*Phytotaxa* 644 (3): 190–200
https://www.mapress.com/pt/


**Article**

ISSN 1179-3155 (print edition)
PHYTOTAXA
ISSN 1179-3163 (online edition)

https://doi.org/10.11646/phytotaxa.644.3.2

# *Salvia josetta* (Nepetoideae; Lamiaceae), a new species from Lebanon

HICHAM EL ZEIN[1,*] & LISA BOTTCHER[2]
[1]*Independent researcher (El Arz Street, 1100, Beirut), Lebanon*
*hichamelzzein@gmail.com; https://orcid.org/0000-0001-7541-9509*
[2]*Independent researcher (Rue de la forêt, 39700, Serre-Les-Moulières), France*
*lisa.bottcher@orange.fr; https://orcid.org/0009-0002-2934-3800*
**Corresponding author: hichamelzzein@gmail.com*

## Abstract

*Salvia josetta*, a new species of Lamiaceae, is described and illustrated. The species was discovered in 2018 from the district of Danniye, North Lebanon. We collected samples each year and prepared herbarium specimens. By comparing our samples with the already known taxa in the genus *Salvia*, through morphological descriptions and herbarium specimens, we established that they belong to a species new to science. This new species grows in openings within pine woodlands on brown soil developed from limestone and sandy bedrocks. Following the guidelines and criteria of the International Union for the Conservation of Nature (IUCN), it is assessed as critically endangered, based on its limited distribution area (0.02 km²) and the threats impacting the site where it was found, namely illegal logging, forest fires, and quarrying. The morphological characters are compared with two similar species, *Salvia fayruziana* from Lebanon and *Salvia veneris* from Cyprus.

**Key words:** Levant, endemic, Mediterranean, pine woodland

## Introduction

*Salvia* is a genus with around 900 species distributed in various regions: Central America (320 spp.), South America (210 spp.), the Mediterranean (250 spp.), Eastern Asia (90 spp.) and Southern Africa (30 spp.) (Alziar 1988, 1989a, 1989b, 1991, 1992, 1993; Walker & Sytsma 2007). Instead of the typical four stamens present in other members of the tribe Mentheae, the genus *Salvia* is characterised by having the two posterior stamens aborted. The thecae of the two expressed stamens are separated by an elongated connective. The elongation of this staminal connective allows the formation of the lever mechanism of pollination (Claßen-Bockhoff *et al.* 2004; Walker & Sytsma 2007). The inflorescence in the genus *Salvia* is called verticillaster and consists of an opposite condensed cyme arranged around an axis like a true verticil.

The most widely accepted classification separates the genus into fourteen sections, nine of which are distributed in the Old World and five in the New World (Bentham 1832). The species belonging to the section *Aethiopis* Bentham present following characters: biennial or perennial herbs with a tubular or campanulate calyx; the upper lip of the calyx is straight at the fruiting stage; the upper lip of corolla is more or less falcate; the corolla tube lacks a ring of hairs; the staminal connective is longer than the filament; the arms are unequal, with the shorter one being more or less dolabriform (Tutin *et al.* 1972; Walker & Sytsma 2007; Celep 2010; Celep & Doğan 2023).

In Lebanon, the genus *Salvia* includes 20 species: *S. bracteata* Banks & Sol., *S. ceratophylla* L., *S. fairuziana* R.M.Haber & Semaan, *S. fruticosa* Miller, *S. hierosolymitana* Boiss., *S. indica* L., *S. judaica* Boiss., *S. microstegia* Boiss. & Bal., *S. multicaulis* Vahl, *S. palaestina* Benth., *S. peyronii* Boiss. ex Post, *S. pinnata* L., *S. rubifolia* Boiss., *S. sclarea* L., *S. spinosa* L., *S. syriaca* L., *S. tomentosa* Miller, *S. verbenaca* L., *S. viridis* L. and *S. viscosa* Jacq. (Mouterde 1984; Haber & Semaan 2004; Tohmé & Tohmé 2011, 2014). Two of them, *S. fairuziana* and *S. peyronii* are strictly endemic to Mount Lebanon. *S. judaica* is endemic to the Levant and *S. hierosolymitana* is endemic to the Levant and Cyprus.

During the botanical expeditions conducted in Wadi Jhannam for the projects "Distribution and Red List Assessment of the restricted range endemic *Jacobaea mouterdei* (Asteraceae)" and "Determination of the Floral Diversity and Conservation Value of the Valleys of Hell with Focus on the Range-Restricted Endemic *Jacobaea mouterdei* (Arènes)

 *Accepted by Enrico Vito Perrino: 28 Mar. 2024; published: 16 Apr. 2024*

Greuter & B.Nord (Asteraceae)", a previously unseen species of *Salvia* was discovered in the District of Danniye in the North Governorate in Lebanon. It was first observed in 2018 and then subsequently collected each year until 2023. A new species was identified through a comprehensive description of the morphology of these collected specimens. The newly discovered species, referred to as *Salvia josetta*, is described and depicted in this study. Furthermore, a comparative analysis between *S. josetta* and the closest related species of *Salvia* occurring in the region of the Levant is presented. The distribution of the species, its habitat, flowering and fruiting periods, as well as its conservation status, are also presented.

## Material and methods

Each year since its initial discovery in 2018, numerous specimens featuring both vegetative and reproductive parts of the species have been gathered. Thorough observations were made regarding the species and its ecological characteristics. Plant measurements were taken using a graph paper and a centimeter rule. The morphology of this novel taxon was meticulously juxtaposed with all relevant species mentioned in the literature: the floras of Lebanon and Syria (Post & Dinsmore 1932; Mouterde 1984; Tohmé & Tohmé 2014), Turkey and East Aegean islands (Davis *et al.* 1965), Cyprus (Meikle 1977), Iran (Hedge 1982) and Europe (Tutin *et al.* 1972), and the recent publications reporting novelties from the region (Donmez 2001; Haber & Semaan 2004; Hamzaoğlu *et al.* 2005; Behçet & Avlamaz 2009; Celep *et al.* 2009, 2015, 2020; İlçim *et al.* 2009; Kahraman *et al.* 2009, 2011; Celep & Doğan 2010; Tohmé & Tohmé 2011; İlçim *et al.* 2023). Specimens of related species from BEI, BR, G and P herbaria (acronyms according to Thiers 2024) were also compared. Through the detailed analysis encompassing morphology and leaf anatomy of these references and the collected samples, a new species was distinguished. The descriptions presented follow the terminology used in the revision of the genus *Salvia* in the Mediterranean and the Aegean geographic regions of Turkey (Celep 2010). The geographic distribution was mapped using the QGIS v. 3.22.5 software (QGIS Development Team 2023). The conservation status of the species was assessed following the criteria B and D and the guidelines of the International Union for the Conservation of Nature (IUCN 2022), using a cell width of 2 km to estimate the extent of occurrence (EOO).

