

NOVELTIES IN *MUSINEON* (APIACEAE) AND *ORTHOCARPUS* (OROBANCHACEAE)
IN THE NORTHERN WASATCH MOUNTAINS OF UTAH AND IDAHO

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ABSTRACT

Two novelties from the Bear River Range of the northern Wasatch Mountains of Utah and Idaho are *Musineon naomiensis* L. M. Shultz & F. J. Smith, sp. nov. (Apiaceae) and *Orthocarpus holmgreniorum* (T.I. Chuang & Heckard) L. M. Shultz & F. J. Smith, comb. et. stat. nov. (Orobanchaceae). With these additions, the Bear River Range harbors 13 endemic plant species, most of which are edaphically restricted to dolomitic rocks in or near Logan Canyon. Most of the 260+ species of the 2600+ native species on the Utah state list of rare plants are in the warm-desert portion of the state. The montane endemics enumerated here demonstrate the unique habitats of the mountains of northern Utah and distinguish the Bear River Range as a hotspot of rarity.

Key Words: Bear River Range, edaphic endemism, glacial refugia, *Musineon* (Apiaceae), northern Wasatch Mountains, *Orthocarpus* (Orobanchaceae), rare plants, Utah.

Utah is known for its high proportion of narrowly restricted species of flowering plants. More than 10% of its approximately 2700 native species are endemic to the state (Albee et al. 1988; Welsh et al. 2008), making the area one of the richest areas of endemism in North America (Stein et al. 2000). Of the 260 endemic species listed as rare and restricted to unique edaphic substrates (Welsh et al. 1978; Stohlgren et al. 2005; Fertig 2012), the majority are restricted to low elevation habitats with low species diversity (Shultz 1993).

Although mountain endemics are uncommon in Utah (Shultz 1993), the Bear River Range of the northern Wasatch Mountains harbors 13 endemics, eight of which are known only from Logan Canyon. The high concentration of endemics signals the Logan Canyon area as an unusual hotspot of rarity in Utah. The two species described here – one with a new status, the other as a novel species – add to a growing list of endemic species in northern Utah.

Notable among these species is the Maguire primrose (*Primula maguirei* L. O. Williams), the only one of the named local endemics that is currently protected with threatened status (US Fish and Wildlife Service 1985). It shows strong genetic differentiation among closely related species in the *Primula cusickiana* (A. Gray) A. Gray complex, as well as surprisingly high levels of heterogeneity within its small geographic range (Wolf and Sinclair 1997; Bjerregaard and Wolf 2008; Davidson et al. 2014). We can infer from these genetic studies as well as the widespread geographic range of *P. maguirei* (Kass and Welsh 1985; Kelso 1991; Holmgren and Kelso 2001) that it is a glacial relict.

The rare plants of Logan Canyon provide an opportunity to study evolutionary forces leading to

relictual endemism, as well as neo-endemism, patterns that can be either anagenetic or cladogenetic (Takayama et al. 2015). The two species described here appear to be closely related species, both nested within species complexes inhabiting mountain ranges of the Intermountain region, which stretches from the Sierra Nevada of California to the Colorado Plateau of Arizona, Colorado, New Mexico, and Utah.

TAXONOMIC TREATMENT

Musineon naomiensis L. M. Shultz & F. J. Smith, sp. nov. (Fig. 1).— TYPE: USA, UTAH, Cache Co., Naomi Peak, Mt. Naomi Wilderness area, Bear River Range of the Wasatch Mountains, 41.9114 N, 111.6686 W, in shaded sites, crevices of limestone, SSE exposure, with *Clematis*, *Penstemon*, *Mertensia*, *Leucopoa kingii*, 2 Jul 2013, Frank J. Smith 4225, with Mike Jablonski and Jane Catlin (Holotype: UTC; isotypes: NY, JEPS).

