

The catapyrenioid lichen genera (*Ascomycota*, *Verrucariales*) in North America

2. *Clavascidium*

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Accepted 24. November 2025 © Austrian Mycological Society, published online 16. December 2025

BREUSS, O., 2025: The catapyrenioid lichen genera (*Ascomycota*, *Verrucariales*) in North America. 2. *Clavascidium*. – Austrian J. Mycol. 33: 175–203.

Key words: lichenized *Ascomycota*, *Verrucariaceae*, taxonomy, mycobiota of Canada, United States, Mexico.

Abstract: *Clavascidium* is segregated from the otherwise very similar genus *Placidium* on account of having rhizines. Three species are known from North America, including one of the most frequent species of catapyrenioids (*C. lacinulatum*), of which four subspecific entities are discussed. The taxa are described and notes on their ecology and distribution are provided. *Dermatocarpon hepaticum* var. *pruinatum* is lectotypified.

Zusammenfassung: *Clavascidium* wird aufgrund des Besitzes von Rhizinen vom sonst sehr ähnlichen genus *Placidium* abgetrennt. Drei Arten sind aus Nordamerika bekannt, darunter eine der häufigsten Arten catapyrenioider Flechten überhaupt (*Cl. lacinulatum*), von der die Aufteilung in vier subspezifische Einheiten diskutiert wird. Die Arten werden detailliert beschrieben, Anmerkungen zu ihrer Ökologie und Verbreitung werden angefügt. *Dermatocarpon hepaticum* var. *pruinatum* wird lectotypifiziert.

Anatomically and morphologically, *Clavascidium* is very similar to *Placidium*, from which it was segregated by BREUSS (1996) on account of clavate asci with biseriate spores. More recent molecular studies (GUEIDAN & al. 2009, PRIETO & al. 2012) questioned the separation of these genera based on the ascospore order. In GUEIDAN & al. (2009) *Clavascidium* was united with *Placidium*. Contrary, PRIETO & al. (2012) found it to form a monophyletic clade with the presence of rhizines as key character. Consequently, former members of *Placidium* with rhizines were combined to *Clavascidium*, leaving *Placidium* for non-rhizinate species.

With the exclusion of “*Clavascidium*” *antillarum* (BREUSS) BREUSS (with uncertain affinity) and *C. liratum* BREUSS (synonymized with *Anthracotheceum virescens* by PRIETO & al. 2010), *Clavascidium* as currently understood comprises seven species, three of which occur in North America.

Material and methods

See the respective chapter in part 1 BREUSS (2025) in Austrian J. Mycol. 32: 118.



Fig. 1. *Clavascidium lacinulatum* var. *lacinulatum*, habitus. Width of photo 11 mm.

***Clavascidium* BREUSS**

Ann. Naturhist. Mus. Wien 98B Suppl. (1996): 41

Type species: *Clavascidium umbrinum* (BREUSS) BREUSS

Thallus: of irregularly arranged, dispersed to slightly overlapping squamules. Individual squamules up to 9 mm wide, adpressed to the substratum or with down rolled or ascending margins, often undulate, rounded or broadly lobed, attached by a rhizohyphal web with additional rhizines. Upper side cream or pale brown to dark brown, dull, epruinose or rarely faintly pruinose. Lower surface pale or brown, rarely black.

Anatomy: Thallus 200–550 μm thick. Upper cortex paraplectenchymatous, 30–70 μm thick, composed of angular cells 6–15 μm in diam., sharply delimited from the algal layer. Amorphous epinecral layer present or absent. Photobiont layer horizontally continuous, algal cells 5–12 μm in diam. Medullary tissue composed of intricately interwoven hyphae with few to numerous globular cells 6–13 μm in diam. Lower cortex weakly differentiated, composed of more densely packed globular to roundish-angular cells or lacking. Rhizohyphae colorless or brown. Rhizines composed of longitudinally arranged adglutinated hyphae, pale or dark.

Perithecia: immersed in the squamules, broadly pyriform to subglobose. Excupulum hyaline to yellowish brown or brown-black. Involucrellum lacking.

Periphyses: simple or slightly furcate.

Asci: (sub)cylindrical when young, soon clavate.

A s c o s p o r e s : in an uni- to biseriate order, simple, narrowly to broadly ellipsoidal.

C o n i d i o m a t a : of *Dermatocarpon*-type, laminally immersed.

C o n i d i a : oblong-ellipsoidal or (sub)cylindrical.

Short characterization:

- Squamules comparatively large, attached by a rhizohyphal weft and rhizines
- Cortex a *lachneum*-type eucortex
- Asci cylindrical to clavate, spores uni- to biseriate
- Conidiomata of *Dermatocarpon* type

Key to *Clavascidium*

- 1 Exciple and rhizines dark brown to black 2
- 1* Exciple and rhizines pale..... 3
- 2 Conidia oblong-ellipsoidal, 3–4.5 × 1.5 µm. Squamules with a conspicuous basal layer of brown hyphae *C. umbrinum*
- 2* Conidia (sub)cylindrical, 4–6 × 1–1.5 µm. Brown basal layer lacking *C. lacinulatum* var. *atrans*
- 3 On rock. Rhizines thin and inconspicuous (attached in minute fissures). Medulla filamentous. Lower cortex distinctly delimited. Conidia bacilliform, 4–5.5 µm long *C. pseudorufescens*
- 3* On soil. Rhizines usually conspicuous. Medulla of mixed type. Lower cortex indistinct. Conidia oblong-ellipsoidal to shortly subcylindrical, 3–5 µm long *C. lacinulatum*
- a Underside of squamules ± reddish. Ascospores 12–15 × 7.5–9 µm var. *erythrostratum*
- a* Underside of squamules not reddish b
- b Ascospores 12–16(–17) × 6–8(–9) µm var. *lacinulatum*
- b* Ascospores 15–19 × 7.5–10(–11) µm var. *latisporum*

The species

Clavascidium lacinulatum (ACH.) M. PRIETO, Amer. J. Bot. 99(1): 28 (2012).

Syn. *Placidium lacinulatum* (ACH.) BREUSS, Ann. Naturhist. Mus. Wien 98B Suppl.: 39 (1996).

Endocarpon hepaticum β *lacinulatum* ACH., Lich. Univ. (1810): 299. Type: Helvetia (H-ACH no. 853 sub *Endocarpon hepaticum* var. “*laciniatum*”, left piece – lectotype, selected by BREUSS 1990: 92).

Placidium rufescens var. *trapeziiforme* A. MASSAL., Schedul. crit. 6 (1856): 114. Type: MASSALONGO, Lich. Exs. Ital. 189 (W – lectotype, selected by BREUSS 1990: 92).

Dermatocarpon hepaticum var. *pruinoseum* B. DE LESD., Ann. Crypt. Exot. 5 (1932): 101. Type: New Mexico, Santa Fé, 1927 A. BROUARD (UPS – lectotype, selected here).

T h a l l u s : of irregularly arranged squamae forming loose or dense colonies up to several centimeters across, individual squamae 3–9 mm wide, roundish to deeply lobed



Fig. 2. *Clavascidium lacinulatum* var. *lacinulatum*, habitus. Width of photo 10 mm.

(Figs. 1, 2), scattered to adjacent or somewhat overlapping, closely adhering to the substratum and flat or with down rolled or upturned edges, sometimes with strongly raised and wavy margins, often forming cushion-like aggregates. Upper side pale to dark brown, dull, smooth or rough, epruinose or faintly pruinose, sometimes furrowed with deep fissures. Lower surface colorless to brown. Rhizines few to many per squama, originating from most of the underside or centrally crowded, pale or brownish (black in var. *atrans*), simple or branched, thin, short and inconspicuous to easily seen with main strands up to 0.3 mm thick and more than 10 mm long (Figs. 3, 4).

A n a t o m y : Thallus ca 300–550 μm thick. Upper cortex 40–80 μm thick. Amorphous epinecral layer usually thin or lacking, sometimes thick and cracked. Photobiont layer c. 60–180 μm high, algal cells 5–15 μm in diameter. Medulla of mixed type, with many globular cells 8–14 μm in diam., rarely largely filamentous. Lower cortex usually not clearly delimited from the medulla, of more densely aggregated globular cells. Rhizohyphae colorless (3–)4–5 μm in diameter.

P e r i t h e c i a : up to 600 μm broad and causing round swellings on the underside of the squamae. Excipulum colorless to brownish (blackening in var. *atrans*).

P e r i p h y s e s : 25–35 μm long and c. 3 μm thick.

A s c i : cylindrical, 65–85 \times 12–17 μm when young, becoming more or less clavate during maturity and then 65–75 \times 17–25 μm .

A s c o s p o r e s : in uniseriate to biseriate order, 12–16(–17) \times 6–8(–9) μm in the type variety (see key).

P y c n i d i a : laminally immersed, up to 650 μm wide. Conidia oblong to subcylindrical, 3–5 \times 1.3–2 μm or 4–6 \times 1–1.5 μm depending on variety).

Icon.: BREUSS 1990: 172, BRODO & al. 2001: 569 (sub *Placidium* l.), KNUDSEN & al. 2013: 29, MCCUNE 2017: 205 (var. *atrans*), MCCUNE & ROSENTERER 2007: 75 (sub *Placidium* l.), MCMULLIN 2023: 176 f, MÖBERG & al. 2017: 62, ROSENTERER & al. 2007: 73 (sub *Placidium* l.).

Characterization: *Clavascidium lacinulatum* is recognized by the presence of rhizines, medium sized to rather large squamae and laminal pycnidia. The rhizines are very variable in size, number, and ramification and may originate from the entire underside or may be centrally crowded. Specimens with few and indistinct rhizines may be confused with *Placidium squamulosum* that may look very similar and has the same anatomy but lacks rhizines. To detect inconspicuous rhizines, clean the soil off the lower side with a needle or pincer while the squama is submerged in water in a small dish under the dissecting microscope. Some specimens have a weak rhizohyphal web and are fixed mainly by rhizines. Especially on fine-grained soils extremely crispy looking specimens can be found with squamae mainly anchored by a central group of conspicuous rhizines and free ascending wavy margins.

Variability: *Clavascidium lacinulatum* shows considerable variation concerning size, shape and lobation of the squamae, development of rhizines, pigmentation of exciples and conidial characters. Thallus morphology and development of rhizines may be largely induced by environmental conditions, especially by substrate conditions. Other characters are more likely to be genotypically fixed. In most specimens the exciples are colorless, but they may darken with age; in var. *atrans* they are dark from an early stage on. The shape of the conidia varies from oblong-ellipsoidal to (sub)cylindrical with the longest ones in var. *atrans*. The ascospores also vary in size and shape (ellipsoidal to broadly ellipsoidal), more or less convincingly correlated with other features as shown in the key. The medullary tissue, usually of mixed type, may be filamentous in thick squamae. The diffuse reddish coloring of the lower side of the squamae in var. *erythrostratum* (Fig. 5) might be induced by substrate conditions as it is most conspicuous in freshly collected material and seems to fade during herbarium storage. In some specimens also the rhizines are slightly reddish. Samples lacking the reddish tinge may be identified by their rather short and broad ascospores.

The infraspecific grouping of *Clavascidium lacinulatum* needs further study including molecular data. There are intermediate specimens which cannot be assigned to one of the varieties suggested. Only well-developed material with mature perithecia and with pycnidia can be determined to subspecific level with certainty; and it is only these collections which are cited below under the variety name. Most records belong to var. *lacinulatum*.

Ecology and distribution: *Clavascidium lacinulatum* colonizes soil in open, dry areas from low to rather high elevations and is frequent in biological soil crusts. The species shows a clear preference for fine-grained sandy soils where it often forms loose heaped aggregates of squamae. It prefers calciferous soils but occurs also on granite-derived soil and decomposed granite. Many collections are from shallow soil pockets on ledges or over crumbling rock surfaces.



Fig. 3 (left). *Clavascidium lacinulatum* var. *lacinulatum* with conspicuous rhizines. Width of photo 6 mm. – Fig. 4 (right). *Clavascidium lacinulatum* var. *lacinulatum*, weakly rhizinate. Width of photo 2.5 mm.

Var. *lacinulatum* is widely distributed in the Holarctic with concentration in southern temperate latitudes. From the Southern Hemisphere it is only known from scattered records in South America and Australia (BREUSS 1993, 2001 sub *Catapyrenium*). In North America it is distributed over most states of the USA, temperate Mexico and the southern parts of Canada becoming rarer northwards (with a few outlying localities in the Northwest Territories and Nunavut) and most common in the arid southwestern states (Map 1). There are many reports from California (e. g., BREUSS & BRATT 2000, KNUDSEN & al. 2013).

Varietas *atrans* and var. *erythrostratum* are known only from North America¹; the records are from within the distribution range of the type variety but lacking in its northernmost parts (Map 2). Varietas *latisporum* was known from the Canary Islands, Spain, and Jordan (BREUSS 1990); in America it is restricted to the Baja California peninsula.

Annot.: Specimens formerly determined as *Placodium squamulosum* var. *argentinum* mostly belong to *Clavascidium lacinulatum* var. *lacinulatum* (with poorly developed rhizines).

¹ The record of var. *atrans* from a single locality in Switzerland (NIMIS & al. 2018) is doubtful.

The varieties

Clavascidium lacinulatum var. *lacinulatum*

Short characterization: Rhizines and excipulum colorless to brownish. Ascospores 12–16(–17) × 6–8(–9) µm. Conidia oblong-ellipsoidal to shortly subcylindrical, 3–5 × 1.3–2 µm.

Specimens examined:

CANADA: BRITISH COLUMBIA: China Flats, Lower Alkali Creek, sheltered shrubby and teed gully, 51°43' N, 122°21' W, 13.6.1994 T. GOWARD & ANNA ROBERTS 94-114 (UBC); China Flats, near confluence of Fraser River and Alkali Creek, open sage grassland, 51°43' N, 122°21' W, 350 m, 13.6.1994 T. GOWARD & ANNA ROBERTS 94-50 (UBC). – Dog Creek area: 3 km N of bridge across Fraser River, on east bank, S-facing disturbed grassland, 51°32' N, 122°16' W, 850 m, 4.7.1994 T. GOWARD & C. CLEMENT 94-414, 94-407 (UBC); 2 km S of Dog Creek off main road, gravelly SW-facing slope, 51°34' N, 122°15' W, 850 m, 4.7.1994 T. GOWARD & C. CLEMENT 94-394, 94-395, 94-396 (UBC); S of Meason Creek, open sandy area with *Artemisia tridentata*, 51°04' N, 122°21' W, 400 m, 30.6.1994 T. GOWARD & C. CLEMENT 94-316, 94-317 (UBC). **NORTHWEST TERRITORIES:** Mackenzie District, Inuvik, 68°20' N, 133°45' W, 13.6.1964 J. W. THOMSON & J. A. LARSEN (CANL). – Great Slave Lake, vicinity of Fort Reliance, 62°45' N, 106°35' W, 12.7.1962 J. W. THOMSON & J. A. LARSEN (WIS). **NUNAVUT:** Victoria Island, NW of Cambridge Bay, 130–140 m, on soil over calcareous rocks, 28.7.2018 R. TÜRK (hb. Türk). **SASKATCHEWAN:** South Saskatchewan, 7.1879 J. MACOUN, Flora of the Great Plains 3075 (CANL). – Assiniboia Co., on calcareous soil in dry open prairie vegetation, 3.7.1961 J. LOOMAN T801 (CANL with *Placidium squamulosum*, DUKE, WIS); Rock Glen, 2900 ft, eroded calcareous loam in south slope, 4.7.1963 J. LOOMAN 633603 (WIS). – Spy Hill, banks of Qu'appelle River, soil in eroded grassland, 1650 ft, 28.9.1962 J. LOOMAN 622101 (CANL, WIS). – Grayson Rural Municipality, 50°38' N, 102°50' W, Qu'appelle River Valley, near junction of hwy 247 and 47, short grass prairie, 17.8.1982 M. J. SHCHEPANER & A. DUGAL (CANL, WIS). – Midale Co., on calcareous soil, dry open prairie, 1.7.1961 J. LOOMAN T701 (DUKE, WIS).

U.S.A.: ARIZONA: S.E. Arizona, without precise locality, 1881 C. G. PRINGLE (US): – **Cochise Co.:** Chihuahua desert, 10 mi W of Bisbee, 18.3.1972 T. H. NASH 5405 (SFSU). – **Coconino Co.:** Diamond Cañon (close to Grand Cañon of the Colorado), 30.5.1885 W. G. FARLOW (BM, NY, UPS, W); 2 mi N of entrance to Kaibab National Forest along US Alt. 89, S of Fredonia, in flat area with few pinyon pine and juniper, 5700 ft, 27.6.1967 C. M. WETMORE 17136 (MIN). – Grand Canyon National Park: head of Bright Angel Trail, A. E. HASSE (MIN); along Hermit's Rest Trail into the canyon (South Rim), rocky ledges with pine, yucca and sage brush, 5000–6000 ft, 28.6.1966 C. M. WETMORE 14983 (MIN); South Rim, on Rowe Well Road near edge of park in open area with ponderosa pine, sage brush and cactus, 7000 ft, 29.6.1966 C. M. WETMORE 15034 (MIN); Furnace Flats along the Colorado River, 24.6.1974 T. H. NASH 9356 (ASU); mile 172 below Lee's Ferry, 27.6.1974 T. H. NASH 9384 (ASU); North Kaibab Trail, c. 200 m downtrail from footbridge, off north side of trail, 36°12'30" N, 112°02'30" W, c. 1920 m, 5.8.1991 M. BOYKIN 2473 (ASU); Colorado River Trail, NNW-facing arroyo c. 50 m W of silver bridge over river, 36°05'40" N, 112°06'00" W, c. 750 m, 9.11.1991 M. BOYKIN 2684 (ASU); along the North Kaibab Trail 6 km N of Phantom Ranch, 36°08'30" N, 112°04' W, c. 975 m, 10.11.1991 T. H. NASH 30694 (ASU); N-facing tributary canyon just S of Colorado River and c. 1 km from Phantom Ranch, 36°06' N, 112°06' W, c. 760 m, 9.11.1991 T. H. NASH 30642 (ASU, LI), *ibid.* 10.11.1991 T. H. NASH 30699, 30701 (ASU, LI); South Kaibab Trail, small arroyo off east side of trail, desert scrub, c. 950 m, 36°05'45" N, 112°05'05" W, 21.5.1992 M. BOYKIN 2851 (ASU); South Kaibab Trail, just off east side of trail at NPS 2700 ft elev. sign., 36°05'00" N, 112°05'30" W, c. 1430 m, 19.5.1992 M. BOYKIN 2815 (ASU); Grandview Trail, c. 1 km past path to group campsite, 36°01'40" N, 111°58'00" W, c. 1490 m, 21.9.1991 M. BOYKIN 2669 (ASU); Echo Cliffs 10 mi SSW of Page along U.S. 89, 5400 ft, 23.4.1973 T. H. NASH 6543 (ASU). – **Gila Co.:** 1.5 mi S of Sierra Ancha Experiment Station, on soil in grassland, 4800 ft, c. 33°44' N, 110°58' W, 15.2.1992 collector unknown (ASU); Gila National Forest, Little Diamond Rim above Beaver Valley, pinyon-juniper woodland, c. 1840 m, 34°20'30" N, 111°18'30" W, 22.5.1992 T. H. NASH 42899 (ASU); 1 km S of Payson on AZ 87, Pinyon-juniper woodland, 5.2.1995 L. SCHWARZ (ASU); Tonto National Forest, 260 Trailhead, along Hwy 260,

