



## A new *Agave* species (Asparagaceae, Agavoideae), from southern Oaxaca, Mexico

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### Abstract

A new species, *Agave calciphila*, endemic to the limestone hills north of Nizanda, Oaxaca, Mexico, is described. Its vegetative and flower morphology place this species in the section *Heteracanthae*, and close to *Agave angustiarum*, *A. ghiesbreghtii*, and *A. huehueteca*. After a comparison with these three species, *A. calciphila* was found to have shorter sterile peduncle and flowers.

**Keywords:** *Agave* sect. *Heteracanthae*, MacDougall, *Marginatae* group, Nizanda

### Introduction

In contrast to their traditional use to help determine species delimitations, flowers in *Agave* sect. *Heteracanthae* Salm-Dyck (1861: 179), corresponding to the informal group *Marginatae* (Thiede *et al.* 2019), show very little difference in their features among species. In fact, Gentry (1982) stated that the uniform aspect of flowers is only of secondary use in species circumscription. He also argued that the evolution of flowers has been very conservative while leaf and inflorescence structure have greatly diversified. This leaves other components of these plants, such as distribution, soil and habitat, inflorescence, and leaf morphology as potentially more informative for taxonomy. The *Heteracanthae* currently consist of 30 taxa (28 species and two subspecies) ranging from Texas throughout much of mainland Mexico into Guatemala. Three taxa, i.e. *Agave* ×*glomeruliflora* (Engelmann 1883: 48) Berger (1915: 94), *A. peacockii* Croucher (1873: 1400), and *A. pumila* De Smet ex Baker (1888: 172), included by Gentry (1982) in the section *Heteracanthae* (under group *Marginatae*), and two recently described species, i.e. *A. doctorensis* Hernández-Sandoval & Magallán (2014: 1) and *A. montium-sancticaroli* García-Mendoza (2007: 79), included in the *Heteracanthae* by the respective authors, show indications of hybrid origin involving species in the subgenera *Littaea* and *Agave* due to their intermediate inflorescence structures and are not considered part of the section by Thiede (pers. comm.). The intermediate inflorescence type has been described as a racemose panicle by Gentry (1982), who also made a case for the hybrid nature of both *A.* ×*glomeruliflora* and *A. peacockii* and speculated on the possible hybrid nature of *A. pumila*. Concerning the two recently described species, both *A. doctorensis* and *A. montium-sancticaroli* exhibit similar racemose panicles as those of *A.* ×*glomeruliflora* and *A. peacockii* and the possible hybrid nature should be researched in more detail.

While *Agave lechuguilla* Torrey (1859: 213) has a very widespread distribution, some species within the *Heteracanthae* have a more restricted distribution. For example, *Agave chazaroi* Vazquez & Valencia (2007: 48) is currently known only from the type locality near Tequila, Jalisco and *A. pelona* Gentry (1972: 76) is restricted to four localities in a limited area of northwestern Sonora. Similarly, many of the *Heteracanthae* found in Oaxaca also tend to be limited in their distribution, as is the case for *A. dissimulans* Trelease (1920: 138), which is restricted to the Cerro Campana and surrounding hills south of Ignacio Mejia along the Rio Salado (pers. obs.), and *A. quioepeccensis* García-Mendoza (2019: 9) which is found in a limited area from Quioepecc south to San José del Chilar (García-Mendoza *et al.* 2019).

In October 2004, I found another similarly geographically restricted member of the *Heteracanthae* that matches no known species description. This distinct agave is restricted to the limestone hills north of Nizanda, Oaxaca, where no other species of the *Heteracanthae* have been documented by herbarium specimens. The nearest documented *Heteracanthae* collection is Gentry 12234 (DES, MEXU, MICH, US; herbarium codes follow Thiers [2019]), collected

58 km (36 miles) west of Sanatepec near La Ventosa and about 16 km southeast of the limestone hills north of Nizanda on the Isthmus of Tehuantepec in southern Oaxaca and labeled as *Agave ghiesbreghtii* Lem. ex Baker, which corresponds to *Agave ghiesbreghtii* Verschaffelt (1862: 3) according to World Checklist of Selected Plant Families (WCSP 2019). Although Gentry collected numerous *Agave* specimens, he apparently never collected at Nizanda as I have been unable to find any vouchers of his from the area.

