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## *Salvia ozolotepecensis*, *S. patriciae* and *S. sirenis* (Lamiaceae), three new species from Miahuatlán district, Oaxaca, Mexico

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### Abstract

*Salvia ozolotepecensis*, *S. patriciae* and *S. sirenis* (Lamiaceae) from Oaxaca, Mexico, are described and illustrated as three new species. The first one is characterized by its glandular-capitate pubescence in stems, leaves and inflorescences, mostly persistent floral bracts, entire and 5-veined upper calyx lip, red corolla, epapillate inside, included stamens, and connective ornate with opposed retrorse and antrorse teeth bordering an incision. It is most similar to *S. perlonga* and *S. praestans* to which it is compared. The second can be distinguished in having ovate to ovate-deltoid leaf blades, entire, acute and 7-veined upper calyx lips, red corollas, internally ornate near the base with two slender linguiform papillae, upper corolla lip shorter than the lower one, exserted stamens and glabrous style. This new taxon is morphologically similar to the species belonging to *Salvia* sections *Cardinales*, *Charantia*, *Incarnatae*, *Flexuosa*, *Fulgentes*, *Iodophyllae* and *Pedicellata*; although, it cannot be unambiguously assigned to one of these. In contrast, *S. sirenis* clearly belongs to *S. sect. Scorodonia*; amongst the species therein, the new species can be differentiated by the concolorous leaves, rounded to slightly oblique at base, 6–8-flowered floral nodes, longer floral bracts, pedicels, calyces and corollas, and 5 or 7-veined upper calyx lip. Also, it represents an addition to Mexican *Salvia* with white corollas. The molecular markers ITS, *trnL-trnF* and *trnH-psbA* were sequenced for two of the three new species, and their phylogenetic position is discussed.

### Resumen

Se describe e ilustra como tres especies nuevas a *Salvia ozolotepecensis*, *S. patriciae* y *S. sirenis*, provenientes de Oaxaca, México. La primera de ellas se caracteriza por la presencia de pubescencia glandular-capitada en tallos, hojas e inflorescencias, brácteas florales generalmente persistentes, labio superior del cáliz entero y 5-nervado, corola roja y epapilada en el interior, estambres incluidos y conectivo ornamentado con un par de dientes opuestos entre sí al borde de una pequeña hendidura. Esta especie es más similar a *S. perlonga* y *S. praestans*, contra las que se compara. La segunda puede distinguirse por sus láminas foliares ovadas a ovado-deltoides, labio superior del cáliz entero, agudo y 7-nervado, corolas rojas, ornamentadas en el interior con un par de papilas delicadas, labio superior de la corola más corto que el inferior, estambres exsertos y estilo glabro. El taxon nuevo es semejante por su morfología a las especies de las secciones *Cardinales*, *Charantia*, *Incarnatae*, *Flexuosa*, *Fulgentes*, *Iodophyllae* y *Pedicellata*; aunque, no puede asignarse sin ambigüedad a alguna de ellas. En contraste, *S. sirenis* pertenece con claridad a la sect. *Scorodonia*; entre las especies que abarca, la especie nueva puede diferenciarse por las hojas concoloras, redondeadas a poco oblicuas en la base, nodos florales con 6–8 flores, brácteas florales, pedicelos, cálices y corolas más largos, y el labio superior del cáliz con 5 o 7 venas. Además, ésta representa una adición a las salvias mexicanas con corolas blancas. Los marcadores moleculares ITS, *trnL-trnF* y *trnH-psbA* fueron secuenciados para dos de las tres especies nuevas, y su posición filogenética es discutida.

## Introduction

Mexico is one of the nations with the largest *Salvia* diversity (Alziar 1988, Hedge 1992, Walker *et al.* 2004), 306 species inhabit in the country and 77 % are endemic (Martínez-Gordillo *et al.* 2017). A wide proportion of these species are concentrated in Oaxaca, 94, which ranks the first amongst the other Mexican states (unpublished data). In fact, Oaxaca is the richest in overall vascular plants with 8903–10299 species (García-Mendoza & Meave 2011, Villaseñor 2016). The magnitude of the diversity in Oaxaca is explained by the spatial and historical complexity of its territory, which is translated into heterogeneity promoting diversification and providing a wide habitat spectrum to be occupied (García-Mendoza *et al.* 2004).

In recent years, several new species of *Salvia* have been described from Oaxaca: *Salvia clarkcowanii* Turner (2008: 141), *S. pericona* Turner (2009a: 260), *S. robertoana* Martínez-Gordillo & Fragoso-Martínez (2016b: 272), *S. tetramerioides* Martínez-Gordillo *et al.* (2016a: 217), *S. textilana* Turner (2009b: 454) and *S. tilantongensis* González-Gallegos & Aguilar-Santelises (2014: 13). The above testifies that our knowledge on the diversity of the flora from Oaxaca and on the genus *Salvia* is a field still in construction. More efforts are necessary, and as long as the herbarium collections are more thoroughly curated, and remote areas are explored, new findings will come to light. Here we contribute on this aspect with the description and illustration of three new species that were discovered while verifying *Salvia* determinations of specimens from Oaxaca in GBH herbarium: *Salvia patriciae* and *S. sirenis*, and when trying to collect the first two: *S. ozolotepecensis*.

Although an updated phylogenetic framework for *Salvia* subgenus *Calosphace* (Bentham 1833: 198) Epling (1939: 4) was published recently (Fragoso-Martínez *et al.* 2018), only ca. one third of the species of this subgenus are represented in it, and the newly described Mexican taxa are underrepresented. Also, the latter study, along with previous efforts to provide a phylogeny for the subgenus (Jenks *et al.* 2013), revealed a highly artificial infrageneric classification in *Calosphace*, with only a few of Epling's (1939) sections resulting monophyletic. As a consequence, assigning new taxa to non-monophyletic sections has become controversial. In addition to the morphological comparison of the new species with similar taxa, in this study we provide their phylogenetic position, by obtaining DNA sequences for three molecular markers and analyzing them in combination with previous datasets (Fragoso-Martínez *et al.* 2018).

## Materials and methods

**Herbarium and field work:**—The three new taxa were identified as such by using identification keys and descriptions authored by Epling (1939) for *Salvia* subgen. *Calosphace*, and the complementary literature cited in González-Gallegos *et al.* (2013), and contrasting against herbarium specimens of similar species and types of these from JSTOR Global Plants (2017). Also, we conducted two series of botanical explorations in order to collect more material of each species and to better interpret and describe morphological variation. The first collections were made in November 2015, and the second in November 2017, both in Miahuatlán district, Oaxaca. At least three duplicates were obtained for each collection number and these are distributed mainly in the following herbaria: CIIDIR, IBUG and MEXU. The specimens were prepared and processed according to the standard methods described in Lot & Chiang (1986). Silica dried foliar tissue and pictures of living plants were also taken during field exploration, except for *Salvia sirenis*, which was not found in the field and not included in the phylogenetic analysis because it could not be extracted DNA of good quality from the herbarium specimens.

**Taxon sampling:**—To advance our knowledge in the phylogenetic position of some of the recently described species of Mexican salvias; in addition to the three new taxa described here, we included other six species that have been described in the last three years (Table 1). These species were placed in *S.* sections *Angulatae* (Epling 1935: 67) Epling (1939: 234), *Brandegeia* Epling (1939: 314) (Bedolla-García & Zamudio 2015), *Lavanduloideae* Epling (1939: 34) (Fragoso-Martínez *et al.* 2015) and *Uliginosae* (Epling 1935: 52) Epling (1939: 54) (Bedolla-García & Zamudio 2015, Martínez-Gordillo *et al.* 2016). However, one of these species, *Salvia madrigalii* Zamudio & Bedolla-García (2018: 77), could not be placed in an existing section due to its particular characteristics (Zamudio & Bedolla-García 2018). To assess the phylogenetic position of these taxa, the obtained DNA sequences were combined with the currently most comprehensive dataset for *Calosphace* (Fragoso-Martínez *et al.* 2018), which includes 245 species representing 85 sections.

**Molecular methods:**—DNA extraction from silica gel-dried tissue followed Fragoso-Martínez *et al.* (2017). Amplification of the ITS, *trnH-psbA* and *trnL-trnF* regions for the species in Table 1 was carried out in 15 µl reactions,

following the PCR profiles and primer combinations described in Fragoso-Martínez *et al.* (2018). Sanger sequencing was performed at the Laboratorio de Biología Molecular de la Biodiversidad y la Salud, Instituto de Biología, Universidad Nacional Autónoma de México.

