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Japewiella dollypartoniana, a New Widespread Lichen in the Appalachian Mountains of Eastern North America

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ABSTRACT *Japewiella dollypartoniana* is described as new to science based on material from the Appalachian Mountains and adjacent regions of the Atlantic Coastal Plain. It is distinguished from other species of *Japewia* and *Japewiella* by its sorediate thallus and production of norstictic acid. Placement in *Japewiella* is supported by characters from fertile populations discovered in the Unicoi Mountains of western North Carolina which have apothecia that resemble those of *Japewia tornoënsis* (Nyl.) Tønsberg but differ in having a well-developed proper exciple and ascospores without a thick, gelatinous sheath.

Key words: Biogeography, Dolly Parton, endemism, heath bald, sterile crustose lichen.

INTRODUCTION The Unicoi Mountains span the border of Tennessee and North Carolina in the southern Appalachian Mountains of eastern North America, encompassing ~2,590 square kilometers of relatively uninhabited land. During recent fieldwork we explored some of the highest peaks in this area as part of a broader project to ground truth the distributions of endemic lichens projected by Maxent modeling (Allen, in prep.). On the summit of Hangover Mountain, one of the highest peaks in the Unicoi Mountains (elevation ca. 1,569 m), we collected fertile specimens of a sorediate crust with norstictic acid that had previously been collected elsewhere throughout the Appalachian Mountains. With these new data we were able to firmly place the undescribed species within *Japewiella* due to its excipular structure and ascospore characters. Here we describe this taxon as *Japewiella dollypartoniana*.

MATERIALS AND METHODS The present study is based on material deposited in the New York Botanical Garden (NY). Morphology was studied using dissecting (Olympus SZ60, Spach Optics Inc., Rochester NY) and compound (Olympus BH-2) microscopes. Measurements were made in CellSens Standard (Olympus, Tokyo, Japan) from images of water mounts captured with an Olympus DP72 digital camera fitted onto an Olympus BZ-53. The size ranges for ascospores, photobiont cells, fungal hyphae, and soredia include the mean ($\bar{x}$), the mean ($\bar{x}$) ± 1 standard deviation (SD), and the maximum and minimum values followed by the sample size (n). These ranges are expressed as [lowest value]–($\bar{x}$ − 1 SD)–$\bar{x}$–($\bar{x}$ + 1 SD)–[highest value]. All other measurements are expressed as a range of observed values. Chemical substances were determined with spot tests using standard reagents (see Brodo et al. 2001) both directly on the thallus and on fragments mounted on slides in water. Thin-layer chromatography was also conducted using solvents A and C following Culberson and Kristinsson (1970).

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TAXONOMIC SECTION

Japewiella dollypartoniana J.L. Allen & Lendemer, **sp. nov.**
Mycobank #811236.
Figure 1.

TYPE: USA, North Carolina: Graham County, Nantahala National Forest, Joyce Kilmer-Slickrock Wilderness, vicinity of the summit of Hangover Mountain, approximately 4 mi SW of Tapoco, and approximately 5.3 mi W of the N end