Scottish botanist Thomas MacDougall collected specimens from the hills near Nizanda (*MacDougall 168*) on 18 February 1961, which he labeled only as *Agave* species. I traced two duplicates belonging to this gathering at MEXU (voucher 254002) identified by García-Mendoza in 1991 as *Agave* aff. *ghiesbreghtii*, and at CAS (voucher 616690, barcode 604778). The gathering *Pérez-García 1026* from Nizanda is deposited at MEXU (voucher 742842) and identified by García-Mendoza as *A. ghiesbreghtii*. The gathering *Meave 2441* from Nizanda is deposited at MO (voucher 5804640, barcode MO708957) and was identified by E. Pérez-García as *A. ghiesbreghtii* and listed as such in Pérez-García *et al.* (2001).

García-Mendoza (2011) collected several specimens in Puebla that he ascribed to *Agave ghiesbreghtii*, providing a detailed description of a small, compact rosette with 70–90 leaves that are green or yellow green, sometimes with a clear, central stripe, and deltoid or broadly lanceolate with few, small, widely spaced teeth.

Greulich (2012) classified the *Heteracanthae* agave at Nizanda as *Agave angustiarum* Trelease (1920: 139), a name that seems to have become a catchall for many agaves throughout much of southern Mexico much as *A. ghiesbreghtii* has been. Therefore, the new species from Nizanda is also compared to *A. angustiarum* as originally described in the protologue. Later, Greulich reassessed his initial interpretation and identified the plant as *A. ghiesbreghtii* (Thiede, pers. comm.).

The Agavaceae Database website (Etter & Kristen 2019) includes the plants found at Nizanda under *Agave ghiesbreghtii*.

Although Gentry (1982) included the Guatemalan *Agave huehueteca* Standley & Steyermark (1943: 4) in the synonymy of the southern Mexican *A. ghiesbreghtii*, the description by Standley and Steyermark is different enough from Gentry's expanded concept of *A. ghiesbreghtii* to warrant a separate comparison to the plants found at Nizanda (Table 1). The identity of *Agave ghiesbreghtii* and its relation to *A. huehueteca* should be researched in more detail to determine if they are warrant separation.

## Materials and Methods

Morphological data were gathered at the type locality on 18 February 2017 and 13 March 2019 from six flowering individuals with vouchers made and deposited at ARIZ. Electronically available specimens of plants collected at Nizanda were studied. Three populations of *Agave ghiesbreghtii* as listed by García-Mendoza (2011) were studied in the field for comparison.

