

DISTRIBUTION OF DWARF MISTLETOES (*ARCEUTHOBIMUM* SPP., VISCACEAE)
IN DURANGO, MEXICO

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ABSTRACT

The dwarf mistletoes (*Arceuthobium* spp., Viscaceae) are an ecologically and economically important group of hemi-parasitic flowering plants that parasitize members of the Pinaceae in both the Old and New Worlds. There are two areas of maximum diversity for the dwarf mistletoes: northern California and Durango, Mexico. Here we provide additional information on the distribution of dwarf mistletoes in Durango based on field observations and herbarium collections. This information supplements data provided in a monograph on *Arceuthobium* published in 1996. Needed research on the dwarf mistletoes in Durango is also discussed.

Key words: *Arceuthobium*, distribution, dwarf mistletoes, Durango, México.

RESUMEN

Los muérdagos enanos (*Arceuthobium* spp., Viscaceae) son un grupo de plantas hemiparásitas ecológica y económicamente importantes que parasitan a miembros de la familia Pinaceae, tanto en el Viejo como en el Nuevo Mundo. Existen dos áreas de máxima diversidad para los muérdagos enanos: el norte de California y Durango, México. En este trabajo se provee de información adicional sobre los muérdagos enanos en Durango con base en observaciones de campo y datos de material de herbario. Esta información complementa los datos presentados en una monografía sobre *Arceuthobium* publicada en 1996. Se discute también la necesidad de más investigación sobre los muérdagos enanos en Durango.

Palabras clave: *Arceuthobium*, distribución, muérdagos enanos, Durango, México.

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(*ARCEUTHOBIMUM* SPP., VISCACEAE) IN
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Dwarf mistletoes (*Arceuthobium* spp., Viscaceae) are among the most economically and ecologically important parasitic flowering plants in North America (Hawksworth and Wiens 1996; Mathiasen 1996; Hawksworth et al. 2002; Shaw et al. 2004). They are common and abundant parasites of the Pinaceae and affect nearly all of the commercially important coniferous species in the western United States, Canada, and Mexico

(Hawksworth and Shaw 1984; Hawksworth and Wiens 1996; Geils and Hawksworth 2002). The geographic regions with the greatest diversity and concentration of dwarf mistletoes are northern California and southern Oregon, United States with 12 taxa and Chihuahua and Durango, Mexico with 13 taxa (Hawksworth and Wiens 1996; Mathiasen and Marshall 1999; Hawksworth et al. 2002). Eleven of the taxa found in the Sierra Madre Occidental of Chihuahua and Durango occur in Durango. Two additional taxa, *A. abietinum* Engelm. ex Munz and *A. vaginatum* (Willd.) Presl subsp. *cryptopodum* (Engelm.)

Hawksw. & Wiens, occur north of Durango in Chihuahua, giving this area of the Sierra Madre Occidental the most diverse assemblage of dwarf mistletoes in North America.

Information on the distribution and hosts of dwarf mistletoes in Durango, Mexico has been primarily based on the work of Hawksworth and Wiens (1965, 1970, 1972, 1977, 1989, 1996). Hawksworth and Wiens (1996) provided distribution maps for each dwarf mistletoe found in Durango, primarily based on their collections obtained from 1961–1987.

More recent collections, however, provide additional information on dwarf mistletoe distributions and hosts in the region. The senior author has been collecting additional data on the distribution of dwarf mistletoes in Durango since 1997. In addition, other investigators have deposited many specimens of *Arceuthobium* collected throughout Durango with the Herbario CIIDIR, Instituto Politécnico Nacional located in Durango City, Mexico (CIIDIR). Based on our extensive field observations and these herbarium records we now have a great deal of additional information on the distribution of these economically and ecologically key parasitic plants in Durango. These data illustrate that there are three areas of the state that have been intensively sampled: west-central Durango near Altares, east and west of El Salto along Mexico Route 40, and southeast of Durango City. These areas have been intensively sampled because they are transected by major roads, making access to them much easier than for the more remote regions of the state. Areas in Durango that have not been adequately sampled for dwarf mistletoes include the regions south of La Flor and south and west of Topia. These areas are dominated by mountainous terrain high enough in elevation to support extensive pine forests, and hence dwarf mistletoes, and should be surveyed. Eastern Durango is dominated by grasslands and xerophytic scrub with few pines, and thus far, no dwarf mistletoes have been reported from this part of the state. In addition, although the state has extensive piñón woodlands (García and González 2003), no dwarf mistletoes have been reported on piñones in the state (Hawksworth and Wiens 1996). Because the pine forests of the Sierra Madre Occidental are among the most productive commercial forests in Mexico, studies of the distribution and host range of dwarf mistletoes and the damage associated with severe infection by these parasites should continue there.