## Results

## Taxonomy

***Salvia josetta*** H. El Zein, *sp. nov*. (Figs. 1, 2, 3, 4, 5, 6. Table 1)

**TYPE**:—LEBANON. Danniye: Wadi Jhannam, close to the village of Jayroun, 1380 m, 34.426485° N, 036.128039° E, 14 July 2021, fl., H. El Zein HELB1220 (holotype: BEI!, isotype: P!).

**Diagnosis**:—**Plant** perennial, herbaceous, c. 30–80 cm in height. **Roots** thin, cylindrical, woody, from which several basal leaves rosettes emerge; each individual forming a clump of one to 20 rosettes. **Leaves** all basal, ovate to ovate-oblong, petiolate, 3–10 cm long including petiole, 1–4.5 cm wide, with blade doubly crenate to lobed-crenate margins and narrowly and asymmetrically cordate base; in the initial stage of development leaves covered with a dense indumentum of woolly eglandular white hairs along with short glandular hairs on the adaxial surface; as the leaves develop, wooliness quickly disappearing and leaves gradually becoming villous and then only pubescent with short and glandular hairs, revealing a verrucose surface; abaxial surface initially woolly, covered with an indumentum of white eglandular hairs, shorter than the ones on the adaxial surface, along with short glandular hairs, and then becoming densely pubescent with an assemblage of glandular short hairs with some eglandular white trichomes; ***petiole*** 1.5–9 cm long, often as long as the blade or longer, flat, covered with woolly hairs and short glandular hairs at first stage of development; only pubescent on the sides when mature. **Inflorescence** widely spaced panicle of 4–6 verticillasters, the main stem of the panicle usually branched at the two or three first stem nodes, secondary stems shorter than the main axis, sometimes also branched at their first and second stem nodes; internodes 4–7 cm long between verticillasters; first two or three lowest verticillasters with 4–6 flowers, highest verticillasters only with 1–2 flowers, verticillaster

with flowers unilaterally arranged towards the outside. **Stem** tetragonal, 2–3 mm large, densely pubescent with short glandular hairs and sessile glands; sometimes edges of the stem with a line of short stiff eglandular hairs. **Bracts** of the branched nodes 1–2.2 cm long and 0.5–1 cm wide, ovate, with serrate margin, acuminate apex, cordate base, green, pubescent with short glandular hairs, verrucose on the adaxial surface; bracts of the verticillasters 0.6–1.2 cm long and 0.3–0.7 cm wide, orbicular, with cuspidate apex, rounded base, entire margin, bicolor, white at the center and green on the margins, pubescent with short glandular hairs. **Flowers** 1.8–2.4 cm long excluding pedicel; pedicels 2–3 mm long when flowering, 3–4 mm when fruiting, pubescent with short glandular hairs and sessile glands; ***calyx*** 0.8–1.1 cm long and 0.5–0.9 cm wide during flowering, slightly accrescent,; densely pubescent with short glandular hairs and sessile glands, bilabiate, upper lip 3-toothed, lower lip 2-toothed, all teeth acuminate, spinose, aristate with a 1 mm mucro, except the median tooth of the upper lip which is shorter; calyx tube 0.5–0.6 cm long, with 13 ribs, reticulate venation between the ribs visible by transparency; ***corolla*** bicolor, with sparse sessile glands; upper lip 1.1–1.3 cm long, lilac, falcate, bifid; lower lip 0.6–0.8 cm long, white, with a deflexed median orbicular lobe and two oblong lateral lobes; ***staminal connectives*** 1.3 cm long, including the staminal filaments 3 mm long; the lower thecae reduced to a dolabriform adhering tissue; ***stigma*** 2.5 cm long. **Fruit** calyx reaching 1.1–1.3 cm length and 0.9–1 cm width when fruiting, tips of the teeth turning dark purple when fruiting on some individuals. **Seeds** 25–30 mm long and 18–20 mm wide, ovoid, light brown with dark brown venation.

**Habitat and distribution**:—*Salvia josetta* was observed in only one site (Fig. 1), despite thorough surveys of the surroundings slopes and plateaus conducted since 2018. The new species occurs in open conifer woodlands of the supra-Mediterranean level, dominated by *Pinus brutia* Ten. (El Zein *et al.* 2022) at elevation between 1300 and 1400 m a.s.l., with a significant presence of *Quercus coccifera* L. Other trees and shrubs that contribute to these woodlands include *Juniperus oxycedrus* R.P.Adams, *J. drupacea* Labill., *Quercus infectoria* G.Olivier and *Styrax officinalis* L.. The most common accompanying herbaceous plants were *Dactylis glomerata* L., *Echinops spinosissimus* subsp. *macrolepis* (Boiss.) Greuter, *Jacobaea mouterdei* (Arènes) Greuter & B.Nord., *Ononis natrix* L., *Verbascum libanoticum* Murb. & J.Thiébaut, *Stachys distans* Benth., *Salvia tomentosa* Mill.. The soil is brown, derived from a limestone substrate, with some areas having a sandy texture.