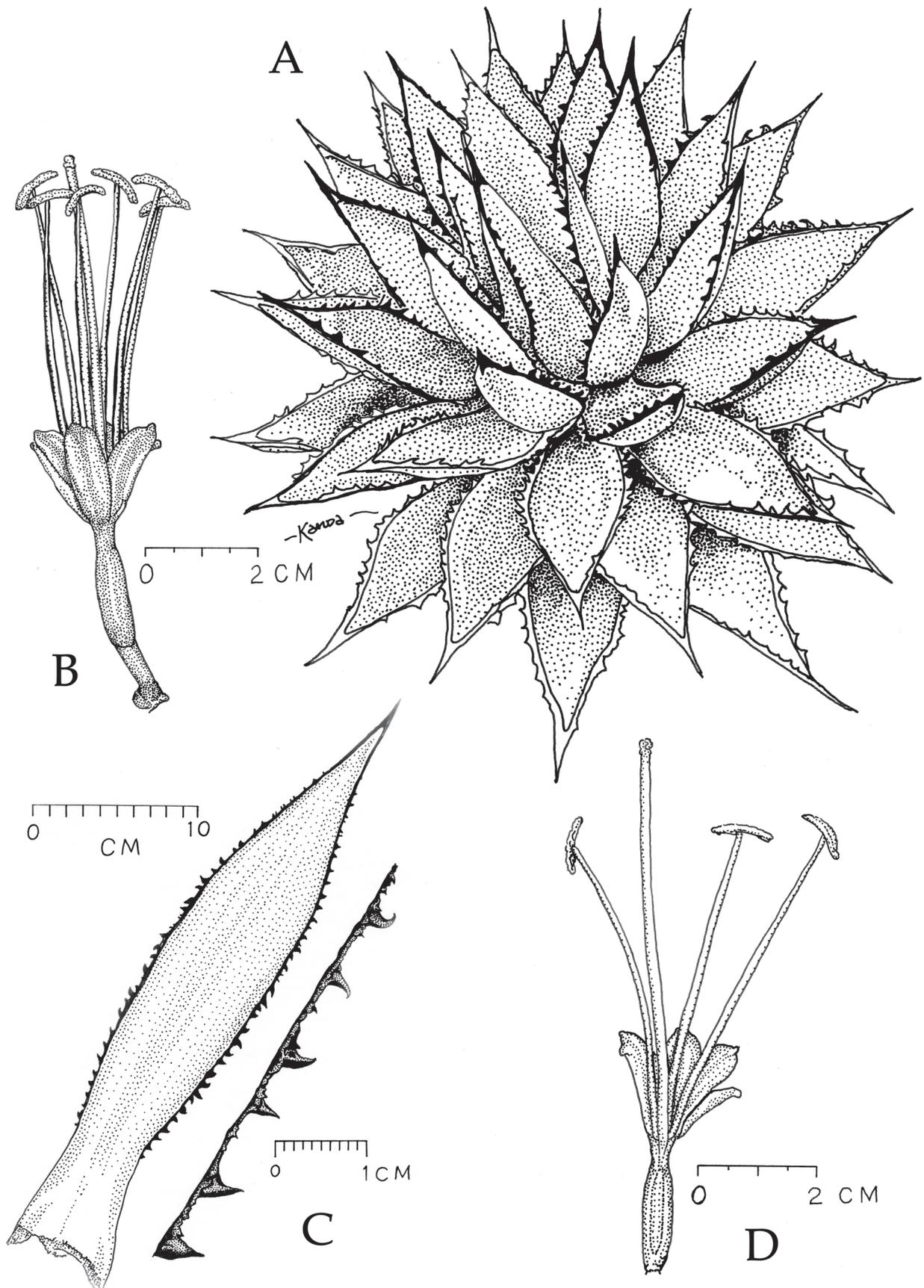
## Taxonomy

*Agave calciphila* G. Starr, *sp. nov.* (Figs. 1–2).

