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TAXONOMIC REVISION OF THE *LOMATIUM FOENICULACEUM* COMPLEX (APIACEAE) AND A NEW SPECIES (*LOMATIUM SEMIVAGINATUM*)

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ABSTRACT

The *Lomatium foeniculaceum* (Nutt.) Coult. & Rose complex, which spans from British Columbia, Canada to Texas, and westward to California, consists of taxa that have historically been treated as infrataxa of *L. foeniculaceum*: *L. foeniculaceum* subsp. *foeniculaceum*, *L. foeniculaceum* subsp. *daucifolium*, *L. foeniculaceum* subsp. *macdougalii*, *L. foeniculaceum* subsp. *fimbriatum*, and *L. foeniculaceum* subsp. *inyoense*. New phylogenetic analyses and concurrent morphological features support the recognition of *L. macdougalii* Coult. & Rose and *L. inyoense* Mathias & Constance as initially described. *Lomatium foeniculaceum* var. *foeniculaceum* and *L. foeniculaceum* var. *daucifolium* are retained as varieties. A new combination elevating a previously recognized variety to specific rank and a new species are recognized here: **L. fimbriatum** (W.L. Theob.) Botello & J.F. Sm., **comb nov.**, and **L. semivaginatum** Botello & J.F. Smith, **sp. nov.** *Lomatium semivaginatum* is a species occurring throughout southern and central Idaho, and adjacent Oregon and Montana.

The perennial endemic North American clade of Apiaceae (PENA) consists of 18 currently recognized genera and about 230 described species (Lomatium & Friends Online Monographs 2024; Ottenlips et al. 2021). Species of the PENA clade occur in arid, semi-arid, mesic, wetland, montane, and alpine habitats ranging from Alaska and the Yukon, Canada to northern Mexico, with most species occurring in the western USA (Downie et al. 2002; Feist et al. 2017; Lomatium & Friends Online Monographs 2024; Mathias 1930; Nesom 2012). Species of the PENA clade are long-lived herbaceous

perennials often with a xerophytic or semi-xerophytic growth-form. They are typically low-growing and acaulescent, with open to compact, compound umbels, compound, dissected, or cleft leaves, and thickened, deeply-seated taproots, with many species as xeric-adapted geophytes (Downie et al. 2002; Hartman 2000; Sun et al. 2004). Long-standing challenges with identifying and studying these species arise from the high degree of morphological similarity between vegetative and reproductive characters, narrow endemism, sympatry, putative variation within species and species complexes, and misidentification of specimens which inflates the range of some species and obscures the range of others (Feist et al. 2017; George et al. 2014; Mansfield 2015).

Recent molecular phylogenetic research on the PENA clade has revealed that morphology-based classifications often do not accurately reflect the evolutionary history of the species. Homoplastic reproductive characters used to distinguish the genera, such as fruit wing differences in *Cymopterus* and *Lomatium*, have resulted in polyphyletic groupings (Carlson et al. 2011b; Downie et al. 2002; George et al. 2014; Ottenlips et al. 2020; Sun and Downie 2010). Within the PENA clade, *Lomatium* is the genus with the most species, currently 103 (Lomatium & Friends Online Monographs 2024; Ottenlips et al. 2021), and new species continue to be described in western North America (Carlson et al. 2011a, 2011b; McNeill 2014; Darrach and Hinchliff 2014; Stevens et al. 2018; Darrach 2018).

The *Lomatium foeniculaceum* complex is presently recognized as the most geographically widespread complex within the genus, spanning a broad area from central British Columbia to southern New Mexico, and from Missouri westward to California (Coulter and Rose 1900; Munz and Roos 1955; Theobald 1963). All taxa within the complex, with the exception of *L. foeniculaceum* subsp. *fimbriatum*, were first described at specific rank within *Lomatium* and later recognized as infrataxa of *L. foeniculaceum* by Cronquist (1961) and Theobald (1966) who noted an apparent morphological continuum between the species. Doubts regarding the validity of the taxonomy within the complex began when McGregor and Bare (1968) concluded that all but one morphological character (pubescence on fruits and ovaries) had significant overlap for taxa of the Great Plains (*L. foeniculaceum* subsp. *foeniculaceum* and subsp. *daucifolium*). The separating character of petal margin cilia between the Great Basin taxa (*L. foeniculaceum* subsp. *macdougalii* and subsp. *fimbriatum*) was determined to be unreliable as a distinguishing character, with the degree of pubescence varying widely in Utah (Welsh et al. 1993). Identifying Idaho specimens (by Botello) of *L. foeniculaceum* with the available treatments proved to be nearly impossible, as the specimens seemed to be intermediate between subsp. *macdougalii* of the Southwest and subsp. *foeniculaceum* of the northern Great Plains.

Previous phylogenetic work on *Lomatium* did not include sufficient samples of each *Lomatium foeniculaceum* subspecies or did not include some subspecies at all (Carlson et al. 2011b; Downie et al. 2010; George et al. 2014; Sun and Downie 2002; Ottenlips et al. 2020). To test the taxonomic boundaries as circumscribed in existing treatments and the taxonomic nature of the *L. foeniculaceum* complex as a whole, 50 tissue samples were procured both from herbarium specimen vouchers and populations sampled in the field. The specimens were subjected to DNA extraction and phylogenetic analyses using next-generation sequencing. As described by Carstens et al. (2013), molecular data alone delimits genetic structure within a species but may not necessarily reflect species boundaries. Therefore, as described here, molecular data were used to define clades, and additional morphology and distribution data were used to describe taxa boundaries within and between these clades. Following Carstens et al. (2013) and the general lineage concept of species (de Queiroz 1998), which recognizes alternative species concepts as explaining different events of the speciation process, well-supported clades were recovered applying molecular and bioinformatic statistical analysis methods, and then other lines of evidence (morphology and distribution) were used to support the existence of distinct species.

Methods

DNA was extracted from 50 voucher specimens representing areas of sympatry and disjunct populations of all five subspecies, identified as such using the traditional classifications. A phylogenetic framework of the *L. foeniculaceum* complex was constructed from up to 286 genes using the Angiosperm353 bait kit, next-generation sequencing methods and phylogenetic bioinformatic analyses: maximum likelihood (RAxML), pseudo-coalescent (ASTRAL), and coalescent methods (STACEY) (Botello 2024).

To cross-reference the phylogenetic data, up to five measurements of each morphological character (Table 1; Table 2; and others, Botello 2024) were measured on vouchers representing most of the populations sampled. Of the 50 vouchers used for DNA sampling, seven were not available for morphological measurements. Characters traditionally used to separate the taxa, such as petiole length and petiole sheathing length, were measured, along with involucel bractlet pubescence, a character not extensively used in previous treatments to separate taxa within the complex (Table 1; Table 2).

Results

The 50 genetically analyzed specimens referable to five infrataxa in the *Lomatium foeniculaceum* complex are placed in seven maximally supported clades: "*inyoense,"* "var. *foeniculaceum*," "var. *daucifolium*," "Idaho (ID) *macdougalii*," "*fimbriatum*," "Southwestern (SW) *macdougalii*," and "*Tiehm 12333*" (Figure 1). Most placements of the specimens into clades agreed with the initial identification for each, except for specimens initially identified as subsp. *macdougalii* in Nevada, Idaho, and Oregon and subsp. *foeniculaceum* in South Dakota. Depending on the type (maximum-likelihood, pseudo-coalescent, and coalescent) and level (number of genes) of phylogenetic analysis, some of the South Dakota specimens initially identified as subsp. *foeniculaceum* were placed in the "var. *daucifolium*" clade (Botello 2024). No other individuals varied in their clade placement between the different types of phylogenetic analyses (Botello 2024).

