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Discovery of naturalized *Clinopodium nepeta* (Lamiaceae) in Oaxaca and San Luis Potosí, Mexico

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Abstract

Clinopodium nepeta is reported for the first time from Mexico as a naturalized plant based on two populations located in Oaxaca and San Luis Potosí. This is a variable species broadly cultivated in several countries as culinary, medicinal and ornamental plant. However, it has not been extensively grown in Mexico. We present a description of the species in the country in order to facilitate its identification and avoid possible confusion with native species of *Clinopodium* or *Hedeoma*.

Resumen

Se registra por primera ocasión para México la presencia de *Clinopodium nepeta* como planta naturalizada, esto con base en las características de dos poblaciones localizadas en Oaxaca y San Luis Potosí. Ésta es una especie variable, cuyo cultivo es amplio en varios países como planta culinaria, medicinal y ornamental. Sin embargo, no ha tenido un auge extensivo en México. Presentamos la descripción de la especie en el país a razón de poder facilitar su identificación y evitar su posible confusión con especies nativas de *Clinopodium* y *Hedeoma*.

Introduction

During a botanical exploration in southeastern San Luis Potosí, Mexico, we found a species of Lamiaceae that could not be referred to any of the native or naturalized labiates listed in the country (Villaseñor & Espinosa-García 2004, Martínez-Gordillo *et al.* 2013). At first we were hesitant in treating this plant as a new taxon of *Clinopodium* Linnaeus (1753: 587) or *Hedeoma* Persoon (1807: 131) since it shares characters of both genera and even the generic delimitation between them (Bentham 1848, Briquet 1896, Correl & Johnston, 1970, Harley 1996, Harely & Granda 2000, Fernández-Alonso 2002, Harley *et al.* 2004, García-Zúñiga 2005, Pool & Knapp 2012, González-Gallegos *et al.* 2016) and their phylogenetic relationships are unclear (Cantino & Wagstaff 1998, Trusty *et al.* 2004, Bräuchler *et al.* 2005, Edwards *et al.* 2006, Bräuchler *et al.* 2008, Schmidt-Lebuhn 2008, Bräuchler *et al.* 2010, Dirmenci *et al.* 2010, Drew & Sytsma 2012). However, when collating against herbarium specimens of similar species of either of these genera in order to prepare a diagnosis of the purportedly new taxon, we found a similar specimen from the state of Oaxaca in southern Mexico. This finding made us discard our first hypothesis because it did not seem plausible the discovery of a new species comprising two disjunct populations in very remote places located in two different biogeographical provinces. Hence, we explored the possibility that the specimens belonged to an introduced species, despite both collections were gathered in woody areas away from human settlements. This proved to be the right solution after corroborating that these plants fit well into the description of the broadly variable and widely cultivated *Clinopodium nepeta* (Linnaeus 1753: 593) Kuntze (1891: 515). Hence, because no previous record of naturalized populations of this species had been made in Mexico, and in order to make easier its identification, we provide the first report of this species in the country and a morphological description.

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Taxonomic treatment

Clinopodium nepeta (L.) Kuntze (1891: 515) ≡*Melissa nepeta* Linnaeus (1753: 593)
Lectotype (designated by Garbari *et al.* 1991: 500):—LINN 745.5.

