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Authors: Reyes, Ernesto Alvarado, and Flores-Olvera, Hilda

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ERNESTO ALVARADO REYES<sup>1</sup> & HILDA FLORES-OLVERA<sup>2\*</sup>

## *Suaeda pulvinata* (*Chenopodiaceae*), a new species from saline lakes of central Mexico

### Abstract

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*Suaeda pulvinata*, a new perennial species of *S.* sect. *Brezia*, is described and illustrated. The new species grows in saline lakes of the central highlands of Mexico in halophytic grasslands of *Distichlis spicata*. It is compared with the similar *S. jacoensis*, which is known from strongly saline and gypsiferous flats in the Chihuahuan Desert region.

Additional key words: *Suaeda* sect. *Brezia*, *S. jacoensis*, taxonomy, aquatic herbs, endemic

### Introduction

*Suaeda* Forsskål ex J. F. Gmelin (*Caryophyllales: Chenopodiaceae*) is a genus of halophytes that dwell on coasts, in saline or alkaline lakes and in wetlands. There are approximately 110 species distributed worldwide (Schütze & al. 2003). The treatments of *Suaeda* in North America were done by Standley (1916), Hopkins & Blackwell (1977) and Ferren & Schenk (2003). In the region that comprises Canada, the United States and Mexico there are 18 species of *Suaeda* (Hopkins & Blackwell 1977; Watson & Ferren 1991; Ferren & Schenk 2003; Noguez-Hernández & al. 2013). In this paper a new species of *Suaeda* from the central highlands of Mexico is described. Following the morphological classification of *Suaeda* by sections (Schenk & Ferren 2001), and the most recent subgeneric classification based on morphological and molecular data (Schütze & al. 2003), the new species described here belongs to *S.* sect. *Brezia* (Moq.) Volk.

The new species was discovered by Ramos-Espinoza (1979), who misidentified it as *Suaeda nigra* (Raf.) J. F. Macbr., which belongs to *S.* sect. *Salsina* Moq. in the classification of Schütze & al. (2003). The specimens misidentified by Ramos-Espinoza (*G. Ramos & al.* 27,

30, 31, 38, 48 & 60, MEXU) have more characters associated with *S.* sect. *Brezia*, such as fresh leaves uniformly green in cross-section and stigma borne on the attenuated apex of the ovary. Sandoval-Jiménez (1984) also cited *S. nigra* in the floristic list of the region of the Sierra Madre that borders Oriental Basin, the place where Lake Totolcingo is found. Alcocer & al. (1997) stated that there are *Suaeda* species living along Lake Totolcingo, but they did not determine them to species level. The flora of Lake Texcoco (c. 150 km W of Lake Totolcingo) was covered by Calderón de Rzedowski (2005), but the species of *Suaeda* growing there were misunderstood (Noguez-Hernández & al. 2013).

### Results and Discussion

*Suaeda pulvinata* Alvarado Reyes & Flores Oliv., **sp. nov.** – Fig. 1.

Holotype: Mexico, Puebla, Lake Totolcingo, E of El Carmen Tequexquitla, 19°17'N, 97°35'W, 2350 m, in halophytic grassland of *Distichlis spicata* in the saline lake, 24 May 2009, *E. Alvarado Reyes 16* (MEXU; isotypes: B, BM, MO).

<sup>1</sup> Laboratorio de Plantas Vasculares, Facultad de Ciencias, Universidad Nacional Autónoma de México, C.P. 04510 México, D.F., Mexico.

<sup>2</sup> Departamento de Botánica, Instituto de Biología, Universidad Nacional Autónoma de México, Apartado Postal 70-233, C.P. 04510 México, D.F., Mexico; \*e-mail: mahilda@ib.unam.mx (author for correspondence).