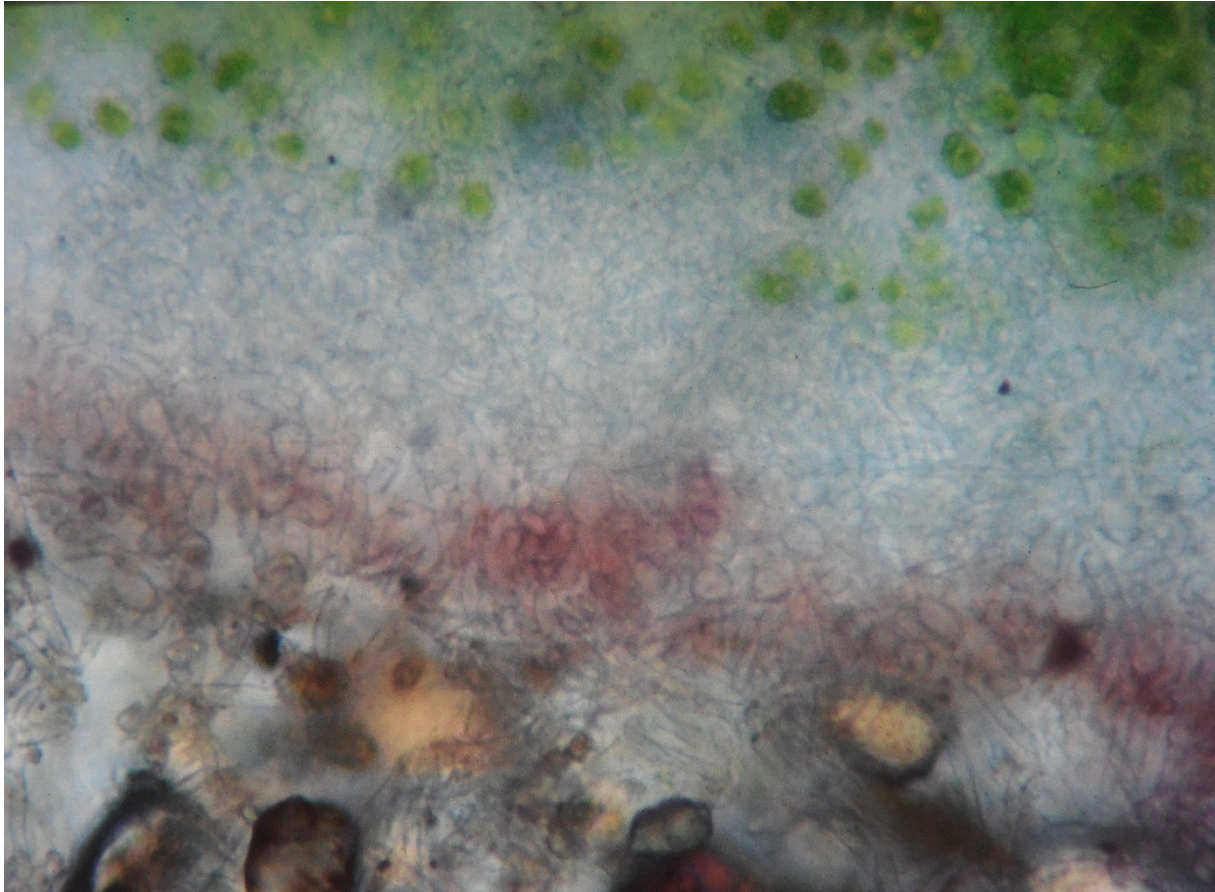
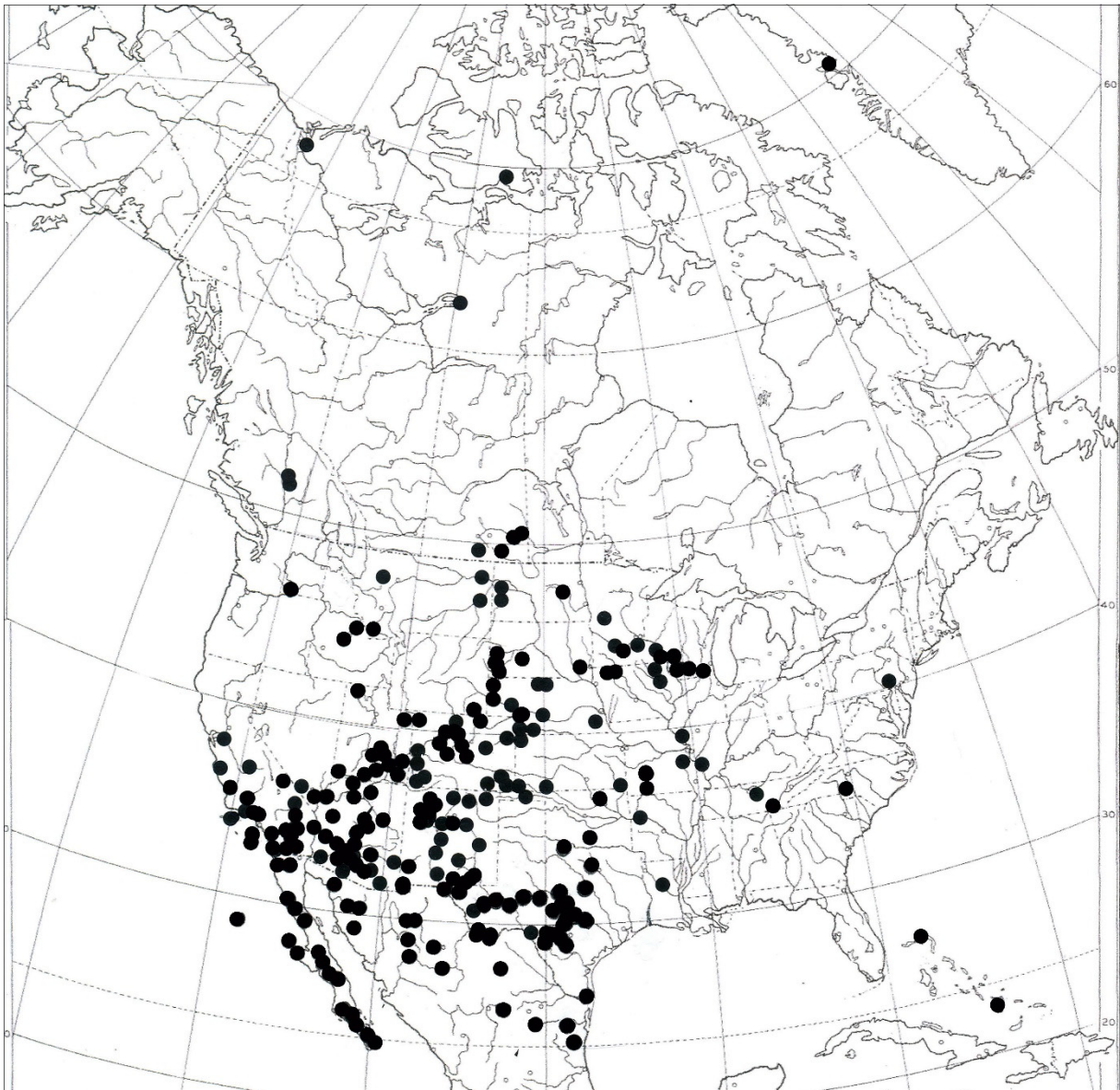


Fig. 5. *Clavascidium lacunculatum* var. *erythrostratum*. Lower side.

34°18' N, 110°57' W, 2000 m, 4.5.1995 B. KANTRUD 303 (ASU); Tonto National Forest, N of Payson, Houston Mesa Rd, Whispering Pines, slope of hill, *Pinus ponderosa*, sandstone and limestone, 11.7.1997 O. BREUSS 13130 (W), 13150, 13170 (LI); Houston Mesa, Pinyon-Juniper area, on soil, 34°16'33'' N, 111°18'16'' W, c. 1630 m, 12.7.1997 T. H. NASH 40248 (ASU). – **Graham Co.:** 33°15' N, 110°15' W, 32 mi E of Globe, south side of Hwy 70, c. 3000 ft (910 m), *Yucca* community, calc. rock, 3.1986 B. D. RYAN 19299 (ASU); Pinaleno Mts., Hwy 366 2 mi above Coronado National Forest boundary, pinyon-juniper, on soil, 32°43' N, 109°44' W, 7.4.1972 E. LEHTO (ASU). – **La Paz Co.:** SW side of Black Peak and c. 10 km SE of Parker, desert area, 114°13' W, 34°07' N, c. 240 m, 1.4.1990 T. H. NASH 27382 (ASU, LI). – **Maricopa Co.:** 3.5 mi S of Aguila, north side of Eagle Eye Butte, 2600 ft, 17.2.1975 T. H. NASH 9972 (ASU); Lake Pleasant Regional Park, W of Ranger Station, south slope, 13.2.1972 E. LEHTO (ASU); SW of Lake Pleasant Regional Park, Morgan City wash, vertical cliff face, 11.3.1972 E. LEHTO (ASU); Belmont Mt., 25 mi SSW of Wickenburg, 1900 ft, 17.2.1975 T. H. NASH 9986 (ASU); east end of the Belmont Mts., bajada and lower slopes, upland Sonoran Desert, 33°37' N, 112°50' W, c. 460 m, 7.3.1998 T. H. NASH 40695 (ASU); Gila Bend, 9.1898 H. E. HASSE 573 (NY); N of Gila Bend near Buckeye on US 80, desert scrub with palo verde and creosote bush, 14.6.1966 C. M. WETMORE 14530 (MIN); 14 mi S of Gila Bend along Ariz. hwy 85 in Saucedo Mts., 14.6.1966 C. M. WETMORE 14537 & 15540 (MIN); just N of Woolsey Peak, W of Gila Bend, 10.1.1975 T. H. NASH 9954 (ASU); along old U.S. 80, 1 mi N of Gillespie Dam, 800 ft, 10.1.1975 T. H. Nash 9807 (ASU); Crater Range, along AZ 85, 42 km S of Gila Bend, Sonoran Desert, 32°32'55'' N, 112°52'40'' W, c. 425 m, 27.2.1998 T. H. NASH 40614 (ASU); north end of Maricopa Mts. where they intersect U.S. 80, 3 mi N of Woods Rd, 1000 ft, 10.1.1975 T. H. NASH 9901 (ASU, MICH), *ibid.*, 33°10'28'' N, 112°38'50'' W, c. 270 m, 27.2.1998 T. H. NASH 40549 p. pte. (ASU); Sierra Estrella Regional Park, Sonoran Desert, 1500 ft, 9.2.1974 E. SUNDELL 14, 18 (ASU). - Phoenix: Camelback Mt., Paradise Valley, N-facing slope, 1800 ft, 22.12.1972 T. H. NASH 6113 (ASU); southern bajadas of the Phoenix Mts., on the Biltmore property, 1800 ft, 9.8.1973 T. H. NASH 8046 (COLO with *Placidium pilosellum*, ASU, CANL, MICH, MIN, UPS). - South Mtn. Park: 1500 ft, 9.3.1972 T. H. NASH 4335, *ibid.* 18.4.1973 J. W. THOMSON & T. H. NASH (WIS), *ibid.* 29.1.1974 T. H. NASH 8526 (ASU); Guadalupe Rd. near South Mtn, 1500 ft,

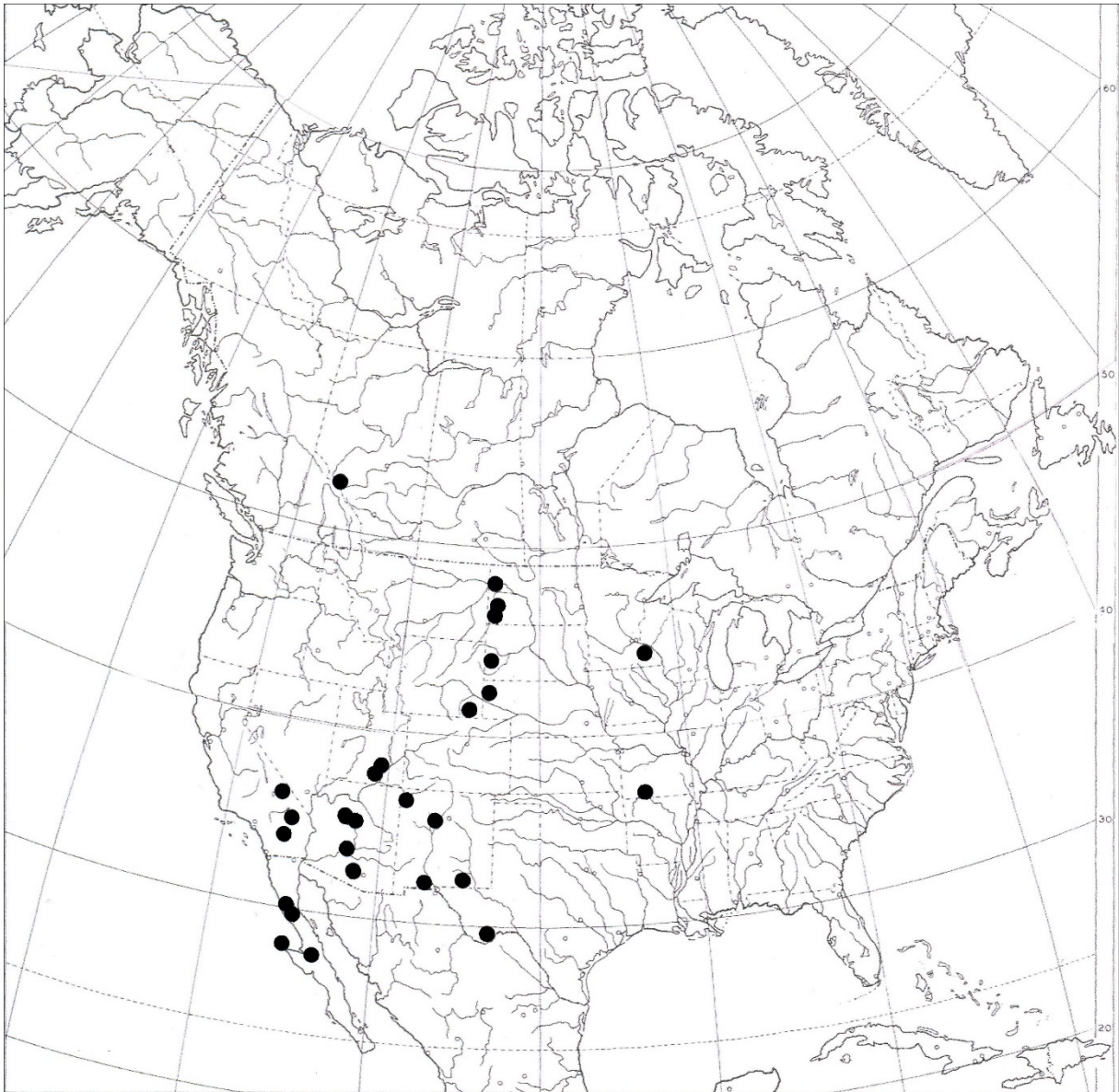
29.1.1974 M. A. LANE 135 (ASU); eastern entrance, N-facing slope, 1200 ft, 17.11.1979 A. OLAFSEN 107 (ASU); Guadalupe Canyon, 450 m, Upper Sonoran Desert community, 9.2.1987 T. H. NASH & J. POELT (GZU); Pima Canyon, 450 m, granitic rocks, 33°22' N, 111°58' W, 27.12.1988 C. BRATT 6860, 6868 & C. M. WETMORE 63280 (SBBG, MIN, MUB), *ibid.* R. S. EGAN 13563 (MIN). - Tempe: 33°25'45'' N, 111°56' W, Tempe Butte ("A" Mountain), N of Arizona State University, 360–450 m, 8.1.1984 B. RYAN 10667 (ASU); Tempe, Wüste, 10.2.1987 J. POELT (GZU). - Usery Mtn., 20 mi E of Phoenix, 22.11.1971 T. H. NASH 5022 (ASU). - McDowell Mts. Regional Park (Ft. McDowell Quadrangle), Upper Sonoran Desertscrub, on soil in open bajada area, c. 1600 ft, 9.2.1974 M. A. LANE 149 (ASU), *ibid.* 28.3.1974 M. A. LANE 354 (ASU); south side of McDowell Mts., 24.2.1974 T. H. NASH 9324 (ASU); Nash property on Overlook Court, Fountain Hills 2 km W of the McDowell Mts., c. 500 m, desert vegetation, 23.2.1987 T. H. NASH & J. POELT (GZU); Fountain Hills, lot 10 on Overlook Court E of the McDowell Mts., 33°39' N, 111°44'30'' W, 610 m, 2.1987 T. H. NASH 25867 (ASU); Pinnacle Peak Pass, 1700 ft, 4 mi from Verde River near Scottsdale, 3.1.1953 W. A. WEBER & J. B. MCCLEARY (COLO); c. 10 mi E of Shea Blvd and Scottsdale Rd, near lookout along a small wash, 3000 ft, 17.3.1973 J. SAUCK (ASU); Coon Bluff, Granite Reef Dam along the river Salt, 33°32'50'' N, 111°38'57'' W, c. 480 m, flat ground along the walkway between cliff and the river Salt, 30.1.1999 F. BUNGARTZ 1422 (ASU). - Tonto National Forest: Bush Highway Research National Area (U.S. Forest Service) near Saguaro Lake, 33°36' N, 111°32' W, 590 m, 15.12.1979 S. O. LINK & T. H. NASH 16895 (ASU, B with *Placidium squamulosum*); 33°27'30'' N, 111°29' W, Lost Dutchman State Park, 10 km NE of Apache Junction, 2050 ft, 1984 B. D. RYAN 10678 (ASU); along Apache Trail (Rte 88), Roosevelt Dam, 3.9.1972 T. H. NASH 5029 (ASU, LD); Apache Trail, 3 mi W of Canyon Lake, 2400 ft, 11.3.1973 T. H. NASH 6593 (ASU); W of Roosevelt Lake, between Apache Lake and Roosevelt Lake, near Burnt Corral, 33°37' N, 111°11' W, desert scrub, 15.12.1992 S. & ST. SHARNOFF 997.13 (CANL); 1 mi S of Sunflower along Hwy 87, 33°52' N, 111°28' W, 1006 m, 20.2.1995 B. KANTRUD 227 (ASU); **Mohave Co.:** Detrital Valley SE of Hoover Dam on US 93, 1900 ft, 26.6.1966 C. M. WETMORE 14895 (MICH, MIN, US); 27 mi E of Kingman near town of Hackberry along US 66, on E-facing slope, 3500 ft, 27.6.1966 C. M. WETMORE 14901 (MIN); canyon above Willow Beach, N-facing slope, 800 ft, 19.2.1973 T. H. NASH 6287 (ASU). – **Navajo Co.:** 10 mi E of Winslow along US 66, in open prairie, 5000 ft, 1.7.1966 C. M. WETMORE 15057 (MIN). – **Pima Co.:** Tucson, 14.10.1933 R. A. DARROW 525 (COLO), 525A,B (ASU); Tucson, Tumamoc Hill, near berm, 2300 ft, 24.4.1982 D. B. JACKSON 115 (ARIZ); ASDM Nature Trail 150 ft from main path, 2775 ft, 20.4.1983 D. B. JACKSON 174 (ARIZ); Tucson Mts., 29.4.1884 C. G. PRINGLE (COLO); Picture Rock, 2600 ft, 15.11.1936 R. A. DARROW 1534 (ASU); near Tucson, 29.11.1936 R. A. DARROW 1343, 1525 (ASU); off Manville Rd., Harvey property, 2500 ft, 25.12.1982 B. D. JACKSON 139 (ARIZ, ASU); W.Tucson Mts., 29.11.1936 R. A. DARROW 1535 (ASU); west side of Tucson Mts., NW facing slope, 3000 ft, 29.12.1972 T. H. NASH 6185 (ASU). - Santa Catalina Mts.: steep slope above Soldiers Canyon, 3250 ft, 1962 W. A. NIERING & R. H. WHITTAKER (ARIZ); open slope, near base of Hitchcock Hwy, 3850 ft, 6.7.1962 W. A. NIERING & R. H. WHITTAKER (ARIZ); on soil along highway, 3100 ft, 27.10.1962 W. A. NIERING & R. H. WHITTAKER (ARIZ); Santa Catalina Hwy, 2550 ft, 8.11.1962 W. A. NIERING & R. H. WHITTAKER (ARIZ); N end of Campbell Avenue, foothill region, Tucson, 26.6.1966 E. A. DUEWER 245 (ARIZ). - Saguaro National Monument, Rincon Mts. Section: *Arctostaphylos pungens-Juniperus* scrub near Douglas Springs, 1460 m, 30.3.1979 B. MCCUNE 10227 (OSC); 1.5 mi NE of Grass Shack along trail from Madrona Ranger Station, in oak, pinyon pine and manzanita on ridgetop, 6500 ft, 24.6.1986 C. M. WETMORE 55136 (MIN); E of picnic area 1.5 mi SE of headquarters, on rocky hillside with mesquite, cactus and saguaro, 3200 ft, 28.6.1986 C. M. WETMORE 55236 (MIN); 1 mi SW of Happy Valley Saddle on west slope, near rocky point along trail to Madrona Ranger Station, 5600 ft, 26.6.1986 C. M. WETMORE 55201 (MIN); at E-end of Speedway Road at north boundary of park on level area along washes with mesquite cactus, creosote bush and saguaro, 2800 ft, 28.6.1986 C. M. WETMORE 55216 (MIN). - Saguaro National Monument, Tucson Mtn. Section: NW of Tucson, 13.6.1966 C. M. WETMORE 14517 (MIN); 0.5 mi NW of visitor center near old trail, desert scrub and cactus on outwash plain, 2500 ft, 29.6.1986 C. M. WETMORE 55304 (CANL, MIN); 2 mi NW of visitor center across from Sus Picnic Area, on level outwash with cactus and scrub, 2380 ft, 29.6.1986 C. M. WETMORE 55293 (MIN); 2 mi S of Panther 3000 ft, 30.6.1986 C. M. WETMORE 55329 (MIN); 1.25 mi S of Avra, in level desert scrub with cactus, creosote and mesquite, 2260 ft, 2.7.1986 C. M. WETMORE 55403 (MIN); King Canyon, along stream Peak, 0.5 mi SE of Cam Both Picnic Area, along gulleys in cactus scrub, 2580 ft, 29.6.1986 C. M. WETMORE 55316 (MIN); Apache Peak, on rocky E-slopes and peak with mesquite, cactus and scrub, near picnic area and on ridges



