Pediomelum Rydberg (Leguminosae) in Arizona and two previously undescribed species

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The genus *Pediomelum* was erected by P.A. Rydberg (1919) to accommodate those plants from North America previously known under the collective heading *Psoralea* L. (Linnaeus 1753). The type material for *Psoralea* came from Africa; and in a strict sense, *Psoralea* consists of a dozen or more species of South African shrubs or small trees. Their relationship to North American materials has been discounted not only by Rydberg but also by other workers in the Leguminosae, tribe Psoraleae (Barneby 1989, Isely 1998, Welsh et al. 2008).

Attention to species of *Pediomelum* Rydberg in Arizona was stimulated when photos and specimens of 2 distinctive acaulescent to short-caulescent species of the genus were received from coauthor Max Licher. The plants differ markedly from each other in floral characteristics. One is large-flowered (11–15 mm) with white banners and with most calyx tubes exceeding 6 mm, the length indicated by Grimes (1990) for *Pediomelum megalanthum*. Specimens of that species from throughout its range had calyx tube lengths of 5.0–6.5 mm. The other plant sent by Licher had smaller flowers (9.8) 10–11.3 mm with blue-purple or purple banners and calyx tubes (3) 3.5–4.8 mm in length. Identification of both the large- and small-flowered plant specimens was attempted following Grimes (1990). The larger, white-banneered plants clearly fit within the concept of *P. megalanthum*. The smaller, purple-banneered plants clearly do not fit within that concept.

Grimes (1990), in his summary monograph of New World *Psoraleae*, limits the concept of *P. megalanthum*, sensu lato—including vars. *megalanthum*, *retrorsum*, and *epipsilum* (herein treated at specific rank)—to those materials having the calyx tube at least 6 (actually 5–6.5) mm long and upper calyx teeth lanceolate. He included among the species having calyx tubes shorter than 6 mm (2–4.5 mm), the geographically disjunct *P. p a r i e n s e* (S.L. Welsh & N.D. Atwood) Grimes and *P. californicum* (S. Watson) Rydberg, and the Arizona species *P. mephiticum* (S. Watson) Rydberg. The first of these, *P. p a r i e n s e*, occurs mainly on Tertiary Claron and Jurassic Carmel limestone formations in central to western Kane County, Utah; *P. californicum* is known from southern California and northern Baja California, Mexico; and *P. mephiticum* is known mainly from northern Mohave County, Arizona, north of the Grand Canyon, and from southwestern Washington County, Utah. *Pediomelum mephiticum* extends south of the Grand Canyon to the vicinity of Wikieup, Arizona.

**METHODS**

A list of specimens from Arizona that we examined and cite appears in the Appendix.
This study is based not only on specimens of *Pediomelum* at the Brigham Young University Stanley L. Welsh Herbarium (BRY) but also on others obtained on loan from the Northern Arizona University Deaver Herbarium (ASC), the Arizona State University Herbarium (ASU), and the University of Arizona Herbarium (ARIZ). The majority of sheets examined of *P. epipsilum* (Barneby) S.L. Welsh were from Utah; only 2 were from Arizona, both on the Triassic Moenkopi Formation west of Fredonia. Specimens from throughout the distribution of *P. megalanthum* were examined, but only those from Arizona and New Mexico are cited. Those of *P. retrorsum* Rydberg were examined also, the majority of which were from Arizona. Three sheets of the acaulescent *P. pentaphyllum* (L.) Grimes were examined, all from Greenlee and adjacent Cochise counties, Arizona; and one sheet was examined of the short-caulescent *P. palmeri* (Ockendon) Grimes from Santa Cruz County, Arizona. Specimens from throughout Arizona (all from populations adjacent to the Nevada border in Mohave County) and Nevada were examined for *P. castoreum* (S. Watson) Rydberg.