With the exception of the Great Plains specimens (var. *foeniculaceum* and var. *daucifolium*), the morphology — especially petiole sheathing length — agrees with the placement of the specimens into clades (Botello 2024). Some morphological characters, such as callus-cuspidate tip length, were not included in the list of diagnostic characters (Table 1; Table 2).

Discussion

Two varieties are retained because some individuals of South Dakota (*Feist 7953*, *Feist 7955*, *Feist 7966*) at the geographic boundary between *Lomatium foeniculaceum* var. *foeniculaceum* and var. *daucifolium* move between the clades, depending on the type and level of phylogenetic analysis (Botello 2024). These individuals from South Dakota have morphologies shared by both clades, or share characters found in specimens exclusively placed in either clade. Var. *foeniculaceum* and var. *daucifolium* do not meet the criterion of representing distinct lineages, following the general lineage species concept (de Queiroz 1998). Together, these Great Plains clades represent a moderately to maximally supported clade, and the morphology suggests incomplete speciation, secondary contact, or ongoing gene flow between the clades. All other clades represent distinct species, supported by congruent morphology. The *L. foeniculaceum* complex consists of five species, with one species having two infraspecific ranks: *L. foeniculaceum* var. *foeniculaceum, L. foeniculaceum* var. *daucifolium, L. fimbriatum, L. macdougalii, L. semivaginatum,* and *L. inyoense*.

The Continental Divide continues to be a reliable geographic barrier useful in separating these taxa (Figure 2; Cronquist et al. 1961; Theobald 1966). Regardless of placement east or west of the divide, specimens of each clade retain the involucel bractlet pubescence type characteristic of their clades (Table 1; Table 2).

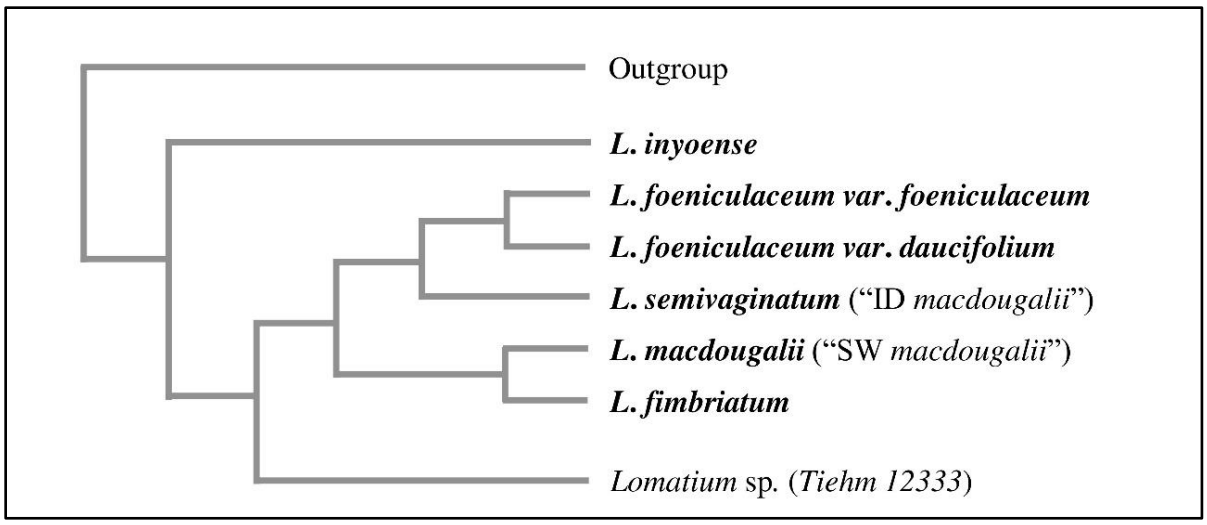

Figure 1. Phylogeny of the *Lomatium foeniculaceum* complex, consisting of *L. inyoense*, *L. foeniculaceum*, *L. semivaginatum*, *L. macdougalii*, and *L. fimbriatum*, nested by the outgroup taxa (*Cymopterus nivalis*, *L. bentonitum*, *L. dasycarpum*, *L. juniperinum*, *L. mohavense*, *L. ravenii*) and *Tiehm 12333* as *Lomatium* sp.

Lomatium inyoense

Lomatium inyoense was thought to be a diminutive and single-rayed, high elevation taxon of the Great Basin, occurring at elevations of 3000 meters and above in the White and Inyo Mountains of California, as well as in Elko Co., Nevada and Custer Co., Idaho (Theobald 1966).

Benkendorf 209 of Custer Co., Idaho (3080 m) is *Lomatium semivaginatum*, and *Mansfield 18567* of Elko Co., Nevada (3214 m) is *L. fimbriatum*. Though superficially resembling *L. inyoense* with a reduced habit and seemingly simple umbels, *Benkendorf 209* and *Mansfield 18567* have yellow petals, blades with petiolate major divisions, and petioles that sheath 45–75%, features not found in *L. inyoense* (Table 1). Thus *L. inyoense* is indeed restricted to Inyo and Mono counties in California.

Lomatium foeniculaceum

Historically, *Lomatium foeniculaceu*m var. *foeniculaceum* was the name assigned to any specimens with pubescent ovaries and fruits, while var. *daucifolium* was assigned to any specimens with glabrous or glabrate ovaries and fruits.

Molecular data and congruent morphology indicate that ovary and fruit pubescence is not an accurate character for distinguishing these Great Plains taxa. The morphologic analysis shows that regardless of ovary and fruit pubescence, specimens with involucel bractlet margins obscured by coiled, villous-woolly pubescence are best assigned to var. *foeniculaceum*, and specimens with involucel bractlet margins not obscured by coiled, villous-woolly pubescence are var. *daucifolium* (Table 2). Despite being intermediate in morphology, some of the South Dakota specimens were referred to var. *daucifolium* due to having involucel bractlet pubescence which more closely approaches that taxon (Table 2).

Lomatium semivaginatum

Specimens heretofore assigned to *Lomatium foeniculaceum* subsp. *macdougalii* of Idaho, western Montana, and eastern Oregon belong to a distinct species, *L. semivaginatum*, which superficially resembles *L. macdougalii* but with sheathing petioles to about 50% (Table 1; Figure 3; Figure 4). All samples of this clade were taken from populations west of the Continental Divide, except for *Hinchliff 1354* from Beaverhead Co., Montana, just 29 miles east of the Continental Divide. The analyses suggest a boundary for this taxon near the Idaho/Utah and Idaho/Nevada borders (Figure 2).

Further sampling from these regions for DNA and morphological analyses is needed to determine the geographic limits of this species.

Lomatium fimbriatum

Theobald (1963) described *Lomatium macdougalii* and *L. foeniculaceum* subsp. *fimbriatum* as being essentially the same in vegetative features, with petal margin pubescence being present only in *L. fimbriatum*. *Baker 18896* of Churchill Co., Nevada, has a combination of glabrous and papillate petal margins, *Gust 3404* of Lincoln Co., Nevada, has a combination of glabrous, papillate, and ciliate petal margins, while *Mansfield 18567* from Elko Co., Nevada, has glabrous petal margins. Regardless of petal margin pubescence, *L. fimbriatum* has petioles that sheath to about 50%–75% the length of the petiole, while petioles of *L. macdougalii* always sheath throughout (100%) (Table 1).

