

PTERIS MULTIFIDA (PTERIDACEAE) REDISCOVERED IN
SOUTHERN CALIFORNIA (U.S.A.), WITH A KEY TO SPECIES
AND NOTES ON ESCAPED CULTIVARS

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ABSTRACT

Pteris multifida Poir. occurs in many tropical, subtropical, and temperate regions of the world. Because it is widely cultivated, populations have escaped from gardens and naturalized in many regions, including in the United States. In California, *P. multifida* was first collected in 1942 growing outside of cultivation in the San Gabriel Mountains, Los Angeles County. It was reported by G.N. Jones in 1955, but otherwise it has been omitted from all local and regional floras. *Pteris multifida* has recently been discovered growing on masonry in coastal urban Los Angeles. These two populations comprise morphologically different plants, a cultivar and the typical, wild form of *P. multifida*. We provide notes on identification, native and introduced ranges, invasive weed status, known and naturalized habitats expected for California, and cite voucher specimens for California. We provide a key to identify the species of *Pteris* known to grow outside of cultivation in the State. A literature review and a search of electronic databases and virtual herbaria are also included.

RESUMEN

Pteris multifida Poir. vive en muchas regiones tropicales, subtropicales, y templadas del mundo. Al estar ampliamente cultivado, las poblaciones se han escapado de los jardines y naturalizado en muchas regiones, incluyendo los Estados Unidos. En California, *P. multifida* se colectó por primera vez en 1942 creciendo fuera de cultivo en las montañas de San Gabriel, condado de Los Ángeles. Se citó por G.N. Jones en 1955, pero por lo demás ha sido omitido en todas las floras locales y regionales. *Pteris multifida* se ha descubierto recientemente creciendo en sobre escombros en la zona urbana costera de Los Ángeles. Estas dos poblaciones contienen plantas diferentes morfológicamente, la cultivar y la forma típica, natural de *P. multifida*. Aportamos notas sobre su identificación, áreas donde es nativa e introducida, estatus de planta invasiva, hábitats conocidos y naturalizados esperados para California, y citamos especímenes testigo para California. Aportamos una clave para identificar las especies de *Pteris* que crecen fuera de cultivo en el estado. Se incluye también una revisión bibliográfica y la búsqueda en bases de datos y herbarios virtuales.

KEY WORDS: *Pteris multifida*, California, fern cultivars, non-native plants, ornamental horticulture, San Gabriel Mountains, Santa Monica Mountains, urban weeds

INTRODUCTION

The Pteridaceae E.D.M. Kirchn. comprises over 50 genera and more than 1,000 species that represent approximately 10% of extant leptosporangiate fern diversity (Smith et al. 2006; Christenhusz et al. 2011). This family also accommodates plants having an unusually broad range of ecological niches, including terrestrial, epiphytic, rupestral (growing on or among rocks), and aquatic habitats (Schuettpelz et al. 2007). The molecular phylogeny and biogeography of *Pteris* have been explored by Chao et al. (2014), and their results suggest that the type of the genus, *P. longifolia* L., and one other species, *P. vittata* L., are not closely related to other species generally placed in the genus. No comprehensive biogeographical history of *Pteris*, which is critical to understanding its cosmopolitan distribution, has been developed (Chao et al. 2014).

Pteris L., a genus found worldwide in temperate, subtropical, and tropical regions, comprises 250–300 species identified primarily by generally large fronds, erect to creeping rhizomes, marginal sori, and brown spores with an equatorial flange (Nauman 1993; Mickel & Smith 2004; Kamau 2012; Chao et al. 2014). *Pteris multifida* (synonyms: *P. serrulata* L.f., *Pycnodoria multifida* (Poir.) Small) is native to temperate and tropical eastern Asia (Zhang et al. 2013; USDA, GRIN 2016).

