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LOMATIUM BASALTICUM (APIACEAE), A NEW SPECIES FROM THE VICINITY OF HELLS CANYON IN OREGON AND IDAHO

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ABSTRACT

Lomatium basalticum Mansfield & M. Stevens, **sp. nov.**, is a narrowly endemic species growing on gravelly meadows and open, xeric, rocky slopes in forest openings on weathered basalt flow entablatures on both the Idaho and Oregon sides of Hells Canyon. The species is most closely related to *L. brunsfeldianum* based on strong support from sequence data from 6 genes; and it is vegetatively very similar to the nearby northern Idaho endemic, *L. brunsfeldianum*. The two species can be distinguished geographically, ecologically and by a combination of characters including fruit length, width, and thickness, leaf sheath width, and foliage vestiture.

In recent years a number of new species and subtaxa in *Lomatium* have been described and supported owing to recent field exploration, morphological analysis and genetic sequencing studies, including *L. ochocense* Helliwell (2010), *L. bentonitum* Carlson & Mansfield (Carlson et al. 2011), *L. pastorale* Darrach & Wagner (2012), *L. brunsfeldianum* McNeill (2012), *L. tarantuloides* Darrach & Hinchliff (2014), *L. knokei* Darrach (2014), and *L. swingerae* McNeill (2014).

During the combined Idaho and Washington Botanical Collection Forays in June 2011, collections were made in Adams Co., Idaho, of a species similar to both *Lomatium brunsfeldianum* and *L. grayi*. Subsequent collections over the next five years provided sufficient materials to distinguish among these species. We are now aware of several populations from both the Idaho and Oregon sides of Hells Canyon and are able to distinguish the species morphologically, ecologically, and genetically from *L. brunsfeldianum* and *L. grayi*.

Lomatium basalticum Mansfield and M. Stevens, **sp. nov.** Figures 1–5. **TYPE**: **USA**. **Oregon**. Wallowa Co.: Hells Canyon National Recreation Area, 1.26 km SE of McGraw Lookout, 370 m due E of Forest Service Road 110, 45.1672124° N -116.7681258° W, sparse *Pseudoroegneria spicata* grassland/forbland, common on silty loam derived from weathered entablature basalt, southerly aspect, with *Pseudoroegneria spicata, Poa secunda, Bromus carinatus, Sedum stenopetalum, Astragalus reventus, Artemisia rigida*, elev. 1804 m (5920 ft), 5 Jul 2015, *M. Darrach* 1115 (holotype: CIC; isotypes: NY, OSC, RM, WTU, ID).

Lomatium basaliticum can be distinguished from all other recognized members of the genus by the following combination of characters: root narrowly taprooted and often with 2–3 branches, older leaf sheaths neither shredding nor persistent atop a caudex, plants glabrous in the lower parts, leaf sheaths wide (12–20 mm), leaf blades highly dissected into quaternary divisions with ultimate segments of 4–5 mm x <0.5 mm, fruits 13–20 mm x 3–5 mm and at least 1.2 mm thick with wings as thick as the fruit body, 0.6–0.9 mm wide.