The taxa of *Arceuthobium* occurring in Durango are listed below and their distributions based on a compilation of published literature, herbarium specimens, and the author's field observations discussed under each taxon. Dwarf mistletoe distributions are illustrated in Figs. 1 and 2 and include information from Hawksworth

and Wiens (1996), data from CIIDIR, and our field observations and collections. Most of the senior author's collections of *Arceuthobium* from Durango are deposited at the Deaver Herbarium, Northern Arizona University, Flagstaff (ASC). Principal hosts of each species, based on data in Hawksworth and Wiens (1996) and our field observations, are listed in Table 1. Pine taxonomy follows Farjon and Styles (1997), except for *Pinus chihuahuana* Engelm. and *P. cooperi* C.E. Blanco being recognized at the species level following García and González (2003) and Almaráz et al. (2006). The taxonomic status of several pines occurring in the Sierra Madre Occidental is still in debate, particularly the classification of pines in subgenus *Strobus*; we have followed the classification used by García and González (2003) for this subgenus. In addition, we discuss needed research on the taxonomy, distribution, and pathology for some of the common dwarf mistletoes in Durango.

ARCEUTHOBIMUM BLUMERI HAWKSW. & WIENS

This parasite of white pines occurs more commonly in Durango than originally reported by Hawksworth and Wiens (1996). It is distributed in the Sierra Madre Occidental from northwestern to southern Durango (Fig. 1). Because it occurs in far southern Durango and its hosts are distributed in adjacent states, it probably occurs in northern Nayarit, northern Jalisco, and western Zacatecas, but it has not been reported in these Mexican states thus far. Although this is the only dwarf mistletoe that parasitizes white pines in Durango, the plants of *A. blumeri* are small and gray, so their presence on infected trees may be overlooked. Hawksworth and Wiens (1972, 1996) reported that this dwarf mistletoe seldom induces the formation of witches' broom on infected trees. However, our field observations from throughout its range in Mexico and in southern Arizona (Huachuca Mountains) indicate it often induces witches' broom formation, even on lightly infected trees. Therefore, infected trees can usually be identified using the presence of witches' brooms (Mathiasen 1979).

Hawksworth (1991) suggested that the pattern of parasitism of the Mexican white pines by *Arceuthobium* may be useful when interpreting the taxonomy and distribution of these pines in Mexico. The classification of the white pine populations in northern Mexico has been debated for many years (Shaw 1909; Martínez 1948; Critchfield and Little 1966; Perry 1991; Farjon and Styles 1997; García and González 2003). Hawksworth (1991) interpreted the selective parasitism of white pines in the Sierra Madre Occidental by *A. blumeri* as evidence that these populations should be classified as *Pinus ayaca-*

