LOMATIUM PASTORALIS (APIACEAE), A NEW NARROW ENDEMIC SPECIES FROM NORTHEAST OREGON

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ABSTRACT

A new species, **Lomatium pastoralis,** is a tap-rooted, narrow endemic growing in shallow soils over basalt bedrock on the Umatilla and Wallowa-Whitman national forests in Umatilla County of northeastern Oregon, U.S.A. The species is most easily distinguished from other members of the genus by leaf morphology, inflorescence presentation, fruit shape, and pedicel length. The two presently recognized populations are confined to small areas over a several km^2 area. Populations can manifest as densely clustered plants in early seral settings wherein the species tends to be ecologically dominant, or as widely scattered plants in later seral stages. The species appears to require periodic disturbances in order to persist. Examination of annual root crown scars indicate that individuals may live in excess of 60 years. These data provide a critical element in the evaluation of population dynamics and informing conservation and management decisions and is apparently of significant conservation concern.

RESUMEN

Una nueva especie, **Lomatium pastoralis,** es una especie de raíz pivotante, endémica restringida descrita de suelos poco profundos desarrollados sobre basaltos en los Bosques Nacionales de la Umatilla y Wallowa-Whitman en el condado de Umatilla en el noreste de Oregón, U.S.A. Evidentemente tiene interés de conservación. La especie se distingue fácilmente de todos otros miembros del género y congéneres locales sobre todo por las características morfológicas de la hoja, tipo de inflorescencia, forma del fruto y la longitud del pedicelo. Las dos poblaciones que se reconocen actualmente están limitadas a pequeñas áreas repartidas en unos pocos km2. Las poblaciones se pueden manifestar como grupos de plantas densamente agrupadas en etapas seriales tempranas en las que la especie tiende a ser ecológicamente dominante, o como plantas dispersas en las últimas etapas seriales. La especie parece requerir alteraciones periódicas para persistir en el paisaje. El examen anual de las cicatrices de la corona de la raíz indican que los individuos pueden vivir más de 60 años. Estos datos proporcionan un elemento crítico en la evaluación de la dinámica de la población e informan de la conservación y de las decisiones sobre su gestión.

INTRODUCTION

Collections were made by David Wagner of an unrecognized *Lomatium* species in June 1978, from shallow lithosol soils at 1555 m on a gentle south-facing slope on the north side of Green Mountain in Umatilla County, Oregon on the Umatilla national forest. Subsequent examination of specimens by Lincoln Constance at the Jepson Herbarium, University of California at Berkeley, confirmed the material to be an undescribed entity. It was provisionally named *Lomatium pastoralis* by Wagner recalling the prior history of the general area as an important domestic sheep pasturing summer range. In the intervening years this species has been purportedly recognized at several other nearby sites, but these locales remain to be revisited and confirmed regarding their present status. Reports of *Lomatium pastoralis* from other nearby localities have either not been successfully relocated, are presently unconfirmed, or have been recently discounted under further scrutiny.

Initial thoughts that the species was most probably not of immediate conservation concern owing to the robust nature of the type locality population and its apparent ability to proliferate in artificially disturbed sites contributed to a delayed publication schedule. Numerous subsequent botanical survey results of the general area by several experienced field botanists on both the Umatilla and Wallowa-Whitman national forests over the last three decades now argues strongly that the species is indeed both rare and in significant need of management as a conservation interest.

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Lomatium is the largest genus of the Apiaceae in North America and it continues to be one of the most noteworthy contributors to the ever-increasing knowledge of vascular plant diversity in North America north of Mexico. Several new species have been described over the last quarter century including *L. cookii* (Kagan 1986), *L. shevockii* (Hartman and Constance 1988), *L. ochocense* (Helliwell 2010), *L. tamanitchii* (Darrach et al. 2010), and *L. bentonitum* (Carlson et al. 2011). In addition, several other confirmed but as yet unpublished *Lomatium* taxa make recent additions to our knowledge of western North America floristics particularly salient (P. Brunsfeld pers. comm.; Darrach in prep; Giblin pers. comm.).