Description:—Perennial herb, 20–40(–60) cm tall, stems short pilose to hispidulous (in Oaxaca, with short glandular-capitate hairs at the apex of floral branches). Leaves with petioles 5.2–11(–39) mm long, short pilose (in Oaxaca, short glandular-capitate); blade ovate, deltoid, ovate-rhombic, elliptic-lanceolate to ovate-elliptic, 1.4–3.2(–5.1) × 0.8–1.6(–3.7) cm, fragrant, apex acute and sometimes rounded, base cuneate to attenuated, margin dentate to serrate in the upper half portion or almost from the base, teeth usually inconspicuous, both faces glabrous or sparsely hispidulous, and covered with amber glandular dots. Inflorescence in axillary fascicles in the upper portion of the branches, 4–6 flowers per cyme, the leaves gradually reduced towards the apex of floral branches, peduncles (0.5–)1.3–1.9 mm long (in Oaxaca, 1.2–1.9 cm long), floral bracts linear, the more external (2.1–)3.2–5.6 mm long, the inner ones (0.5–)1.3–2.4 mm long. Flowers with pedicels 1.8–2(–4.2) mm long, up to 5.7 mm in fruit, short pilose and amber glandular punctate (in Oaxaca, glandular-capitate). Calyx tubular and straight, bilabiate, tube (4–)5–6 × 1.9–2.1(–3) mm, scarcely accrescent, short pilose and amber glandular punctate outside, covered with a ring of hairs below teeth insertion, upper lip (2–)2.5–3.6 mm long, composed by three deltoid teeth joined by half or more their length, lower lip 2.3–3.4(–4) mm long, composed by two slender teeth, both lips ciliated at the margin but with the hairs longer in the lower one. Corolla lilac to pale pink with darker irregular spots in the lower lip towards the throat, externally pilose and naked inside, but sparsely pilose in the throat; tube narrow in the third or half basal portion, then abruptly widened to the throat, (7–)12.9–15.3 × (2.8–)4.8–7.8 mm (width measured at the throat), externally short pilose, internally short pilose in the narrow portion; upper lip (2.2–)4.8–5.6 mm long, short pilose; lower lip (4–)5.9–8.2 × 5–7 mm, trilobed with a cleft middle lobe, short pilose below. Stamens 2 in San Luis Potosí, filaments 9.8–11 mm long, glabrous, thecae 0.8–1 mm long, a pair of staminodes present or absent, attached behind the stamens, filiform, 0.8–1 mm long; stamens 4 in Oaxaca, filaments of the anterior stamens 1.4–3(–4.2) mm long, the posterior (1.9–)4–4.5, both glabrous, thecae 0.3–0.5 mm long; in both populations the stamens included and the thecae set apart by a slight enlargement of the connective. Style 17.7–18.6 mm long (9.7–10.6 mm long in Oaxaca), glabrous, upper stigmatic branch shorter and slenderer than the lower one. Mericarp ovoid, 0.9–1.1 × 0.7–0.8 mm, pale brown to golden, glabrous and smooth (not seen in the populations of San Luis Potosí); Figs. 1, 2 & 3.

Common name:—**"**poleo" in San Luis Potosí, no common name has been recorded in Oaxaca.

Distribution, habitat and phenology:—*Clinopodium nepeta* grows naturally mainly in the Mediterranean basin in Africa, Asia and Europe (Morales 2010a, Tison & Foucault 2014, Tison *et al.* 2014) but it has been introduced as ornamental, medicinal and condiment plant in several countries (Scandaliaris *et al.* 2007), reported as naturalized in the United States (Hammer *et al.* 2004). In Europe it grows in temperate forests (elm, oak, pine), from 0–1500 m elevation (Hammer *et al.* 2004). The two naturalized populations in Mexico are reported here for the first time. One of these comes from southeastern San Luis Potosí, and it is possible that some additional populations might be discovered in nearby localities in Querétaro, and the other from Oaxaca. The plants were found in pine-oak, oak-pine and cloud montane forests, from 1500–2100 m elevation. The more frequent trees in the area are: *Cornus excelsa* Kunth, *Cupressus lusitanica* Mill., *Liquidambar styraciflua*, *Magnolia* sp., *Pinus greggi* Engelm. ex Parl., *Quercus germana* Schltdl. & Cham., *Q. pinnativenulosa* C.H.Mull, *Q. xalapensis* Bonpl. The only set of specimens known from the species were collected in July in two consecutive years, and in December, which present flowers, the most probable is that flowering extends from June to December, and fruiting from August to January.