**RESULTS**

Review of specimens examined for this study confirmed the presence of 10 species of *Pediomelum* in Arizona. Examination also
confirmed the distinct nature of the small-flowered materials with ascending hairs on pedicels and peduncles from the Verde Limestone Formation. This examination also demonstrated the existence of a second set of small-flowered plants with ascending hairs on both pedicels and peduncles from north of the Grand Canyon in the vicinity of Poverty Mountain. The specimens from the Verde Limestone Formation apparently bear flowers with all petals more or less suffused with dark purple or blue-purple. Those from the Poverty Mountain area are pale-flowered and the leaves tend to greatly overtop the inflorescences. Both the Verde Limestone and the Poverty Mountain plants are described and named below. N.D. Atwood provided insight into habitat and growth of the novelty described below from the vicinity of Poverty Mountain in northern Arizona. He is thoroughly familiar with the plant in its habitat and has collected it previously.

Species of the genus *Pediomelum*, as they occur in Arizona, are mainly geographically discrete from each other; that is, the distributions still occupy discrete habitats within areas of apparent overlap (Fig. 1).

**Taxonomy**

The following key will serve to delimit the species of *Pediomelum* that are known to occur in Arizona:

<table>
<thead>
<tr>
<th>1. Leaflets conspicuously bicolored, cinereous beneath, bright green and glabrous to glabrate above (except along some veins); plants only known from the Triassic Moenkopi Formation from SW Kane Co., Utah, and N Coconino Co., Arizona</th>
<th>2. Plants definitely caulescent; leaflets green on both sides; flowers mainly &lt;10 mm long</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Leaves palmately compound; plants erect or ascending, known from the Chinle Formation, SE Washington Co., Utah, and N Mohave Co., Arizona</td>
<td>3. Leaves palmately compound; plants deciduous or prostrate, known from the Chinle Formation, SE Washington Co., Utah, and N Mohave Co., Arizona</td>
</tr>
<tr>
<td>4. Calyx lobes very unequal, the lower one much enlarged or much differing in shape from the narrowly subulate upper ones; seeds reticulate or rugose</td>
<td>5. Calyx lobes subequal to moderately unequal, the lower one not-much enlarged; seeds smooth</td>
</tr>
<tr>
<td>6. Calyx tube mainly 5.0–6.5 mm long; flowers 11–15 mm long</td>
<td>7. Calyx tube mainly 2.5–4.5 mm long; flowers 7.3–13.5 mm long; plants of north central Arizona and SW Utah</td>
</tr>
<tr>
<td>8. Petioles and peduncles with hairs appressed or appressed ascending; sometimes with a few long spreading hairs; plants of Apache Co. and disjunct in S Coconino and adjacent Yavapai cos., Arizona, NW New Mexico, W Colorado, and E Utah</td>
<td>9. Pedicels 3–5 (5) mm long; bracts 5–8 mm long; flowers (9.8) 10–11.3 mm long, banner white or cream, wings of similar color, both contrasting with purple keel</td>
</tr>
</tbody>
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*P. epipsilum* (Barneby) S.L. Welsh

*P. palmeri* (Wooton & Standley) Rydberg

*P. megalanthum* (Wooton & Standley) Rydberg

*P. mephiticum* (S. Watson) Rydberg

*P. retrorsum* Rydberg

*P. castoreum* (S. Watson) Rydberg

*P. verdense* S.L. Welsh & M. Licher

*P. palmeri* (Ockendon) Grimes

*P. megalanthum* (Wooton & Standley) Rydberg

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*P. epipsilum* (Barneby) S.L. Welsh

*P. palmeri* (Wooton & Standley) Rydberg

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*P. epipsilum* (Barneby) S.L. Welsh

*P. palmeri* (Wooton & Standley) Rydberg

*P. megalanthum* (Wooton & Standley) Rydberg

*P. mephiticum* (S. Watson) Rydberg

*P. retrorsum* Rydberg

*P. castoreum* (S. Watson) Rydberg

*P. verdense* S.L. Welsh & M. Licher

*P. palmeri* (Ockendon) Grimes

*P. megalanthum* (Wooton & Standley) Rydberg
Grimes (1990) revised the genus *Pediomelum* as part of a large, very complex work. Under discussion of *P. megalanthum* var. *megalanthum*, he noted (p. 82):