It is also of significance that nearly all of the recently described species in *Lomatium* are of conservation concern (NatureServe Explorer 2010). Overall, of the 102 presently recognized taxa comprising the genus, in excess of 40% are rare or present in abundance only over very narrow ranges. The large number of rare species places *Lomatium* on a par with similar levels of rarity in two other noteworthy, diverse, and largely western North American genera: *Eriogonum* (Polygonaceae) and *Penstemon* (Plantaginaceae) (NatureServe Explorer 2010). The additional importance of *Lomatium* as a critical source of First Foods for native peoples, and for herbal and potential phamaceutical uses (Lee and Soine 1968; Nielson and Jensen 1975; Hunn and French 1981; Chou et al. 2006) points toward a particularly critical need to acquire further understanding of taxonomic relationships and the ecologic requirements and population parameters of this important genus of plants.

TAXONOMY

Lomatium pastoralis D.H.Wagner ex M.E. Darrach & D.H. Wagner, sp. nov. (**Fig. 1**). TYPE: U.S.A. OREGON. Umatilla Co.: N side of Green Mountain, ca. 10 mi NNE of La Grande, T1S R37E Sec. 10. Lat. 45°29'16"N; Long. 118°9'42"W, elev. 1555 m (5100 ft), very abundant in vernally wet open lithosol habitat on south facing portion of ridge top, 23 Jun 1978, *D.H. Wagner 2137* (HOLOTYPE: OSC; ISOTYPES: UC, WTU).

Lomatium pastoralis plantae glabrae acaulescentes e radice elongatae; folia oblonga vel ovata 1–3 ternata, foliis linearibus vel lineari-lanceolatis; radii fertiles inaequales; involucellae bracteolae incospicuae scariosae lineares vel lineari-lanceolatae; flores luteolus; fructus glaber ovalis vel oblongo-ovalis, alis quam corpore multo angustioribus; vittae minimae in intervallis plures.

Herbs perennial, long-lived, weakly aromatic, glabrous, acaulescent, 0.6–3.7 dm. Taproot simple, terete, rarely somewhat tuberous or flattened when growing in narrow rock fractures, 4.0–18.0 cm long, 1.0–15.0 mm wide, surmounted by a simple root crown and a narrow terete subterranean pseudoscape 21.0–78.0 mm long. Old, leaf bases usually present, appressed to the pseudoscape, 1.0–41.0 mm long, entirely beneath the ground surface in all cases. **Leaves** 2–11 (typically 3), glabrous, compound ternate-pinnate, usually partially bipinnate, 4.5–17.9 cm wide, 5.6–15.2 cm long. Petioles 1.1–8.5 cm long with variably developed winged basal portions, winged bases herbaceous, green to light violet-red when young, becoming tawny-chartaceous with age, with 3–15 prominent nerves. Reduced, often once pinnate axillary leaves usually present, petioles enclosed within broad-winged bases of larger primary leaves, wings lacking or minimally developed, often lacking nerves. Pressed leaves usually ca. 15% broader than wide, the leaf outline equilaterally triangular to quadrate, rhombic; axillary leaves narrowly rhombic. Leaflets spreading to weakly overlapping, entire, narrowly elliptical, narrowly oblanceolate, spatulate or linear-filiform, ultimate segments 1–60 mm long, 0.8–9.7 mm wide, occasionally bearing an obscure, minute, non-photosynthetic apiculus. Inner axillary leaves usually have both the longest and most delicate narrow ultimate leaflet segments. Leaves with the most strongly developed petiole wings tend to have the shortest ultimate leaflet segments. Peduncles terete, with minute longitudinal corrugations that are noticeably rough to the touch, often anthocyanic, 6.3–32.3 cm long when mature, basal portion usually strongly decumbent, distal portion curving to sigmoidal, moderately to steeply ascending, greatly exceeding the leaves as the fruits mature. **Inflorescences** compound, involucre none, up to 10 per plant (typically 2 or 3); shorter, axillary peduncles often present. Rays 3–22, unequal in length in flower, becoming markedly so as the fruit matures, dimidiate, usually spreading less than 180°. In flower the shortest rays 1.0–4.0 mm, longest rays 2.3–63 mm, longer rays bearing umbellets with mostly perfect flowers but often a few scattered male flowers present, shorter rays usually bearing predominantly or entirely male flowers. Shortest rays 1.0–22 mm on fruiting inflorescences, longest rays 12.6–106.0 mm on fruiting inflorescences. **Involucel**