Specimens examined:—MEXICO. Oaxaca: San Jerónimo Coatlán, 32.2 km al SW de San Jerónimo Coatlán, brecha a Piedra Larga, 16º12'N, 96º64'W, 1500 m, 1 December 1990 (fl, fr), *Á. Campos-V. 3495* (CHAP!). San Luis Potosí: Xilitla, 1 km al N del Llano de la Garza, por la vereda que va a Las Flores, 4.3 km al N-NW de la comunidad La Trinidad, 21°26'N 99°5'W, 2010 m, 9 July 2015 (fl), *H.A. Castillo-Gómez 1479* (SLPM!, CIIDIR!, IBUG!); Xilitla, al W de la comunidad de La Silleta, por la vereda que va de Las Flores a la cascada de Las Flores, 21°26'N 99°4'W, 1600 m, 10 July 2016 (fl), *H.A. Castillo-Gómez 1844* (CIIDIR!, IEB, QMEX!, SLPM!).

Discussion:—Although *Clinopodium nepeta* is a widely cultivated ornamental plant it has not been introduced extensively in Mexico, at least not in recent times, and no report has been made about the naturalization of this species in the country (Villaseñor & Espinosa-García 2004, Martínez-Gordillo *et al.* 2013). Hence, the discovery of two populations growing in the wild in remote areas away from human settlements is unexpected and difficult to explain. The most reasonable hypothesis is that *C. nepeta* might have been extensively grown in Mexico in times of the Spanish

FIGURE 1. *Clinopodium nepeta* in San Luis Potosí, Mexico. A. Upper portion of a flowering branch showing the leaves. B. Frontal view of the lower corolla lip. C. Lateral view of the flower (photographs taken by H.A. Castillo-Gómez).