Diagnosis. The narrowly endemic *Musineon naomiensis* has white petals 2–3.5 mm long marked with a dark red center, a compact growth form, bractlets 2–4 mm long, glabrous fruit, and a subalpine distribution (Fig. 2A). The closely related and more common *Musineon lineare* (Rydb.) Mathias has yellow petals 4–8 mm long, bractlets 4–7 mm long, scaberulous fruit, a sprawling growth form, and mid to upper montane habit (Figure 2B). In the few sites where the two species are sympatric, they remain morphologically distinct with no evidence of hybridization.

Plants caespitose perennial from a woody base, forming clumps 3–4 cm in diameter, 3–5 cm high,



FIG. 1. *Musineon naomiensis* L. M. Shultz and F. J. Smith, sp. nov. (A) Habit. (B) Fruit. Illustration by Lara Call Gastinger.

with persistent leaf bases; acaulescent, faintly aromatic. **Roots** thick taproot that is usually branched. **Leaves** pinnately compound with 5–7 leaflets, 2–5 (–7) X 1–2 cm, rarely twice-pinnate, broadly lanceolate in outline, glabrous, dark green on both surfaces, leaflets linear-oblancoate, 3–5 (–10) X 1.0–1.5 mm, with revolute margins, apical leaflets longer than the laterals; petioles 1–3 cm long with conspicuous papery sheaths. **Inflorescence** a compound umbel, compact, 5–8 (–10) mm

diameter, terminal on a naked scape immersed in, or barely exceeding the leaves; scape 4–7 cm (–14) cm long. **Bracts** linear-elliptic (broadest in the middle), 2–4 mm long, scarious-margined; bracteoles absent. **Calyx** teeth to 0.5 mm long. **Petals** white with a dark red mid-section, 2.0–3.5 X 0.9–1.0 mm. **Styles** 0.8–1.0 mm long. **Anthers** white, ca. 0.5 mm long; stylopodium wanting; carpophore entire or obscurely bifid. **Fruit** schizocarp subterete, 2.0–4.0 X 1.5 mm, glabrous, ribs white, conspicuous.

Paratypes: USA, IDAHO, **Bear Lake Co.:** 0.25 mi S of Bloomington Lake, Bear River Range, ca. 11 miles NW of St. Charles, Cache National Forest, T15S, R42E, SW1/4 Sec. 4; elev. 9000 ft; N to NW aspect, on limestone, with *Pinus flexilis*, *Pachistima myrsinites*, *Pellaea breweri*. 19 Jul 1990. *M. Mancuso* 286 (NY, ID); cirque headwall above Bloomington Lake, Bear River Range, ca. 9 miles WNW of St. Charles, T15S, R42E, SW1/4 Sec. 5, elev. 8800 ft, on Laketown dolomite; moist ledges, cliff faces, with *Aquilegia coerulea*, *Poa nervosa*, *Abies lasiocarpa*, 18 July 1990, *R. Moseley* and *M. Mancuso* 1793 (ID). UTAH, **Box Elder Co.:** Wellsville Mountains, Wellsville cone, T11N, R2W, Sec 36, elev. 8800 ft, 23 Jul 1991 (long-leaved form), *F. J. Smith* 3501 (UTC); SE of Box Elder Peak, T10N, R2W, S1, elev. 9280 ft, 23 Jul 1991 (scapes to 14 cm), *F. J. Smith* 3506 (BRY). **Cache Co.:** south slopes above White Pine Lake, elev. 8700 ft, 17 Jul 1936, *Bassett Maguire* 14098 et al. (UTC); vicinity of Mt. Naomi, 5 July 1937, *R.S. Snell s.n.* (BRY, UTC); east slope of Mt. Naomi, elev. 9300 ft, 18 Aug 1938, *B. Maguire* 16187 (BRY, UTC); east of Naomi Peak summit, crevices of rocks,