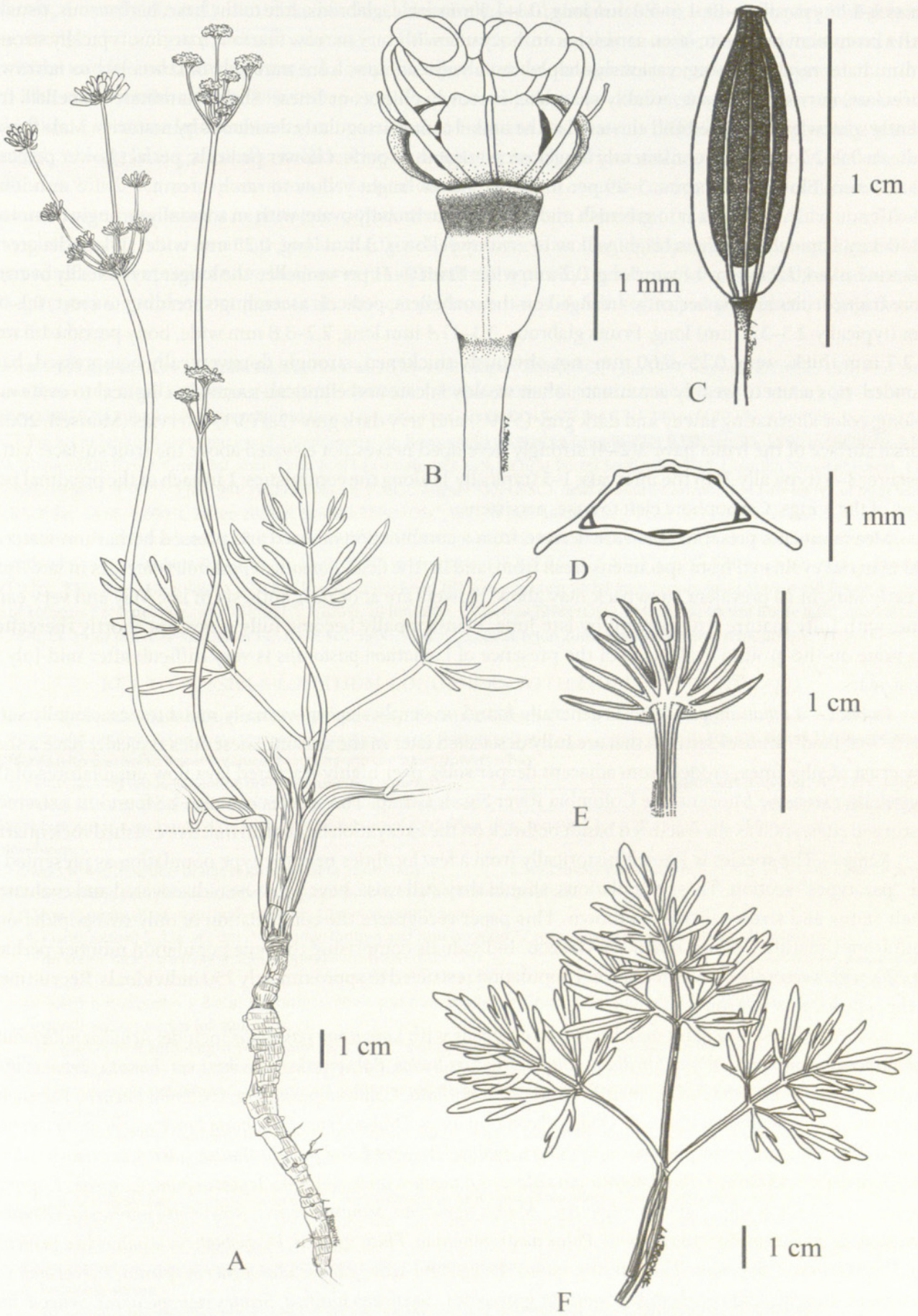

FIG. 1. *Lomatium pastoralis* D.H.Wagner ex M.E. Darrach & D.H. Wagner. **A.** Habit with dashed line representing typical location of ground surface; **B.** perfect flower at anthesis; **C.** mature fruit; **D.** mature fruit transection depicting vittae; **E.** involucel; **F.** typical leaf morphology. Specimen drawn from Mark Darrach collection #429 15 Jun 2009 T1S R37E $NW^{1/4}SE^{1/4}SE^{1/4}$ Sec.10 Umatilla Co. Oregon.

