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A major range expansion for *Platismatia wheeleri*

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Abstract: *Platismatia wheeleri* was recently described as a species distinct from the highly morphologically variable *Platismatia glauca*. Previously, *P. wheeleri* was known only from intermountain western North America in southern British Columbia, Idaho, Montana, Oregon and Washington. After examining collections from the New York Botanical Garden and Arizona State University herbaria we discovered that *P. wheeleri* was collected in southern California and the Tatra Mountains of Slovakia. The morphology, ecology and biogeography of *P. wheeleri* are discussed, and the importance and utility of historical collections is highlighted. This article is intended to alert researchers to the potential presence of *P. wheeleri* in different regions of the world so we can better understand its historical and current distribution and abundance.

Key words: *Platismatia wheeleri*, *Platismatia glauca*, distribution, Parmeliaceae, historical collections

Introduction: *Platismatia glauca* (L.) W.L. Culb. & C.F. Culb. is a morphologically variable taxon that includes individuals with marginal soralia, simple to coralloid isidia, highly branched fruticose lobes, or any combination thereof. Its distribution includes eastern and western North America, coastal Alaska, central Asia, all of Europe, the Canary Islands, the Azores, southern Greenland, Patagonia, and high mountains in Kenya and Tanzania (Culberson and Culberson 1968). In their monograph of *Platismatia*, Culberson and Culberson (1968) concluded that, although it is tempting to separate *P. glauca* into different species because of its morphological variability and wide distribution, all combinations, variations and gradation from soredia and isidia, to highly branched fruticose outgrowths occur, making it impossible to separate species based on these characters alone. Therefore, they suggested that *P. glauca* is simply a very old, widely distributed species.

Recently, however, individuals of *Platismatia glauca* s. lat. with strongly sinuous marginal soralia were segregated and described as *Platismatia wheeleri* Goward, Altermann and Björk (Lumbsch et al. 2011). An individual of *P. wheeleri* was collected in December 2010 at Turnbull National Wildlife Refuge near Spokane, WA, which prompted examination of all holdings of *P. glauca* at The New York Botanical Garden (NY). This search resulted in the discovery of additional *P. wheeleri* specimens that vastly expand its known range. Specimens of *P. glauca* from NY and specimens of *P. wheeleri* from NY, ASU and personal collections allowed thorough comparison of these two species. Using light micrographs and scanning electron micrographs, we further illustrate here the differences between *P. glauca* and *P. wheeleri* and show that *P. wheeleri* was historically collected in Southern California and the Tatra Mountains of Slovakia.

Materials and Methods: All specimens stored at NY under the name *Platismatia glauca* were

examined using a dissecting microscope along with two additional specimens borrowed from Arizona State University (ASU). Light micrographs were taken with a Nikon DXM1200F digital camera attached to a Nikon SMZ1500 dissecting microscope and using Nikon ACT-1 software. In addition to light microscopy, scanning electron microscopy (SEM) was used to more clearly characterize the asexual diaspores. To prepare samples for the SEM, small portions were cut from selected specimens using a razor blade and mounted on aluminum stubs using carbon adhesive tabs. They were sputter coated for 3 minutes at 10 milliamps with gold before examination under a Hitachi S-2700 SEM with a tungsten filament operating at an accelerating voltage of 20 kv. The Quartz PCR Image Management System was used to capture digital images. Photoshop 7.0 was used to edit images and assemble plates.

Thin layer chromatography was performed on four *P. wheeleri* specimens (NY barcode numbers 01562524, 01562525, 01562528 and 01562529) and one *P. glauca* (NY 01562522) using solvent B according to Culberson and Kristinsson (1970), except that it was run in a small glass jar on an aluminum backed plate cut to fit 5 samples.

Results

Distribution and Ecology

Platismatia wheeleri was originally known only from intermountain western North America in southern British Columbia, Idaho, Montana, Oregon and Washington. The record for its southernmost distribution was reported by McCune (2012) from the Soda Mountain Wilderness in Oregon, right across the border from California. By examining all specimens filed as *P. glauca* at NY, we found four specimens of *P. wheeleri*; two from the San Gabriel Mountains in southern California, one near Castle Crags State Park in northern California and one from the Tatra Mountains in Slovakia. Examination of material from ASU revealed two additional specimens from California that extended the

known range of the species even further south (fig. 1).

The specimens cited in the original description occurred only on *Pinus ponderosa* and *Pseudotsuga menziesii*. In addition to specimens occurring on those substrates, one of the specimens from the San Gabriel Mountains was collected on the bark of *Abies*. A recent collection by Björk (UBC) is from a stem of *Amelanchier cusickii*.