Map 1. North American distribution of *Clavascidium lacinulatum* var. *lacinulatum*.

and N-facing rocks in mesquite and cactus, 3200 ft, 2.7.1986 C. M. WETMORE 55385 (MIN); 0.5 mi E of visitor center on NW slope of Red Hills, rocky slope with cactus scrub, 2700 ft, 3.7.1986 C. M. WETMORE 55438 (MIN, US); N of Signal Hill Picnic Area, 2420 ft, 3.7.1986 C. M. WETMORE 55457 (MIN); 0.5 mi NW of Sus Picnic Area, in desert with cactus and scrub, 2320 ft, 5.7.1986 C. M. WETMORE 55523 (ASU, MIN); soil bank along Loop Trail, 32°15' N, 111°12' W, 22.3.1994 B. KANTRUD 98 (ASU). - BML land just N of Organ Pipe NM, BLM road heading SE from AZ 85 near end of road, at Reservation boundary, 32°13' N, 112°45' W, 22.12.1992 S. & ST. SHARNOFF (CANL, LI). - Organ Pipe National Monument: 6 mi NW of visitor's center, 1800 ft, 24.11.1972 T. H. NASH 6030 (ASU); 4 mi E of visitor's center along Ajo Mountain Drive, 1800 ft, 24.11.1972 T. H. NASH 6035 with *Placidium squamulosum* and *P. pilosellum* (ASU), *ibid.* 17.3.1973 R. KELLER (SFSU); near Quitobaquito, 5.4.1979 B. MCCUNE 10278 (OSC, LI); south end of Puerto Blanco Drive, 1st hill on left (i.e. to the south), 31°54' N, 112°50' W, Sonoran desert, 19.12.1992 S. & ST. SHARNOFF (CANL); at Golden Bell Mine, Puerto Blanco Drive, 32°31' N, 112°56' W, 20.12.1992 S. & ST. SHARNOFF (CANL); Diablo Mts., Ajo Mtn. Rd., 32°01' N, 112°44' W, 20.12.1992 S. & ST. SHARNOFF (CANL); near Senita Basin turnoff, Puerto Blanco Drive just W of turnoff, 31°54' N, 112°54' W, 20.12.1992 S. & ST. SHARNOFF (CANL, LI); near Quitobaquito Hills, Puerto Blanco Drive just S of change to 2-way road, 32°01' N, 112°56' W, Sonoran desert, 21.12.1992 S. & ST. SHARNOFF (CANL). - **Pinal Co.:** Santa Catalina Mts., *Fouquieria splendens*, *Agave palmeri* desert grassland, open upper slope, hill above road before descent

into Peppersauce Canyon, 4950 ft, 20.11.1962 W. A. NIERING & R. H. WHITTAKER (ARIZ); Santa Catalina Mts., Oracle Road, 6000 ft, limestone, 15.1.1963 W. A. NIERING & R. H. WHITTAKER (ARIZ); at Picacho Pass NW of Tucson along Interstate 10, with Saguaro cactus, palo verde and creosote bush, 14.6.1966 C. M. WETMORE 14527 (BM, LD, MIN); 2 mi SW of Chiu Chiuschu Silver Reef Mts., on volcanic rock, 1600 ft, 6.4.1973 T. H. NASH 6459 (ASU, MICH); Eleven Mile Corner Rd., Tierra Grande, near San Carlos Irrigation Canal, South Canal, desert floor, c. 2000 ft, 13.1.1988 H. D. HAMMOND 10296 (LI, NY); Tonto National Forest, Lost Dutchman Trail, 33°27'30" N, 111°28'50" W, 536 m, 7.2.1997 J. BIRINGER 34 (ASU). – **Yavapai Co.:** 34°38' N, 111°48' W, along dirt road 0.3 mi E of McGuireville, 2 mi NE of Montezuma Castle National Monument., 1130 m, 3.1.1986 B. D. RYAN 15220 (ASU); 9.3 mi SW of Congress on AZ 71, 2.3 mi SW of US 93 jct., 34°08' N, 112°58' W, saguaro-ocotillo-palo verde, 15.11.1992 S. & ST. SHARNOFF (CANL); Coconino National Forest, 0.5 km N of McGuireville, desert vegetation, 34°38'30" N, 111°49' W, 1070 m, 26.2.1994 B. KANTRUD 36 (ASU); Verde Valley 0.5 km N of McGuireville, 34°38'30" N, 111°49' W, 1070 m, limestone area, *Canotia* and other desert vegetation, 9.2.2000 T. H. NASH & O. BREUSS 16393, 16395, 16407 (LI); 34°33' N, 111°49' W, Old Military Reserve N of State Hwy 260 between Camp Verde and Clear Creek Campground, c. 1000 m, on calc. sandy soil of NW-exposed cliff ledges, 21.2.1999 F. BUNGARTZ 1449 (ASU). – **Yuma Co.:** near Mohawk E of Yuma on US 80 in open desert with creosote, 15.6.1966 C. M. WETMORE 14549 (MIN); Palm Canyon, 1000 ft, 13.1.1973 T. H. NASH 6472 (ASU). **ARKANSAS: Franklin Co.:** Ozark National Forest, summit of White Rock Mtn., c. 2700 ft, sandstone bluffs with oak-dominated forest, 24.4.1988 R. C. HARRIS 21446 (NY, LI). **CALIFORNIA: Imperial Co.:** Torote Bowl Trail, Anza Borego Desert, 6.3.1982 C. BRATT 2272 & T. SMITH (SBBG). – **Inyo Co.:** Death Valley National Monument: entrance to Grotto Canyon, 1 mi S of SR 190, 400 ft, Stovepipe Wells Quadrangle, west wall of canyon, desert holly, dolomite, 11.1.1975 T. E. WEIER 827 (COLO); entrance to Mosaic Canyon, 1000 ft, Stovepipe Wells Quadrangle, 13.1.1978 T. E. WEIER 1596 (COLO); Trail Canyon, Panamint Range, 36°19' N, 116°58' W, 150 m, on soil in crevices of calcareous rocks, 3.1994 B. MCCUNE 21527 (OSC). – **Kern Co.:** E of Mariposa on Calif. hwy 166 in desert with sagebrush in level open land, 500 ft, 23.6.1966 C. M. WETMORE 14803, 14804 (MIN). – **Los Angeles Co.:** Santa Monica Range, 1897 & 1905, H. E. HASSE (B, M), *ibid.* 11.1915 H. E. HASSE, Lich. exs. ex herbario Dr. H. E. HASSE relictus no. 185 sub *Dermatocarpon rufescens* & no. 236 sub *Dermatocarpon hepaticum* (MIN); Claremont, on earth, 24.11.1903 C. F. BAKER 3943 (NY, S). – San Clemente Island: plateau between Thirst and Chukit Canyon (REWS site), c. 1650 ft, 1.10.1996 C. C. BRATT 9822, 9824, 9825 (SBBG); Upper Chukit Canyon, 2.10.1996 C. C. BRATT 9850, 9859, 9860 (SBBG); Upper Cave Canyon, 2.10.1996 C. C. BRATT 9851 (SBBG). – Santa Catalina Island: ridge W of the airport S of road on ridge from 1.6 to 1.9 miles from gate at airport, c. 1600 ft, 21.8.2000 O. BREUSS 16812 (LI); just S of the airport, c. 1600 ft, 21.8.2000 O. BREUSS 16840 (LI); above Fisherman's Cove and USC marine station, 60 m, 27.12.1993 C. M. WETMORE 73238 (MIN); 0.8 km NW of Catalina airfield at jct of road to Avalon and a secondary road to the coast, 440 m, 28.12.1993 C. M. WETMORE 73243 (MIN). – **Madera Co.:** Sierra National Forest, road to Bass Lake SE of Rte 41 near Wishon, 1850 ft, 18.9.1985 C. C. BRATT (SBBG). – **Monterey Co.:** Monterey, 1881 E. PALMER (FH, US). – **Riverside Co.:** Joshua Tree National Monument, 3.1958 F. P. SIPE (COLO). – San Bernardino National Forest, San Jacinto Mts., above Palm Desert, agave and cactus, 2500 ft, 17.6.1966 C. M. WETMORE 14579 & 14598 (MIN); Palm Canyon 2.2 mi S of jct with Calif. 111, on E-facing slope with brush and cactus, 400 ft, 21.6.1967 C. M. WETMORE 16880, 16884 (MIN); Box Canyon between Mecca Hills and Orocopia Mts., 300 ft., 17.1.1978 M. A. HEWLETT 792a (SFSU); 33°35' N, 115°55' W, south side of Hwy 195, Mecca Hills, 9 mi E of Mecca, 800 ft, Mesquite community, 7.1.1986 B. D. RYAN 14891 (ASU); Santa Rosa Plateau Reserve (Nature Conservancy), S end of Santa Ana Mts. W of Murrieta, c. 600 m, 1.11.1986 W. A. WEBER, C. BRATT & J. LARSON 82071 (COLO); S of Twentynine Palms rd to I10 between I10 and Black Eagle Mine Rd., on gravelly desert soil, 3200 ft, Upper Colorado Desert, 33°47' N, 115°48' W, 22.1.1995 S. & ST. SHARNOFF (CANL); hillside with desert scrub above tennis complex at Ritz-Carlton Hotel, Palm Desert, 19.4.1995 C. BRATT 8821 (SBBG); San Jacinto Mts., off Morris Ranch Road, 33°33.242' N, 116°36.353' W, 1647 m, on granite-derived soil, 27.5.2004 K. KNUDSEN 1188 (LI, UCR). – **San Bernardino Co.:** vicinity of San Bernardino, 1000–1500 ft, 22.5.1895 S. B. PARISH 3524 (NY); northern slope of San Bernardino Mt., 4000–6000 ft, 15.6.1895 S. B. PARISH 3912 (NY); Mojave Desert, on soil 3 mi N of Razor, 30.10.1932 E. JAEGER (CAS); 2 mi SW of Parker Dam on the Colorado River, 600 ft, 16.2.1974 T. H. NASH 6455 (ASU); c. 5 mi S of Kelso, stony desert floor, vicinity stabilized sand hills, in desert scrub, on sandy substrate, 3000 ft, 10.11.1975 C. D. MACNEILL & W. BROPHY (UC); Halloran Springs, S of I15,



Map 2. Distribution of *Clavascidium lacinulatum* var. *erythrostrum*.

3000 ft, 13.2.1982 T. E. WEIER 2167 (ASU, UC); 35° N, 116° W, East Mohave Scenic Area, off of Kelso-Baker Road, c. 1200 m, 1.1986 B. D. RYAN 15378a (ASU, LI); 35°25' N, 116°05' W, Hwy 127, c. 10 mi N of Baker, 300 m (1000 ft), 1.1986 B. D. RYAN 17172 (ASU); 34°27' N, 115°25' W, Kelso-Amboy Road, 7.5 mi S of Hwy I-40, Ship Mts., 300 m (1000 ft), 1.1986 B. D. RYAN 17165, 17167 (ASU); 34°15' N, 115°43' W, east side of Amboy Road, Sheep Hole Mts., 27 mi NE of Twentynine Palms, 2200 ft, *Larrea* community, 7.1.1986 B. D. RYAN 14920 (ASU); 33°35' N, 115°55' W, south side of Hwy 195, Mecca Hills, 9 mi E of Mecca, 800 ft, Mesquite community, 7.1.1986 B. D. RYAN 14891 (ASU); Kelbaker Rd just N of Kelso, *Ambrosia-Larrea* scrub, 2600 ft, 31.3.1988 M. BOURELL 3516 (CAS, MICH); 35°25' N, 116°05' W, Hwy 127, c. 10 mi N of Baker, 300 m, B. D. RYAN 17170 (ASU); Mojave Desert, Key's Ranch (Indian Cove: 34°03'09'' N, 116°09'62'' W), 1283 m (4211 ft), *Yucca*, cacti, desert shrubs, scattered pinyon pines, 31.3.2005 K. KNUDSEN 2618 (LI, UCR). – **San Diego Co.:** San Diego, on earth on the Mesa [no precise locality], 30.3.1896 C. E. CUMMINGS, *Lichenes boreali-americani* 252 = *Decades of North American Lichens* 320 sub *Endocarpon hepaticum* (DUKE, US); Soledad, near La Jolla, 3.1917 M. C. FERGUSON (NY); along back road between Calif. 94 and Chula Vista near Otay Reservoir, 2.8 mi E of reservoir on N-facing roadside bank, 800 ft, 23.6.1967 C. M. WETMORE 17003 (MIN). – Anza Borrego Desert: trail to Elephant Tree (*Bursera microtila*), 3.1980 C. BRATT 1263 (SBBG); Torote Bowl Trail, 6.3.1982 C. BRATT 2272 & T. SMITH (SBBG); Split Mountain Rd, c. 8 mi SE of Ocotillo Wells, 19.3.1983 K. RINDLAUB 141 (SBBG). – **San Luis Obispo Co.:**

Los Padres National Forest, Big Rocks: narrow wooded canyon with conglomerate boulders, cliffs, and sloping rock slabs, scattered oaks and chaparral, mostly Chamise (*Adenostoma*), 28.10.1995 S. TUCKER 34161 & C. BRATT (SBBG); off Rte 166, 26 mi E of 101, 20.11.1996 C. BRATT 10047 & B. OWELARSON (SBBG); USFS Rd 30S02 c. 2 mi N of State Hwy 166, 26 mi E of US Hwy 101, 35°07'40.8'' N, 120°06' 59.3'' W, 5.7.1997 C. C. BRATT, O. BREUSS 12972, 12979, 13009, 13025 & S. TUCKER (LI). – **Santa Barbara Co.:** Santa Cruz Island: ridge top along Islay Canyon Road, soil in grassland, 800 ft, 15.3.1983 C. BRATT 3077B (SBBG, COLO); along ridge to Ragged Mtn., with scattered pines on eroded bedrock, 310–400 m, 7.1.1994 B. D. RYAN (ASU); Ridge Road W of Sauces Gate, 1.7.2000 C. BRATT 11447 (SBBG). – Santa Rosa Island, upper part of Cañada Lobos, N-S canyon with stream and rock ledges and some trees, 50–100 m, 4.1.1994 C. M. WETMORE 73884 (MIN). – **Stanislaus Co.:** Frank Raines County Park, Del Puerto Canyon, 27.3.1976 R. HALLING 1250 (ASU). – **Ventura Co.:** open area in Piñon/chaparral area, c. 4 mi S of Lockwood Valley Road, Mutal Flat Road, 3.6.1986 C. BRATT 5082 (SBBG). **COLORADO: Baca Co.:** canyonside, vicinity of Dodge Ranch, SW of Uteville, 4500 ft, 4.9.1955 S. SHUSHAN (COLO); Campo Research Natural Area, Comanche National Grassland, 3.5 mi S of Campo, 4275 ft, 23.6.1985 B. H. M. MOOERS 849 (OSC). – **Bent Co.:** 4 mi S of Hasty, John Martin Reservoir, 38°04' N, 102°57' W, c. 3800 ft, 17.7.1972 S. SHUSHAN sl-6347 (WIS). – **Boulder Co.:** base of Steamboat Mtn., 3 mi NW of Lyons, 5600 ft, 7.2.1954 W. A. WEBER & S. SHUSHAN (COLO); south base of Steamboat Mtn., 1.5 mi NW of Lyons, 5500 ft, 10.3.1959 W. A. WEBER & S. SHUSHAN (MIN); west base of Steamboat Mtn., 2 mi NW of Lyons, c. 6000 ft, 12.3.1959 S. SHUSHAN & W. A. WEBER (COLO); sandstone outcrops, Lytle Formation, Dakota Ridge, Rabbit Mtn., 4 mi NE of Lyons, just above the Little Thompson River, 5200–5350 ft, 15.8.1960 R. A. ANDERSON (COLO); 1.5 mi NW of Lyons on SW slope of Steamboat Mtn., rock outcrops with cactus and brush, 5600 ft, 5.6.1967 C. M. WETMORE 16179 (DUKE, MIN). – **Eagle Co.:** volcanic scoria deposit along Eagle River 6 mi W of Gypsum, 6100 ft, 4.5.1954 W. A. WEBER (COLO); 1 mi W of Eagle, on N facing slope along US 6 on south side of road, in large gypsum soil area with few stunted douglas-fir and sagebrush, 6600 ft, 8.6.1967 C. M. WETMORE 16385 (COLO, MICH, MIN). – **Fremont Co.:** gypsum hills along Beaver Creek, N of Penrose, 7.5.1960 W. A. WEBER (COLO). – **Grand Co.:** 1 mi N of Kremmling, off hwy 40, *Artemisia tridentata* habitat, clay-loam soil, 2286 m, 31.8.2011 R. ROSENRETER 17393, 17394 (LI, SRP). – **Gunnison Co.:** Virginia Basin, Elk Mts., 12000 ft, 38°59' N, 5.7.1952 H. A. IMSHAUG 10636 (MICH); Elk Mts., ridge of Avery Peak, 12300–12400 ft, 38°59' N, 5.7.1952 H. A. IMSHAUG 10589 (MICH). – **Jefferson Co.:** 7 mi S of Boulder, on Rocky Flats Pediment, 2.7.1973 G. KUNKEL & L. SCHULTZ (COLO). – **Larimer Co.:** sandstone and conglomerate outcrops of the Lytle Formation, Dakota Ridge, 4.5 mi SW of Ft. Collins, just above Horsetooth Reservoir, 5450–5900 ft, 16.7.1960 R. A. ANDERSON (COLO); Sylvan Dale Ranch, just E of mouth of Big Thompson Canyon and the Narrows, 40°25' N, 105°13' W, sandstone, 3.8.1984 B. D. RYAN 12118 (ASU). – **Las Animas Co.:** rimrock and canyon of West Carrizo Creek, S of Uteville, c. 4000 ft, 19.5.1956 S. SHUSHAN (COLO); west bank of Trinchera Creek, 25 mi E of Trinidad, 5500 ft, 4.7.1957 S. SHUSHAN (COLO, S). – **Lincoln Co.,** 39.27169° N, 103.70825° W, Limon, W-edge of town, 5390–5400 ft, shortgrass prairie SW of jct I-70 & US-24, 7.9.2007 C. C. FREEMAN 22486 (KANU, LI). – **Mesa Co.:** Colorado NM, headquarters area, 4 mi S of Fruita, c. 6100 ft, pinon-juniper woodland, 15.5.1954 W. A. WEBER (COLO, DUKE); Colorado NM, Fruita Canyon, 5100 ft, 5.1982 SANCHINI & STEIN 78 (MIN); 39°03' N, 108°35' W, 1.2 mi S of Hwy 340, on "Monument Road" from Grand Junction to Colorado NM, sagebrush, 1350 m, 1985 B. D. RYAN 20822 (ASU, LI). – **Moffat Co.:** Dinosaur NM, Gates of Lodore, vicinity of trailhead, 1900 m, 6.6.1992 L. ST.CLAIR, C. NEWBERRY & K. ST.CLAIR 21671 (WIS). – **Montezuma Co.:** c. 30 mi W of Cortez, vicinity of jct of Yellowjacket and McElmo Creeks, 4800 ft, 10.6.1958 S. SHUSHAN (COLO); Mesa Verde National Park, Wetherill Mesa, sandstone rim above Long House draw, *Pinus-Juniperus* association, c. 7100 ft, 6.7.1959 J. ERDMAN (COLO). – **Montrose Co.:** sandstone cliffs, escarpment above West Paradox Creek, west end of Paradox Valley, below Buckeye Reservoir, c. 5800 ft, 30.5.1960 W. A. WEBER, S. SHUSHAN & R. ANDERSON (COLO). – **Otero Co.:** sandstone outcrops, pinyon-juniper stand, c. 5000 ft, 4 mi SW of Bloom, 6.9.1955 S. SHUSHAN (CANL, COLO, DUKE, MICH, MIN, UPS). – **San Juan Co.:** Mesa Verde National Park, Lower Fewkes Canyon, 37°10' N, 108°28'30'' W, 2040 m, 27.5.1980 T. H. NASH 17777 (ASU). – **Weld Co.:** Pawnee Grasslands, 12 mi N of Nunn, 40°52'15'' N, 104°45' W, 5500 ft (1675 m), 15.7.1976 B. D. MOORE (ASU). – **Yuma Co.:** 6 mi E of Wray, on N-facing, dry outcrops of limestone and chert conglomerate, c. 3600 ft, 22.8.1960 S. SHUSHAN & R. ANDERSON (COLO); low caliche S-facing rimrock of bluffs on N-side of Bonny Reservoir at west entrance, 8.5.1971 W. A. WEBER & F. J. HERMANN (MIN). **IDAHO: Custer Co.:** Lost River Range, above Bear