Pteris multifida is widely cultivated and has naturalized on many continents (Nauman 1993; Hoshizaki &

Moran 2001). It was first discovered in the United States in 1868 growing in a Huguenot cemetery, Charleston, South Carolina (Nelson 2000). Herbarium vouchers (SERNEC 2016; SI 2016) document that it established quickly, mostly in urban habitats: South Carolina, Charleston, streets of Charleston, 31 Oct 1871, *Gibbes s.n.* (USCH, HWR-0000202); Charleston, brick wall, streets of Charleston, 30 Sep 1873, *Ravenel s.n.* (USCH, HWR-0000204); Charleston, Charleston College, base of walls of outbuilding, 16 Apr 1880, *Smith s.n.* (US Catalog No.: 828242); Charleston, crevices of old wall, 2 Dec 1898, *Barnhart 2601* (NCU); and Columbia, with label comment “*established*,” 29 Apr 1890, *Smyth 12586* (NCU). Accordingly, *P. multifida* has been cited as an escape from cultivation on many early checklists for North American ferns (Maxon 1901; Broun 1938).

In the continental United States, *P. multifida* has naturalized or has escaped cultivation from Maryland south to Florida and west to Arkansas, and Texas; it has also been reported for Illinois, Indiana, Kentucky, New York, and southern California (Lellingner 1985; Nauman 1993; Peck 2011a; Diggs & Lipscomb 2014; USDA, NRCS 2016a).

Pteris multifida was first reported growing outside of cultivation in California by Jones (1955) in the San Gabriel Mountains, *Proctor s.n.* (US 1814422). However, it was not included in treatments for the Pteridaceae in early floras (Grillos 1966; Munz 1974; Smith & Lemieux 1993). *Pteris multifida* also has not been included in later publications that identify non-native species growing spontaneously outside of cultivation, including Hrusa et al. (2002), DiTomaso and Healy (2007), Roberts et al. (2004), Clarke et al. (2007), Dean et al. (2008), Roberts (2008), Kirkpatrick et al. (2012), Prigge and Gibson (2012), Rebman and Simpson (2014), and the Jepson Flora Project (2016). In addition, no vouchers for cultivated or naturalized populations have been posted by the Consortium of California Herbaria (CCH 2016). In the early to mid-1950s, *P. multifida* was collected from the Los Angeles area, but each of the six collections posted by SI (2016) is clearly identified as a cultivated plant. The Consortium of Intermountain Herbaria (CIH 2016), Consortium of Midwest Herbaria (CMH 2016), and the Southwest Environmental Information Network (SEINet 2016) post a 1999 collection from San Francisco, *Stone 2544* (MO), which likely represents a cultivated herb purchased in a retail market.

Pteris multifida is therefore documented here growing outside of cultivation for the first time since its original discovery in 1942 for the San Gabriel Mountains, Los Angeles County, California.

Voucher specimens: **U.S.A.: CALIFORNIA: Los Angeles Co.:** San Gabriel Mountains, crevices of granite ledges, Santa Anita Canyon, elev. 1600 ft. (500 m), 24 Jan 1942, *G.R. Proctor s.n.* (US 1814422 digital image), with label comment: “*there is no possibility of its having been planted*,” City of Los Angeles, Pacific Palisades, N side of Pacific Coast Highway at Porto Marina Way, near the PCH pedestrian bridge crossing, 34°02'24.7596"N, 118°33'38.2463"W, elev. 11 m, local, joints in masonry of old building, 15 Aug 2015, *Riefner 15-228* (CAS, RSA, UC, UCR), same locality, 5 Sep 2016, *Riefner 16-364* (UC); City of Los Angeles, cultivated, garden on Carline St., 1953, *MacFadden 26803* (US); City of Los Angeles, cultivated Drummond garden, Kings Rd., 1954, *MacFadden 26901* (US); City of Los Angeles, cultivated by W.C. Drummond, Kings Rd., 1953, *Joe 395* (US); City of Los Angeles, cultivated by M.A. MacFadden, 1956, *Joe 12397* (US); City of Los Angeles, cultivated, 1956, *Drummond 36* (US); City of Los Angeles, cultivated, 1956, *Drummond 40* (US). **San Francisco Co.:** City of San Francisco, Gan May Trading, Inc. (wholesale distributor of Chinese herbs), 1350A, Donner Ave, CA 94124, 11 Nov 1999, *Stone 2544* (MO).