Morphology

The most striking characteristic of *Platismatia wheeleri* is the sinuous, marginal soralia that appear to erupt from the medulla. The specimens examined in this study from California, Washington and Slovakia all have strongly sinuous, marginal soralia and no isidia (figs. 2 and 3). Some individuals of *P. glauca* have marginal soralia, but they are not strongly sinuous, and differ from laminal soralia only in location (fig. 4A). Also, close inspection of these specimens always reveals isidia. As seen under the SEM, the soredia of the *P. wheeleri* specimens from Washington and Slovakia are both loose and powdery with clearly distinguishable hyphae and no gelatinized covering (fig. 5E). Specimens of *P. glauca*, on the other hand, all have isidia. When they do have soredia, they are markedly different in that they have at least some gelatinized covering (fig. 4).

Platismatia wheeleri is also superficially similar to some members of the genus *Parmotrema*, especially *Parmotrema perlatum* and *Parmotrema austrosinense*. However, the species of *Parmotrema* differ in their medullary chemistry: *Platismatia wheeleri* contains caperatic acid (Lumbsch et al 2011), while *Parmotrema perlatum* contains stictic acid (Louwhoff 2009) (medulla K+ yellow, P+ orange), and *P. austrosinense* contains lecanoric acid (Hale 1974) (medulla C+ red). All the specimens examined with TLC in this study

contained only atranorin and caperatic acid (medulla K-, P-, C-).

Notable differences between the herbarium specimens of *Platismatia wheeleri* and the recent collection from Washington are the tan color of the old herbarium specimens (which was expected and noted by Culberson and Culberson (1968) as a common occurrence in old specimens of *Platismatia*) and the surface texture. The surface of *P. wheeleri* varies from smooth (fig. 4B) to pitted and irregular (fig. 4A), a characteristic that was highlighted in the original description (Lumbsch et al. 2011).

Discussion: While *Platismatia glauca* still encompasses a wide range of morphological variation, *P. wheeleri* is clearly distinct, falling outside that morphological range. This study proposes a large geographical range expansion for the latter species mainly based on historical collections. Since the species is similar to *P. glauca* and some members of the genus *Parmotrema*, critical examination of additional herbarium material from around the world could turn up many more specimens of *P. wheeleri*. However, the species may simply be extremely rare or no longer extant in places like southern California and Slovakia. Both of the mountain ranges in these regions have experienced declines in biodiversity due to a multitude of anthropogenic forces (Bielczyk 2006, Fenn et al. 2003, Lovich and Bainbridge 1990, Oleksyn and Reich 1994, Richardson et al. 2007). Many lichens historically collected in southern California are now very rare, if not extinct (Knudsen and Magney 2006), and the same can be said for lichens in Slovakia, where there are currently over 100 lichen species presumed to be extinct, with many more recognized as endangered (Pišut 1993).

The currently known geographical distribution of *P. wheeleri* has parallels in several other lichen and bryophyte species, each with a distribution

from southern California north to interior southern British Columbia and eastern Washington, and east to northern Idaho and northwestern Montana. Among these are the lichens *Ahtiana pallidula*, *Alectoria imshaugii*, *Candelaria pacifica*, *Esslingeriana idahoensis*, *Hypogymnia recurva*, *Leptogium californicum*, *Leptogium subaridum*, *Massalongia microphylliza*, *Platismatia herrei*, *Platismatia stenophylla*, *Tuckermannopsis platyphylla*, *Xanthomendoza oregana*, and the bryophytes *Anacolia menziesii*, *Antitrichia californica*, *Codriophorus varius*, *Dendroalsia abietina*, *Phaeoceros hallii*, *Pseudobraunia californica*, and *Targionia hyophylla*. Collectively, this suite of cryptogams is limited to regions of western North America having a Mediterranean precipitation regime (humid winters and dry summers), and occurrences of these are unknown or rare in regions having continental (dry winters and humid summers) or maritime precipitation patterns. Among the above-mentioned species, several are found as disjuncts also in Europe, as with *Anacolia menziesii*, *Antitrichia californica* (Schofield 1988), *Alectoria imshaugii* (Østhagen & Krog 1979) and *Leptogium subaridum* (Aragon et al. 2004).

This study illustrates the immense value of historical collections in helping to understand species circumscription and distribution. Collections from NY and ASU have alerted us to the presence of *P. wheeleri* (at least historically) in two regions where it was previously unknown. The next step will be to examine these areas further to determine whether it is regionally extinct, rare or simply overlooked and misidentified. Once we gain further knowledge of the current distribution of this species, we can ascertain whether its historical range was much broader, and use this information to inform conservation measures. We hope that the additional morphological and geographical data presented in this article will help lichenologists to clearly differentiate *P. wheeleri* from *P. glauca* so

we can fill any additional gaps in our knowledge of its distribution and abundance.

