



<https://doi.org/10.11646/phytotaxa.446.2.6>

## A new *Werauhia* (Tillandsioideae, Bromeliaceae) from Mexico with observations about its reproductive biology

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### Abstract

*Werauhia maculata* a new species from Tabasco, Mexico is described and illustrated. The new taxon possesses a large tank-rossette, with conspicuous and irregularly disposed dark purple marks on the basal portion of the leaves abaxial surface, a simple inflorescence, with secund and numerous whitish-flowers densely arranged on the rachis. The new taxon is compared with *W. pectinata* and *W. noctiflorens*, species with similar characteristics. In addition, some data about its reproductive biology are presented.

**Keywords:** Bromeliad, Mexico, nectar, Tabasco

### Resumen

Se describe e ilustra *Werauhia maculata* sp. nov. con material procedente del estado de Tabasco, México. El nuevo taxon presenta grandes rosetas tipo tanque con las hojas conspicua e irregularmente variegadas con grandes manchas de color púrpura oscuro en la porción basal de la superficie abaxial, la inflorescencia simple con numerosas flores blancas, secundas y densamente dispuestas sobre el raquis. Se compara el nuevo taxon con *W. pectinata* y *W. noctiflorens*, especies con las que presenta algunas similitudes y se proporcionan datos sobre su biología reproductiva.

**Palabrasclave:** Bromelia, México, néctar, Tabasco

### Introduction

In Mexico, the family Bromeliaceae is represented by 19 genera and 422 species, and presents a high percentage of endemism at species level (75.3 %) (Espejo-Serna & López-Ferrari, 2018). One of the richest genera in the family is *Werauhia* which includes around 92 species worldwide (Gouda *et al.* Cont. updated). *Werauhia* is characterized by its

generally coriaceous floral bracts and flowers, with nocturnal anthesis, inflorescences that are mostly not eye-catching or colored and with white or greenish-white frequently secund zygomorphic flowers; the petals have dactyloid basal appendages on its adaxial surface, cupuliform stigmas, and septicidal capsules generally dark colored. The genus *Werauhia* was elevated to its new status from *Vriesea* section *Xiphion* by J. R. Grant (1995a, 1995b).

The genus *Werauhia* is distributed from southern Mexico to Peru and northeastern Brazil and are also present in The Antilles. Most of the species of this genus are concentrated in Costa Rica and eastern Panama (Grant 1995a 1995b; Morales 2003). In Mexico, 10 species of the genus have been recorded, nine of which are in Chiapas (Espejo-Serna *et al.* 2017), six in Oaxaca and five in Veracruz, while in Tabasco only *W. gladioliflora* (H. Wendland) J. R. Grant is known (Espejo-Serna & López-Ferrari 2018). Two species, *W. nocturna* and *W. vanhyningii*, restrict their distribution to Mexico (Espejo-Serna 2012, Espejo-Serna & López-Ferrari 2018). As a result of the field work for an ongoing project about bat-pollination in Mexican bromeliads, a population of *Werauhia* was found in the state of Tabasco, Mexico, that cannot be linked to any of the known species in the genus. A careful and thorough review of the material leads us to conclude that this is an undescribed species that we propose here as *Werauhia maculata*.

