OPUNTIA HUMIFUSA SENSU STRICTO (CACTACEAE): NEW TO KENTUCKY (U.S.A.) AND CONFIRMED IN THE UNGLACIATED APPALACHIAN PLATEAUS

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ABSTRACT

A new population of *Opuntia humifusa* (Raf.) Raf. was found in Pike County, Kentucky. Consequent examination of other misidentified populations in Kentucky (Harlan and Pike counties) and West Virginia (Jackson County) provides the first known occurrences of *Opuntia humifusa* (sensu stricto) in Kentucky and a confirmed range extension into the Unglaciated Appalachian Plateaus Province.

RESUMEN

Se encontró una población nueva de *Opuntia humifusa* (Raf.) Raf. en el Condado de Pike, Kentucky. El consecuente examen de otras poblaciones mal identificadas de Kentucky (condados de Harlan y Pike) y Virginia Occidental (Condado de Jackson) aporta las primeras ocurrencias conocidas de Opuntia humifusa (sensu stricto) en Kentucky y confirman el rango de extensión a la Provincia de la Meseta de los Apalaches no afectada por la Glaciación.

Key Words: *Opuntia humifusa,* prickly pear cactus, distribution, Unglaciated Appalachian Plateaus Province

INTRODUCTION

A previously unknown population of *Opuntia humifusa* (Raf.) Raf. was discovered in Pike County, Kentucky on 19 December 2018. Returning on 4 June 2019 to observe flowering permitted a final determination to be made (*Adanick & Deskins 193*, EKY) (Fig. 1, a & b).

While reviewing herbarium specimens of *Opuntia cespitosa* (Raf.) Raf. from southeastern Kentucky, two specimens presented themselves as potentially incorrect. *Opuntia cespitosa* typically exhibits basally tinged dark red, crimson, orange-red, or reddish-pink tepals in the flower base, the presence of primary spines and dark red, crimson red, or dark amber glochids (Majure et al. 2012, 2017; Weakley 2015). Specimens from Pike County, Kentucky (*Browne & Browne Jr. 8641*, EKY, TENN) and Harlan County, Kentucky (*Gross 151*, MDKY) exhibited none of these characteristics (a comparison of *Opuntia humifusa* and *Opuntia cespitosa* characteristics is given in Table 1). Field examination of the Harlan County site during flowering in June 2019 confirmed the identity of *Opuntia humifusa* at this location (*Adanick & Buskirk 194*, EKY) (Fig. 1, c & d).

We also noted that the geology of the Pike County site was incorrectly identified by the initial collectors Browne & Browne Jr., as their specimen described limestone bedrock as opposed to the Pennsylvanian sandstone which is found in the area. This perhaps influenced the identification, as *O. cespitosa* is more common on calcareous substrate. While the site has not been relocated, the original specimens from the Brownes' Pike County population were reevaluated and annotated as *O. humifusa* by the authors. Subsequent field examination of the Jackson County, West Virginia site (*Sayre 40*, MUHW) also confirmed the presence of *O. humifusa* (*Adanick 196*, EKY) (Fig. 1, e & f).

Multiple trips to rediscover a Cabell County, West Virginia, population were not successful, but we have examined seven duplicate, digitized specimens (*Williams 366*, BRIT, CM, FSU, GH, MO, TENN, WIS). These specimens did not exhibit the evidence of spines and the predominant cladode shape, areole and glochid characteristics and geology of the area led the authors to determine these specimens as *O. humifusa* (sensu stricto). An herbarium record also exists for Summers County, West Virginia (*Richmond 18*, MUHW) at a disjunction of 309 km from the Pike County, Kentucky population, but it is labeled as *Opuntia calcicola* Wherry, a synonym

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Fig. 1. *Opuntia humifusa*. (**a**) Pike County, KY: specimen (**b**) habitat (**c**) Harlan County, KY: specimen (**d**) habitat (**e**) Jackson Co., WV: specimen (**f**) habitat.

Table 1. Comparison of *Opuntia humifusa* and *Opuntia cespitosa* characteristics.