Creek, tributary of Pass Creek, low calcareous ridge, *Artemisia* grassland, 2130 m, 43°49' N, 113°28' W, 7.1992 B. MCCUNE 19756 (OSC, LI). – **Lehmi Co.:** 44°15' N, 111°00' W, 5 km up Keg Gulch Rd, W of Idaho Hwy 28, c. 5 km N of Lone Pine, c. 2000 m, 7.1987 B. D. RYAN 21816 (ASU). **ILLINOIS:** **Monroe Co.:** Eagle Cliff, E of Fountain, prairie, 19.7.1972 R. A. EVERS 108645 (MIN). – **Pike Co.:** on a limestone ledge, bluffs S of New Canton, 11.10.1972 R. A. EVERS 109821 (MIN). **IOWA:** **Dickinson Co.:** dry open prairie, 12.6.1961 J. LOOMAN T101 (COLO). – **Fayette Co.:** without precise locality, 1894 B. FINK (MIN, NY, US); Fayette, on calcareous earth, 4.11.1895 B. FINK, CUMMINGS et al., Decades of North American Lichens no. 206 sub *Endocarpon hepaticum* (DUKE, LD, NY, S, U). – **Howard Co.:** along Co. Rd. V58, 1 mi N of Co.Rd. A23, c. 3 mi S of Granger, 43°27'30" N, 92°07'45" W, c. 365 m, roadside limestone outcrop and adjacent abandoned quarry, 29.9.1991 W. R. BUCK 20938 (NY). – **Osceola Co.:** Ocheyedon Mound, 1 mi S of Ocheyedon, on bare soil in pasture, 1675 ft, 26.7.1965 C. M. WETMORE 12626 (MIN). **KANSAS:** **Cherokee Co.:** 2 mi E & 1 mi N of Crestline, 4.4.1954 C. L. KRAMER 1201 (NY). – **Cheyenne Co.:** ca 9.5 mi N, 0.5 mi E of St. Francis, 3270–3550 ft, grazed short-grass prairie above Hackberry Creek, 26.6.2007 C. A. MORSE 15562 & J. ELLIOTT (KANU, LI). – **Clark Co.:** c. 15 mi N, 1 mi W Ashland, NE-side of Clark Co. State Lake, 2340–2440 ft, prairie on steep, primarily W-facing slopes above lake, 24.8.2006 C. A. MORSE 14013a (KANU, LI). – **Logan Co.:** 8 mi S of Oakley, 20.7.1950 C. L. KRAMER 428 (NY). – **Morton Co.:** 6.5 mi N, 2 mi W of Elkhart, Cimarron National Grasslands, vicinity of Point of Rocks, 37.1037° N, 101.9400° W, 3430–3540 ft, short-grass prairie above Cimarron River, 27.6.2006 C. A. MORSE 13375 & C. C. FREEMAN (KANU, LI). **LOUISIANA:** **Winn Parish:** Saline Creek Prairie c. 4 km NW of Tullos, 2.4 km W of Castor Creek, near Saline Creek, 13.3.1992 S. TUCKER 31542 (MIN). **MINNESOTA:** **Goodhue Co.:** at N edge of Cannon Falls along hwy 20, on SW-facing hillside with exposed sandstone, 24.6.1973 C. M. WETMORE 21384 (MIN); Frontenac State Park, 0.5 mi S of Lake Pepin and Mississippi River, on exposed hillside prairie, 17.9.1994 J. P. SCHUSTER 3250 (MIN). – **Nicollet Co.:** c. 4 mi SE of Fort Ridgely State Park on Rte 21, NE of road, in dry prairie opening on *Juniperus virginiana* wooded slope, 25.5.1997 G. A. WHEELER 15763 (MIN). – **Otter Tail Co.:** Leaf Hills, on calc. earth, 2.7.1900 B. FINK 389 (MIN). – **Renville Co.:** c. 3.5 mi SE of Franklin on Rte 5, dry prairie opening on *Juniperus virginiana* wooded hillside, 3.7.1997 G. A. WHEELER 16547 (MIN). – **Scott Co.:** 5 mi SW of Shakopee along US 169, in open short grass prairie with limestone outcrops and granite boulders, 17.4.1971 C. M. WETMORE 19782 (MIN). – **Wabasha Co.:** Snake Creek Valley State Forest Area, 4 mi NW of Weaver (8 mi SE of Wabasha), prairie with scattered rock outcrops, 15.7.1979 L. BRAKO 1887 (MIN). – **Winona Co.:** Whitewater Wildlife Management Area, 4 mi N of Elba (20 mi NW of Winona), thick deciduous wood, 24.6.1979 L. BRAKO 1275A (MIN); Whitewater Wildlife Management Area, 2 mi SE of Beaver (20 mi SW of Wabasha), S-facing slope of rock outcrops with prairie, 16.7.1979 L. BRAKO 2023B (MIN). **MISSOURI:** **Dallas Co.:** top of Vesper Rock, by the Niangua River Ozark glade in the Oak-Hickory deciduous forest, 1000 ft, 20.5.1974 G. R. TRUSSELL (NY). – **Franklin Co.:** River 'Round Conservation Area, at entry on Old Cove Road, 38°21'30" N, 90°53'14" W, dolomite glade, 18.5.2003 W. R. BUCK 44303 (NY, W). – **Jefferson Co.:** W-facing Ordovician dolomite glade, E of Mammoth Creek Road, on slopes above Ridenour Hollow, 19.9.1990 R. C. HARRIS 25433 (NY, LI), *ibid.* 19.9.1990 W. R. BUCK 18005 (NY, LI). – **Taney Co.:** exposed dolomite ledge in extensive glade on Dewey Bald, 24.8.1983 M. K. SOLECKI 1103 (COLO). – Mark Twain National Forest, Hercules Glades: 2 mi NW of Hercules Lookout Tower, in open glade with limestone and scattered grass and juniper and oaks, 29.8.1991 C. M. WETMORE 68392, 68417 (MIN); 1 mi N of Persimmon Hollow, on SW facing slope with patchy open calc. rock outcrops and trees, 30.8.1991 C. M. WETMORE 68496 (ASU, MIN); along trail S of Long Creek, on SE facing slope in openings with sandstone rock and grass, 9.1991 C. M. WETMORE 68695 (NY); 0.5 mi NE of Hercules Lookout Tower, on ridge in openings with sandstone and limestone rocks, 2.9.1991 C. M. WETMORE 68822 (LD); 0.5 mi NE of Hercules Lookout Tower on ridge in openings with sandstone and limestone rocks and patches of trees, 2.9.1991 C. M. WETMORE 68822, 68826 (MIN); Coy Bald at western side of wilderness, on hilltop with limestone outcrops and scattered patches of juniper, 3.9.1991 C. M. WETMORE 68908 (MIN); central hill of Upper Pilot Knob, on SW-facing slope in grass openings with juniper and along edge of forest with oaks, 5.9.1991 C. M. WETMORE 68995 (MIN). **MONTANA:** **Beaverhead Co.:** Pioneer Mts., subalpine limestone ridge between Sheep Mtn. and Black Lion Mtn., at head of Cannivan Gulch, broken krummholz *Pinus albicaulis*, 2680 m, 45°39' N, 112°58' W, 7.1993 B. MCCUNE 20652 (with *Catapyrenium cinereum*), 20655 (OSC); Pioneer Mts., narrow limestone valley, Lime Gulch off Birch Creek, 1830 m, 45°23' N, 112°48' W, 7.1993 B. MCCUNE 20796 (OSC). – **Dawson Co.:** 10 mi SW of Glendive in open rolling prairie with yucca, cactus and sage, 31.7.1965 C. M.

WETMORE 12802, 12803 (MIN). – **Roosevelt Co.:** on calc. soil in dry, open prairie, 27.6.1961 J. LOOMAN T171 (DUKE, WIS). – **Teton Co.:** saddle on ridge above Our Lake, 2 km N of Headquarters Creek Pass, 47°49'N, 112°49'W, 2345 m, 14.8.1985 B. MCCUNE 15089 (OSC). **NEBRASKA: Cherry Co.:** in city park in Valentine, on steep S-facing slope with scattered ponderosa, yucca and cactus, 5.8.1965 C. M. WETMORE 13093, 13095 (MIN). – **Dundy Co.:** Rock Creek Park, c. 40°N, 3300 ft, 3.8.1945 W. KIENER 19472 (MIN). – **Garden Co.:** Ash Hollow, 22 mi NW of Ogallala, 1 mi S of North Platte River, on rock outcrops on E-facing hillside with juniper, cactus and yucca, 41°17'52'' N, 102°07'23'' W, 29.6.1997 C. M. WETMORE 77409 (MIN). – **Hitchcock Co.:** Driftwood Creek valley slope, 2650 ft, calcar. rocks, 14.9.1942 W. KIENER 13069 (MIN); 6 mi W of Culbertson on US 6, in N-S erosion valley in unpastured grass, 1.7.1967 C. M. WETMORE 15715 (MIN). – **Keith Co.:** Kingsley Dam N of Ogallala, 3200 ft, soil among grasses, ranchland, ca 41° N, 4.12.1948 W. KIENER 24344 (MIN). – **Keya Paha Co.:** Niobrara Valley Preserve, along north side of Niobrara River, c. 5 mi SSE of Norden, *Pinus ponderosa* woodland on slopes above river, E of Norden bridge, 12.6.1992 D. LADD 16462 (COLO). – **Lancaster Co.:** Lincoln, dry calcareous soil on rocky hills, 1.1896 T. A. WILLIAMS & E. N. WILCOX, Lichenes boreali-americanus no. 133 sub *Endocarpon rufescens* (MIN) & Decades of North Amer. Lichens nos. 133 & 203 sub *Endocarpon rufescens* (DUKE, NY, S, WIS); Lincoln, prairie soil, c. 1200 ft, 30.11.1940 W. KIENER 9702 (NY, US, WIS). – **Lincoln Co.:** Sandhills, High Plains, near Dexter, 3000 ft, 16.7.1936 W. KIENER (US). – **Scotts Bluff Co.:** Scotts Bluff National Monument: on top of bluff around North Overlook with rock outcrops, ponderosa pine and juniper, 4649 ft (1417 m), 41°50'23'' N, 103°41'53'' W, 30.6.1997 C. M. WETMORE 77455 (MIN); on top of bluff around South Overlook with rock outcrops, ponderosa pine and juniper, 4645 ft (1415 m), 41°50'07'' N, 103°42'04'' W, 30.6.1997 C. M. WETMORE 77469 (MIN); along top of SW ridge from parking lot above road, on rock outcrops with scattered pine and juniper, 4600 ft, 41°50'07'' N, 103°42'14'' W, 3.7.1997 C. M. WETMORE 77604 (MIN). - South Bluff on south point of ridge, on ridge with rock outcrops, 4550 ft, 4.7.1997 C. M. WETMORE 77665 (MIN); South Bluff on point of ridges S of Coyote Pass, on ridgetop with hard rocks and scattered ponderosa pine, 4550 ft, 4.7.1997 C. M. WETMORE 77650 (MIN). – **Sioux Co.:** Agate Fossil Beds National Monument: W of headquarters at Sand at S-end of ridge near road, on cliffs at end of ridge, 4480 ft, 42°25'33'' N, 103°44'47'' W, 7.7.1997 C. M. WETMORE 77772 (MIN); 1.5 mi W of head-quarters on N-side of road, on end of ridge with hard cap rock, 4530 ft, 9.7.1997 C. M. WETMORE 77902 (MIN); 1 mi W of Carnegie Hill on S-side of road, on bluff at N-end of ridge with little hard rock cap, 4540 ft, 42°24'60'' N, 103°44'51'' W, 9.7.1997 C. M. WETMORE 77922 (MIN). **NEVADA: Clark Co.:** along US 91 NE of Las Vegas 22 mi at road going to Axial, on rocky ridge with cactus, creosote bush and yucca, 2300 ft, 26.6.1967 C. M. WETMORE 17035A (MIN); Rte 77, c. 2 mi N of Colorado River, very dry rolling hills, Mohave desert, *Larrea* dominant, 27.4.1974 T. REEVES & D. J. PINKAVA P11993 (ASU); 36°12'30'' N, 115°00' W, south side of Nevada Hwy 147, 8 mi E of Interstate Hwy 15 in North Las Vegas, 2500 ft (760 m), *Larrea* community, 5.1.1981 B. D. RYAN 14981 (ASU); 36°20' N, 114°57' W, just E of Interstate Hwy 15 at junction with US Hwy 93, 73 mi S of Alamo, 2600 ft, hill with scattered shrubs and Joshua Trees, 1.1986 B. D. RYAN 14970, 14972 (ASU, LI); 36°01' N, 114°45' W, south side of US Hwy 466 S of Lake Mead, 5 mi NE of Boulder City, c. 610 m, 5.1.1986 B. D. RYAN 15932 (ASU); Lake Mead National Recreation Area, just NE of Echo Bay turnoff along NV 169, E of Las Vegas, 36°14' N, 114°36' W, Mojave Desert, 22.5.1995 S. & ST. SHARNOFF (CANL); Mojave Desert, Lake Mead National Recreation Area, Creosote bush and bursage, West End Wash, 36°05'N, 114°45'W, 23.2.2000 R. ROSENTERER 13806b (SRP, LI). – **Nye Co.:** near Mercury along US 95 near base of hill of lava rock, 2100 ft, 26.6.1966 C. M. WETMORE 14890 (MIN). **NEW MEXICO: Bernalillo Co.:** Arroyo San Antonio, 6800 ft, 2 mi above jct of Hwy 66 and Sandia Loop Drive, Sandia Mts., 26.3.1956 S. SHUSHAN & W. A. WEBER (COLO, DUKE, MIN, UPS); Buckman Hill, 21.3.1979 J. M. WALSH (DUKE). – **Colfax Co.:** vicinity of Ute Park, 2200–2900 m, 20.8.1916 P. C. STANDLEY 13355 (US). – **Dona Ana Co.:** 2 mi E of the Joronada Exptl. Range, on soil in *Larrea*, *Flourensia*, *Scleropogon* area, 3900 ft, 20.2.1973 D. M. JACKSON (ASU); Franklin Mts., 3.4 mi W jct hwy's 213 and 404, 4800 ft, limestone cliff base, 1.4.1978 R. D. WORTHINGTON 2456 (COLO); Bishop's Cap, 4600–5000 ft, limestone, NW-facing slope, 31.12.1980 T. K. TODSEN (CANL). – **Eddy Co.:** near town of Hope 21 mi W of Artesia along US 82, in burned pasture, 9.6.1966 C. M. WETMORE 14318 (MIN); Guadalupe Mts., 0.4 mi E of the Dark Canyon Fire Lookout Tower on N slope near ridge top, 32°05.19' N, 104°44.02' W, 6800 ft, forested canyon with juniper, pine, oak and douglas fir, limestone and sandstone rocks, top of ridge, 14.3.2000 R. D. WORTHINGTON 28888 (LI, UTEP); along US 62-180 at the TX-NM state line, 32°00' N, 104°31.96' W, 3920 ft, limestone substrate, desert-scrub community,