Some plants in populations of var. *megalanthum* commonly are canescent. This is particularly true of those populations disjunct in Yavapai County, Arizona. In one collection from Yavapai County, (Harbison, 9 June 1941, DS), the floral measurements fall within the range of *Pediomelum mephiticum*, but the peduncular pubescence is that of var. *megalanthum*. As *P. mephiticum* is not otherwise known to occur in Yavapai County, and as there are adjacent populations whose flower sizes fit nicely into *megalanthum*, I take this specimen to be an aberrant variant of the latter.

A duplicate of the Harbison collection is at ARIZ and is herein described and long known as *P. verdiense*. Specimens from near the locality known for *P. verdiense*, in adjacent Coconino County (vicinity of or actually within Sedona), are clearly *P. megalanthum*, sensu lato, and are disjunct from the remainder of that species’ distribution by more than 100 km. However, pubescence of stems (appressed or ascending) and peduncles (spreading) is hardly characteristic of *P. megalanthum* as a whole, as it occurs from northeastern Arizona and northwestern New Mexico northward in the Colorado drainage system of western Colorado and eastern Utah. Possibly this disjunct material, herein still included in *P. megalanthum*, also deserves taxonomic consideration, but that question is beyond the scope of this paper.

Two previously undescribed species are named and described below.

**Pediomelum verdiensis** S.L. Welsh & M. Licher sp. nov.

Similis *P. mephiticum* sed in pubescentiis ascendentibus caulium floribus plerumque majoribus et vexillis purpurascens et pubescentibus densioribus interalia differt.

**Type.**—USA, Arizona, Yavapai Co., wash just north of Middle Verde exit from I-17, on flats above wash, locally frequent, 34°37′34″N, 111°51′43″W, 3445 ft (ca. 1050 m), desert scrub with widely scattered junipers, Verde Formation limestone soils, M. Licher 1911, 18 April 2008, holotype BRY, isotype ASC.

**Verde Breadroot**

Acaulescent to short caulescent, 4.5–9 (15) cm tall, from slender, subterranean caudex branches arising from deep-seated ellipsoid to narrowly tapering tuberous roots; aboveground stems lacking or with very short internodes and more or less obscured by leaf bases and stipules, less commonly with internodes elongated (pseudo-peduncles) 0.5–6.5 cm long, spreading white-hairy; leaves (3) 5-foliolate; petioles 2–7.5 (10) cm long, with hairs appressed-ascending;
leaflets 8–23.5 mm long, 7–16.5 mm wide, obovate to broadly so, gray green, densely strigose, and obscurely punctate beneath; green to yellow green, thinly strigose overall (more densely canescent along veins above and on the lower surface), obviously punctate above; stipules scarious, 4–16 mm long, connate and without leaf otherwise on lowermost nodes of caudex, adnate to petiole base and bilobed on foliage leaves above, the upper ones densely white strigose; peduncles 0.5–2 (6) cm long, spreading or spreading-ascending white-hairy; inflorescences (cymose) with branches mainly 5–7-flowered, 1.5–2.5 cm long; pedicels 3–3.5 (5) mm long, filiform; bracts elliptic, 5–8 mm long; flowers (9.8) 10–11.3 mm long, the banner purple or suffused with pale purple, the wings and keel dark purple; calyx (9) 10–11 mm long (11.7 mm in fruit), the tube (3) 3.5–4.8 mm long (from end of strongly gibbous-saccate base to the sinus between the 2 lateral teeth), the lower tooth elliptic, (4.5) 6.0–8.2 (9.2 in fruit) mm long and 2.0–3.5 mm wide, the upper teeth lance-elliptic to lance-subulate or ob lanceolate, 4.2–6.5 (7.3) mm long and 1.5–2.3 mm wide; pods included in the calyx; seed 4.2–4.8 mm × 2.8–3 mm, gray brown with purple mottling (Fig. 2).