Herbs: (Fig. 1) perennial, short-lived, non-aromatic, glabrous except in the umbel rays, caulescent, 35–60 cm in height with typical plants approximately 50 cm in height when in mature fruit. **Root:** typically specimens have non-tuberous taproots (2–4 mm thick) that can be +/- branched bearing 1–3(5) separate taproot-like dvisions (Fig. 2). **Stems:** from a short, reduced caudex, rarely bearing many old leaf scars; 3–8 mm thick, previous years' sheaths never disintegrating into a thatch. **Basal leaves:** ±old sheathing leaf bases, basal leaves 1–4, typically 2, glabrous, compound, 18–30 cm in length, ternate-pinnate and pinnately dissected into quaternary divisions, ultimate segments linear, terete, 4–5 mm X <0.5 mm, basal-most pinnules of tertiary leaflets originating close (<2 mm) to rachis appearing, or nearly, sessile. Petioles of basal leaves 6–14.5 cm long with dark brown sheathing basal portions, 13–17 mm wide. **Cauline leaves:** 1, glabrous, compound, 13–19 cm in length, pinnately dissected into quaternary divisions, ultimate segments 4–5 mm X <0.5 mm, ultimate pinnules nearly sessile. Petioles of cauline leaves 4–6.5 cm with sheathing basal portions. Fresh leaves filling three dimension, never planar (Fig. 3). Pressed leaves usually about equally as long as wide, the leaf outline quadrate, rhombic, or triangular. **Inflorescences:** (Fig. 4) compound, involucre lacking, peduncles strongly ascending to erect, terete. Peduncle 23–41 cm. Rays 6–15, unequal in length in flower, grossly so in fruit, glabrous to sparsely puberulent with short, triangular hairs. Ray length per inflorescence in fruit 4–10 cm. **Involucel:** bractlets typically absent, rarely up to 2 and linear, 3–4 mm. **Flowers:** primarily polygamo-monoecious, flowers glabrous 6–35 per umbellet, many aborting, petals yellow, 0.8–1.4 mm X 0.5–0.8 mm, obovate and obtuse, sometimes with an apiculus; stamens 5 and alternating with the 5 petals, anthers yellow to pale yellow, 0.4–0.6 mm X 0.2–0.4 mm, pollen yellow. Stylopodia greenish. Styles laterally flattened, 1.2–1.5 mm, strongly curved, outwardly divergent; ovaries green and glabrous. **Fruit:** (Figs. 5 and 6) hemispherically arranged with 0–25 fruits per umbellet, typically 6–10, pedicels spreading-ascending to semi-erect, 5.0–10.0 mm, typically 6–8 mm. Fruits glabrous, 12.0–20.3 mm X 3.0–4.8 mm. Fruit wing width 0.6–0.9 mm, about as thickened as the fruit body. Fruit aspect (length/width) ratio 3.4–5.6. Fruit shape elliptical dark brown in the intervals. Dorsal fruit surfaces with typically 3 well-developed nerves slightly elevated above the fruit surface; vittae obscure, 4–7 in the intervals, 1–3 along the commisure. **Carpophore:** cleft nearly to the base, persistent.

Additional specimens examined. Idaho. Adams Co.: Snake River, mile 262.4, 1850 m., 30 Apr 1974, *Lauer sn*. (ID); Payette National Forest, Council Cuprum road (4056 Natl Forest Dev Road 002), above Summit Gulch, N 45° 1' 44.688", W 116° 41' 41.172", 1437 m, 26 Jun 2011, *George 140* (ID); Payette National Forest, Ditch Creek Road, N 44° 53.912', W 116° 42.852', 4889 ft, 24 Jun 2011, *Smith 9644* (ID); Payette National Forest Road 002, ca. 1 mi W of jct with Forest Service Road 071, N 45° 3' 14.8314", W 116° 42' 23.22", 4858 ft., 26 Jun 2011, *Ardern 11-89* (ID); 1.6 mi from turnoff at Bear to Cuprum along FR 002, N 45° 1.88', W 116° 41.753', 4760 ft., 23 Jun 2014, *Polito 043* (CIC, ID, OSC); near the turnoff at Bear to Cuprum, ca. 0.8 mi W of junction between FR 002 and FR 071 on FR 071, N