	Opuntia humifusa	***Opuntia cespitosa***
Spines	absent	1–2 per areole (most commonly 1)
Cladode (pad) shape	Cladodes elliptical or rotund	Cladodes mostly obovate, rotund, or elliptical in outline
Areoles	4–5 (mostly 4) areoles per diagonal row at midstem	4–6 (generally 5) areoles per diagonal row
Glochids	Glochids inconspicuous, generally only exserted in older, basal stems, stramineous, but turning light brown or amber in age	Glochids exserted, reddish-brown, or dark brown aging light to very dark brown
Color	Dark green, not glaucous	Cladodes strongly glaucous-green (gray-green) when developing, aging dark green or light gray-green

*The author's description of glochid color differs from Majure (2017), as neither has seen "crimson-red" to "dark-amber" in populations in AL, GA, KY, OH or TN.

of *O. humifusa*. Plants could not be located again in the field by the authors. Interviews with the local residents indicated the *Opuntia* population may have originally been planted.

The *Flora of West Virginia* (Strausbaugh & Core 1991) describes *O. compressa* as having: "flowers pure lemon yellow, … mostly on shale barrens in the eastern counties (Cabell, Grant, Hampshire, Hardy, Mason, Mineral, Pendleton, Roane, and Tucker counties)," but does not indicate the presence of spines in the species description. *Opuntia calcicola* is described as spineless but having yellow flowers often with red centers in contradiction to Wherry (1926) and Majure et al. (2017) and cited as occurring in Berkeley, Hardy, Jefferson, and Summers counties. After extensive fieldwork, the authors have found no populations of *Opuntia cespitosa* in West Virginia and are doubtful that it occurs as a native.

Specimens examined: **U.S.A. KENTUCKY: Harlan Co.:** dry, rocky area, south facing hillside dominated by *Quercus montana, Pinus rigida, Kalmia latifolia, Smilax rotundifolia*; elev. 2000 ft, Louellen Quad, Hi Lewis Barrens State Nature Preserve, dry slopes below outcrop, near old homestead, ca. 0.9 mi SW of Hurricane Gap. 36°58'22"N -83°2'3"W, 21 May 1999, *Brian Gross 151* (MDKY); Pine Mountain (Hi-Lewis Barrens).36.9732, -83.0347. 593 m elev., S facing rock outcrop, many clumps of plants at edges of outcrop and scattered in depressions, Alticrest-Totz-Helechawa soil complex: coarse-loamy residuum weathered from sandstone, geology: Lee formation (Mississippian to Pennsylvanian), collected under OKNP permit, 29 Jun 2019, *Adanick & Buskirk 194* (EKY). **Pike Co.:** Draffin community, off HWY 80, steep shale bank, W side of RR track, 3+ large clumps, Berks soil type (residuum weathered from shale, siltstone and fine-grained sandstone), geology: lower part of Breathitt formation (Pennsylvanian), 37.3491, -82.3947 ± 4 m, WGS 84, 229 m elev., 4 Jun 2019, *Adanick & Deskins 193* (EKY); Old US 460, 4.6 mi E of jct. of this road and Ky 80 near Fishtrap Dam construction site, shallow soil on exposed limestone in road cut, Cumberland Plateau Province, 9 Jun 1964, *Elizabeth M. Browne, Edward T. Browne, Jr. 8641* (EKY, TENN). **WEST VIRGINIA: Cabell Co.:** sandy field, near Milton, 9 Oct 1935, *Louis Williams 366* (BRIT, CM, FSU, GH, MO, TENN, WIS). **Jackson Co.:** back of Hopewill Baptist Church in Mt. Alto, dry, very little growth around it, some grasses, 18 Apr 1987, *Tim Sayre 40* (MUHW); Mt. Alto, hillside behind Hopewill Baptist Church, 1.6 km from the Ohio River, 420 m^2 of scattered clumps, no spines present in population, heavy damage to cladodes from mowing, Upshur-Gilpin silt loam soils (residuum from clayey shales), some erosion, geology: Dunkard Group -non-marine cyclic sequence of sandstone, siltstone, red /gray shale, limestone and coal (Permian-Pennsylvanian), 38.8623, -81.88006 ± 4 m, WGS 84, 207 m elev., 6 Jul 2019, *P. Adanick 196* (EKY). **Summers Co.:** 100 yards E on Willow wood Road across Greenbriar River off Route 3, 5 mi E of Hinton, W.V. Dry, rocky bank below railroad tracks, 3 Nov 1979, *Cathy Richmond 18* (MUHW).

IDENTIFICATION ISSUES

Caution is warranted in the determination of seemingly spineless populations of *Opuntia*. There are currently 48 counties in in Kentucky that have known occurrences of *Opuntia cespitosa* (Campbell & Medley 2012) and many of these have few or no spines as a result of environmental conditions. As the invasive understory shrub *Lonicera maackii* (Rupr.) Maxim. and other small trees and shrubs become more prevalent, populations of *Opuntia* begin to decline. Eventually succumbing to heavy shade, cladodes thin, elongate (etiolate) and become spineless (Adanick & Medley, pers. obs.). This morphological plasticity was also studied in the species *Opuntia drummondii* Graham in Maund (*O. pusilla* Haw.). In a controlled greenhouse experiment, cladodes subjected to full sunlight exhibited a 99.8% increase in spine production compared to specimens grown in shade (Majure 2007).