Selected Material Examined: (Complete list of specimens examined was submitted to datadryad.org and is available at <http://dx.doi.org/10.5061/dryad.k06p5>)

***Platismatia wheeleri* Goward, Altermann and Björk**

U.S.A., CALIFORNIA, Los Angeles Co., San Gabriel Mtn., on bark of *Abies*, 1897, *H. E. Hasse* (NY 01562524); San Gabriel Mtn., *H. E. Hasse* (NY 01562525); San Diego Co., Agua Tibia Wilderness, Magee Palomar Trail, in vicinity of Eagle Crag, Sept 1989, *B. Ryan 25860* (ASU); Agua Tibia Wilderness, Magee Palomar Trail at Crossley Saddle, 26 Sept 1989, *B. Ryan 25927* (ASU); Shasta Co., Near Castle Craigs State Park near the Sacramento River, 5 mi south of Dunsmuir, 9 June 1985, *J. P. Dey 16157* (NY 1611353); IDAHO, Adams Co., Weiser River Trail, south of Tamarack, on *Pseudotsuga* in *Abies-Pseudotsuga* forest, 16 May, 2012, *C. Björk 26100* (UBC); WASHINGTON, Spokane Co., NE corner of Turnbull National Wildlife Refuge, Channeled scablands, *Pinus ponderosa* forest, on *Pinus ponderosa* bark, determined by B. McCune, 15 Dec 2012, *J. Allen 48* (NY 01562528); Little Spokane River Natural Area, northern suburbs of Spokane, slopes north of the petroglyphs, on twigs of *Pseudotsuga* in open *Pinus ponderosa-Pseudotsuga* forest on rocky, granitic slope, 4 April, 2011, *C. Björk 22280* (NY 1575165); Spokane Co., Dishman Hills Natural Area, on *Amelanchier cusickii* in open *Pinus - Pseudotsuga* forest, 23 May, 2012, *C. Björk 26241* (UBC); **SLOVAKIA**, Tatras, *F. A. Hazlinszky von Hazslin* (NY 01562529).

***Platismatia glauca* (L.) W.L. Culb. and C.F. Culb.**

U.S.A., ALASKA, Evans Island, Port San Juan, on spruce bark, 10 May 1948, *Eyerdam 600* (NY 01562513); CALIFORNIA, Humboldt Co., Peninsula, Eureka, on dead *Myrica*, 02 Jun 1896, *Howe 947* (NY 01562521); Santa Cruz, Devil's

Canyon, on Douglas spruce, 16 Oct 1903, *Herre 285* (NY 01562523); Santa Lucia Mountains, Los Padres National Forest, 12 June 1962, *N. Lofton* (NY 01557308); IDAHO, Boundary Co., Easport, 16 Sep 1927, *Jones 3051* (NY 01557310); MAINE, Knox Co., Vinalhaven, Huber Preserve, coastal spruce-fir forest with gabbro-diorite bedrock and outcrops, 30 May 2009, *Harris 55597* (NY 1103940); MARYLAND, Garrett Co., W of Amish Road ca. 6.5 km SSW of Grantsville, Foxtown Swamp, Swamp forest and sphagnum bog, 23 Sep 1989, *Harris 24523* (NY 01557273); MASSACHUSETTS, Berkshire Co., N Adams, Mt. Greylock, on old limb, 13 Jul 1961, *Hutchinson 179* (NY 01557274); MONTANA, Missoula Co., Lewis and Clark Campground Day Use Picnic Area on Lolo Creek on US Hwy 12, 17.2 mi E of Lolo Pass and 15.5 mi W of US Hwy 93 at Lolo, on log, May 1996, *Dey 27863* (NY 1235949); NEW HAMPSHIRE, Coos Co., Great Gulf Wilderness, August 1933, *G. P. Anderson* (NY 01557278); NEW YORK, Essex Co., slope of Whiteface Mountain, spruce-fir woods, 23 Aug 1983, *Harris 16555* (NY 01557254); NORTH CAROLINA, Yancey Co., Balsam Cove in the Black Mountains, along Mt. Mitchell State Park boundary, Spruce-fir forest, on *Abies*, 1972, *Dey 1201* (NY 1225613); OREGON, Deschutes Co., Elk Lake at Elk Lake Point Campgrounds in Deschutes National Forest west southwest of Bend, 1987, *Dey 16297* (NY 1235936); TENNESSEE, Sevier Co., Great Smoky Mountains National Park, High Top of Mount LeConte, Spruce-fir forest, on *Abies*, 1972, *Dey 3220* (NY 1225602); VERMONT, Bennington Co., Mt. Equinox, coniferous trees, 14 Jun 1907, *Anderson* (NY 01557287); WASHINGTON, Pacific Co., North Head, on twigs, 06 Aug 1930, *Howard 457a* (NY 01549742); CANADA, BRITISH COLUMBIA, Wells Gray Provincial Park area, Clearwater Valley, ca. 20 km north of town of Clearwater, slopes east above the Moul Falls Trailhead, open forest on east-facing slope, on twigs of *Pseudotsuga menziesii*, 12 April, 2012, *C. Björk 25655*; ALBERTA, 1.3 mi E of Goose Mt. Firetower, mesic spruce-fir forest, 22 May 1971, *D. H. Vitt 3858* (NY 01557341); BRITISH COLUMBIA, Chapmans, at Alexandra's Suspension Bridge on Route 1, E side of Fraser River, on *Pseudotsuga*, 12 Jun 1966, *I. M. Brodo 8400* (NY 01557346); NEW BRUNSWICK, Charlotte Co., Lepreau Parish, New River Beach Provincial Park, Barnaby Head Trail between Raspberry Cove and Chitticks Beach, on *Picea* branch, 29 Apr 2011, *J. C. Lendemer 27749* (NY 1222438); NEWFOUNDLAND, Port-aux-Basques district, W slope of Table Mountain, Mixed woods, on trunk of *Picea*, 22 Jul 1953, *I. M. Lamb 7715* (NY 974338); NOVA SCOTIA, Colchester Co., Economy River Wilderness Area, N end of Simpson Lake, *Abies balsamea* swamp and *Acer saccharum*-*Betula alleghaniensis* forest, on fallen *Abies*, 17 May 2004, *R. C. Harris 49942* (NY 01557298); QUEBEC, Gaspé Co., Along Riviere Ste. Anne des Monts, Woods, on twigs, 22 July 1923, *J. F. Collins 2631* (NY 01557294); ARGENTINA, Santa Cruz, Morro Philippi, Basalt-Inselberg in der Nahe der Ea. Glencross (Rio Rubio), 07 Nov 1950, *H. O. Sleumer* (NY 01562492); Tierra del Fuego, Laguna Roca, on fallen wood stumps, 10 Feb 1963, *G. W. Prescott Ar1.-5* (NY 01562490); CHILE, Antarctica Chilena Province, Comuna Cabo de Hornos, Isla Navarino, Parque Etnobotanico Omora, ca. 3 km W of Puerto Williams, *Nothofagus* forest and peat bog, 21 Nov 2001, *W. R. Buck 40704* (NY 01562481); AUSTRIA, Styria, 20 Apr 1875, *A. Vigener* (NY 01562443); DENMARK, Faroe Islands, Streymoy, Túrshavn, tree plantation in city, wet forest of exotic trees over Tertiary basalt, 16 Jul 1987, *W. R. Buck 14791* (NY 01562435); CZECH REPUBLIC, Sudetis Silesiae, 1849 (NY 01562444); FINLAND, Uusimaa, Porvoo rural commune, Pirttisaari, growing on old wooden fence at forest margin, 23 Sep 1981, *P. Alanko 41775* (NY 01562471); FRANCE, Faucille (Jura), 27 (NY 01562430); GERMANY, Thüringen, *W. O. Müller* (NY 01562446); Nordrhein-Westfalen, 28 Sep 1900 (NY 01562448); SPAIN, Leûn, Parque Nacional de la Montana de Covadonga, E of Soto de Sajambre, along the Rio Dobra, dense, humid *Fagus* dominated forest over mostly acidic