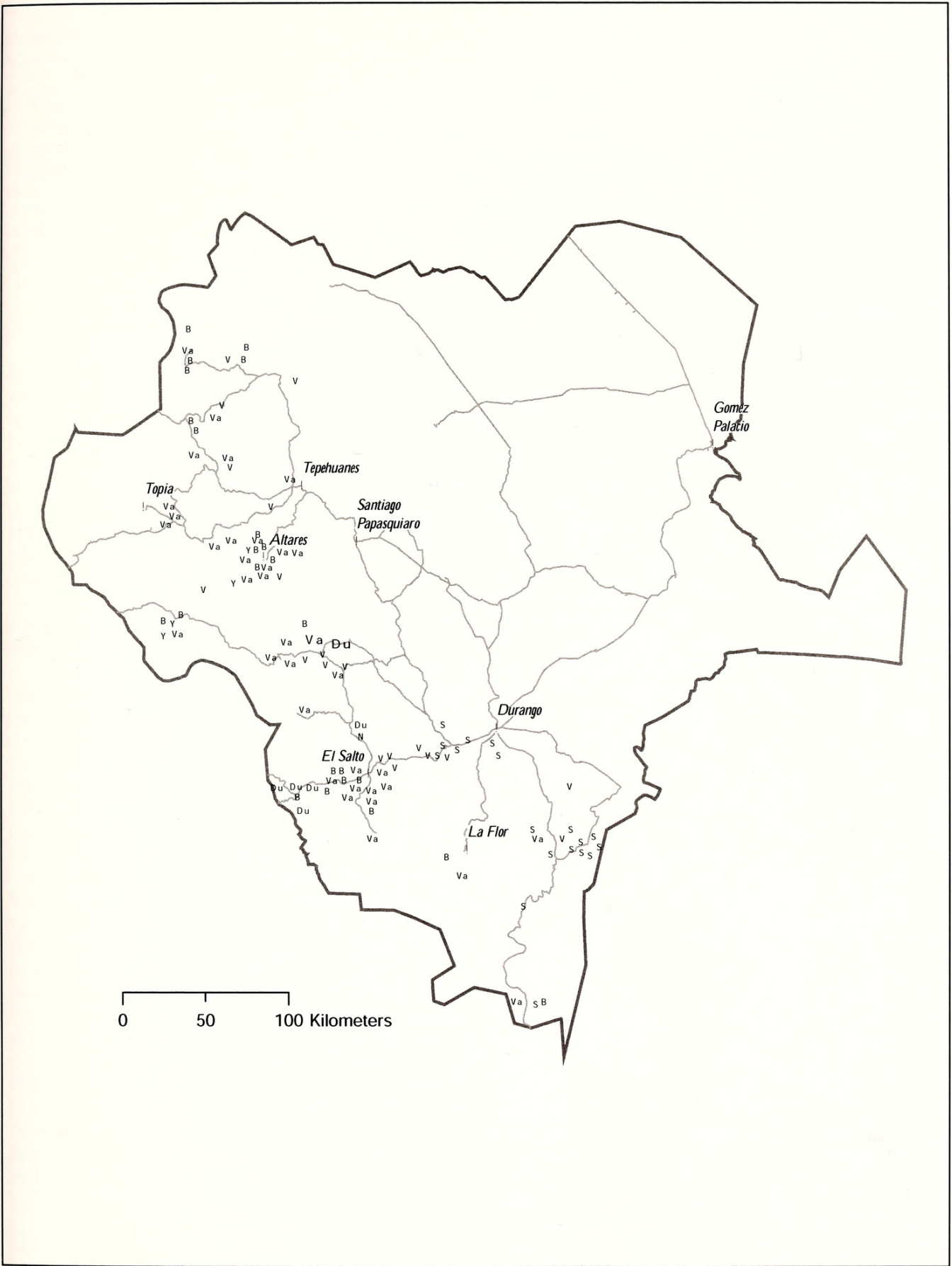


FIG. 1. Distribution of *Arceuthobium blumeri* (B), *A. strictum* (S), *A. vaginatum* subsp. *vaginatum* (Va), *A. vaginatum* subsp. *durangense* (Du), *A. verticilliflorum* (V), and *A. yecoreense* (Y) in Durango, Mexico. Distributions are based on data in Hawksworth and Wiens (1996), specimens deposited at the Herbario CIIDIR, Durango, Mexico, the Deaver Herbarium, Flagstaff, AZ, and field observations. Populations designated with large, bolded letters are specifically discussed in the text.