8.8.2004 R. D. WORTHINGTON 32706 (LI, UTEP); Yeso Hills, along US 62-180 2.3–2.4 road miles NE from crossing of NM-TX state line, 32°00.71' N, 104°29.54' W, 3870 ft, gypsum, 8.8.2004 R. D. WORTHINGTON 32709 (MIN). – **Guadalupe Co.:** grassland area S of Las Vegas near the Pecos River along US 84, 13.7.1971 R. S. EGAN 6945 (MIN). – **Grant Co.:** Little Hatchet Mts., Howell's Ridge, 5000–5500 ft, NE limestone slopes, 14.5.1992 R. D. WORTHINGTON 20853 (COLO). – **Hidalgo Co.:** Peloncillo Mts., Whitmire Canyon, ca 31°08' N, 109° W, 5450 ft, on ground, 17.10.2004 R. D. WORTHINGTON 32889 (LI, UTEP). – **Lincoln Co.:** 2 mi E of Capitan on road to Capitan Gap, 6400 ft, 8.7.1968 S. SHUSHAN & R. S. EGAN 2433 (MIN). – **McKinley Co.:** Cibola National Forest at Quaking Aspen Campground SE of Gallup, in open area with ponderosa pines, 7300 ft, 2.7.1966 C. M. WETMORE 15123, 15126, 15136 & 15139 (MIN). – **Otero Co.:** Jornada Experimental Range, 10 mi N on hwy 70, N of Las Cruces, Chihuahuan desert, on silt loam soil, c. 1200 m, 32°30' N, 106°50' W, 20.2.2001 R. ROSENRETER 14539 (LI, SRP); Guadalupe Mts., Guadalupe Rim, 0.6 air mi W Brister Tank, near 32°10.75' N, 104°52.45' W, 6200 ft., 29.4.2001 R. D. WORTHINGTON 30479, 30480 (LI, UTEP); Guadalupe Mts., 1 air mi N of Coon Dog Tank, 32°22.91' N, 104°56.42' W, 5950 ft, sedimentary rock, on ground on flat top of ridge, 6.5.2001 R. D. WORTHINGTON 30502 with *var. erythrostratum* (UTEP, LI). – **Rio Arriba Co.:** Navajo Canyon, Abiquiu, 16.8.1934 S. K. HARRIS & R. GOODWIN 6305 (MIN); San Juan River 3 mi S of Rosa, 6000 ft, Alle Canyon, 4.7.1960 S. FLOWERS (COLO); San Juan River in La Jara Canyon, 6100 ft, 15.7.1960 S. FLOWERS 1048 (COLO). – **San Juan Co.:** Kutz Canyon, on bare silt-sand slopes with no other vegetation, 5800 ft, 20.1.1973 J. T. WYNHOFF NM-53 (ASU); Kutz Canyon, on sand-silt knoll, exposed location, 5820 ft, 5.2.1973 J. T. WYNHOFF NM-67 (ASU); Archuleta in the San Juan Valley, 5840 ft, 18.6.1974 M.-B. CARMER & J. T. WYNHOFF 2749 (CANL); Chaco Canyon NM, Charca Mesa S of Wijiji ruins, 36°01' N, 107°52' W, 6400 ft, 6.8.1979 L. SIGAL & T. H. NASH 16408 (ASU); Chaco Canyon National Monument, south side of Chaco Wash across from Hungo Pavié ruins, 36°02' N, 107°56' W, 6200 ft, 7.8.1979 L. SIGAL & T. H. NASH 16101 (US). – **San Miguel Co.:** Pagosa Canyon just NE of McAllister Lake, NE-facing rimrock, 1950–2000 m, 39°32' N, 105°08' W, 15.9.1973 WEBER, KUNKEL & LAFARGE (COLO); c. 1 mi W of Las Vegas, open Ponderosa pine stand on hillside, 35°36' N, 105°15' W, 6500 ft, 16.8.1979 L. SIGAL & T. H. NASH 16071 (ASU, MIN). – **Santa Fe Co.:** in montibus Santa Fe, E. TUCKERMAN (UPS). – **Socorro Co.:** 6 mi from Hwy 60 junction up Water Canyon, north side of Magdalena Mts., SE of Magdalena, 7000 ft, 28.3.1956 S. SHUSHAN & W. A. WEBER (COLO). – **Taos Co.:** mature *Pinus edulis* stand, 7800 ft, c. 4 mi S of Tres Piedras, 25.3.1956 S. SHUSHAN & W. A. WEBER (CANL, COLO, LI, MICH). – **Union Co.:** Capulin Mtn. National Monument, around campground at base of mt., area with pine, oak, juniper and cactus, 7500 ft, 5.7.1966 C. M. WETMORE 15207 (MIN); 3 mi N of Capulin Mtn. National Monument, in pasture around lava flow, 6900 ft, 3.7.1967 C. M. WETMORE 17407 (MIN). – **Valencia Co.:** lava flows and sandstone ledges along San Jose River, 3.5 mi SE of Correo on road to Las Lunas, c. 5500 ft, 27.3.1956 S. SHUSHAN & W. A. WEBER (COLO, UPS). **NORTH CAROLINA: Mecklenburg Co.:** Charlotte, on sandy soil in open pasture, 1927 F. W. GRAY (NY). **NORTH DAKOTA: Billings Co.:** S of town of Medora in North Dakota Badlands, in open eroded area, 30.7.1965 C. M. WETMORE 12771 (COLO, MICH, MIN, US, WIS). - Theodore Roosevelt National Park, S. Unit: near Peaceful Valley near Little Missouri River (2.5 mi N of Medora), on prairie ridges above prairie dog town, 2400 ft, 24.7.1982 C. M. WETMORE 44924 (MIN); ridge W of Badlands Overlook (3 mi E of Medora), on ridge and upper N-facing slope, 2650 ft, 25.7.1982 C. M. WETMORE 45036 (MIN, US); SE of Wind Canyon (5.5 mi NE of Medora), on ridgetops with scoria rock, 2500 ft, 28.7.1982 C. M. WETMORE 45340 (MIN). – **Foster Co.:** on calc. soil in dry, open prairie, 15.7.1961 J. LOOMAN T401 (DUKE). – **McKenzie Co.:** Theodore Roosevelt National Park, N. Unit: 0.5 mi NE of overlook on N-side of Cedar Canyon (14 mi SW of Watford City), on ridgetop with scoria rocks and in nearby prairie, 2400 ft, 16.7.1982 C. M. WETMORE 44435, 44442 (MIN); along Caprock Coulee Trail 1 mi E of turnout, on S-side of road (15 mi SW of Watford City), along ridge with prairie and rocks, 2350 ft, 16.7.1982 C. M. WETMORE 44463 (MIN); SW corner of Stevens Plateau (14 mi SW of Watford City), prairie and erosion area, 2400 ft, 22.7.1982 C. M. WETMORE 44874 (MIN). – **Slope Co.:** 0.1 mi W of intersection of East River Road and road to Amidon, south side of road, 46°36' N, 103°28' W, open soil, west facing slope, 29.6.1998 J. A. HERTZ 1266 (NDSU); 0.1 mi N of intersection of East River Road and road to old Logging Camp Ranch, west side of road, on exposed soil, slump area, 30.6.1998 J. A. HERTZ 1487 (NDSU). **OKLAHOMA: Murray Co.:** Arbuckle Mt., Turner Falls, 26.8.1960 J. W. THOMSON 8930 (MICH); summit of Arbuckle Mt., 6 mi S of Turner Falls, 28.8.1960 WEBER, SHUSHAN & ANDERSON (COLO, DUKE). - Platt National Park, SW-facing dry slope with scattered trees and cactus, 3.6.1961 H. A. SIERK 1328

(US), *ibid.* C. M. WETMORE 13133 (MIN), *ibid.* 9.7.1962 D. KECK 1514 (COLO). – **Osage Co.:** Tallgrass Prairie Preserve, c. 9 mi N of Pawhuska, in vicinity of bluffs along lower reaches of Wild Hog Creek, just above confluence with Sand Creek, prairie/woodland interface on slope above creek, 14.11.1996 D. LADD 19939 (LI). – **Texas Co.:** 7 mi NE of Guyman on US 54, on gravelly roadbank, 3500 ft, 5.7.1966 C. M. WETMORE 15223 (MIN). **PENNSYLVANIA: Chester Co.:** Nottingham Barrens, 2 mi S of Oxford, on serpentine soil, 28.10.1967 C. F. REED 75985 (NY). **SOUTH DAKOTA: Custer Co.:** Black Hills: 16 mi SW of Custer along Pass Creek Road, in open ponderosa pine area in prairie, 4800 ft, 3.7.1960 C. M. WETMORE 6744 (MICH); in grazing enclosure near Hell Canyon (18 mi SW of Custer), in prairie, 4600 ft, 3.7.1960 C. M. WETMORE 6821 (MICH, MIN); along road to Argyle 7 mi NW of US 385 (7 mi NW of Hot Springs), ponderosa pines with open areas, 4550 ft, 8.7.1961 C. M. WETMORE 10840 (BM, LD, MICH, US); Schenk Canyon (18 mi WSW of Custer), on E facing hillside in open pines, 4650 ft, 20.8.1961 C. M. WETMORE 11808 (BM, MICH); 3 mi E of Dewey (26 mi WNW of Hot Springs), along valley on west facing slope, 3950 ft, 20.8.1961 C. M. WETMORE 11862 (LD, MICH, WIS). – **Fall River Co.:** Black Hills, on hill above dam at north end of Angostura Reservoir, in open prairie, 3350 ft, 30.6.1960 C. M. WETMORE 6637 (WIS). – **Jackson Co.:** Badlands National Park, 2 mi W of Cedar Pass on Hwy 16A, c. 2500 ft, 14.8.1959 R. A. ANDERSON (COLO). – **Lawrence Co.:** Black Hills, 5 mi NW of Spearfish, in steep gulch with limestone cliffs, 3700 ft, 10.8.1961 C. H. WETMORE 11200 (MICH). – **Pennington Co.:** E of Hayward (15 mi SSW of Rapid City), on ridgetop with open pines, 4000 ft, 27.7.1961 C. M. WETMORE 11067 (DUKE). – **Turner Co.:** 3 mi W of Parker, on banks of the Vermillion River, 8.1959 R. A. ANDERSON (COLO). **TENNESSEE: Davidson Co.:** very common on bare, open soil in cedar glades, c. 12 mi SE of Nashville, 23.8.1958 R. A. PURSELL 3383 (COLO, NY, LI). – **Hamilton Co.:** [Chattanooga,] summit of Lookout Mtn, H. W. RAVENEL 446 (BM). – **Wilson Co.:** E of Lebanon near Smith Co. line, 11.4.1958 A. J. SHARP 15970 (COLO); on soil in limestone barrens, Cedars of Lebanon State Park, ca 10 mi S of Lebanon on US 231, ca 520 ft, 11.10.1958 R. A. PURSELL 3456 (COLO, NY). **TEXAS: Bexar Co.:** Utesville, 13.10.1941 H. B. PARKS (WIS); NW of San Antonio in the Edwards Plateau region, Friedrich Park, juniper-oak association, 8.8.1991 S. C. TUCKER 30949 & A. W. LIEVENS (ASU, MIN). – **Blanco Co.:** Pedernales Falls State Park, 10 mi E of Johnson City, 28.10.1977 R. S. EGAN 10301 (MIN). – **Brewster Co.:** 36 km N Big Bend National Park, 1000 m, 2.5.1977 O. H. VOLK (STU). - Big Bend National Park: W of junction of road to Santa Elena Canyon with Tex 170, desert with creosote bush and cactus, 8.6.1966 C. M. WETMORE 14308 (COLO, MIN, NY); Creosote bush area along main road 2 mi W of junction with road to Castolan, 3500 ft, 10.5.1969 C. M. WETMORE 18301 (BM); in creosote bush desert along main road 7 mi W of jct. with road to Basin Campground, 3700 ft, 10.5.1969 C. M. WETMORE 18297 (MIN); around Boulder Meadows S of The Basin, pine-oak forest, 5600 ft, 19.5.1969 C. M. WETMORE 18438 (MIN); Lost Mine Trail on ridge at top, pinyon pine-juniper woodland around rock ledges, 6800 ft, 18.4.1970 C. M. WETMORE 19274, 19279 (MICH, MIN, US); along river at Hot Springs near Rio Grande Village, in open desert back from river, 3.5.1969 C. M. WETMORE 18188 (MIN); Rio Grande Village, on hills N of campground in desert, 1800 ft, 1.5.1970 C. M. WETMORE 19332 (MIN); around Croton Spring, S of Craton Peak, on rock ledges facing south, 3400 ft, 7.5.1970 C. M. WETMORE 19465 (MIN); in Green Gulch in foothills below pine-juniper zone, 5100 ft, 17.5.1969 C. M. WETMORE 18435 (MIN); in Green Gulch on rocky knobs, 5300 ft, 19.5.1970 C. M. WETMORE 19735 (MIN); Paint Gap Hills NW of park headquarters, along ridgetop and on E-facing rocks, 3500 ft, 5.5.1970 C. M. WETMORE 19396 (COLO, MIN); Paint Gap Hills, on ridge W of road down canyon, in grassland desert with rock outcrops, 3680 ft, 16.4.1980 C. M. WETMORE 40773 (ASU, MIN), 40783 (MIN); Dagger Flats, on E-facing hillside and low rocky ridges in desert, 4200 ft, 5.5.1969 C. M. WETMORE 18206, 18207 (MIN); Dagger Flats, on W-facing hillside in open cactus-thorn desert, 4200 ft, 29.4.1970 C. M. WETMORE 19302 (MIN); along US 385 4 mi N of headquarters, in creosote bush desert near a wash, 3100 ft, 14.5.1970 C. M. WETMORE 19602, 19604 (MIN), 19606 (MIN, WIS); Hayes Ridge S of headquarters on Pine Canyon Road, in desert scrub, 4000 ft, 18.5.1970 C. M. WETMORE 19693, 19675 (MIN); hill S of Kit Mtn., on hill with lechugilla and cactus, 3000 ft, 17.4.1980 C. M. WETMORE 40801 (MIN); near Dog Canyon at northern edge of park, on limestone hills and flats with creosote bush, 2600 ft, 21.4.1980 C. M. WETMORE 40898, 40903 (CANL, MIN, US); 8 mi N of headquarters near fossil bone exhibit, creosote bush flats on silt soil, 2760 ft, 22.4.1980 C. M. WETMORE 40909 (MIN); Chilictal Mtn. SE of headquarters, on top of flat mountain with lechugilla, grass and cactus, 4100 ft, 25.4.1980 C. M. WETMORE 40967 (MIN); near Hot Springs, 2000 ft, 6.9.1982 D. B. JACKSON 141 (ASU); SE of Panther Junction, south end of Old Ore Rd., c. 0.7 mi N of Rio Grande Village Rd, 29°12' N, 103°00' W, Chihuahuan Desert, 13.1.1995 S. & ST.

SHARNOFF 1596.04 (hb. BRODO, CANL). - Black Gap Wildlife Management Area (55 mi SSE Marathon): walls of Frog Canyon, 11.10.1975 T. R. HOPKINS 351 (LI, UTEP); lava soils of gap, 19.6.1976 T. R. HOPKINS 488 (UTEP, LI, MIN), *ibid.* 4.1.1978 T. R. HOPKINS 788 (UTEP, LI). - 69 km S of Alpine, c. 400 m E of TX 118, 1153 m, nearly level basin landform subject to periodic overland flows, carbonatic soils, 20.8.2016 C. JACKSON 1061 (LI, SRP). – **Brown Co.:** SW of Brownwood on US 67, on hill with scrub oak, cactus and mesquite, 5.6.1966 C. M. WETMORE 14213 (CANL, DUKE, MIN); Brownsville, NE of Resaca Park, chaparral, 1.5.1944 R. RUNYON 3818, 3819 (US). – **Burnet Co.:** Inks Lake, 10 mi W of Burnet, 4.4.1956 C. L. KRAMER 1639 & B. SCOTT (NY); 7 mi ESE of Marble Falls along N-shore of the Colorado River, 18.5.1976 R. S. EGAN 8792 (MIN); granitic rock and soil area of the Inks Lake State Recreation Area 10 mi W of Burnet, on soil, 31.7.1976 T. R. HOPKINS 531 (MIN); 2 km S of Inks Lake State Park off Park Route 4, rock outcrops with mixed oak and juniper, 25.9.1976 R. S. EGAN 9191 (MIN); Longhorn Cavern State Park, N of Park Road, 4.6 mi W of US281, 30°41'06" N, 98°20'58" W, juniper-dominated dry forest over calcareous bedrock, 14.8.2005 W. R. BUCK 49250 (NY, W). – **Cameron Co.:** near Rio Hondo, 8.2.1944 R. RUNYON 3644 (US); 8 mi W of Boca Chica along Texas 4, dry mesquite scrub, 14.7.1963 R. A. PURSELL 5928 (US). – **Denton Co.:** around edge of Garza-Little Elm Reservoir, Lewisville, scrub oak thicket, 21.3.1970 M. J. DIBBEN 21180 (DUKE). – **El Paso Co.:** El Paso, 1885 W. G. FARLOW (W). - Franklin Mts.: 3.6 mi by Gasline Rd S of hwy 62-180 at Martin Canyon, 4320 ft, 4.3.1978 R. D. WORTHINGTON 2152 (COLO); Vinton Canyon (31°58' N, 106°30'45" W), 5200 ft, along limestone cliff face, 10.3.1979 R. D. WORTHINGTON 3958 (COLO); mouth of Vinton Canyon, 31°58.07' N, 106°30.84' W, 4870 ft., SE slope, on ground, limestone alluvium, 17.8.2001 R. D. WORTHINGTON 30675 (LI, UTEP). - Hueco Mts., limestone hills 2.5 mi E of Nations East Well and 3 mi W of Hueco Tanks State Historical Park, 35°55' N, 106°07' W, 1300–1500 m, Chihuahuan Desert shrub community, 2.6.1991 R. D. WORTHINGTON 19407 (COLO). – **Hudspeth Co.:** canyon in south end of Huesco Mts. (32°42'36" N, 105°59'22" W), 4800 ft, 18.3.1979 R. D. WORTHINGTON 4035 (COLO); stabilized gypsum ridge 11.5 mi E of Dell City, 14.10.1984 R. D. WORTHINGTON 12762 (COLO). - **Irion Co.:** on soil at Union Oil Rig 1 c. 13 mi NW of Mertson, 19.5.1976 T. R. HOPKINS 437 (MIN). – **Jeff Davis Co.:** Davis Mts., along route 118 in Madera Canyon, Laurence E. Wood rest area, on steep rock walls, 6000 ft (1830 m), 30.9.1978 R. S. EGAN 11415 (MIN). – **Johnson Co.:** Cleburne State Park: Grand Prairie, limestone slope, 13.4.1947 E. WHITEHOUSE 18038 (US); on east facing hill above lake with juniper, scrub oak and cactus, 4.6.1966 C. M. WETMORE 14183 (COLO), 14188 (MIN), 14191 (MICH, MIN, US). – **Llano Co.:** 19 mi SSW of Llano, near Enchanted Rock, granitic rock and soil, 6.12.1975 T. R. HOPKINS 322 (UTEP, LI). – **Mason Co.:** 1.5 mi SSE Katemey, granitic rock and soil area of the McWilliams Ranch, 8.11.1975 T. R. HOPKINS 373 (UTEP, MIN, LI), *ibid.* 19.8.1976 T. R. HOPKINS 577 (COLO, UTEP, LI). – **Presidio Co.:** 29 mi SE of Presidio along Rte 170, on steep N-facing rock walls, 11.6.1977 R. S. EGAN 10019, 10026 (MIN); The Solitario, NW-side of The Solitario on Santa Elena Formation limestone along access road, 29°30'05" N, 103°48'15" W, 4600 ft, area in South Crawford Pasture, Big Bend Ranch State Natural Area, 24.3.1994 R. D. WORTHINGTON 23046 (UTEP, LI). – **Reeves Co.:** near Pecos, 4.1949 B. OSBORN (US); N of Pecos along US 285, desert scrub with mesquite and creosote bush, 9.6.1966 C. M. WETMORE 14314 (MIN, US), 14317A (CANL, DUKE). – **Somervell Co.:** dry slope with *Juniperus* along Brazos River, c. 6 mi ENE of Glen Rose along US 67, 28.6.1961 R. A. PURSELL 4806 & W. D. REESE (NY, US). – **Tom Green Co.:** near town of Christoval and the South Concho River, 8.10.1977 R. S. EGAN 10164 (MIN). – **Travis Co.:** Hamilton's Pool off FM 3238, just E of the Pedernales River, 20.11.1976 R. S. EGAN 9475 (MIN). – **Upton Co.:** N of McCamey in King Mt. Area, in desert with creosote bush and cactus, 6.6.1966 C. M. WETMORE 14234 (MIN). – **Uvalde Co.:** pebbly limestone pavement in open llano with *Prosopis* and other shrubs, 18 mi W of Uvalde on Hwy 90, just E of Cline, 30.4.1974 W. A. WEBER (COLO, U); Garner State Park, along the Frio River, 25 mi N of Uvalde, mixed juniper and oak hillside with exposed rocks, 27.11.1976 R. S. EGAN 9576 (MIN). – **Val Verde Co.,** 13 mi SE of Del Rio near Sycamore Creek, alluvial soil, 23.4.1948 E. WHITEHOUSE 19750 (US); Dolan Creek Ranch about 14 mi W of Loma Alta near jct Devil's River and Dolan Creek, 18.5.1976 T. R. HOPKINS 422 (UTEP, LI); 14 mi W of Loma Alta near union of Devil's River and Dolan Creek, 18.5.1976 T. R. HOPKINS 421 (MIN); 4 mi W of Langtry, S of Hwy 90, bluffs along Osman Creek, 9.4.1979 K. S. DERSTINE 1069 (ASU, GZU, MIN). – **Ward Co.:** 5 mi S of Pyote, 10.12.1982 O. H. BERRY (US). – **Wichita Co.:** 2 mi W of Electra, 3.2.1945 E. WHITEHOUSE 9499a (US). – **Williamson Co.:** 8 mi W of Georgetown along the South Fork of the San Gabriel River, 18.5.1976 R. S. EGAN 8764 & 8766 (MIN). – **Wilson Co.:** 20 mi NW of San Antonio, Creabrua limestone, 20.8.1941 H. B. PARKS, hb. THOMSON 1107 (WIS). **UTAH: Box Elder Co.:** Curlew