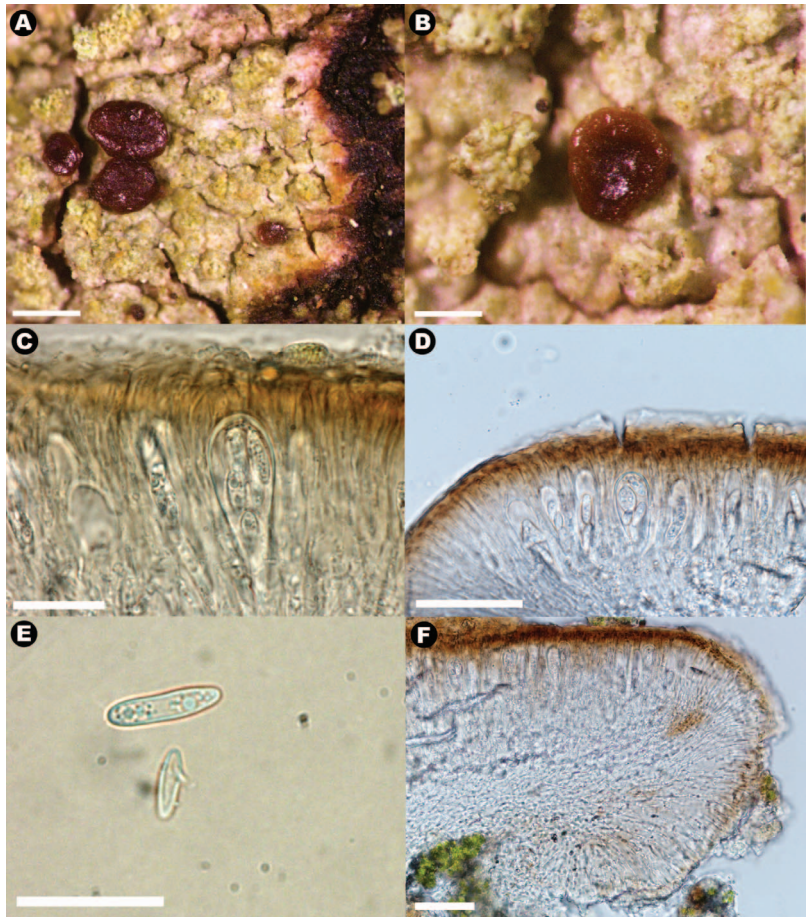

Figure 1. Morphology of *Japewiella dollypartoniana*. A–B, apothecia and thallus (0.5-mm scale bars). C–D, asci (C—20 μm, D—50 μm). E, ascospore (20 μm). F, details of excipular anatomy (50 μm).

of Santeetlah Lake, 5,160 ft, heath bald community dominated by ericaceous shrubs (*Rhododendron*, *Vaccinium*, *Kalmia*) and exposed rock with sparse *Acer*, *Betula*, and *Ilex*, 30.ix.2014, on *Rhododendron*, *Allen 4018 & Lendemer* (NY, holotype).

Diagnosis. Similar to *Japewia subaurifera* Muhr & Tønsb., but differing in the production of norstictic acid, characters of the apothecia which suggest placement in *Japewiella* (i.e., well-developed proper exciple with radiating hyphae, branched and anastomosing paraphyses), and size and shape of the ascospores (narrowly elongate ellipsoid and 12–14 × 4.3–5.5 μm vs. broadly ellipsoid and 15–22 × 12–17 μm in *J. subaurifera*).

Description. **Thallus** crustose, varying from endo- to episubstratal, sorediate, when episubstratal continuous, becoming cracked and superficially appearing areolate, forming ± circular thalli 2–6 cm sometimes coalescing to forming extensive colonies several feet in diameter, greenish-gray to brown. **Prothallus** indistinct and colorless, not fibrous. **Hyphae** [1.5]–(2.2)–3.2–(4.3)–[5.7] μm (n = 72) wide. **Soralia** erupting and breaking through the surface of the thallus or substrate, flat to moderately convex and rounded, greenish-gray to brown, greenish-gray in outer areas sometimes grading to brown in central areas, punctiform, discrete, with age edges becoming poorly defined and often merging with adjacent soralia to form irregular, diffuse sorediate patches. **Soredia**

globose [10.9]–(16.2)–23.8–(31.4)–[49.9] μm (n = 108) diameter, ecorticate, well organized and discrete, often forming aggregates; brown pigments dissolving in KOH. **Apothecia** very rare, known only from populations on Haoe Mountain, reddish brown, shiny with biatorine exciple. **Epihymenium** red-brown to olive-brown, pigment present in both the gelatinous matrix and the apical cell walls of the paraphyses, 10–30 μm thick. **Hymenium** hyaline, 30–50 μm thick, I+ blue. **Paraphyses** hyaline except in the terminal cell which has brown pigmented walls, simple and little branched or anastomosed, 1–2 μm wide, apical cell weakly enlarged and with a distinctive thick gelatinous sheath. **Hypothecium** hyaline, 50–80 μm thick. **Exciple** composed of branched and radiating hyphae that have a thick gelatinous wall and contrast strongly with the organization of the adjacent hypothecium, internally hyaline transitioning to light or dark red-brown in the outer portions, 50–100 μm thick. **Asci** *Lecidella*-type, 33.1–33.4 × 12.5–15 μm. **Ascospores** simple, hyaline, elongate-ellipsoid, with a single wall and lacking a gelatinous epispore, [12]–(12.1)–13.3–(14.4)–[13.7] × [4.3]–(3.8)–4.4–(5.0)–[5.5] μm (n = 27). **Photobiont** coccoid, green, cells globose [5]–(6.3)–8–(9.7)–[14.4] μm (n = 105) diameter.

