

1028. SALVIA HISPANICA

Lamiaceae

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Summary. The history and application of the name *chia* and its scientific equivalent, *Salvia hispanica*, are outlined. The relationship of *S. hispanica* with other species known as *chia* is discussed including those within the genus *Salvia* and those without. Its native distribution and habitat are described. *Chia* was an important crop in Aztec society and the seeds had a wide range of uses beyond their use as a food grain. Following the Spanish conquest of Mexico, cultivation and use both declined but in recent years there has been a striking reawakening of interest in *chia* as a superfood with many benefits for the consumer. Contemporary as well as traditional uses are described with notes on its culinary uses and its health benefits. Propagation is by seed and its cultivation is discussed and attention drawn to new varieties more suitable for temperate climates.

Salvia hispanica is known to the wider public as *chia*, a plant which has a long and chequered history going back to ancient times. The current status of its seeds as a fashionable superfood is a recent phenomenon. A quarter of a century ago it was a minor, near forgotten grain of local consumption with a very low profile. It did not appear, for example, in the otherwise excellent *New Oxford Book of Food Plants* (Vaughan & Geissler 1997) which, in contrast, did feature today's equally fashionable *quinoa*. Further back in the 18th and 19th century it was even less esteemed, although there is an excellent illustration in Bonelli's (Bonelli 1772–1783) *Hortus Romanus*, vol. 3 t. 22. Nor has it ever been illustrated in this journal despite our emphasis on plants of horticultural or commercial importance. However, before the arrival of the Spanish in America in the time of the Aztecs, its seeds were of supreme cultural and economic importance.

Salvia hispanica L. is a misnomer. This does not mean that the name is illegitimate botanically but that it is highly misleading. When Linnaeus (1753: 25) gave it the name *hispanica*, meaning Spanish, he seems to have repeated the error of the author of the publication he cited, Tabernaemontanus (1664: 764), who

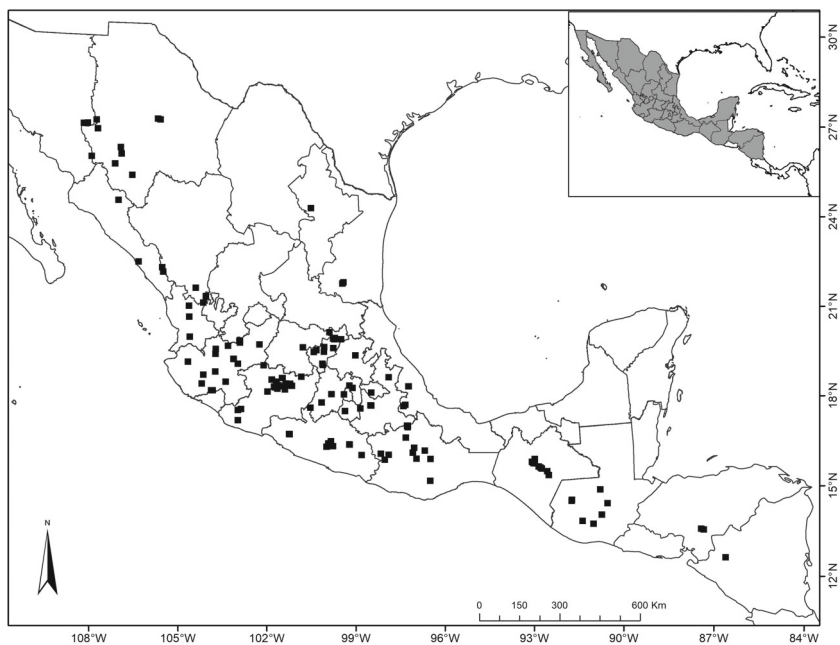
described it in his *Neu Vollkommen Kräuterbuch* as ‘Spanisch Sharlach’ or ‘Sclarea hispanica’ from which the epithet is derived. In fact, Tabernaemontanus’ illustration is not very satisfactory as it shows a plant that is more branched, with a laxer inflorescence and larger flowers than is typical. Neither Tabernaemontanus nor Linnaeus seems to have realized that this was not a Spanish or even a European native and provided no information about how it came to be cultivated in Europe at the time. No one seemed aware that it was an important food plant from Mexico, known as *Chia*. The world of systematic botany long remained ignorant of its origin and uses; Bentham (1833, 1847) seems to have been equally ignorant of both although he cited its occurrence in Mexico as well as Ecuador, Jamaica, Italy, Spain and Germany but without giving any indication of where it was native or of its use as a food. This ignorance of the true identity of *Salvia hispanica* continued late into the 19th century when Sessé & Mociño (1893: 9) described *Salvia chia* as distinct from but similar to *Salvia hispanica* in their posthumous *Flora Mexicana* without recognizing they were one and the same species.