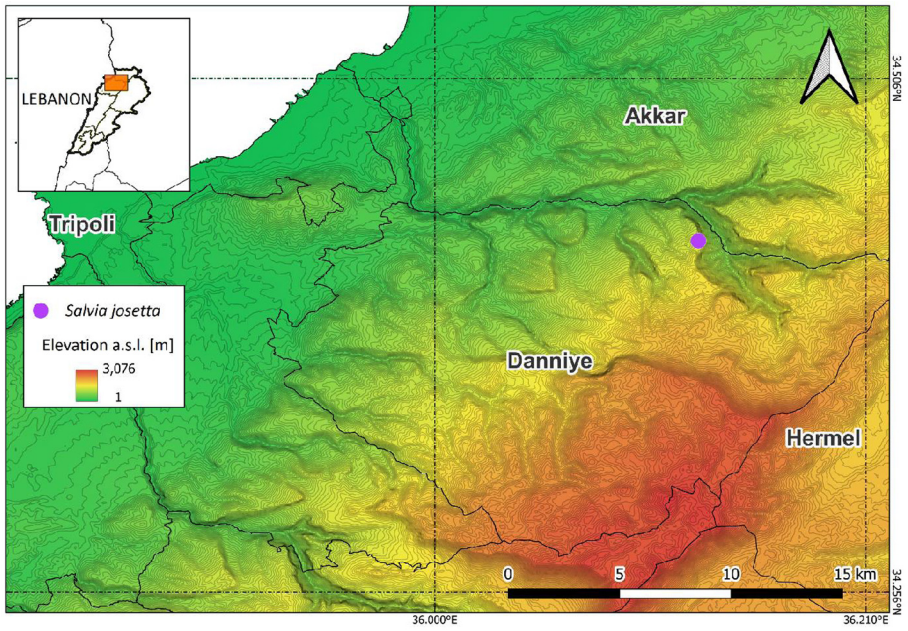


**FIGURE 1.** Location of the only known site of Salvia josetta.

**Similar species**:—*Salvia josetta* resembles *S. fairuziana*, a species endemic to Mount Lebanon and belonging to the section *Aethiopis*, which was discovered relatively recently (Haber & Semaan 2004). It also resembles *S. veneris* Hedge, a species endemic to the North of Cyprus (Meikle 1977; Gucel & Yildiz 2008; Dereboylu *et al.* 2010; Hacioğullari *et al.* 2019;). However, it is easily distinguishable by several characteristics. Firstly, it differs from *S. fayruziana* in height, with the former reaching up to 110 cm, while *S. josetta* has a smaller size, never exceeding 80 cm. *S. fayruziana* produces larger and denser inflorescences with verticillasters very close to each other, and entirely violet flowers. While the new species shares the same flower color with *S. veneris*, the latter is easily distinguishable by its relatively shorter size, denser verticillasters clumped in the upper part of the inflorescence, suborbicular leaves

that are permanently lanate and densely araneous petiole. Another characteristic of the *Aethiopis* section is the straight teeth of the calyx, whereas, in *S. veneris*, the calyx has upper lip that concave-bisulcate in fruit, placing it in the section *Plethiosphace* (Meikle 1977; Celep 2010). The new species also exhibits a clear mountainous habitat, being present above 1300 m a.s.l., which is not the case for the other species, both of which occur below 1000 m a.s.l. (for more information see Table 1 and Figure 2).

**TABLE 1.** Morphological differences between *Salvia josetta*, *S. fayruziana* and *S. veneris*.

| Characters | *Salvia josetta* | *Salvia fayruziana* | *Salvia veneris* |
|---|---|---|---|
| **Plant height (cm)** | 30–80 | 50–110 | 20–40 |
| **Leaves position** | All leaves basal | Caulinary and basal leaves | All leaves basal |
| **Leaves morphology** | Ovate to ovate-oblong | Ovate | Ovate to suborbicular |
| **Leaves apex and base** | Apex rounded, base narrowly and asymmetrically cordate | Apex rounded, base cordate | Apex rounded to acute, base truncate to subcordate |
| **Leaves margins** | Doubly crenate to lobed-crenate | Lobed-crenate | Sub-entire, crenate to serrate |
| **Leaves length (cm)** | 3–10 | 15–18.5 | 2.5–8 |
| **Leaves width (cm)** | 1–4.5 | 6.5–8 | 1.7–8 |
| **Leaves indumentum and texture** | Lanate eglandular, then pubescent with short glandular hairs, verrucose texture | Constantly villous, with presence of short glandular hairs, verrucose texture | Constantly lanate on both surfaces, smooth texture, petioles densely araneous |
| **Inflorescence architecture** | Spaced panicle branched at the base with 2–3 lateral stems | Dense panicle branched with up to 15 lateral stems, each 7–10 cm long | Panicle branched at the base with 4 lateral stems |
| **Floral stem indumentum** | Densely pubescent with short glandular hairs and sessile glands, edges with short hispid hairs | Densely pubescent with short glandular hairs and sessile glands, edges with long hispid hairs | Entirely hispid with long eglandular hairs, accompanied with short glandular hairs |
| **Stem width (mm)** | 2–3 | 6–7 | 2–3 |
| **Number of verticillasters** | 4–6 | 5–7 | 6–12 |
| **Verticillasters internodes length (cm)** | 4–7 | 1.5–2.5 | 2–3 |
| **Number of flowers per verticillaster** | 2–6 (lower verticillasters), 1–2 (upper verticillasters) | 2–6 | 2–6 |
| **Floral bract shape** | Orbicular, cuspidate apex, rounded base, entire margin | Ovate, acuminate, cordate base, entire margin | Ovate to suborbicular, acuminate, rounded base, entire margin |
| **Floral bract color and indumentum** | Bicolor, white center and green margins, pubescent with short glandular hairs | Bicolor, white center and green margins, ciliate, glabrous to pubescent with short glandular hairs | Green, lanate on lower surface |
| **Floral bract size (cm) (length × width)** | 0.6–1.1 × 0.3–0.7, often as long as calyx | 1.0–2.6 × 0.5–2.3, longer than calyx | 0.2–0.3 × 0.1–0.2, less than half the length of the calyx |
| **Calyx morphology** | Campanulate, upper lip straight with spread teeth in fruit | Campanulate, upper lip straight with spread teeth in fruit | Tubular-campanulate, upper lip bisulcate with connivent teeth in fruit |
| **Calyx teeth shape** | All teeth acuminate and mucronate, middle tooth of the upper lip is shorter | All teeth acuminate and mucronate, middle tooth of the upper lip is shorter | Upper lip with mucronulate teeth, lower lip with mucronate teeth |
| **Calyx length (cm)** | 0.8–1.1 (in flower), 1.1–1.3 (in fruit) | 1.0–1.2 (in flower), 1.1–1.4 (in fruit) | 0.7–1.0 (in flower), 1.2 (in fruit) |
| **Calyx indumentum** | Densely pubescent with short glandular hairs and sessile glands, ribs with short hispid hairs | Densely pubescent with short glandular hairs and sessile glands, ribs with short hispid hairs | Pilose with eglandular scabridulous hairs, short glandular hairs and sessile glands |
| **Corolla color** | White labellum and pale lilac hood | Entirely violet | White labellum and pale lilac hood |
| **Corolla length (cm)** | 1.8–2.4 | 2.4–2.7 | 1.7–2.4 |