Whether non-native plants are incorporated into floras is based largely on their reproductive and dispersal success, i.e., naturalized versus waif, but the definition and interpretation of these terms is often inconsistent (Nesom 2000; see Richardson et al. 2000, for definitions and concepts). Hrusa et al. (2002) adopted the Richardson et al. (2000) definitions, but split the ‘naturalized’ classification into subcategories: 1) naturalized in wildlands; and 2) naturalized outside of wildlands. They believed weeds that invade natural or undisturbed habitats have different environmental concern and may exhibit ecological or reproductive strategies much different from the non-native plants restricted primarily to agricultural lands or other heavily disturbed sites. Non-native plants escaping cultivation and restricted to urban and wildland-urban interface habitats could be assigned to the Hrusa et al. (2002) subcategory 2, naturalized outside of wildlands.

For The Jepson Manual, Second Edition (TJM2), however, Baldwin et al. (2012) provided the following definitions: naturalized plants are non-native species growing in wild or approximately wild conditions and reproducing either sexually or asexually; non-native plants that occur in similar conditions that are not reproducing, and therefore not persisting and not established in the flora are considered to be waifs. Waifs that have not been collected within the last 50 years are not treated in TJM2, and non-native plants growing outside of

cultivation in highly modified environments, such as urban or agricultural lands, also are omitted. In addition, non-native plants are often given low priority by collectors, therefore, leading to gaps in our knowledge (Hrusa et al. 2002; Baldwin et al. 2012). Accordingly, without continuing documentation needed to make informed decisions, i.e., collecting specimens, monitoring occurrences, and maintaining professionally curated herbaria, some naturalized species and waifs may not have been included in TJM2 (Baldwin et al. 2012). Lacking current distributional data, *P. multifida* has been overlooked. As encouraged by Dean et al. (2008), we reiterate the need for documentation of unrecorded invasions of non-native plants into wildlands, agricultural lands, or urban environments.

Introduced Range and Invasive Weed Status

Even within its native range, such as China and Singapore, *P. multifida* is weedy and grows frequently on the concrete walls of old buildings (Zhang et al. 2013; Tan et al. 2014). This species is apogamous and capable of producing new sporophytes from single spores (Kawakami et al. 1995; Peck 2011b). Accordingly, *P. multifida* has been identified as a casual alien, an escape from cultivation, or a naturalized weed (HEAR 2016a). Many countries, however, list it as an invasive species because it is easily dispersed by spores (Kamau 2012).

In Europe, *P. multifida* has been documented widely growing outside of cultivation in the Azores, Belgium, Great Britain, the Canary Islands, Germany, Italy, Madeira, the Netherlands, and Romania (Euro+Med PlantBase 2016). *Pteris multifida* grows in montane regions on the southern slope of the Himalaya Range, such as Dehradun, New Forest Campus (670 m elevation), Uttarakhand (Rani et al. 2009). Occurrences are also known for cool temperate regions in the Southern Hemisphere, such as Victoria, Australia (AVH 2016).

Pteris multifida has also naturalized or is adventive in tropical regions, such as Fiji in the South Pacific (Brownsey & Perrie 2011), Amazonas, Bahia, Minas Gerais, Rio de Janeiro, and São Paulo, Brazil (Jones 1955; Prado & Windisch 2000), and Uganda, East Africa (Kamau 2012). It is found as a weed on walls in various cities in Brazil (Prado & Windisch 2000). *Pteris multifida*, however, has not been documented for Hawaii or Mexico (Hillebrand 1888; Valier 1995; Palmer 2003; Mickel & Smith 2004; SI 2016).

There are few *Pteris* species naturalized in the continental United States; *P. multifida* is the most widely distributed species, especially for the southeastern states (Lellinger 1985; Diggs & Lipscomb 2014; SERNEC 2016; USDA, NRCS 2016a). It is also established in the West Indies (Jones 1955). *Pteris multifida*, like other *Pteris* species, has not been listed as an invasive plant of natural areas in the United States, nor are any species of *Pteris* considered noxious weeds (IPA 2016; USDA, NRCS 2016b). *Pteris multifida* received a low weed risk assessment for Florida (HEAR 2016b), and thus has not been considered as invasive (FLEPPC 2016). In Louisiana, however, *P. multifida* has been assigned a Tier II Invasive Species status (defined as having moderate negative impacts on wildlife or natural communities in Louisiana, but of limited concern and/or extent; LWAP 2015).