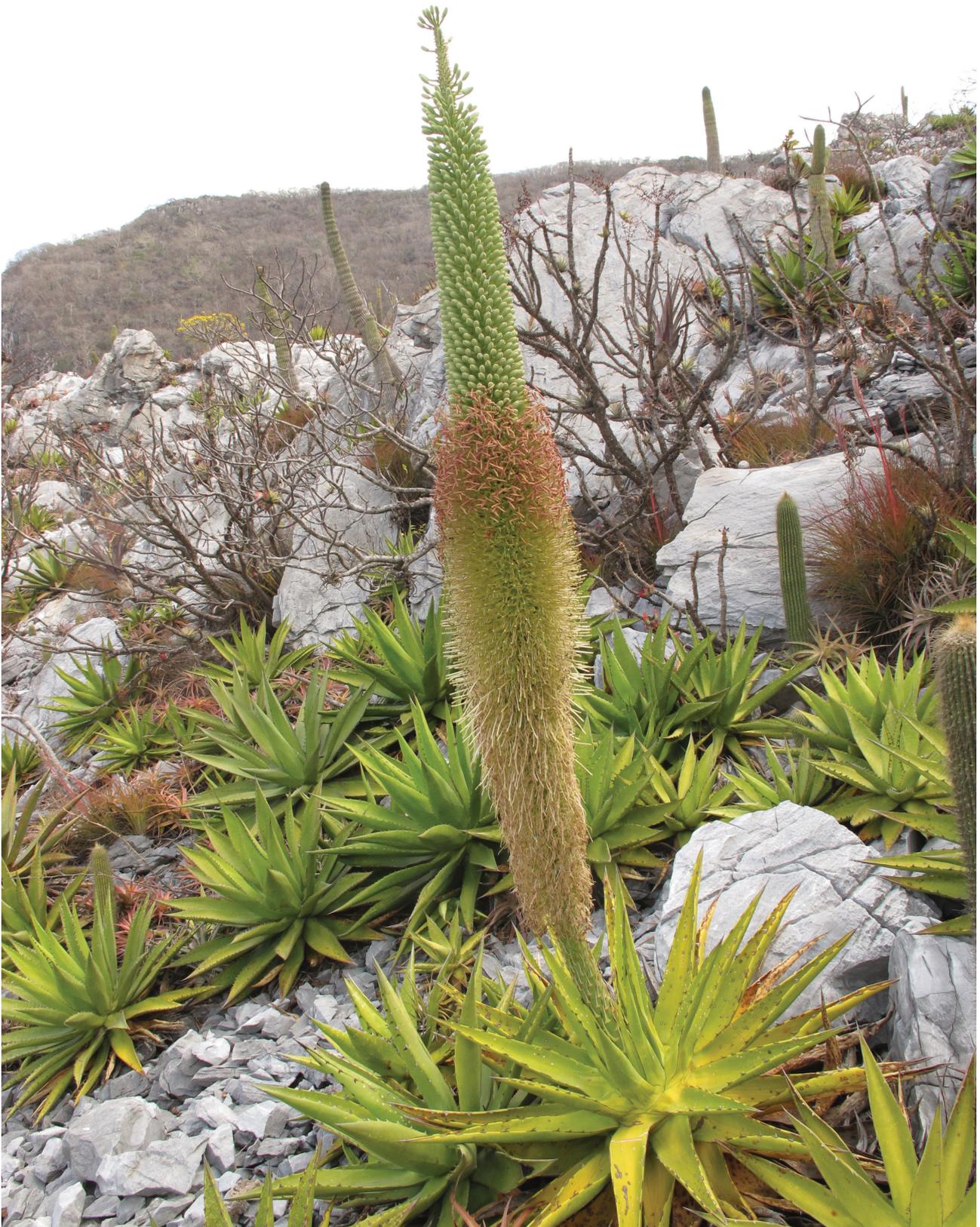
**Type:**—MEXICO. Oaxaca, District of Juchitán, municipality of Asunción Ixtaltepec, limestone outcrop 1 kilometer north of Nizanda, Sierra Tolistoque, 158 meters, 16° 40.070' N, 95° 0.601' W, 13 March 2019. *Starr 2019-005* (holotype ARIZ!, isotypes MO!, MEXU!).

**Additional specimens (paratypes):**—MEXICO. Oaxaca, District of Juchitán, municipality of Asunción Ixtaltepec, limestone outcrop 1 kilometer north of Nizanda, 190 meters, 16° 39.951' N, 95° 0.4338' W, 13 March 2019, *Starr 2019-006* (ARIZ!); Oaxaca, Nizanda, *MacDougall 168*, 18 February 1961 (UNAM!); Oaxaca, District of Juchitán, 1.75 kilometer northwest of Nizanda, 250 meters, 16° 40' 23" N, 95° 0' 50" W, 22 February 2001, *Meave del Castillo 2441* (MO!); Oaxaca, District of Juchitán, 1 kilometer northeast of Nizanda, limestone outcrop 150 meters, 16° 39' 53" N, 95° 0' 26" W, 16 March 1996, *Pérez-García 1026* (UNAM!).

**Diagnosis:**—Similar to *Agave ghiesbreghtii* and *A. huehueteca* but differs from both in having an extremely short sterile peduncle on the inflorescence (0–15 % of the total length vs. 50–70 % of the total length); a shorter overall flower length (34–42 mm vs. 50 mm and 40–45 mm, respectively); and a shorter flower tube (1 mm vs. 2–4 (10) mm and 5 mm, respectively).