bracts 1–12 (typically 4–8), 1.6–5.0 mm long, 0.1–1.3 mm wide, glabrous, free to the base, herbaceous, usually with a prominent mid-vein, often somewhat anthocyanic with very narrow scarious margins, typically strongly dimidiate, rarely wanting, variously shaped but always narrow, from narrowly oblanceolate to narrowly lanceolate, narrowly obovate, weakly spatulate, narrowly elliptic, or linear. Short, staminate umbellets frequently somewhat contorted and clustered at the umbel center, irregularly deciduous by maturity. Male flower pedicels 0.9–2.7 mm long, consistently longer on average than perfect flower pedicels; perfect flower pedicels 0.3–1.2 mm. **Flowers** glabrous, 5–29 per umbellet; petals bright yellow to rarely cream, 1.2–1.6 mm long, 0.4–0.9 mm wide, with a clear to greenish midvein, ovate to broadly ovate, with an adaxially strongly incurved, 0.2–0.3 mm apiculus; anthers bright yellow to creamy yellow, 0.3 mm long, 0.25 mm wide; stylopodia green, styles incurved, 1.2 mm to 1.8 mm long, 0.2 mm wide. **Fruit** 0–21 per umbellet, the longer rays usually bearing more fruits, fruits hemispherically arranged on the umbellets, pedicels ascending-spreading to erect, 0.1–5.4 mm (typically 2.5–3.5 mm) long. Fruits glabrous, 5.3–11.4 mm long, 2.2–3.8 mm wide, body portion 1.5 mm to 2.7 mm thick, wing 0.15–0.60 mm, not obviously thickened, strongly dorsiventrally compressed, base rounded, tips acute to weakly acuminate, often weakly falcate and elliptical, narrowly elliptical to ovate and oblong, color alternating tawny and dark gray (5Y4/3) and very dark gray (2.5Y3/1) intervals (Munsell, 2000). Dorsal surface of the fruits have 3(2–4) strongly developed nerves not elevated above the fruit surface; vittae obscure, 3–5 (typically 3) in the intervals, 1–3 (typically 1) along the commisure, 1 in each of the proximal portions of the wings. Carpophore cleft to base, persistent.

Measurements presented here are derived from a combination of dried and pressed herbarium material and material evaluated from specimens fresh from, and in, the field. *Lomatium pastoralis* emerges in late April to early May, or as prevalent snowpack may allow. Flowers are at or near anthesis in late May and very early June, with fully mature fruit present by late June. Plants rapidly become fully senescent shortly thereafter. Accurate on-the-ground evaluation of the presence of *Lomatium pastoralis* is very difficult after mid-July in most years.

Habitat.—*Lomatium pastoralis* is generally found on gently sloping, vernally moist to occasionally saturated "scabland" lithosol settings that are fully dessicated later in the season. These sites typically have a shallow crust of silty fines, eroded from adjacent deeper soils, over highly-fractured lava flow entablatures of the regionally extensive Miocene age Columbia River Basalt Group. The species can also be found in extremely disturbed sites, such as the fractured basalt bedrock on the excavation floor of an inactive crushed rock quarry.

Range.—The species is known historically from a few localities near the type population as presented in the "paratypes" section. These populations, should they still exist, have yet to be rediscovered and evaluated. Their status and size/vitality is unknown. This paper recognizes the confirmation of only two populations, both from Umatilla County, northeast Oregon. Individuals comprising the type population number perhaps 10,000, with a recently discovered second population restricted to approximately 750 individuals. Recruitment at the type locality is strong.

