	(E; TRF; 582 m; *RAM 91* Photo)
92.	*Trichosalpinx ciliaris* (Lindl.) Luer	(E; TRF; 882 m; *RAM 92* Photo)
93.	*Vanilla planifolia* Andrews	(H; TRF; 277 m; *RAM 25* Photo) Pr (*) (†)

Abstract

The orchid flora of Puebla State represents 16% of the total species present in Mexico demonstrating rich biodiversity. However, several municipalities in the north-east of Puebla area are located within a conservation priority area for its tropical montane cloud forest and tropical rain forest due to decision of the Comisión Nacional para el Conocimiento y el Uso de la Biodiversidad of Mexico. We have recorded 93 species from Cuetzalan del Progreso with 25 new records of the flora of the state. These new additions thereby currently increase the orchid flora of Puebla to 197 species. Of these, six species are classified as threatened, three as subject to special protection by the NOM-059-SEMARNAT-2010 and one classified as least concern by the International Union for the Conservation of Nature. Moreover, we recorded 37 species illegally traded in "*tianguis*" (informal markets) of Cuetzalan del Progreso. The orchid diversity in the fragmented forests can be harnessed in establishing a model for the sustainable management and to promote conservation action of species at some level of threat and in the restoration of areas with fragmented forests. Unfortunately, the orchid diversity has been seriously endangered by several anthropogenic factors. We have also recorded significant anthropogenic threats in this municipality for the long-term existence of the local orchid members and species with potential for commercial production. A viable approach will be to allow the introduction of *in vitro* germination program and organic production of orchids by local and fringe communities; this will reduce inhabitants' dependence on the scarce forest resources, lessen illegal harvesting and trafficking of wild orchids, and at the same time provide economic development for the local communities.

Key words: anthropogenic factors, biodiversity, conservation, Cuetzalan del Progreso, Mexico, orchids

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Różnorodność storczyków w Cuetzalan del Progreso, Puebla, Meksyk – antropogeniczne zagrożenia i potencjał do produkcji ekologicznej w celach ochronnych

Streszczenie

Flora storczyków stanu Puebla charakteryzuje się dużą różnorodnością i stanowi 16% ogólnej liczby gatunków występujących w Meksyku. Kilka gmin w północno-wschodniej części Puebla, położonych w obrębie górskiego tropikalnego lasu mglistego i lasów tropikalnych deszczowych, jest szczególnie chronionych przez Krajową Komisję ds. Wiedzy i Użytkowania Różnorodności Biologicznej Meksyku. W Cuetzalan del Progreso odnotowano 93 gatunki storczyków, wśród których 25 było nowych dla flory tego stanu. Powiększyło to liczebność flory storczykowej Puebla do 197 gatunków. Spośród nich, 6 gatunków zaliczono do zagrożonych, 3 do podlegających szczególnej ochronie przez NOM-059-SEMARNAT-2010 oraz 1 sklasyfikowano jako gatunek najmniejszej troski wg Międzynarodowej Unii Ochrony Przyrody. Ponadto odnotowano 37 gatunków w nielegalnym handlu „*tianguis*" (na nieformalnym rynku) w Cuetzalan del Progreso. Różnorodność storczyków we fragmentarycznych lasach można wykorzystać w tworzeniu modelu zrównoważonego zarządzania i promocji działań ochronnych gatunków na tym samym poziomie zagrożenia oraz w odtwarzaniu tych obszarów. Niestety, różnorodność storczyków jest poważnie zagrożona przez kilka czynników antropogenicznych. W badanych gminach stwierdzono istotne zagrożenia antropogeniczne dla długoterminowej lokalnej egzystencji przedstawicieli storczykowatych oraz gatunków z potencjałem dla produkcji komercyjnej. Stosownym rozwiązaniem będzie możliwość wprowadzenia programu *in vitro* do kiełkowania i produkcji ekologicznej storczyków przez lokalne społeczności, co przyczyni się do poprawy miejscowej gospodarki, zmniejszenia jej zależności od ograniczonych zasobów leśnych oraz nielegalnego pozyskiwania i handlu dzikimi storczykami.

Słowa kluczowe: czynniki antropogeniczne, bioróżnorodność, ochrona, Cuetzalan del Progreso, Meksyk, storczyki

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