Salvia hispanica is distinct enough from other species of *Salvia* to have been placed by Epling (1939) in its own section, *Potiles* Epling in his monograph of New World Salvias. There are no recorded instances of hybridization with other species of *Salvia* and it has been reported on various occasions to have a uniquely low chromosome number ($2n = 12$) in the genus (Cahill 2003: 6005). However, molecular studies suggest it belongs to the Angulatae clade *sensu* Fragoso-Martínez *et al.* (2018) and is closely related to the Mexican *S. leptostachys* Benth. and, slightly more distantly, to the widespread neotropical *S. tiliifolia* Vahl, both annual species. These results are interesting as *S. leptostachys* is morphologically rather similar to *S. hispanica* in leaf and floral characters including the subventricose calyx with a 3-veined upper lip. There are no major recorded differences between wild and cultivated forms of *Salvia hispanica* although a denser inflorescence, slightly larger flowers and seeds and a closed fruiting calyx have been reported in cultivated plants (Hernández Gómez & Miranda Colín 2008) (Plate 1028).



Plate 1028 *Salvia hispanica*

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Map 1. Presumed native distribution of *Salvia hispanica* in Mexico and Guatemala based on herbarium records at IEB, K, iNaturalist <https://www.inaturalist.org/> and MEXU.

As a native plant, *Salvia hispanica* is probably restricted to Mexico and Guatemala (Map 1). It should be stressed, however, that it is not always easy to be certain of the status of a particular population, particularly those from Central America, from where it is recorded from all countries apart from Panama and Belize. Casuals and relics of cultivation occur not only within its presumed native range but also in other places where it has been cultivated. Records from Cuba, Jamaica, Venezuela, Colombia, Ecuador and Bolivia are presumably casual introductions and similar records may be expected from other countries and continents where *Salvia hispanica* is cultivated or its seeds thrown out in waste products.

Salvia hispanica occurs naturally from *c.*1300 to 2550 m altitude in the sierras of Mexico and Guatemala. It is reported to be a plant of seasonally dry oak and pine woodland but is also recorded from scrub and ‘brush’ on steep rocky slopes and less commonly in ravines and near streams (Figs 1, 2).



Fig. 1. Disturbed scrub-covered hillside, where *Salvia hispanica* occurs naturally at 1750 m, San José de Gracia, Michoacán, Mexico. Photo: Ignacio García Ruíz.



Fig. 2. Steep sandstone slopes, a natural habitat of *Salvia hispanica* at 1750 m, San José de Gracia, Michoacán, Mexico. Photo: Ignacio García Ruíz.

It is sometimes found in secondary bushland and in ruderal habitats where it may be of cultivated origin. It mostly occurs in isolated stands or as individuals (Fig. 3), but denser populations are not unknown in the wild (Fig. 4). Nearly all records of flowering have been made in the northern hemisphere autumn after the cessation of the main rains from October to December.