## Taxonomy

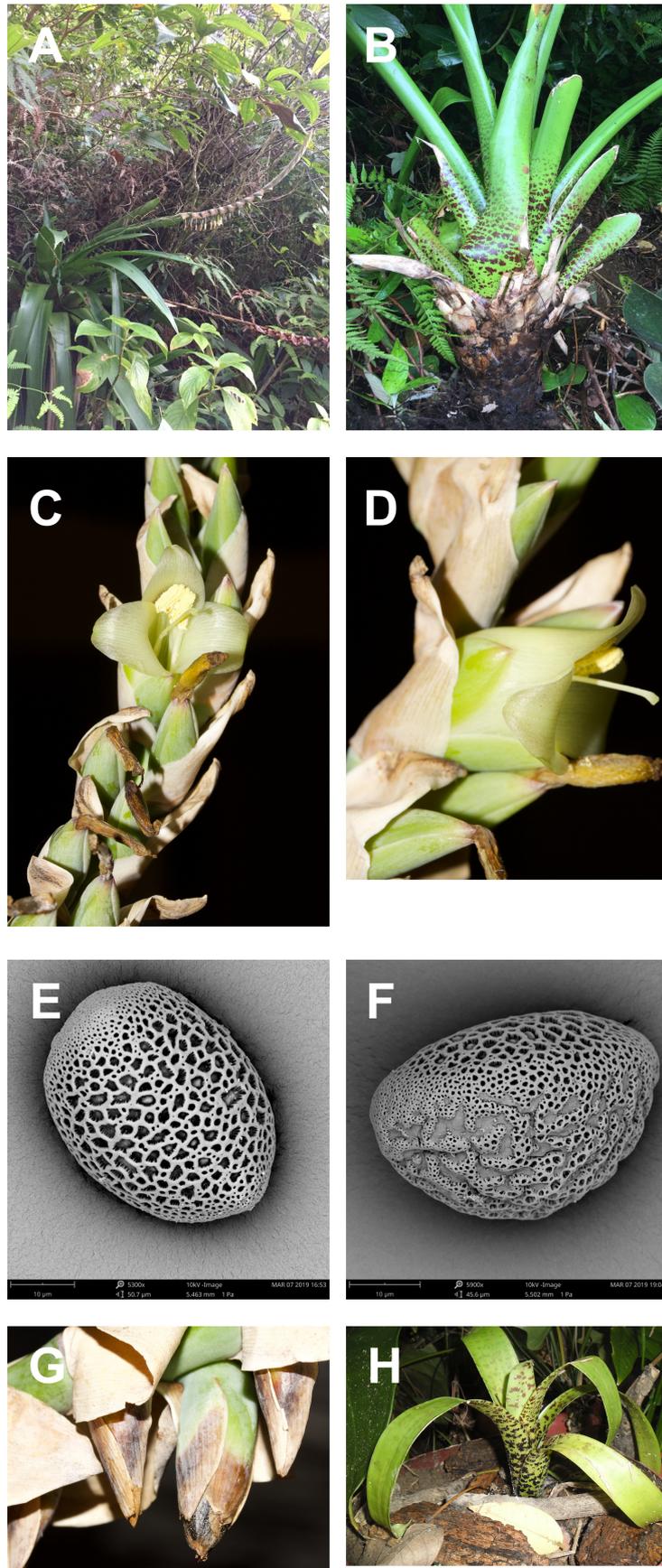
*Werauhia maculata* Espejo-Serna, López-Ferrari, Aguilar-Rodr., Díaz Jim., *spec. nov.* (Fig. 1)

A species similar to *Werauhia pectinata*, but differing in its larger tank forming rosette with leaves conspicuously variegated with dark large purple markings on the abaxial surface (*vs.* some small purple spots), and in the number of flowers in the inflorescence (38–70 *vs.* 20–40), and in the size of sepals (1.7–2.3 × 1–1.2 *vs.* 2.2–3 × 1.2–1.4 cm), and petals (3–3.7 × 1.3–1.4 *vs.* 2.5–2.8 × 0.8–1 cm) and filaments of the stamens (2.2–2.4 *vs.* 1.2–1.3)

