



A new species of Annonaceae, endemic to the limestone karst forests of Chiapas, Mexico

Una especie nueva de Annonaceae, endémica de los bosques kársticos de Chiapas, México

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Abstract:

Background and Aims: In Mexico, the Neotropical genera of Annonaceae tribe Miliuseae, including *Sapranthus*, *Stenanona* and the Mexican endemic genus *Tridimeris*, are particularly diverse and many of their species are endemic to this country. This diversity is not fully documented and many new species have been discovered as a result of recent botanical explorations in southern Mexico. Here, we describe a new species of *Stenanona*.

Methods: We collected a new species of *Stenanona* during field work in a little known karst forest area located in the highlands of Chiapas, Mexico. The new species was recognized using the unique combination of features through comparisons with morphologically similar species and literature review. We assessed its conservation status by calculating its extent of occurrence (EOO) and its area of occupancy (AOO) using the GeoCAT tool and applying the IUCN Red List Categories and criteria.

Key results: A new species of Annonaceae, namely *Stenanona morenoi*, endemic to karstic forests of southern Mexico, is described and illustrated. According to the criteria established by the IUCN, it is possible to tentatively determine the species as Critically Endangered (CR B1ab (iii)).

Conclusions: Based on its general floral morphology, *S. morenoi* is hypothesized to belong to subclade A of the *Desmopsis-Stenanona* clade. Within this lineage, *S. morenoi* shares several morphological features with *S. migueliana*, *S. stenopetala* and *S. zoque*.

Key words: cauliflory, Miliuseae, Neotropics, tropical rainforest.

Resumen:

Antecedentes y Objetivos: En México, los géneros neotropicales de la tribu Miliuseae (Annonaceae), en específico *Sapranthus*, *Stenanona* y *Tridimeris*, son muy diversos y muchas de sus especies son endémicas de este país. No obstante, su diversidad total no está completamente documentada y como resultado de recientes exploraciones en el sur de México, muchas especies nuevas han sido colectadas. En este artículo, se describe una especie nueva de *Stenanona*.

Métodos: Colectamos una especie nueva de *Stenanona* durante trabajo de campo en una zona de bosques kársticos poco estudiada y ubicada en las tierras altas de Chiapas, México. El reconocimiento de la especie nueva se basó en la correlación de varios caracteres morfológicos, a través de comparaciones con especies morfológicamente similares y revisión de literatura. Con base en las localidades conocidas para la nueva especie, calculamos su extensión de ocurrencia (EOO) y su área de ocupación (AOO) en GeoCAT, aplicando las categorías y criterios de la Lista Roja de la UICN, determinamos su estado de conservación.

Resultados clave: Se describe e ilustra a *Stenanona morenoi*, una especie nueva de Annonaceae endémica de los bosques kársticos del sur de México. Con base en los criterios establecidos por la UICN, es posible determinar, de manera tentativa, que la especie está en peligro crítico (CR B1ab (iii)).

Conclusiones: Dentro del clado *Desmopsis-Stenanona*, las características morfológicas que distinguen a *S. morenoi* sugieren una cercana relación filogenética con los miembros del subclado A. Dentro de este linaje, *S. morenoi* comparte varias características morfológicas con *S. migueliana*, *S. stenopetala* y *S. zoque*.

Palabras clave: bosque tropical perennifolio, caulifloría, Miliuseae, Neotrópico.

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Introduction

Tropical karst forests are very diverse biomes characterized by the high number of endemic species (Bystriakova et al., 2019). This huge diversity has been associated with their naturally fragmented distribution (archipelago-like), soil characteristics (shallow and poor in nutrients) and climatic oscillations of the past (Wendt, 1989). These characteristics have promoted the development of communities rich in species, with high levels of endemism and a unique physiognomy, structure and floristic composition (Brewer et al., 2003).