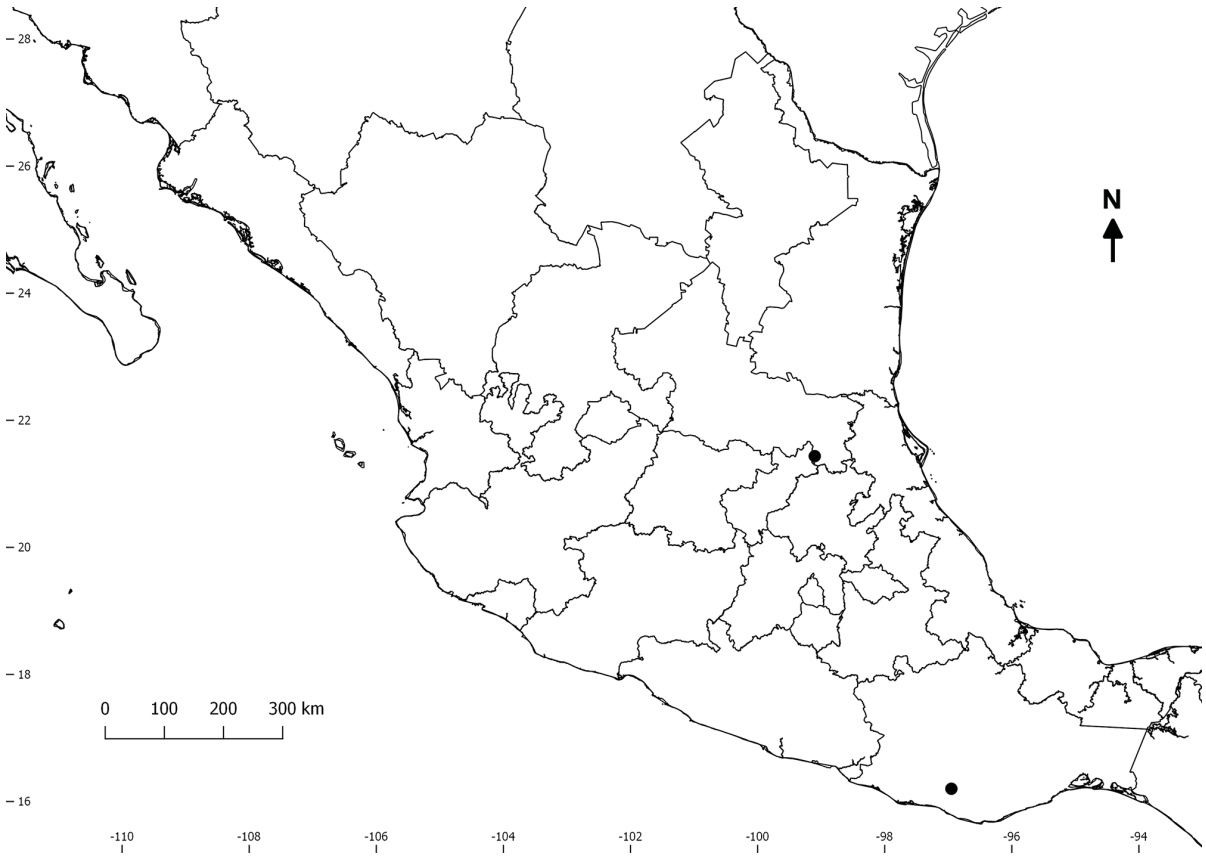

FIGURE 2. Distribution map of *Clinopodium nepeta* (black dots) in Mexico.

colony since the Spaniards brought with them those European species they found useful (Challenger 1998, Morales 2010b). A large amount of Eurasian plants were introduced in Ibero-America between the seventeenth and eighteenth centuries as medicinal plants; this is clearly testified when studying historical registers of Colonial drugstores and pharmacopoeias administrated by religious orders (Díaz & Mantilla 2002, Fernández-Alonso & Rivera-Díaz 2006, Díaz 2012). However, not many of these acclimatized well to the conditions in the New World and others just were forgotten or abandoned once they stopped being popular. It is possible that was what happened with this *Clinopodium* Linnaeus (1753: 587), and that only some few plants escaped cultivation and remained alive in natural environments. However, due to the lack of good historical reports of plants in cultivation in Mexico, the supporting evidence for this approach is weak. The other possibility is that the naturalization is much more recent as consequence of sporadic and marginal introductions in a low scale. This species is currently used in San Luis Potosí as infusion of branches and leaves to heal respiratory ailments.

It should be noted that several discussions have been devoted to the terminology and the process of how an alien plant arrives to a new geographic area and might start a path towards the transformation of the new habitat (Pyšek 1997, Pyšek *et al.* 2004, Coloautti & MacIsaac 2004, Richardson *et al.* 2000, 2011). However, these analyses have let it clear that there is wide heterogeneity on how the authors deal with this, and no standard criteria have been coined. Due to the situation above, the terminology applied here is the one proposed by Richardson *et al.* (2000). They defined naturalized plants as those which reproduce consistently over many life cycles without direct intervention by humans. *Clinopodium nepeta* in San Luis Potosí fits better into this category because both populations grow far from human influence and they were collected in different years, suggesting it is not a casual alien plant (those that flourish by means of repeated introductions; i.e., adventitious plants according to Fernández-Alonso 2013). In contrast, the species in Oaxaca is known only in base to a unique collection, so that makes difficult its assignation to any category, but also due the magnitude of the distance of the locality to human settlements, it is most probable it would fit better as naturalized plant. In both cases a status as plants escaped from cultivation is unlikely because the species is not extensively grown in the area, not even in the country. A strict categorization of the alien plants demands an accurate monitoring of population behavior with the proper investment in time and resources, however, it is important drawing attention to plants that might qualified as naturalized as a strategy of early warning of its presence out of cultivation.
Although, the population from Oaxaca differs in several characters with respect to those in San Luis Potosí: indumenta on stems, petioles, pedicels and calyces with glandular-capitate hairs, longer petioles, peduncles and pedicels, and shorter calyces, corollas, thecae and styles (table 1), both extremes of variation fit well into the circumscription of a well-known variable species. It has been largely documented that *Clinopodium nepeta* varies in several orders in terms of essential oil composition, leaf size, pubescence, peduncle length (0−20 mm long), inflorescence architecture, calyx and corolla size, and number of flowers per cyme, depending on variables such as levels of sun exposition and water availability (Pooter *et al.* 1986, 1987, Morales & Nieves-Luque 1997, Hammer *et al.* 2004, Scandaliaris *et al.* 2007, Morales 2010a). Therefore, it is not surprising that the different populations of *C. nepeta* in Mexico are not morphologically uniform.