Chemistry. Norstictic and connorstictic acids. Spot tests: K+ yellow turning red (producing red crystals in a water mount), KC–, C–, P+ yellow, UV–.

Etymology. *Japewiella dollypartoniana* is named in honor of Dolly Parton, one of the most famous country singers of all time and a native of the southern Appalachians. Ms. Parton rose to stardom from humble beginnings in the mountains of eastern Tennessee on the edge of the Great Smoky Mountains where this species grows abundantly (Parton 1995). Over her career she has written thousands of songs, starred in influential movies, as well as been nominated for and won numerous awards. Her tireless efforts have led to national and even global attention for one of America's most scenic and biologically significant regions.

Ecology and Distribution. The new species is widely distributed in the Appalachian Mountains of eastern North America where it occurs from Maine south to Georgia, USA (Figure 2C). Its core distribution appears to be centered in the southern Appalachian Mountains where it is common and often abundant on the branches of trees and the stems of saplings and shrubs at middle to high elevations (i.e., >762 m). It is particularly common on heath balds (Figure 2A, 2B). Although it occurs in the central and northern Appalachians, the species is much less common there and is instead replaced by *Ropalospora viridis* (Tønsberg) Tønsberg which has a similar ecology.

As is the case with other temperate Appalachian species such as pitch pine (*Pinus rigida* Mill), *Japewiella dollypartoniana* is also found in the Atlantic Coastal Pine Barrens of southern New Jersey and Long Island, New York (for discussion of this biogeographic pattern, see Heusser 1998). In the northern portions of its range *J. dollypartoniana* is typically found on the branches of conifers (*Chamaecyparis*, *Pinus*) in swamp forests which may exhibit humidity similar to high-elevation habitats that the species occupies elsewhere in its range.

Conservation. This species is of low conservation concern due to its extensive range and ability to grow on a variety of substrates. If northern or coastal populations were threatened, the southern Appalachian populations would likely act as a stable refuge for *Japewiella dollypartoniana*.

Discussion. *Japewiella dollypartoniana* is one of a handful of common sorediate species that has perplexed us for more than a decade. Indeed it has been reported as an unidentified sterile sorediate crust in several checklists (e.g., Harris and Lendemer 2005, Lendemer and Tripp 2008). Although the morphology of the thallus and presence of norstictic acid are distinctive features, the generic placement of the species was unclear. We long suspected a relationship with *Japewia* based on the variable pigmentation of the soredia, but were nonetheless uncertain in the absence of fertile material since norstictic acid would be chemically discordant with both *Japewia* and *Japewiella* (Tønsberg 1990, Printzen 1999, Kantvilas 2011). The discovery of abundantly fertile populations on a single peak in the Unicoi Mountains of western North Carolina finally allowed us to determine that it is actually an endemic member of the genus *Japewiella*, a genus which is not otherwise known from the Appalachian Mountains.