In Mexico, the Neotropical genus *Stenanona* Standl. of the family Annonaceae is particularly diverse and half of its species are restricted to the karst forests of this country, specifically to the Uxpanapa-Chimalapas region in Veracruz, the Sierra el Madrigal in Tabasco, and the Ocote area in Chiapas (Schatz and Wendt, 2004; Schatz and Maas, 2010; Ortiz-Rodríguez et al., 2014, 2018b). This greater diversity of the genus in karst forests could be the result of numerous events of allopatric speciation, where the naturally fragmented distribution of these forests and the dynamics in the time of isolation between islands of vegetation has promoted the disjunction between populations with different levels of morphological and genetic divergence (Wendt, 1989; Ortiz-Rodríguez et al., 2018b).

Here we describe a new species of *Stenanona* endemic to the karst forests of Chiapas, Mexico. The species can be distinguished from the other species of *Stenanona* based on its vegetative and reproductive characteristics, even exhibiting morphological characteristics not previously described for the genus. Like the other Mexican species of *Stenanona*, the new species presented here has a very restricted and allopatric distribution range. This discovery arises as a result of recent botanical explorations in little known karst regions in the highlands of northern Chiapas.

Material and Methods

The new species was recognized using the unique combination of features criteria (Donoghue, 1985) through comparisons with morphologically similar species and literature review. We visited and examined the specimens of *Desmopsis* Saff. and *Stenanona* deposited in the CHIP, HEM, MEXU and XAL herbaria (acronyms follow Thiers, 2019). Additio-

nally, we consulted the digitized type specimens available at JSTOR Global Plants (JSTOR, 2019).

Based on the only known localities for the species, we assessed its conservation status by calculating its extent of occurrence (EEO) and its area of occupancy (AOO) using the GeoCAT tool (Bachman et al., 2011) and applying the IUCN Red List Categories and criteria (IUCN, 2011).

Results

Taxonomy

Stenanona morenoi Ortiz-Rodr. & Moreno-Méndez, sp. nov., Figs. 1-3.

TYPE: MEXICO. Chiapas, municipio Chilón, ejido San Jerónimo, 1.42 km al sur de la comunidad Jol Cacuala, camino al predio de Don Jerónimo Moreno, 1520 m, 17°03'04"N, 92°04'35"W, 03.VII.2019, G. Moreno Méndez 87 (holotype: HEM!, isotypes: MEXU!, MO!, NY!).

Stenanona morenoi is similar to *S. migueliana* Ortiz-Rodr. & G.E. Schatz, *S. stenopetala* (Donn. Sm.) G.E. Schatz and *S. zoque* Ortiz-Rodr. & Gómez-Domínguez, but it can be distinguished from these three species by the combination of 2 or 4-flowered inflorescences, partially fused sepals, cream to light yellow flowers with a red blotch at the base of the inner petals, numerous ovules per carpel and surface of the monocarps completely covered with short, golden-brown, erect hairs, resulting in a velvety texture.

Trees 10-20 m tall, 28 cm diameter; young twigs, buds and petiole densely covered with appressed, golden-brown hairs; leaves distichous, oblong-elliptic, chartaceous, punctate with minute lens-like warts, 8-24 cm long, 3-8 cm broad, base obtuse to acute, apex acute to short acuminate, margins slightly revolute, upper side of leaves shiny and glabrous, lower side of leaves very sparsely covered with appressed, golden-brown hairs to glabrous; venation weakly brochidodromous with 8-14 lateral veins/side, midrib impressed above, raised below, densely covered with appressed hairs; petiole 5-10 mm long, ~2 mm diameter, canaliculate; inflorescence borne on leafless portions of old branches (ramiflory), 2 or 4-flowered, pedicels and outer side of bracts densely to rath-