Valley near Snowville, 1350 m, 8.1973 O. L. LANGE & E. D. SCHULZE (COLO, STU-Wirth). – **Carbon Co.:** Wood Hill, Price, 12.4.1930 S. FLOWERS 77 (COLO, NY). – **Emery Co.:** Pinyon-Juniper community, 6 km E of Buckhorn Reservoir and 15 km SE of Cleveland, 39°14'41'' N, 110°48'15'' W, 24.3.1982 L. L. ST. CLAIR sl-359 (MIN, WIS); San Rafael Swell, N of Wedge Overlook, 39°06' N, 110°46' W, Colorado Plateau, pinyon-juniper community, 1380 m, 3.9.1993 S. & ST. SHARNOFF 1180.22 (hb. BRODO). – **Garfield Co.:** Colorado River, Ticcaboo Canyon, c. 3400 ft, 6.7.1958 S. FLOWERS 762 (COLO, NY). – **Grand Co.:** 16 km W of Arches National Park, S of Horsethief Campground, Pinyon/juniper habitat, 1760 m (5777 ft), 20.4.2011 R. ROSENRETER 17066 (LI). - Arches National Park: trail to Delicate Arch, 38°45' N, 109°45' W, 1984 B. D. RYAN 11662 (ASU); 1465 m, on soil over gypsum, 38°45'29'' N, 109°37'07'' W, 24.9.2003 R. TÜRK & J. BELNAP 39938 (hb. TÜRK); Double Arch, 1480 m, on soil over sandstone, 1.10.2003 R. TÜRK 41570, 41587 (hb. TÜRK). - Moab: close to Arches National Park, 1440 m, on soil over sandstone, 38°52'54'' N, 109°45'31'' W, 24.9.2003 R. TÜRK 40593, 40599 (hb. TÜRK); W Arches National Park, Klondike Bluffs Trail, 1240 m, on soil over limestone, 38°46'36'' N, 109°42'48'' W, 28.9.2003 R. TÜRK 40935 (LI), 40923, 40926, 40930, 40933 (hb. TÜRK); Klondike Bluffs Trail, 1434 m, on soil over sandstone, 28.9.2003 R. TÜRK 41469 (hb. TÜRK); NW Moab, 1446 m, on soil over calcareous rocks, 38°38'35'' N, 109°39'03'' W, 22.9.2003 R. TÜRK & J. BELNAP 39397 (hb. TÜRK); Colorado Valley, 1364 m, on soil over Morrison shale formation, 38°43'17'' N, 109°41'31'' W, 23.9.2003 R. TÜRK & J. BELNAP 39551, 39557, 39558, 39559, 39563, 39565, 39885, 39889, 39891 (hb. TÜRK); Colorado River, 1382 m, on soil over calcareous rocks, shale and gypsum, *Atriplex confertifolia* community, 23.9.2003 R. TÜRK & J. BELNAP 39424, 39427, 39431, 39456, 39459 (hb. TÜRK); SE Bartlett Flat, 1730 m, on soil over sandstone, 25.9.2003 R. TÜRK 41089, 41206 (hb. TÜRK); Kane Creek Road, Moab Rim, 1240 m, on soil over sandstone, 27.9.2003 R. TÜRK 40868, 40873, 40877, 40879, 40891, 40898, 40902, 40920 (hb. TÜRK). – **Kane Co.:** E of Kanab, Five Mile Road, off Hwy 89, gravel pit area with *Artemisia tridentata* ssp. *wyomingensis*, c. 1650 m, 37°02' N, 112°14' W, 24.1.2002 R. ROSENRETER 14527, 14528 (LI). – **San Juan Co.:** near Bluff, 20.5.1947 S. FLOWERS 348 (COLO, NY); Devils Canyon, 6300 ft, 21.6.1952 S. FLOWERS 598 (COLO); south side of Abajo Mts., 18 mi W of Blanding, head of Cottonwood Canyon, c. 6600 ft, 5.8.1954 S. FLOWERS 745 (COLO); W of Blanding, Trockenwaldgebiet des Colorado-Plateaus, 2500 m, 5.1973 O. L. LANGE (STU-Wirth 4142). - Canyonlands National Park: Virginia Park, 5.1968 E. KLEINER (WIS); Needles District, north side of Woodenshoe Butte, 5000 ft, 4.8.1982 ANN DEBOLT 204 (GZU, LI); Needles District, along jeep road 2 mi E of Colorado Overlook, 4900 ft, 8.8.1982 ANN DEBOLT 146 (GZU, WIS); Needles District, south side of Squaw Butte near residence area, 5000 ft, 14.8.1982 ANN DEBOLT 203 (WIS); Needles District, trail to Chesler Park, *Artemisia* grasslands, 5600 ft, 8.11.1988 R. ROSENRETER & ANN DEBOLT 6061 (US); Gordon Flats, 6600 ft, 9.7.1983 SANCHINI & STEIN 311 (MIN); close to Grand View Point, 1850 m, on soil over sandstone, 30.9.2003 R. TÜRK 41438, 41440 (hb. TÜRK). – **Utah Co.:** Dinosaur National Monument, mouth of Split Mountain Gorge, c. 5000 ft, 1.11.1961 ANDERSON, AWASTHI & DAHL (COLO, UPS). – **Washington Co.:** 8 mi E of St. George on west bank of Virgin River, 2500 ft, 1.9.1957 S. SHUSHAN (COLO); 13 mi W of Santa Clara along US 91 W of St George just inside Shivwits Indian Reservation, on gentle N-facing slope with pinyon pine, juniper and sage, 4000 ft, 26.6.1967 C. M. WETMORE 17057 (COLO, MICH, MIN); 3 mi W of Hurricane, along road, 3100 ft, gypsiferous soil, 7.1975 D. C. ANDERSON 99-208 (WIS). – **Wayne Co.:** Ekkers Range, dry sandy soil under shrubs, 6000 ft, 19.5.1951 S. FLOWERS 379 (COLO, NY); Caineville Wash, 9 mi W of Hanksville on road to Capitol Reef National Park, 2–5 mi N of junction with main road, 24.10.1988 TIMDAL, WEBER & BRATT 5968 (SBBG). **WASHINGTON: Benton Co.:** Horse Heaven Hills, S of Benton City, on a very rocky SW-facing slope, in a draw, 274 m, 46°13.06' N, 119°26.38' W, 30.10.1998 J. PONZETTI 1137 (OSC), Horse Heaven Hills SW of Benton City, on soil just above the cut bank of a draw, in an unburned patch of *Artemisia tridentata/Agropyron spica-tum/Poa secunda* shrub steppe community, 448 m, 46°13.89' N, 119°37.49' W, 21.10.1998 J. M. PONZETTI 992 (OSC). **WISCONSIN: Dane Co.:** on calc. soil in dry, open prairie, 4.8.1960 J. LOOMAN (WIS). – **Iowa Co.:** hill near Tower Hill State Park, 28.5.1939 J. W. THOMSON (WIS); Sawle's Mill, 3 mi SE of Arena, on sandstone outcrop, 26.7.1956 H. A. IMSHAUG 19203 (MICH); bluff by Mill Creek 6 mi W of Arena, 19.8.1965 H. A. SIERK 2835 (COLO) & I. M. BRODO 5646 (MICH). – **Monroe Co.:** 2 mi NE of Melvina, open scrub oaks and *Pinus banksiana*, prairie, 25.6.1957 H. H. ILTIS (WIS). – **Richland Co.:** calc. soil prairie on hill W of Gotham, 2.6.1965 J. W. THOMSON (WIS); 4 mi N of Hub City, small formerly grazed prairie opening on top of ridge with sandstone outcrops, 8.7.1973 M. NEE 6067 (NY); 5 mi W of Richland Center, at

Girl Scout Camp, prairie, 2.8.1974 M. NEE 13212 (WIS). – **Walworth Co.:** on prairie soil on moraine ridge near Troy Center, Lulu Lake Scientific Area, 24.6.1985 J. W. THOMSON (WIS).

MEXICO: BAJA CALIFORNIA: California Floristic Province: Punta Banda, S of Ensenada, cherty outcrops above La Bufadora, 300 ft, 22.4.1966 W. A. WEBER & R. SANTESSON (COLO); Sierra de Juarez just W of crest, Chamise area, 4200 ft, 5.6.1972 T. H. NASH 4407 (ASU); along Rte 1, 2 km S of Colonet, coastal scrub community, 50 m, 31°04' N, 116°13' W, 3.1.1989 J. M. EGEE (MUB); 2 km SE of Colonet along secondary dirt road E of highway 1, coastal chaparral (*Agave*, *Ambrosia*, *Euphorbia*, *Lycium*), 31°02'43" N, 116°11'50" W, 100 m, 28.12.1997 O. BREUSS 14274, 14283, 14284, 14289 (LI, W); 23 km S of Colonet, along Hwy, 30°51' N, 116°04' W, c. 150 m, low scrub with open sandy and stony soil patches, 16.2.1987 T. H. NASH & J. POELT (GZU); Playa at Bahía San Quintin, 20 ft, 127 mi S of Ensenada, 23.4.1966 W. A. WEBER & R. SANTESSON (COLO). – **Vizcaino Region of the Sonoran Desert:** Cañon del Rosario, 10 km N of El Rosario, 90 m, 30°08' N, 115°46' W, 5.1.1989 J. M. EGEE (MUB), C. Bratt 7063 (SBBG), A. & M. APTROOT (U); 6 km N of El Rosario along Hwy 1, on top of mesa, 280 m, 30°07' N, 115°46' W, 23.2.1993 C. M. WETMORE 72391 (MIN); 11 km N of El Rosario, 30°08'21" N, 115°45'59" W, 100 m, 29.12.1997 O. BREUSS 14340, 14346, 14348, 14349, 14350 (LI), C. M. WETMORE 79156 (MIN); 9.7. mi E of El Rosario, steep slope above broad wash Playa de Rosario, 10.6.1972 T. H. NASH 4849 (ASU); 30°02' N, 115°31' W, 17 km E of El Rosario along Hwy 1, 250 m, 16.2.1987 B. D. RYAN 21473 (ASU, LI); Sarcophyllous desert 26 km E of El Rosario, along hwy 1, 30°03' N, 115°27' W, 400 m, 16.2.1987 T. H. NASH & J. POELT (GZU); 23 km E of El Rosario along Rte 1, on steep hillside, desert with *Ambrosia*, *Idria columnaris*, *Opuntia molesta*, *Pachycereus pringlei*, 200 m, 30°02' N, 115°31' W, 5.1.1989 C. M. WETMORE 63753 (MIN), C. BRATT 7075, 7081 (SBBG), J. M. EGEE (MUB); El Rosario Arroyo, c. 15 km ENE of El Rosario, on hillside in desert with *Agave shawii*, *Opuntia molesta*, 40 m, 30°07' N, 115°08' W, 5.1.1989 R. S. EGAN 13882 (MIN), C. M. WETMORE 63743 (MIN); along Rte 1, 31 km E of El Rosario near El Aguajito, high mesa top overlooking Arroyo El Rosario to the north, 500 m, volcanic rocks, 30°03' N, 115°25' W, 10.1.1989 J. M. EGEE (MUB); along route 1 c. 20 km E of bridge across Arroyo El Rosario and near El Aguajito, desert with *Agave*, *Ambrosia*, *Idria*, *Opuntia*, *Pachycereus*, 30°02'20" N, 115°30'48" W, 400 m, 29.12.1997 O. BREUSS 14396, 14397, 14399, 14400, 14416 (LI), C. M. WETMORE 79201, 79202 (MIN); 10 km E of bridge over El Rosario Wash, *Agave*, *Ambrosia*, *Machaerocercus* assoc., 30°03'21" N, 115°34'56" W, c. 200 m, 9.1.1998 T. H. NASH 40143 (ASU); along Rte 1 on S-side of Cañada el Aguajito and 10 km ESE of bridge over Arroyo El Rosario, 250 m, 30°03'21" N, 115°34'56" W, 9.1.1998 C. M. WETMORE 79812 (MIN); 12 mi SE of El Rosario, Sonoran Desert, 8.6.1972 T. H. NASH 4698 (ASU); Punta Baja 3 mi SW of El Rosario, 150 ft, 6.10.1972 T. H. NASH 4892 (ASU, COLO); along secondary track 0.5 km SW of route 1 and 13 km N of Cataviña, desert with *Eriogonum*, *Idria*, *Larrea*, *Lophocereus*, *Opuntia*, *Pachycereus*, 29°49'29" N, 114°49'13" W, 650 m, 30.12.1997 O. BREUSS 14424 (LI); 1 km N of Cataviña, 560 m, 6.1.1989 C. BRATT 7096 (SBBG); 10 km N of Cataviña, 570 m, 6.1.1989 C. BRATT 7088 (SBBG); arroyo with *Washingtonia* 1 km N of Cataviña, 560 m, batholithic granite boulder area, 29°43' N, 114°40' W, 6.1.1989 J. M. EGEE (MUB), C. M. Wetmore 63788 (MIN); near km 172.5 on road from San Quintin to Parador Punta Prieta, c. 1 km before Cataviña, 29°43' N, 114°40' W, c. 600 m, 6.1.1989 H. SIPMAN 24953 (B); 29°42' N, 114°41' W, 6.3 mi S of Cataviña and 0.8 mi W of km. marker 185 of Mex. Rte. 1, 590 m, 4.3.1994 J. P. REBMAN 2296 (ASU); 9 km NW of Rancho Santa Ines, 550 m, 29°46' N, 114°46' W, on decomposed granite, 20.3.1986 W. H. CLARK P3539 with *Peltula patellata* (LI, SRP), 3539A (MIN); just N of Laguna Chapala, on base of E facing hillside, 665 m, 29°26' N, 114°26' W, 22.2.1993 C. M. WETMORE 72313 (MIN), *ibid.* 22.2.1993 T. H. NASH 34004 (ASU); 6 km W of Laguna Chapala, 29°26' N, 114°28' W, desert locality, 2300 ft, 12.3.1976 T. H. NASH 12976 (ASU); 3 km WNW of Laguna Chapala, on mountain slope at border of Lower Colorado Valley, desert with *Eriogonum fasciculatum*, *Larrea tridentata*, *Ferocactus acanthodes*, 780 m, 29°27' N, 114°25' W, 6.1.1989 C. M. WETMORE 63827 (MIN), T. H. NASH 26314 (ASU), J. M. EGEE (MUB); along lower slopes of Cerro los Enjambres and c. 2 km WNW of Laguna Chapala, 700 m, 29°23'39" N, 114°23'30" W, 30.12.1997 C. M. WETMORE 79221 (MIN); along Rte 1, 30 km S of turnoff for Bahía de Los Angeles, 28°45' N, 114°07' W, *Idria columnaris*, c. 170 m, 22.2.1993 T. H. NASH 34002 (ASU); N of Guerrero Negro, 5 km N of Rosarito, along the road to Punta Prieta, area with *Idria columnaris*, *Ferocactus* and *Bursera*, 150 m, 28°38.6' N, 114°2.8' W, 21.7.2000 P. V. D. BOOM 25034 with *Placidium andicola* (hb. V. D. BOOM); along sideroad to Punta Rosarito, 0.3 km W of Rte 1 and 11 km S of Rosarito, on low ridges in southern Vizcaino region with *Ambrosia*, *Fouquieria diguetii*, 30 m, 28°34' N, 114°04' W,