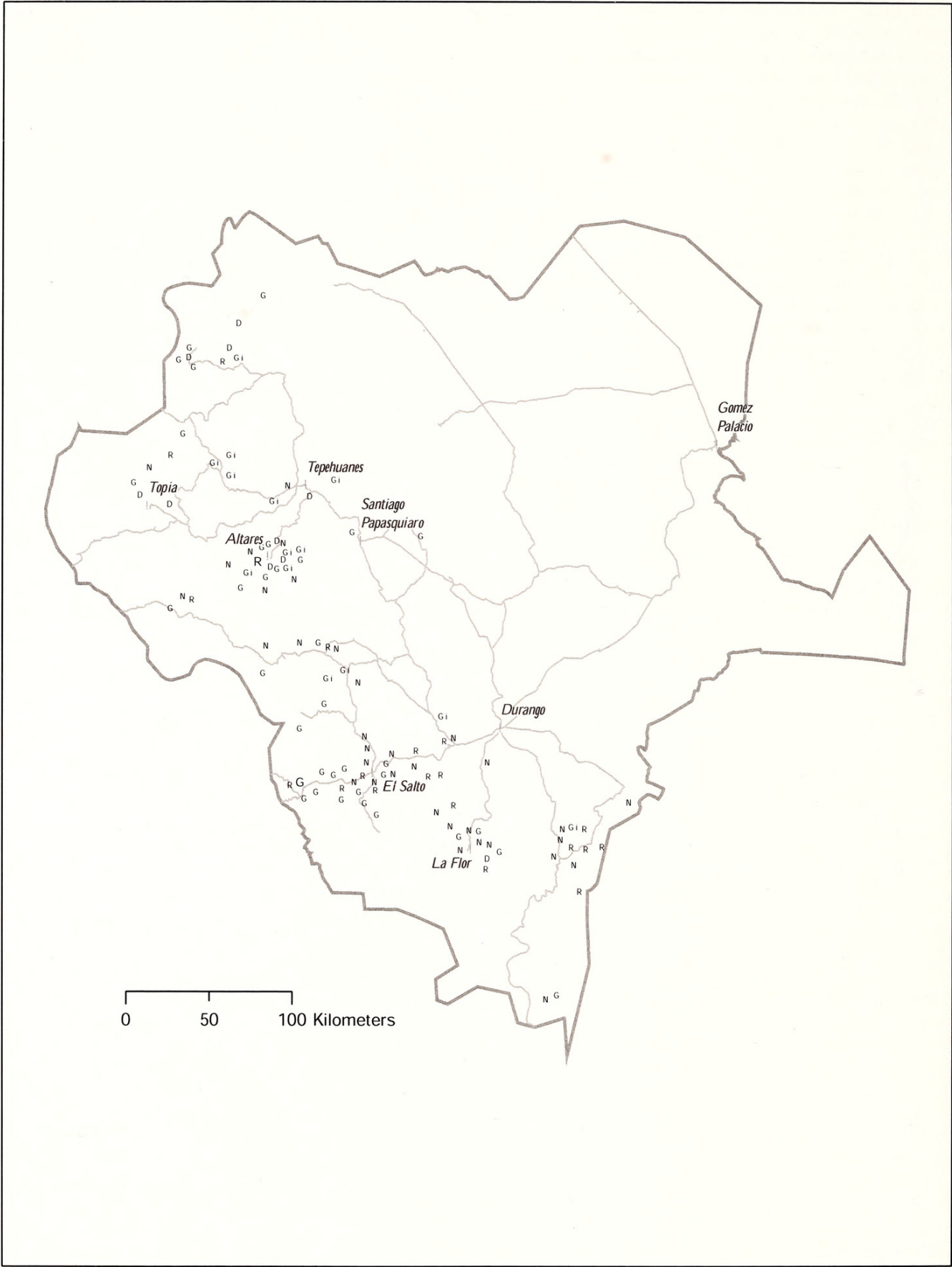


FIG. 2. Distribution of *Arceuthobium douglasii* (D), *A. gillii* subsp. *gillii* (Gi), *A. gillii* subsp. *nigrum* (N), *A. globosum* (G), and *A. rubrum* (R) in Durango, Mexico. Distributions are based on data in Hawksworth and Wiens (1996), specimens deposited at the Herbario CIIDIR, Durango, Mexico, the Deaver Herbarium, Flagstaff, AZ, and field observations. Populations designated with large, bolded letters are specifically discussed in the text.

TABLE 1. PRINCIPAL HOSTS OF DWARF MISTLETOES THAT OCCUR IN DURANGO, MEXICO. Host classification of the pines follows Farjon and Styles, 1997 (in part) and García and González 2003.