**FIGURE 1.** *Agave calciphila*: (A) rosette drawn from photo of a plant at the type locality; (B) flower drawn from photograph of holotype; (C) leaf drawn from holotype; (D) flower cross section drawn from photograph of holotype. Drawings by Kim Duffek, 2019.



**FIGURE 2.** *Agave calciphila* from the type locality showing an inflorescence with a very short sterile peduncle.

**Description:**—**Plant** multiannual, monocarpic, solitary or sparingly surculose. **Rosette** moderately dense, 55–80 cm tall × 60–120 cm in diameter (Fig. 1A). **Leaves** 25–50 per rosette, broadly linear-lanceolate to ovate-lanceolate

narrowed near the base, widest near the middle, and then shortly acuminate to the tip; rigid, smooth, thick at the base and thinner toward the tip; deeply concave above and convex below (Fig. 1C); 25–50 cm long × 5–10 cm wide at the widest point near the middle; light yellow green to medium green, with faint bud printing on the back of the leaves; **leaf margin** straight or rarely mammillate, continuous and horny (Figure 1C); **marginal teeth** 1–15 mm long, 5–15 mm apart, occasionally with smaller interstitial teeth, first tooth 20–25 mm below the terminal spine, straight to curved forward or back toward the base, reddish-brown to dark brown on new leaves, aging to gray on old leaves; **terminal spine** 10–25 mm long, with a broad and shallow to broad and deep groove, or groove narrow and shallow to narrow and deep, reddish-brown to dark brown on new leaves, aging to gray on old leaves, decurrent to the first pair of teeth. **Inflorescences** 1.3–2.6 m tall (Fig. 2); **sterile peduncle** very short, 0–35 cm long, comprising 0–15 percent of the overall length, 45–50 mm in diameter; **lower bracts** (peduncular bracts) filiform, 70–90 mm long × 1–2 mm wide above the base, **floral bracts** filiform, 14–22 mm long × 3–5 mm wide at the base, quickly tapering to 1 mm wide near the tip; **fertile spike** 1.3–2.25 m long, comprising about 85–100 percent the total length of the stalk, 15–15.5 cm in diameter (including flowers). **Flowers** 2 per node, greenish white to greenish yellow, sometimes flushed with red or purplish-red, 34–42 mm long (Figs. 1B, 1D); **pedicels** 5–10 mm long; **flower buds** green; **tepals** green, greenish white, or greenish yellow, cup-shaped to spreading at anthesis, 15–22 mm long × 5–7 mm wide; **ovary** 12–17 mm long, cylindric, 4–6 mm diameter; **neck** 3–6 mm long, 2–3 mm diameter; **tube** 1 mm long × 5–7 mm wide; **filaments** 40–60 mm long, yellow or green, sometimes flushed red or reddish purple, not set in a vertical groove of the tepal; **anthers** 10–15 mm long, yellow, greenish yellow, or red; **pistil** 120–130 mm long. **Capsules** 16–20 mm long × 12–14 mm wide, oblong, dark brown, dehiscent. **Seeds** 3–4 mm long × 2–3 mm wide, half-moon to crescent shaped, black.

**Phenology:**—*Agave calciphila* can begin blooming as early as mid-January and continue through February, March, and into April with seed setting from April to July.

**Etymology:**—The species name means “limestone loving” and describes the preference these plants have for growing on limestone.

**Distribution:**—*Agave calciphila* is restricted to the limestone outcrops north of Nizanda on the Isthmus of Tehuantepec in southern Oaxaca.