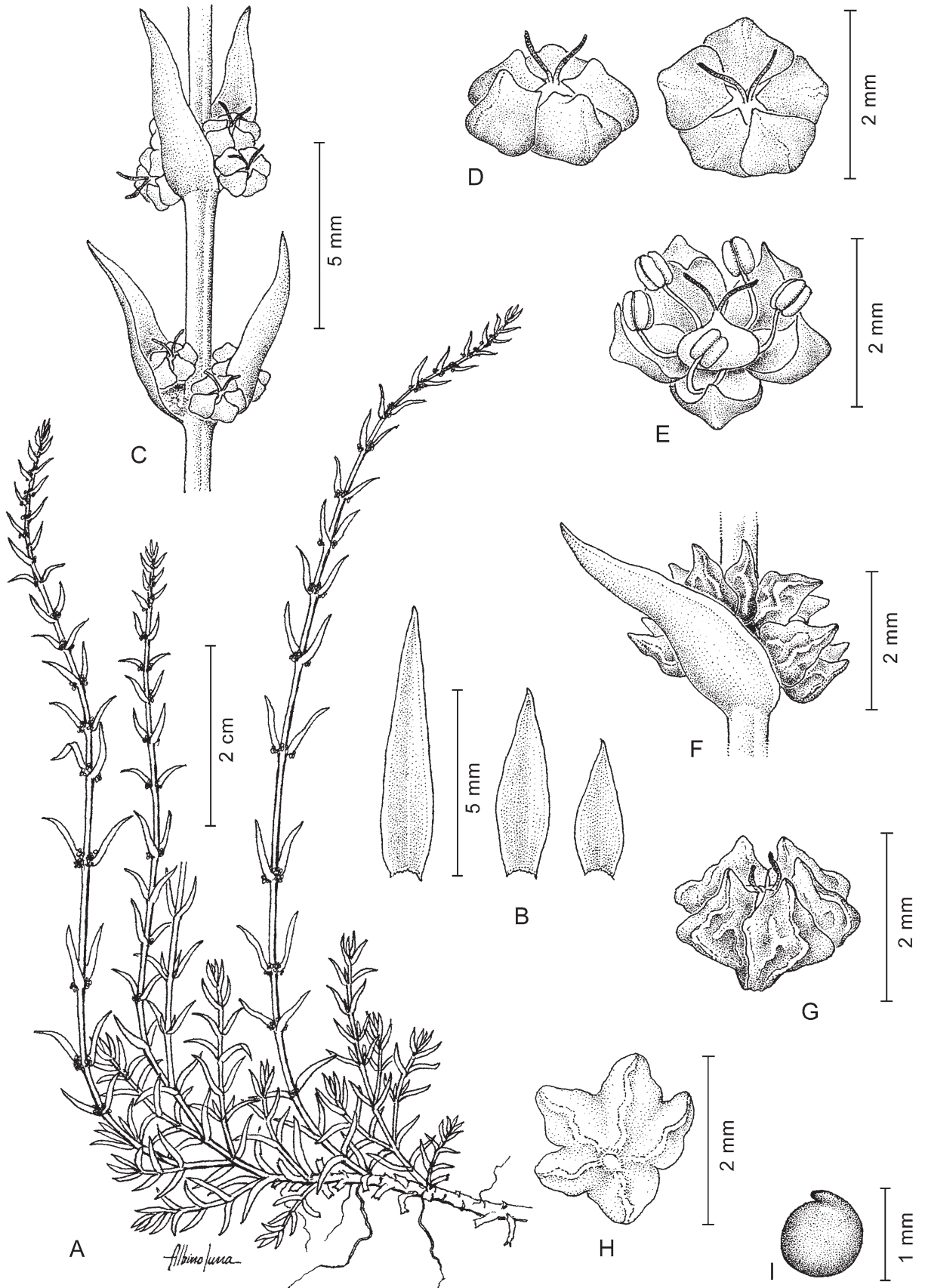


Fig. 1. *Suaeda pulvinata* – A: habit; B: bracts; C: detail of arrangement of glomerules along spike-like inflorescence; D: flowers at beginning of anthesis; E: mature flower; F: older glomerules; G: flower at fruiting stage; H: perianth abaxial view at fruiting stage; I: seed. – A–E from the holotype and isotypes; F–I from *G. Ramos & al.* 27 (MEXU).