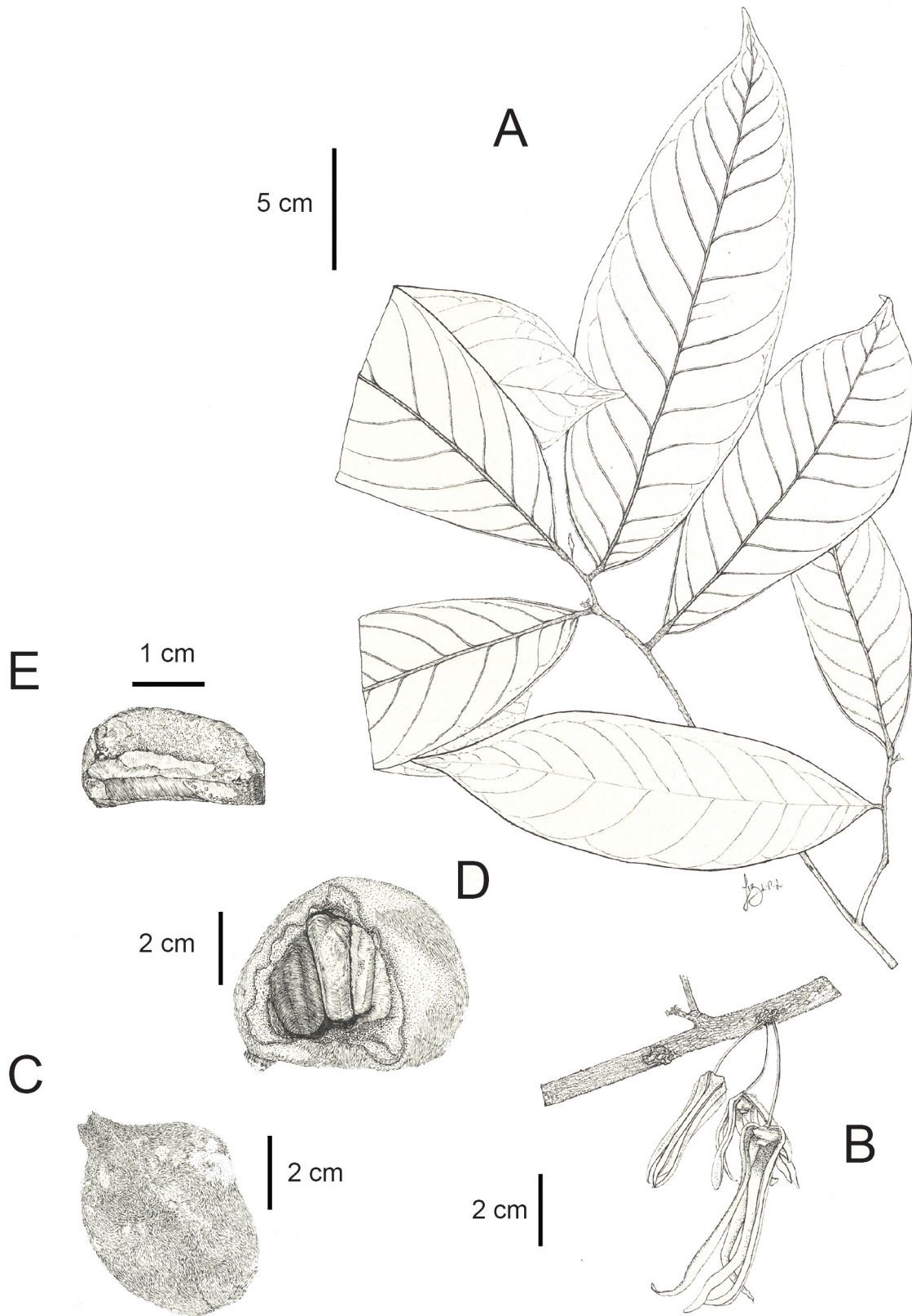


Figure 1: *Stenanona morenoi* Ortíz-Rodr. & Moreno-Méndez. A. branchlet; B. inflorescences borne on leafless portions of branches; C. velvety fruit surface; D. fruit inside; E. seed. Drawn by Lizbeth Pérez Lucas from the type (A) and from G. Moreno Méndez 177 (B-E).