Lomatium macdougalii

All specimens belonging to the "SW *macdougalii*" clade have morphology that closely resembles the morphology of the type specimen, *MacDougal 84* of Arizona, with sheathing throughout the entire petiole length (100%) (Table 1). The reliable separating character of petiole sheathing length should be used to correctly identify specimens of *L. macdougalii* throughout its range and to locate the area of sympatry with *L. fimbriatum*.

Tiehm 12333

This specimen from Washoe Co., Nevada superficially resembles *L. macdougalii* but has white flowers and a unique combination of petiole sheathing (basally, middle, and throughout) not found in *L. macdougalii* or *L. semivaginatum* (Table 1). *Lomatium semisepultum* M. Peck, a species described from a white-flowered specimen, is a synonym of *L. macdougalii* from a collection in Deschutes Co., Oregon, representing the most westward limit of the taxon (Coulter & Rose 1900). More collections should be made in central Oregon and northwestern Nevada to see if these specimens identified as *L. macdougalii* belong to *L. semivaginatum*, *L. macdougalii*, or represent an undescribed species.

Key to the taxa of the complex

1. Petals cream-white or pale-yellow; 1–2 rays; leaves narrowly ovate-oblong, without any petiolate major divisions; Inyo and White Mountains, CA. ..... 1. **L. inyoense**
1. Petals yellow, purple-tinged or purple; 2–24 rays; leaf major divisions petiolate.
    2. Involucel bractlets conspicuously connate, never distinct (20–65%); petioles sheathing 50%; east of the Continental Divide.
        3. Involucel bractlets villous-woolly, with coiled or wavy hairs usually obscuring the margins; involucel bractlets connate 20–65%; ovaries and fruits usually pubescent; BC, AB, SK, MB; U.S., MT, ND, WY, SD, NE ..... 2. **L. foeniculaceum var. foeniculaceum**
        3. Involucel bractlets nearly glabrous, villous, or sparsely villous-woolly, with tangled, wavy, twisted, or bent hairs not obscuring the scarious margins; bractlets connate 18–63%; ovaries and fruits rarely pubescent; SD, NE, OK, KS, TX, CO, MO, IA ..... 3. **L. foeniculaceum var. daucifolium**
    2. Involucel bractlets usually distinct, or basally connate (0–28%); petioles sheathing 35–100%, west of the Continental Divide.
        4. Petioles sheathing 100%; petal margins glabrous, not ciliate; AZ, NM, UT ..... 4. **L. macdougalii**
        4. Petioles sheathing up to 75%; petal margins ciliate or glabrous; AZ, CA, ID, OR, MT, NV, UT.

5. Petioles sheathing 35–65%, usually 50%, petal margins glabrous; ID, OR, MT ..... 5. **L. semivaginatum**
5. Petioles sheathing 50–75%, petals margins usually ciliate, but sometimes glabrous; AZ, CA, NV, OR, UT ..... 6. **L. fimbriatum**

1. LOMATIUM INYOENSE Mathias & Constance, Aliso 3: 120. 1955. *Lomatium foeniculaceum* subsp. *inyoense* (Mathias & Constance) W.L. Theob., Brittonia 18: 16. 1966. *Lomatium foeniculaceum* var. *inyoense* (Mathias & Constance) B. Boivin, Phytologia 17: 100. 1968. **TYPE: California.** Inyo Co.: Pass at crest of Inyo Mtns, near Sidehill Spring, 3 mi E of Badger Flat, 3108 m, 24 Jun 1954, *Roos 6148* (holotype: UC 1018152; isotypes: K, LA, RSA, US).

Habit: acaulescent; 3–12 cm high; hirtellous-puberulent to villous. **Roots:** long and slender taproot. **Leaves:** narrowly oblong-ovate in outline; blades appearing as one unit, without any petiolate major divisions; blades 1–6.5 cm long, 2–3 pinnate; petioles 1–3 cm long, sheathing basally or to middle (30–50%), purplish; ultimate leaf segments obovate to ovate to broadly elliptic, 1–2 mm long, 0.5–1 mm wide, apex acute to apiculate, tip callus-cuspidate. **Peduncles:** 3–12 cm long. **Rays:** 1 (–2), usually only one ray developing; 0.1–1.5 cm long; the umbel appearing simple. **Involucel bractlets**: linear to linear-lanceolate, acute, purplish, distinct to slightly connate at base, shorter than or equaling flowers, hirtellous-puberulent. **Pedicels:** 0.1–9 mm long, the umbellets many-flowered. **Flowers:** petals cream-white to pale yellow, glabrous, obovate with a narrower inflexed apex; ovaries hirtellous-puberulent. **Fruits:** ovate to ovate-oblong, 4–9 mm long, 3–5 mm broad, the body and wings puberulent, the wings narrower than the body; vittae 2–7 in the intervals, 5–8 on the commissure.

Inyo and White Mountains of California. Rocky subalpine openings, open forests, at elevations of greater than 2900 m.

Other collections examined. California. Inyo Co.: Inyo Mtns ca. 1⁄4 mi W of Side Hill Spring and 4 mi E of Badger Flat, 3091 m, 23 Jun 2009, *Andre 13826* (RSA); Inyo Mtns Wilderness, on Sidehill Springs Trail, about 2 mi E of wilderness boundary, at clearing about 70 yd to the left of trail, 3090 m, 1 Jul 2023, *Botello 349* (SRP); Inyo National Forest, about 0.45 mi S of Sidehill Springs Trail and Inyo Mtns Wilderness boundary, along 36E404 trail, 2892 m, 1 Jul 2023, *Botello 350* (SRP); Inyo National Forest, about 0.65 mi SW of Sidehill Springs Trail and Inyo Mtns Wilderness boundary, along 36E404 trail, 2879 m, 1 Jul 2023, *Botello 351* (SRP).

2. LOMATIUM FOENICULACEUM (Nutt.) Coult. & Rose [var. **FOENICULACEUM]**, Vasc. Pl. Pacif. N.W. 3: 552. 1961. *Ferula foeniculacea* Nutt., Gen. N. Amer. Pl. 1: 183. 1818. *Pastinaca foeniculacea* (Nutt.) Spreng., Syst. Veg. 6: 587. 1820. *Peucedanum foeniculaceum* (Nutt.) Nutt. ex Torr. & A. Gray, Fl. N. Amer. 1(4): 627. 1840. *Lomatium foeniculaceum* (Nutt.) Coult. & Rose, Contr. U.S. Natl. Herb. 7(1): 222. 1900. *Cogswellia foeniculacea* (Nutt.) Coult. & Rose, Contr. U.S. Natl. Herb. 12: 449. 1909. *Lomatium foeniculaceum* (Nutt.) Coult. & Rose [subsp. *foeniculaceum*], Brittonia 18: 13. 1966. **NEOTYPE: South Dakota**. Jackson Co.: Buffalo Gap National Grassland, 2000 m S of I-90 and 20 m W of Co. Rd 7, 727 m, 10 May 2021, *Feist 7966* (holotype: WIS).

A neotype has been designated, as the type specimen for *Lomatium foeniculaceum* (a specimen of *Nuttall* from the confluence of the Missouri and James Rivers in southeastern South Dakota) is possibly lost (Coulter and Rose 1900). The type locality of *Feist 7966* is approximately 230 air miles northwest of the type locality given by Coulter and Rose (1900).