Despite, the distinctiveness of *Salvia hispanica*, the name *chia* is less precise in its application. It is probably derived from the Nahuatl word *chian* (the language of the original peoples of Mesoamerica), meaning oily, although some Internet sites suggest it originated from the Mayan word for “strength” (for example, Ancient Grains 2022). The Mayan origin of the word seems unlikely as *chia* was almost certainly first cultivated in the Nahuatl speaking regions of central Mexico several thousand years ago, and there is no firm evidence of its cultivation in Mayan areas until after the collapse of their civilization around 900 A.D. (Ayerza & Coates 2005: 74). Although generally used for *Salvia hispanica*, *chia* can be used to refer to the unrelated *Salvia columbariae* Benth., from northwest Mexico (Sonora, Baja California) and the United States Southwest (California, Arizona, Nevada, Utah etc.) whose seeds are used by native Americans in a similar way to those of *S. hispanica*. However *S. columbariae* is not generally cultivated and has not entered international trade. *Chia* is also used to refer to *Mesosphaerum suaveolens* (L.) Kuntze, which is better known as *Hyptis suaveolens* (L.) Poit. and which also has oleaginous seeds. It is occasionally used to refer to other species of *Salvia* with small blue flowers including *Salvia amarissima* Ortega, *S. lavanduloides* Kunth, *S. leptostachys* Benth., *S. longispicata* M. Martens & Galeotti, *S. misella* Kunth and *S. polystachya* Ortega, although there is no evidence that their seeds are used in a similar manner to those of *S. hispanica*. *Chia* is even used sometimes to refer to *Amaranthus hypocondriacus* L. treated as *A. leucocarpus* S. Watson by Ayerza & Coates (2005): 89 ff.). Although Nahuatl usually distinguishes between different kinds of *chia* (*Chian-tzotzotl* refers to *Mesosphaerum suaveolens*, for example), uncertainty in identifying references to *chia* or *chian* is understandable.



Fig. 3. *Salvia hispanica* often grows naturally as isolated individuals, here in a reforested area near Morelia, Michoacán, Mexico. Photo: Brenda Bedolla.

In popular usage the word *chia* is usually taken to refer to the seeds of *Salvia hispanica* which are narrowly ovoid, smooth, somewhat shiny, grey-brown, sometimes veined or white and scarcely 2 mm long (Fig. 5). There is evidence that cultivated



Fig. 4. *Salvia hispanica* growing naturally in temperate montane forest near Xalapa, Veracruz, Mexico. Photo: Arturo Hernández-Huerta.

plants have larger seeds as a result of selection when compared to seeds from plants of wild provenance (Cahill 2005, Hernández Gómez & Miranda Colín, 2008). The seeds are mucilaginous and become sticky when wetted and easily coalesce into a ball which can be carried in a bag. Seeds are also somewhat oily and it is these qualities which have allowed the



Fig. 5. Chia seeds, showing variation with occasional white seeds mixed with brown seeds and mottled seeds. Photo: John Baker.

creation and commercialization of ‘chia pets’ in recent years. These are terracotta animals to which *chia* seeds are affixed. The seeds readily sprout when moistened resulting in a hair-like growth on the ‘animal’ as if it is living. Popular in the United States millions of these chia pets have been sold.

How *Salvia hispanica* first came into cultivation is lost in the mists of time (Cahill 2005). *Chia* was of economic and cultural importance for the Aztecs and probably also for the Teotihuacán civilization that preceded them a thousand years earlier. Our knowledge of the pre-Columbian uses of *chia* depends heavily on the Codices (handwritten books describing Pre-Columbian customs) dating from the 16th century and on various 16th and 17th texts which discuss the history and culture of Mexico at and soon after the Spanish conquest. Most interesting perhaps is the Codex Mendoza (1541); Berdan & Anawalt (1992), which contains the pre-conquest Matrícula de Tributos. This lists *chia* as one of four food tributes (together with maize, beans and amaranth) paid to the Aztecs by tributary states, thus underlining its importance in the Aztec economy. There are accounts



Fig. 6. Drawing of *Salvia hispanica* in the *Codex Florentino* (de Sahagún 1579) with a chia user.