45° 1.869', W 116° 43.611', 4913 ft, 23 Jun 2014, *Polito 044* (CIC, ID, OSC, NY); on Payette Forest Rd 071, 6 mi S of turnoff from Bear/Cuprum road and 2.7 mi from OX Ranch, ca. 6 mi SW of Bear, N 44.98783°, W 116.72482°, 4500 ft, 14 Jun 2016, *Mansfield 16056* (CIC, ID, NY); on Council-Cuprum road, 1.1 mi S of OX Ranch turn off, and just S of Lick Creek Crossing, N 44.98137°, W 116.66527°, 4356 ft, 14 Jun 2016, *Mansfield 16057* (CIC, ID); on Bear/Cuprum road, 1.4 mi from the turnoff from Bear to Cuprum, on N side of road, NW of Council on Council Cuprum road, N 45.0409°, W 116.69463°, 4693 ft, 14 Jun 2016, *Mansfield 16044* (CIC, ID, NY, SRP); on Bear/Cuprum road, 3.3 mi from the turnoff from Bear to Cuprum, on N side of road, N 45.02935°, W 116.70708°, 4940 ft, 14 Jun 2016, *Mansfield 16048* (CIC, ID, NY, OSC, WTU); on Forest Rd 071, 4.3 mi S from Bear/Cuprum road, ca. 7 mi SW of Bear ID and six and a half miles W of OX Ranch, N 44.99456°, W 116.74632, 4700 ft, 14 Jun 2016, *Mansfield 16053* (CIC, ID, NY, WS). **Oregon**. Baker Co.: Vic. Copperfield, Hell's Canyon, Hess road, ca. 5 mi from canyon bottom, N 45.071427°, W 116.825775°, 1246 m, 12 Jun 2010, *Hinchliff 891* (CIC, SRP). Wallowa Co.: Wallowa Whitman National Forest, N 45.1195°, W 116.7920°, T05S R48E S24 NE1/4 of NW1/4, 3130 ft, 13 Jun 2013, *Yates 1065* (CIC, OSC, WWNF); Wallowa Whitman National Forest, N 45.12866°, W 116.78901°, 3050 ft, *Yates 1064* (CIC, OSC, WWNF).

Etymology

The epithet "*basalticum*" refers to the distinctive red, weathered entablatures of the Miocene Columbia River Basalt Group substrate that distinguishes this species substrate preference from the related species, *Lomatium brunsfeldianum*, which grows on intrusive or metamorphic substrates.

Figure 1 (left). *Lomatium basalticum* habit. The plant is ca. 45 cm tall.

Figure 2 (right). *Lomatium basalticum* root. Stems emerge from branched root, lacking a long-lived caudex All photos by the first author unless otherwise noted.

Figure 3. *Lomatium basalticum* cauline leaf. The leaf is ca. 20 cm long.

Habitat

Lomatium basalticum is known from open, gravelly, dry meadows and gently sloping, rocky, xeric sites in ponderosa pine and mixed conifer forest openings. The type locality in the Wallowa Whitman National Forest in Wallowa Co., Oregon, and is on frigid, silty loam inceptisol soils of the Albee-Bocker Complex on parent material of mixed volcanic ash, loess, and colluvium derived from highly weathered, often red, entablature basalt of the Middle and Lower Miocene (15-17 MYA) Grande Ronde basalt flows (WebSoilsSurvey 2016; USGS 2016) between 900 and 1900 m in grassland/forb communities dominated by *Pseudoroegneria spicata, Poa secunda* subsp. *secunda*, and *Festuca idahoensis*, often with surrounding stands of *Pinus ponderosa* forest on adjacent colonnade basalts (Figs. 10 A & B). Additional associated species found with *Lomatium basalticum* include *Achillea millefolium, Artemisia rigida, Astragalus reventus, Balsamorhiza hookeri, B. sagittata*, *Bromus carinatus, Eriogonum heracleoides, E. sphaerocephalum* var. *halimioides, E. umbellatum* var. *ellipticum, Ipomopsis aggregata* subsp. *aggregata, Lomatium dissectum var. multifidum, L. leptocarpum, L. macrocarpum, L. nudicaule, Perideridia bolanderi, Purshia*

tridentata, and *Sedum stenopetalum*. When all five of these *Lomatium* species occur on the same site in Adams Co., they mature phenologically in the following order: *L. leptocarpum* is earliest, followed by *L. dissectum* var. *multifidum*, then *L. nudicaule*; *L. macrocarpum* and *L. basalticum* mature last.

Range

Lomatium basalticum is presently known from only northwestern Adams Co., Idaho, southeastern Wallowa Co., Oregon, and northeastern Baker Co., Oregon, between the N latitudes of 44.898° and 45.167° and the W longitudes of 116.665° and 116.792°.