Habit: acaulescent; 10–50 cm high; villous to glabrate. **Roots:** long, thick taproots; 4–17 mm wide, when measured 20 mm below the sheath/taproot boundary. **Leaves:** blades rhomboidal to deltoid to broadly ovate to ovate-oblong in outline, 4–15 cm long, pinnately decompound; primary leaflets petiolate, 3–4 pinnate; petioles 3–10 cm long, sheathing to about the middle; ultimate leaf segments linear to elliptic to ovate to obovate, 1–5 mm long and 0.5–1 mm wide, apex apiculate, tip callus-

cuspidate. **Peduncles:** 10–50 cm long. **Rays**: 8–24, 0.5–4 cm long, spreading to erect, unequal to subequal. **Involucel bractlets:** linear-lanceolate, acute to acuminate, entire or lobed; conspicuously connate basally or to middle or to above the middle (20–65%); 1.4–3.9 mm long, and 0.4–1.3 mm wide at the widest free portion, shorter than or equaling flowers; moderately to densely villous-woolly or nearly tomentose pubescence of coiled, sometimes wavy hairs that usually obscure the margins; pubescence lost with age. **Pedicels:** 2–15 mm long, the umbellets many-flowered. **Flowers:** petals yellow, glabrous; ovaries sparsely to densely villous. **Fruits:** ovate-oblong, 5–12 mm long, 4–8 mm broad, the body and wings pubescent to nearly glabrate, the wings narrower than the body; vittae 2–4 in the intervals, 2–4 on the commissure.

Mostly east of the Continental Divide, with a few outlying populations just west in Wyoming. Central British Columbia and Alberta, to southern Saskatchewan; Montana, Wyoming, North Dakota, South Dakota, and northwestern Nebraska. Open, rocky, prairie hilltops, dry plains, and slopes (McGregor 1986).

The use of variety rather than subspecies is implemented here, following Article 4 of the Shenzhen code (Turland et al., 2018) and Nesom and Lipscomb (2005).

Other collections examined. USA. Montana. Carter Co.: Custer National Forest, Long Pines, on Exie Rd (Forest Rd 3119), above and along North Tie Creek, ca 10 air mi WNW of Camp Crook, SD, 1098 m, 15 Jun 2021, *Smith 17415* (SRP). Phillips Co.: Upper Missouri River Breaks National Monument, along Bull Creek Rd just W of the boundary, ca 3.5 mi NW of DY Junction, ca 54 air mi SW of Malta, plains S of Little Rockies, 988 m, 17 Jun 2021, *Smith 17419* (SRP). **North Dakota.** McKenzie Co.: Little Missouri National Grassland, 728 m, 13 May 2021, *Feist 7971* (SRP). **Wyoming.** Campbell Co.: Thunder Basin National Grassland and Vicinity, western edge of Duck Creek Breaks, immediately E of Duck Creek on two track road, ca 35 mi NE of Gillette, ca 15 air mi NW of Oshoto, 1245 m, 15 Jun 2021, *Smith 17414* (SRP). Carbon Co.: Upper North Platte and Laramie River Drainages, ca 0.5 air mi N of Chalk Draw near Chalk Hills, 2197 m, 14 Jun 2021, *Smith 17109* (SRP). Park Co.: Absaroka Mountains, along Monument Hill or County Rd 7UH on Rattlesnake Mountain, ca 12.5 air mi NNW of Cody, 2238 m, 17 Jun 2021, *Smith 17428* (SRP). Sublette Co.: Green River Basin, BLM Road 5410, ca 1.3 road mi SE of Wyo Hwy 351, ca 4 air mi WSW of jct of Wyo Hwy 351 and U.S. Hwy 191, 2193 m, 24 May 2021, *Smith 17353* (SRP). Sweetwater Co.: S of Wamsutter, 2061 m, 26 May 2021, *Smith 17389* (SRP).

3. LOMATIUM FOENICULACEUM var. **DAUCIFOLIUM** (Torr. & A. Gray) Cronquist, Vasc. Pl. Pacif. N.W. 3: 552. 1961. *Peucedanum foeniculaceum* var. *daucifolium* Torr. & A. Gray, Fl. N. Amer. 1(4): 627. 1840. *Lomatium daucifolium* (Torr. & A. Gray) Coult. & Rose., Contr. U.S. Natl. Herb. 7: 221. 1900. *Cogswellia daucifolia* (Torr. & A. Gray) M.E. Jones., Contr. W. Bot. 12: 34. 1908. *Lomatium foeniculaceum* subsp. *daucifolium* (Torr. & A. Gray) W.L. Theob., Brittonia 18: 13. 1966. **TYPE: Missouri**. Jackson Co.: On the Platte (River), near Independence, *Nuttall s.n.* (holotype: PH 00023033).

Lomatium villosum Raf., J. Phys. Chim. Hist. Nat. Arts 89: 101. 1819. *Cogswellia villosa* (Raf.) Spreng., Syst. Veg. 6: XLVIII. 1820. **TYPE**: On the Missouri River, *Bradbury* (no holotype or isotypes listed). *Peucedanum villosum* (Raf.) Nutt. ex S. Wats., in part., U.S. Geog. Expl. 40th Par. 5, Bot: 131. 1871. **TYPE**: Platte prairies, *Nuttall s.n.* (holotype: BM 000645571).

Habit: acaulescent; 10–50 cm high; villous to glabrate. **Roots**: long taproots, usually swollen or thickened at the middle; 6–15 mm wide, when measured 20 mm below the sheath/taproot boundary. **Leaves**: blades rhomboidal to deltoid to broadly ovate to ovate-oblong in outline, 4–19 cm long, pinnately decompound; primary leaflets petiolate, 3–4 pinnate; petioles 3–15 cm long, sheathing to about the middle, purplish; ultimate leaf segments filiform to linear to elliptic or obovate, 1–7 mm long, 0.5–1 mm wide, apex acute or apiculate, tip callus-cuspidate or not. **Peduncles**: 10–50 cm long. **Rays:** 10–31, 1.5–8 cm long, spreading to ascending, usually unequal. **Involucel bractlets**: linear-lanceolate, acute to acuminate, entire or lobed; sometimes conspicuously nerved; conspicuously connate basally

to middle and rarely to above the middle (18–62%); 1.3–6 mm long, 0.3–1.3 mm wide at the widest free portion, shorter than or equaling flowers; nearly glabrous, villous, or sparsely villous-woolly pubescence of tangled, wavy, twisted, or bent hairs, not obscuring the scarious margins; sometimes pubescent only at the margins; pubescence lost with age. **Pedicels**: 2–13 mm long, the umbellets many-flowered. **Flowers**: petals usually yellow, sometimes purple, or yellow with purple tinge, or yellow and purple flowers combined in the same umbellet, glabrous; ovaries usually glabrous, can be sparsely or densely pubescent. **Fruits**: ovate-oblong, 5–11 mm long, 3–8 mm broad, the body and wings glabrous, rarely sparsely or densely pubescent, the wings narrower than the body; vittae 1–4 in the intervals, 2–4 on the commissure.

Southern South Dakota, Kansas, Oklahoma, eastern Iowa, eastern Missouri, southeastern Colorado, and northern Texas. Open, rocky, prairie hilltops, dry plains, and slopes (McGregor 1986).

The type locality of *Lomatium daucifolium* of Coulter & Rose (1900), and not of subsequent authors, is used here because the specific taxon was established in an effort to resolve taxonomic confusion, and its description of involucel bractlet pubescence closely aligns with the description here.

