

A putative hybrid between *Phoradendron juniperinum* and *P. capitellatum* (Viscaceae) from northern Arizona

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ABSTRACT.—Juniper mistletoe (*Phoradendron juniperinum*, Viscaceae) and hairy mistletoe (*P. capitellatum*) commonly parasitize junipers (*Juniperus* spp.) in Arizona. Although hybridization between species of *Phoradendron* is rare, this note reports the occurrence of a putative hybrid between these mistletoes in northern Arizona. The principal characteristics of the hybrid plant are the length, width, and pubescence of leaves, which are intermediate between the parent species. The putative hybrid is a female plant, and although it flowered and formed 17 fruits in 2017, seeds from the mature fruits did not germinate, suggesting that the hybrid is probably sterile.

RESUMEN.—El muérdago de enebro (*Phoradendron juniperinum*, Viscaceae) y el muérdago peludo (*P. capitellatum*) comúnmente parasitan a los enebros (*Juniperus* spp.) en Arizona. Aunque la hibridación entre especies de *Phoradendron* es rara, en esta nota se informa de la presencia, en el norte de Arizona, de un híbrido putativo entre estos muérdagos. Las características principales de la planta híbrida son la longitud, ancho, y pubescencia de las hojas, que son intermedias entre las especies parentales. El híbrido putativo es una planta femenina y aunque floreció y formó 17 frutos en el 2017, las semillas de los frutos maduros no germinaron, lo que sugiere que el híbrido es probablemente estéril.

Several species of *Phoradendron* (Viscaceae) inhabit the United States (Wiens 1964, Kuijt 2003). *Phoradendron juniperinum* Engelm (juniper mistletoe) and *P. capitellatum* Torrey ex Trelease (hairy mistletoe) are common parasites of several junipers (*Juniperus* spp.) in the Southwest. While *P. juniperinum* has an extensive geographic range, from central Oregon south through California and then east to Utah, Colorado, Arizona, New Mexico, and northwestern Mexico, *P. capitellatum* has a much less extensive distribution, from central Arizona south to western New Mexico and into northwestern Mexico (Kuijt 2003).

Although both of these mistletoes exclusively parasitize junipers and frequently occur on the same tree and sometimes even on the same branch in Arizona, they are morphologically distinct. The leaves of *P. juniperinum* are reduced to scales ca. 1–2 mm in length, whereas the leaves of *P. capitellatum* are 8–15 mm long (mean 11 mm) and 1–3 mm wide (mean 1.7 mm) (Wiens 1964, Kuijt 2003). Another major morphological difference between these species is that the stems and

leaves of *P. capitellatum* are covered with a dense stellate-pubescence, hence the common name “hairy mistletoe.” In contrast, the stems of *P. juniperinum* are glabrous. The staminate inflorescences of *P. juniperinum* have 1–2 segments with 5–9 flowers per segment, while those of *P. capitellatum* have 1–3 segments with 6–16 flowers per segment. The pistillate inflorescences are morphologically similar, but *P. juniperinum* consistently only forms one segment with 2 flowers, whereas *P. capitellatum* can produce 1 or 2 segments, each with 2–3 flowers (Wiens 1964). Mature fruits of both species are ca. 3–4 mm in diameter and pinkish-white.

While natural hybridization is a characteristic of many groups of flowering plants, it has been rarely reported for *Phoradendron* species. Thus far, the only reported hybrids in the genus have been for *P. juniperinum* crossing with *P. densum* Torrey ex Trelease (= *P. bolleanum* (Seemann) Eichler subsp. *densum* (Torrey) Wiens) (Vasek 1966, Wiens and DeDecker 1972, Wiens and Hawksworth 2002) and a putative hybrid between *P. macrophyllum*

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Fig. 1. Putative hybrid plant between *Phoradendron juniperinum* and *P. capitellatum* on branch of *Juniperus monosperma*. The darker green, female plant just above the putative hybrid is *P. juniperinum*.

(Engelmann) Cockerell and *P. villosum* (Nuttall) Nuttall (Wiens and DeDecker 1972). This note reports a possible example of natural hybridization between *P. juniperinum* and *P. capitellatum*.

The Hybrid Plant

The putative hybrid was observed on a branch of one-seed juniper (*Juniperus monosperma* (Engelmann) Sargent). The mature tree was located by a drainage ditch between private residences at 1015 and 1035 Rodeo Road in Sedona, Arizona (34°52'39.0"N, 111°48'03.9"W, Datum WGS 84; elevation 1360 m). Although the tree was in a flat, landscaped setting, the dominant natural vegetation of the surrounding area was a mixture of one-seed juniper and Colorado pinyon (*Pinus edulis* Engelmann) with interspersed turbinella oak (*Quercus turbinella* Greene) and catclaw acacia (*Senegalia greggii* (A. Gray) Britton & Rose). The host tree was infected by both *P. juniperinum* (9 female plants and 4 male

plants) and *P. capitellatum* (2 female plants and 1 male plant). Only one putative hybrid plant was observed, growing ca. 0.2–1.5 m below 4 female *P. juniperinum* plants (Fig. 1). The putative hybrid plant was distinguished by its leaves, which were shorter and narrower than those of *P. capitellatum*, and by its lack of a dense covering of stellate hairs (Figs. 2, 3, 4). A specimen of the putative hybrid plant has been deposited at the Rancho Santa Ana Botanic Garden Herbarium (Accession Number RSA 877833; Barcode RSA 0162344).