**Habitat and plant associations:**—The agaves are most frequent on the south and west facing exposures nestled into cracks and crevices of the large limestone boulders with few plants found on the north exposure or rarely in the shade of trees. The elevation range is between 150–360 m a.s.l. The region is tropical deciduous forest, and associated plants include *Acanthocereus tetragonus* (Linnaeus 1753: 466) Hummelinck (1938: 165) (Cactaceae), *Agave nizandensis* Cutak (1951: 151) (Asparagaceae), *Anthurium nizandensis* Matuda (1959: 35) (Araceae), *Beaucarnea* sp. (Asparagaceae), *Bursera* spp. (Burseraceae), *Cephalocereus apicicephalium* Dawson (1948: 10) (Cactaceae), *Combretum fruticosum* (Loefling 1758: 248) Stuntz (1914: 86) (Combretaceae), *Cyrtopodium punctatum* (Linnaeus 1759: 1246) Lindley (1833: 188) (Orchidaceae), *Erythrina lanata* Rose (14: 81) (Fabaceae), *Ficus petiolaris* Kunth (1817: 49) (Moraceae), *Hechtia macdougallii* Smith (1969: 138) (Bromeliaceae), *Mammillaria albilanata* Backeberg (1939: 47) (Cactaceae), *Mammillaria voburnensis* Scheer (1845: 136) (Cactaceae), *Pseudobombax ellipticum* (Kunth 1821: 299–300) Dugand (1943: 67) (Malvaceae), *Selenicereus grandiflorus* (Linnaeus 1753: 467) Britton & Rose (1909: 430) (Cactaceae), *Tillandsia caput-medusae* Morren (1880: 90) (Bromeliaceae), and *Tillandsia ionantha* Planchon (1855: 1006) (Bromeliaceae).

**Taxonomic relationships:**—The circumscription of *Agave ghiesbreghtii* is unclear as the plant was originally introduced by Verschaffelt (1862) and listed, with a brief description, in his catalog from that same year. Whether or not that constitutes a valid description is not resolved here, however, the World Checklist of Selected Plant Families (WCSP 2019) uses the Verschaffelt catalog (1862) as the place of valid publication but that catalog is not available electronically for checking. Baker (1877) ascribed the name to Lemaire in Jacobi (1864) with a mention that the plant was introduced by Verschaffelt in 1862. Baker (1888) reasserted that Lemaire was responsible for the description of *A. ghiesbreghtii* and included a detailed drawing of a potted plant, remarking that it is widely spread in cultivation. After researching the nomenclature of agaves described from European gardens, Smith & Figueiredo (2013) concluded that the name should be cited as *A. ghiesbreghtii* Hort. ex Jacobi. There appears to be conflicting opinion of the proper citation for *Agave ghiesbreghtii*, which is beyond the scope of this paper and not resolved here. Berger (1915) later supplemented the description based on plants in cultivation at La Mórtoia. Gentry (1982) selected a Berger specimen kept at US as the neotype.

Gentry collected many specimens from southern Mexico, including Oaxaca, that he identified as *A. ghiesbreghtii*, using that name seemingly as a catchall for those plants that did not fit any known species. Gentry (1982) acknowledged his uncertainty regarding the identity of *A. ghiesbreghtii* and considered it as a name encompassing a diverse species complex. Because Gentry (1982) significantly broadened the description of *A. ghiesbreghtii*, the descriptions provided

by Berger (1915) and García-Mendoza (2011) are used as a comparison. *Agave calciphila* differs from *A. ghiesbreghtii* by the number of leaves, leaf shape, leaf color, fertile section to overall inflorescence length ratio, and flower length, flower tube length, and filament insertion. *Agave calciphila* has 25–50 light yellow-green to medium green leaves that are broadly linear-lanceolate to ovate-lanceolate with the widest point near the middle and lack a central stripe, while *A. ghiesbreghtii* is described as having up to 60–90 green, yellow green, dark green, or dull and pale grayish-green leaves that are obovate, elliptic, or lanceolate with the widest point being mid-blade, sometimes with a central stripe. The inflorescence of *A. calciphila* is 1.3–2.6 m tall, with a thick, fertile section comprising 85–100 percent of the stalk. The inflorescence of *A. ghiesbreghtii* measures 3.5–4.5 (rarely 6.0) m with a long, narrow fertile section occurring in the upper 30–50 percent of the stalk. Overall flower length for *A. calciphila* is 34–42 mm with the very short tube measuring 1 mm, compared to the flower length for *A. ghiesbreghtii* of 50 mm and the tube measuring 2–4 (–10) mm. The filaments on *A. calciphila* are not set in a vertical groove of the tepal while the filaments of *A. ghiesbreghtii* flowers are set in a vertical groove.