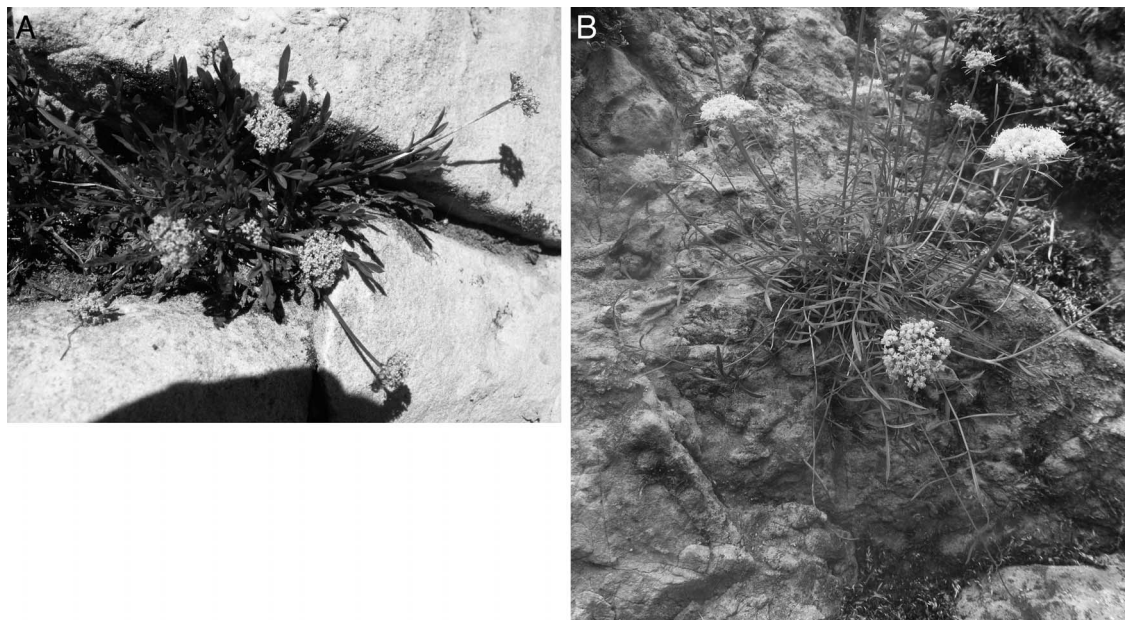


FIG. 2. Photos showing the white-flowered *Musineon naomiensis* (A) and yellow-flowered *Musineon lineare* (B). Photographs by Frank J. Smith.

30 Jul 1944, *A.H. Holmgren 3595* (UTC); infrequent on rock faces along ridge to south slope of Mt. Naomi, 23 Jul 1953, *S. Tillett 276* (NY, UTC; bare limestone outcrop near summit of Mt. Naomi, elev. 9100 ft, 25 Jun 1981, *L. Shultz 5401*, with J. Shultz, C. Loveland, and D. Thomas (UTC); summit of Mt. Naomi, 3.5 mi above Tony Grove Lake, 24 Jun 1987 (voucher for chromosome count sent to R. Hartman), *L. M. Shultz 10475* with J. Shultz, D. and J. Cade (RM, UTC); Bear River Range, Smithfield Canyon, 2.8 mi up from campground, T13N, R2E, NWSW1/4 Sec. 3, elev. 8200 ft, limestone cliff, with *Petrophytum*, 17 May 1989, *F. J. Smith 3003* (BRY) [*bracts to 6 mm]; south fork of High Creek, Bear River Range, T14N, R2E, NENE1/4 Sec. 26; elev. 7640 ft 29 May 1989, *F. J. Smith 3023* (BRY); south fork of High Creek, Bear River Range, T14N, R2E, SWSW1/4 Sec. 11; 29 May 1989, *F. J. Smith 3027* (BRY); Naomi Peak Wilderness area, NW slope of ridge (between) Smithfield and Cottonwood Canyons, T13N, R2E, SWSE1/4 Sec. 11, elev. 8800 ft; crevices and soils in dolomite outcrops, spruce-fir community, 20 July 1989, *M. A. (Ben) Franklin 6848* (BRY); NW ridge of Cherry Peak, Naomi Peak Wilderness Area, T14N, R2E, NWSE1/4 Sec. 26, elev. 9120 ft, 21 July 1989, *M. A. (Ben) Franklin 6850* (BRY) [*annotated by Fengjie Sun as *M. lineare* on 6 Jan 2001]; exposed limestone near Mt. Naomi, in crevices, 41°54'71.0"N, 111°40'107"W, elev. 9452 ft, 9 Jul 2008 (in bud), *L. M. Shultz 20658* (UTC); below Mt. Naomi, 41°54'40.7"N, 111°40'05.9"W, elev. 9404 ft, 9 Jul 2008 (in bud), *L. M. Shultz 20656* (UTC).