Similar species

Lomatium basalticum is similar to *L. brunsfeldianum* and *L. grayi* and best distinguished from those species in the field by ten characters (Table 1). A principal components analysis (SIGMA PLOT 13 2016) of 8 specimens of *L. basalticum*, 6 of *L. brunsfeldianum*, and 4 of *L. grayi* using the 10 characters shown in Table 1 and 11 additional characters, shows the three species clearly distinguished (Fig. 7). *Lomatium basalticum* is best distinguished from *L. brunsfeldianum* by its fruit characteristics — having thicker, and to a lesser extent, longer and wider fruits, and also by glabrous stems and foliage and a wider leaf sheath (F.ig 8, Table 1). *Lomatium basalticum* is completely allopatric with *L. brunsfeldianum*, the latter of which is unknown south of latitude 46.236 in north-central Idaho, Montana, and British Columbia.

Lomatium brunsfeldianum is ecologically well-differentiated from *L. basalticum*. *Lomatium brunsfeldianum* is lower in elevation (450 to 1000 m), on granite or metamorphosed slates and quartzites from Precambrian Belt Series rocks. It is restricted to wet, mossy cliffs amidst northern coniferous forest dominated by some combination of *Abies grandis, Alnus rubra, Larix occidentalis, Picea engelmanii, Pinus monticola, Pseudotsuga menziesii, Thuja plicata,* and *Tsuga heterophylla*, with a well-developed shrub layer including some combination of *Amelanchier alnifolia, Cornus sericea, Holodiscus discolor, Philadelphus lewisii, Physocarpus malvaceus*, and *Vaccinium membranaceum*. Understory associates of *L. brunsfeldianum* include *Claytonia cordifolia, Collinsia parviflora, Cystopteris fragilis, Dactylis glomerata, Fragaria vesca, Lomatium ambiguum, L. dissectum* var. *multifidum, Mimulus clivicola, M. guttatus, Orobanche fasciculata, Penstemon wilcoxii, Poa bulbosa, Polypodium hesperium, Sedum stenopetalum, Saxifraga occidentalis*, and *S. caespitosa*.

Lomatium grayi is widespread and grows sympatrically with *L. basalticum*. *Lomatium grayi* often is glaucous, and all populations of *L. grayi* observed in sympatry with *L. basalticum* were glaucous, so throughout the latter's range the two species are readily distinguished (Fig. 9). *Lomatium basalticum* is readily distinguished from *L. grayi* by the much shorter distance from rachilla to basal pinnules of tertiary leaflets, the shorter-lived habit, lacking a substantial caudex with a thatch of old, fibrous leaf sheaths, a narrower, thicker fruit wing, a much larger fruit aspect (length/width) ratio, and by never possessing a glaucous body as often seen in *L. grayi* (Figs. 8 and 9, Table 1). The features of the fruits of the three species are illustrated in Figure 6. Additionally, mature fruit mass, though not a good field characteristic, is perhaps the most discriminating of characters.

L. basalticum: 34.3 ± 14.5 mg/schizocarp
L. brunsfeldianum: 4.8 ± 0.1 mg/schizocarp
L. grayi: 6.7 ± 1.8 mg/schizocarp

Masses were determined by n = 3-4 populations of 15-20 largest mature fruits per population.

Table 1. Comparison of *Lomatium basalticum* with similar species.

Discriminating Character	***Lomatium basalticum***	***Lomatium brunsfeldianum***	***Lomatium grayi***
Small triangular hairs on lower foliage	Absent	Present	Present
Distance from rachilla to basal pinnules of tertiary leaflets	0.3–2 mm	0–2 mm	3.3–6.5 mm
Fibrous thatch of old leaf sheaths on caudex	No	Sometimes	Yes
Basal leaf sheath width	11–17 mm	7–12 mm	8–10 mm
Waxy plant surfaces	Green; glabrous	Green; glabrous	Green to gray; glabrous to glaucous
Fruit length	12–21 mm	9.8–17 mm	8.3–14 mm
Fruit width	3–4.8 mm	2–3.8 mm	4.5–5.8 mm
Fruit aspect ratio (length/width)	3.3–5.6	3.3–5.5	1.6–2.2
Fruit thickness	1.2–2.4 mm	0.5–1.1 mm	0.3–2.1 mm
Fruit wing width	0.5–0.9 mm	0.5–0.6 mm	1.3–2.0 mm

Figure 4. *Lomatium basalticum* inflorescence.