**Sequence edition, alignment and analyses:**—Sequences were assembled and edited with Geneious version 10 (<http://www.geneious.com>, Kearse *et al.* 2012). The alignments of each region were made using the online version of MAFFT (Katoh & Standley 2013), followed by minor manual adjustment in PhyDE (Müller *et al.* 2005). The concatenated matrix is 2246 base pairs (bp) long, from which 718 bp belong to the ITS region, 505 bp to the *trnH-psbA* intergenic spacer (IGS), and 970 to the *trnL-trnF* region. Previous to phylogenetic inference, model selection was achieved using the phylogenetic aware terrace data structure (Chernomor *et al.* 2016). The models selected were GTR+F+I+G4 for the ITS matrix, TVM+F+G4 for the *trnH-psbA* IGS, and TIM+F+G4 for the *trnL-trnF* region. The maximum likelihood analysis was carried out using the IQ-TREE algorithm (Nguyen *et al.* 2015) in the IQ-TREE web server (Trifinopoulos *et al.* 2016). The phylogenetic trees were drawn using FigTree version 1.4.2 (Rambaut 2014). To ease visualization of the phylogeny and given branch heterogeneity, the outgroup was pruned from the resulting phylogram using the phytools package (Revell 2012) in R (R Core Team 2014). Using the same software, the pruned tree was transformed to ultrametric using the “extend” method and the branch lengths were scaled to an arbitrary scale of 0 at the tips and 1 at the root of *Calosphaea*. A complete version of the tree along with unmodified branch lengths can be consulted in Supplementary Material 1.

**TABLE 1.** Newly sequenced species of recently described Mexican salvias.

| Taxon                       | Voucher information   | GenBank accession numbers |                  |                  |
|-----------------------------|---|---------------------------|------------------|------------------|
|                             |   | ITS                       | <i>trnH-psbA</i> | <i>trnL-trnF</i> |
| <i>Salvia calderoniae</i>   | <i>S. Zamudio et al.</i> 16545 (IEB)                            | MH574780                  | MH613774         | MH594469         |
| <i>Salvia madrigalii</i>    | <i>S. Zamudio et al.</i> 17060 (IEB)                            | MH574781                  | MH613775         | MH594470         |
| <i>S. ozolotepecensis</i>   | <i>I. Fragoso-Martínez et al.</i> 380 (MEXU)                    | MH574774                  | MH613776         | MH594471         |
| <i>Salvia patriciae</i>     | <i>I. Fragoso-Martínez et al.</i> 363 (MEXU)                    | MH574775                  | MH613777         | MH594472         |
| <i>Salvia semiscaposa</i>   | <i>I. Fragoso-Martínez &amp; M. Martínez Gordillo</i> 26 (MEXU) | MH574776                  | MH613778         | MH594473         |
| <i>Salvia tetrameroides</i> | <i>P. Tenorio</i> 18100 (MEXU)                                  | MH574777                  | MH613779         | MH594474         |
| <i>Salvia xolocotzii</i>    | <i>S. Zamudio et al.</i> 16450 (IEB)                            | MH574778                  | MH613780         | MH594475         |
| <i>Salvia zamoranensis</i>  | <i>S. Zamudio et al.</i> 16091 (IEB)                            | MH574779                  | -                | MH594476         |

## Taxonomic descriptions

*Salvia ozolotepecensis* J.G.González & Fragoso, *sp. nov.* (Figs. 1 & 2)

*Differt a S. perlonga foliis ovatis vel ovato-lanceolatis (oblongo-lanceolatis), brevioribus (2.7–10.5 vs. 10–15 cm longis), bracteis floralibus perstatis vel sub-perstatis (vs. deciduis), calycibus brevioribus (7.2–9 vs. 13–14 mm longis), corollarum tubis brevioribus [9.9–12.3 vs. (13–)14.5–19 mm longis], corollarum labiis superis brevioribus (6.9–11.2 vs. 14–16.7 mm longis), corollarum labiis inferis brevioribus (6.9–10.4 vs. 18–21 mm longis), staminibus inclusis (vs. exsertis 3–4 mm) et connectivis brevioribus (12.5–13.3 vs. 20–22 mm longis).*

**Type:**—MEXICO. Oaxaca. Miahuatlán district. Mun. San Juan Ozolotepec: 1.3–1.5 km al NW de San Juan Ozolotepec por la brecha a Santo Domingo Ozolotepec, 16.142°N, 96.26°W, 2229 m, 27 November 2017, *J.G. González-Gallegos, G. González-Adame, A. Casasola-González & M. Cruz-Aguilar* 2317 (holotype CIIDIR!, isotypes HUAA!, IBUG!, IEB!, MEXU!, OAX!).

Perennial herb, erect to subscandent, 0.6–2 m tall; stems hirsute with glandular-capitate hairs. Leaves with petioles (0.5–)1.4–2.7 cm long, pilose with eglandular hairs; blade ovate to ovate-lanceolate, 2.7–10.5 × 1.5–5.7 cm, acute to acuminate at apex, truncate to subcordate at base, margin serrate, rugose above (especially in immature leaves), pilose in both faces, pubescence denser beneath. Inflorescence in racemes 7–25 cm long, with 3–12 floral nodes, each with 4–8(–10) flowers, the lowermost 1.3–2.3 cm apart from each other; floral axis pilose with eglandular hairs. Floral bract persistent (or the majority of them persisting after anthesis), ovate to lanceolate, 6.3–15.9 × 2.7–6 mm, apex acuminate to caudate, base truncate to cordate, margin entire, pilose. Flowers with pedicels 1.4–2.3 mm long, up to 7.9 mm long in fruit, short pilose. Calyx 7.2–9 × 3.9–5.1 mm, up to 11.2 × 7 mm in fruit, pilose with glandular-capitate hairs and hispidulous outside, short hispidulous inside, lips subequal, 1.9–2.8 mm long, the upper one entire

and 5-veined. Corolla red, short pilose with the hairs dorsal and distally concentrated, upper surface of the lower lip glabrous; tube 9.9–12.3 × 3.2–4.9 mm, ventricose, straight or slightly invaginated towards the base, epapillate inside; upper lip 6.9–11.2 mm long, lower 6.9–10.4 × 6.3–9 mm (the lower usually longer than the upper one). Stamens included, filament 2.9–4.1 mm long, connective 12.5–13.3 mm long, ornate at midportion with a retrorse and antrorse teeth bordering an incision, thecae 2.5–2.8(–3.2) mm long; a pair of filiform staminodes above and behind filament insertion. Gynobasic horn 0.6–0.7 mm long, style 16.1–22.6 mm long, included (except by the branches) or up to 1 mm exerted, short pilose towards the apex, lower stigmatic branch acute and shorter than the upper one. Mericarp ovoid, 2.2–2.5 × 1.3–1.5 mm, light brown and irregularly marbled with a darker tone, glabrous and smooth.

**Common name:**—In both *Hunn 243* (OAX!) and *Hunn 1978* (OAX!), it is stated that this plant is known as *guizh-dzing* in Zapotec language.

**Etymology:**—The name of this new *Salvia* was coined in honor to the localities of Miahuatlán district bearing the name of Ozolotepec, especially to the town and people of San Juan Ozolotepec. On this way, we recognize the help and hospitality of them while conducting fieldwork to collect the new species.