*Agave calciphila* is also compared to *A. huehueteca* (sensu stricto) and differs in the leaf shape, leaf color, terminal spine length, flower stalk length, and floral tube length. *Agave calciphila* leaves are broadly linear-lanceolate to ovate-lanceolate and vary in color from light yellow green to medium green while the leaves on *A. huehueteca* are oblong-ovate or obovate, gray-green or glaucous. The terminal spine on *A. calciphila* measures 10–25 mm compared to 25–40 mm on *A. huehueteca*. The total length of the flower stalk is shorter for *A. calciphila* than it is for *A. huehueteca* (1.3–2.6 m v 3.0–5.0 m), and the floral tube is shorter for *A. calciphila* than for *A. huehueteca* (1 mm v. 5 mm).

*Agave calciphila* differs from *A. angustiarum* in having a dense rosette of 25–50, thick, yellow green to medium green leaves vs. an open rosette of 15–30, thin, glaucous leaves, shorter leaves (25–50 cm vs. 80–100 cm), and a shorter terminal spine (10–25 mm vs. 25–35 mm). *Agave calciphila* leaf shape is broadly linear-lanceolate to ovate-lanceolate narrowed near the base, widest near the middle, and then shortly acuminate to the tip. Though Trelease (1920) does not indicate leaf shape and the leaf on the type specimen is divided into three sections, the shape can be interpreted as broadly lanceolate, broadest from near the base to near mid-blade and then acuminate to the long, slender terminal spine.

#### Key to *Agave calciphila* and similar species

1. Inflorescence ratio of fertile section to overall length of stalk greater than 0.85, leaves broadly linear-lanceolate to ovate-lanceolate, light yellow green to medium green, terminal spine shorter than 25 mm..... *A. calciphila*
- Inflorescence ratio of fertile section to overall length of stalk less than 0.85, leaf shape otherwise, yellow green to dark green, gray green, or glaucous, terminal spine longer than 25 mm..... 2.
2. Rosettes open, few leaved (15–30), leaves thin, broadly lanceolate, 80–100 cm long, flowers 35–40 mm long..... *A. angustiarum*
- Rosettes dense, leaves more numerous (40–90), obovate, elliptic, lanceolate, oblong-ovate, less than 80 cm long, flowers longer than 40 mm..... 3.
3. Rosettes consisting of 40–50 leaves, flowers 40–45 mm long..... *A. huehueteca*
- Rosettes consisting of 60–90 leaves, flowers 50 mm long..... *A. ghiesbreghtii*

**TABLE 1.** Comparison of *Agave calciphila* and similar species.

	<i>A. calciphila</i>	<i>A. angustiarum</i>	<i>A. ghiesbreghtii</i>	<i>A. huehueteca</i>
Rosette size (height by width)	55–80 cm × 60–120 cm	80–100 cm × 150–180 cm	40–70 cm × 60–80 cm	40 cm × 80 cm
Leaf number	25–50	15–30	60–90	40–50
Leaf shape	Broadly linear-lanceolate to ovate-lanceolate	Broadly lanceolate	Obovate, elliptic, to lanceolate	Oblong-ovate or obovate
Leaf color	Light yellow green to medium green	Green or glaucous	Yellow green, dark green, to pale grayish green	Gray green or glaucous
Terminal spine	10–25 mm	25–35 mm	25–35 mm	25–40 mm
Inflorescence length	1.3–2.6 m	2.5–3 m	3.5–4.5(–6.0) m	3.0–5.0 m
Fertile section percentage	85–100%	25–33%	30–50%	50%
Flower length	34–42 mm	35–40 mm	50 mm	40–45 mm
Flower tube length	1 mm	4–5 mm	2–4(–10) mm	5 mm

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