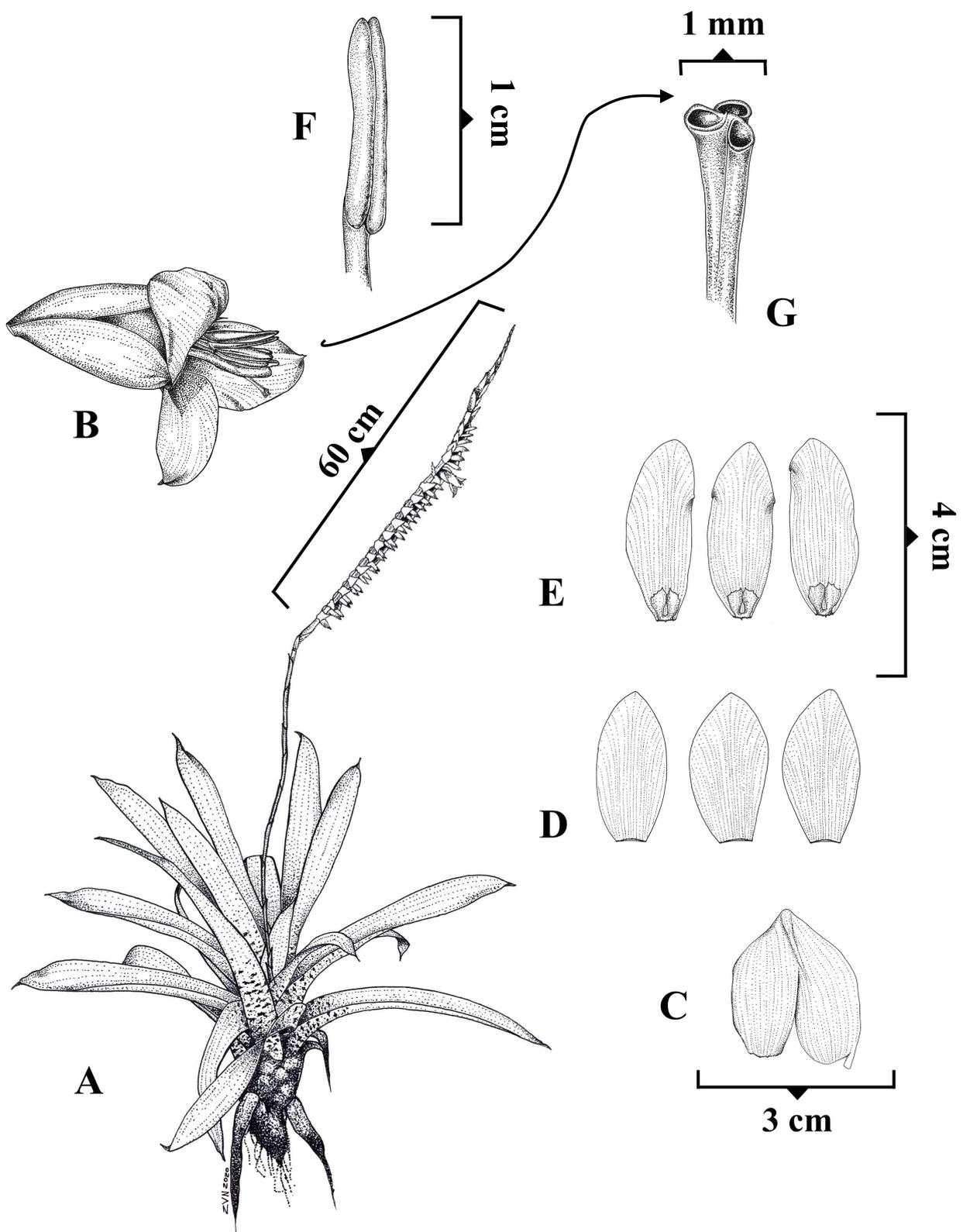
TYPE: MÉXICO, Tabasco, mpio. de Huimanguillo, Cerro de las Flores, Villa de Guadalupe, 17°22'23.57" N, 93°37'42.57" W, 833 m a. s. l., ecotone of tropical montane cloud forest and evergreen tropical forest, rocky wall, May 6, 2018 (fl), *P. A. Aguilar-Rodríguez, P. Díaz Jiménez, M. C. MacSwiney G. & Z. Vallado Negroe PA0015* (holotype: UAMIZ!, isotype: UJAT!) (Fig. 2).