Associated vascular plant taxa known to co-occur with *Lomatium pastoralis* include: *Achillea millefolium, Achnatherum lemmonii, Allium fibrillum, Antennaria luzuloides, Balsamorhiza hookeri var. hirsuta, Bromus marginatus, B. tectorum, Camassia quamash, Cistanthe umbellata, Collinsia parviflora, Collomia linearis, Danthonia unispicata, Delphinium nuttallianum, Dodecatheon conjugens, Draba verna, Epilobium brachycarpum, Eriogonum heracleoides, Floerkia proserpinacoides, Fritillaria pudica, Hesperochiron pumilis, Juncus parryi, Lewisia nevadensis, Linanthus harknesii, Lithophragma parviflora, Lomatium ambiguum, L. leptocarpum, L. grayi, L. piperi, Lupinus aridus var. aridus, Lupinus sulphureus, Madia glomerata, Montia linearis, Navarretia intertexta, Olsynium douglasii var. inflatum, Paeonia brownii, Phlox austromontana, Phlox gracilis, Plagiobothrys scouleri var. penicillatus, Poa secunda, Polygonum douglasii var. majus, Polygonum kelloggii, Pseudoroegneria spicata, Pyrrocoma carthamoides, Sanguisorba occidentalis, Sanicula graveolens, Saxifraga nidifica, Sedum stenopetalum, Senecio integerrimus var. exaltatus, Sidalcea oregana var. procera, Triteleia grandiflora var. grandiflora,* and *Vulpia bromoides.*

Lomatium pastoralis is distinct and most readily identified in the field relative to its immediately associated and nearby congeners by the following characters: narrowly elliptical fruits on short, but easily-observed

pedicels, a usually strongly dimidiate involucel, relatively broad simple leaflets, and peduncles that remain very strongly decumbent proximally through to full maturity with weakly-to-moderately ascending and often sigmoidal middle and distal segments. A composite illustration of the species is provided in Figure 1.

The species with which *Lomatium pastoralis* is most likely to be confused are *L. leptocarpum* and *L. ambiguum*. *Lomatium leptocarpum* is an occasional to frequent associate. It differs in having nearly sessile, narrowly oblong fruits, a usually well-developed radial involucel, narrow and more numerous leaflets, and peduncles which are only rarely strongly decumbent at the base. *Lomatium ambiguum* is infrequently found scattered within the known *L. pastoralis* populations but it is more abundant on directly adjacent scabland lithosol sites with better drainage and similar gentle, but somewhat steeper slopes. *Lomatium ambiguum* has long pedicels with upright fruits, lacks an involucel entirely, typically includes at least one cauline leaf on mature specimens, and does not possess decumbent peduncle bases. A full key to possible nearby congeners is presented below.

PARATYPES. **U.S.A. OREGON. Umatilla Co.:** type locality, 23 Jun 1978, *Wagner 2138* (OSC); 4 Jun 1979, *Wagner 2303* (OSC, UC); 5 Jul 1980 *Wagner 2516* (OSC); 12 Jun 1991, *Wagner 4521* (OSC); 6 Jul 2002, *S. Markow 12354*, 6 Jun 2003, *S. Markow 12467* (OSC, RM); 20 Jun 2003, *S. Markow 12481* (OSC); Ruckel Ridge near Big Saddle, ca. 15 mi N of La Grande, T1N R37E Sec. 13, 1,280 m (4,200 ft); 5 Jul 1980, *Wagner 2522* (OSC); Ruckel Ridge Road near junction of Thimbleberry Mt. Road, ca. 13 mi N of La Grande, T1N R37E Sec. 25, 1,400 m (4,600 ft); 5 Jul 1980, *Wagner 2530* (OSC); Green Mt. area, 15 mi N of La Grande, in a rock pit near Forest Service Rd 3116, Umatilla National Forest, T1S R37E Sec. 10 $SE^{1/4}$ of $SE^{1/4}$, 3 Jul 1991, *Paula Brooks* s.n. (OSC); *Wagner 4521* (OSC); head of Smith Canyon, ca. 13 air mi NE of Meacham, T1N R37E Sec. 24 SE, 5,600 ft, 28 Jun 2003, *S. Markow 12493* (OSC, RM); W side Mount Emily Road, 100 yards W of and overlooking Pot Creek, ca. 14 air mi E of Meacham, T1S R37E Sec. 6 $SW^{1/4}NW^{1/4}$, *S. Markow 12468* (OSC,RM); meadow 100 yards W side Mount Emily Road, 100 yards N of and overlooking Pot Creek, ca. 15 air mi NE of Meacham, T1S R37E Sec. 25 $NW^{1/4}NW^{1/4}$, 5,600 ft, 6 Jun 2003, *S. Markow 12471* (OSC, RM); Nine Mile Ridge ca. 30 ft E of Forest Service Road 287 at intersection with Forest Service Road 31 (Summit Road), ca. 6 air mi S of Tollgate, T3N R38E Sec. 32 $NW^{1/4}SE^{1/4}$, 5,200 ft, 20 Jun 2003, *S. Markow 12484* (OSC, RM); E side Mount Emily Road, overlooking Fir Creek, ca. 15 air mi NE of Meacham, T1S R37E Sec. 36 $NE^{1/4}NE^{1/4}$, 5,600 ft, 6 Jun 2003, *S. Markow 12468* (OSC,RM).