The length and width of 50 leaves from the putative hybrid were measured to the nearest 0.1 mm with a 7× hand lens equipped with a micrometer (Bausch & Lomb, Bridgewater, NJ). In addition, 5 plants each of *P. capitellatum* and *P. juniperinum* (3 males and 2 females for each species) were collected from one-seed junipers in the vicinity of the tree with the hybrid plant. The length and width of 10 leaves from each plant (50 leaves total) were measured to the nearest 0.1 mm. Leaves of the hybrid



Fig. 2. Shoots of the putative hybrid. Note that the shoots have short, narrow leaves and segments with 2 flowers in the axils of several nodes. The dark green, female plant in the background is *Phoradendron juniperinum*.



Fig. 3. Comparison of leaves of *Phoradendron juniperinum* (left), the putative hybrid (middle), and *P. capitellatum* (right).

plant were intermediate in length and width between those of the parent species (Table 1).

The hybrid plant was female and had 17 fruits on it when it was first observed in November 2017. The pistillate inflorescences of the hybrid plant were typical of *P. juniperinum*, with 2 flowers produced on a single segment of each inflorescence. The fruits on the

hybrid plant were 3–4 mm in diameter and pinkish-white like those of each parent species. Fruits on the hybrid plant were allowed to mature until late December 2017. At that time, seeds from 15 fruits were removed and placed on small branches (1–3 cm in diameter) on the host tree near the hybrid plant and marked so they could be observed over time.



Fig. 4. Leaves of *Phoradendron capitellatum* (right) and the putative hybrid (left). Note the dense covering of hairs on the stem and leaves of *P. capitellatum* and the lack of hairs on the hybrid.

TABLE 1. Mean length and width of 50 leaves of *Phoradendron juniperinum*, the putative hybrid, and *P. capitellatum*. Standard deviations (SD) were rounded to the nearest 0.1 mm.

	Leaf length (mm)			Leaf width (mm)		
	Mean	SD	Range	Mean	SD	Range
<i>Phoradendron juniperinum</i>	1.1	0.1	0.8–1.6	1.2	0.1	0.9–1.4
hybrid	5.8	0.7	4.1–6.8	1.6	0.2	1.2–2.1
<i>Phoradendron capitellatum</i>	12.9	1.7	7.4–17.8	1.9	0.2	1.3–2.8

The seeds placed on the host tree were observed for 5 months; none of the seeds germinated. Although this experiment did not have a control, the lack of seed germination could indicate that the seeds were not viable.

Phenology

An issue surrounding the formation of the putative hybrid between *P. juniperinum* and *P. capitellatum* is that while *P. juniperinum* has been reported to flower during the summer (July–September), *P. capitellatum* has been reported to flower in the winter (December–February) (Wiens 1964). Therefore, according to the literature, the flowering periods of these mistletoes do not overlap. However, during 2018, flowering of each species was observed in the vicinity of the hybrid plant and there was some overlap in flowering. Staminate flowers of *P. capitellatum* started anthesis in

early October, but peak flowering did not occur until early December. In addition, although peak flowering of *P. juniperinum* occurred in August and September in 2018, some pistillate flowers were still open on female *P. juniperinum* plants above the hybrid plant in October. In 2018, the putative hybrid plant started flowering in late September, peaked in late October and early November, and had a few open pistillate flowers in early December. Therefore, if flowering occurred in a similar pattern in 2017, as well as in previous years, pollen from *P. capitellatum* would have been available to fertilize pistillate flowers of *P. juniperinum*, as well as the putative hybrid, during October.

The only male plant of *P. capitellatum* on the same tree as the putative hybrid was ca. 2 m from the hybrid plant at about the same height from the ground. This male plant died

during the summer of 2018, and no fruits were produced on the hybrid plant that year. Therefore, it appears probable that pollen from the male *P. capitellatum* plant that died was responsible for backcrossing to flowers on the hybrid plant during 2017. However, this is only speculation, as pollen could have been transferred from male *P. juniperinum* plants growing on the same tree ca. 1 m above the hybrid plant (backcrossing to *P. juniperinum*) or from other male *P. capitellatum* plants which were growing within 30 m of the tree with the hybrid plant. But the lack of any fruit set on the hybrid plant during 2018 suggests that pollen came from the dead male *P. capitellatum* plant on the same tree and not from the male *P. juniperinum* plants growing just above the hybrid. In any case, in 2017, the hybrid plant produced receptive pistillate flowers that were pollinated and developed mature fruits, but likely infertile seeds. It is unfortunate that the male *P. capitellatum* plant near the hybrid died in 2018, thereby precluding observations of its flowering pattern. Observations of the phenology of the parent species and the hybrid are continuing. Because little is known regarding the pollination ecology of dioecious species of *Phoradendron*, observations of potential pollinators (insects) are also being made.

The plant with the intermediate leaf characteristics between *P. juniperinum* and *P. capitellatum* is considered to be a putative hybrid

because no evidence other than the intermediate dimensions of its leaves and lack of stellate hairs was obtained. While Wiens and DeDecker (1972) conducted an examination of the pairing relationships of the chromosomes during microsporogenesis of a hybrid between *P. juniperinum* and *P. densum*, I was unable to do so. Although the putative hybrid female plant did produce mature fruit by backcrossing with pollen from one of the parental species in 2018, the lack of germination of seeds from the hybrid formed in 2017 suggested that the seeds were infertile. Therefore, the plant with the intermediate leaf characteristics could represent a sterile F₁ hybrid.

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