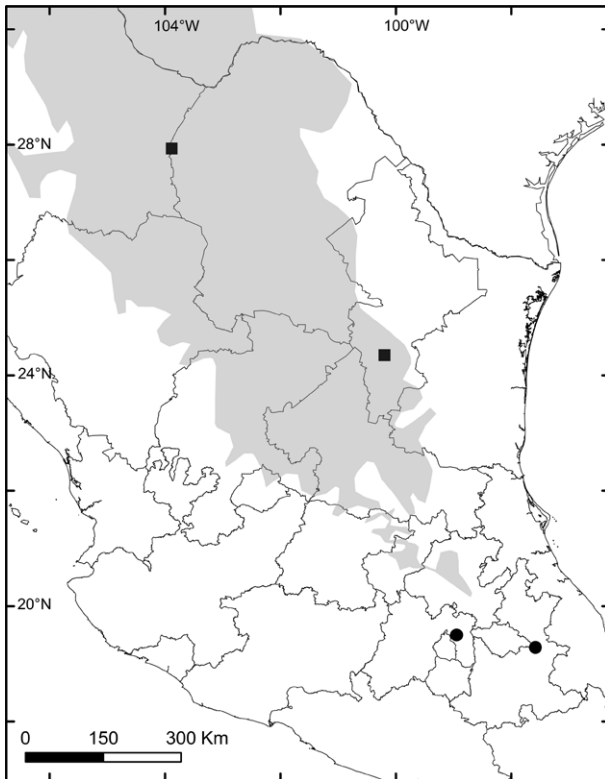


Fig. 2. Distribution of *Suaeda jacoensis* (squares) and *S. pulvinata* (circles). The shaded area indicates the Chihuahuan Desert region.

**Diagnosis** — *Suaeda pulvinata* differs from *S. jacoensis* I. M. Johnst. as follows: plants pulvinate with creeping prostrate stems rooting at nodes as a mode of propagation; flowering stems held erect above sterile ones; leaves mostly opposite throughout plant, but alternate toward the apex of inflorescence; basal leaves significantly smaller than inflorescence leaves; glomerules clustered in simple spike-like inflorescences or sometimes branching at proximal nodes of main spike; perianth wider; seeds wider.

**Description** — *Herbs* perennial, green, scarlet or yellowish, creeping, pulvinate, 6–20 cm tall. *Stems* prostrate, rooting at nodes, except those of inflorescence held erect above sterile stems; *branches* decumbent, spreading or prostrate. *Leaves* opposite throughout plant, or alternate toward apex of inflorescence, ascending or spreading; *leaf blade* linear to narrowly ovate, revolute, 0.3–10(–12) × 0.4–1.2 mm, those at base significantly smaller than those in inflorescence, succulent, adaxially channelled, margin thin, apex apiculate. *Inflorescence* of glomerules of 2–4(or 5) flowers clustered into simple spikes 1–9(–13) cm long, sometimes branching at proximal nodes of main spike; *bracts* subtending glomerules linear to ovate-acuminate, 0.5–4.3 × 0.7–1.7 mm, margin thin; *bracteoles* ovate, 0.5–1 mm, hyaline, margin entire or lacinate, apex acute to acuminate. *Flowers* all bisexual; *perianth* actinomorphic from earlier stages to anthe-

sis, then in fruit zygomorphic, 1.85–2.6 mm in diam.; *perianth segments* winged proximally in some flowers, rounded and keeled or winged abaxially along midvein and/or hooded distally; *stamens* 4 or 5; *stigmas* 2(or 3). *Seeds* lenticular, 1.1–1.5 mm in diam.; seed coat black or blackish red, shiny.