Herbarium specimens from Caldwell County, Kentucky, show spineless cladodes (*Thompson 09-340*, BEREA; *Hannan & Phillippe 5837*, EKY). Both specimens (per label data) were collected from within a 5 km area. One population, central to the others, was found by the first author in December 2018 and verified again in January 2020 (*Adanick & Becker 207*, EKY). Although most of the population was spineless and heavily etiolated, several spiny cladodes were found. Another, in Elliott County, Kentucky is vouchered with a single spineless cladode (*Griffith 320*, MUHW). The first author visited the site on 16 June 2017 and found a small population heavily shaded by *Juniperus virginiana* Mill. and *Toxicodendron radicans* (L.) Kuntze, on a narrow sandstone point. While strongly etiolated, the population exhibited the color, areole and glochid characteristics of *O. cespitosa* (Table 1) and a few spines were present. The site of another single-cladode specimen from Franklin Co., Tennessee (*Priestley 3278,* UOS) was visited by the authors on 6 March 2020. On a small sandstone flat rock with approximately 20 scattered plants, only one cladode was found bearing two spines (*Adanick & Medley 208,* APSC).

Many more spineless herbarium specimens exist, and a reasonable determination can often be made with careful consideration of other morphological characteristics. With the ease at which these morphological transformations can take place, the determination of a species with the examination of the total population, geology and edaphic factors is paramount. The authors often find it necessary to revisit the site or collect plant material for extended observation under cultivation. Care should also be taken to collect a more representative sample of that population when preparing a voucher.

Specimens examined: **U.S.A. KENTUCKY: Caldwell Co.:** Jones Keenley WMA, 37.13961, -87.75423, few primary spines present, glaucous, glochids dark amber, most cladodes spineless and etiolated, under heavy shade on sandstone point, associated species: *Carex* cf. *nigromarginata* Schwein., *Fraxinus americana* L., *Juniperus virginiana* L., *Nyssa sylvatica* Marshall, *Quercus alba* L., *Quercus* cf. *shumardii* Buckley, *Quercus falcata* Michx., 15 Jan 2020, *Adanick & Becker 207* (EKY); Dulaney, 500 yards E of US 62 and White School Road intersection, xeric very rocky limestone hillside in shallow and exposed basic soils, associates: *Juniperus virginiana* L., *Carex ovata* Burm.f., *Celtis occidentalis* L., *Gleditsia triacanthos* L., *Maclura pomifera* (Raf.) C.K. Schneid., native perennial, common, 05 Jun 2009, *Ralph L. Thompson 09-340* (BEREA); growing on rocky ledge on the North Rim of French Spring Hollow, gorge is about 0.5 mi SE of the Beulah Hill Church, USGS Topo, Princeton East 3787-17, elev. ca. 600 ft, 1 Oct 1980, *Hannan & Phillippe 5837* (EKY). **Elliott Co.:** 15 mi up Little Fork Road, near Blaine's Trace, KY, rocky, sandy soil, dry with *Diospyros virginiana* L., without date, *Griffith 320* (MUHW). **TENNESSEE: Franklin Co.:** TUS Domain, sandstone outcrop behind Cannon Dorm and below parking lot behind Fulford Hall, 35.205484, -85.922797, 12 Sep 1999, *Mary P. Priestley 3278* (UOS); Sewanee, University of the South, small sandstone flatrock below the back edge of the parking lot behind Fulford Hall, 35.2055, -85.9228, ca. 20 small scattered plants, most cladodes spineless, only 1 cladode with 2 spines, associated species: *Sedum acre* L. (abundant), *Cardamine hirsuta* L., *Cerastium glomeratum* Thuill., *Juniperous virginiana* L., *Andropogon virginicus* L., *Ligustrum sinense* Lour., *Pinus virginiana* Mill., *Lonicera fragrantissima* Lindl. & Paxton, 6 Mar 2020, *Adanick & Medley 208* (APSC).