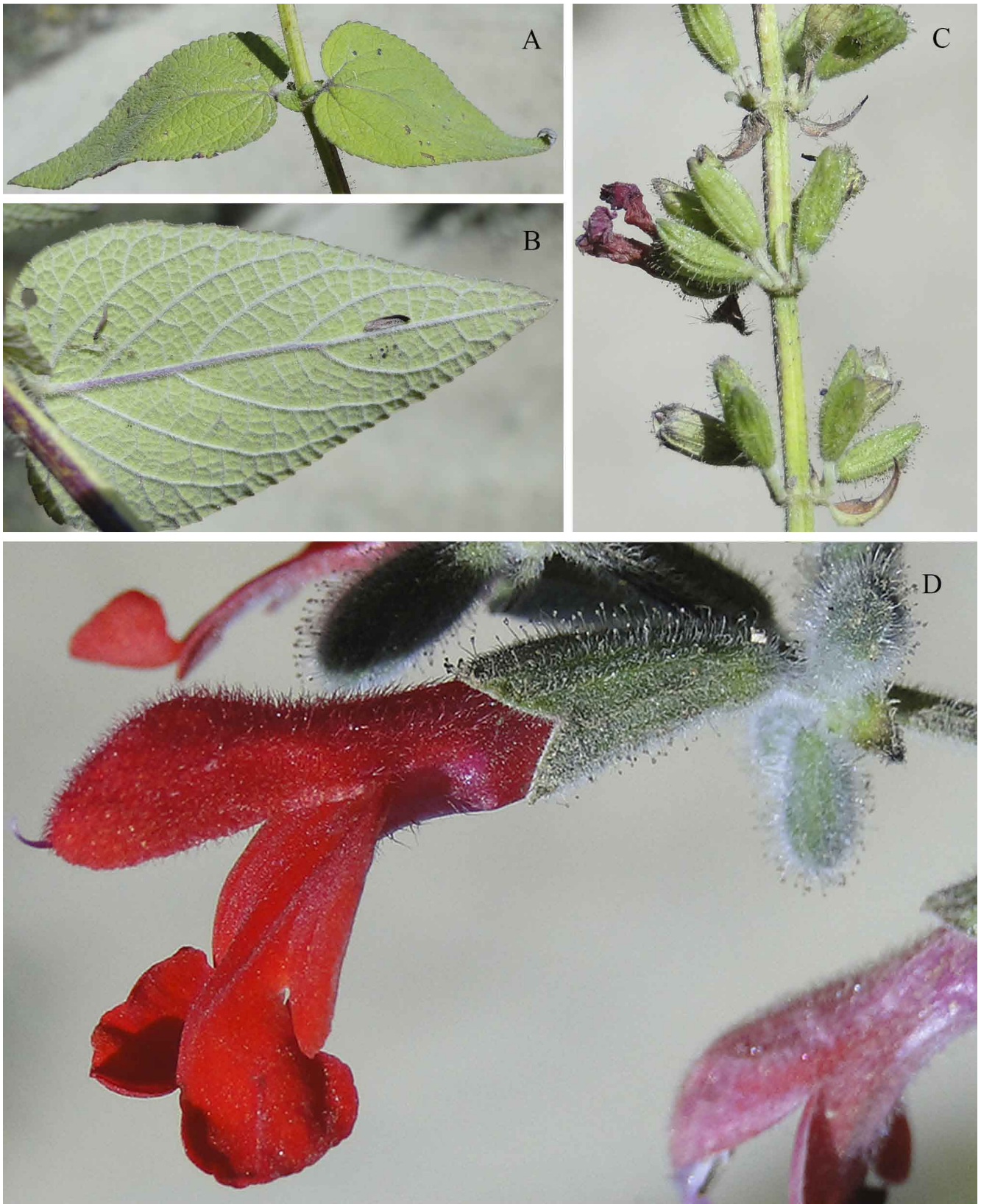
**Distribution, habitat and phenology:**—*Salvia ozolotepecensis* is an endemic species from Oaxaca, Mexico (Fig. 3). The known distribution of this taxon is restricted to Miahuatlán district in the municipalities of San Juan Mixtepec, San Juan Ozolotepec and Santo Domingo Ozolotepec; although, it is very likely that it would be eventually found in nearby municipalities. It grows in pine-oak forest from 1960–2473 m elevation. Flowering and fruiting probably from August to February.

**Notes:**—According to the indumenta composed by simple hairs, persistent floral bracts, 5-veined calyx tube, red corolla, included stamens and non-geniculate connective, *Salvia ozolotepecensis* should be placed within *S. sect. Brandegeia*. However, the placement of *S. ozolotepecensis* within this section would be somewhat unusual in terms of geographical distribution since the three species in the section inhabit western and northern Mexico: *Salvia angustiarum* Epling (1939: 315) in Jalisco, Nayarit and Zacatecas; *S. blepharophylla* Brandegei in Epling (1939: 314) in Nuevo León, San Luis Potosí and Tamaulipas; and *S. oresbia* Fernald (1900: 536) in Nuevo León and San Luis Potosí; whereas *S. ozolotepecensis* is located in the southern region. From *S. sect. Brandegeia*, and following the identification key provided by Epling (1939), the new species is morphologically most similar to *S. oresbia*; however, it differs from this in having taller stems (0.6–2 vs. 0.2–0.8 m), longer leaves (2.7–10.5 vs. 1–2.5 cm), usually longer petioles [(0.5–)1.4–2.7 vs. up to 1 cm], pilose leaves above and beneath (vs. glabrous), shorter pedicels (1.4–2.3 vs. 3–7 mm long), shorter (7.2–9 vs. 10–16 mm) and pubescent calyces (pilose with glandular-capitate hairs and hispidulous vs. glabrous), and shorter corolla tube (9.9–12.3 vs. 14–16 mm).

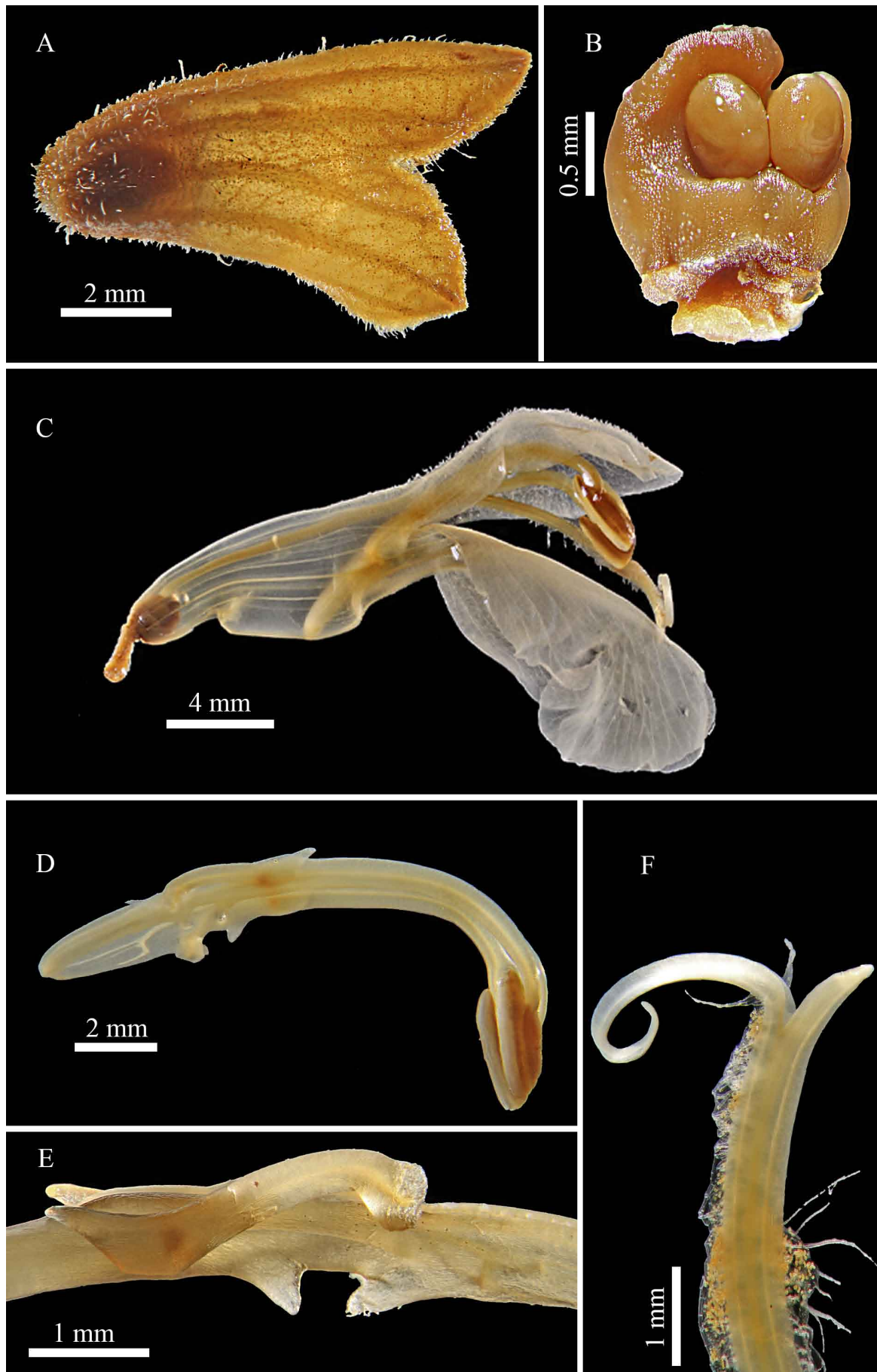
In general morphology, and free from the constrictions in the identification key, *Salvia ozolotepecensis* is also similar to *S. praestans* Epling (1940: 530), the only species in *S. sect. Hintoniana* Epling (1940: 530), and *S. perlonga* Fernald (1900: 546), also monotypic from *S. sect. Nelsonia* Epling (1947: 516). *Salvia ozolotepecensis* differs from the first by its mostly persistent floral bracts (vs. deciduous), shorter calyces [(7.2–8.9 vs. 13.2–14.8(–17) mm long], shorter corolla tube (9.9–12.3 vs. 1–19 mm long), internally naked towards the base (vs. rugose or ornate with two papillae), shorter upper corolla lip (6.9–11.2 vs. 17–20.1 mm long), smaller lower corolla lip (6.9–10.4 × 6.3–9 vs. 22.4–29 × 18.3–24 mm), included stamens (vs. exerted by 2.1–4 mm), shorter connective (12.5–13.3 vs. 27.5–30 mm long), shorter style (16.1–22.6 vs. 40–41.2 mm long), and smaller mericarps (2.2–2.5 × 1.3–1.5 vs. 2.5–2.7 × 1.5–1.6 mm). It can be distinguished from *S. perlonga* in having ovate to ovate-lanceolate leaf blades (vs. oblong-lanceolate) and shorter (2.7–10.5 vs. 10–15 cm long), persistent floral bracts (vs. deciduous), shorter calyx (7.2–9 vs. 13–14 mm long), shorter corolla tube [9.9–12.3 vs. (13–)14.5–19 mm long], naked inside (vs. ornate with a couple folds inside towards the base), shorter upper (6.9–11.2 vs. 14–16.7 mm long) and lower (6.9–10.4 vs. 18–21 mm long) corolla lips, included stamens (vs. exerted), and shorter connective (12.5–13.3 vs. 20–22 mm long).