KEY TO POSSIBLE *LOMATIUM* CONGENERS WITH *LOMATIUM PASTORALIS*

1. Plants with obvious simple tuberous thickened root; rarely, if ever, moniliform.
   2. Plants with partially fused ovate to obovate involucel bracts; flowers yellow _____ **L. cous** (S. Wats.) J.M Coult & Rose
   2. Plants with narrow to linear involucel bracts free to the base; flowers white.
      3. Plants lacking reduced cauline bract; mature fruit scabrous _____ **L. gormanii** (Howell) J.M Coult. & Rose
      3. Plants with a single reduced cauline bract; mature fruit glabrous _____ **L. piperi** J.M Coult. & Rose
1. Plants lacking or very rarely displaying simple tuberous thickened root, but may have distinctly moniliform root thickenings.
   4. Flowers white; involucel bracts distinctly ciliate-short hairy _____ **L. macrocarpum** (Nutt. ex Torr. & A. Gray) J.M. Coult. & Rose
   4. Flowers yellow, pale yellow or, occasionaly, red-purple; involucel bracts glabrous.
      5. Large majority of ultimate leaf segments 10 mm in length or less.
         6. Plants robust; 5–15(–20) dm at maturity; umbels and fruit large (to 17 mm in length); in this region plants often on steep, rocky, partially shaded slopes or soil pockets on cliffs _____ **L. dissectum var. multifidum** (Nutt.) Mathias & Constance
         6. Plants not robust; <5 dm at maturity; umbels and fruit smaller (<17mm in length); plants typically on more gentle terrain, and in full sun.
            7. Mature fruit with length/width ratio typically 6:1 but ranging from 3.3:1 to 13.3:1; mature fruit pedicels very short (0.9–)1.2–2.0(–2.7) mm; ultimate leaf segments few _____ **L. leptocarpum** Torr. & A. Gray
            7. Mature fruit with length/width ratio 3:1 or less; mature fruit pedicels at least 4mm; ultimate leaf segments very numerous.
               8. Ultimate leaf segments numerous and mostly in same plane; 1.5–8.0 mm, usually overlapping and strongly bluish-glaucous; root crown simple and largely lacking old leaf bases; plant odorous, but not strongly so _____ **L. donnellii** (J.M Coult. & Rose) J.M Coult. & Rose
               8. Ultimate leaf segments up to 6 mm, very numerous, and non-planar; rarely clearly glaucous; root crown with a branching caudex that retains old leaf bases; strongly, pungently odorous when crushed _____ **L. grayi** (J.M Coult. & Rose) J.M Coult. & Rose
      5. Large majority of ultimate leaf segments greater than 10 mm in length.
         9. Involucel absent.
            10. Leaflets prominently veiny; 1–4 cm broad; usually toothed at terminus; leaves basally disposed; inflorescences with swelling at base of umbel _____ **L. nudicaule** (Pursh) J.M Coult. & Rose
            10. Leaflets not prominently veiny; segments narrow (0.7–)1.0–4.0(–5.0) mm broad; at least one cauline leaf on most specimens; inflorescences lacking swelling at base _____ **L. ambiguum** (Nutt.) J.M Coult. & Rose
         9. Involucel present; very rarely absent.