**Plant** rupicolous, acaulescent, up to 2 m high in flower; rosettes forming a tank, 50–70 cm tall, 50–60 cm diameter. **Leaves** rosulate, 15 to 30 per rosette, spreading to recurving; **sheaths** oblong, 15–20 cm long, 9–11 cm wide, adaxially light brown with dark brown base, abaxially conspicuously variegated with dark purple markings distally, both surfaces densely brown punctulate-lepidote; **blades** narrowly oblong, 45–60 cm long, 6–9 cm wide, inconspicuously brown punctulate-lepidote on both sides, light green, abaxially conspicuously variegated with dark purple markings on the basal portion (the purple markings more notable on juvenile leaves, covering all of the back, while on the adult leaves they cover only the lower third of the blade). **Inflorescence** terminal, hanging over to nearly horizontal and then ascending at the distal portion, simple, stramineous both in live material and in herbarium specimens; **peduncle** terete, robust, 70–90 cm long, 8–10 mm diameter, partially covered by the bracts; **peduncle bracts** vaginiform, 5–10 cm long, acuminate, green with irregularly distributed purple markings, sparsely punctulate-lepidote; **spike** linear-oblong, 55–65 cm long, with densely arranged 38–70 flowers; rachis whitish-green, 6–7 mm diameter; **floral bracts** coriaceous, stramineous, ovate, 3–4.5 cm long, 2–3 cm wide when extended and flattened, lustrous, margins hyaline and sinuate, acute or obtuse, inconspicuously veined, ecarinate, glabrous on the abaxial surface, inconspicuous and sparsely brown punctulate-lepidote on the adaxial surface, equal to or larger than the internodes. **Flowers** divaricate, downward secund, zygomorphic, sessile or very slightly pedicellate; **sepals** free, coriaceous, green with reddish-purple apex, lustrous, ovate, 2–2.3 cm long, 1–1.2 cm wide, inconspicuously veined, ecarinate, margins hyaline, acute, glabrous; **petals** white to greenish-white, narrowly oblong, the blade spreading to recurving, especially the two lateral ones, 3.7–4 cm long, 1.3–1.4 cm wide, rounded, the two basal appendages 4–10 mm long; **stamens** subequal, shorter than the petals, all gathered and pressed to the upper petal; filaments white, linear, flat, 2.2–2.4 cm long; anthers yellow, oblong, 7–10 mm long; **pollen grains** monocolpate, elliptic in shape with an irregular outline, reticulate, heterobrochate; **ovary** ovoid, 8–10 mm long, **style** white, linear, 20–28 mm long, exceeding the stamens; **stigma** light green, much reduced, 1–2 mm in diameter. **Capsule** ellipsoid, dull brown, 1.6–2 cm long and 6–9 mm diameter. **Seeds** 3–5 mm long with a coma 2–10 mm long, reddish brown.

**Additional specimen examined (paratype):**—MEXICO. Tabasco: Municipio Huimanguillo, Cerro de las Flores (Cerro el microondas), Villa de Guadalupe, 17°22'26"N 93°37'51"W, 750 m, 28 April 2009, *Pedro Díaz Jiménez, T. Magaña R. & A. M. de la Cruz Lopez 784* (UJAT).