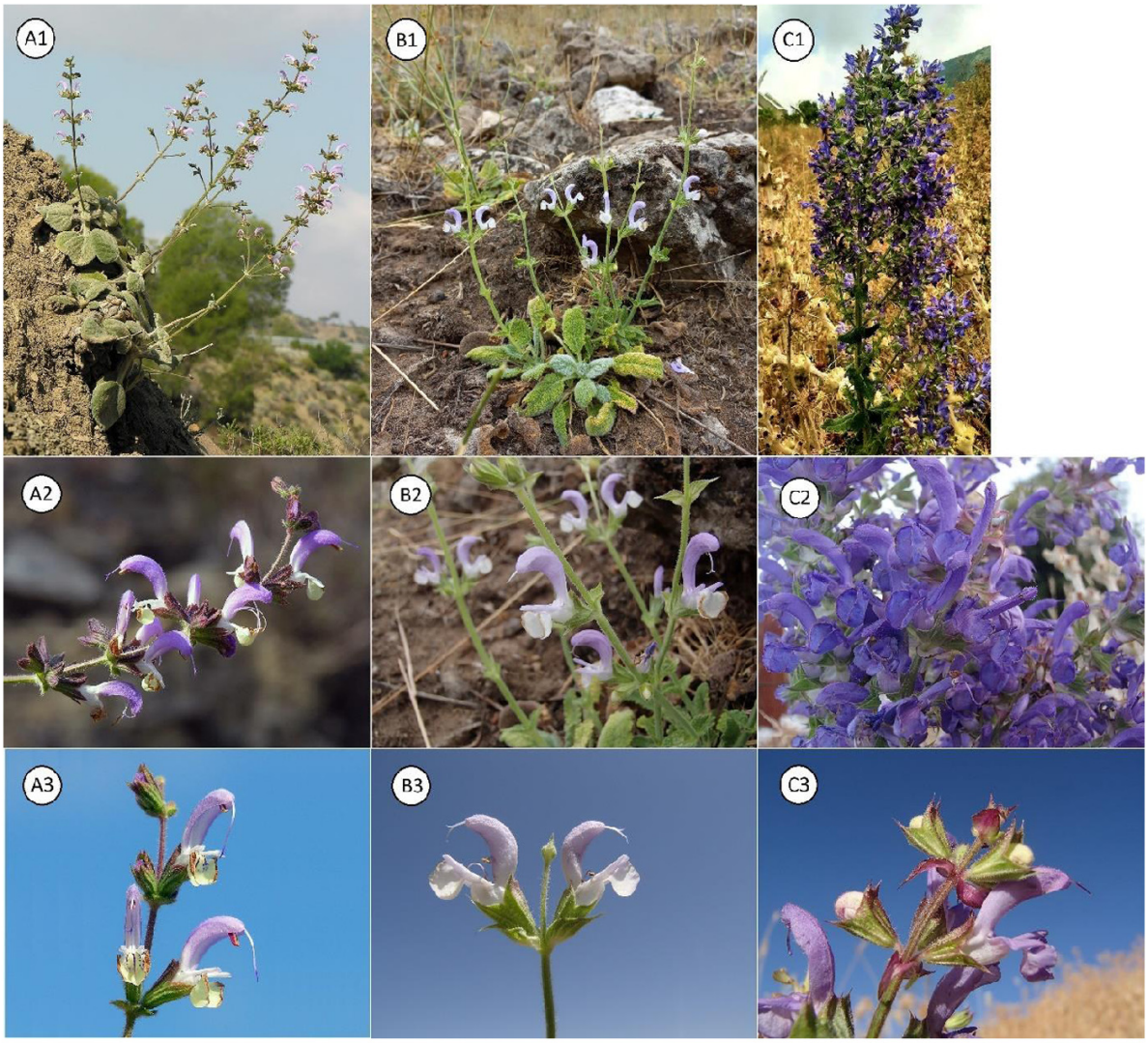


**FIGURE 2.** Comparison of habits (1), verticillasters (2), and flowers (3) of **A1**–**A3.** Salvia veneris, **B1**–**B3.** S. josetta, and **C1**–**C3.** S. fayruziana. Photographs A1–A3 by Charalambos Christodoulou (Flora of Cyprus 2023), photograph C1 by Samira Matta, photographs B1–B3, C2–C3 by Hicham El Zein.

**Etymology**:—*Salvia josetta* is named in honor of Josette Duteil, who supported our conservation projects. Without her, these explorations and research would not have been possible.

**Conservation assessment:**—Currently, the new species is known only from one single site, reaching a distribution area of only 0.02 km². As a consequence, following the guidelines and criteria of the International Union for the Conservation of Nature (IUCN 2022), the Area of Occupancy (AOO) and the Extent of Occurrence (EOO) are both of 4 km². Several severe threats were recognized impacting the locus classicus of the species, including deforestation for charcoal production, illegal logging, forest fires, and expanding quarries. According to the detected threats, a single *location* (*sensu* IUCN) has been recognized. Therefore, following the IUCN (2022), the new species is here assessed as Critically Endangered (CR) under criterion B, B1ab(iii)+2ab(iii). However, as for other newly described taxa with an almost punctiform or very limited distribution, provisionally assessed as CR (Wagensommer & Venanzoni 2021; Zavatin *et al.* 2023a; 2023b), it will be necessary collecting further data on distribution, population size, and threats, and defining the appropriate strategies for the long-term conservation of the new species.