DISTRIBUTION, HABITAT, AND ABUNDANCE

The Mt. Naomi musineon is both rare and edaphically restricted. It is found on dolomitic limestone of the Silurian Laketown formation and its habitat is restricted to high elevation rock crevices. It occurs both in the Bear River Range (Utah and southern Idaho) and Wellsville Range (Utah) of the northern Wasatch Mountains. Our searches of similar habitats in Idaho, Utah, and Wyoming have failed to extend its range. Surveys by botanists doing rare plant surveys (Shultz and Shultz 1979; Moseley and Mancuso 1990) support our conclusion that the species is indeed isolated and extremely rare. The documented populations grow on exposed rock outcrops within subalpine communities dominated by *Picea engelmannii* Engelm. (Engelmann spruce), *Abies lasiocarpa* (Hook.) Nutt. (subalpine fir), and *Pinus flexilis* James (limber pine). Associated herbaceous species include *Heuchera rubescens* Torr., *Pellaea breweri* D. C. Eat., *Draba maguirei* C. L. Hitchc. var. *maguirei*, *Erigeron eatonii* A. Gray, *Ranunculus adoneus* A. Gray, *Aquilegia caerulea* James, *Mertensia ciliata* (Torr.) G. Don, *Clematis occidentalis* (Hornem.) DC., and *Penstemon leonardii* Rydb.

ETYMOLOGY

We have chosen the species name for the location of the largest known population and type locality within the Mt. Naomi Wilderness Area of the Bear River Range of Utah and Idaho and propose using Mt. Naomi musineon as the common name.

TAXONOMIC AFFINITIES

Considered by earlier authors as conspecific with the yellow-flowered *Musineon lineare* (Rydb.) Mathias, *M. naomiensis* is distinctive both morphologically and ecologically (Fig. 2). *Musineon* is a phylogenetically problematic genus whose relationship within Apiaceae is unclear (Downie et al. 2002; Sun et al. 2004; Sun and Downie 2004, 2010). Originally described as *Daucophyllum lineare* Rydb., *M. lineare* also shares morphological similarities with some species of *Cymopterus*, *Orogenia*, and *Harbouria*.

TAXONOMIC TREATMENT

Orthocarpus holmgreniorum (T. I. Chuang & Heckard) L. M. Shultz & F. J. Smith, comb. et stat. nov., based on *Orthocarpus tolmiei* Hook. & Arn. subsp. *holmgreniorum* T. I. Chuang and Heckard, Systematic Botany 17(4): 565-. 1992. (Fig. 3) — TYPE: USA, UTAH, Cache Co., along Tony Grove Lake Road, Bear River Range, Wasatch Mountains, ca. 2 mi (3.2 km) from route 89 in Logan Canyon, above and northwest of the Utah State Forestry Field Station, 6750 ft (2057 m), 41.876447 N, 111.573029 W, 2 Aug 1984, Heckard 6169 (holotype: JEPS; isotypes: F, GH, MO, NY, US, UTC), $n = 14$. *Diagnosis.* Holmgren owl clover is distinguished by its pinkish purple flowers, narrowly-branched inflorescence, glandular-pubescent galea, densely glandular calyx, and dark-green leaves (Fig. 3A). In contrast, *O. tolmiei* has yellow flowers, a widely branched inflorescence, glabrous galea, sparsely glandular calyx, and light-green leaves (Fig. 3B). When Chuang and Heckard described *Orthocarpus tolmiei* subsp. *holmgreniorum*, so little was known of its distribution and ecology that they hesitated to describe it as a distinct species even though that was their initial intent (L. Heckard, pers. comm.).

