

Packera serpenticola (Asteraceae; Senecioneae), a New Species from North Carolina, U. S. A.

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Abstract—*Packera serpenticola* (Asteraceae; Senecioneae), an interesting arachnoid pubescent species restricted to dunite derived soils (olivine and serpentine) in Clay County, North Carolina, is described as new. The plants most closely resemble *Packera aurea*, a common species of the Appalachian region, but are diminutive in all parts, conspicuously arachnoid pubescent, especially when young, and dull gray in appearance. In addition to phenotypic differences, our molecular analysis with limited samples show that the two species have marked divergence at one nuclear gene (*waxy*) and one chloroplast intergenic spacer (*psbA-trnH*). *Packera aurea* is also absent on dunite.

Keywords—Asteraceae, North Carolina, *Packera*, serpentine endemic, taxonomy.

An interesting arachnoid pubescent *Packera* (Asteraceae), resembling a miniature *Packera aurea* (L.) A. Löve & D. Löve in habit, from Clay County, North Carolina, has been a source of confusion and various interpretations for a number of years. Ted Barkley, who revised the *Senecio* [now *Packera*] *aurea* complex (Barkley 1962), in response to specimens sent to him from Buck Creek, commented in a letter to Boufford in 1977 (Barkley pers. comm.) "...while *S. aureus* is not regularly pubescent, there are some populations where there is a light but persistent tomentum on much of the herbage. Some of these hairy-phases have received names in the past, but field work shows that the hairy-phases lack sufficient population integrity to warrant taxonomic recognition." The Buck Creek population, however, does exhibit clear population integrity and is restricted to an area underlain by metamorphosed mafic and ultramafic rocks, primarily dunite (Hunter 1941; Milton and Purdy 1988), which Berger et al. (2001) refer to as the Buck Creek complex.

Berger et al. (2001) further refer to the Buck Creek complex as being among the largest and most lithologically diverse of the mafic/ultramafic bodies in the eastern Blue Ridge of the southern Appalachians. Hunter (1941) further characterizes the dunite as consisting essentially of olivine "...with small, variable amounts of green and colorless amphibole, chromite, and magnetite. In a great majority of the sections studied, alteration has given rise to one or more of the secondary products—serpentine, talc, chlorite, carbonates, and iron oxides."

In several visits to the site over a number of years dating back to 1974, we have never found individuals of typical *Packera aurea* among these atypical plants, nor in the immediate vicinity of this unusual area of metamorphosed mafic and ultramafic rocks. Instead, the arachnoid pubescent plants that resemble *P. aurea* have remained conspicuously uniform, abundant, and restricted to the site of the Buck Creek complex.

In his 1962 treatment, Barkley mentions specimens of *Packera aurea* from Maryland to Missouri and southward as being more robust, having larger basal leaves, and occasionally having more pubescence in the axils of the basal leaves and among the heads in the inflorescence, but does not mention diminutive, arachnoid pubescent plants.

According to Barkley (1962), Fernald recognized these larger southern plants as typical var. *aurea*, but Barkley found them to intergrade so completely that "...even with reference to geography, I have been unable to separate them with reasonable consistency."

Additional southern, but more diminutive, mostly glabrous plants, sometimes recognized as var. *gracilis*, were also relegated to synonymy under var. *aurea* by Barkley (1962) as lacking the consistent morphological characteristics and habitat preference to warrant formal recognition, although with the comment "...may be worthy of additional investigation." Trock (2006) also included var. *gracilis* in the synonymy of *Packera aurea* var. *aurea* without comment.

For the *Packera aurea* group as a whole, Barkley (1962) states "The *Aurei* are primarily glabrous or at most only lightly pubescent when young. However, both *S. plattensis* and *S. hartianus* are more or less persistently floccose-tomentose. *S[enecio] smallii* is normally densely lanate-tomentose at the base of the stem." The Buck Creek plants, however, are conspicuously covered with mostly persistent arachnoid pubescence on the stems, lower (and sometimes upper) surface of the leaves, the peduncles and (at least at the base) involucre.

The Buck Creek plants clearly differ from both the southern and northern expressions of *Packera aurea*, and from other members of the broader *aurea* group, although in the past they have been variously attributed to other species, or considered to be hybrids (see examples under *Additional Specimens Examined*). In addition to their phenotypic distinctions, our DNA molecular analysis also shows them to differ. We therefore propose treating them as a distinct, localized species.