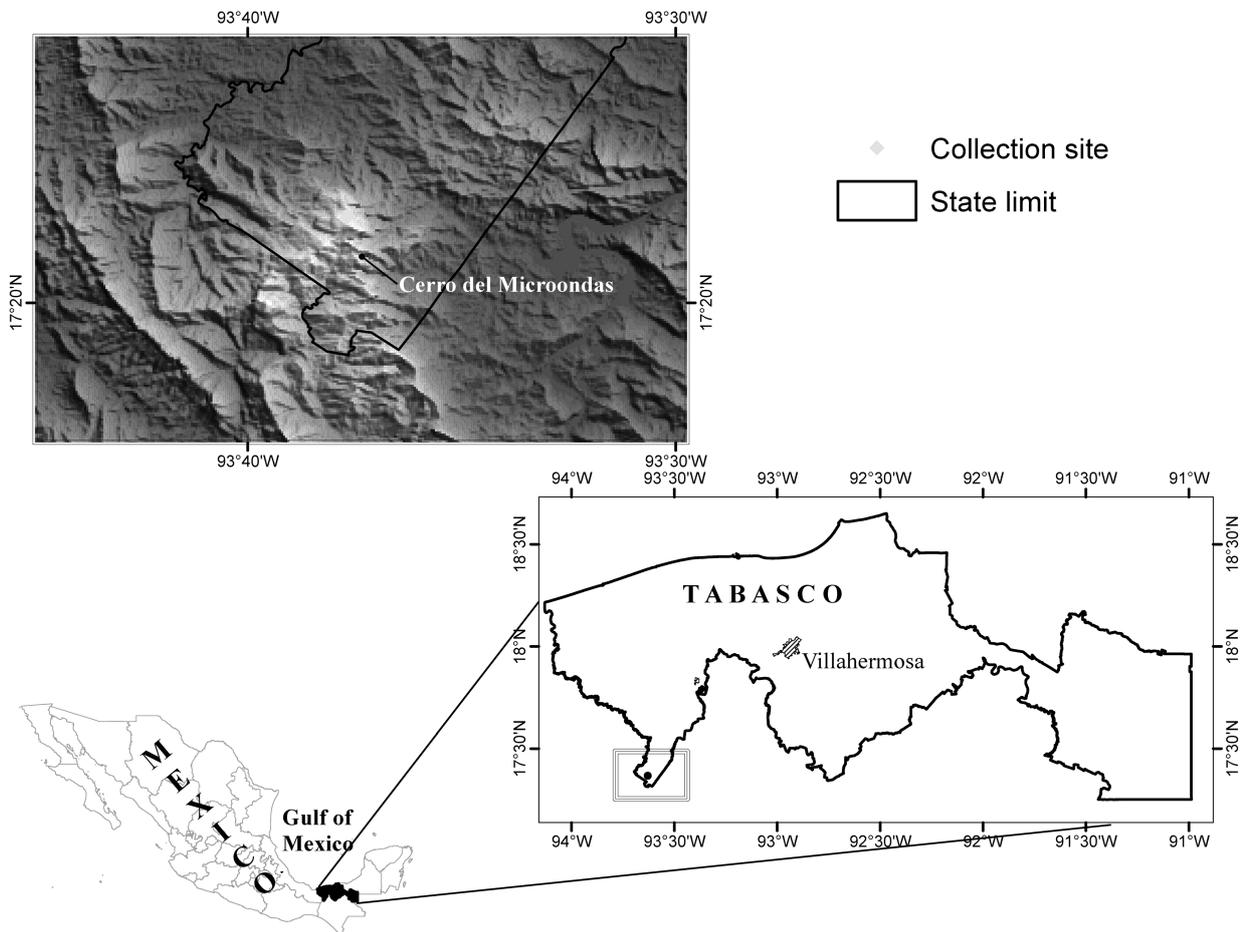
**FIGURE 1.** Adult individual of *Werauhia maculata* at the type locality. A. Flowering plant; B. Detail of the tank rosettes of a grown plant; C. Frontal view of the flower in anthesis; D. Lateral view of the flower; E. Ecuatorial view of a pollen grain; F. Lateral view of the pollen grain, showing the aperture and ornamentation; G. Fruit; H. Juvenile individual. Photos: A and B: Zuemy Vallado; C, D and G: Roberto Castro; E and F: Heiko Hentrich; H: Pedro Díaz Jiménez.



**FIGURE 2.** *Werauhia maculata*. A—Habit. B—Flower. C—Floral bract. D—Sepals. E—Petals. F—Anther. G—Detail of the stigma. Based on a cultivated individual. Drawings by Zuemy Vallado Negroe.

**Etymology:** The specific epithet ‘*maculata*’ refers to the conspicuously large dark purple spots on the abaxial surface at the base of the leaves.

**Distribution, habitat and phenology:** *Werauhia maculata* is until now only known from the municipality of Huimanguillo in the state of Tabasco, Mexico (Fig. 3); however, it is likely to be present in other adjacent locations of the states of Chiapas and/or Oaxaca. Plants of the new taxon grow rupicolous on the edge of the talus, exposed to the sun, and forming groups of numerous individuals, and grow together with other bromeliad species such as *Pitcairnia recurvata*, *Pitcairnia imbricata* and *Werauhia nutans*, between 700 and 1000 m a.s.l. elevation. It flowers from April to July.