The rank of variety rather than subspecies is used here, following Article 4 of the Shenzhen code (Turland et al. 2018) and Nesom and Lipscomb (2005).

Other collections examined. Colorado. Las Animas Co.: Comanche National Grassland, ca 3 air mi S of Tobe, 1825–1845 m, 26 May 2007, *Hartman 84868* (RM); Comanche National Grassland, ca 3 air mi S of Tobe, 1825–1845 m, 26 May 2007, *Hartman 84873* (RM). **Kansas.** Coffey Co.: Harvey East Lake County Park, S of NE 24th St, 439 m, 22 Apr 2021, *Feist 7949* (SRP). Cowley Co.: Behind Highland Cemetery at top of slope between the cemetery and the river, 369 m, 22 Apr 2021, *Feist 7948* (SRP). Manhattan Co.: Steep S-facing hillside along KS-13 just E of the Turtle Creek Lake Dam, 346 m, 23 Apr 2021, *Feist 7952* (SRP). Russell Co.: Along the E side of 175th St, 388 m S of W 300th Dr, 679 m, 22 Apr 2021, *Feist 7950* (SRP); Just E of 184th Blvd, 170 m S of Land Rd, 557 m, 22 Apr 2021, *Feist 7951* (SRP). **Oklahoma.** Blaine Co.: Roman Nose State Park, on slope between P63 Rd and Watonga Lake, near the Canyon Vista RV/Tent Area, 458 m, 20 Apr 2021, *Feist 7944* (SRP). Caddo Co.: Just N of OK-19, 1 mi E of OK-58, 493 m, 20 Apr 2021, *Feist 7942* (SRP). Carter Co.: Pull-off area along I-35, 406 m, 19 Apr 2021, *Feist 7939* (SRP). Cleveland Co.: Thunderbird State Park, South Dam Loop Trail, 307 m, 20 Apr 2021, *Feist 7941* (SRP). Pawnee Co.: By Pawnee Lake, just W of intersection of N4380 Rd and Tower Rd, 270 m, 21 Apr 2021, *Feist 7945* (SRP). **South Dakota.** Lyman Co.: Lower Brule Unorganized Territory, just E of SD-1806, 2.2 mi SE of 221 St/County Line Rd, 485 m, 9 May 2021, *Feist 7953* (SRP). Stanley Co.: Fort Pierre National Grassland, N of War Creek Rd, 1.1 mi W of US-83, 581 m, 9 May 2021, *Feist 7955* (SRP). **Texas.** Dallas Co.: Cedar Hill State Park (entrance about 3 mi NW of Cedar Hill along Hwy 1382), 179 m, 21 May 1997, *Baldon 212* (TEX).

4. LOMATIUM MACDOUGALII Coult. & Rose, Contr. U.S. Natl. Herb. 7: 233. 1900. *Lomatium jonesii* Coult. & Rose, Contr. U.S. Natl. Herb. 7: 233. 1900. *Cogswellia macdougalii* (Coult. & Rose) M.E. Jones, Contr. W. Bot. 12: 34. 1908. *Cogswellia jonesii* (Coult. & Rose) M.E. Jones, Contr. W. Bot. 12: 34. 1908. *Lomatium semisepultum* M. Peck, Proc. Biol. Soc. Washington 50: 122. 1937. *Lomatium foeniculaceum* var. *macdougalii* (Coult. & Rose) Cronquist, Vasc. Pls. Pacif. N.W. 3: 552. 1961. *Lomatium foeniculaceum* subsp. *macdougalii* (Coult. & Rose) W.L. Theob., Brittonia 18: 15. 1966. **TYPE: Arizona**. Coconino Co.: Mormon Lake, 1829 m, 11 Jun 1898, *MacDougal 84* (holotype: US 334180; isotypes: NY, UC, US).

Habit: acaulescent; 7–40 cm high; hirtellous-puberulent to villous. **Roots:** slender, elongated taproots, 6–10 mm wide, when measured 20 mm below the sheath/taproot boundary. **Leaves:** blades rhomboidal to deltoid to broadly ovate to ovate-oblong in outline, 2–15 cm long, pinnately

decompound; primary leaflets petiolate, 2–3 pinnate; petioles 1–3 (–4.3) cm long, usually sheathing throughout (100%), purplish; ultimate leaf divisions linear to broadly-elliptic to obovate, 1–6 mm long, 0.5–1 mm wide, apex apiculate, tip callus-cuspidate. **Peduncles:** 10–40 cm long. **Rays:** 2–24, 0.5–7 cm long, spreading-ascending, usually unequal. **Involucel bractlets:** linear, acute to acuminate, entire or slightly scarious; distinct to nearly distinct to basally connate (0–28%); 1.6– 6 mm long, 0.3–1.2 mm wide, shorter than or equaling flowers; nearly glabrous to sparsely villous to densely villous. **Pedicels:** 2–13 mm long, the umbellets many-flowered. **Flowers:** petals usually yellow, sometimes purple, or yellow with purple-tinge, or yellow and purple flowers combined in the same umbellet, glabrous; ovaries hirtellous-puberulent to villous. **Fruits:** ovate-oblong to broadly elliptic to suborbicular, 5–11 mm long, 4–8 mm broad, the body and wings hirtellous-puberulent, the wings narrower than the body; vittae 1–6 in the intervals, 3–8 on the commissure.

Southwestern New Mexico, central and northern Arizona, and southern Utah. Sagebrush steppe, open ponderosa pine forests, and open juniper woodlands, at elevations of 1,615–2,419 m.

Other collections examined. USA. Arizona. Coconino Co.: Grand Canyon National Park, Greenland Point, 2408 m, 20 Jun 2011, *Rink 10618* (ARIZ). Yavapai Co.: Coconino National Forest, Bull Pen Ranch Camp Ground and West Clear Creek Wilderness Trail Head, USFS Trail #17 (West Clear Creek Trail), 1097 m, 16 May 2003, *Bond 310* (ASU). **New Mexico.** Grant Co.: Ca. 0.6 road miles E of Burro Cienega Canyon on Separ Road, 1628 m, 5 Apr 2010, *Sivinski 7524* (UNM). **Utah.** Kanab Co.: About 7.5 mi SE of Kanab, about 1.5 mi S of U.S. 89 along County Rd 2445, 1566 m, 26 May 2023, *Botello 338* (SRP). Juab Co.: About 10.3 mi SW of Levan along State Rd 78, about 85 yds up hill on right side of road, 1599 m, 27 May 2023, *Botello 344* (SRP). Millard Co.: Ca. 2.5 mi E of Holden, along Maple Hollow Rd, 1 mi E of intersection with I-15 Frontage Rd, 1625 m, 27 May 2023, *Botello 343* (SRP).

5. LOMATIUM SEMIVAGINATUM Botello & J.F. Sm., **sp. nov. TYPE: Idaho.** Custer Co.: Copper Basin, 12 mi SE of intersection with Trail Creek Rd, 2278 m, 28 Jun 2023, *Botello & Bloom 345* (holotype: SRP 082388; isotypes: to be distributed to CIC, WIS).

Similar to *Lomatium macdougalii* but with longer petioles (2–6 cm, as opposed to 1–3 cm) and petioles usually sheathing only basally or to half the length, rarely the full length, and with more densely pubescent involucel bractlets. Similar to *Lomatium foeniculaceum* var. *foeniculaceum* but occurring mainly west of the Continental Divide, in western Montana, throughout Idaho, and eastern Oregon. With involucel bractlets distinct or connate basally, without the consistent villous-woolly pubescence characteristic of *L. foeniculaceum* var. *foeniculaceum*.