Furthermore, morphological evidence supports a stronger relationship with *S. perlonga* than to any other species including those in *S. sect. Brandegeia* in spite of matching sectional diagnostic characters. The peculiar connective ornamentation exhibited in the new species (opposing retrorse and antrorse teeth bordering an incision at connective midportion) is also present in *S. perlonga* as it can be seen in the corolla dissection available in the isotype kept at UC (*Salvia perlonga* UC1943339, JSTOR Global Plants 2018). This condition is uncommon in Mexican *Salvia*, perhaps only similar in some species from *S. section Uliginosae* (Epling 1935: 52) Epling (1939: 54), which embraces very distinctive species in terms of the trimucronate upper calyx lip, conspicuous and abundant glandular dots throughout the calyx, geniculate connective and swollen upper portion of the style.



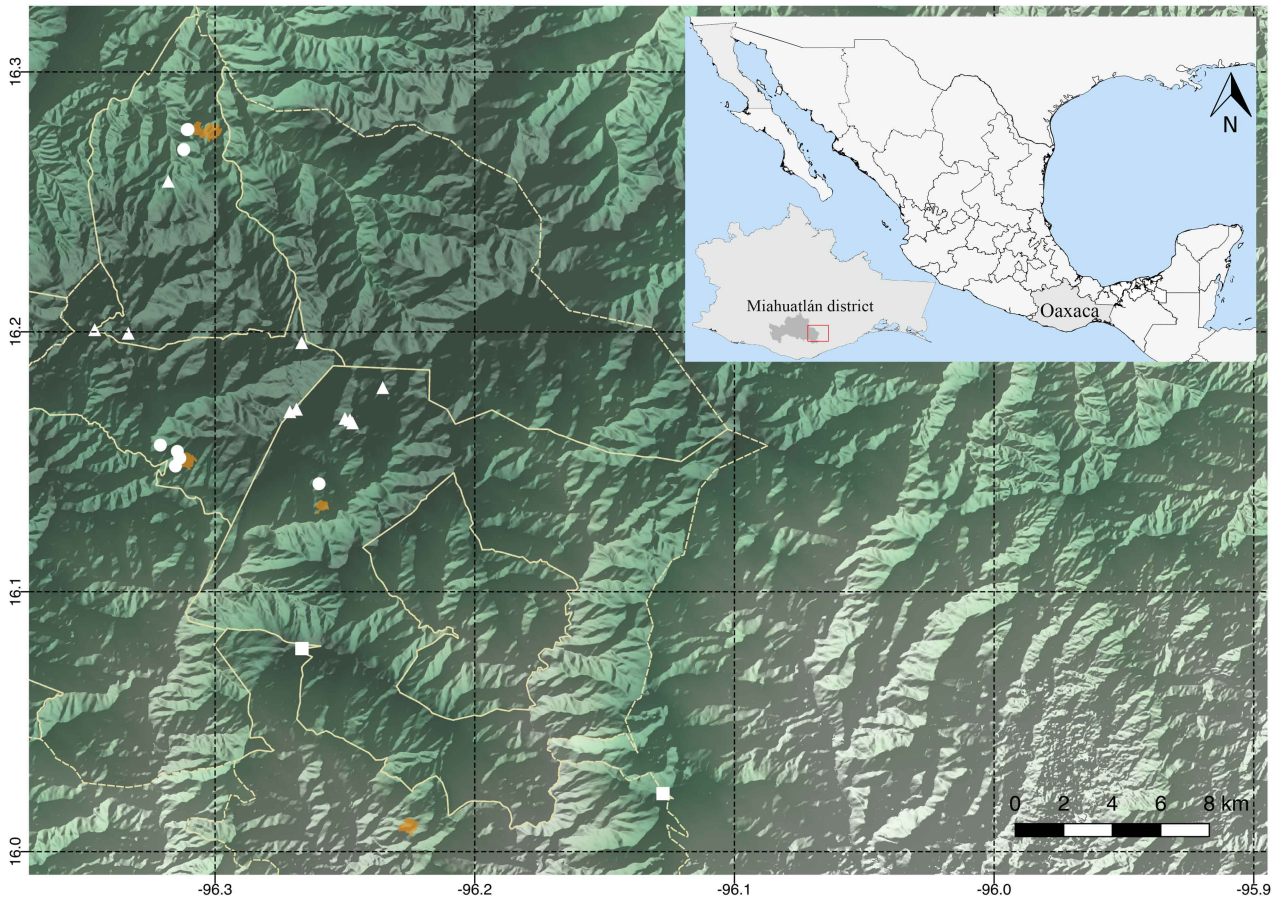


**FIGURE 1.** *Salvia ozolotepecensis*. **A** Leaves. **B** Leaf blade underside. **C** Inflorescence portion showing persistent floral bracts. **D** Flower (Photographs taken by G. González-Adame from type locality).



**FIGURE 2.** *Salvia ozolotepecensis*, floral details. **A** Calyx. **B** Ovary and gynobase. **C** Corolla. **D** Stamens. **E** Stamen detail showing connective ornamentation. **F** Style apex [Photographs taken from *I. Fragoso 369* (MEXU!)].