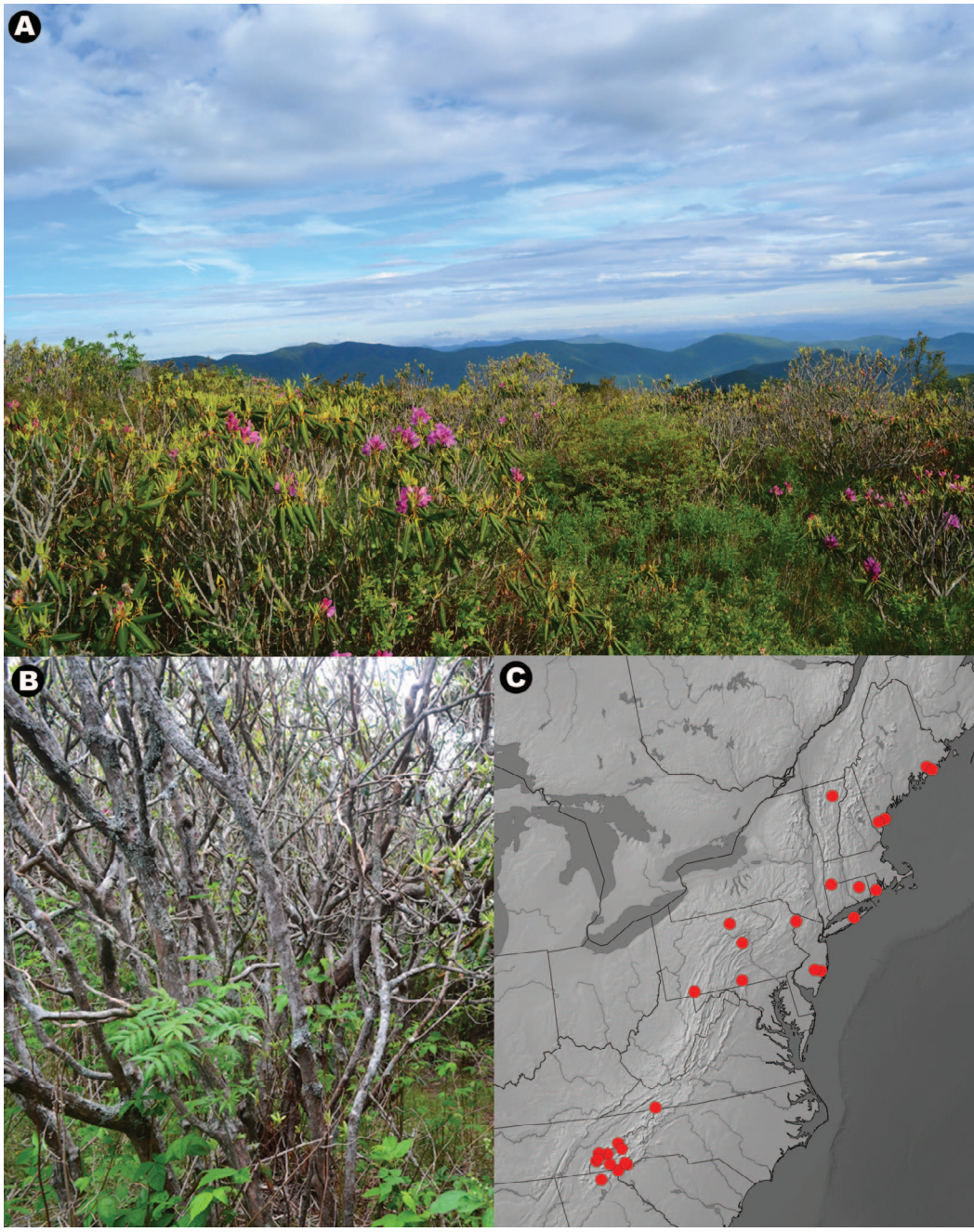

Figure 2. Ecology and distribution of *Japewiella dollypartoniana*. A–B, high-elevation heath balds where the species is most commonly found in the southern Appalachians (photographs by S. McKenzie). C, known distribution of the species.

The genus *Japewiella* was originally included within a broad concept of *Japewia*; however, it was separated from that genus by Printzen (1999) based on a suite of differences in the apothecia, ascospores, and chemistry. Most notably, species of *Japewiella* differ from *Japewia* in having apothecia with a prominent (at least in section) proper exciple composed of radiating hyphae (vs.

a poorly developed proper exciple composed of hyphae that are undifferentiated from the hamathecium), paraphyses which are abundantly branched and anastomosed (vs. not branched and anastomosing), ascospores that do not have multiple walls, and a thick gelatinous epispore. All of these features are present in *J. dollypartoniana* and suggest that placement in *Japewiella* is appropriate. The one discordant feature of *J. dollypartoniana* is the production of norstictic acid, as all other members of the genus produce either atranorin and xanthones or atranorin and other unrelated substances (Kantvilas 2011). Additionally, *J. dollypartoniana* is the first sorediate species to be placed in *Japewiella*. However, the discovery of a sorediate member of the genus is not unexpected considering that *Japewia* comprises two species, one sorediate (*J. subaurifera*) and one that is not (*J. tornoënsis* (Nyl.) Tønsberg). A key distinguishing the new species from all other species of *Japewia* and *Japewiella* is provided below.