Dwarf mistletoe	Principal hosts
<i>A. blumeri</i>	<i>Pinus strobiformis</i> ; <i>P. ayacahuite</i> var. <i>brachyptera</i>
<i>A. douglasii</i>	<i>Pseudotsuga menziesii</i>
<i>A. gillii</i> subsp. <i>gillii</i>	<i>Pinus chihuahuana</i> ; <i>P. herrerae</i> ; <i>P. leiophylla</i> ; <i>P. lumholtzii</i>
<i>A. gillii</i> subsp. <i>nigrum</i>	<i>Pinus chihuahuana</i> ; <i>P. leiophylla</i> ; <i>P. lumholtzii</i> ; <i>P. teocote</i>
<i>A. globosum</i>	<i>Pinus cooperi</i> ; <i>P. durangensis</i> ; <i>P. engelmannii</i>
<i>A. rubrum</i>	<i>Pinus cooperi</i> ; <i>P. durangensis</i> ; <i>P. engelmannii</i> ; <i>P. herrerae</i> ; <i>P. teocote</i>
<i>A. strictum</i>	<i>Pinus chihuahuana</i>
<i>A. vaginatum</i> subsp. <i>vaginatum</i>	<i>Pinus arizonica</i> ; <i>P. cooperi</i> ; <i>P. durangensis</i> ; <i>P. engelmannii</i>
<i>A. vaginatum</i> subsp. <i>durangense</i>	<i>Pinus cooperi</i> ; <i>P. devoniana</i> ; <i>P. douglasiana</i> ; <i>P. durangensis</i> ; <i>P. engelmannii</i>
<i>A. verticilliflorum</i>	<i>Pinus arizonica</i> ; <i>P. cooperi</i> ; <i>P. durangensis</i> ; <i>P. engelmannii</i>
<i>A. yecorens</i>	<i>Pinus chihuahuana</i> ; <i>P. durangensis</i> ; <i>P. herrerae</i> ; <i>P. leiophylla</i> ; <i>P. lumholtzii</i>

huite Ehrenb. ex Schltdl. var. *brachyptera* Shaw, a view supported by Eguiluz Piedra (1991). Hawksworth's conclusion was influenced by the selective parasitism of *Arceuthobium apachecum* Hawksw. & Wiens of the white pine populations in Arizona, New Mexico, and northeastern Mexico that he classified as *Pinus strobiformis* Engelm. Hawksworth (1991) argued that parasitism by *A. blumeri* was confined to *P. ayacahuite* var. *brachyptera* in Mexico and southern Arizona and that *A. apachecum* was the only parasite of *P. strobiformis* in the southwestern United States and northeastern Mexico.

Pinus ayacahuite is not parasitized by dwarf mistletoes in central Mexico, but *Arceuthobium guatemalense* Hawksw. & Wiens parasitizes *P. ayacahuite* starting in central Oaxaca extending through Chiapas and into western Guatemala (Hawksworth and Wiens 1996; Mathiasen et al. 2003). The absence of *A. blumeri* and *A. guatemalense* from central Mexico is noteworthy. Perry (1991) considered that both *P. strobiformis* and *P. ayacahuite* var. *brachyptera* co-exist in the Sierra Madre Occidental of northern Mexico, a view shared by García and González (2003). Based on our field observations of the white pines in Durango, we also consider both *P. strobiformis* and *P. ayacahuite* to be present in the state. These white pines are both parasitized by *A. blumeri* there (Mathiasen 1979). Therefore, we don't consider the parasitism by *A. blumeri* as a consistent character that can be used to separate these white pines from each other in northern Mexico. Additional taxonomic studies are needed for the white pine populations throughout northern Mexico.

ARCEUTHOBIUM DOUGLASII ENGELM

This important parasite of *Pseudotsuga menziesii* (Mirb.) Franco has now been collected from seven locations in northwestern Durango and from one location in southern Durango (Fig. 2). Therefore, it is probable that it will be discovered from additional locations in west-central Du-

rango. Because stands of *Pseudotsuga* have only persisted in the Sierra Madre Occidental where site conditions favor their regeneration and growth, this tree species occurs in scattered stands (Guerra-De la Cruz 2001), and *A. douglasii* has evidently persisted in some of these areas and not others. It is probable that as more stands of *Pseudotsuga* are examined in Durango, this dwarf mistletoe will be discovered in many new areas. Although *A. douglasii* forms very small, olive-green plants that are not easily observed, it induces the formation of large, distinctive witches' brooms on infected trees, which are easy to observe in stands of *Pseudotsuga* (Hawksworth and Wiens 1996).

ARCEUTHOBIUM GILLII HAWKSW. & WIENS
SUBSP. GILLII AND SUBSP. NIGRUM HAWKSW. & WIENS

These parasites of *Pinus leiophylla* Schiede ex Schltdl., *P. lumholtzii* B. L. Rob. & Fernald, and *P. chihuahuana* are common in the Sierra Madre of Durango (Fig. 2). Although Hawksworth and Wiens (1989, 1996) recognized *A. gillii* subsp. *nigrum* at the species level (*A. nigrum* (Hawksw. & Wiens) Hawksw. & Wiens), we prefer to apply the earlier classification of this mistletoe by the same authors (1965, 1972) as a subspecies of *A. gillii* because recent molecular data indicate these taxa are very closely related (Nickrent et al. 2004). The molecular data and the morphological similarities between *A. gillii* and *A. nigrum* strongly support the earlier classification of *A. nigrum* as a subspecies of *A. gillii*.