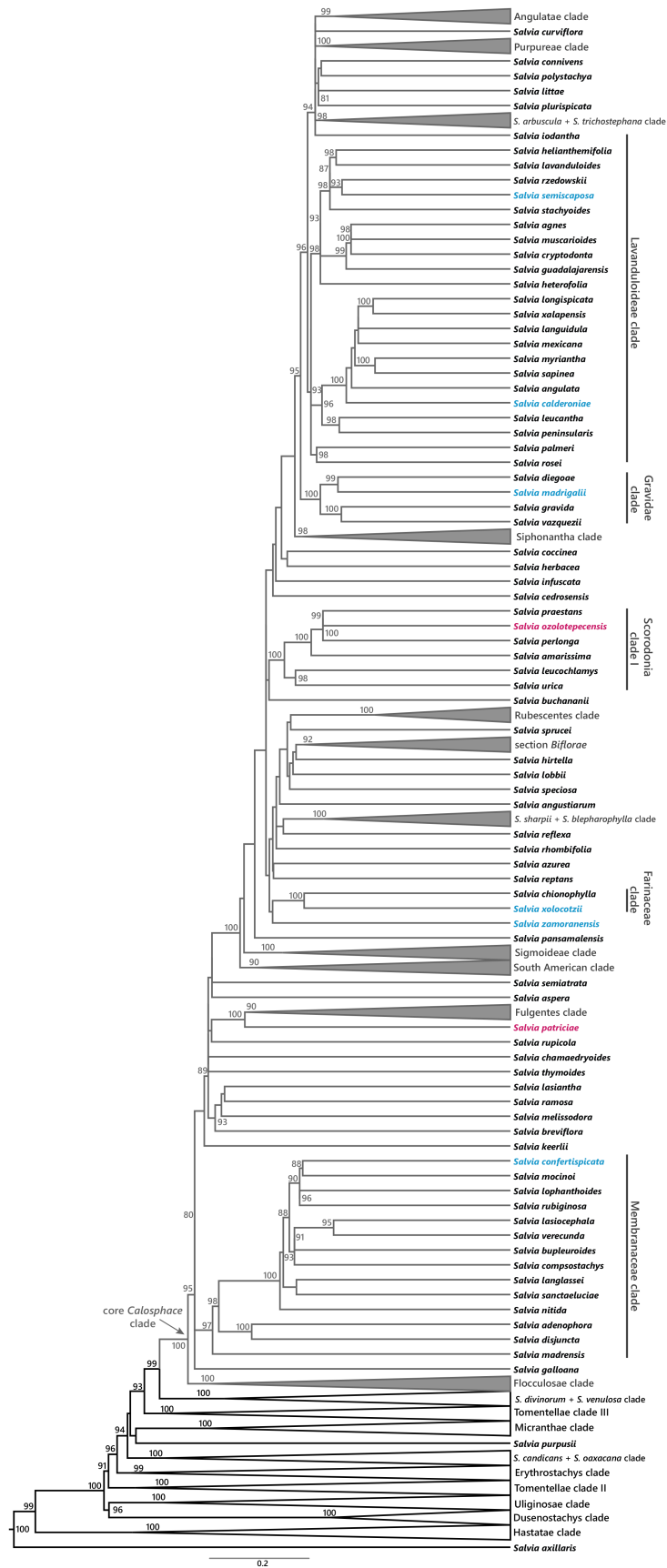




**FIGURE 3.** Distribution map of *Salvia ozolotepecensis* (white dots), *S. patriciae* (white triangles) and *S. sirenis* (white squares). Upper right corner showing the location of Oaxaca and Miahuatlán district; the red rectangle highlights the territory magnified in the rest of the figure. Sand lines correspond to municipalities boundaries within Miahuatlán district. Orange shadows represent the towns of, from top to bottom, San Juan Mixtepec, Santo Domingo Ozolotepec, San Juan Ozolotepec and Santiago Xanica.

Due to the above, *Salvia ozolotepecensis* cannot be assigned unambiguously to any of the recognized sections, it is more likely that in the near future, once *Salvia* classification is restructured, this new taxon together with *S. perlonga* and *S. praestans* will belong to the same section. These observations are supported by the molecular data; as shown in figure 4, both *S. perlonga* and *S. praestans* form a clade that also includes the new species (100 % Bootstrap Support; BS). This subclade is nested in the Scorodonia clade I (Fragoso-Martínez *et al.* 2018), which is a morphologically heterogeneous group where the only common characters are the presence of glandular indumentum, ovate-acuminate lately deciduous (or persistent) bracts, 5–7 veined upper calyx lip, ventricose and clearly or slightly invaginated corolla tube, longer lower corolla tube than the upper one, and pubescent style. Within this clade, the subclade in which *S. ozolotepecensis* is placed, contains red-flowered species, sister to blue-flowered. In light of these results, it would be important to re-evaluate the staminal morphology of the remaining species of the clade; as has been made with the Uliginosae clade (Barrera-Aveleida 2017), to uncover a common pattern in otherwise morphologically different species.

**Additional specimens examined (paratypes):**—MEXICO. Oaxaca. Miahuatlán district. Mun. San Juan Mixtepec: NE edge [from San Juan Mixtepec], 1960 m, 14 October 1996, *E. Hunn 243* (OAX!); 1.3 km WSW from San Juan Mixtepec, 16°17'N, 96°18'W, 2200 m, 12 August 1998, *E. Hunn 1889* (MEXU!); west edge of town [San Juan Mixtepec], 2050 m, 29 January 2000, *E. Hunn 1978* (OAX!). Mun. Santo Domingo Ozolotepec: 0.7 km de Santo Domingo Ozoltepec por la terracería a San José del Pacífico, 16°8'54"N, 96°18'55"W, 2343 m, 29 November 2015, *I. Fragoso-Martínez et al. 366* (MEXU!); 1.8 km de Santo Domingo Ozoltepec por la terracería a San José del Pacífico, 16°9'23"N, 96°19'16"W, 2373 m, 29 November 2015, *I. Fragoso-Martínez et al. 369* (MEXU!); La Cruz, Santo Domingo Ozoltepec, 16°9'5"N, 96°18'49"W, 2473 m, 29 November 2015, *I. Fragoso-Martínez et al. 380* (MEXU!); 1.5–2 km al NO de Santo Domingo Ozolotepec, por la brecha a San José del Pacífico, 16°9'14.3"N, 96°18'52.4"W, 2421 m, 26 November 2017, *J.G. González-Gallegos et al. 2314* (CIIDIR!, IBUG!, MEXU!).



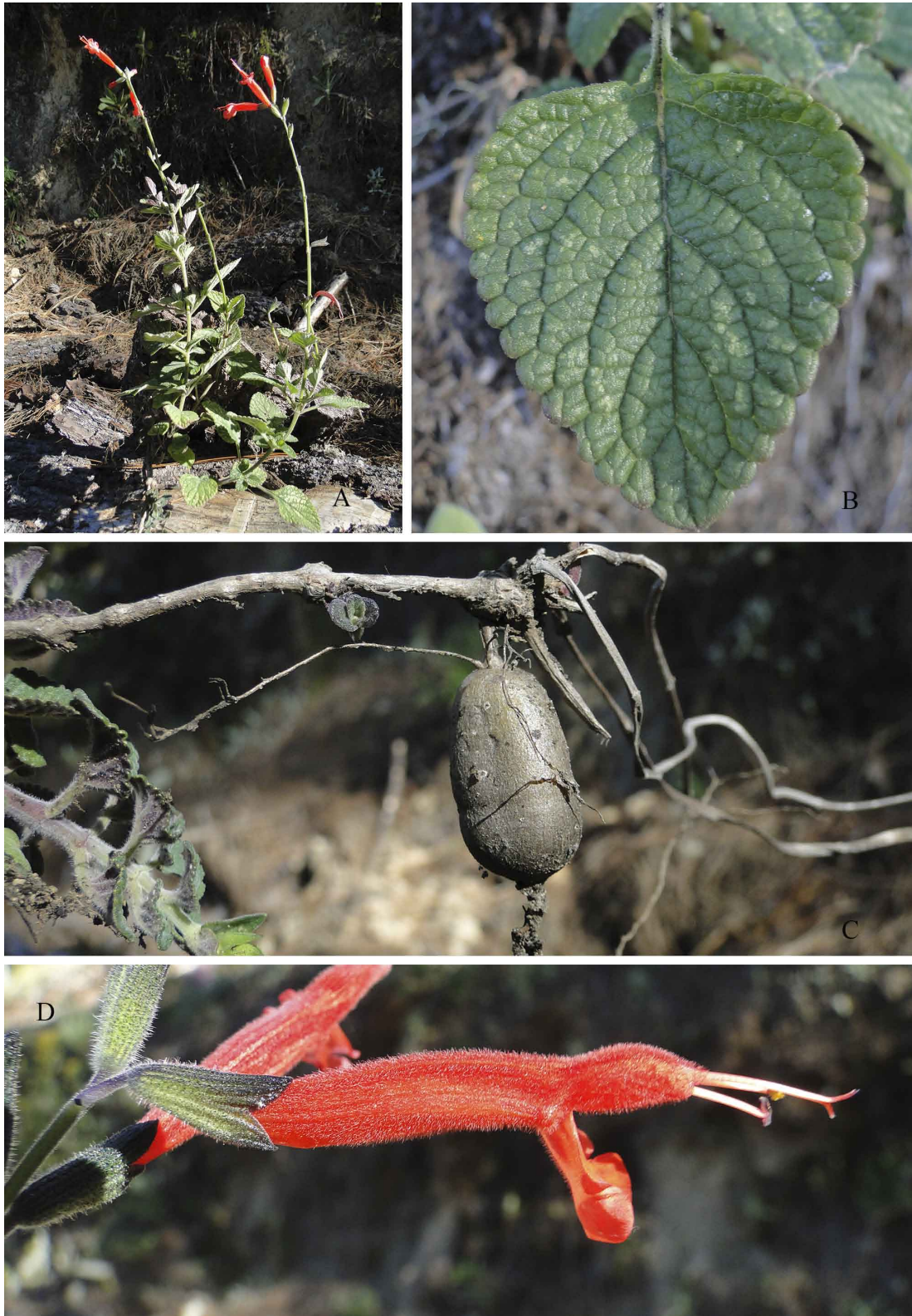
**FIGURE 4.** Phylogenetic relationships of *Salvia* subgenus *Calosphace* based on three molecular markers (nrITS, *trnH-psbA* and *trnL-trnF*) and an extended taxon sampling including the species of Table 1. Bootstrap values  $\geq 80\%$  are shown above the branches. Species names in blue and pink correspond to the new species published earlier and herein, respectively. The clades remaining unchanged with the new taxon additions have been collapsed to ease visualization. An expanded version of the phylogeny can be seen in Supplementary materials.