Habit: acaulescent; 12–20 cm high (reduced size of ~3.5 cm tall at elevations of over 3000 m); villous. **Roots:** slender, long taproot, 3–8 mm cm wide, when measured 20 mm below the sheath/taproot boundary. **Leaves:** blade rhomboidal to deltoid to broadly ovate to ovate-oblong in outline, 3–7 (–11) cm long, pinnately decompound; primary leaflets petiolate, 2–3 pinnate; petioles 2–6 (–8 mm) long, sheathing 35–66%, usually sheathing to middle (50%), rarely sheathing throughout (100%), purplish; ultimate leaf segments linear to elliptic to ovate to obovate, 1.1–4.7 mm long, 0.4–1 mm wide; apex apiculate, tip callus-cuspidate. **Peduncles:** 7.6 –15 (–20.5) cm long; as short as 3.2 cm at elevations over 10,000 ft. **Rays:** 2–16, 0.4–3.2 (–6.5) cm long, spreading-ascending, usually unequal. **Involucel bractlets:** linear, acute to acuminate, entire or slightly scarious, distinct to nearly distinct to basally connate (0–26%); 1.9–4.4 mm long, 0.2–0.9 mm wide, shorter than or equaling flowers; villous, often with wavy or bent hairs, some populations approaching woolly-villous pubescence. **Pedicels:** 2–13 mm long, the umbellets many-flowered. **Flowers:** petals usually yellow, sometimes purple, or yellow with purple tinge, or yellow and purple flowers combined in the same umbellet, glabrous; ovaries densely hirtellous-puberulent to villous. **Fruits:** elliptic to ovate-oblong to orbicular, 4.6–10 mm long, 3–7.7 mm broad, the body and wings hirtellous-puberulent, the wings narrower than the body; vittae 1–6 in the intervals, 3–8 on the commissure.

Mostly west of the Continental Divide, and mostly occurring on the Snake River Plain and dry hills of southern and central Idaho. In Malheur Co., Oregon, and just east of the Continental Divide in Beaverhead Co., Montana; at elevations of 701–3,079 m.

Some petioles in specimens of *Lomatium semivaginatum* at the periphery of the range have been observed to sheath throughout (75%–100%) in Malheur Co., Oregon, Owyhee Co., Idaho, and barren soils of eastern Lemhi Co., Idaho (near the Continental Divide where unusual petiole length and sheathing lengths have been observed in *L. foeniculaceum* var. *foeniculaceum*). In these specimens of *L. semivaginatum*, only one or few of the petioles sheath throughout, with the majority of the petioles in each individual sheathing halfway.

Lomatium semivaginatum somewhat fits the description of *L. jonesii*, a taxon described alongside *L. macdougalii* in 1900 by Coulter & Rose, which eventually became a synonym of *L. macdougalii* when significant morphological differences were deemed insufficient. *Lomatium jonesii* was described as a northern taxon, occurring from Utah to Idaho and Alberta, Canada, while *L. macdougalii* was described as occurring from Utah to Arizona (Coulter & Rose 1900). Differences in petiole lengths and petioles sheathing lengths were never described. Although the description and distribution of *L. jonesii* approaches the description of *L. semivaginatum*, the name of *L. jonesii* cannot be used, as the type locality for *L. jonesii* is in central Utah (Saline Canyon of Sevier County) where *Johnson 3488* from Juab County was placed within the southwestern clade of *L. macdougalii*.

Other collections examined. USA. Idaho. Butte Co.: Ca. 2.7 air mi W of Clyde and Little Lost River Highway, steep E-facing slope near Horse Creek Rd, 2126 m, 16 Jun 2016, *Smith 13382* (SRP). Cassia Co.: ca. 14.3 air mi SSW of Malta, off of Upper Jim Sage Rd, 1662 m, 30 Apr 2018, *LeBlanc 5-18* (ID). Custer Co.: White Cloud Mountains, ridge leading towards Patterson Peak, separating the Antz basin from 4th of Jul Lake, 3080 m, 19 Aug 2016, *Benkendorf 209* (CIC); Copper Basin Rd, 12 mi SE of intersection with Trail Creek Rd, 2278 m, 28 Jun 2023, *Botello & Bloom 345* (SRP); White Cloud Mountains, ridge between 4th of Jul Lake and Antz Basin, ca. 0.9 air mi W-NW of Patterson Peak, 3093 m, 24 August 2022, *Corbin 2434* (SRP); Ryan Peak, Boulder Mountains, 3352 m, 1 Aug 1944, *Hitchcock & Muhlick 10621* (ID); Copper Basin Rd, 12 mi SE of intersection with Trail Creek Rd, 2278 m, 12 Jul 2009, *Smith 8403* (SRP). Elmore Co.: 7.9 air mi SE of Glenns Ferry, off of Shoestring Rd, 882 m, 28 May 2017, *Smith 14132* (SRP). Lemhi Co.: Agency Creek Campground, between Tendoy and Lemhi Pass of the Continental Divide, ca. 4.7 mi E of Tendoy, 1630 m, 28 Apr 2019, *Benkendorf 2004* (SRP). Owyhee Co.: ca. 17 mi SSE of Grasmere on Sheep Creek/Roland Rd, 1576 m, 18 May 2023, *Smith 18937* (SRP). **Montana.** Beaverhead Co.: Bannack State Park, E side of southernmost summit of Badger Ridge, ca. 1.9 mi E of Bannack, 2108 m, 29 Jun 2011, *Hinchliff 1354* (CIC). **Oregon.** Malheur Co.: On ashy bluff overlooking Succor Creek ca. 6 mi SW of Homedale, 747 m, 10 Apr 2007, *Mansfield 07010* (CIC).

6. LOMATIUM FIMBRIATUM (W.L. Theob.) Botello & J.F. Sm., **comb nov.** *Lomatium foeniculaceum* subsp. *fimbriatum* W.L. Theob., Brittonia 18: 15. 1966. *Lomatium foeniculaceum* var. *fimbriatum* (W.L. Theob.) B. Boivin, Phytologia 17: 110. 1968. **TYPE: California**. Inyo Co.: Among junipers, 0.1 mi NW of summit of Westgard Pass, 2225 m, 8 Jun 1962, *Theobald 708* (holotype: LA).

Habit: acaulescent; 7–30 cm high; hirtellous-puberulent to villous. **Roots:** taproots long and slender; 3–8 mm wide, when measured 20 mm below the sheath/taproot boundary; occasionally with a tuber below. **Leaves:** blades rhomboidal to broadly ovate to ovate-oblong in outline, pinnately decompound; primary leaflets themselves petiolate, 2–3 pinnate, blades 2.2–8 cm long; petioles 1–3 (–10) cm long, shorter than the blades, usually sheathing 50–75%, purplish; ultimate leaf divisions linear to elliptic to ovate to obovate, 1–5 mm long and 0.5–1 mm wide, apex apiculate, tip callus-cuspidate.