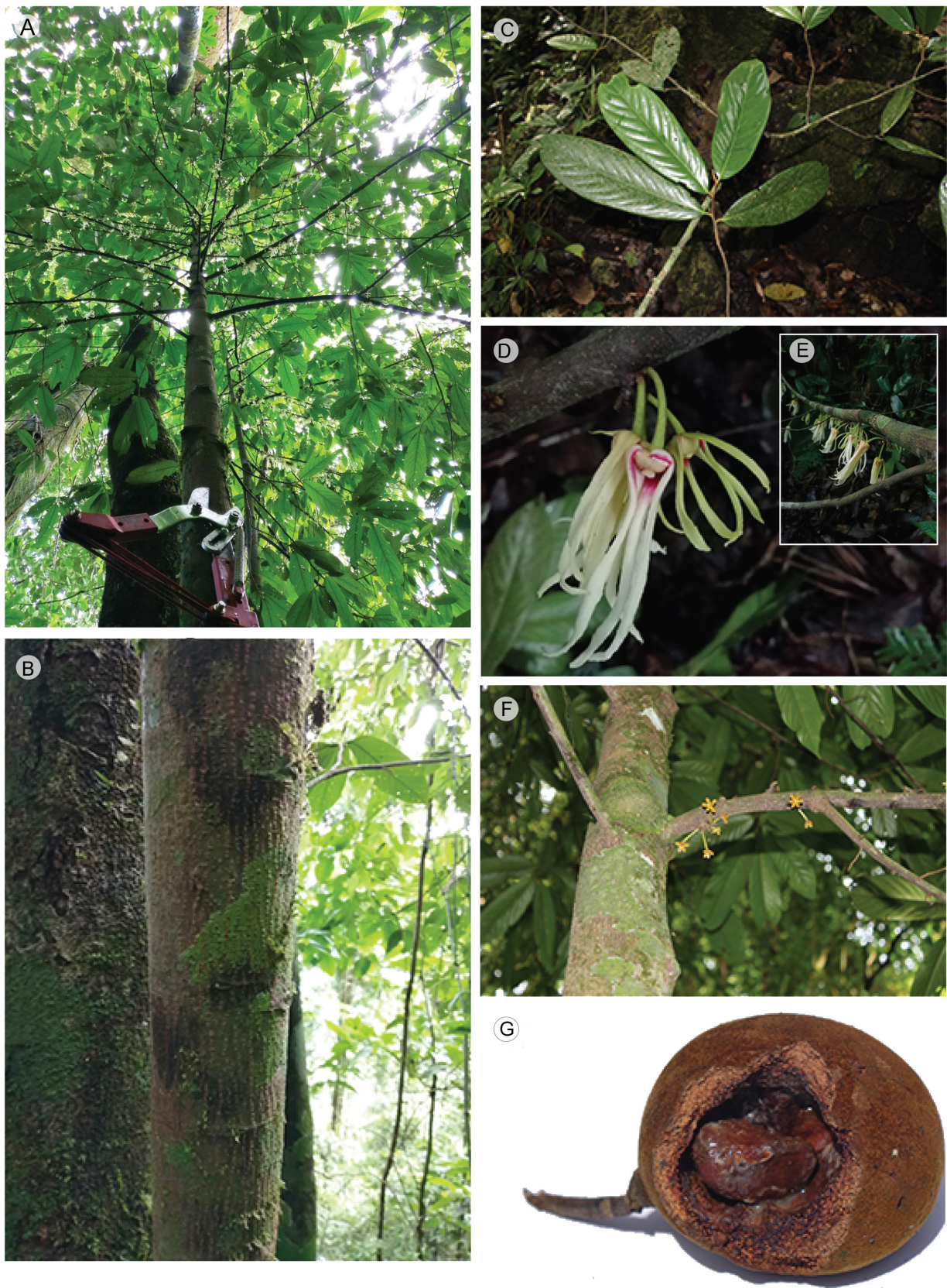


Figure 2: Photos of *Stenanona morenoi* Ortiz-Rodr. & Moreno-Méndez in vivo. A. habit; B. bark ; C. branchlet ; D. inflorescences and flowers (note the red blotch at the base inside); E. inflorescences borne on leafless portions of branches; F. young fruits borne on leafless portions of branches; G. velvety fruit. Photos by Gaspar Moreno-Méndez.