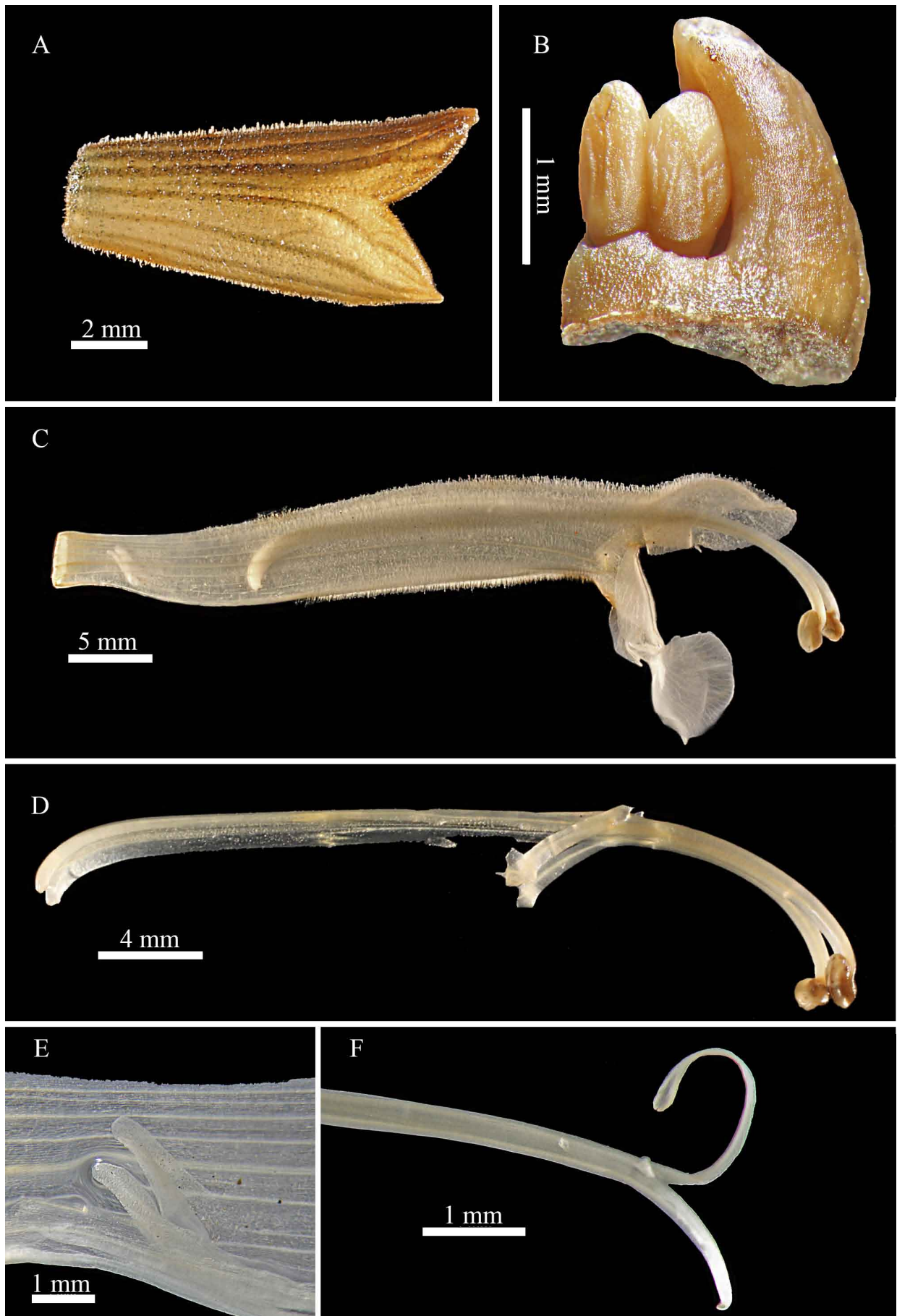
*Salvia patriciae* J.G.González & E.Martínez-A., sp. nov. (Figs. 5 & 6)

*Salvia stolonifera* primo aspectu maxima simile, sed corolla tubis angustioribus (3.5–6.5 vs. 7–9.5 mm latis), corollarum labiis superis brevioribus [(5.9–)7.8–10 vs. 12–15.5 mm longis] et inferis brevioribus vel longitudo quasi eadem (vs. longioribus vel quasi eadem), papillis erectis (vs. recurvatis) et brevioribus [1–1.4 vs. 6–7(–10) mm longis], staminibus exsertis (vs. inclusis), connectivis longioribus [(18.4–)27.6–40 vs. 21.6–25 mm longis], et stylis prope ad medium pilosulis (vs. pilosulis infra stylos ramarum).

**Type:**—MEXICO. Oaxaca: Miahuatlán district. Mun. San Juan Ozolotepec: Quiexobra [Cerro del Agua], 3550 m, 15 October 1995, G.B. Hinton 26159 (holotype CIIDIR!, isotype GBH!).



**FIGURE 5.** *Salvia patriciae*. **A** General habit. **B** Leaf blade, upperside. **C** Tuber and roots. **D.** Flower (Photographs taken by G. González-Adame from Cerro Quiexobra [Cerro del Agua]).



**FIGURE 6.** *Salvia patriciae*, floral details. **A** Calyx. **B** Ovary and gynobase. **C** Corolla. **D** Stamens. **E** Corolla tube papillae. **F** Style apex [Photographs taken from *I. Fragoso 363* (MEXU!)].



Perennial herb or subshrub, erect, 20–50 cm tall; stems short pilose; developing stolons and tubers. Leaves with petioles (0.3–)1.2–2.7 cm long, short pilose; blade deltoid to ovate-deltoid, 2.5–5.1 × 1.6–4 cm, acuminate to acute at apex, cuneate at base, margin crenate to crenate-serrate, pilose in both faces and covered with amber glandular dots, pubescence longer and denser beneath. Inflorescence in racemes (5.2–)9–22 cm long, with 3–8 floral nodes, each with 2–4 flowers, the lowermost 1.4–2.1(–4.4) cm apart from each other; floral axis with sparse simple hairs and more abundant tiny glandular-capitate. Floral bract soon deciduous, rhomboid-elliptic to lanceolate, 3.9–6.1 × 1.2–1.5 mm long, apex short caudate, base cuneate and then truncate, margin entire, pubescence as in the floral axis. Flowers with pedicels (2.9–)3.6–5.5 mm long, sparsely pilose and with dense tiny glandular-capitate hairs. Calyx (9.3–)10.2–12 × 3.2–5.2 mm, up to 8 mm long in fruit, pubescence outside as in floral axis, short hispidulous inside, lips subequal, (2–)2.5–3.4(–4.5) mm long, the upper one entire and 7-veined. Corolla red to orange-red, sparsely short pilose; tube 22.2–31.7 × 3.5–6.5 mm, thin throughout, straight at base and with two slender linguiform papillae inside (1–1.4 mm long); upper lip (5.9–)7.8–10 mm long, lower (5.5–)7–11.5 × (4.5–)7–12.8 mm. Stamens exerted by 3.2–7 mm, filament 3.4–4.5(–6.1) mm long, connective (18.4–)27.6–40 mm long, slightly curved and with and antrorse short tooth near midportion, theca (1.7–)2.3–3.1 mm long; a pair of small staminodes above and behind filament insertion. Gynobasic horn 1.3–1.5 mm long, style (30–)37.7–45 mm long, 7–10.7 mm exerted, sparsely pilose near midportion, lower stigmatic branch acute and shorter than the upper one. Mericarp ovoid, 2.8–3.2 × 1.5–1.8 mm, brownish gray and irregularly punctate with a darker tone, glabrous and smooth

**Etymology:**—The epithet honors Patricia Hinton, member of an outstanding family of plant collectors in Mexico, which dates back to George B. Hinton (1882–1943). They have contributed greatly to increase the knowledge of the Mexican flora, and in their collecting adventures have explored very remote and inaccessible localities. Their legacy includes 19 type specimens of currently accepted names in *Salvia*.

**Distribution, habitat and phenology:**—*Salvia patriciae* is an endemic species from Oaxaca, Mexico; known from several localities no more than 6 km apart from each other (Fig. 3). It grows in the mountains of Miahuatlán district in Sierra Madre del Sur from 2655–3550 m elevation. It dwells in pine forests. Flowering from June to November, and fruiting probably from late August to February.