**FIGURE 3.** Salvia josetta. Illustration by Lisa Bottcher.

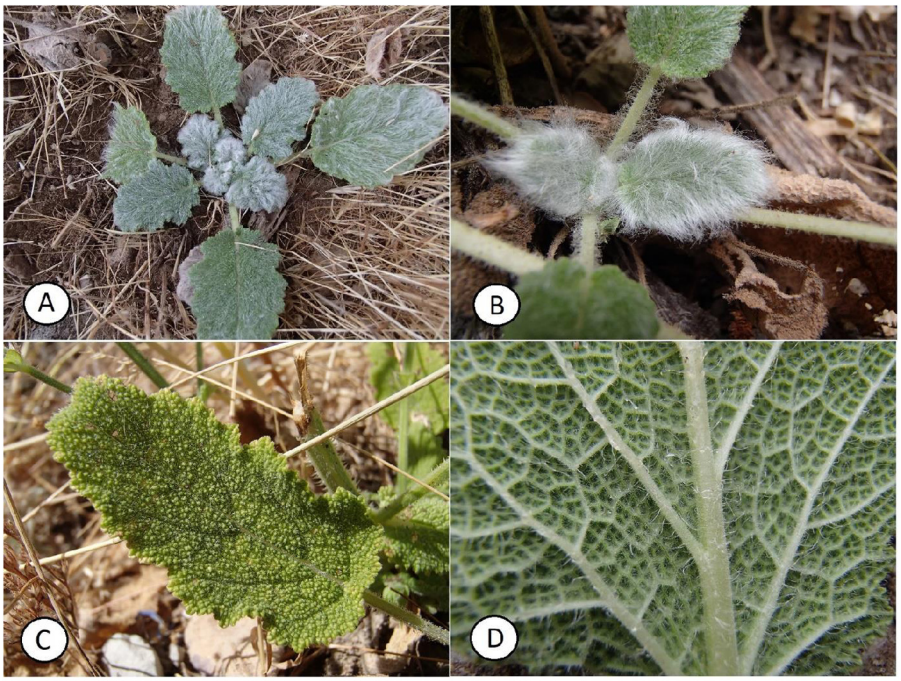


**FIGURE 4.** Leaves of Salvia josetta **A.** young rosette, **B.** Young leaves, **C.** Mature leaf, **D.** Abaxial face of mature leaf. Photographs by Hicham El Zein.

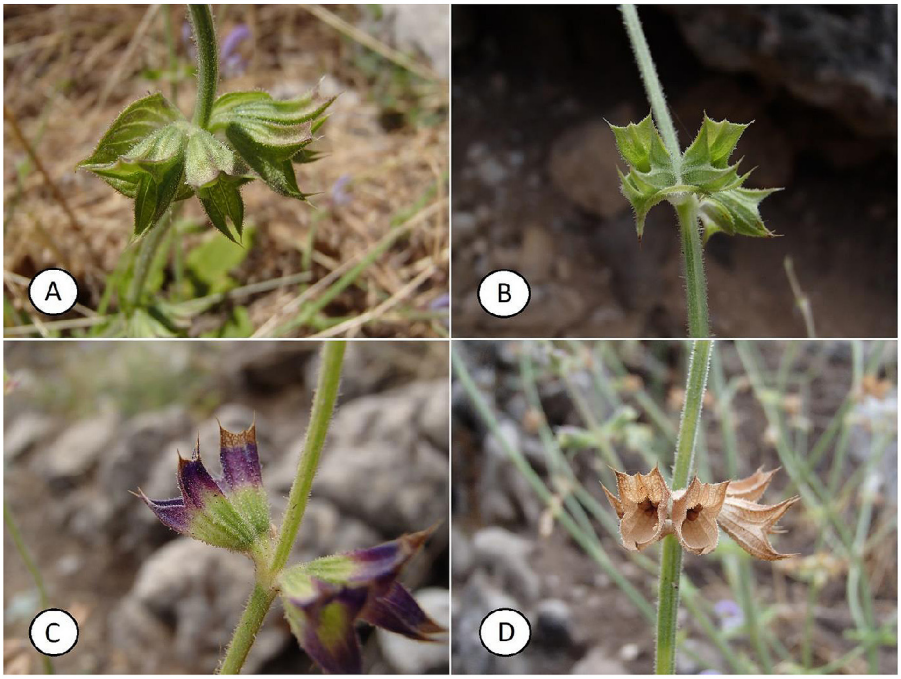


**FIGURE 5.** Inflorescence and flowers of Salvia josetta. Photographs by Hicham El Zein.

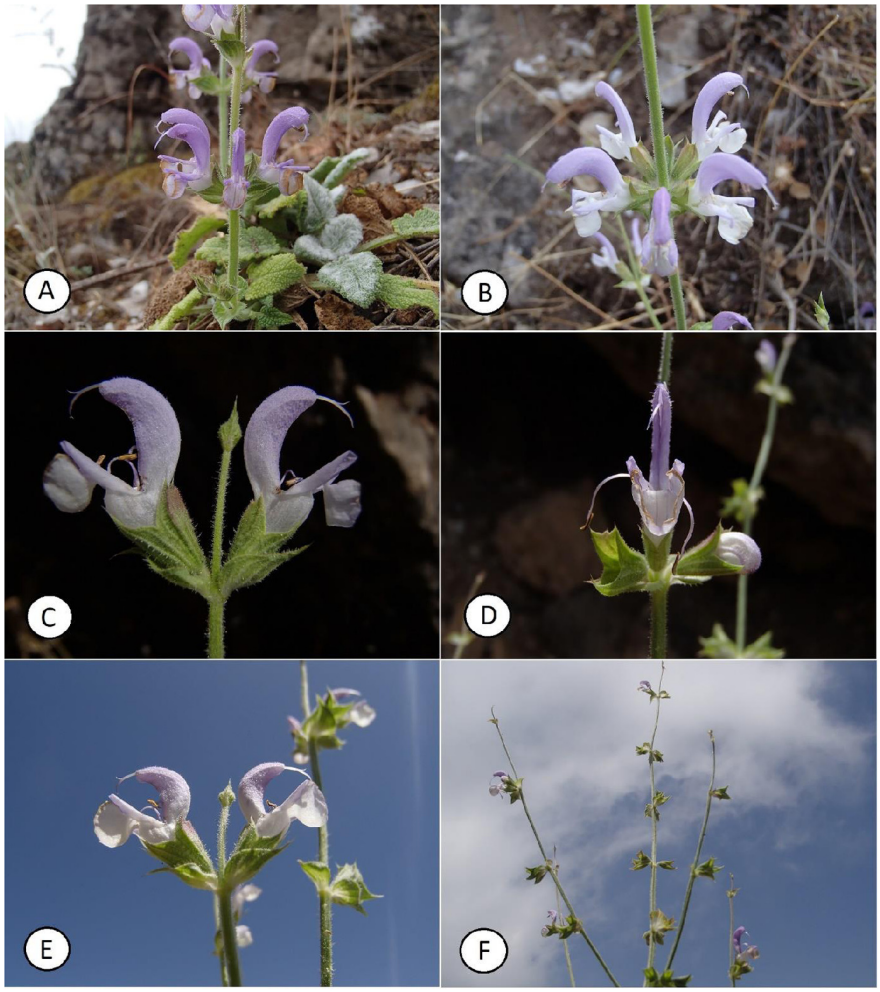


**FIGURE 6.** Calyx of Salvia josetta**. A**–**B.** Calyx after flowering, **C.** Purple calyx, **D.** Calyx with mature seeds. Photographs by Hicham El Zein.