10.1.1989 C. M. WETMORE 64005, 64008 (MIN); Guadalupe Island, narrow E–W canyon into the southern peak on the east side, 29°00′50″ N, 118°15′50″ W, 800 m, 4.1.1996 T. H. NASH 38543 (ASU); Isla Cedros, N-facing slope on NE corner of the island, 28°22′30″ N, 115°13′ W, c. 100 m, 17.3.1994 T. H. NASH 34228 (ASU); Isla Cedros, N-facing slope on NE ridge top with pines at north end of the island, c. 400 m, 28°22′ N, 115°15′ W, 18.3.1994 T. H. NASH 34299 (ASU). **BAJA CALIFORNIA SUR: Vizcaino Region of the Sonoran Desert:** Peninsula Vizcaino, 135 km W of Rte 1, along road to Bahía Tortugas, 27°42′ N, 114°35′ W, c. 380 m, 30.12.1990 T. H. NASH 29655 (ASU); Peninsula Vizcaino, along road to Bahía Tortugas, 125 km W of Rte 1, 27°38′ N, 114°32′ W, pleistocene alluvial deposits, c. 150 m, 30.12.1990 T. H. NASH 29611 (ASU); Peninsula Vizcaino, 125 km W of Rte 1, 2 km S of Bahía Tortugas Road along secondary road to Puerto Nuevo, 27°38′ N, 114°32′ W, c. 210 m, 30.12.1990 T. H. NASH 29581 (ASU); 3 mi S of El Arco bluff above arroyo, 27°59′ N, 113°28′ W, 850 ft, 14.3.1976 T. H. NASH 12920 (ASU); along Rte 1, 31 km W of San Ignacio at jct of road to Punta Abreojos, on NE-slope of a cerro with *Bursera* and *Pachycereus*, 180–200 m, 27°20′ N, 113°07′ W, 7.1.1989 C. M. WETMORE 63876B (MIN), C. Bratt 7133 (SBBG), R. S. EGAN 13988, 13989 (MIN), *ibid.* 9.1.1989 J. M. EGEA (MUB); 32 km (on road) NW of Santa Rosalia, along road to San Ignacio, gently N-exposed slope with small ledges, 200 m, 112°27.7′ W, 27°25.1′ N, 22.7.2000 P. v. D. BOOM 25066 (hb. v. D. BOOM); W of San Ignacio, 30.5.1974 T. H. NASH 8965 (ASU); Loma Buenaventura, c. 4 km NE of route 1 along secondary road to San Francisco de la Sierra, *Ambrosia*, *Bursera*, *Larrea*, *Yucca*, 120 m, 27°27′12″ N, 113°13′20″ W, 31.12.1997 O. BREUSS 14487 (LI); Mesa los Crestones, 21 km ENE of route 1 along secondary road to San Francisco de la Sierra, small N-facing cliff adjacent to a large canyon, *Bursera* and shrubs, 500 m, 27°32′30″ N, 113°05′53″ W, 31.12.1997 O. BREUSS 14496, 14501, 14509 (LI). – **Magdalena Region of the Sonoran Desert:** Arroyo San Raymundo, along road from Mulegé to Rancho la Ballena and 4 km west of junction to Misión Guadalupe near Misión San Miguel, 500 m, 26°44′35″ N, 112°17′45″ W, 3.1.1998 O. BREUSS 14678 (LI); top of basalt cliffs above Bahía San Juanico c. 3 km E of San Juanico, *Fouquieria*, *Jatropha*, 100 m, 26°15′57″ N, 112°25′58″ W, 4.1.1998 O. BREUSS 14754, 14755 (LI); 7.7 km along dirt road to San Juanico from jct at paved road (10 km WSW of San Isidro), on dry ridge, 220 m, 26°09′30″ N, 112°11′ W, 20.3.1992 C. M. WETMORE 70224 (MIN); 51 km SW of San Javier along San Javier wash, on N-facing slope of small volcanic mountain, 150–200 m, 25°36′30″ N, 111°45′ W, 18.3.1992 C. M. WETMORE 70087 (MIN); E side of the Sierra de la Gigante along dirt road to San Javier, north slope along desert wash with palo blanco, 25°58′ N, 111°27′ W, on soil over acidic rock, c. 230 m, 18.3.1992 T. H. NASH 30390 (ASU); along dirt road to San Javier, 7 km NE of paved road at jct 28 km NNW of Ciudad Insurgentes, 25°30′ N, 111°50′ W, c. 100 m, 18.3.1992 T. H. NASH 30573 (ASU); along Rte 1, 20 km ENE of Ciudad Insurgentes, 25°21′ N, 111°37′ W, 75 m, sandy coastal plain with scattered basaltic rocks, 8.1.1989 J. M. EGEA (MUB); along Rte 1, 68 km NE of Ciudad Insurgentes, in a pass through the Sierra de la Gigante, thorn forest, 400 m, 25°36′ N, 111°20′ W, 8.1.1989 J. M. EGEA (MUB); S of Ciudad Constitución c. 3 km W of route 1 along road to Puerto Cancún, *Fouquieria*, *Jatropha*, *Opuntia*, 60 m, 24°42′46″ N, 111°32′55″ W, 5.1.1998 O. BREUSS 14782, 14785 (LI), T. H. NASH 39753 (LI); c. 20 km S of Loreto along Mex 1, near El Juncalito, N-exposed rock faces, 111°20′ W, 25°53′ N, 100 m, 17.7.2000 P. v. D. BOOM 24926 (hb. v. D. BOOM); 76 km WNW of La Paz along route 1, desert scrub, c. 110 m, 17.2.1993 T. H. NASH 33863 (ASU); N of Todos Santos, turnoff to Presa de Santa Cruz at 42 km post along hwy 19, 180 m, 23°33′ N, 110°13′ W, 14.2.1993 C. M. WETMORE 71934 (MIN), *ibid.* 14.2.1993 T. H. NASH 33727 (ASU); 15 km N of Todos Santos, road (Mex 19) to San Pedro, W exposed slope with low granite outcrops and mainly with cacti, 110°10′ W, 23°37′ N, 200 m, 11.7.2000 P. v. D. BOOM 24776 (hb. v. D. BOOM); NE of San Jose del Cabo, E side of Mex 1, sandy road to Palo Escopeta, 1 km E of Santa Catarina, area with cacti and *Bursera*, 150 m, 109°40.9′ W, 23°8.7′ N, 13.7.2000 P. v. D. BOOM 24835 (hb. v. D. BOOM). **CHIHUAHUA:** Along Rte 10 c. 25 mi SE of Nuevo Casas Grandes, desert grassland, 4830 ft, 7.6.1976 T. H. NASH 13763 (ASU); Microndas de Santa Cruz, c. 48 mi S of Chihuahua City along Rte 45, *Larrea-Ocotillo*-cacti habitat, 27°41′ N, 105°10′ W, 4350 ft, 13.6.1976 T. H. NASH 13828 (ASU); small mountain SW and above reservoir on Rio San Pedro, heavily grazed area with scattered shrubs and trees, 30°34′ N, 108°28′ W, c. 1600 m, 16.7.1994 T. H. NASH 36175 (ASU); Distr. Iturbide, rimrock outcrops, Majalca Cr., 35 km N of Ciudad Chihuahua, c. 5000 ft, 6.–16.10.1962 W. A. WEBER & L. A. CHARETTE (COLO); 50 mi W of La Hunta along Rte 14, pine-oak woodland, 28°45′ N, 107°50′ W, 7500 ft, 9.6.1976 T. H. NASH 13645 (ASU). **COAHUILA:** 27 mi W of Paila along Rte 40, cactus hillside, 3930 ft, 25°34′ N, 102°35′ W, 17.6.1976 T. H. NASH 13967 (VASU); Cuatro Ciénegas basin, Chihuahuan desert, limestone area, 19.3.1973 T. H. NASH 6713 (ASU). **NUEVO LEON:** near San Roberto jct of road to Linares,

desert dominated by *Yucca*, 24°40'N, 100°20'W, 6100 ft, 21.6.1976 T. H. NASH 14118 (ASU); between Saltillo and Matehuala, Cerro Potosi - El Potosi, Los Cedros, 24°30' N, 100°45' W, 1500 m, 15.2.1995 J. J. HALDA & J. HALDOVA (hb. Halda); Sierra Madre Oriental, Aramberri, 24°20' N, 100°20' W, 1500 m, 17.2.1996 J. J. HALDA (hb. HALDA, LI). **SONORA:** On rocky hillside at eastern outskirts of Hermosillo, 13.11.1939 D. RICHARDS & F. DROUET (FH, NY, S); on soil on high mountains W of Baviácora, 17.11.1939 D. RICHARDS, F. DROUET & W. A. LOCKHART (S); 21 mi W of Sonoyta along Rte 2, 31°58' N, 113°09' W, 1200 ft, 24.10.1975 T. H. NASH 11906 (ASU); 5 mi SE of Sonoyta, 30°30'N, 112°02'W, Sierra Cubart, 1200 ft, 24.10.1975 T. H. NASH 11927 (ASU); 20 mi E of Altar along Mex. Rte 2, 30°38' N, 111°42' W, 2300 ft, 25.10.1975 T. H. NASH 12073 (ASU); Cerreo Chino, 15 mi S of Caborca, 1200 ft, 25.10.1975 T. H. NASH 11935 (ASU, S); Cerro El Tordillo, 33 km E of Hermosillo and 4 km E of intersection of routes 16 and 20, c. 450 m, 29°00' N, 110°45' W, 22.2.1987 T. H. NASH 25630 (ASU), B. D. RYAN 21663 (ASU, LI), T. H. NASH & J. POELT (GZU); La Puerta, 60 mi W of Sonoyta, N-slope, on rotten granite, 5.6.1957 S. SHUSHAN 11197 (US); 30°14' N, 111°02' W, Sierra el Caracahui, just N of Santa Eva Microondas, 32 km S of Santa Ana, 8 km E of Hwy 15, 1000 m, 2.1987 B. D. RYAN 21665 (ASU). **TAMAULIPAS:** 2 km SW of Miguel Hidalgo, 7 mi NE of San Fernando on Mex. Hwy 101, grazed Coastal Plain Desert, with shrub layer 1-5 m tall, 11-12.6.1973 B. & J. A. HANSEN & M. NEE 1797 (NY); open oak forest on hill side c. 6 mi N of Villa Aldama, c. 500 ft, 24.7.1961 R. A. PURSELL 5205 (US); dry scrub area 33 mi E of Victoria along the road to Soto La Marina (E of Casas), c. 1000 ft, 6.8.1961 W. D. REESE 5338 (US), *ibid.* 6.8.1991 R. A. PURSELL 5507 & W. D. REESE (COLO, LI, NY, US).

Varietas *atrans* (BREUSS) M. PRIETO, Amer. J. Bot. 99(1): 28 (2012)

Placidium lacinulatum var. *atrans* BREUSS, in LENDEMÉR, Opusc. Philolichenum 1: 54 (2004)

Type: U.S.A, Maryland, Cecil Co., on soil in a serpentine barren with sparse grass, shrubby cover, and dead pine trees, on a hillside on the north/east shore of Conowingo Creek, E of Pilot Town Road (across from entrance to Girl Scout Camp), c. 0.75 mi SE of Pilot, Pilot Barrens, Nature Conservancy Property, elev. c. 300 ft, 39°42'08''N, 76°11'25''W, 26.5.2003 J. C. LENDEMÉR 867 (hb. LENDEMÉR – holotype, W – isotype). Material of this collection was distributed as Lich. East. N. Amer. Exs. III, no. 102.

Short characterization: Lower side of squamules and rhizines brown to black. Excipulum brown to black. Ascospores 11–15 × 6–8 μm. Conidia (sub)cylindrical, 4–6 × 1–1.5 μm.

Specimens examined:

U.S.A.: ARIZONA: Gila Co.: Houston Mesa, Pinyon-Juniper area, 34°16'33'' N, 111°18'16'' W, c. 1630 m, 12.7.1997 T. H. NASH 40249 (ASU). – **Maricopa Co.:** 14 mi S of Gila Bend along Ariz. Hwy 85 in Saucedo Mts, 14.6.1966 C. M. WETMORE 14537 (LD); north end of Maricopa Mts. where they intersect U.S. 80, 33°10'28'' N, 112°38'50'' W, c. 270 m, 27.2.1998 T. H. NASH 40549 p. pte. (ASU). – **Pima Co.:** near Quitobaquito, Organ Pipe National Monument, 5.4.1979 B. MCCUNE 10278 (WIS); western section of Saguaro National Monument in Tucson Mts., 2600 ft, 9.10.1966 E. A. DUEWER 596 (ARIZ). **CALIFORNIA: Kern Co.:** E of Maricopa on Calif hwy 166 in desert with sagebrush in level open land, 500 ft, 23.6.1966 C. M. WETMORE 14798 (MIN). – **San Diego Co.:** along back road between Calif. 94 and Chula Vista near Otay Reservoir, 2.8 mi E of reservoir on N-facing roadside bank, 800 ft, 23.6.1967 C. M. WETMORE 17003 (ASU); open sandy soil in *Hymenoclea-Ephedra* desert at the confluence of Sheep and Indian Creeks c. 6 mi NW of Borrego Springs, 1600 ft, 8.3.1983 P. LESICA 2913 (SRP). – **Riverside Co.:** San Bernardino National Forest, San Jacinto Mts., above Palm Desert, agave and cactus but no trees, 2500 ft, 17.6.1966 C. M. WETMORE 14606 (MIN). **COLORADO: Elbert Co.:** 10 mi NW of Limon, c. 39°23' N, 103°46' W, Cedarbrakes, 5800 ft, 28.6.1961 S. SHUSHAN sl-304 (WIS). – **Park Co.:** Riverside Campground, Elevenmile Canyon, 2 mi S of town of Lake George, 8300 ft, 38°55' N, 105°25' W, 8.1984 B. D. RYAN 11721 (ASU). **MICHIGAN: Chippewa Co.:** Drummond Island, Maxton Plains Nature Preserve, 46°04'29'' N, 83°39'43'' W, dolomite alvar, 16.7.2002 W. R.

BUCK 42106 (LI, NY). **MINNESOTA: Goodhue Co.:** River Terrace Prairie Scientific and Natural Area, cedar/oak bluff c. 500 ft S of the Cannon River, N of the Cannon Valley Trail, c. 4 mi ENE of Cannon Falls, 5.1991 J. P. SCHUSTER 2730 & H. DUNEVITZ (MIN). **MONTANA:** Lewis and Clark Cavern State Park, scattered *Juniperus* and *Pinus flexilis* in calcar. rocky grassland, near old gypsum mines, Jefferson Canyon, 45°49.5' N, 111°52' W, 1360 m, 4.2001 B. MCCUNE 25966, J. PONZETTI & R. ROSENTERER (OSC). **NEBRASKA: Polk Co.:** along Nebr. 92, 4 mi E of Platte River, on steep W-facing bank, 6.8.1965 C. M. WETMORE 13119 (MIN). **NEW MEXICO: Los Alamos Co.:** Bandelier National Monument, vicinity of Juniper Campground, 6700 ft (2037 m), pinyon-juniper woodland, 10.8.1975 R. S. EGAN 7104 (MIN). – **San Miguel Co.:** Kearny's Gap, W of Las Vegas on road to Mineral Hill, on rocky cliffs with juniper, ponderosa pine and pinyon pine on top, 6500 ft, 3.7.1966 C. M. WETMORE 15153 (MIN). **SOUTH DAKOTA: Lawrence Co.:** vicinity of Timon Campground, 4 mi WSW of Savoy, 11 mi W of Lead, in Limestone Plateau Region, near Little Spearfish Creek, c. 5600–5900 ft, 4.6.1960 R. A. ANDERSON 20506 (MICH). **TEXAS: Burnet Co.:** Inks Lake State Park, 8 mi WSW of Burnet, granite outcrops and mixed oak-juniper woods, 15.10.1977 R. S. EGAN 10264 (MIN). – **El Paso Co.:** Franklin Mts., west bajada of mts., 2.3 air mi WNW top of South Franklin Mt., 31°52.72' N, 106°32.06' W, limestone hill, 4300 ft, 30.12.2001 R. D. WORTHINGTON 30890 (MIN). – **Johnson Co.:** Cleburne State Park, on E-facing hill above lake with juniper, scrub oak and cactus, 4.6.1966 C. M. WETMORE 14183 (MIN). – **Mason Co.:** between Streeter and Grit on US Rte 377, open oak woodland and exposed rocks, 15.8.1975 R. S. EGAN 7204 (MIN). – **Nacogdoches Co.:** Garrison Road 10 mi NE of Nacogdoches, 1.10.1941 H. B. PARKS, hb. THOMSON 1103 (WIS). – **Val Verde Co.:** 4 mi W of Langtry, S of Hwy 90, bluffs along Osman Creek, 9.4.1979 K. S. DERSTINE 1069 (COLO, MIN). – **Williamson Co.:** 8 mi W of Georgetown along the South Fork of the San Gabriel River, 18.5.1976 R. S. EGAN 8753 (MIN). **UTAH: San Juan Co.:** north side of Woodenshoe Butte, 5000 ft, Needles District, Canyonlands National Park, 4.8.1982 ANN DEBOLT 143 (WIS). **WISCONSIN: Iowa Co.:** on sandstone outcrops, Sawle's Mill, 3 mi SE of Arena, 26.7.1956 H. A. IMSHAUG 19203 (LD). **WYOMING: Converse Co.:** 25 mi W of Douglas, Little Box Elder Creek, on sandstone rocks W of portal of Little Box Elder Cave, 10.8.1956 H. G. RODECK (COLO).

MEXICO: BAJA CALIFORNIA: El Rosario Arroyo, ca 15 km ENE of El Rosario, on hillside in Northern Vizcaino region of the Sonoran Desert with *Agave shawii*, 40 m, 30°07' N, 115°08' W, 5.1.1988 C. M. WETMORE 63734 (MIN); Isla Cedros, N-facing slope on NE corner of the island, 28°22'30'' N, 115°13' W, c. 100 m, 17.3.1994 T. H. NASH 34228 (ASU); mountain slope 3 km WNW of Laguna Chapala, border of the Lower Colorado Valley – Vizcaino regions of the Sonoran Desert, 780 m, 29°27' N, 114°25' W, 6.1.1989 J. M. EGEA (MUB). **BAJA CALIFORNIA SUR:** S of Ciudad Constitucion along road to Cancun, c. 3 km W of route 1 along road to Puerto Cancun, Magdalena Region of the Sonoran Desert, 24°42'46'' N, 111°32'55'' W, 5.1.1998 T. H. NASH 39753 (ASU). **CHIHUAHUA:** open, N-facing hillside along a secondary dirt road with the valley of Arroyo Ancho, 5 km W of paved road to Creel, on acidic rock, 28°12'25'' N, 107°31'55'' W, 23.7.1994 T. H. NASH III 37573 (ASU).

Varietas erythrostratum (BREUSS) M. PRIETO, Amer. J. Bot. 99(1): 28 (2012)

Placidium lacinulatum var. *erythrostratum* BREUSS, Bryologist 103(4): 705 (2000).

Type: U.S.A.: ARIZONA: Gila Co., Tonto National Forest, N of Payson, Houston Mesa Road, Whispering Pines, slope of hill with *Pinus ponderosa*, sandstone and limestone, 11.7.1997 O. BREUSS 13168 (LI–holotype).

Short characterization: Lower side of squamules ± reddish (check in microscopical section!). Rhizines pale. Excipulum colorless to brownish. Ascospores broadly ellipsoidal, 12–15 × 7.5–9 µm. Conidia oblong-ellipsoidal to shortly subcylindrical, 3–5 × 1.3–2 µm.

Specimens examined:

CANADA: ALBERTA: N Saskatchewan River watershed, N-side of Bighorn Reservoir beside David Thompson Hwy, on S-facing hillside with scattered *Pinus flexilis*, 4500 ft, 52°15' N, 116°24' W, 19.6.1971 C. M. WETMORE 20086 (MIN).

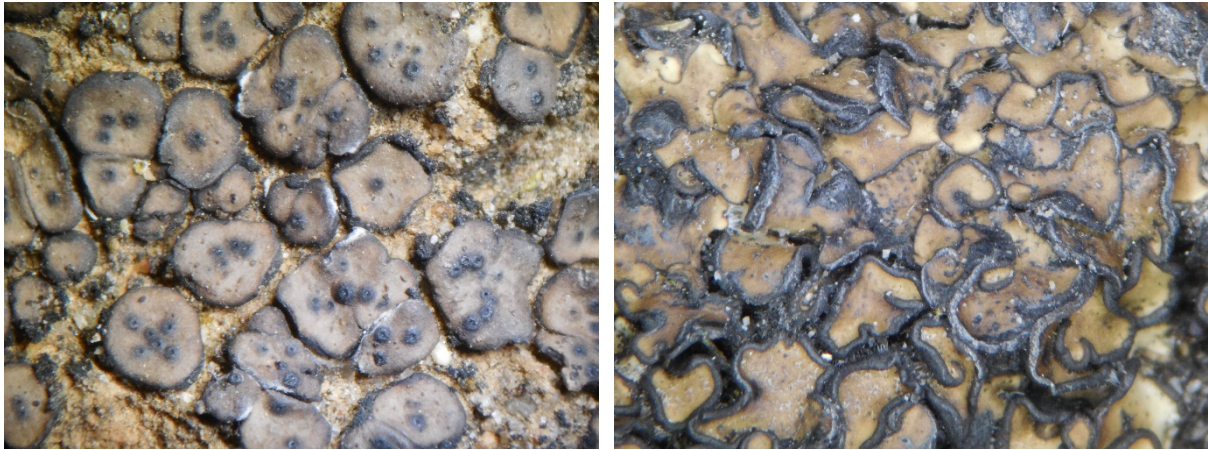


Fig. 6a, b. *Clavascidium umbrinum*, variously shaped squamae. Width of photos a = 10 mm, b = 9 mm.