of *chia* cultivation on floating islands (*chinampas*) on Lake Texcoco (de Torquemada 1615), site of present-day Mexico City and in plots around houses in Aztec settlements. The *Codex Florentino* (de Sahagún 1579; Anderson & Dibble 2002) details the use of *chia* in Aztec society, contains an immediately identifiable picture of *Salvia hispanica* (Fig. 6) and describes its use in religious ceremonies. Its use in non-Christian religious ceremonies partly explains the abandonment of *chia* following the Spanish conquest as these associations were anathema to the Spanish clergy, but a more important factor in its decline may have been the introduction of European crops as part of a Eurocentric cultural take-over. *Chia* was replaced by flax and its cultivation declined dramatically over the next few centuries, surviving until today only in isolated communities, which continued practising traditional methods of small-scale production (Muñoz Máximo *et al.* 2017). Folk memory of its uses declined with the reduction in its cultivation and Cahill (2003: 612) records how some growers were unaware that wild plants were the same as the legendary *chia*.

Many ethnobotanical uses for *chia* are recorded and these can be grouped under the headings of medicinal, culinary, artistic and religious uses (Cahill 2003). Not only the seeds but the roots were used medicinally. *Chia* was used in combination in various potions and treatments rather than as a

remedy for specific diseases as chia seeds were often seen (in the Florentine codex, for example) as valuable in enhancing the take-up of specific medicines. The mucilaginous qualities of the seeds were particularly valued in the treatment of eye disorders but curiously this was more a post-conquest than a traditional use (Cahill 2003). Culinary uses included the production of Chianpinolli, chia flour, to be used in the preparation of tamales and tortillas. Chia flour has a long history in the preparation of refreshing drinks (de Sahagún 1579; de Torquemada 1615) while *chia* seeds have been used to flavor a drink known as *agua de chia* or *chia fresca* that is popular today. The production of *chia* seed oil and the growth of *chia* sprouts may be ancient but most confirmed production is modern. However, de Sahagún (1579) compares *chia* oil to linseed oil in its use in paintings and it has long been used to provide the glossy finish to clay gourds and as a component of different paints, including that used in painting circles on the cheeks of Aztec gods. Use of *chia* paint in religious and social ceremonies, such as that following ear piercing (de Sahagún 1579: 154), seems to have declined sharply after the 16th century (Cahill 2003: 611).

MODERN USES. Since the late 1990s, there has been a massive revival of interest in *chia*, an enthusiasm which has spread from its original home in Mexico to many parts of the world. Today it enjoys a high profile as a fashionable superfood. There is strong evidence of many nutritional benefits from *chia*, although there is little information about the level of consumption needed to optimize these benefits. Chia oil is very rich in omega-3 fatty acids. Chia seeds are a rich source of antioxidants as they contain chlorogenic acid, caffeic acid, myricetin, quercetin, and kaempferol, which are reported to promote a wide range of health benefits. They are a good source of dietary fibre with benefits to the digestive system. They are low in sodium, have a higher protein content than other grains, such as wheat, rice and oats and, importantly, are gluten free. They are a good source of Vitamin B and essential minerals including calcium, phosphorus, magnesium, potassium and iron. (Ayerza & Coates 2005; Rahman Ullah *et al.* 2016).

Modern myths abound about the benefits of *chia* and it is not always easy to disentangle the truth from misinformation. The following recommendations are cautious and based on an article by Jo Lewin (2022). *Chia* seeds are probably good for bones as they contain calcium, magnesium and phosphorus, which are known to be good for bone health. A 25 gm portion of chia seeds contains approx. 158 mg of calcium. They may also be good for the heart and can reduce blood pressure. The high levels of omega-3 fatty acid, protein and fibre help to stabilize blood sugar levels and may reduce the risk of diabetes. *Chia* seeds are about a third by weight in fibre and so are likely to improve digestive health and reduce the risk of several diseases. In general, *chia* seeds have few contraindications - they do not contain gluten or obvious allergens – but excessive consumption is unwise. The reader should note the use of cautionary words above as many claims have not been tested extensively in the real world. Some authors, such as Ayerza & Coates (2005), are very positive about the health benefits of consuming *chia* products whereas others, such as Souza de Souza Ferreira et al. (2015) are much more cautious.