rock, 09 Aug 1987, *W. R. Buck 15212* (NY 01562436); **SWITZERLAND**, Vaud, La Dole, Foret de la Barillette, Tres a l'ombre, peuplement tres dense, sur tout le pourtour, sur tronc de *Picea*, 21 Jun 1967, *F. S. Page 383* (NY 01562432); **SWEDEN**, *T. M Fries 74511* (NY 01562464); **UNITED KINGDOM**, Wales, County Gwynedd, W of Betws-y-coed, humid mountain ridge with large trees in partially cleared pasture, 30 Jul 1985, *W. R. Buck 13090* (NY 01561843); **RUSSIA**, Caucasus occidentalis, Rossia australis, districtus Sochi, vicinitas balneorum, Staraja Macesta, apud viam publicam, orlynyje scaly, on twig of Norway spruce (*Picea abies*), 01 Jun 1989 (NY 01562476).

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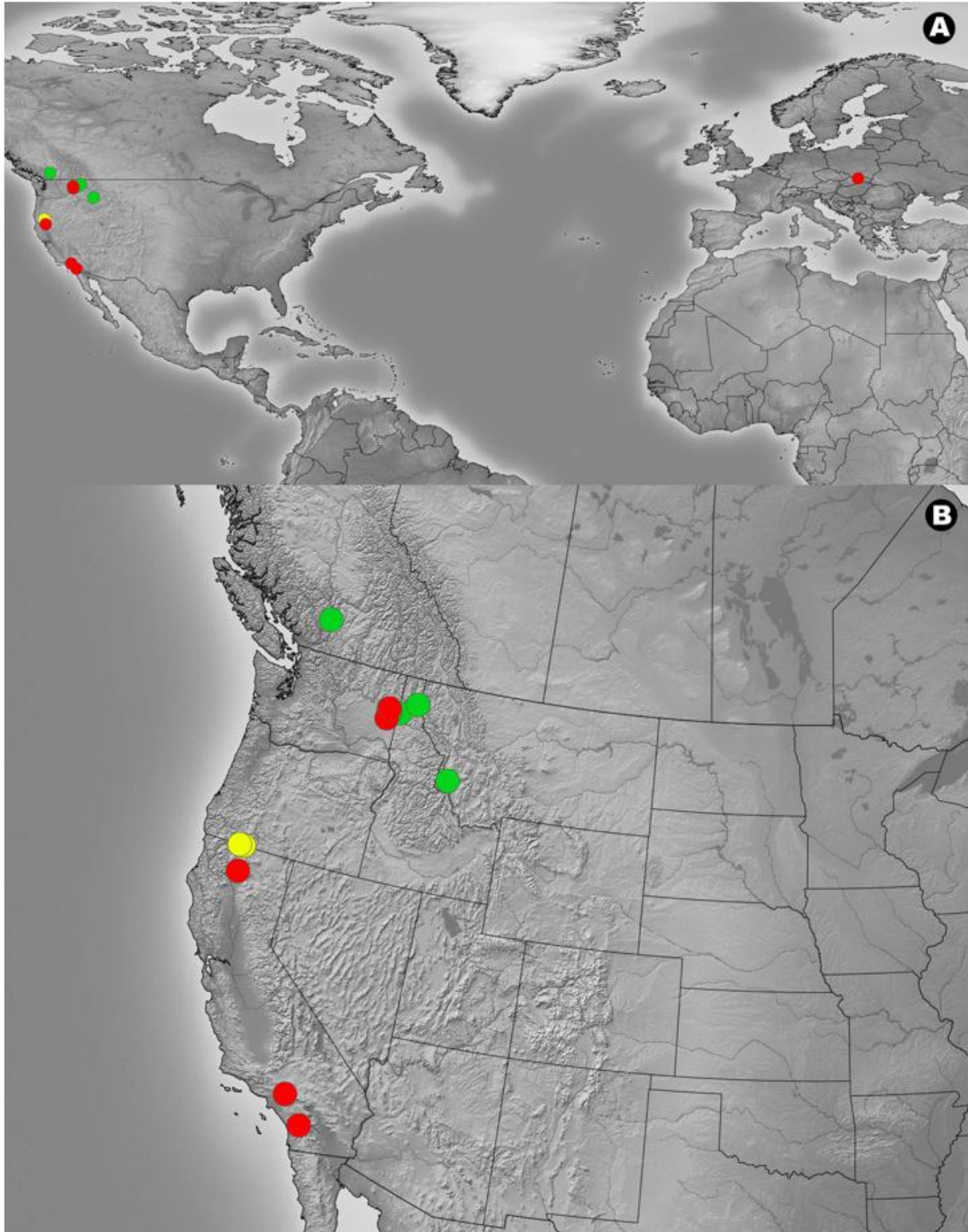


Figure 1. Current distribution of *Platismatia wheeleri* worldwide (A) and in western North America (B). Red circles are specimens newly reported here, green circles are from the original description, and yellow circles are from McCune 2012.