“Flat-topped, grayish-white hills in the center of the Verde Valley are chalky lake limestone and siltstone deposited when the Verde River was dammed at its southeast end by uplift of the Central Highlands” (Chronic 1983). “The chalk-like limestone layers are interlayered with pink silt and sand brought in by streams, and with volcanic ash from long-continued vulcanism in this region” (loc.cit., 191). Deposition of the limestone was evidently from lime-rich waters draining from Paleozoic limestones of the Colorado Plateau (Chronic 1983), which preserve the remains of horses and mastodons as well as snails and clams “of the same species that live in fresh water streams and lakes today” (Nations and Stump 1981, p. 54). The Verde Formation is estimated to be 1.8–10 million years old.

The more-ancient lacustrine limestones in Utah and the White and Pink limestones of the early Tertiary Claron Formation serve as substrates for a series of local endemics (including *P. pariense*, which is not known from Arizona). It is hardly surprising that such endemics might occur in similar substrates in Arizona.

**Pediomelum pauperitense** S.L. Welsh, M. Licher, & N.D. Atwood sp. nov.

Similis *P. verdiensem* in pubescentiis ascendentiis caulium sed in vexillo et alis albis (nec purpureis) et floribus foliorum plus superantibus differt.

**TYPE.**—USA, Arizona, Mohave Co., T35N, R12W, Sec. 35/36, SW of Poverty Mountain, near Dewdrop Spring; 1756 m, in gravelly limestone soil in pinyon-juniper community, L.C. Higgins 23135, 25 May 2001, holotype BRY, isotypes distributed previously as *P. mephiticum*.
Poverty Mountain Breadroot

Acaulescent to short caulescent, 10–15 cm tall, from slender, subterranean caudex branches arising from deep-seated tuberous roots; stems above ground lacking or with very short internodes and more or less obscured by leaf bases and stipules, less commonly with internodes elongated (pseudo-peduncles) 0.5–2.5 (5) cm long, spreading white-hairy; leaves 5-foliolate; petioles 2–11.5 cm long, much surpassing the inflorescences, with hairs appressed-ascending; leaflets 8–28 mm long, 4–22 mm wide, obovate to broadly so, gray green, densely strigose, and obscurely punctate beneath; green to yellow green, thinly strigose overall above (more densely canescent along veins above and on the lower surface), and obviously punctate above; stipules scarious, 4–16 mm long, connate, adnate to petiole base and bilobed on foliage leaves above, the upper ones densely white strigose; peduncles 0.5–4.5 cm long, ascending or spreading-ascending white-hairy and with longer spreading white hairs; inflorescences (cymose) with branches mainly 3–7-flowered, 1.5–2.5 cm long; pedicels 1.5–2.5 (3) mm long, filiform; bracts elliptic, 3–5 mm long; flowers 7.3–10 (10.2) mm long, the banner white or cream, the wings pale, the keel dark purple; calyx (7) 7.3–9.6 mm long, the tube (2.5) 3–3.7 mm long (from end of strongly gibbous-saccate base to the sinus between the 2 lateral teeth), the lower tooth elliptic, (4) 5–6.0 mm long and 1.4–2.5 mm wide, the upper teeth lanceolate to oblong and attenuate to acute, 4.2–6.5 mm, 0.9–1.5 (2.5 in fruit) mm wide; pods included in the calyx, transversely ruptured; seed 3.8 × 2.5 mm, olive to gray brown (Fig. 3).


Acknowledgments

We wish to acknowledge the curators of the herbaria in Arizona for loaning specimens, especially those at Northern Arizona University at Flagstaff (ASC), Arizona State University at Tempe (ASU), and University of Arizona at Tucson (ARIZ). Acknowledged also for their help with this paper are graphics expert Handy Baker, who provided the illustrations of the 2 new taxa, and Shannie Workman.