Figure 5. *Lomatium basalticum* (left) and *L. brunsfeldianum* (right) schizocarps showing distinctive corky-thickened wing characterizing both species. Note that *L. basalticum* schizocarps are significantly ($p<0.05$, n=8, t-test) wider (3.7 mm ± 0.6 mm) than those of *L. brunsfeldianum* (2.9 mm ± 0.5 mm) and significantly ($p<0.001$, n=8, t-test) thicker (1.6 mm ± 0.4 mm) than those of *L. brunsfeldianum* (0.7 mm ± 0.2 mm).

Figure 6. Schizocarps of *Lomatium grayi* (top row; ca. 10 mm long), *Lomatium basalticum* (middle row; ca. 15 mm long), and *L. brunsfeldianum* (bottom row; ca. 11 mm long).

Figure 7. Principal Components Analysis of *L. basalticum* (a), *L. brunsfeldianum* (b), and *L. grayi* (g).

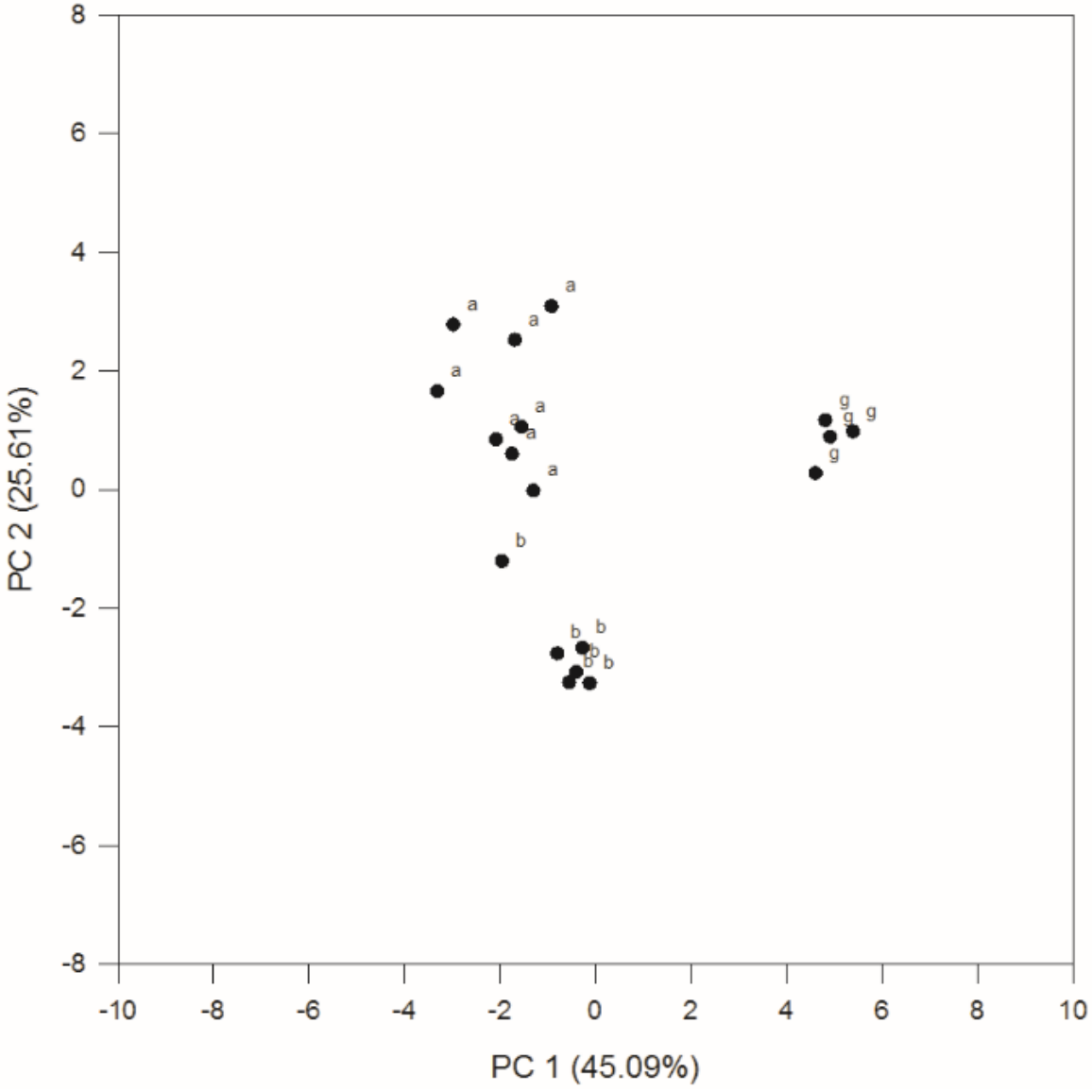

Figure 8. Variables explaining variation among the three *Lomatium* species shown in Figure 7. Each vector indicates the direction and strength of correlation of the variable with thefirst (x-axis) and second (y-axis) principal components.

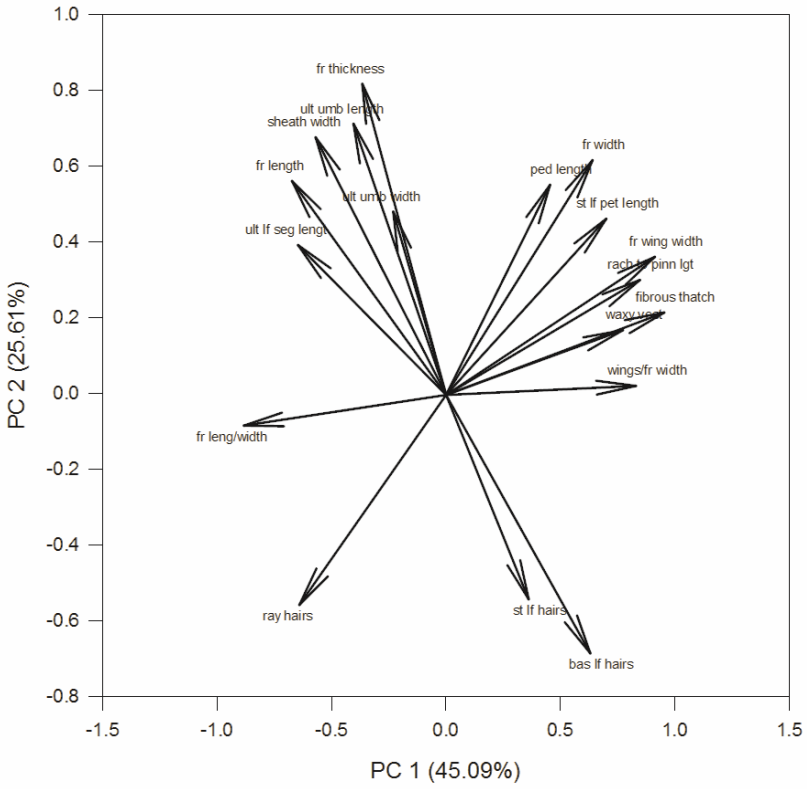

Figure 9. *Lomatium grayi* (left) is often glaucous, and *L. basalticum* (right) is never glaucous.

Figure 10A. *Lomatium basalticum* habitat. Wallowa Co., Oregon. Photo by Gene Yates.

Figure 10B. *Lomatuium basalticum* habitat. Adams Co., Idaho.