## Discussion

The new species was assessed as Critically Endangered (CR) based on its limited distribution area (0.02 km²) and the threats impacting its location. The entire region is heavily impacted by illegal logging and forest fires, particularly since the onset of the Lebanese economic crisis in 2019 (Germanos & Azzi 2024). Traditionally, deforestation for charcoal production has been part of wood harvesting in the region. However, due to the crisis, charcoal production starts earlier in summer, contrary to the usual autumn schedule. This shift increases the risk of forest fires, especially during the driest period of the year, further exacerbating the region's susceptibility to fires (Mitri 2022). Illegal logging and forest fires have been encouraged by soaring fuel prices, driving people to gather firewood in the forests. The proliferation of illegal quarries has been an ongoing environmental threat for three decades, and it continues to escalate due to the lack of government oversight. These illegal extraction sites have extensive and lasting impacts on the ecosystems (Basbous 2023; Mitri *et al.* 2021). They significantly alter the landscape through the removal of entire soil layers and the seed bank contained within them (Khawlie 1998). The exposed mineral surface left behind impedes the reestablishment of plant species, and therefore of forests. Additionally, quarries make the surrounding area vulnerable to landslides triggered by natural factors like earthquakes and heavy rainfall (Kaafarani & Abou Jaoude 2021).

The Mediterranean Basin is renowned as one of the global biodiversity hotspots (Mittermeier *et al.* 2004; Myers *et al.* 2000). Despite covering less than 2% of the Earth′s land area, it harbours over 10% of global plant diversity, with more than 25,000 species, many of which are endemic (Cowling *et al.* 1996). Floristic and taxonomic research are essential for the understanding of plant diversity of a region. Even in areas with a long history of floristic studies like the Mediterranean, new species continue to be discovered (Bogdanović *et al.* 2022; Doumas *et al.* 2022; Laface

*et al.* 2022; Koçyiğit *et al.* 2023) highlighting the ongoing exploration discovery and valorisation of plant life in the Mediterranean countries (Ben Mahmoud *et al*. 2024).

In particular, the Mediterranean is a centre of diversity for the genus *Salvia*, and ongoing explorations continue to reveal new species. Lebanon, despite its relatively small size, harbors three *Salvia* species endemic to the Mount Lebanon range. This discovery significantly contributes to the understanding of the plant diversity of the Levant, particularly within the Lamiaceae family, which ranks as the third richest family in Lebanon with 16 endemic species (Mouterde 1966, 1970, 1984). The regions of Danniye and Akkar, where the new species is found, are already recognized for hosting numerous narrow endemic plants, including one exclusive to this same valley, *Jacobaea mouterdei* (Mouterde 1984). Many Mediterranean regions exhibit a high number of rare and narrow endemic taxa, which persist as small populations (Cowling *et al.* 1996). Further investigations into the ecological requirements of the new species are required. Additionally, continued monitoring and research efforts are essential to track the long-term viability of the species.

The valley remains relatively preserved compared to neighbouring areas, primarily due to the lower human population density (Verdeil *et al.* 2019). This discovery reinforces the pressing need for swift conservation measures in the remaining wild areas to safeguard the unique natural heritage of Mount Lebanon. Regarding habitat conservation, we recommend establishing a protected area in the valley and implementing management practices to ensure the survival of these patrimonial species and their environment. This could also encourage involvement from local communities, who play a major role in conservation efforts.

## Acknowledgements

We are grateful to the Mohamed bin Zayed Species Conservation Fund for supporting the project "Distribution and Red List Assessment of the restricted range endemic *Jacobaea mouterdei* (Asteraceae)" (fund number 180519099) and to the Rufford Foundation for supporting the project "Determination of the Floral Diversity and Conservation Value of the Valleys of Hell with Focus on the Range-Restricted Endemic *Jacobaea mouterdei* (Arènes) Greuter & B.Nord (Asteraceae)" (fund number 32258-1). We are also grateful to Josette Duteil for supporting our research on the flora, and to Octave Khoury, Rami Chahine, Dima Mabsout, Zoe Filloux, Paul Douaihy, Youan Lefauve, Amalric Pouzoulet, Josie Bitar, Tom Bousquet, and Carla Khater for accompanying us during the field trips. We are also deeply grateful to Robert Philipp Wagensommer for his thorough review of our manuscript, which significantly enhanced its quality.

## References

Alziar, G. (1988) Catalogue synonymique des *Salvia* du monde (Lamiaceae) I. *Biocosme Mesogéen* 5: 87–136.

Alziar, G. (1989a) Catalogue synonymique des *Salvia* du monde (Lamiaceae) II. *Biocosme Mesogéen* 6: 79–115.

Alziar, G. (1989b) Catalogue synonymique des *Salvia* du monde (Lamiaceae) III. *Biocosme Mesogéen* 6: 163–204.

Alziar, G. (1991) Catalogue synonymique des *Salvia* du monde (Lamiaceae) IV. *Biocosme Mesogéen* 7: 59–109.

Alziar, G. (1992) Catalogue synonymique des *Salvia* du monde (Lamiaceae) V. *Biocosme Mesogéen* 9: 413–497.

Alziar, G. (1993) Catalogue synonymique des *Salvia* du monde (Lamiaceae) VI. *Biocosme Mesogéen* 10: 33–117.