Species of *Packera* with highly restricted ranges are not without precedent. Other recently described local endemics in *Packera* include *P. texensis* Trock & O'Kennon on soils made up mainly of granite, sandstone, gneiss, schist, and granite-derived sands on the Edwards Plateau of Texas, a region primarily underlain by limestone (Trock and O'Kennon 2003), and *P. insulae-regalis* R. R. Kowal (Kowal et al. 2011) on thin soils underlain by greenstone, a metamorphosed basalt rich in calcium on Isle Royale, Michigan.

MATERIALS AND METHODS

To confirm the distinctness of *Packera serpenticola*, the morphology of new and old collections was compared with specimens of *Packera aurea* in the Harvard University Herbaria and collected throughout its range in eastern North America. Leaves from one individual in two populations each of *P. serpenticola* and *P. aurea* (Voucher specimens: D. E. Boufford & J. T. Kartesz 42947, 42949, 42948, 42950) were collected for molecular analysis. Genomic DNAs of these plants were extracted from dried leaf tissues using the CTAB method (Doyle and Doyle 1987). Nuclear ribosomal internal transcribed spacer (ITS), one low-copy nuclear gene (*waxy*; granule-bound starch synthase gene) and two chloroplast intergenic spacers (*trnL-trnF* and *psbA-trnH*) were amplified using universal primers (White et al. 1990; Taberlet et al. 1991; Hamilton 1999; Li and Donoghue 1999). The PCR was conducted under the following conditions: 94°C for 4 min, followed by 30 cycles of 94°C for 30 s, 55°C for 30 s, 72°C for 1.5 min, and a final extension of 8 min at 72°C. The PCR products were purified by electrophoresis through a 1.0% agarose gel followed by use of a Pearl gel extraction kit (Pearl Bio-tech, Guangzhou, China) and then sequenced on an ABI 3730 DNA analyzer with the BigDye terminator cycle sequencing ready reaction kit (Applied Biosystems, Foster City, California). All the sequences have been deposited in GenBank with accession numbers KF584243-KF584258.

RESULTS

We sequenced one individual in each of the two separate populations for both *P. serpenticola* and *P. aurea*. No sequence variation was found at the ITS, *waxy*, and two chloroplast intergenic spacers (*trnL-trnF* and *psbA-trnH*) between the two individuals of *P. serpenticola*, while minor variation was detected at the *waxy* and *psbA-trnH* regions between samples from the two populations of *P. aurea*. Although *P. serpenticola* and *P. aurea* have the same sequences at the ITS and *trnL-trnF* regions, they show sequence divergence at the *waxy* and *psbA-trnH* regions. There are thirty-seven substitutions in the *waxy* gene (mostly in the intron region) and one nucleotide substitution in the *psbA-trnH* intergenic spacer between *P. serpenticola* and *P. aurea*. Molecular evidence supports the recognition of these plants, which we name *Packera serpenticola*, as distinct. The observed pattern suggests that the two taxa might have diverged in the face of gene flow, with free exchange at neutrally evolved genes but not at genes underlying differential adaptation. It should be noted that our molecular analysis was restricted to few individuals of either taxon with neighboring occurrence. Additional samples for each population and samples from additional locations should provide more comprehensive information on the relationships between the two taxa.

TAXONOMIC TREATMENT

Packera serpenticola Boufford, Kartesz, S. H. Shi & Renchao Zhou, sp. nov.—TYPE: U. S. A. North Carolina: Clay County, W of the city of Franklin and E of the town of Shooting Creek; 2.25 km (1.4 miles) N of U. S. route 64 on Buck Creek Road, W side of Buck Creek. *Pinus rigida-Viburnum cassinoides-Andropogon scoparius* community with intermittent seepages and small streams over olivine/serpentine and around olivine/serpentine outcrops; 35°5'3"N, 83°37'0"W; 1,020 m, 5 May 2013, D. E.

Boufford & J. T. Kartesz 42949 (holotype: A; isotypes CAS, FLA, GA, IBSC, KUN, MO, NCU, NY, P, PE, SYS, TEX, TI, WIS).

Resembling *Packera aurea*, but differing in the diminutive stature, arachnoid pubescent stems, leaves, peduncles and involucre and in the overall dull green aspect.