11. Peduncles usually strongly ascending at maturity; and lacking clearly decumbent bases.
    12. Mature fruit narrow, nearly linear, with length-width ratio typically 6:1 but ranging from 3.3:1 to 13.3:1; mature fruit pedicels short (0.9–)1.2–2.0(–2.7) mm _____ **L. leptocarpum** Torr. & A. Gray
    12. Mature fruit narrowly elliptical to oblong, length-width ratio 3.5:1 or less; pedicels 2-10 mm.
        13. Mature fruits lacking broad wings _____ **L. triternatum var. triternatum** (Pursh) J.M. Coult. & Rose
        13. Mature fruit with prominent wings nearly or quite as wide as body _____ **L. simplex var. simplex** (Nutt.) J.F. Macbr.
11. Peduncles usually weakly ascending at maturity with strongly decumbent bases _____ **L. pastoralis** D.H. Wagner ex M.E. Darrach & D.H. Wagner

CONSERVATION, ECOLOGY, AND PHENOLOGY

Lomatium pastoralis typically emerges in late April or early May, but may emerge earlier in low snowpack years. Flowering progresses through mid-May to anthesis around the last week of May through the first week of June. Mature fruit are present and dehiscent by the end of June and the plants are quickly senescent and largely reduced to remnant material around the root crown by mid-July.

Lomatium pastoralis is known to grow exclusively on shallow, poorly-developed soils over Miocene age Columbia River Basalt bedrock in open, vernally moist, "scabland" lithosol settings. These soils typically display a thin veneer of silty, non-plastic fines with very little exposed rock. However, an abundant, highly fractured basalt layer is present at very shallow depths, well within the rooting zone of the plants.

The species typically occurs as very dense populations in which it is generally either a dominant or co-dominant species. Observations of the documented populations strongly argue that the species is an early seral occupant of disturbed landscapes. One segment of what is presumed, in lieu of a more formal census and search effort, to be the largest population of the species now occupies the floor of a road metal basalt quarry that has been inactive for approximately 20-years (Anderson pers. comm.). In this setting the species forms a near monoculture, locally achieving 100 percent cover or in co-dominance with *Camassia quamash* and *Floerkia proserpinacoides*. In contrast, a recently discovered population in a later seral ecological setting on the southeast slopes of Green Mountain numbers approximately 750 widely-scattered individuals as other species have established and proliferated in vegetative succession; particularly *Lupinus aridus* var. *aridus*.

The area where *Lomatium pastoralis* is found has a history of intensive domestic sheep grazing by large flocks numbering in the many thousands. In the wake of these destructive land usage policies, most notably in the early part of the 20th century, unforested shallow soil habitats were left largely devoid of a native grass component. The type locality is immediately adjacent to a water source, so that flocks of sheep were frequently kept overnight in this meadow (C. Johnson pers. comm.). These areas were nearly completely denuded at times and left in a vegetative disclimax condition that persists to the present (Darrach pers. obs.; Langford 1996). It is surmised that disturbance of this magnitude may well have provided ideal conditions for proliferation of the species as an early seral strategist reliant upon a persistent disturbance regime. In addition, some unpalatable *Lomatium* taxa are known to increase in biomass under grazing pressure (Lathrop pers. comm.; Utah State University 2011; Johnson unpublished data). Another possible allied factor includes allelopathic interactions. A number of *Lomatium* taxa are quite pungent and have secondary chemicals that make them likely candidates for possessing inhibiting allelopathic qualities (Asuming et al. 2004; Meepagala et al. 2006).

An affinity to occupy sites with an ecological approach dependent upon some form of persistent landscape disturbance can be a precarious evolutionary strategy that may inherently lead to rarity upon the landscape (Parsons & Brown 1982; Hardin & White 1989; Lesica & Cooper 1999). This is particularly so if the source(s) of disturbance are not consistent over the long term (Parsons & Brown 1982). Conversely, reliance upon disturbance as an ecological strategy can provide long-term viability if primary disturbance factors such as the inherent instability of a geologic substrate—for example talus slopes and shrink-swell clay substrates—is the primary source of disturbance (Parsons & Brown 1982; Mastroguiseppe et al. 1985; Darrach & Thie 2010). As discussed above regarding observations by the authors, *Lomatium pastoralis* appears to have a strong affinity for disturbed locales and is most probably adapted as an early seral species.