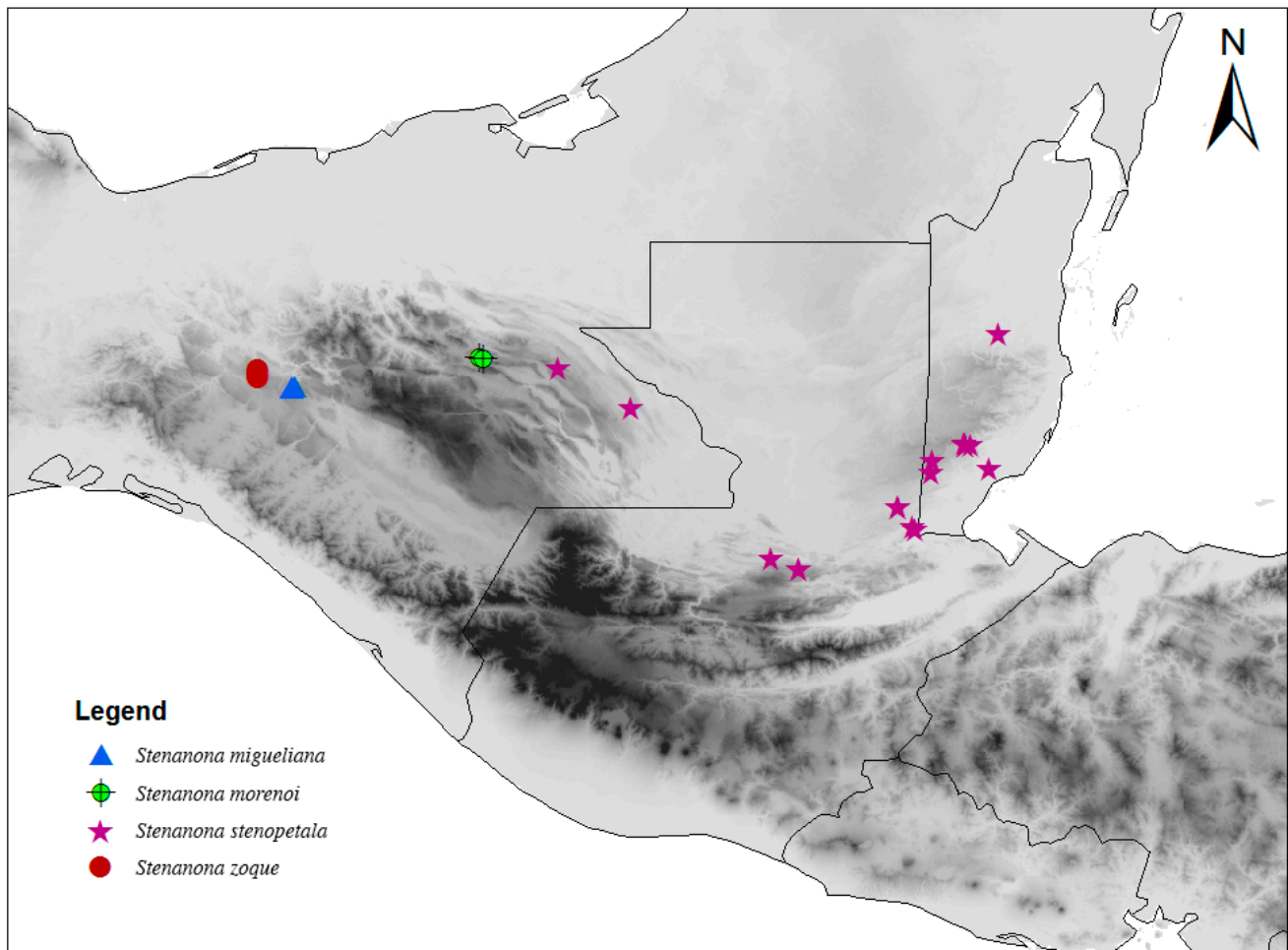


Figure 3: Distribution of *Stenanona morenoi* Ortiz-Rodr. & Moreno-Méndez, *Stenanona migueliana* Ortiz-Rodr. & G.E. Schatz, *Stenanona stenopetala* (Donn. Sm.) G.E. Schatz and *Stenanona zoque* Ortiz-Rodr. & Gómez-Domínguez, based on georeferenced localities available at the Global Biodiversity Information Facility (GBIF. 2019a; GBIF. 2019b) and supplemented with field records.