Literature Cited


Linnarss, C. 1753. Species Plantarum. Holmiae, Impensis Laurentii Salvii. 2 volumes [xii], 560, [ii], 561–1200, [31] pp.).


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APPENDIX. Pediomelum specimen citations.

**Pediomelum aromaticum** (Payson) W.A. Weber

**Arizona**: Mohave Co.—T40N, R5W, S5, Clay Basin, ca. 1.5 mi SE of Lone Butte and E of the Kane Beds, elevation 1500 m, *Atwood* 18202A, 13 Jun 1993, ASU!, BRY!, ARIZ!—*T40N*, R6W, Sec. 12, Chinle clay soils, Cedar Ridge, 1550 m, *Higgins* 26666, 25 May 2003, BRY!

**Pediomelum castoreum** (S. Watson) Rydberg


**Pediomelum epispilum** (Barney) S.L. Welsh


**Pediomelum megaleanthum** (Wooton & Standley) Rydberg

woodland, 34°55'17"N, 111°54'29.9"W, 4740 ft, Lecher 1176, 4 May 2005, ASC! – 3.3 mi W of Hwy, 279, on road to Cherry, flowers with a cream banner, dark blue violet wings and keel, Spellenberg et al. 3119, 15 May 1973, ASU! 

**COLORADO:** **Delta Co.** – 1 specimen at BRY! Mesa Co. – 15 specimens at BRY! Montezuma Co. – 2 specimens at BRY! Montrose Co. – 4 specimens at BRY! 


**NEVADA:** **Clark Co.** – T22N, R56E, Sec. 7, ca. 17 mi SE Pahrump, Charleston Mountains, 3400 ft, Thorne & Atwood 4354, 14 Apr 1986, BRY! 

**Pediodemum palmeri** (Ockendon) Grimes 

**ARIZONA:** **Santa Cruz Co.** – Growing under Quercus sp., on south side of Penasco, about 0.5 miles up from junction with Sycamore Canyon. Previously known in Arizona from a single collection in Peci Canyon. Flowers red brown, Sycamore Canyon, Pajarito Mountains, Toplin & Kaiser #029, 25 Aug 1978, ARIZ! 

**Pediodemum pauperisense** S.L. Welsh, M. Licher, & N.D. Atwood 

Specimens cited following original description. 

**Pediodemum pentaphyllum** (L.) Rydberg 

**ARIZONA:** **Cochise Co.** – Hwy. 181, near Chiracahua National Monument, SE of Wilcox, Deaver 6574, 1 Sep 1963, ASU! – Sunizona, from junction of Rt. 181 and Rt. 191, S 1.5 mi along 191, then E 0.5 mi to base of hill, grassland, silt, sandy clay, T18S, R26E, Sec. 22, McGill 6062, 9 Apr 1993, ASC!, ASU! – Sulfur Spring Valley, Sunizona, from junction of Rt. 181 and Rt. 191, 1.5 mi S, then 0.5–1 mi E, T18S, R26E, Sec. 22/15, McGill 6042. 1 Apr 1995, ASU! – Sulphur Springs Valley, ca. 3 miles SW of Sunizona, 1.5 miles S of Hwy. 59/91 junction, then 0.5 miles E of Rainbows End Road, N side of 4533' Hill, sandy loam, ca. 25 plants along dirt road, T18S, R26E, Sec. 15, Anderson 2006-7; 30 Aug 2006, ARIZ! Graham Co. – Near lower Sun Simon plot, 3000 ft, Anderson & Rhinehart 953, 1 Apr 1936, ARIZ!
Pedionemum retrosum Rydbell