Paratypes: USA, IDAHO, Caribou Co., Elk Valley, Caribou National Forest, Cronemiller 348 (USFS). Franklin Co.: Mill Canyon, USFS Grazing Reconnaissance 265 (USFS). UTAH, Box Elder Co.: Willard Basin, Cottam et al. 14924 (ARIZ, RSA). Cache Co.: Tony Grove, 4 Jul 1932, F. B. Wann s.n. (UTC); vicinity USU Forestry Camp, 24 Jul 1937, R. S. Snell s.n. (UTC); West Hodges Pasture, 11 Jul 1935, H. B. Passey 68 (UTC); Hardware Ranch, 5300–6300 ft, 23 Jul 1972, M. A. Bayoumi s.n. (UTC); Bear River Range, Logan Canyon, Tony Grove Lake road, 2.7 km (1.7 miles) above US hwy 89; T13N, R3E, S11, 2010 m (6600 ft) elev., locally common

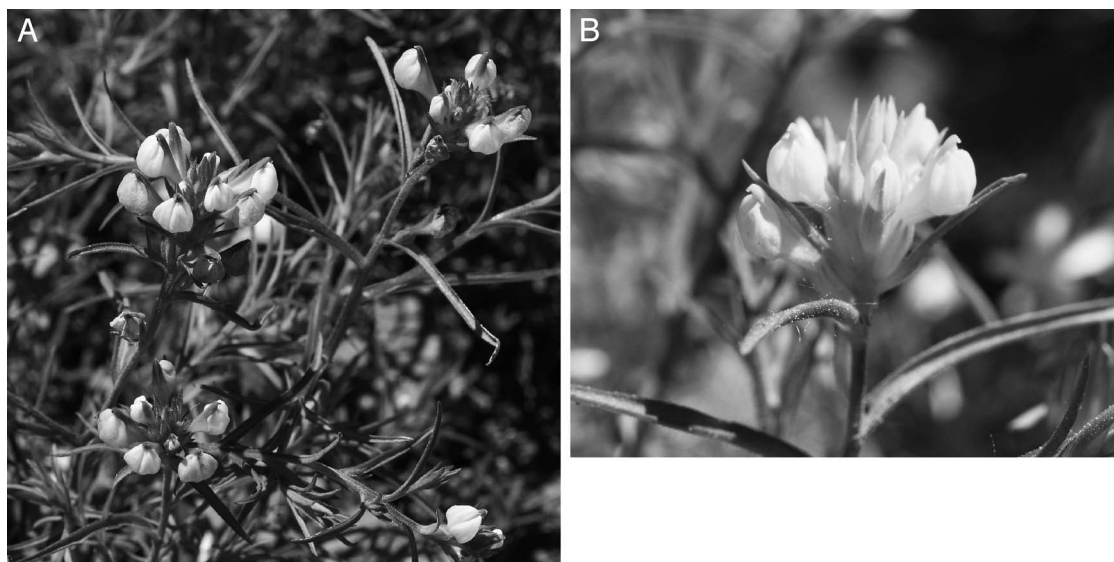


FIG. 3. Photos comparing the pink-flowered *Orthocarpus holmgreniorum* (A) and the yellow-flowered *Orthocarpus tolmei* var. *tolmei* (B). Photographs by Wayne Padgett.