Chia products are often recommended for culinary use but *chia* seed is perhaps more noteworthy for its texture than its taste. *Chia* seeds are lacking in strong flavour so are very suitable for combination with a range of products, both savoury and sweet. They can be added to porridge and puddings or incorporated in muesli, granola and seed bars. They can be sprinkled over salads, yoghurt, rice dishes, porridge and crumbles or baked into puddings, cakes and biscuits. They can be mixed into jams, smoothies, salad dressings and any casserole or grain dish. *Chia* flour is highly nutritious and can be used to replace wheat flour in sweet and savoury baked foods, such as bread, flat-bread, cakes and rolls, with the advantage of being gluten free. *Chia* flour also makes a great egg substitute in vegan and vegetarian recipes. To make *chia* egg substitute, mix two tablespoons of *chia* flour with $\frac{1}{2}$ cup of cold water and let it stand for about 30 minutes. That makes about $\frac{1}{4}$ cup of egg substitute, equivalent to one egg in a recipe, although the same result may be achieved by simply mixing chia seed with water (Pacific Grain

and Food 2022). *Chia* oil is also an ideal ingredient for healthy salad dressings. It makes an excellent health-boosting addition to all types of smoothies but is not suitable for frying.

CULTIVATION. *Salvia hispanica* can be grown from seed and appears to be easily cultivated in tropical and subtropical countries with warm temperatures and seasonal rainfall. It is not frost tolerant and seeds do not ripen in time at higher latitudes. Sowing should take place at or just before the rains as moisture is necessary for successful germination. Harvesting for seeds ideally takes place at the beginning of the dry season about six months after sowing. Ants are reported to be the only significant pest but competition from weeds can be serious for young plants. Traditionally all stages from soil preparation to harvesting were carried out by hand and this is still the practice in parts of rural Mexico, (Muñoz Máximo *et al.* 2017). Outside areas of traditional cultivation, mechanization is widely practised in the commercial sowings reported from tropical countries today, including Argentina, Australia, Bolivia, Colombia, Ecuador, Mexico and the United States amongst others (Fig. 7). Weeding, however still needs to be done by hand as no suitable herbicide is available (Ayerza & Coates 2005: 101 ff.).



Fig. 7. Field of cultivated *Salvia hispanica* in Bolivia. Photo: copyright 123RF.com



Fig. 8. *Salvia hispanica*. Young inflorescence showing distinct persistent bracts. Photo: Brenda Bedolla.

In temperate countries, such as the U.K., cultivation is more tricky and seeds are rarely produced. One of us (L.P) sowed seeds with a light covering of soil in a heated propagator in late April. Young plants were planted out in late May after all risk of frost had passed. Some were also potted up. By October no plant was flowering but some were in bud when on October 19th the potted plants were brought into a conservatory to avoid the first frosts. The first flowers appeared at the beginning of November and the plant illustrated in our painting was in full flower at the end of November. It has been reported that *Salvia hispanica* is “short day adapted”, that is it only flourishes in climates where day and night lengths are roughly equal. However, our experience suggests that temperature may also be a significant factor in explaining why plants grown in subtropical climates take longer to mature.

In recent years new varieties have been developed which come into flower during longer days and can produce seeds in a range of environments in temperate areas (Jamboonsri *et al.* 2012). *Salvia hispanica* was previously thought not to grow

to maturity in the UK climate but the Fair family have selected a strain that has ripened and yielded well on their Essex farm at Great Tey (Smithers 2018). It is possible that *chia* cultivation will become practical in more temperate regions with greater day/nighttime differences in the near future.

Salvia hispanica L., Sp. Pl. 25 (1753). Type: Icon. in Tabernaemontanus., Hist. [New Vollkommen Kräuterbuch] 764, t. 374 (1664), designated by Wood & Harley, Kew Bull. 44(2): 225. (1989)

Kiosmina hispanica (L.) Raf., Fl. Tellur. 3: 92 (1836) [1837], *nom. inval.*

Salvia tetragona Moench., Methodus 373 (1794), *nom. illeg., superfl.* for *S. hispanica* L.