ARIZONA: Coconino Co.—near Fredonia, T41N, R1W, Sec. 28, Gierisch 4321, 16 May 1978, ASC!, ASU! – Hwy. 66, halfway between Ashfork and Seligman, 5000 ft, Miraula & Deaver 5734, 26 May 1960, ASC! – near Fredonia, T41N, R1W, Sec. 28, Gierisch 4321, 16 May 1978, BRY! – along Winter Road, 1.3 mi NE of junction with Hwy. 89A, T41N, R1W, Sec. 28, Bronen et al. 649, 16 May 1978, BRY! – 7 mi E of Fredonia, 0.2 mi NE of Hwy. 89A, on Winter Road, red soil, big sage grassland, Lehto L23765, 19 May 1979, ASU! – 7 mi E of Fredonia, 0.2 mi NE of Hwy. 89A, on Winter Road, red soil, big sage grassland, Lehto L23770, 19 May 1979, ASU! – 7.1 mi E of Fredonia, opposite road oil storage tank, T41N, R1W, Sec. 28, 4850 ft, Brown & Parfitt s.n., 14 Apr 1962, ASC! – Arizona 87, 2 miles N of Saguaro Lake, growing in a ravine with Yucca baccata, 29 Apr 1984, ASU! – Hwy. 93, 5 mi E of Hackberry, 3200 ft, Deaver 6147, 16 Apr 1963, ASC! – Sandy soil along road to Cottonwood Spring, T38N, R15W, Sec. 2, Mason & Phillips 2888, 19 Jun 1969, ARIZ! – ca. 19 mi S of Virgin River bridge on Hwy. 64, along dugway, Atwood 1729, 26 May 1969, BRY! – E bajada of the Peacock Mountains, 3.5 mi due SE of Hackberry, T23N, R13W, Sec. 32, 3900 ft, N. & P. Holmugen 7138, 7 May 1973, BRY! – ca. 10 mi E of Fredonia sawmill along the logging road, red shale of Atriplex community, Atwood 4798, 12 May 1973, BRY! – About 3 mi N of Valentine, Hwy. 66, Gierisch 3013, 20 May 1977, ASU! – Kanab Creek Overlook Road, 1.3 km (0.8 mi) SE of Toroweap Road turnoff, 13.5 km (8.4 mi) S of Arizona Hwy. 38, 26 km (16 mi) due SW of Fredonia, T39N, R4W, 523, 1400 m, N. Holmugen et al. 9130, 24 May 1979, BRY! – Near Robinson Reservoir, T36N, R3W, Sec. 21, Goons & Bundy 2828, 12 Jun 1979, ASC!, ASU!, BRY! – along road at Little Robinson Canyon, T36N, R5W, Sec. 20, Bundy 140, 1 Jul 1980, ASC!, BRY!, ARIZ! – T26N, R11W, Sec. 28, 5 mi S of Peach Springs Post Office, Peach Springs Canyon, 3600 ft, B. Welsh 1345, 17 May 1982, ASU!, BRY! – East bajada of the Peacock Mountains, 3.5 mi due SE of Hackberry, T23N, R13W, Sec. 32, 3900 ft, N. & P. Holmugen 7138, ASU! – Hwy. 93, W of Aquarius Mountains, T38N, R13W, Sec. 8, Butterwick et al. 5036, ASU! Yavapai Co.—Hills on E side of Black Mountains, W of Hwy. 93, T31N, R5W, Sec. 28, 2700 ft, basalt and andesite, Fischer 6414, 6 May 1979, ASC!, BRY!, ARIZ! – Williamson Valley Road, ca. 30 mi N of Prescott and 10 mi SW of Walnut Creek, 4600 ft, McLaughlin & Others 6890, 30 May 1993, ARIZ!

NEVADA: Lincoln Co.—White River Valley, 5.9 mi SSE of county line on Hwy. 318 to Hiko, then WSW 0.6 mi, T2N, R6E2, Sec. 3, 5100 ft, Tiehan & Nachlinger 14198, 23 May 2005, ASC!


Pedionemum cverdianum S.L. Welsh & M. Licher

Specimens cited following original description.