As domestic sheep grazing has become much more tightly regulated, and indeed permit grazing of both

sheep and cattle in the general area of the known *Lomatium pastoralis* populations has been greatly curtailed relative to historic levels (Lathrop pers. comm.), a significant source of disturbance that may have allowed for the persistence of the species upon the landscape has been reduced. However, an additional important source of persistent disturbance at the type locality at the present time is provided by a robust population of the fossorial northern pocket gopher—*Thomomys talpoides*. As long as this rodent population persists at the site, the bioturbation activites of these small mammals would appear to create an ideal disturbance vehicle in turn supporting a continuing healthy population of *Lomatium pastoralis*. Other possible sources of persistent ground disturbance in the area include periodic fire control activities, the presence of herds of big game, unauthorized off-road vehicle usage, sheet runoff during snowmelt and extreme precipitation events, and soil surface movements associated with freeze-thaw cycles under saturated conditions. Freeze-thaw cycles are most probably a minor contributor as the clay content of soil fines is low and winter soil temperature fluctuations are likely moderated by the insulating effects of significant snow cover in most years.

The possibility that the historical vegetation character of these open scabland sites was sufficiently robust to carry low intensity fire is also of interest. Fire is a disturbance that often plays a fundamental role in plant community and plant population dynamics (Bond & van Wilgen 1996). Fire suppression activities over the last 100-years have greatly altered fire return intervals and indeed the absence of fire is implicated as the principal threat to approximately 4% of the endangered flora in the United States (Schemske et al. 1994). While little research has specifically centered upon the role of fire as a contributing factor to population dynamics in the genus *Lomatium*, the work of Kaye and others (2001) is a notable exception. Their stochastic transition matrix modeling efforts as applied to a series of experimental fire treatments on populations of the federally endangered species *Lomatium bradshawii* in the Willamette Valley of Oregon clearly illustrates the critical role fire plays to this disturbance-dependent species. It seems likely that the damage inflicted to soils by historical long-term intensive grazing on the sites presently occupied by *Lomatium pastoralis* may have reduced the capacity of these locales to support sufficient biomass to carry fire. In this regard, the near absence of a native perennial bunchgrasss (e.g. *Poa secunda* and *Pseudoroegneria spicata*) component in particular is noteworthy.

Conservation management concerns regarding *Lomatium pastoralis* center around the likelihood of the plant as being dispersal-limited (Thompson 1985; Marsico & Hellmann 2009), having short seed bank residence time with questionable year-over-year viability (Thompson 1985; Kaye et al. 2001), and as an early seral specialist reliant on a possibly unstable disturbance regime for long-term persistence upon the landscape. Judicious use of periodic surface scarification in the area of existing populations is suggested for consideration as a management tool—particularly as later seral vegetative stages begin to take hold. In addition, the possible use of low intensity fire, perhaps with minor fuels enhancement may be of management value. While in-situ seed predation is noted from entrance holes in endosperm material on a few mature fruits, and rodent activity observed in the field (Wagner pers. obs.) while conducting the morphometric analysis, the impact of seed predation upon recruitment remains to be more fully evaluated.

Inspection of root morphology reveals that individuals of *Lomatium pastoralis* typically display well-developed root crown scars. These root crown scars, which clearly appear to be correlated with plant age, have been observed to be 13–61 in number in a sample of 76 specimens (Darrach unpublished data). These data provide an important temporal element to understanding the population dynamics of the species. While some plants may indeed live to be much older, or, conversely, the 61-year-old specimen may be an outlier in a species that rarely achieves such longevity, this information provides some guidance that can inform conservation management decisions.

We note that the genus *Lomatium* as a whole, and indeed perhaps a much broader suite of perennial herbaceous plants that die back to the root crown each season, deserves attention regarding this readily observed, but previously overlooked source of information. While some species may prove difficult to evaluate for longevity owing to morphologies that preclude accurate analysis—for example persistent strongly sheathing leaf bases that obscure the root crown and caudices—the large number of rare species in this genus indicate that the effectiveness of conservation biology efforts may benefit considerably from a study of plant longevity. In

addition, the emerging climatology sub-field of shrub and herb chronology (for example Rayback & Henry 2006; Rozema et al. 2009; Franklin pers. comm.) may find value in this information.

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