**Distribution and ecology** — This species inhabits Lake Texcoco, which is found in the border of Distrito Federal and the state of Mexico; and Lake Totolcingo, which is found in the border of the states of Puebla and Tlaxcala (Fig. 2). It grows in saline grasslands of *Distichlis spicata* (L.) Greene frequently flooded by saline water. Both lakes are found within endorheic basins above 2000 m in altitude. The two populations of the newly described species are geographically isolated from each other. Most of the original surface of Lake Texcoco is now part of Mexico City. The parts of the lake that remain intact are separated from each other and surround the east side of the city. The place where *Suaeda pulvinata* has been collected is found between Benito Juárez International Airport and the town of Texcoco. Lake Totolcingo occupies a large continuous extent. *Suaeda pulvinata* is found in almost all its edges. Both Lake Totolcingo and the remnants of Lake Texcoco are mostly dry during astronomical winter and spring, retaining water in their deepest parts only. During this time of the year, *S. pulvinata* has all its leaves and branches (except its partially buried prostrate stem) in direct contact with the atmosphere, and the leaves look reddish. In astronomical summer and autumn, the lakes increase their amount of water, grow in size and cover the areas where *S. pulvinata* lives (Fig. 3). When the lakes rise to their maximum level, the plants live with their leaves and stems partially or fully submerged in water. The leaves look green during these seasons. On the beaches of the lakes, where the water never floods the land but is close to it, *S. pulvinata* is absent. Sandstorms are common in spring in the lakes where *S. pulvinata* occurs, and the species is quite resistant to being covered by sand. It can overcome being interred by growing branches above the substrate that buries it.

**Etymology** — The specific epithet means cushion-like. This name is suitable, as no other species of *Suaeda* that lives nearby shares this appearance. The Latin adjective “*pulvinata*” comes from the Latin noun “*pulvinus*”, which literally means cushion.

**Taxonomic remarks** — The morphological differences between *Suaeda pulvinata* and the other similar North American species of *S.* sect. *Brezia* are given in Table 1. *Suaeda pulvinata* has opposite leaves found throughout the plant, but alternate toward the apex of the inflorescence. *Suaeda jacoensis* and *S. mexicana* (Standl.) Standl. also have opposite leaves, but in *S. jacoensis* they are opposite to alternate throughout the plant and in *S. mexicana* they are opposite only at the base (Ferren &

Table 1. Comparison of relevant morphological characters of *Suaeda pulvinata* and similar species of *Suaeda* sect. *Brezia*.

Species	<i>Suaeda pulvinata</i>	<i>Suaeda jacoensis</i>	<i>Suaeda mexicana</i>	<i>Suaeda edulis</i>
Plant height [cm]	6–20	10–30	30–150	15–110
Leaves position	opposite throughout plant, or alternate toward apex of inflorescence	opposite to alternate throughout plant	alternate, sometimes opposite at base	alternate
Habit	perennial, pulvinate	annual to subshrub	perennial	annual
Stems	prostrate, rooting at nodes	erect to decumbent	decumbent	erect to ascending
Leaves length [mm]	0.3–10(–12)	6–20	12–45	10–54
Main inflorescence type	mostly spike-like	mostly racemes, subspicate	paniculately branched	glomerules in axis of bracts
Inflorescence length [cm]	1–9(–13)	7–12	6–30	1–3
Flowers per glomerule	2–4(or 5)	4 or 5	1–5	1–3(–5)
Bract length [mm]	0.5–4.3	3–5	1.5–10	2–12
Flower symmetry	actinomorphic	actinomorphic	zygomorphic	zygomorphic
Flower diameter at anthesis [mm]	1–2	1–1.4	1–3	0.5–0.7
Perianth diameter in fruit [mm]	1.85–2.6	1.35–1.9	1.8–4	0.8–3
Number of stamens	4 or 5	0–5	5	2 or 3
Seed diameter [mm]	1.1–1.5	0.75–1.1	0.7–1.1	0.9–1.6