Herbs, perennial, 10–60 cm tall, rhizomatous. Rhizomes horizontal, apically ascending. Roots fibrous. Stems 1–5, clustered, arachnoid pubescent, especially when young. Basal leaves petiolate; petiole 2.5–20 cm long, arachnoid pubescent, especially when young; blade ovate to broadly ovate to orbicular, 1.5–6.8 × 1–6.5 cm, base conspicuously to shallowly cordate, margins bluntly dentate, teeth obtuse-rounded, apex rounded, both surfaces dull grayish green, lower surface arachnoid pubescent, upper surface sparsely arachnoid pubescent. Cauline leaves gradually reduced upward, lower ones petiolate, petiole clasping, upper ones sessile, clasping; lower cauline leaves resembling basal leaves, sometimes with 1 or 2 small pinnae below blade; upper leaves oblong, lyrate to pinnate, lateral lobes 1–8 on each side of midrib. Synflorescence corymbiform to subumbelliform. Heads 3–17. Peduncles 2–18 cm long, sparsely tomentose to arachnoid or floccose. Calyculi 0–4, linear, inconspicuous. Phyllaries 20–22, green (apex purple or black), margins usually darkened longitudinally, 5.5–6.5 mm long, arachnoid or floccose, especially basally, central portion and apex glabrescent. Ray florets 9–11, lemon yellow; corolla lamina 7–8 mm long. Disc florets 18–20, lemon yellow; cylindrical portion of corolla tube 3.5–4.5 mm long, funnel form portion ca. 3 mm long, lobes ca. 1 mm long. Cypselae 3–3.2 mm long, glabrous; pappus ca. 6 mm long. Chromosome number: unknown. Flowering May–June. Figure 1.

Distribution and Ecology—*Packera serpenticola* is known from North Carolina, apparently endemic to Clay County on gentle, moist slopes in open and in shade and along intermittent rivulets over dunite (serpentine and olivine) in clay-gravel soils.

Etymology—The epithet *serpenticola* refers to the restricted occurrence of the species to serpentine and olivine soils.

Conservation Concerns—Although *Packera serpenticola* is known from only this one area within Nantahala National Forest, the population is of such size that it does not appear to be under threat of extinction.

Additional Specimens Examined—All U. S. A., North Carolina, Clay County. *Pinus rigida* community on U. S. Forest Service Road along Buck Creek, 11 June 1974, D. E. Boufford et al. 14103 (NCU; as *Senecio aureus*); 1 km (0.6 mile) from U. S. route 64 on Perry Gap Road on E side of Buck Creek, 13 May 1982 D. E. Boufford et al. 22843 (A; as *Senecio aureus*; annotated as *S. aureus* × *plattensis* by L. J. Uttal in 1983; annotated as “serpentine race” by A. M. Mahoney in 2000); Perry Gap Road along Buck Creek, 8 May 1998, C. C. Davis & R. E. Spangler 55 (GH; as *Senecio aureus*); Buck Creek serpentinized olivine barren, N of US 64, 22 May 1993, B. A. Sorrie 7316 (“with Weakley, Van Eerde, Russo”) (GH; as “*Senecio aureus* L. ? var. *ashei* Greenman”); W of the city of Franklin on U. S. route 64, then NNW on Buck Creek Road to fork in road, then left on Perry Gap Road (E of Perry Gap). Seepage on steep slope at edge of mixed deciduous forest of *Liriodendron tulipifera*, *Betula lenta*, *Acer saccharum* and diverse herbaceous ground cover, 35°5'12"N, 83°37'58"W; 1,050 m, 7 May 2013, D. E. Boufford & J. T. Kartesz 42947 (CAS, GH, MO, NCU, TI).

KEY TO SEPARATE *PACKERA AUREA* AND *P. SERPENTICOLA*

- Plants glabrous or leaf axils tomentose, 30–120 cm tall; blade of basal leaves cordate to reniform, 2–22 × 2–16 cm, base truncate, abruptly contracted or ± cordate; disc florets 55–70+ *P. aurea*
- Plants arachnoid-lanate pubescent on all parts, especially when young, 10–60 cm tall; blade of basal leaves ovate to broadly ovate to orbicular, 1.5–6.8 × 1–6.5 cm, base conspicuously to shallowly cordate; disc florets 18–20 *P. serpenticola*