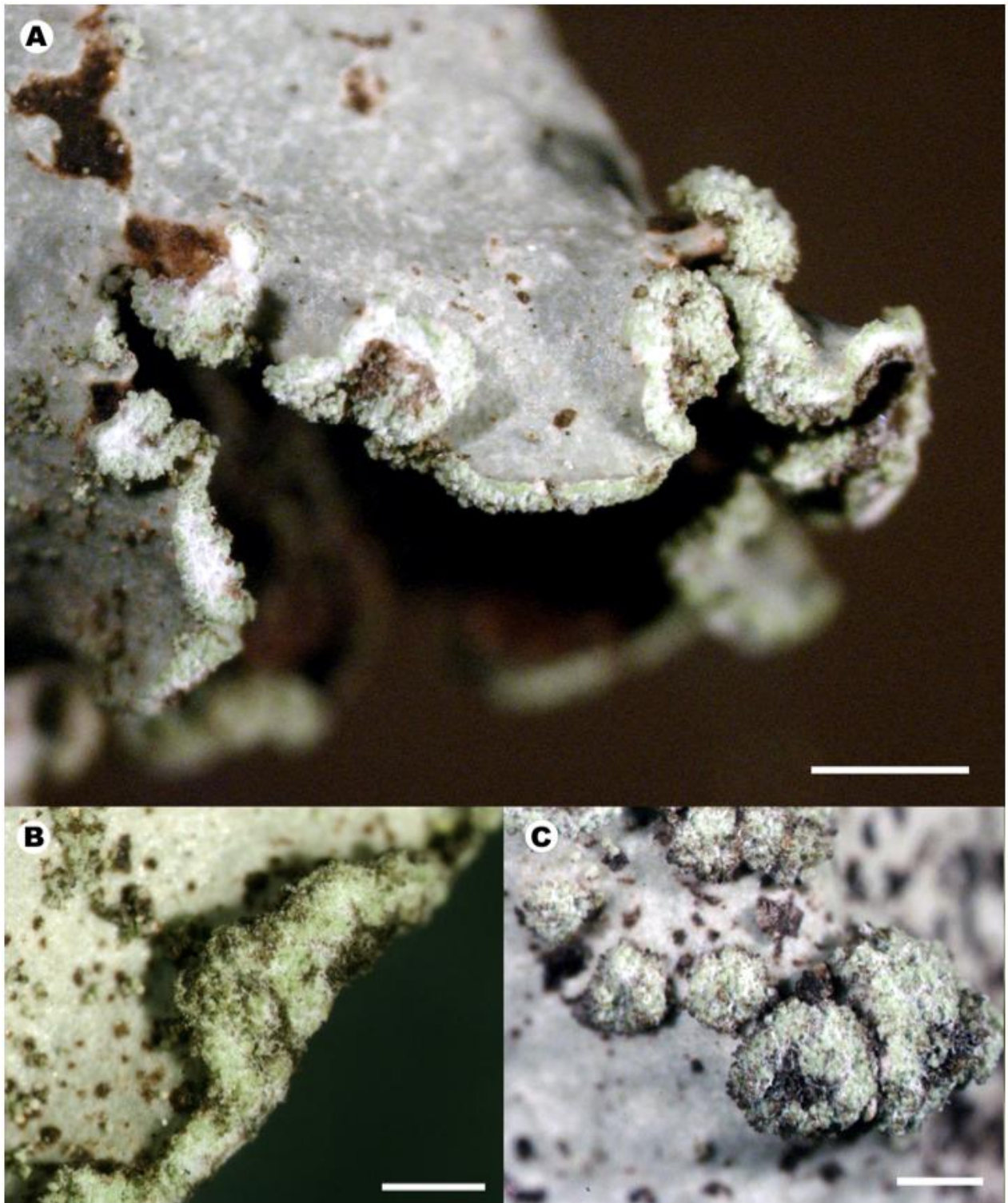


Figure 2. *Platismatia wheeleri* from eastern Washington (Allen 48). A and B, Lobe showing sinuous marginal soralia (A scale = 1 mm; B scale = 0.5 mm). C, Round laminal soralia (scale = 0.5 mm).