Schenk 2003). *Suaeda pulvinata* seems to be the only perennial herb of the section with branches arising from the nodes of stoloniferous prostrate stems as a mode of propagation. All the stems are prostrate except the flowering ones arranged in simple spike-like inflorescences or sometimes branching at the proximal nodes of the main spike. *Suaeda mexicana* is also perennial (Noguez-Hernández & al. 2013), but with erect to ascending stems able to reach significantly higher, up to 150 cm; the axillary glomerules are arranged in large paniculately branched inflorescences (see Table 1). The plants of *S. jacoensis* have erect or decumbent stems arising from a small caudex crowning a coarse persistent root (Johnston 1943); the glomerules are arranged in terminal spikes or mostly in scattered side branches in the lower part of the inflorescence. Taking into account all morphological characters, *S. pulvinata* is most similar to *S. jacoensis* than to the other species of *S.* sect. *Brezia*. Furthermore, *S. jacoensis* is taller than the new species, and its flower and seed diameters are smaller (see Table 1). According to our observations, *S. pulvinata* forms large aggregations in its type locality, very likely due to vegetative reproduction of its prostrate stems, whereas *S. jacoensis* tends to be a scattered, scarce plant (Fig. 3). Ecologically, *S. pulvinata* is semiaquatic in saline lakes, living underwater during half the year (Fig. 3), whereas *S. jacoensis* lives on the flats at the SE end of the Lake Jaco, Coahuila, where the soil is wet, strongly saline and gypsiferous (Johnston 1943). *Suaeda jacoensis* was considered as apparently endemic to the type locality (Hopkins & Blackwell 1977), but it has also been collected in saline gypsum flats in Galeana, Nuevo León (*G. B. Hinton & al.* 27879, MO; *Flores-Olvera & al.* 1688, MEXU, TEX).

We hypothesize that the substrate could be an evolutionary selective pressure that determines what species grow, and that the isolation of these species is therefore correlated with the equally isolated substrates. The known populations of *S. jacoensis* are found in the Chihuahuan Desert region, whereas *S. pulvinata* is found in the lakes of the mountains of Central Mexico (Fig. 2).

*Additional specimens seen (paratypes)* — MEXICO: PUEBLA: San Salvador El Seco County, Lake Totolcingo, 2 km before reaching El Carmen along Zacatepec-El Carmen highway, limit between Puebla and Tlaxcala, 2640 m, wet grassland, marshy sandy soil, 14 Jun 1981, *J. I. Calzada 7434* (MEXU, XAL); 2 km away from Oriental, 2350 m, in halophytic grasslands, Jul 1976, *F. G. Medrano & al.* 9298 (MEXU); along highway 136 before Zacatepec, km 201, 7800' [2380 m], desert flood plain (dry), 24 Jul 1965, *S. M. Mertz 139* (MEXU); Lake Totolcingo, 2350 m, halophytic grasslands, 3 Oct 2012, *H. Flores-Olvera & R. Noguez-Hernández 1668* (B, CHAPA, ENCB, MEXU). TLAXCALA: 3 km W of El Carmen, 2350 m, halophytic grasslands of *Distichlis spicata* in endorheic basin, Jul 1976, *G. Ramos & al.* 27, 30, 31, 38, 48 & 60 (MEXU). DISTRITO FEDERAL: flats of Lake Texcoco, 5.5 km W of Texcoco close to Bosque de Aragón at officially closed road, 2200 m, 28 Sep 1982, *M. Iltis & al.* 28608 (CHAPA). MÉXICO: Texcoco county, road to Lake Texcoco, salty alkaline soils, 9 Aug 1986, *L. Guerrero 50* (CHAPA); km 7 of Peñon- Texcoco road on former Lake Texcoco, 2240 m, salty soil with scarce vegetation but abundant *Distichlis spicata*, 26 Aug 1972, *E. Hernandez X. s.n.* (CHAPA); 2 km from junction with highway 142 along Peñon- Texcoco highway, 2240 m,