Salvia prismatica Cav., Descr. 14 (1802) [1801]. Type: Plant from Mexico cultivated in Madrid. (holotype MA-257321).

Salvia chia Sessé & Mociño, Fl. Mexic. 9 (1893). Type: Mexico, unspecified. (possible lectotype MA-604393).

Salvia schiedeana Stapf, Bull. Misc. Inf., Kew 1899: 17 (1899). Type: Plant cultivated at Kew in 1895 from seed sent by Deppe & Schiede. (holotype K-000929956).

Salvia neohispanica Briq., Annuaire Conserv. Jard. Bot. Genève 2: 137 (1898), *nom. illeg. superfl.*

Salvia hispanica var. *chionocalyx* Fernald, Proc. Amer. Acad. of Arts 43(2): 63(1908) [1907]. Type: Mexico, Michoacán, Uruapan, Pringle 8837 1/2. (holotype GH-00001655, isotypes ASU, COLO, DAO, DAV, ENCB, LL, MEXU, MICH, MSC, VT).

Salvia hispanica var. *intonsa* Fernald, Proc. Amer. Acad. of Arts 43(2): 63 (1908) [1907]. Type: Guatemala, Santa Rosa, Buena Vista, Heyde & Lux 4401. (holotype GH-00001656, isotypes G, K, US)

DESCRIPTION. Annual *herb* (10–) 30–70 (–200) cm high; *roots* fibrous, numerous, forming a dense mass under favorable conditions. *Stems* erect, simple or sparingly branched, quadrangular, deeply sulcate between the prominent, rounded angles, appressed pubescent with whitish hairs. *Leaves* petiolate, lamina 1.4–11.5 × 0.5–6 cm, ovate to ovate-elliptic, apex acute to shortly acuminate, base cuneate to rounded, margin serrate, adaxially pubescent, abaxially densely pubescent with whitish hairs; petioles 0–3.5 cm, diminishing in length upwards, pubescent. Inflorescence of dense racemes, (1–) 5–17 cm long and 1.3–2 cm wide, terminal on the main stem and on branches from the uppermost leaf axils, usually solitary but occasionally with a pair of racemes arising at the base of the main raceme, the flowers in 6–12-flowered verticillasters, these imbricate except lowermost up to 5 mm apart; *peduncles* 1.5–11.5 cm long, pubescent; *bracts* 5–8 × 3–5 mm, narrowly to broadly deltoid, acuminate and mucronate, entire, pubescent, 3-veined, persistent (Fig. 8); *calyx* c. 5 mm long in