with low sagebrush, 11 Aug 1984, *N. H. Holmgren and P. K. Holmgren 10673*. (NY, UTC); along Tony Grove Lake road, common in dry, hard soil openings, elev. 6750 ft 14 Aug 1984, *L. R. Heckard 6211*. (JEPS, UTC); road to Tony Grove, 41°52'40"N, 111°29'3.8"W, in shallow clay soil with *Artemisia arbuscula*, *Elymus spicatus*, *Madia glomerata*, *Ceanothus velutinus*, 23 Aug 1985, *L. M. Shultz 8815* et al. (UTC, JEPS, NY); 1.5 km E of Logan Canyon and 1.4 km N of right hand fork road, dry meadow with *Wyethia amplexicaule*, *Artemisia tridentata*, *Rosa woodsii*, elev. 2025 m; UTM 447986E, 4626681N, 9 Jul 2003, *E. Johnson 08-03-E*. (UTC); 1 km E of Logan Canyon and 1 km N of right hand Fork, UTM 447461E, 4626691N, elev. 2104 m, 9 Jul 2003, *E. Johnson 08-01-B* (UTC); road to Tony Grove 41°52'37"N, 111°33'43"W, 2002 m elev., 29 Sep 2005 [in fruit], *L. M. Shultz 20221*. (UTC). **Morgan Co.:** approx. 5 mi N of Mountain Green, *Albee 3236* (UT). **Rich Co.:** Swan Peak Road, elev. 8200 ft, T14N, R4E, Sec. 10 [41°58'15.3"N, 111°29'3.8"W], limestone outcrop, steep hillside with snowberry, sagebrush, mountain mahogany, 20 Aug 1983, *K. Thorne 2977* (BRY, UTC). **Wasatch Co.:** Strawberry Divide, 31 Jul 1955, *H. E. Ahles 9765* (UTC). **Weber Co.:** Mt. Ogden, Snow Basin ski area, *S. Clark 2167* (BRY, UTC).

ETYMOLOGY

We retain the name *holmgreniorum* in honor of Noel Herman Holmgren and Patricia Kern Holmgren, primary authors of the Intermountain Flora (Cronquist et al. 1973+) and extraordinary botanical explorers of western North America.

DISTRIBUTION AND HABITAT

Orthocarpus tolmei Hook. & Arn. subsp. *holmgreniorum* T. I. Chuang & Heckard (Holmgren owl clover) was first described as a purple-flowered, annual, unbranched plant with a narrow inflorescence, occurring in the Wasatch Mountains (Chuang and Heckard 1992; Fig.3A). The species is found in the Wasatch Mountains, from areas north of Salt Lake City to southern Idaho. It grows on shallow, rocky, clay soils dominated by *Artemisia arbuscula* Nutt. subsp. *thermopola* Beetle (low sagebrush), *Madia glomerata* Hook. (tar weed), and associated grasses. It is found near populations of the more common, yellow-flowered *O. tolmei* Hook. & Arn. subsp. *tolmei* (Yellow owl clover; Figure 3B) which typically grows in soils with higher organic matter and in association with *Artemisia tridentata* Nutt. subsp. *vaseyana* (Rydb.) Beetle (mountain big sagebrush). In the few places where we have seen the pink-flowered and yellow-flowered plants growing together, we have seen no evidence of hybridization. The lack of apparent introgression and distinctive morphologies has led us to treat the purple-flowered form (sometimes mistaken for *O. purpureo-albus* A. Gray) as a distinct species.

DISCUSSION

The Mt. Naomi musineon and Holmgren owl clover make a total of thirteen rare and endemic plant species found in Logan Canyon, eight of which are known only here. These are *Erigeron cronquistii* Maguire, *Draba maguirei* C. L. Hitchcock, *Musineon lineare* (Rydb.) Mathias, *Musineon naomiensis* L. M. Shultz & F. J. Smith; *Orthocarpus holmgreniorum* (T.

I. Chuang & Heckard) L. M. Shultz & F. J. Smith; *Penstemon compactus* (Keck) Crosswhite, *Primula maguirei* L. O. Williams, and *Viola frank-smithii* N. Holmgren. The five other endemic species found in Logan Canyon as well as other places in the northern Wasatch Mountains are *Arabis lasiocarpa* Rollins, *Eriogonum loganum* A. Nels., *Ericameria obovata* (Rydb.) G. L. Nesom, *Lesquerella multiceps* Maguire, and *Tonestus kingii* (D. C. Eat) G. L. Nesom. Detailed descriptions of all thirteen species can be found in the *Illustrated Flora of the Intermountain Region* (Cronquist et al. 1973+) and *Flora of North America North of Mexico* (Flora of North America Editorial Committee, 1993+). As evolutionary theory and studies of these narrow endemics progress, we hope to arrive at a better understanding of the origins and relationships of these species as well as patterns of rarity.

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