Peduncles: 10–30 cm long. **Rays:** 2–14, 0.5–6 cm long, spreading-ascending, usually unequal. **Involucel bractlets:** linear, acute to acuminate; distinct to basally connate (0–25%); shorter than or equaling flowers, 2.3–3.7 mm long; sparsely–moderately villous. **Pedicels:** 2–10 mm long, the umbellets many-flowered. **Flowers:** petals usually yellow, or yellow with purplish tinge, or yellow and purple flowers combined in the same umbellet; petals margin pubescence usually ciliate, but sometimes papillate or glabrous; occasionally a few hairs present on the upper surface; ovaries hirtellous-puberulent. **Fruits:** ovate-oblong to suborbicular, 5–9 mm long, 4–7 mm broad, the body and wings hirtellous-puberulent, the wings narrower than the body; vittae 1–6 in the intervals, 3–8 on the commissure.

Northwest Arizona, north to Malheur Co., Oregon, throughout Nevada, southwestern Utah, and southern California, at elevations of 1400–3290 m.

Other collections examined. Arizona. Mohave Co.: Lime Klin Canyon, 1500 m, 1 May 2010, *Higgins 29045* (SRP). **California.** Inyo Co.: Inyo National Forest, off of Route 168 E of White Mountain Rd, 2219 m, 14 Jun 2023, *Smith 19114* (SRP). **Nevada.** Elko Co.: Jarbridge Wilderness Area, on pretty barren E summit ridge, gravels weathering to clay, 3200 m, 5 Aug 2018, *Mansfield 18567* (CIC). Esmeralda Co.: Sylvania Mountains, ridge E of Cucomungo Canyon, 0.8 air mi just N of due E Cucomungo Springs, 2164 m, 15 May 2015, *Tiehm 16924* (RSA). Churchill Co.; Camp Creek Canyon, 1780 m, 16 May 2017, *Baker 18896* (ASU). Lincoln Co.: Basin and Ridge National Monument, Mt Irish, Logan Pass on Logan Rd, 2178 m, 17 May 2017, *Gust 3404* (RENO); vicinity of Pioche, unmarked road (main route over hills) about 6.5 mi lineally WNW from Pioche, 2032 m, 10 May 2011, *Hinchliff 1306* (SRP); White Rock Mtns, 4.4 road mi N of the Donahue Ranch road on the main road to Atlanta, 2043 m, 16 May 1987, *Tiehm 11026* (ID). **Oregon.** Malheur Co.: Clay flat near ash outcrop, near road pull-out at intersection of US-95 and Chalk Basin Rd, 1125 m, 22 Apr 2023, *Botello 273* (SRP); ash outcrop at intersection of Hwy 95 and Chalk Basin Rd, 4 mi W of Rome, 1127 m, 1 Apr 2007, *Carlson 002* (CIC).

Table 1. Distribution and diagnostic characters for members of the *L. foeniculaceum* complex west of the Continental Divide. Ultimate leaf segments = the smallest units into which the leaf is divided. Y = yellow, P = purple, P-T = purple-tinged, W = white. The most easily diagnostic traits are in bold.

	L. inyoense	*L. semivaginatum*	*L. fimbriatum*	*L. macdougalii*	*Tiehm 12333*
Plant Height	3–12 cm	12–20 cm	7–30 cm	7–40 cm	6–20 cm
Distribution	**Inyo & White Mtns, CA**	Mostly W of the Continental Divide: ID, MT, OR	CA, UT, NV, AZ, OR	W of the Continental Divide: AZ, NM, UT	Washoe Co, NV
Petiole Length	1–3 cm	2–6 (–8) cm	1–3 (–10) cm	1–3 (–4.3) cm	2.5–4.5 cm
Petiole Sheath Length	30–50%	**35–66, usually 50%**	**50–75%**	**100%**	30–100%
Ultimate Leaf Segment Shape	obovate to ovate to broadly-elliptic	linear to elliptic to ovate to obovate	elliptic to ovate to obovate	linear to broadly-elliptic to obovate	linear to broadly-elliptic to obovate
Ray Count	**1 (–2)**	2–16	2–14	2–24	6–13
Petal Color	**cream W–pale Y**	Y, P, P-T	Y, P, P-T	Y, P, P-T	**W**
Petal Margins	glabrous	glabrous	**ciliate, papillate**, or glabrous	glabrous	glabrous
Involucel Bractlet Fusion	distinct	distinct to basally connate (0–26%)	distinct to basally connate (0–25%)	distinct to basally connate (0–28%)	distinct
Involucel Bractlet Pubescence	hirtellous-puberulent	**sparsely to densely villous, or nearly villous-woolly; bent or wavy hairs**	sparsely to moderately villous	nearly glabrous to sparsely villous to densely villous	hirtellous-puberulent
Ovary Pubescence	hirtellous-puberulent	hirtellous-puberulent to villous	hirtellous-puberulent	hirtellous-puberulent to villous	hirtellous-puberulent

Table 2. Distribution and diagnostic characters for members of the *L. foeniculaceum* complex east of the Continental Divide. Ultimate leaf segments = the smallest units into which the leaf is divided. Y = yellow, P = purple, P-T = purple-tinged, W = white. The most easily diagnostic traits are in bold.

	L. foeniculaceum var. *foeniculaceum*	*L. foeniculaceum* var. *daucifolium*
Plant Height	10–50 cm	10–50 cm
Distribution	Mostly E of the Cont. Div., **BC–SD**	E of the Cont. Div., **SD–TX**
Petiole Length	3–10 cm	3–15 cm
Petiole Sheath Length	50%	50%
Ultimate Leaf Segment Shape	linear to elliptic to ovate to obovate	**filiform** to linear to elliptic to obovate
Ray Count	8–24	10–31
Petal Color	Y	Y, P, P-T
Petal Margins	glabrous	glabrous
Involucel Bractlet Fusion	**connate 20–65%**	**connate 20–63%**
Involucel Bractlet Pubescence	**moderately to densely villous-woolly; coiled or wavy hairs usually obscuring margins**	**nearly glabrous, villous or sparsely villous-woolly; tangled, wavy, twisted, or bent hairs not obscuring scarious margins; sometimes pubescent only at margins**
Ovary Pubescence	**sparsely to densely villous**	**glabrous to sparsely villous**