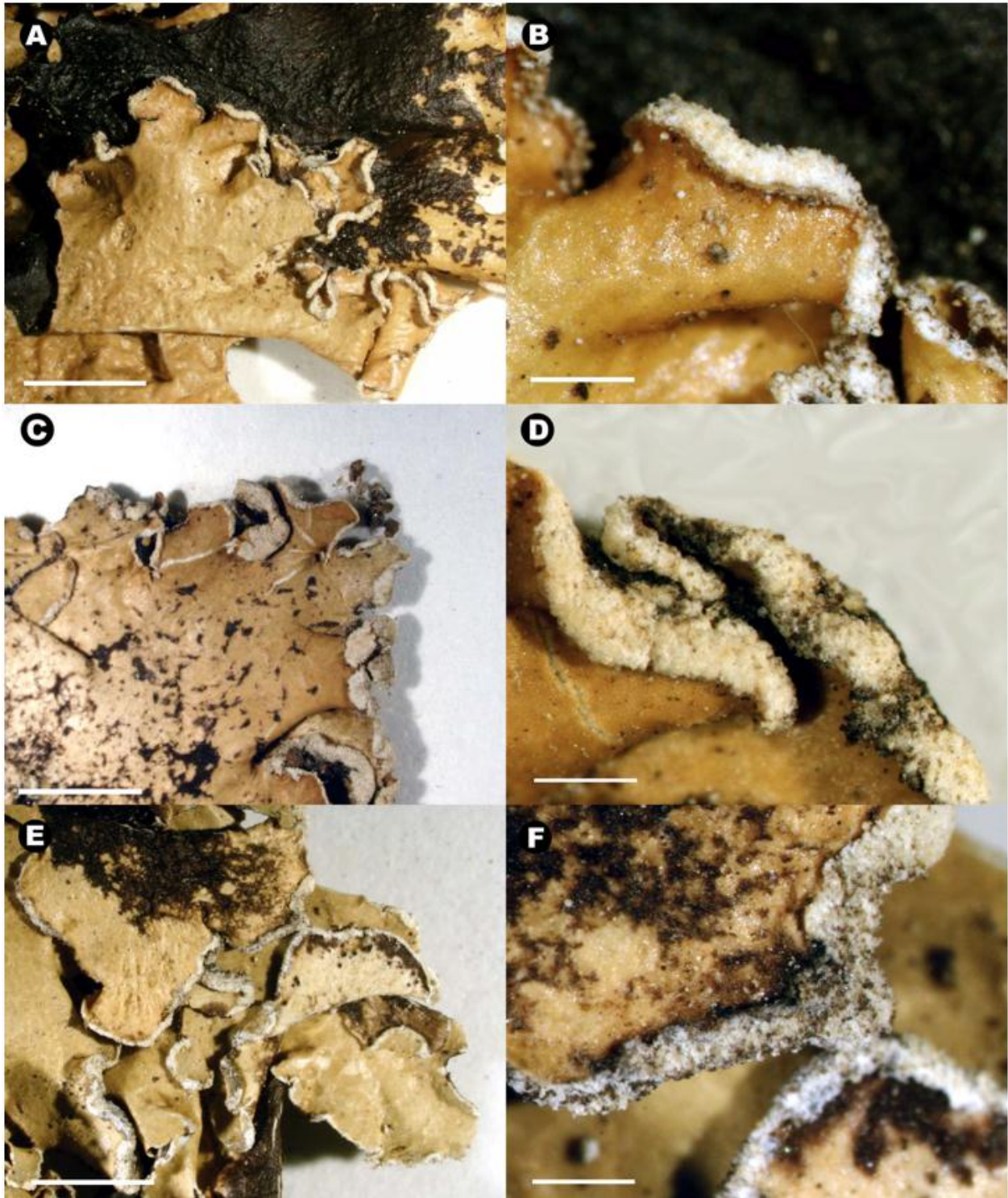


Figure 3. *Platismatia wheeleri* from Europe and Southern California. A and B Slovakia (NY 01562529). C and D (*H. E. Hasse* 1897) E and F (*H. E. Hasse* 17-45) San Gabriel Mountains, CA. (A, C and D scale = 2 mm; B, D and F scale = 0.5 mm).

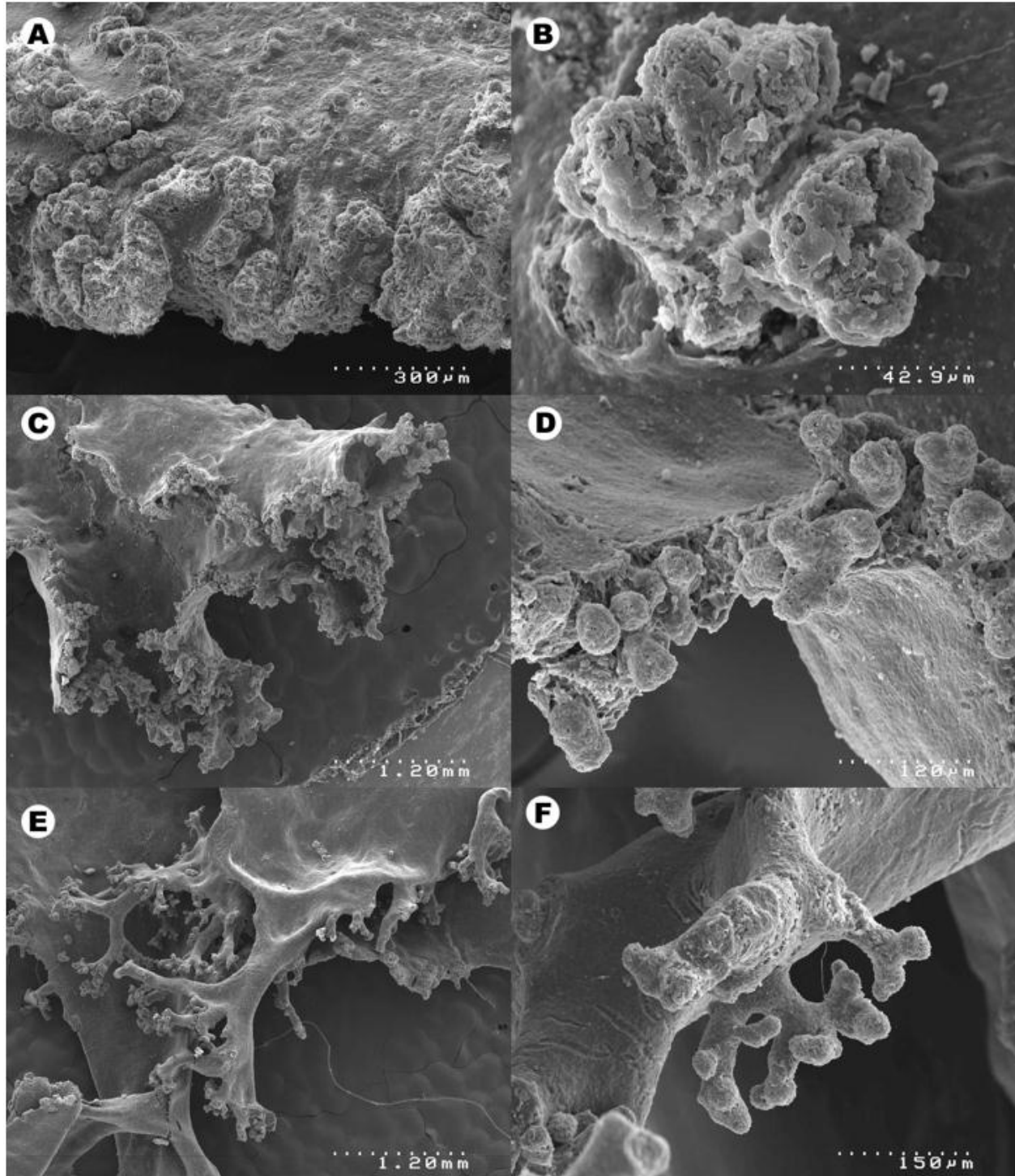


Figure 4. Scanning electron micrographs showing morphological variation in *Platismatia glauca*. A and B, Quebec, Canada; marginal (A) and laminal (B) isidioid soredia with gelatinized covering (*Miller 1967*). C and D, Missoula, MT, U.S.A. (*Dey 27863*). E and F, Sitka, AK, U.S.A. highly branched, fruticose lobes (*G. 1124*).