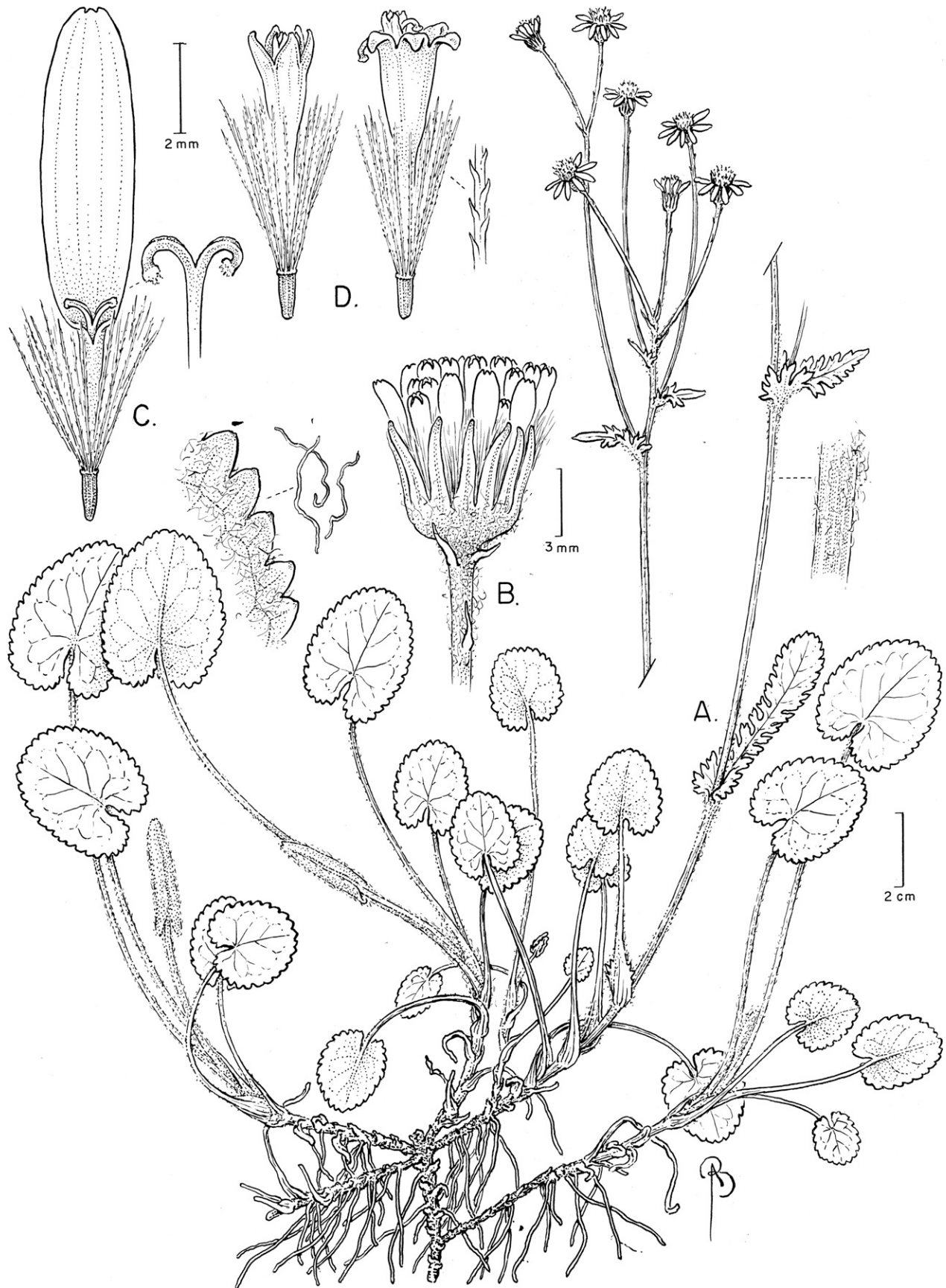


FIG. 1. *Packera serpicicola*. A. Habit, with enlargement of stem surface (on right) showing arachnoid-lanate pubescence and enlargement of abaxial surface of leaf (on left) showing arachnoid-lanate pubescence and isolated trichomes. B. Capitulum showing arachnoid-lanate pubescence on peduncle and phyllaries. C. Ray floret with ovary and pappus and enlargement of style and stigmas. D. Disc florets with enlargement of pappus to show surface.

In addition to the various identifications on the herbarium labels of *Packera serpenticola* from Buck Creek are also literature reports citing these plants as *Senecio plattensis*, or *P. plattensis* (Mansberg and Wentworth 1984; Marx 2007), *P. paupercula* var. *appalachiana* (Weakley 2007, p. 117, under *Hexastylis arifolia* (Michaux) Small var. *ruthii* (Ashe) Blomquist (*P. paupercula* var. *appalachiana* is later treated in the same work (Weakley 2007, p. 189) as a synonym of *P. plattensis*), or only as *Senecio* (*Senecio* sp.) (Milton and Purdy 1988).

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