Basbous, M. (2023) The Violence of Extractive Urbanization: Dying to Live in Lebanon. *Middle East Critique*: 1–22. https://doi.org/10.1080/19436149.2023.2245295

Behçet, L. & Avlamaz, D. (2009) A New Record for Turkey: *Salvia aristata* Aucher ex Benth. (Lamiaceae). *Turkish Journal of Botany* 33: 61–63. https://doi.org/10.3906/bot-0808-14

Ben Mahmoud, K., Mezzapesa, G.N., Abdelkefi, F. & Perrino, E.V. (2024) *Beta macrocarpa* Guss. in Tunisia: nutritional and functional properties of the underutilized wild beet in relation to soil characteristics. *Euro-Mediterranean Journal for Environmental Integration*. https://doi.org/10.1007/s41207-024-00468-5

Bentham, G. (1832) *Labiatarum genera et species*. James Ridgway and sons, London, United Kingdom, 783 pp.

Bogdanović, S., Boršić, I., Ljubičić, I., Brullo, S. & Giusso del Galdo, G. (2022) *Centaurea lovricii*, a new species of C. sect. Centaurea (Asteraceae) from Croatia. *PhytoKeys* 214: 97–114. https://doi.org/10.3897/phytokeys.214.89404

Celep, F. (2010) *Revision of the genus Salvia L. (Labiatae) in the Mediterranean and the Aegean geographic regions of Turkey*. Middle East Technical University.

Celep, F., Dirmenci, T. & Güner, Ö. (2015) *Salvia hasankeyfense* (Lamiaceae), a new species from Hasankeyf (Batman, South-eastern

Turkey). *Phytotaxa* 227 (3): 289–294.
https://doi.org/10.11646/phytotaxa.227.3.9

Celep, F. & Doğan, M. (2010) *Salvia ekimiana* (Lamiaceae), a new species from Turkey. *Annales Botanici Fennici* 47: 63–66.
https://doi.org/10.5735/085.047.0108

Celep, F. & Doğan, M. (2023) The Genus *Salvia* in Turkey: Morphology, Ecology, Phytogeograpy, Endemism and Threat Categories. *In*: Máthé, Á. & Turgut, K. (Eds.) *Medicinal and Aromatic Plants of Turkey*. Springer International Publishing, Cham, pp. 107–120.
https://doi.org/10.1007/978-3-031-43312-2_5

Celep, F., Doğan, M., Bagherpour, S. & Kahraman, A. (2009) A New Variety of *Salvia sericeotomentosa* (Lamiaceae) from South Anatolia, Turkey. *Novon: A Journal for Botanical Nomenclature* 19: 432–435.
https://doi.org/10.3417/2008003

Celep, F., Raders, E. & Drew, B. (2020) Two new hybrid species of *Salvia* (*S.* × *karamanensis* and *S.* × *doganii*) from Turkey: evidence from molecular and morphological studies. *Turkish Journal of Botany* 44: 647–660.
https://doi.org/10.3906/bot-2007-28

Claßen-Bockhoff, R., Speck, T., Tweraser, E., Wester, P., Thimm, S. & Reith, M. (2004) The staminal lever mechanism in *Salvia* L. (Lamiaceae): a key innovation for adaptive radiation? *Organisms Diversity & Evolution* 4: 189–205.
https://doi.org/10.1016/j.ode.2004.01.004

Cowling, R.M., Rundel, P.W., Lamont, B.B., Kalin Arroyo, M. & Arianoutsou, M. (1996) Plant diversity in Mediterranean-climate regions. *Trends in Ecology & Evolution* 11: 362–366.
https://doi.org/10.1016/0169-5347(96)10044-6

Davis, P.H., Cullen, J. & Coode, M.J.E. (1965) *Flora of Turkey and the East Aegean Islands*. Edinburgh University Press, 5836 pp.

Dereboylu, A.E., Sengonca, N., Güvensen, A. & Gücel, S. (2010) Anatomical and palynological characteristics of *Salvia willeana* (Holmboe) Hedge and Salvia veneris Hedge endemic to Cyprus. *African Journal of Biotechnology* 9: 2076–2088.
https://doi.org/10.4314/ajb.v9i14

Donmez, A.A. (2001) A new Turkish species of *Salvia* L. (Lamiaceae). *Botanical Journal of the Linnean Society* 137: 413–416.
https://doi.org/10.1111/j.1095-8339.2001.tb02336.x

Doumas, P., Goula, K. & Constantinidis, T. (2022) Thirty-two new and noteworthy floristic records from north-eastern Greece. *Biodiversity Data Journal* 10: e81817.
https://doi.org/10.3897/BDJ.10.e81817

El Zein, H., Stephan, J., Khater, C., S. Al-Zein, M. & Bou Dagher-Kharrat, M. (2022) Aligning terrestrial habitat typology of Lebanon with EUNIS habitat classification. *Phytocoenologia* 51 (3): 233–244.
https://doi.org/10.1127/phyto/2022/0390

Flora of Cyprus (2023) *Salvia veneris*. *Flora of Cyprus—a dynamic checklist*. Available from: https://www.flora-of-cyprus.eu/cdm_dataportal/taxon/0bf27b23-41f1-44eb-893f-7e0d06fadfce (accessed 1 March 2024)

Germanos, P.S. & Azzi, S. (2024) The Devastating Impact of Lebanon's Environmental Failures | The Washington Institute. Available from: https://www.washingtoninstitute.org/policy-analysis/devastating-impact-lebanons-environmental-failures (accessed 1 March 2024)

Gucel, S. & Yildiz, K. (2008) Morphological investigations and transplantation attempts on some endemic species of northern cyprus. *Pakistan Journal of Botany* 40.

Haber, R.M. & Semaan, M.T. (2004) *Salvia fairuziana* (Lamiaceae), a New Species from Lebanon. *Novon* 14: 437–439.

Hacioğullari, I., Gücel, S., Fuller, W.J. & Özden, Ö. (2019) Abundance and spatial distribution analysis of *Salvia veneris*: a critically endangered plant species endemic to Cyprus. *Biodiversity* 20: 98–105.
https://doi.org/10.1080/14888386.2019.1662327

Hamzaoğlu, E., Duran, A. & Pınar, N.M. (2005) *Salvia anatolica* (Lamiaceae), a new species from East Anatolia, Turkey. *Annales Botanici Fennici* 42: 215–220.

Hedge, I.C. (1982) *Salvia* L. *In*: Rechinger, K.H. (Ed.) *Flora Iranica*. Akademische Druck- und Verlagsanstalt, Graz, Austria, pp. 403–476.