er densely covered with appressed and erect, golden-brown hairs; peduncles minute; pedicels arise from a condensed short shoot, 18-45 mm long, 2-2.5 mm diameter in vivo (1-1.5 in sicco, up to 3 mm diameter in fruit), pendent, with a tiny basal bract; sepals 3, partially fused at the base, broadly ovate, 2-3 mm long, 2-3 mm broad, base truncate, apex acute, externally densely covered with golden-brown appressed hairs, sparsely covered with golden-brown appressed hairs inside, sepals persistent in young fruits; petals 6, free, linear to linear-triangular, in two sub-equal whorls, cream to light yellow at anthesis with a red blotch at the base of the inner petals, 23-60 mm long, 1-3 mm broad, base rounded to truncate, apex acute to aristate, densely covered with golden-brown appressed hairs externally, sparsely covered with golden-brown appressed hairs to glabrous inside; stamens ~80, 1.2-1.8 mm

long, apical part of connective expanded above the thecae, truncate discoid or slightly prolonged toward the gynoecium, sparsely covered with erect golden-brown hairs; carpels 3-6, ~2.5 mm long, stigma globose to reniform, ovary prismatic to pear-shaped, densely covered with appressed and erect golden-brown appressed hairs, ovules 9-12, uniseriate; monocarps 1-4, globose to ellipsoid, 55-60 mm long, 45-50 mm broad, surface completely covered with short golden-brown erect hairs (velvety), stipes 4-6 mm long, ca. 10 mm diameter, fleshy mesocarp, granular when dry; seeds 6-8, wedge-shaped to depressed globose, 22-25 × 12-14 × 7-11 mm.

Etymology: the specific epithet honors Manuel Moreno Demeza for his extraordinary work in favor of forest conservation in northern Chiapas.

Distribution and ecology: the species is only known from the karstic type locality in the highlands of northern Chiapas (more than 1000 m a.s.l., Fig. 3), where contrary to other karstic regions of southern Mexico, organic matter in the soil is very abundant and covers large part of the limestone rocks. *Stenanona morenoi* is part of the upper strata and is associated with species as *Quercus paxtalensis* C.H. Mull., *Garcinia intermedia* (Pittier) Hammel, *Quararibea funebris* (La Llave) Vischer, and *Guarea glabra* Vahl. Frequently the stems of *S. morenoi* are so long that they lie on other trees for support (also observed in *S. stenopetala* but not in other species of *Stenanona*). During the morning, the flowers of *S. morenoi* release a fruity aroma, but no flower visitors were observed.

Conservation status: We currently lack the necessary information to assess definitively the conservation status of *Stenanona morenoi*. However, according to the criteria established by the IUCN (2011), it is possible to tentatively determine that the species is Critically Endangered (CR B1ab (iii)). Its estimated area of occupancy (AOO) is 8 km² and extent of occurrence (EOO) is 0 km². Although it is likely that the small number of georeferenced data results in an underestimation of its EOO, at the type locality the species was found into two nearby patches of forest isolated from each other by corn crops. Furthermore, the species appears to be extremely rare. In one of the patches only five individuals were counted, while in the other site only eight were observed.

Additional specimens examined: MEXICO. Chiapas, municipio Chilón, ejido San Jerónimo, 1.42 km al sur de la comunidad Jol Cacuala, camino al predio de Don Jerónimo Moreno, 1360 m, 17°03'35"N, 92°06'09"W, 09.VII.2019, G. Moreno Méndez 177 (HEM, MEXU).

Discussion

Extraordinary plants and where to find them

Based on its general floral morphology, *Stenanona morenoi* is placed within subclade A of the *Desmopsis-Stenanona* clade (Ortiz-Rodríguez et al., 2018a). Within this lineage, *S. morenoi* is related to *Stenanona migueliana*, *S. stenopetala* and *S. zoque* (here named the *Stenanona stenopetala*