**FIGURE 3.** Type locality and known distribution of *Werauhia maculata* in Tabasco, Mexico.

**Biology and floral ecology:** The flowers of *Werauhia maculata* begin anthesis between 17:00 and 18:00 o’clock approximately one and a half hours before nightfall. The species produces one to a maximum of two flowers every one or two days, during its flowering period. Flowering appears to be synchronous in the whole population. Dehiscence of the pollen occurs between 18:00 and 19:00 o’clock when the stigma also becomes receptive. The flower withers at dawn, around 06:30 hrs. We performed hand-pollination treatments *in situ* (see Aguilar-Rodríguez *et al.* 2014), and tests of self-pollination resulted in no fruits due to spontaneously self-pollination (i.e., untouched flowers and excluded from pollinators), probably due to the disposition of the anthers (herkogamy). It is a facultative self-compatible species, producing seeds with pollen from the same flower ( $384 \pm 42.44$  seeds,  $n=3$  fruits of 3 individuals) or from another flower ( $388.67 \pm 161.81$  seeds,  $n=3$  fruits of 3 individuals). The accumulated production of nectar per night ranges from 60 to 100  $\mu$ l per flower, with a mean sugar concentration of 13 % ( $13.79 \% \pm 2.74 \%$ ,  $n=3$  flowers of 3 individuals), which is similar to other species within the genus; Krömer *et al.* 2008). It presents a musky floral aroma, similar to that of other species in the genus *Werauhia*, which is the most intense between 20:00 and 22:00 o’clock, continuing until the following morning. Analysis of the chemical composition of the aroma has mainly identified Acetoin, Acetoin acetate, (*Z*)- or (*E*)- $\alpha$ -Bergamotene, 2,3-Butanediol, Isoamyl acetate, 3- + 2-Methyl-1-butanol, 4-Methyl-3-penten-2-one, and 2-Phenylethanol (P. Díaz Jiménez *et al.* unpublished data). Considering the characteristics of the nectar, the

time of anthesis, and the floral morphology of the new species, as well as the previous reports for the genus (Aguilar-Rodríguez *et al.* 2019), it is possible to associate it with a bat-pollinated syndrome.

**Comments:** According to the infrageneric classification proposed by Grant (1995a), *Werauhia maculata* belongs to the section *Werauhia* J. R. Grant. Although it had mistakenly been identified as *Werauhia gladioliflora* (Díaz Jiménez *et al.* 2010), the new species presents some similarities with *W. pectinata* (Smith 1941: 387) Grant (1995a: 33) and *W. noctiflorens* Krömer *et al.* (2007: 336); however, these three species present clear differences in floral characteristics and ecology (Table 1). Its distribution, probably restricted, makes this a species vulnerable to the threat of habitat loss.

**TABLE 1.** Comparison (morphology and distribution) of *Werauhia maculata* with similar species within the genus.

	<i>W. maculata</i>	<i>W. noctiflorens</i>	<i>W. pectinata</i>
Foliar sheath	Pale brown, darker on the adaxial surface, brown at the base, apical portion conspicuous and irregularly variegated with dark purple on the abaxial surface, 15–20 × 9–11 cm	Pale green on both sides 6–11.5 × 5.6–6 cm	Pale brown on both sides 13–15 × 8–10 cm
Foliar blades	Oblong, light green, conspicuously variegated with large dark purple spots on the basal portion of the abaxial surface, brown punctulate-lepidote on the adaxial surface, 45–60 × 6–9 cm	Oblong, green- grayish, darker on abaxial surface, not variegated 36–65 × 3.5–4.7 cm	Oblong, green with some small spots on the abaxial surface 50–60 × 3.2–4.8 cm
N° of flowers per inflorescence	38–70	7–22	22–42
Floral bracts	3–4.5 × 2–3 cm	2.5–4 × 3–4 cm	2.5–3.5 × 1.8–2.7 cm
Sepals	2–2.3 × 1–1.2 cm	3–3.3 × 1.6–2 cm	2.2–3 × 1.2–1.4 cm
Petals	3.7–4 × 1.3–1.4 cm	5–5.5 × 2–2.3 cm	2.5–2.8 × 0.8–1 cm
Filaments	2.2–2.4 cm long	3.8–4 cm long	1.2–1.3 cm long
Ecological information, and known distribution in Mexico	Rupicolous Tropical Montane Cloud Forest and Evergreen Forest 800–1000 m TAB	Epiphyte Tropical Montane Cloud Forest 800–1200 m CHIS, VER	Terrestrial, rupicolous or epiphyte Tropical Montane Cloud Forest and <i>Quercus</i> forests 800–2200 m CHIS, VER

## Acknowledgements

We thank to Trinidad Magaña Ramírez and Andrés Manuel de la Cruz López for bringing us to the site and help us to collect the first individuals, as well as the Molina-Ramos family for their help. Also, to Ellen Salzer for her help taking the pollen photographs with a microscope. To Zuemy Vallado for her help in the field, Samaria Armenta for preparing the map, and A. Francisco D. Cuautle for the figures. The first author wants to thank the Tel Aviv University for founding this study through the Postdoctoral Scholarship to Pedro Aguilar. Further we want to thank the anonymous reviewers and editor Eric Gouda for their helpful comment to improve this manuscript.

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