İlçim, A., Celep, F. & Doğan, M. (2009) *Salvia marashica* (Lamiaceae), a New Species from Turkey. *Annales Botanici Fennici* 46: 75–79.
https://doi.org/10.5735/085.046.0110

İlçĭm, A., Tel, A.Z. & Kocabaş, Y.Z. (2023) *Salvia adiyamanensis* (Lamiaceae), a new species from South East Anatolia, Turkey. *Phytotaxa* 592 (1): 49–58.
https://doi.org/10.11646/phytotaxa.592.1.4

IUCN (2022) Guidelines for using the IUCN Red List categories and criteria. Version 15.1. Prepared by the Standards and Petitions Committee. Available from: https://www.iucnredlist.org/documents/RedListGuidelines.pdf (accessed 25 January 2024)

Kaafarani, R. & Abou Jaoude, G. (2021) Landslide hazard and risk level assessment of quarried slopes in Lebanon using drone imagery. *In*: Hammah, R.E., Yacoub, T.E., McQuillan, A. & Curran, J. (Eds.) *The Evolution of Geotech—25 Years of Innovation*. CRC Press,

Leiden, The Netherlands.
https://doi.org/10.1201/9781003188339-64
Kahraman, A., Celep, F. & Dogan, M. (2009) A New Record for the Flora of Turkey: *Salvia macrosiphon* Boiss. (Labiatae). *Turkish Journal of Botany* 33: 53–55.
https://doi.org/10.3906/bot-0806-3
Kahraman, A., Doğan, M. & Celep, F. (2011) *Salvia siirtica* sp. nov. (Lamiaceae) from Turkey. *Nordic Journal of Botany* 29: 397–401.
https://doi.org/10.1111/j.1756-1051.2011.00916.x
Khawlie, M.R. (1998) An environmental perspective on quarrying for the construction industry in Lebanon. *Aggregate Resources*. CRC Press.
Koçyiğit, M., Salmeri, C., Özhatay, N., Kaya, E. & Brullo, S. (2023) *Allium sphaeronixum* (Amaryllidaceae), A New Species from Turkey. *Plants* 12: 2074.
https://doi.org/10.3390/plants12112074
Laface, V.L.A., Musarella, C.M., Sorgonà, A. & Spampinato, G. (2022) Analysis of the Population Structure and Dynamic of Endemic *Salvia ceratophylloides* Ard. (Lamiaceae). *Sustainability* 14: 10295.
https://doi.org/10.3390/su141610295
Meikle, R.D. (1977) *Flora of Cyprus*. Royal Botanic Gardens, Kew, United Kingdom, 860 pp.
Mitri, G., Nasrallah, G. & Nader, M. (2021) Spatial distribution and landscape impact analysis of quarries and waste dumpsites. *Environment, Development and Sustainability* 23: 12302–12325.
https://doi.org/10.1007/s10668-020-01169-z
Mitri, G.H. (2022) The Use of Earth Observation Data in Wildfire Risk Management: A Case Study from Lebanon. *In*: Al Saud, M.M. (Ed.) *Applications of Space Techniques on the Natural Hazards in the MENA Region*. Springer International Publishing, Cham, pp. 513–531.
https://doi.org/10.1007/978-3-030-88874-9_22
Mittermeier, R., Gil, P., Hoffmann, M., Pilgrim, J., Brooks, T., Mittermeier, C., Lamoreux, J. & Fonseca, G. (2004) *Hotspots Revisited. Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*.
Mouterde, P. (1966) *Nouvelle flore du Liban et de la Syrie*. Dar El-Machreq, Beirut, Lebanon, 642 pp.
Mouterde, P. (1970) *Nouvelle flore du Liban et de la Syrie*. Dar El-Machreq, Beirut, Lebanon, 720 pp.
Mouterde, P. (1984) *Nouvelle flore du Liban et de la Syrie*. Dar El-Machreq, Beirut, Lebanon, 579 pp.
Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. & Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858.
https://doi.org/10.1038/35002501
Post, E.G. & Dinsmore, J.E. (1932) *Flora of Syria, Palestine, and Sinai*. Second Edition. American University Press, Beirut, Lebanon. 920 pp.
QGIS Development Team (2023) QGIS Geographic Information System.
Thiers, B. (2024) Index Herbariorum—The William & Lynda Steere Herbarium. Available from: https://sweetgum.nybg.org/science/ih/ (accessed 26 March 2024)
Tohmé, G. & Tohmé, H. (2011) Nouvelles recherches sur la flore endémique et naturalisée du Liban. *Lebanese Science Journal* 12: 133–141.
Tohmé, G. & Tohmé, H. (2014) *Illustrated flora of Lebanon*. National Council for Scientific Research, Beirut, Lebanon, 612 pp.
Tutin, T.G., Heywood, V., Burges, N.A., Moore, D.M., Valentine, D.H., Walters, S.M. & Webb, D.A. (1972) *Flora Europaea: Diapensiaceae to Myoporaceae*, Volume 3. Cambridge University Press, United Kingdom, 430 pp.
Verdeil, E., Faour, G. & Hamzé, M. (2019) *Atlas of Lebanon: New Challenges*. Presses de l'Ifpo, CNRS Liban, Beirut, Lebanon, 133 pp.
https://doi.org/10.4000/books.ifpo.13178
Wagensommer, R.P. & Venanzoni, R. (2021) *Geranium lucarinii* sp. nov. and re-evaluation of *G. kikianum* (Geraniaceae). *Phytotaxa* 489 (3): 252–262.
https://doi.org/10.11646/phytotaxa.489.3.2
Walker, J.B. & Sytsma, K.J. (2007) Staminal Evolution in the Genus Salvia (Lamiaceae): Molecular Phylogenetic Evidence for Multiple Origins of the Staminal Lever. *Annals of Botany* 100: 375–391.
https://doi.org/10.1093/aob/mcl176
Zavatin, D.A., Almeida, R.B.P., Ramos, R. & Lombardi, J.A. (2023a) *Chionanthus monteazulensis* (Oleaceae), a new species from the campo rupestre of Espinhaço Range, Brazil. *Phytotaxa* 603 (3): 289–296.
https://doi.org/10.11646/phytotaxa.603.3.8
Zavatin, D.A., Ramos, R., Watanabe, M.T.C., Pedrosa, L.G. & Lírio, E.J. de (2023b) A new species of *Mollinedia* (Monimiaceae, Laurales) from the Quadrilátero Ferrífero, Brazil. *PhytoKeys* 234: 189–201.
https://doi.org/10.3897/phytokeys.234.109804