TABLE 1. Morphological comparison between both *Clinopodium nepeta* populations found in the Mexican states of Oaxaca and San Luis Potosí.

Character	*C. nepeta* in Oaxaca	*C. nepeta* in San Luis Potosí
Pubescence in the upper portion of the branches	short glandular-capitate	short pilose (eglandular hairs)
Petiole length (cm)	1.1–3.9	0.5–1
Petiole pubescence	short glandular-capitate	short pilose (eglandular hairs)
Inflorescence peduncle length (mm)	12–19	(0.5–)1.3–1.9
Pedicel length (mm)	2–4.1	1.8–2
Pedicel pubescence	short glandular-capitate	short pilose (eglandular hairs)
Calyx tube length (mm)	4–5	5–6
Upper calyx lip length (mm)	2–2.6	2.5–3.6
Corolla tube size (mm)	7–9 × 2.8–3.2	12.9–15.3 × 4.8–7.8
Upper corolla lip length (mm)	2.2–2.6	4.8–5.6
Lower corolla lip length (mm)	4.4–5	5.9–8.2
Number of stamens	4	2
Thecae length (mm)	0.3–0.5	0.8–1
Staminodes	0	2 or 0
Style (mm)	9.7–10.6	17.7–10.6

FIGURE 3. Dissected corolla of *Clinopodium nepeta* (*Castillo-Gómez 1844*, CIIDIR). Above, the thecae of fertile stamens highlighted in red, staminodes in blue. Below, close-up to the staminodes, highlighted in blue, no fertile structures are observed. Scale bars (white) represent 1 mm in both captures.

Clinopodium nepeta is a very variable species in which several subspecies are recognized (i.e. Peruzzi & Conti 2008, Bartolucci & Conti 2011, Tison & Foulcault 2014, Tison *et al.* 2014, Govaerts 2017). According to recent identification keys (Tison & Foulcault 2014, Tison *et al.* 2014) the plants in Mexico mix characters from three of these subspecies: some calyces less than 6.5 mm long and corollas less than 16 mm long [*C. nepeta* subsp. *ascendens* (Jordan 1846: 8) Bock (2011: 275)], lower calyx teeth more than 2.5 or 3 mm long [*C. nepeta* subsp. *sylvaticum* (Bromfield 1845: 49) Peruzzi & Conti (2008: 264)], and leaves covered with glandular dots beneath [*C. nepeta* subsp. *spruneri* (Boissier 1859: 23) Bartolucci & Conti (2011: 143)]. Due to the uncertainties and inconsistencies expressed above, we prefer not to assign the plants in Mexico to any of these taxa, but providing only a clear morphological description of the variation they embrace. An exhaustive study in the future on the morphological and genetic variation of this complex might provide new insights for a more stable classification.

Independently to the explanation of how *Clinopodium nepeta* became naturalized in two spots in Mexico, it is worth noting that the flowers in the populations from San Luis Potosí present only two fertile stamens instead of four (Fig. 3), a character condition not previously described in the species (Morales 2010a). Stamen reduction is an evolutionary tendency observed in several lineages within Lamiaceae and frequently associated with more specialized pollination syndromes (Walker & Systma 2007, Drew & Systma 2012). Hence, Mexican *C. nepeta* could constitute a good study model to understand the evolutionary mechanisms underlying this transition. Nevertheless, in order to achieve a better understanding of the variation on the number, size and shape of the stamens and staminodes among both Mexican populations, it would be necessary to conduct a specific study to clarify this, including a genetic analysis either to support or refute our hypothesis that these belong to the same taxon.

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