group, Table 1). The four species are medium to large sized trees (7-25 m tall) and share the cauliflorous/ramiflorous inflorescences and the long-pedicellate flowers with six free, sub-equal, linear to linear-triangular petals (Ortiz-Rodríguez et al., 2014; 2018b). These shared characteristics (synapomorphies) among the members of the *Stenanona stenopetala* group contrast with those present in the type species of the genus (Standley, 1929; Fries, 1931), with which they are not phylogenetically related (Ortiz-Rodríguez et al., 2016; 2018a). The type species, *Stenanona panamensis* Standl., is a small sized tree with short pedicellate flowers, partially fused petals and long sepals with obvious venation in vivo, none of these features shared with members of the *Stenanona stenopetala* group (Schatz and Maas, 2010; Ortiz-Rodríguez et al., 2014; 2018b). Members of the is group are distributed in the north of Mesoamerica and are restricted to the karst areas of the region. The four species have a very restricted distribution range and occur allopatrically (Ortiz-Rodríguez et al., 2018b, Fig. 3). Within the genus *Stenanona* the species distributed in Guatemala and Mexico occur within this biome and tend to be phylogenetically related (Ortiz-Rodríguez et al., 2016; 2018a), and based on their different levels of morphological and genetic variation, it is possible to hypothesize that karst areas have played a very important role in the evolutionary history of this genus in Mesoamerica.

Among the members of the group, *S. morenoi* is well differentiated based on its vegetative and reproductive characteristics (Ortiz-Rodríguez et al., 2018b; Figs. 1, 2, Table 1). The partially fused sepals of *S. morenoi* are not shared with other species of the *Stenanona stenopetala* group, but are common in other species of *Stenanona* such as *S. carrillensis* G.E. Schatz & Maas, *S. cauliflora* (J.W. Walker) G.E. Schatz and *S. hondurensis* G.E. Schatz, F.G. Coe & Maas (here named the *Stenanona cauliflora* group). However, members of the *Stenanona cauliflora* group are invariably tetramerous and have many carpels with few ovules each (Schatz and Maas, 2010). Interestingly, fruits characteristics of *S. morenoi* (Figs. 1, 2) are absent in the other species of *Stenanona* (Schatz and Maas, 2010). Its velvety fruits are rather similar to those present in some species of *Sapranthus* Seem. (Schatz et al., 2018) and in *Tridimeris hahniana* Baill., but its floral characteristics are very different from those of these genera.

Table 1: Morphological features of *Stenanona morenoi* Ortiz-Rodr. & Moreno-Méndez compared with its close relatives.

Features	Species			
	<i>Stenanona migueliana</i> Ortiz-Rodr. & G.E. Schatz	<i>Stenanona morenoi</i> Ortiz- Rodr. & Moreno-Méndez	<i>Stenanona stenopetala</i> (Donn. Sm.) G.E. Schatz	<i>Stenanona zoque</i> Ortiz- Rodr. & Gómez- Domínguez
Inflorescence	Cauliflory	Ramiflory	Cauliflory	Cauliflory
Number of flowers per inflorescence	1 or 2	2 to 4	1 or 2	1 or 2
Color of petals	Salmon-pink	Cream to light yellow	Salmon-pink	Yellow
Inner sepals surface	Glabrous	Sparsely pubescent inside	Glabrous	Glabrous
Sepals fused	No	Yes	No	No
Number of carpels	9-11	3-6	6-16	6-10
Ovules per carpel	8-11	9-12	6-8	6-9
Ovule arrangement	Biseriate	Uniseriate	Uniseriate	Biseriate
Fruit surface	Verrucate, sparsely covered with golden brown, erect and appressed hairs	Smooth, completely covered with short golden-brown erect hairs (velvety)	Smooth, sparsely covered with golden brown, erect and appressed hairs	Not seen

Besides the features mentioned, another attribute that distinguishes *S. morenoi* from its congeners is its distribution at higher altitudes. The new species inhabits within a tropical karst forest between 1300 and 1500 m a.s.l., while most species of *Stenanona* occur between 200 and 1000 m a.s.l. (Schatz and Maas, 2010; Ortiz-Rodríguez et al., 2014, 2018b).

Author contributions

GMM led the fieldwork and collected the species, AEOR reviewed the literature and herbarium specimens, conducted the species description and wrote the manuscript. Both authors reviewed the manuscript and prepared the final version.

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