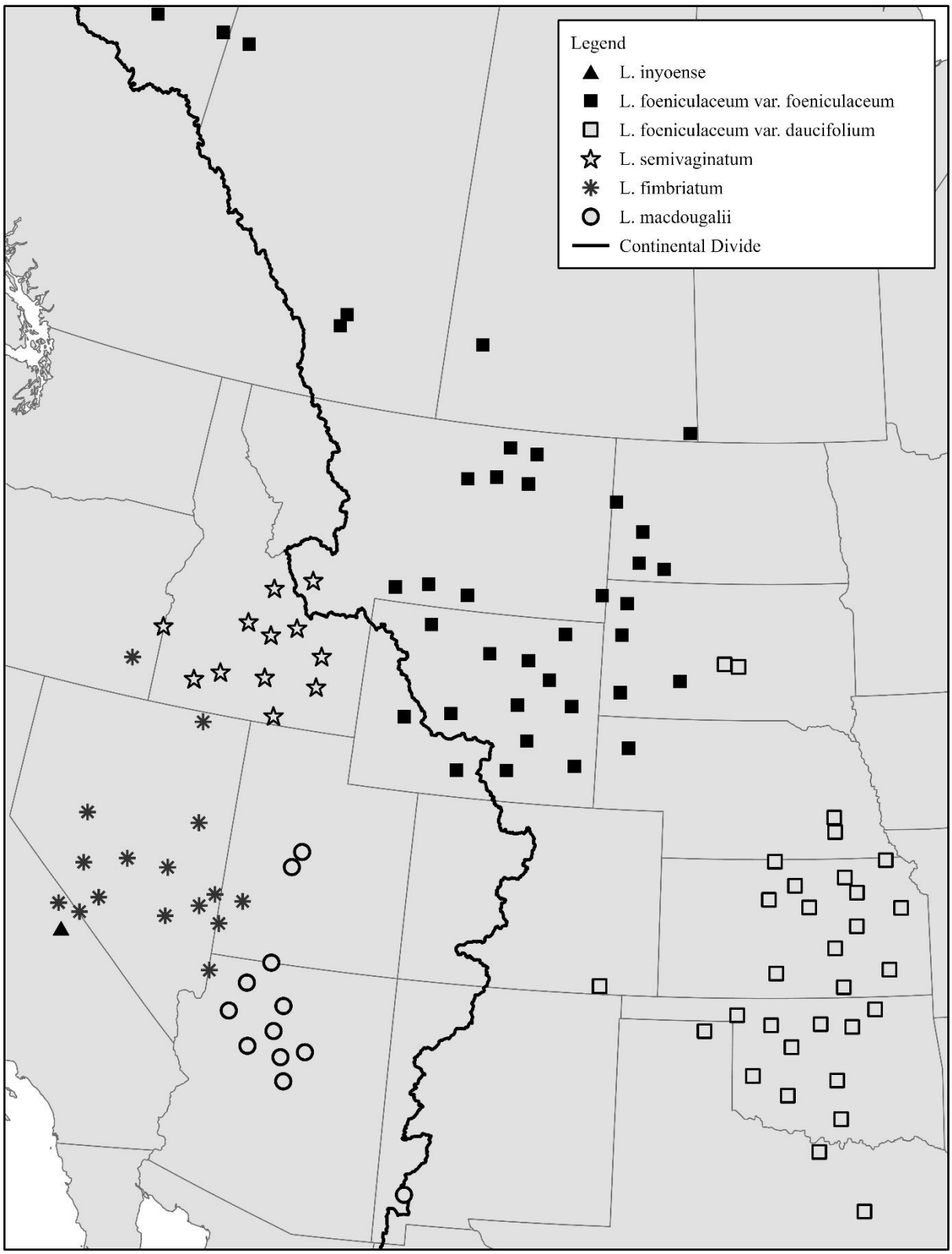

Figure 2. Distribution of taxa within the *Lomatium foeniculaceum* complex, based on displayable map data from the Lomatium & Friends Online Monographs (2023), and results of the phylogenetic analyses. Lomatium & Friends (2024) displays *L. macdougalii* as occurring throughout Nevada, but as evidenced here, these specimens with glabrous petal margins may be *L. fimbriatum*.

Figure 3. *Lomatium semivaginatum*. Holotype — *Botello & Bloom 345* (SRP).

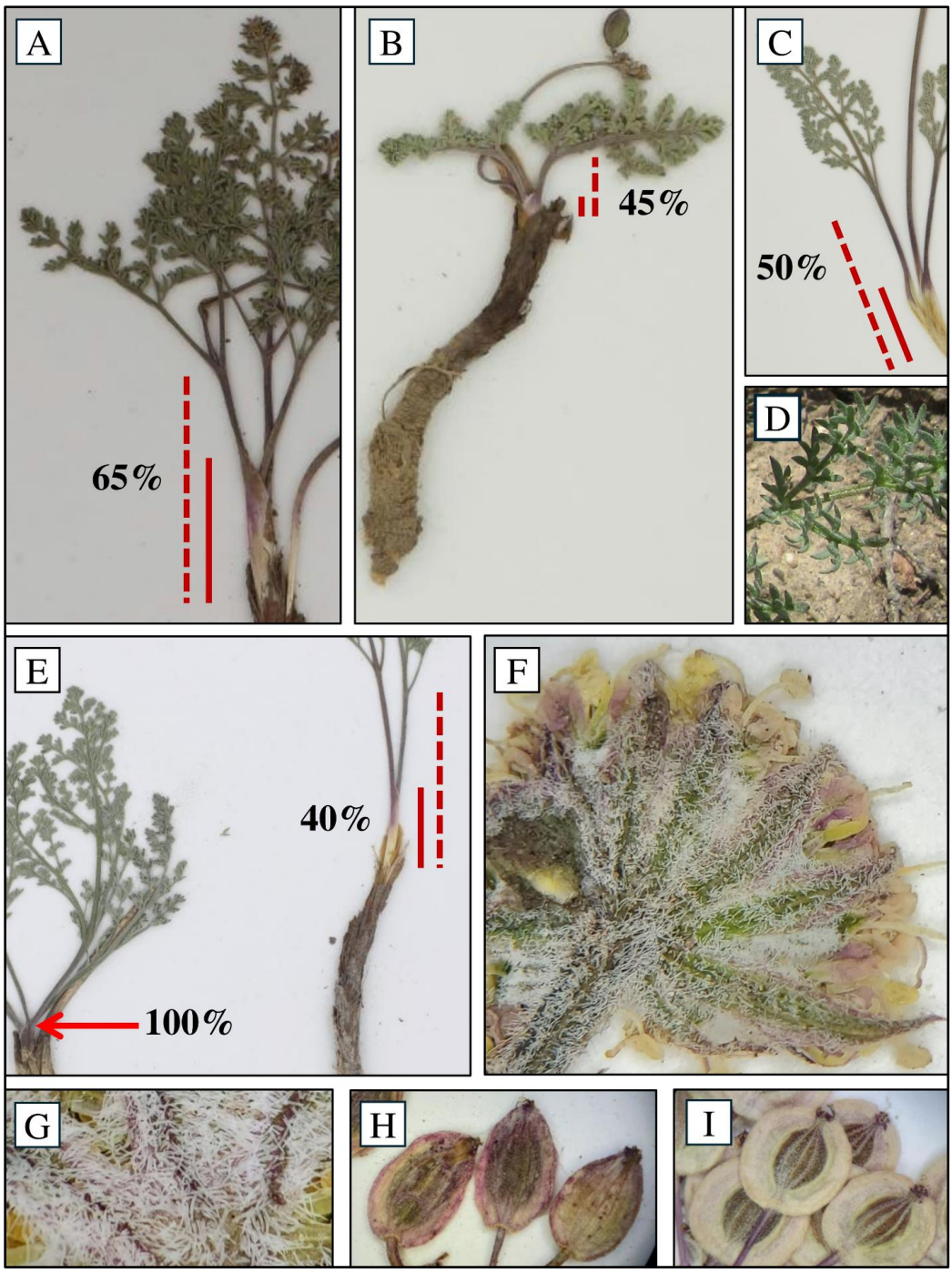

Figure 4. *Lomatium semivaginatum*. **A.** Petiole sheathing as indicated by solid red line, *Botello & Bloom 345*, type specimen (Custer Co., Idaho). **B.** Petiole sheathing in a diminutive specimen, *Benkendorf 209* (Custer Co., Idaho, 3080 m). **C.** Petiole sheathing in *Hinchliff 1354* (Beaverhead Co., Montana). **D.** Ultimate leaf segments of *Botello and Bloom 345*. **E.** Petiole sheathing in *Mansfield 07010* (Malheur Co., Oregon). **F.** Villous involucel bractlet pubescence and purple-tinged petals in *Botello & Bloom 345*. **G.** Villous-woolly involucel bractlet pubescence in *LeBlanc 5-18* (Cassia Co., Idaho). **H.** Ovate and elliptic fruits of *Smith 8403* at type locality. **I.** Orbicular fruits of *Smith 14132* (Elmore Co., Idaho).

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