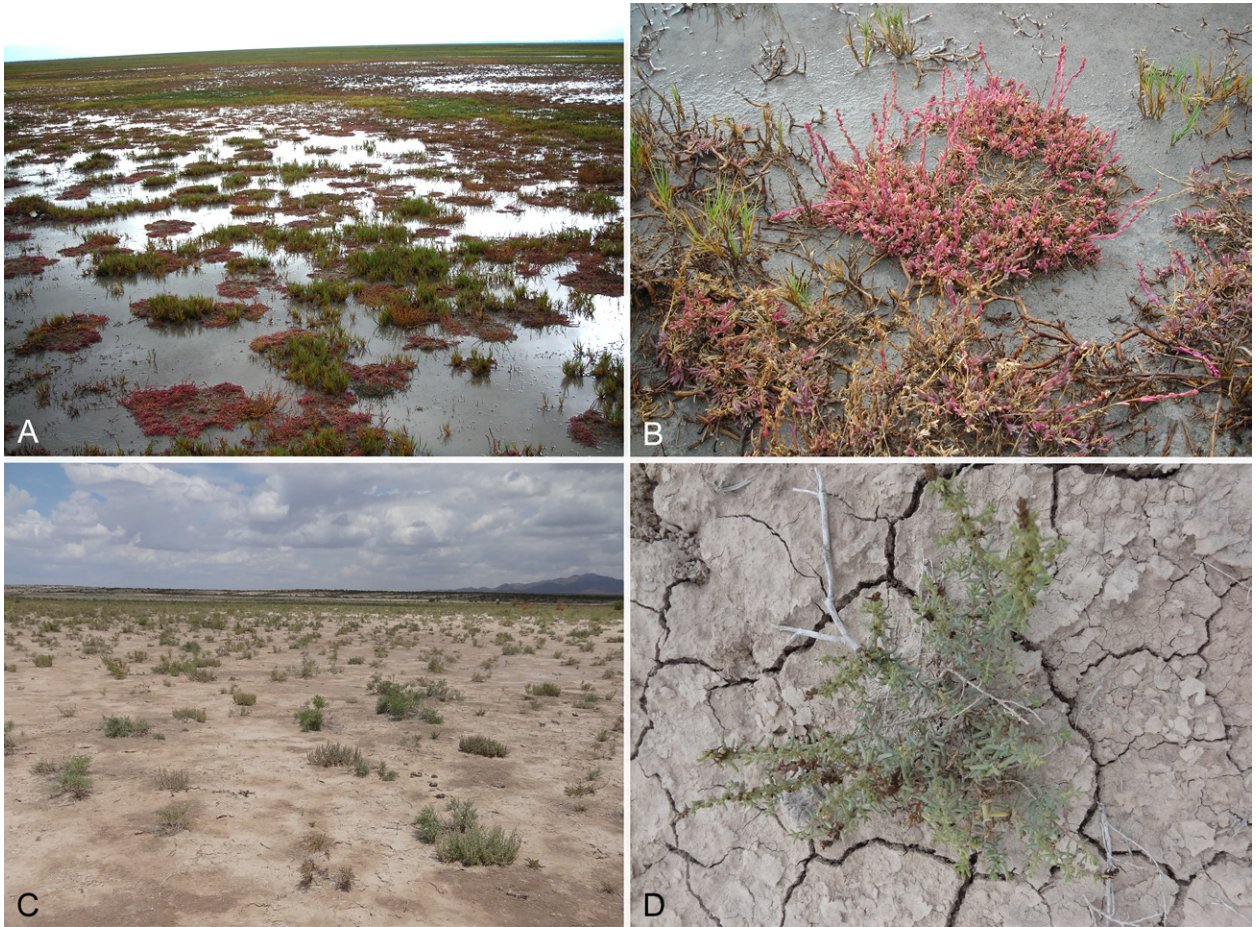


Fig. 3. *Suaeda pulvinata* compared to *S. jacoensis* – A: habitat of *S. pulvinata*; B: habit of *S. pulvinata*; C: habitat of *S. jacoensis*; D: habit of *S. jacoensis*. – A, B: type locality, 24 May 2009, photographs by Ernesto Alvarado Reyes; C, D: Mexico, Coahuila, Lake Jaco (type locality), 28 Aug 2012, photographs by Helga Ochoterena.

salty wet soil with *Suaeda edulis* Flores Oliv. & Noguez, 3 Oct 2013, H. Flores-Olvera & R. Noguez-Hernández 1689 (B, CHAPA, MEXU).

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