Documented and Expected Southern California Habitats

In the United States, *P. multifida* is terrestrial, and has been documented growing in moist circumneutral soils of woodlands, along stream banks, or is rupestral on or among rock outcrops, especially moist lime-rich substrates, including calcareous sandstone, shady walls, and old masonry (Broun 1938; Lellinger 1985; Nauman 1993; Diggs & Lipscomb 2014).

In southern California, the historic 1942 collection locale in the San Gabriel Mountains, Santa Anita Canyon, was visited in 2016 (Riefner), but *P. multifida* was not found. However, owing to rugged canyon topography, restricted access, and extensive, mesic cliff and rock outcrop habitats, it could be easily overlooked and may still be extant. Peck (2011a) also noted *P. multifida* may be easily overlooked in the field.

In Pacific Palisades, coastal Los Angeles County, *P. multifida* is locally abundant on shaded masonry of an old building. At this locale, plants likely benefit from unintentional urban water runoff and seasonal rainfall that provide deep wetting within the concrete joints, thus enabling establishment and survival in arid coastal southern California. In addition, ocean breezes likely contribute to a year-round source of moisture. Its urban habitat, habit, and close-up photographs of a fertile frond are depicted in Figure 1.

Additional urban populations of *P. multifida* will likely be identified at new localities on shaded concrete



FIG. 1. Urban masonry habitat of *Pteris multifida* (15 Aug 2015) seen at Pacific Palisades, California. Inset, upper left, depicts evergreen, narrow pinnae typical of wild forms. Inset, lower right, abaxial surface of a fertile frond shows marginal, linear sori and distal pinnae decurrent along the rachis. Red arrows in each inset point to important diagnostic features. Note, new frond growth is present in late summer, despite several years of severe drought.

walls and old masonry. It may also naturalize in seepage areas or mesic sites associated with calcareous outcrops in native plant habitats in southern and central California. In Arkansas, *P. multifida* has been documented from calcareous formations where it is associated with *Adiantum capillus-veneris* L. (Peck 2011b); Arkansas, Garland Co.: 100 feet west of the hot spring, vertical sides of limestone tufa niche, facing north, under curtain of honeysuckle vines, 6 or 8 plants in colony with one *Adiantum capillus-veneris*, 19 Apr 1941, *Chandler 4141* (US). Similar native habitats in California are probably well-suited to colonization by *P. multifida*. However, based on its distribution in other regions, and microhabitat preferences available here, *P. multifida* is not expected to become an invasive pest plant in California's native plant communities.

Identification and Potential Confusion with Cultivars

For botanists unfamiliar with the genus, the fronds of *Pteris* species are somewhat feather-like, one-several times pinnate, the petioles greenish, stramineous, or light brown, with two or three longitudinal grooves on the adaxial side, generally with one vascular bundle, and scaly at the base (Nauman 1993; Mickel & Smith

2004; Diggs & Lipscomb 2014). Fronds of *P. multifida* are evergreen, essentially glabrous, partially two-pinnate, basal pinnae sometimes with 1–3 basiscopic lobes, distal pinnae are decurrent (winged) along the rachis, and the rhizome scales are dark reddish brown to chestnut brown (Nauman 1993; Diggs & Lipscomb 2014).

There are about 50 named cultivars for *P. cretica* L. (BGCI 2016), and some may be easily confused with *P. multifida* or other species (Hoshizaki & Moran 2001). Accordingly, *Pteris* cultivars escaping to urban or native plant communities in California could be problematic and may not be easily identified.

Pteris multifida most closely resembles *P. cretica*, especially juvenile forms, but differs in having narrower pinnae, proximal pinnae sometimes forked or lobed on the acroscopic as well as on the basiscopic side, and the rachis conspicuously winged (the wings abruptly narrowed just above the next lower pinna pair) between each of the three distal pinna pairs (Nauman 1993; Hoshizaki & Moran 2001; Kamau 2012).