When apothecia are present it is unlikely that *Japewiella dollypartoniana* will be confused with any other crustose lichen in eastern North America. Nonetheless, since fertile populations are known from only a single location, most readers are likely to encounter *J. dollypartoniana* in a sterile state. When sterile, *J. dollypartoniana* can be recognized by the combination of the production of norstictic acid and the color of the soredia which are either light green-brown or dark brown. There are few sympatric species with which *J. dollypartoniana* can be confused. The most likely cause of confusion is *Buellia griseovirens* (Turner *ex* Borr. & Sm.) Almb., a northern boreal species that also produces norstictic acid, although always in addition to atranorin (Allen and Lendemer 2013). In addition to the difference in chemistry, the soredia of *B. griseovirens* typically have a distinctive dark blue-gray or green-gray coloration that contrasts strongly with a thick white thallus (Allen and Lendemer 2013). Odd forms of *Mycoblastus caesius* (Coppins & P. James) Tønsberg with a thallus that is lighter gray than usual can also be confused with *J. dollypartoniana*. That species is also common at high elevations in the southern Appalachian Mountains and closer to sea level in the northern Appalachians. Nonetheless it can be easily separated from *J. dollypartoniana* by the presence of a dark blue-black prothallus and by the production of perlatolic acid instead of norstictic acid.

Selected Specimens Examined. USA. **CONNECTICUT. Litchfield Co.:** Holleran Swamp Preserve, 10.ix.2003, on *Pinus* branch, *Harris 47972* (NY). WINDAM CO.: Windham Bog, S of US 6, 20.ix.2009, on *Chamaecyparis* twigs, *Harris 55734* (NY). **GEORGIA. Rabun Co.:** Chattahoochee National Forest, Rabun Bald, 20.ix.1996, on *Kalmia*, *Harris 38989* (NY). **Union Co.:** Chattahoochee National Forest, along Duncan Ridge Trail from Wildcat Gap to Coosa Bald, 6.x.1998, on *Nyssa*, *Harris 42540* (NY), on *Betula*, *Harris 42554* (NY). **MAINE. Hancock Co.:** Donnell Pond Maine Public Reserve Lands, Black Mountain, East Black Peak, 5.vi.2012, on *Picea* branch, *Lendemer 32331 & Moroz* (NY). **Washington Co.:** Dyer Neck, Eagle Hill, 24.vii.2006, on *Pinus*, *Harris 52843* (NY). **York Co.:** Ferry Beach State Park, Tupelo Swamp, 15.ix.2002, on *Vaccinium*, *Harris 46361* (NY). **NEW JERSEY. Burlington Co.:** Bass River State Park, along Dans Bridge Rd., E of Lake Absegami, 12.v.2007, on *Chamaecyparis*, *Lendemer 8914 & Moroz* (NY). **NEW YORK. Suffolk Co.:** Cranberry Bog Nature Preserve, 20.ix.1986, on *Chamaecyparis*, *Harris 19438* (NY). **NORTH CAROLINA. Graham Co.:** Nantahala National Forest, Cherohala Skyway [NC143], Stratton Ridge, 1.x.1997, on *Acer*, *Harris 41002* (NY), Nantahala National Forest, Joyce Kilmer-Slickrock Wilderness, summit of Hangover Mt., 30.ix.2014, on *Sambucus*, *Lendemer 43895 & Allen* (NY); Nantahala National Forest, Huckleberry Knob, 30.ix.2014, on *Fagus*, *Lendemer 43968 & Allen* (NY). **Haywood Co.:** Great Smoky Mountains National Park, summit of Purchase Knob, 20.vi.2011, on hardwood, *Lendemer 29341 & Davoodian* (NY). **Jackson Co.:** Nantahala National Forest, Panthertown Valley, vicinity of Schoolhouse Falls, 29.iv.2006, on twig, *Buck 50127* (NY). **Macon Co.:** Nantahala National Forest, N slope of Wayah Bald along Appalachian Trail, 12.x.1998, on *Vaccinium*, *Harris 42818* (NY). **Swain Co.:** Great Smoky Mountains National Park, 0–2 mi SE of jct w/Welch Ridge Trail/Cold Spring Gap Trail, above Poplar Flats Campground, 6.viii.2012, on *Oxydendrum*, *Tripp 3419 & Lendemer* (NY); Nantahala National Forest, Cheoah Wilderness, Cheoah Bald, 23.ix.2013, on *Amelanchier*, *Lendemer 43688 & Allen* (NY). **Transylvania Co.:**