**Notes:**—Following Epling (1939) identification keys for *Salvia* subgenus *Calosphace* does not lead to a clear assignment to one of the sections. The most morphologically suitable are *Charantia* Epling (1939: 141), *Flexuosa*, *Iodophyllae* Epling (1939: 141) and *Pedicellata* Epling (1949: 518) based on sharing exerted stamens, papillae inside corolla tube base, 5–7-veined upper calyx lip, upper corolla lip longer than the tube and deciduous floral bracts. However, *Salvia patriciae* differs from the species in *S. sect. Charantia* by having deltoid to ovate-deltoid leaf blades (*vs.* oblong to oblong-lanceolate) and straight corolla tube at base (*vs.* invaginated). The species in *S. sect. Flexuosae* differs by the longer leaves (6–18 *vs.* 2.5–5.1 cm long), usually longer floral bracts (5–25 *vs.* 3.9–6.1 mm long) or upper corolla lip longer or as long as the lower; besides, this section is restricted to South America. *Salvia sect. Iodophyllae* possesses only one species, *Salvia iodophylla* Epling (1939: 141), which differs from the new one by its 2-flowered floral nodes (*vs.* 2–4-flowered), 5-veined upper calyx lip (*vs.* 7-veined), lower corolla lip shorter than the upper (*vs.* lower longer than the upper) and entire connective (*vs.* ornate with an antrorse short tooth). Finally, *S. sect. Pedicellata* has also only one species, *Salvia palealis* Epling (1940: 519), which differs in having bigger leaves (11–13 × 6–9 *vs.* 2.5–5.1 × 1.6–4 cm), cordate leaf blades (*vs.* cuneate), 12-flowered floral nodes (*vs.* 2–4-flowered), 5-veined upper calyx lip (*vs.* 7-veined), and subequal corolla lips (*vs.* the upper shorter than the lower).

In general aspect, *Salvia patriciae* is more similar to the species in section *S. sect. Incarnatae*. At first glance, it looks like *Salvia elegans* Vahl (1804: 238) but with bigger flowers and exerted stamens. Nonetheless, more detailed observations reveal there are other deep discrepancies: entire and acute upper calyx lip (*vs.* trimucronate or caudate), corolla internally ornate with two slender papillae (*vs.* epapillate), lower corolla lip longer than the upper (*vs.* shorter than the upper).

If stamen exertion is ignored, following the identification key leads to *S. sect. Fulgentes* Epling (1939: 273) when trying to identify *Salvia patriciae*. Amongst the species of this group, *Salvia lineata* Benth (1835: 724) is the morphologically most similar. However, *S. patriciae* can be distinguished because the pilose leaves (*vs.* glabrous), shorter floral bracts (3.9–6.1 *vs.* 6–10 mm long), longer corolla tube (22.2–31.7 *vs.* 19.6–20.4 mm long), exerted stamens (*vs.* included below upper corolla lip), antrorse tooth in connective midportion (*vs.* retrorse) and style short pilose near midportion (*vs.* pilose towards the apex). If the proportion between corolla lips is also ignored (upper one as long or shorter than the lower, *vs.* as long or longer), *S. patriciae* can be related to *S. sect. Cardinales* Epling (1939: 295), and within this, to *S. stolonifera* Benth (1840: 70). Both species are very similar and hard to be separated considering only vegetative characters, except by the leaves that are cordate, cordate and short cuneate to truncate (*vs.* cuneate) at base and slightly papillate beneath (*vs.* smooth) in *S. stolonifera*. However, once floral characters are



compared, stronger evidence arises in order to support the recognition of two different species; *S. patriciae* differs in having thinner corolla (3.5–6.5 vs. 7–9.5 mm wide), shorter upper corolla lip [(5.9–)7.8–10 vs. 12–15.5 mm long] and this as long or shorter than the lower (vs. as long or longer), straight vertical (vs. recurved and oriented forwards) and shorter papillae [1–1.4 vs. 6–7(–10) mm long] inside corolla tube, exerted stamens (vs. included), longer connective [(18.4–)27.6–40 vs. 21.6–25 mm long], and style short pilose near midportion (vs. with the hairs disposed in the apex just before stigmatic branches).

Because of the similarity between *Salvia patriciae* and *S. stolonifera*, this was referred as the latter in the floristic inventory conducted by McDonald (2013) in Cerro Quiexobra. Later, B.L. Turner labeled the specimen *McDonald 3004* (TEX!) as *Salvia macdonaldii*, no date on the label, revealing his intention of publishing this as a new species; however, he did not validate the name.

In summary, *Salvia patriciae* is a distinctive new species sharing characters with the species of several Epling's sections, but which cannot be unambiguously assigned to one of these. However, although the results of the phylogenetic analysis (Fig. 4) do not show a clear assignment to any of the sections, it is shown a close relationship with the Fulgentes clade. This group is a heterogeneous assemblage including some species of 4 different sections: *Cardinales* [as *Holwaya* Ramamoorthy (1984: 323) according to a more recent proposal], *Flocculosae* (Epling 1935: 77) Epling (1939: 153), *Fulgentes* and *Nobiles* Epling (1939: 280) [the sampled species from this section also might belong to *Holwaya* according to dos Santos (1991)]. The species in this clade share 5–7 veined upper calyx lip, red corollas (mostly), ventricose corolla tube and pubescent style [except *S. univerticillata* Ramamoorthy ex Klitgaard (2007: 208) according to the description in *Flora Mesoamericana* (Klitgaard 2012)]. All of these characters are shared with *S. patriciae*; however, the remaining species of the clade have stamens that are included in the upper corolla lip. The differences in the level of exertion of the stamens have been used by Epling (1939) to separate species into contrasting sections. These results could suggest that the transition from exertion to inclusion is more common and labile, and/or that there are still a number of species that remain to be sampled. Expanding the taxon sampling in the phylogenetic framework would shed light into the evolution of floral morphological characters and their value as taxonomic diagnostic characters, such as stamen exertion.

Due to the above, and in face that Epling's classification needs to be rearranged since it is far from natural (Jenks *et al.* 2013), no section is here designated.

**Additional specimens examined (paratypes):**—MEXICO. Oaxaca. Miahuatlán district. Mun. San Juan Mixtepec: San Juan Mixtepec, 5 km SW of town, 16°20'8"N, 96°19'9"W, 2900 m, 23 June 1997, *E. Hunn 1259* (MEXU!). Mun. San Juan Ozolotepec: 35 km ESE of Miahuatlán, 5 km NE of Santo Domingo Ozolotepec, Cerro Quiexobra, 16°10'N 96°15'W, 3500–3700 m, 3 October 1990, *J.A. McDonald 3004* (TEX!); Quiexobra [Cerro del Agua], 3425 m, 6 August 1996, *G.B. Hinton 26787* (GBH!); Zona de aprovechamiento forestal, camino al Cerro del Agua, 16°10'42.77"N 96°14'7.59"W, 3126 m, 27 November 2017, *G. González-Adame et al. 2830* (Herbario de la Universidad Sierra Juárez!, SERO!); camino de acceso al Cerro del Agua, 16°9'58.04"N 96°14'52.99"W, 3141 m, 27 November 2017, *G. González-Adame et al. 2831* (Herbario de la Universidad Sierra Juárez!, SERO!); Cerro del Agua, 3.5–4 km al NE de San Juan Ozolotepec, 16°9'53.9"N 96°14'49.5"W, 3128 m, 27 November 2017, *J.G. González-Gallegos et al. 2321* (CIIDIR!, HUAA!, IEB!, MEXU!, OAX!, ZEA!). Mun. Santo Domingo Ozolotepec: Neverías, 2655 m, 3 August 1996, *G.B. Hinton 26651* (GBH!); Las Trancas, 16°11'45"N 96°16'0"W, 3516 m, 8 July 2010, *A. Sánchez M. 2906* (MEXU!, SERO); desviación a Santo Domingo Ozolotepec, 16°12'3"N 96°20'47"W, 2920 m 28 November 2015, *I. Fragoso-M. et al. 363* (MEXU!).

***Salvia sirenis* J.G. González & G. González, sp. nov. (Fig. 7)**

*A Salvia pericona foliis concoloribus* (vs. *bicoloribus*), *foliorum laminae basi truncatis vel leviter obliquis* (vs. *cordatis*), *floribus 6–8 in nodis floralibus* (vs. 10–12), *bracteis floralibus magnioribus* [(10.8–)14–15.3 × 7.2–10 vs. 6–8 × 4–6 mm], *calycibus magnioribus* (11–12.7 × 4.5–6.5 vs. 8–9 × 3–3.5 mm), *calycum labiis superis 5 vel 7-nervatis* (vs. 7-nervatis), *corollarum tubis longioribus* [(12.4–)13.6–15 vs. (8–)10–13 mm longis], *corollarum labiis superis longioribus* (6.4–7.8 vs. 4–6 mm long) *et corollarum labiis inferis longioribus* [(5.5–)7–9.2 vs. 4.5–6 mm long] *statim dignoscenda*.