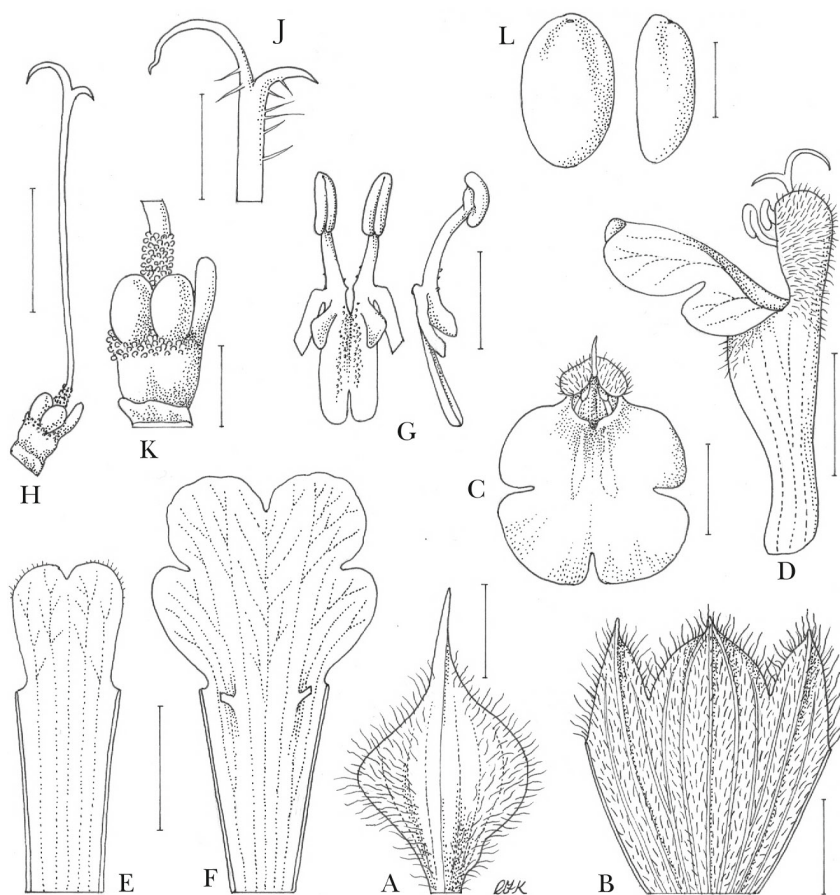


Fig. 9. *Salvia hispanica*. A, bract; B, calyx, opened out; C, corolla, face view; D, corolla, side view; E, corolla, upper lip; F, corolla, lower lip; G, androecium (stamens, 2 views); H, gynoecium including style; J, style arms; K, ovary; L, nutlets (2 views). Scale bars A–F = 3 mm; G–J = 2 mm; K–L = 1 mm. Drawn by Christabel King from a plant cultivated by Lynsey Pink in Hampshire.

flower, accrescent to 11 mm in fruit, rather bulbous (ventricose) at the base, pubescent with sessile glands near base, 2-lipped, the upper lip with 3 prominent veins and sometimes two additional less prominent veins, teeth mucronate, the lower lip 2-lobed; *corolla* 2-lipped, blue with small white 'honey guide' on lower lip, 7–8 mm long, tube 4–5 mm long, $\pm$ enclosed by the calyx, white, $\pm$ glabrous, the upper lip c. 3 mm long, blue, hooded, densely pubescent, the lower lip 4–5 mm long, shallowly 3-lobed, pubescent on the exterior, papillae absent from the interior; *stamens* included in upper lip, anthers c. 1.25 mm long, yellowish; *style*

whitish, glabrous, glandular at base, shortly exerted, bilobed, the arms blue, upper arm reflexed, twice as long as the lower arm. *Nutlets* ovoid, 1.4–2 mm long, smooth, glabrous, pale grey-brown mottled with white or (rarely) entirely white, becoming mucilaginous when wetted. (Fig. 9).

NOTES. The whole plant is grey-puberulent when dry except for the stems that turn light brown. The abaxial leaf surface appears paler in dried specimens but this is not obvious in fresh material. Flowering specimens can be very short, reaching only a few centimetres in height in years of low rainfall but conversely can attain 2 m in well-watered, fertilized situations. Dispersal may well be facilitated by the sticky nature of wetted seeds which adhere readily to almost all surfaces including fur, feathers, beaks or skin.

DISTRIBUTION. Probably native to Mexico and Guatemala (Map 1) but widely cultivated elsewhere in tropical America and increasingly in the Old World. Recorded as a casual or weed of disturbed places throughout its range in the Americas and to be expected to occur casually wherever cultivated.

ECOLOGY. As a native species, a plant of pine and oak woodland on shallow soils often on rocky slopes usually between 1800 and 2000 m but sometimes reaching 2550 or as low 1200 m in abandoned fields where it grows spontaneously. Associated species include *Alnus acuminata* Kunth, *Arbutus xalapensis* Kunth, *Buddleja cordata* Kunth and *Rhus schiedeana* Schltdl.

PHENOLOGY. Flowers and fruits principally in the late autumn, *i.e.* November to December in the northern hemisphere and April to June in the southern hemisphere, but flowers are sometimes found earlier in the season.

CONSERVATION. Least Concern (LC) according to IUCN guidelines.

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