DISCUSSION

Geographically, *Opuntia humifusa* is most often found between regions dominated by *O. mesacantha* subsp. *mesacantha* and *O. cespitosa* (Majure 2017). From existing herbarium records, recent works by Majure et al. (2012, 2017) and collections made by the authors, this range is from the Ridge and Valley in Virginia and to the Coastal Plain northward to Massachusetts (Fig. 2). Oddly, disjunct populations exist in six contiguous counties in Mississippi (*Majure 799 & 1833*, MISSA, MMNS; *Philley 498 & 499*, FLAS).

No published records had previously verified this species (sensu stricto) in Kentucky. The closest verified population of *O. humifusa* to the Pike County, Kentucky, collection site was Craig County, Virginia (*Doyle 310*, UNC) in the Valley and Ridge physiographic province, a disjunction of 322 km.

Though *O. humifusa* is a xerophytic species, it is tolerant of mesic conditions (Majure 2017). The Pike County population was found growing on a very steep, shaley hillside adjacent to a railroad track. Associated species included *Ambrosia artemisiifolia* L., *Astragalus canadensis* L., *Conyza canadensis* (L.) Cronquist, *Lactuca hirsuta* (Muhl.) ex Nutt., *Pinus virginiana* Mill., and *Solidago altissima* L. The Pike County population and the Harlan County population are growing on acidic soils of the Lower Pennsylvanian sandstone Breathitt and the Lee Formations (Rice 1986; Soil Survey Staff 2019). The Harlan County site is located on the upper, south face of Pine Mountain. A thrust fault exposed the sandstone ridges and outcrops with Pine-Oak woodlands and a pine barren community surrounding the area. While the authors have found many populations throughout

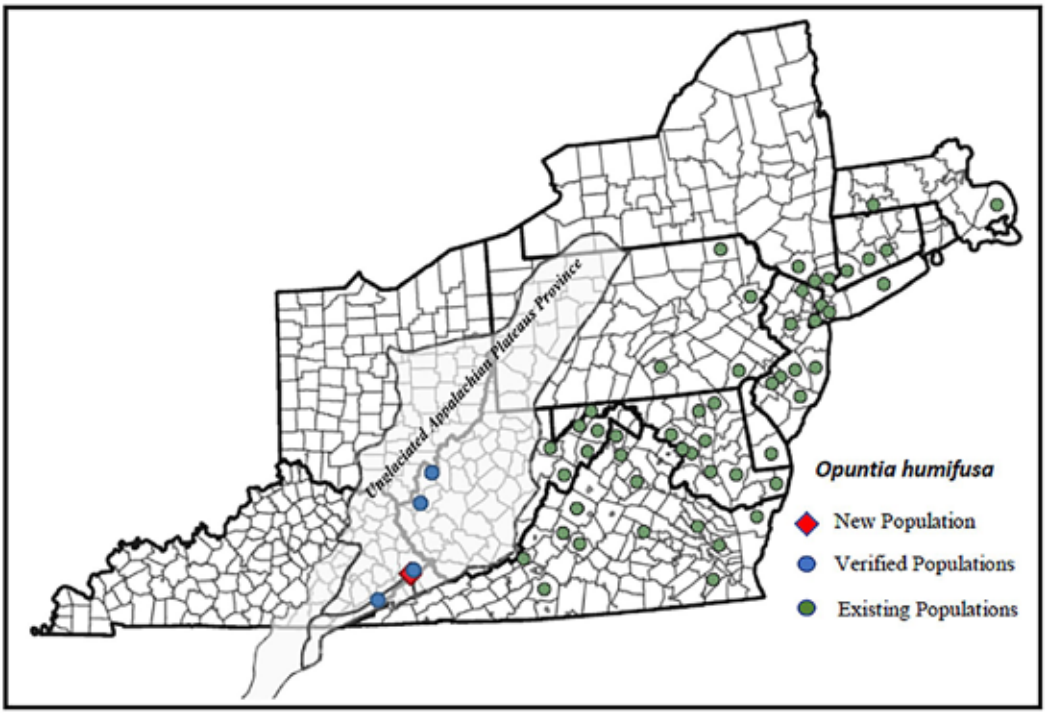

Fig. 2. Location of *Opuntia humifusa* in the Unglaciated Appalachian Plateaus Province and distribution based on herbarium specimens. Disjunct populations in MS are not shown.

Virginia and West Virginia on shale barrens and residuum from sandstones, shales and siltstone, this species can also be found on mafic substrate in Virginia (*Stevens 13064*, MO).

In conclusion, further attention is warranted for this taxonomically difficult genus. The authors encourage others to investigate the existence of *Opuntia* in the Unglaciated Appalachian Plateaus Province.

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