Genetics

Methods used by recent phylogenetic studies of *Lomatium* (George et al. 2014) have been extended to the clades including *L. basalticum*, *L. brunsfeldianum*, and *L. grayi* (Fig. 11). *Lomatium basalticum* is monophyletic and sister to *L. brunsfeldianum* yet also closely related to *L. grayi.*

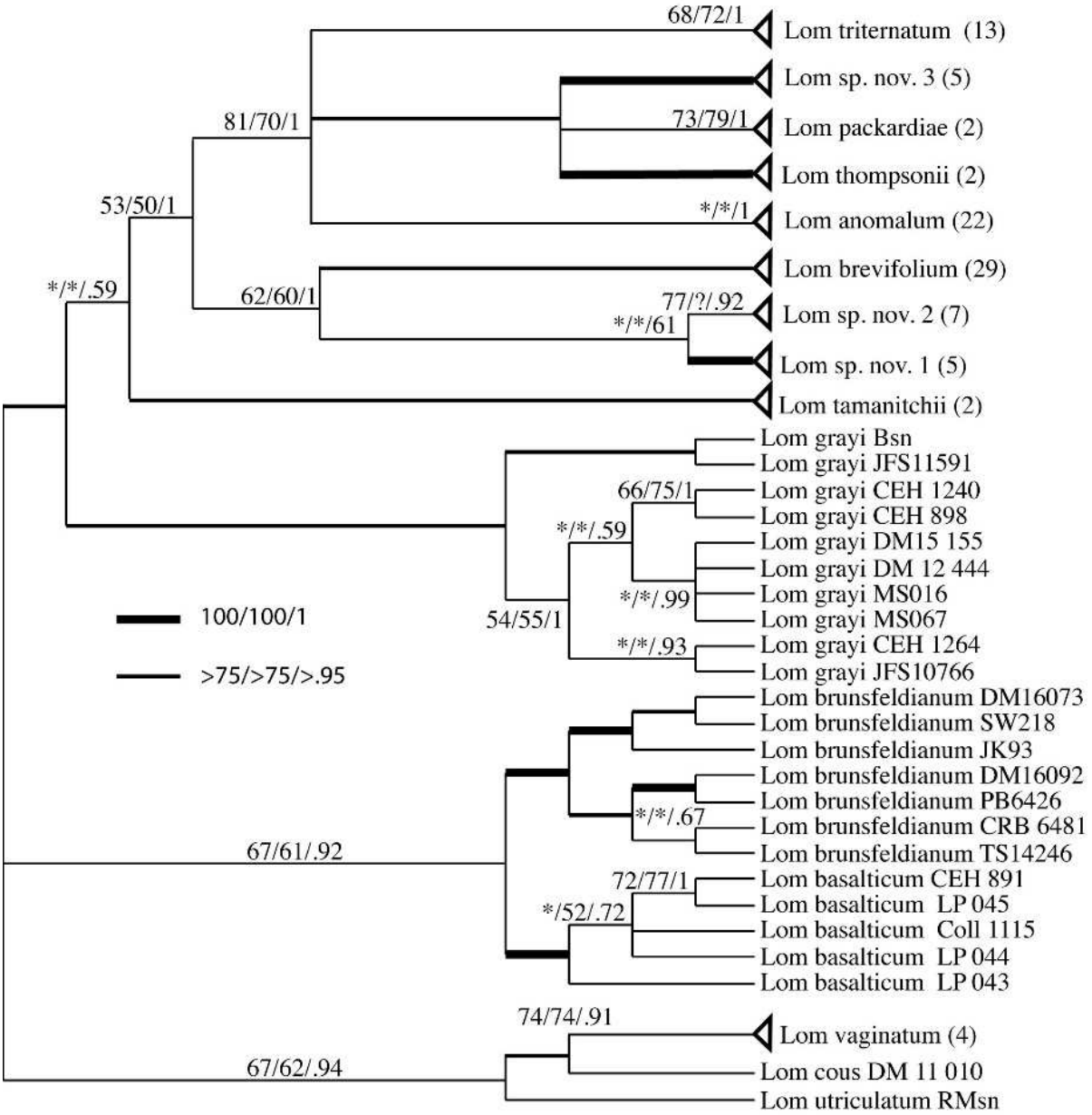

Figure 11. Cladogram showing support for monophyly of *Lomatium basalticum.* Support values indicated as a/b/c are from three analyses, where a = maximum parsimony bootstrap values, b = maximum likelihood bootstrap values, and c = posterior probabilities of 1-model Bayesian analysis. Collection voucher information available on request to the first author.

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