**Type:**—MEXICO. Oaxaca. Miahuatlán district. Mun. San Juan Ozolotepec: La Sirena, summit, 2980 m, 23 October 1995, *G.B. Hinton 26385* (holotype CIIDIR!, isotype GBH!).

Shrub, erect, 1 m tall; stems puberulent and short pilose in the nodes. Leaves with petioles 7–13.4 mm long, puberulent and sparsely hispidulous; blade ovate to ovate-lanceolate, coriaceous, (4.6–)7–8 × 3.2–4 cm, acuminate to acute at apex, rounded to slightly oblique at base, margin finely serrate, both faces puberulent, sparsely hispidulous to glabrescent and covered with ocher glandular dots. Inflorescence in racemes 19–27.5(–58) cm long, with 10–14 floral nodes,



HERBARIUM OF G. B. HINTON NO. 26385  
LAMIACEAE  
Salvia sp.  
Determined by  
April 1996

HERBARIUM OF G. B. HINTON NO. 26385  
Collected by Hinton et al. 1995/10/23  
La Sirena, summit, 2980 m.  
Mihuatlán, Oax., México.  
Rocky pine and oak forest.  
Fl. white. 1 m. Small colonies.  
Common.

FIGURE 7. Holotype of *Salvia sirenis* kept in CIIDIR.

each with 6–8 flowers, the lowermost 3–3.2(–5.8) cm apart from each other; floral axis hispidulous and with short glandular-capitate hairs and amber glandular dots. Floral bract deciduous, ovate to ovate-rhomboid, (10.8–)14–15.3 × 7.2–10 mm, caudate at apex, truncate at base, margin entire, puberulent and scarcely hispidulous. Flowers with pedicels 2.7–5(–5.7) mm long, up to 7.8 mm in fruit, hispidulous, with short glandular-capitate hairs and amber glandular dots. Calyx 11–12.7 × 4.5–6.5 mm, pubescence outside as in the pedicel, short hispidulous inside, lips subequal, 4.8–5.4 mm long, the upper one entire and 5 or 7-veined. Corolla white, dorsal and upper lip sparsely pilose, tube (12.4–)13.6–15 × 4.3–5.4 mm, ventricose at the middle, straight at the base and with two papillae inside; upper lip 6.4–7.8 mm long, lower (5.5–)7–9.2 × (6.8–)9.4–10.6 mm. Stamens inserted, filament 2.2–3.3 mm long, connective 9–10.1 mm long almost straight and with a retrorse acute tooth at midportion, theca 1.8–2.1 mm long; a pair of small staminodes above and behind filament insertion. Gynobasic horn 1.3–1.4 mm long, style 18.2–21.6 mm long, slender throughout, short pilose near the apical portion, lower stigmatic branch acute and shorter than the upper one. Mericarp ovoid, 2–2.1 × 1–1.1 mm, brown and irregularly marbled with a darker tone, glabrous and smooth.

**Etymology:**—The epithet make reference to the type locality of the species, La Sirena, in its Latinized form.

**Distribution, habitat and phenology:**—*Salvia sirenis* is an endemic species from Oaxaca, known only from two localities in Miahuatlán district 2572–2980 m elevation (Fig. 3). It inhabits pine-oak forests. Flowering and fruiting probably from September to December.

**Notes:**—*Salvia sirenis* matches with *S.* sect. *Scorodonia* Epling (1939: 166) in every character according to Epling (1939), Turner (2009a) and Olvera-Mendoza *et al.* (2017) circumscriptions. *Salvia sirenis* is morphologically most similar to *Salvia periconia* Turner (2009: 260) sharing ovate leaves, truncate to rounded at base, no glandular hairs in the calyx, white corollas, ventricose, upper corolla lip longer than the lower one, and short pilose style. However, *Salvia sirenis* differs in having almost concolorous leaf blades (*vs.* bicolored), rounded to slightly oblique at base (*vs.* cordate), 6–8-flowered floral nodes (*vs.* 10–12-flowered), larger floral bracts [(10.8–)14–15.3 × 7.2–10 *vs.* 6–8 × 4–6 mm], larger calyx (11.5–12.7 × 4.5–6.5 *vs.* 6–8 × 4–6 mm), 5 or 7-veined upper calyx lip (*vs.* 7-veined), longer corolla tube [(12.4–)13.6–15 *vs.* (8–)10–13 mm long], and longer upper (6.4–7.8 *vs.* 4–6 mm long) and lower [(5.5–)7–9.2 *vs.* 4.5–6 mm long] corolla lips.

It is interesting that in the last two decades several species with white corollas have been described from Mexico: *Salvia diegoae* Martínez-Gordillo & Lozada-Pérez (2011: 211), *S. madrigalii*, *S. meera* Ramamoorthy ex González-Gallegos *et al.* (2012: 593), *Salvia periconia* and *S. wixarika* González-Gallegos & López-Enríquez (2016: 178). This corolla color is unusual among Mexican species, being present now in 18 of them (González-Gallegos *et al.* 2012, González-Gallegos & López-Enríquez 2016, Zamudio & Bedolla-García 2018), *i.e.* about 6 % of the total.

**Additional specimen examined (paratype):**—MEXICO. Oaxaca. Miahuatlán district. Mun. Santiago Xanica: Punto Trino en el Cerro Lobo, 16°1'20.2"N 96°7'39"W, 2572 m, 17 December 2003, *J. Pascual 958* (SERO!).

## Phylogenetic analyses

In the present study we advanced in the knowledge of the phylogenetic position of recently described Mexican sages including those described herein. According to the results showed in Figure 4 and Supplementary Material 1, these new taxa can be divided into two groups. The first encompasses those taxa that are morphologically congruent with their phylogenetic position: *Salvia ozolotepecensis*, which is similar to *S. perlonga* and *S. praestans*, to which it is closely related; *S. confertispicata* Fragoso-Martínez & Martínez-Gordillo (2013: 2) that was described into the monophyletic *S.* sect. *Membranaceae* (Bentham 1833: 202) Epling (1939: 143); *S. semiscaposa* Fragoso-Martínez *et al.* (2015: 60), another example of a species that was described into a monophyletic section, *Lavanduloideae*; although *S. calderoniae* Bedolla-García & Zamudio (2015: 39) was described into the polyphyletic *S.* sect. *Angulatae*, its phylogenetic placing coincides with the species against it was compared in the protologue; this is the same case with *S. madrigalii*, a species that was not assigned to any section but only its morphological resemblance to *Salvia diegoae* was established.

The second group is represented by the taxa that have been difficult to assign to any of the described sections due to the presence of a combination of diagnostic characters of different sections in only one species. In this group fits one of the species described here, *Salvia patriciae*, that shares characters with at least six sections, and it is phylogenetically related with taxa from *S.* sect. *Flocculosae*, *Fulgentes* and *Holwaya* (Fragoso-Martínez *et al.* 2018). *Salvia xolocotzii* Bedolla-García & Zamudio (2015: 43) was described into *S.* sect. *Uliginosae*, but it is included instead in the core Calosphace clade. It should be noted that in the original description of *S. xolocotzii* (Bedolla-García & Zamudio 2015), the authors related the new taxa to *S.* sect. *Uliginosae* because of the resemblance to *S. galloana* Turner (2009b: 448),



but at the same time they enumerated several discrepancies of these with the circumscription of the section. *Salvia galloana* is also in the core *Calosphace* clade; however, it is not closely related to *S. xolocotzii*. Instead, *S. galloana* seems to form part of one of the early-diverging lineages of core *Calosphace*, but the relationships at the backbone of this clade still lack resolution. *Salvia zamoranensis* Zamudio & Bedolla in Bedolla-García & Zamudio (2015: 48) is compared to taxa in *S. sect. Brandegeia* but its phylogenetic position is uncertain, suggesting a lack of sampling of taxa from the mid-center and north of Mexico.

We are aware that Epling's classification is largely artificial, but it represented an effort of summarizing the diversity of *Calosphace* into more manageable and practical units that have been useful to the botanists involved with the subgenus. However, with an increasing and continuous description of new Neotropical sages, more than ever a re-evaluation of this classification and a proposal of a new one is needed. This classification could be based on natural units such as clades, and an effort should be made to reflect the complex evolution of *Calosphace* in the New World.

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