U.S.A.: ARIZONA: Gila Co.: Tonto National Forest, N of Payson, Houston Mesa Rd, Whispering Pines, slope of hill, *Pinus ponderosa*, sandstone and limestone, 11.7.1997 O. BREUSS 13168, 13169 (LI). – **Maricopa Co.:** Usuary Pass at Usuary Mts. N of Mesa, Tonto National Forest, 33°29'30" N, 111°37'15" W, c. 671 m, 27.2.1998 T. H. NASH 40530 (ASU). – **Pima Co.:** Saguaro National Monument, Tucson Mt. Section, 1.25 mi N of visitor center along Hugh Norris Trail in W-facing valley in cactus scrub, 2800 ft, 29.6.1986 C. M. WETMORE 55266 (MIN). – **Yavapai Co.:** Coconino National Forest, Verde Valley 0.5 km N of McGuireville, 34°38'30" N, 111°49' W, 1070 m, limestone area, *Canotia* and other desert vegetation, 9.2.2000 T. H. NASH & O. BREUSS 16394, 16408 (LI). **CALIFORNIA: Inyo Co.:** Death Valley National Monument, entrance to Mosaic Canyon, E-bank on rockslide, 1000 ft, Stove Pipe Wells Quadrangle, on limestone soil between rocks, Desert Holly, 13.1.1978 T. E. WEIER 1600, 1601, 1602 (MIN). – **Riverside Co.:** Palm Springs, 1901 HASSE 292 (NY); San Jacinto Mts., Snow Creek, slope about water company facility, 33°52.489' N, 116°40.923' W, 590 m, NE-facing slope of granite boulders with mixed chaparral, 15.12.2002 K. KNUDSEN 733 & K. KRAMMER (LI, UCR). – **San Bernardino Co.:** Mid Hills campground, on granitic soil, 5500 ft, 14.2.1982 T. E. WEIER 2170 (UC); North Providence Mts., Hole-in-the-Rock campground, on tertiary volcanic soil, 4500 ft, 15.2.1982 T. E. WEIER 2174 (UC). **MINNESOTA: Goodhue Co.:** Soldier's Memorial Park, Sorin's Bluff, prairie on SW-facing slope in Mississippi River valley, c. ¼ mi SE of Red Wing, 22.5.1991 J. P. SCHUSTER 2760 & H. DUNEVITZ (MIN). **MISSOURI: Taney Co.:** Mark Twain National Forest, Hercules Glades, along trail S of Long Creek, on SW-facing slope in openings with sandstone rock and grass, 1.9.1991 C. M. WETMORE 68695 (MIN). **NEBRASKA: Sioux Co.:** Agate Fossil Beds National Monument, 1 mi E of entrance on N-side of road, on ridge with hard rock chips, 4520 ft, 9.7.1997 C. M. WETMORE 77968 (MIN). **NEW MEXICO: Bernalillo Co.:** sandstone ledges, Arroyo San Antonio, 6800 ft, 2 mi above jct of Hwy 66 and Sandia Loop Drive, Sandia Mts., 26.3.1956 S. SHUSHAN & W. A. WEBER (COLO, LD with *Placidium squamulosum*). – **Dona Ana Co.:** East Potrillo Mts., N end of Mts., 31°54.68' N, 107°02.12' W, 4750 ft., limestone hills with outcrops of quartzite, 24.3.2001 R. D. WORTHINGTON 30336 (LI, UTEP). – **Otero Co.:** Guadalupe Mts., 1 air mi N of Coon Dog Tank, 32°22.91' N, 104°56.42' W, 5950 ft., sedimentary rock, on ground on flat top of ridge, 6.5.2001 R. D. WORTHINGTON 30502 (LI, UTEP). – **San Juan Co.:** along route 173 c. 8 mi E of Aztec, open pinyon-juniper-sagebrush roadside community, 6.6.1978 R. S. EGAN 11375 (MIN). **NORTH DAKOTA: Billings Co.:** 0.2 mi E of Interstate 94 interchange E of Medora, south of I 94, 46°54' N, 103°29' W, east facing slope, 23.7.1998 J. A. HERTZ 1956 (NDA); Theodore Roosevelt National Park, S.Unit, ridge NW of Buck Hill (6.5 mi E of Medora), on rock ledges and in prairie on top just W of main hill, 2780 ft, 26.7.1982 C. M. WETMORE 45142 (MIN); Theodore Roosevelt NP, S.Unit, SE of Wind Canyon (5.5 mi NE of Medora), on ridgetop with scoria rock, 2500 ft, 28.7.1982 C. M. WETMORE 45338 (MIN). – **Slope Co.:** west side of East River Road just S of intersection with road to old Logging Camp Ranch, on open soil, hilltop, 29.5.1998 J. A. HERTZ 839 (NDSU). – **Williams Co.:** Fort Union Trading Post National Historic Site, Bodmer Overlook, N of fort (25 mi SW of Williston), on hill in prairie with some glacial erratics, 2000 ft, 48°00'36" N, 104°01'51" W, 26.6.1998 C. M. WETMORE 80243 (MIN). **SOUTH DAKOTA: Pennington Co.:** Black Hills, E of Hayward (15 mi SSW of Rapid City), on ridgetop with open pines, 4000 ft, 27.7.1961 C. M. WETMORE 11067 (MICH). **TEXAS: Brewster Co.:** Big Bend National

Park, in level creosote bush area along main road 2 mi W of jet with road to Castolan, 3500 ft, 10.5.1969 C. M. WETMORE 18300 (MIN); walls of Frog Canyon, Black Gap Wildlife Management Area ca 55 mi SSE of Marathon, 11.10.1975 T. R. HOPKINS 351 (MIN). **UTAH: Grand Co.:** Moab, Kane Creek Road, Moab Rim, 1240 m, on soil over limestone, 38°34'16" N, 109°34'12" W, 27.9.2003 R. TÜRK 40875, 40899 (hb. TÜRK); Moab, Klondike Bluffs Trail, 1434 m, on soil over sandstone, 28.9.2003 R. TÜRK 41465 (hb. TÜRK). – **San Juan Co.:** Canyonlands National Park, Needles District, north side of Woodenshoe Butte, 5000 ft, 4.8.1982 ANN DEBOLT 143 (WIS). **WYOMING: Albany Co.:** Morton Pass, 25 mi N of Laramie, 7300 ft (2219 m), 8.1968 J. K. MITCHELL 5078 (MIN).

MEXICO: BAJA CALIFORNIA: Arroyo with *Washingtonia*, 1 km N of Cataviña, northern Vizcaino Region of the Sonoran Desert, 560 m, batholithic granite boulder area, 29°43' N, 114°40' W, 6.1.1989 R. S. EGAN 13910 (MIN); lower slopes of Cerro los Enjambres c. 2 km WNW of Laguna Chapala, Vizcaino Region of the Sonoran Desert (*Agave, Ambrosia, Bursera, Idria, Opuntia*), 29°23'39" N, 114°23'30" W, 700 m, 30.12.1997 O. BREUSS 14437, 14441 (LI), *ibid.* C. M. Wetmore 79224 (MIN); Isla Cedros, mountain slope to W of the town of Cedros, 28°08' N, 115°12'45" W, c. 510 m, 21.3.1994 T. H. NASH 34546 (ASU); 115°45' W, 30°04' N, "Petrified Forest" area just W of El Rosario near the ocean, 15.2.1994 J. P. REBMAN 2192 (ASU). **BAJA CALIFORNIA SUR:** Loma Buenaventura, c. 4 km NE of route 1 along secondary road to San Francisco de la Sierra, Vizcaino Region of the Sonoran Desert (*Ambrosia, Bursera, Larrea, Yucca*), 120 m, 27°27'12" N, 113°13'20" W, 31.12.1997 O. BREUSS 14488, 14489, 14493 (LI).

Varietas *latisporum* (BREUSS) M. PRIETO, Amer. J. Bot. 99(1): 28 (2012)

Placidium lacinulatum var. *latisporum* BREUSS, Stapfia 23: 94 (1990).

Type: Spain, Islas Canarias, Tenerife, Cardonal de Guimar, 10.1.1984 X. LLIMONA & J. M. EGEA (MUB – holotype).

Short characterization: Lower side of squamules and rhizines colorless to brownish. Excipulum colorless. Ascospores broadly ellipsoidal, 15–19 × 7.5–10(–11) µm. Conidia oblong-ellipsoidal to shortly subcylindrical, 3–5 × 1.3–2 µm.

Specimens examined:

MEXICO: BAJA CALIFORNIA: 2 km SE of Colonet along secondary dirt road E of highway 1, coastal chaparral (*Agave, Ambrosia, Euphorbia, Lycium*), 31°02'43" N, 116°11'50" W, 100 m, 28.12.1997 O. BREUSS 14291, 14292 (LI); 11 km N of El Rosario in small canyon S of route 1, Vizcaino Region of the Sonoran Desert, 30°8'21" N, 115°45'59" W, c. 100 m, 29.12.1997 T. H. NASH 40176 (ASU); lower slopes of Cerro los Enjambres c. 2 km WNW of Laguna Chapala, Vizcaino Region of the Sonoran Desert (*Agave, Ambrosia, Bursera, Idria, Opuntia*), 29°23'39" N, 114°23'30" W, 700 m, 30.12.1997 O. BREUSS 14450 (LI, W); 10 km E of bridge over El Rosario Wash, Vizcaino Region of Sonoran Desert, *Agave, Ambrosia, Machaero-cerus* assoc., 30°3'21" N, 115°34'56" W, c. 200 m, 9.1.1998 T. H. NASH 40144 (ASU). **BAJA CALIFORNIA SUR:** 62 km WNW of La Paz canyon (km-post 62), 24°12' N, 110°58' W, 300 m, 17.2.1993 R. MOBERG 10351 (UPS, LI).

***Clavascidium pseudorufescens* (BREUSS) M. PRIETO**, Amer. J. Bot. 99: 28 (2012).

Placidium pseudorufescens BREUSS, in NASH, T. H. III, RYAN, B. D., GRIES, C. & BUNGARTZ, F. (eds.): Lichen flora of the greater Sonoran Desert region Vol. 1: 391 (2002).

Type: Mexico, Baja California Sur, 33 km SW of Lreto, Sierra de la Giganta, 25°43' N, 111°24' W, on soil over volcanic rock, 28.5.1974 T. H. NASH 8879 (ASU – holotype).

Thallus: Squamae rather large (up to 7 mm wide) and almost leafy, densely aggregated to slightly overlapping, lobate, wavy, with margins free from substratum and



Map 3. North American distribution of *Clavascidium umbrinum*.

upturned or downcurved. Upper surface medium to dark brown, matt. Lower side pale brown, bare marginally, central parts with a rhizohyphal web and a few pale, thin, slightly branched rhizines.

A n a t o m y : Thallus 300–500 μm thick. Upper cortex 40–60 μm high, overlain by a thin amorphous layer. Photobiont layer ca 100–130 μm high, algal cells 8–13 μm in diam. Medulla thick, composed of interwoven filamentous hyphae. Lower cortex distinctly delimited, 30–50 μm thick, subparaplectenchymatous of roundish cells 8–13 μm in diameter. Rhizohyphae colorless, ca 5 μm thick, forming a web in central parts of the underside. Rhizines 50–100 μm thick.

P e r i t h e c i a : up to 400 μm wide. Excipulum colorless.

P e r i p h y s e s : 35–50 μm long and 3–4 μm thick.

A s c i : subcylindrical to narrowly clavate, 50–65 \times 14–20 μm .

A s c o s p o r e s : initially uniseriate, in maturity (sub)biseriate, ellipsoidal, 11–14 \times 6–7.5 μm .

Pycnidia: laminally immersed in squamae. Conidia bacillar, $4-5(-5.5) \times 1-1.5$ μm .

Icon.: BREUSS 2002: 391 (sub *Placidium* p.)

Characterization: Diagnostic features of *Clavascidium pseudorufescens* are the large, almost leafy squamae with a filamentous medulla and a distinct lower cortex, comparatively small ascospores, laminal pycnidia with cylindrical conidia and the presence of rhizines. It is morphologically very similar to *Placidium rufescens* from which it differs in being rhizinate, in having laminal pycnidia and its much smaller ascospores. *Clavascidium lacinulatum* may also be found on thin earthcovers over decomposed rock surfaces, but differs in its mixed-type medulla, an indistinct lower cortex, and usually thicker rhizines.

Ecology and distribution: *Clavascidium pseudorufescens* grows on rock or over cyanophilic lichens thereon or on a thin earth cover over rock. The rhizines are fixed in minute fissures of the rock. The species is known only from Baja California Sur.

Specimens examined:

MEXICO: BAJA CALIFORNIA SUR: 33 mi SW of Loreto, Sierra de la Giganta, $25^{\circ}43' \text{ N}$, $111^{\circ}24' \text{ W}$, on soil over volcanic rock, 28.5.1974 T. H. NASH 8879 (ASU); near km 68 on road from Ciudad Insurgentes to Loreto (Route 1), pass through the Sierra de la Giganta, $25^{\circ}36' \text{ N}$, $111^{\circ}20' \text{ W}$, c. 400 m, rocky mountain slope with thorn forest, on nearly vertical rockface at foot of cliff, 8.1.1989 H. SIPMAN 25045 (B); Sierra de La Laguna, along river bottom below Picacho de La Laguna, 500 m, $23^{\circ}30' \text{ N}$, $110^{\circ}00' \text{ W}$, 16.2.1993 C. M. WETMORE 72040 (MIN).

***Clavascidium umbrinum* (BREUSS) BREUSS**, Ann. Naturhist. Mus. Wien 98B Suppl.: 41 (1996).

Catapyrenium umbrinum BREUSS, Linzer biol. Beitr. 22/1: 78 (1990).

Type: [Croatia,] Dalmatien, Nordseite der Svilaja-Planina zwischen Sinj und Vrlika, Kalk, c. 1440 m, 14.5.1906 J. BAUMGARTNER (W – holotype).

Thallus: of dispersed or more or less densely gathered squamules, individual squamules 2–5(–7) mm wide, roundish or variously lobed (Fig. 6a, b). Upper side medium to dark brown, matt. Lower side pale or dark brown, attached to the substratum by a thick hyphal layer and a few additional brown rhizines.

Anatomy: Thallus 250–350(–500) μm thick. Upper cortex 30–50 μm , epinecral layer 5–25 μm . Photobiont layer about 50–100 μm . Medulla \pm filamentous with hyphae divided into a varying number of globular cells, with small interhyphal spaces, grading into a conspicuous brown basal layer up to 200 μm , a true lower cortex lacking. Rhizohyphae brown, 4–6 μm in diameter. Rhizines brown to black, few per squamule, main stems 50–150 μm thick, rarely up to 200 μm , simple or branched.

Perithecia: 250–400 μm broad. Excipulum blackish brown.

Periphyses: c. 20–30 μm long and 2–2.5 μm thick, often indistinct.

Asci (sub)cylindrical when young, soon \pm clavate, $60-75 \times 13-18(-23)$ μm .

Ascospores: biseriate, ellipsoidal, $(11-13-17) \times (5-6-8)$ μm .

Pycnidia: laminally immersed. Conidia oblong-ellipsoidal, $3-4.5(-5) \times 1.5$ μm .

Characterization: *Clavascidium umbrinum* is recognized by brown squamules with laminal pycnidia, dark exciples, a conspicuous basal layer of brown hyphae and dark rhizines. Specimens with a weaker developed basal layer may be confused with *C. laciniatum* var. *atrans* which also has dark exciples and dark rhizines. A useful distinguishing feature is the shape and size of the conidia: oblong-ellipsoidal and $3\text{--}4.5 \times 1.5 \mu\text{m}$ in *C. umbrinum* vs. (sub)cylindrical and $4\text{--}6 \times 1\text{--}1.5 \mu\text{m}$ in *C. laciniatum* var. *atrans*.

Ecology and distribution: The species grows on soil in (semi)dry habitats. It is very scattered throughout the submediterranean region of Europe and the southern half of North America (Map 3).

Specimens examined:

CANADA: ONTARIO: Bruce Co., Bruce Alvar Nature Reserve, NW of Hwy 6, 0.4 km N of Dyer's Bay Road, $45^{\circ}07'38''$ N, $81^{\circ}26'38''$ W, c. 210 m, alvar with extensive system of grykes and clints, 26.9.2010 R. C. HARRIS 56542 (LI).

U.S.A.: ARIZONA: Coconino Co.: 20 km S of Flagstaff, just N of Oak Creek Canyon, W of the scenic overlook, 1969 m (6460 ft), $35^{\circ}01'56.5''$ N, $111^{\circ}44'21.6''$ W, 4.5.2005 R. ROSENRETER 16024 (SRP, LI). – **Gila Co.:** 1 km S of Payson along hwy AZ 287, $34^{\circ}13'$ N, $111^{\circ}21'$ W, 1525 m, on soil, 25.9.1983 T. H. NASH 21237 (ASU). **CALIFORNIA: San Diego Co.:** Kearney Mesa just S of General Dynamics plant, E of Cabrillo Freeway, field with depressions and scattered *Adenostoma*, 19.4.1966 W. A. WEBER & R. SANTESSON (COLO). **DELAWARE: New Castle Co.:** on dry serpentine rocks, Christina Hd, 20.4.1892 A. COMMON (FH). **MARYLAND:** near Baltimore, 12.11.1909 C. C. PLITT: MERRILL, Lich. exs. 189 (W). **MINNESOTA: Scott Co.:** 5 mi SW of Shakopee along US 169, in open short grass prairie with limestone outcrops and granite boulders, 17.4.1971 C. M. WETMORE 19788 (WIS). **SOUTH DAKOTA: Custer Co.:** Black Hills, SW of Hermosa, 0.5 mi W of S.D.79 on S.D.36 (18 mi ENE of Custer), in open pines on south facing hill, 3400 ft, 25.6.1961 C. M. WETMORE 10223 (CANL, DUKE, LD, MICH, PRM, UPS); Black Hills, 3 mi E of Dewey (26 mi WNW of Hot Springs), along valley on west facing slope, 3950 ft, 20.8.1961 C. M. WETMORE 11862 (CANL, UPS, US). **TEXAS: Burnet Co.:** Granite Mts., Marble Falls, 2.4.1928 C. C. PLITT 33 (US). **VIRGINIA: Goochland Co.:** on granite rocks at Columbia, Rte. 6, Fluvama, 10.10.1964 C. F. REED 68770 (NY). **WISCONSIN: Iowa Co.:** Sawle's Mill, 3 mi SE of Arena, on sandstone outcrops, 26.7.1956 H. A. IMSHAUG 19203 with *Clavascidium laciniatum* (COLO, LD). – **Sauk Co.:** Spring Green Prairie NE of town of Spring Green, 25.10.1981 B. MCCUNE 11080 (OSC).

MEXICO: BAJA CALIFORNICA: Lower slopes of Cerro los Enjambres c. 2 km WNW of Laguna Chapala, Vizcaino Region of the Sonoran Desert (*Agave*, *Ambrosia*, *Bursera*, *Idria*, *Opuntia*), $29^{\circ}23'39''$ N, $114^{\circ}23'30''$ W, 700 m, 30.12.1997 O. BREUSS 14432, 14461 (LI). **CHIHUAHUA:** Samachiqui, between Rio Urique bridge and Quirire, on road to Barranca Batopilas, 2100 m, with *Pinus ayacahuite* and *Quercus omissa*, 29.7.1977 W. A. WEBER & R. BYE (COLO).

For Acknowledgements see BREUSS (2025) part 1 in Austrian J. Mycol. 32. 147.

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