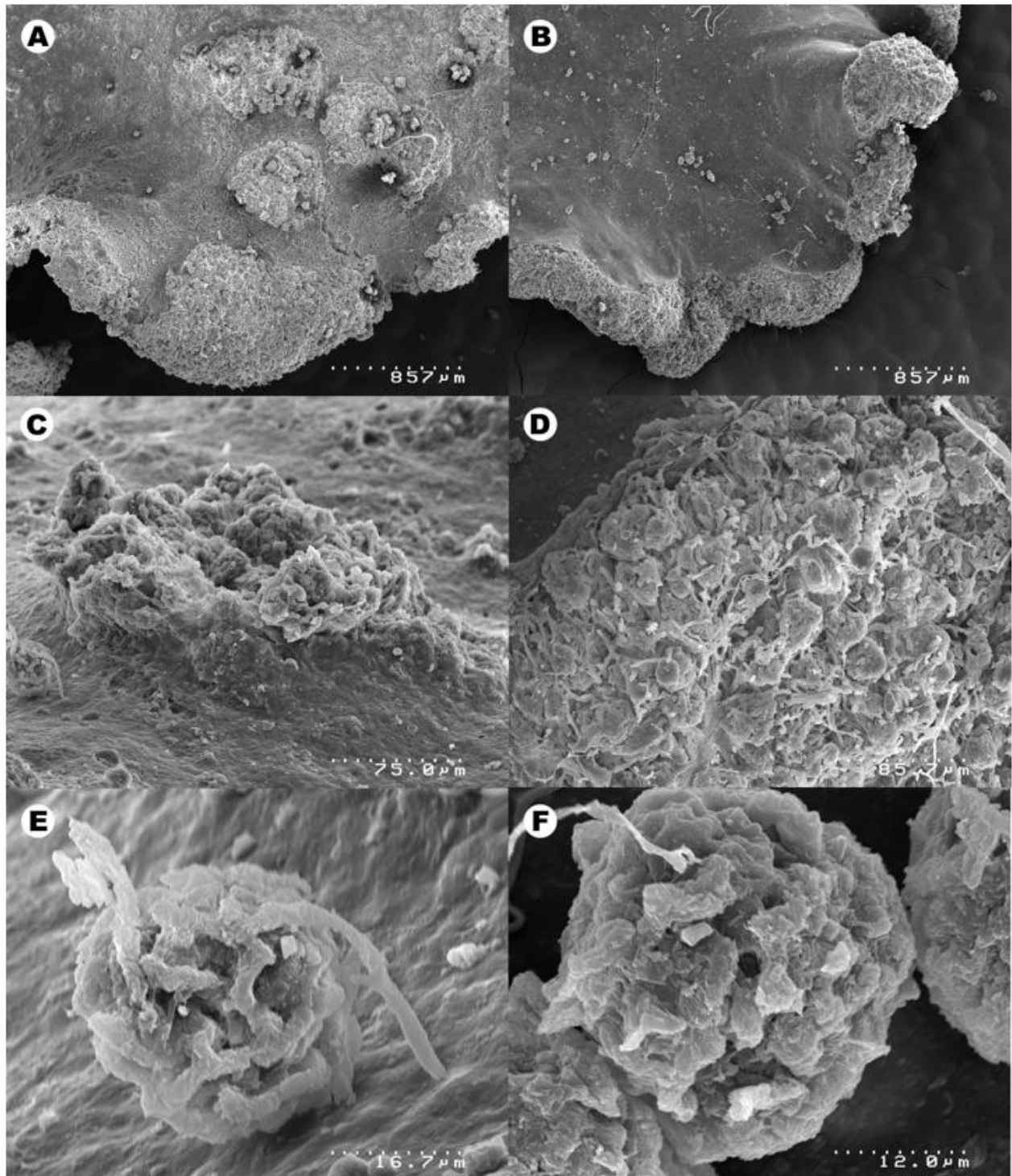


Figure 5. Scanning electron micrographs comparing *P. wheeleri* from eastern Washington and Slovakia. A, C and E specimen from Turnbull National Wildlife Refuge, near Spokane, WA showing marginal and laminal soralia (A), laminal soralia (C), and one soredium (E) (Allen 48). B, D and F from the Tatras in Slovakia showing sinuous marginal soralia (B and D), and one soredium (F) (NY 01562529).