Gorges State Park, along Grassy Ridge Rd., Grassy Ridge, 9.viii.2005, on *Acer*, *Lendemer 4741 & Tripp* (NY). **PENNSYLVANIA. Fayette Co.:** Ohiopyle State Park, along the Great Allegheny Passage paralleling the Youghiogheny River, 28.iv.2012, on fallen branch, *Harris 57410* (NY). **Franklin Co.:** 1.vi.2009, on *Acer*, *Lendemer 18152* (NY). **Tioga Co.:** Tioga State Forest, W-facing slopes of S end of Callahan Hill, 14.v.2009, on *Pinus* branch, *Lendemer 16891* (NY). **Pike Co.:** Delaware Water Gap National Recreation Area, 23.iv.2004, on branch, *Harris 49509* (NY). UNION CO.: Bald Eagle State Forest, The Hook Natural Area, 13.ix.2010, on *Acer*, *Lendemer 25252* (NY). **RHODE ISLAND. Washington Co.:** Marion Eppley Wildlife Sanctuary, ~1.5 mi NE of Usquepaug, 16.ix.2006, on *Acer*, *Harris 53167* (NY). **TENNESSEE. Blount Co.:** Great Smoky Mountains National Park, between Flint Gap and Hannah Mt. on Hannah Mountain Trail, 9.viii.2012, on *Acer*, *Tripp 3600 & Lendemer* (NY). **Cocke Co.:** Great Smoky Mountains National Park, summit of Mt. Cammerer, 21.x.2012, on *Rhododendron*, *Lendemer 33400 & Moroz* (NY). **VERMONT. Caledonia Co.:** Wheelock Farm, NW shore of Flagg Pond, 22.x.2010, on *Alnus*, *Lendemer 27579 & Sundue* (NY). **VIRGINIA. Smyth Co.:** Jefferson National Forest, Whitetop Mountain, 5.iv.2009, on *Rhododendron*, *Harris 54126* (NY).

KEY TO THE GENERA *JAPEWIA* AND *JAPEWIELLA*

1. Thallus sorediate 2
1. Thallus esorediate 3
2. Norstictic acid present, thallus K+ yellow turning red and P+ yellow ..... *Japewiella dollypartoniana*
2. Norstictic acid absent (no substances present, lobaric acid present, or secalonic acid A present), thallus K– and P– .... *Japewia subaurifera* Muhr & Tønsberg
3. Ascospores with a thick, multilayered wall that is ≥1.5 μm thick; exciple poorly developed and not differentiated from the hamathecium; atranorin absent . *Japewia tornoensis* (Nyl.) Tønsberg
3. Ascospores with a thin, uniform wall that is ≤1.5 μm thick; exciple well developed and strongly differentiated from the hamathecium; atranorin and/or other substances present 4
4. Hypothecium and subhymenium ≤60 μm tall .. *Japewiella carrollii* (Coppins & P. James) Printzen
4. Hypothecium and subhymenium ≥100 μm tall .. 5
5. Proper exciple quickly excluded and not inspersed with granules..... ..... *Japewiella djagensis* (Zahlbr.) Printzen
5. Proper exciple persistent and inspersed with granules 6
6. Crystals in the proper exciple soluble in K; thallus warty-areolate; atranorin and 3-chlorostenosporic acid, 3-chloroperlatolic acid, and 3-chlorodivaricatic acid present .. *Japewiella pacifica* Printzen
6. Crystals in the proper exciple not soluble in K; thallus continuous and smooth; other combinations of substances present 7
7. Apothecia small, ≤0.5 mm in diameter; atranorin present..... .... *Japewiella tavaresiana* (H. Magn.) Printzen
7. Apothecia larger, 0.3–1.0 mm in diameter; pannarin and xanthones variably present but often difficult to detect..... .... *Japewiella pruinosula* (Müll. Arg.) Kantvilas

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