Several species of *Pteris* are popular and readily available in the horticultural trade (Morton 1957; Walker 1970; Page & Bennell 1986; Brenzel 2007). The most commonly available ones include Cretan brake (*P. cretica*), spider brake (*P. multifida*), Victorian brake (*P. ensiformis* N.L. Burman), Australian brake (*P. tremula* R. Br.), and rusty brake (*P. vittata*), which are vigorous growers adapted to a wide range of soils and moisture conditions (Hoshizaki & Moran 2001). Numerous cultivars are known, and the ‘crested pinnae’ forms, particularly for *P. cretica* and *P. multifida*, have been popular for decades (Hemsley 1908; Benedict 1922; Hoshizaki & Moran 2001; BGCI 2016; Dave’s Garden 2016). In cultivated varieties, ‘crested’ seems to be a permanent characteristic, which breeds true in the spore progeny (Benedict 1922; Hoshizaki & Moran 2001). Cresting usually refers to fronds, pinnae, or segments having forked tips (Hoshizaki & Moran 2001).

Upon visual inspection, the *Proctor s.n.* collection (US 1814422) appears to be an escaped cultivar of *P. multifida* characterized by crested pinnae, depicted in Figure 2. Conversely, the Pacific Palisades urban population is typical of the wild form, i.e., without crested pinnae. For comparison of cultivar versus the wild form, the conspicuous rachis wings and narrow pinnae of the *P. multifida* population are shown in Figure 1.

RESULTS AND DISCUSSION

An electronic search of herbaria databases, a literature review, and preliminary field surveys indicate that *P. multifida* is an uncommon garden escape in California. Urban weed studies have documented some previously overlooked but rather conspicuous species in southern California (Riefner & Smith 2015; Riefner 2016). Because it is relatively inconspicuous, *P. multifida* could be easily overlooked; it likely occurs in other metropolitan areas. *Pteris multifida* is not expected to become a pest plant in California; however, because of its broad ecological tolerances, it may establish in native habitats, especially calcareous rock substrates, due to ease of spore dispersal and propagule pressure associated with widespread cultivation. Accordingly, *P. multifida*, and *P. tremula* as well, need further study to determine their complete range, naturalized status, and habitat associations in California.

Numerous *Pteris* cultivars are readily available in the California horticultural trade and may escape to urban and native habitats, which may be difficult to identify. We provide the following key to identify species of *Pteris* naturalized or known to grow outside of cultivation in California.

A KEY TO *PTERIS* IN CALIFORNIA

1. Blades 2–3+–pinnate, at least proximally; ultimate sterile segments crenate _____ **P. tremula**
1. Blades 1–pinnate, or with proximal pinna pair 1–forked or few-lobed; ultimate sterile segments serrulate.
 2. Lateral pinnae all undivided, 10–25 pairs, proximal 3–6 pairs of pinnae reduced; pinnae auriculate or subcordate at bases; stipes with spreading scales at bases _____ **P. vittata**
 2. Lateral pinnae simple or proximal 1–2 pinna pairs lobed; pinnae rounded to adnate at bases; stipes lacking spreading scales at bases.
 3. Distal pinnae adnate or shortly decurrent, but rachis not continuously green-winged in distal half of blades; sterile pinnae 1.5–2.5 mm wide; proximal pinnae lobed only on basiscopic side, lobes 1–2 per pinna _____ **P. cretica**
 3. Distal pinnae strongly decurrent and rachis green-winged in distal half (or more) of blades, the wings contracting just above each lower pinna pair; sterile pinnae 4–10(–15) mm wide; pinnae often lobed on both basiscopic and acroscopic sides, lobes 2–5 per pinna _____ **P. multifida**



Fig. 2. Digital image of *Pteris multifida*, G.R. Proctor s.n. (US 1814422; San Gabriel Mountains, Los Angeles County, California), which appears to be an escaped cultivar characterized by crested pinnae. Note the decurrent (winged) rachis between each of the three distal pinnae, a diagnostic feature that distinguishes *P. multifida* from some *P. cretica* cultivars. Red arrows point to important diagnostic features. Image courtesy of the Smithsonian Institution, Washington, DC.

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