Although Hawksworth and Wiens (1996) only reported two locations for *A. gillii* subsp. *gillii* in Durango, collections at CIIDIR and our field observations indicate it is widely distributed from northern to southeastern Durango. *Arceuthobium gillii* subsp. *nigrum* is also distributed from northern to southern Durango and is one of the most common dwarf mistletoes in the state. Although it also parasitizes *P. teocote* Schltdl. and Cham., *P. lumholtzii*, and *P. chihuahuana* in

Durango, it is most common on *P. leiophylla*. Hawksworth and Wiens (1996) reported that these two dwarf mistletoes occur in the same mountain range near Tepehuanes, Durango, but they indicated these taxa were separated by elevation differences; *A. gillii* occurring below 2200 m and *A. gillii* subsp. *nigrum* occurring above 2600 m.

Plant color was considered by Hawksworth and Wiens (1996) as one of the distinguishing characters separating *A. gillii* from *A. nigrum*: plants of *A. gillii* are greenish-brown and those of *A. nigrum* are dark brown to black. However, Hawksworth and Wiens (1989) mentioned in their discussion of *A. nigrum* that shoots of this species could also be dark green. Our field observations in Durango indicate that plants of *A. gillii* subsp. *nigrum* are usually greenish-brown, dark green, or dark brown, and only occasionally black. Plants of *A. gillii* subsp. *nigrum* in central Mexico are dark green to black. However, these plant characteristics are also representative of a morphologically similar, but phenologically and genetically distinct dwarf mistletoe that has now been reported from southern Mexico, *A. hondurensis* Hawksw. & Wiens (Mathiasen et al. 2001, 2003). The morphological similarities between these dwarf mistletoes are demonstrated by the earlier identifications of *A. hondurensis* in Chiapas and Oaxaca as *A. gillii* subsp. *nigrum* (Hawksworth and Wiens 1972) and later as *A. nigrum* by Hawksworth and Wiens (1989, 1996). Further studies are warranted to determine the taxonomic status of the populations of *A. gillii* subsp. *nigrum* in central Mexico. Furthermore, because of the similarity in plant color of subsp. *gillii* and subsp. *nigrum* in Durango, the identification of these taxa is often difficult. We have primarily relied on the size of plants as the key characteristic to distinguish these taxa; plants of *A. gillii* subsp. *nigrum* being larger than those of *A. gillii* subsp. *gillii* (Hawksworth and Wiens 1989, 1996). Further taxonomic studies of these taxa are also needed in Durango.

ARCEUTHOBium GLOBOSUM HAWKSW. & WIENS SUBSP. *GLOBOSUM*

This dwarf mistletoe is one of the most widespread in Durango occurring through the Sierra Madre Occidental from northern to southern Durango (Fig. 2). It has been reported to parasitize three common and economically important pines in Durango (Table 1). It is most common on *Pinus cooperi* and *P. durangensis* Martínez in this region. Although this dwarf mistletoe does not usually induce the formation of witches' brooms on infected pines, it is easily identified by its bright yellow plants that form large, round masses of shoots in infected trees. Its extensive distribution, its large plants, and its distinctive yellow color have all contributed to its

being extensively collected in Durango. Because it is so widespread and locally abundant its effects on the growth of its hosts should be investigated.

Populations of *A. globosum* approximately 50 km west of El Salto near Buenes Aires (Fig. 2) have some very large (>30 cm), green plants which are morphologically similar to *A. globosum* Hawksw. & Wiens subsp. *grandicaule* Hawksw. & Wiens, a common dwarf mistletoe on pines in central Mexico (Hawksworth and Wiens 1996). However, these populations also have plants that are characteristic of typical *A. globosum* subsp. *globosum*. Therefore, we have classified these populations as *A. globosum* subsp. *globosum*, but further taxonomic studies of these populations are warranted.

ARCEUTHOBium RUBRUM HAWKSW. & WIENS

This distinctively red dwarf mistletoe that has shiny fruits has only been reported in the Sierra Madre Occidental of Durango and extreme eastern Sinaloa (Hawksworth and Wiens 1996). It is widely distributed in Durango (Fig. 2) and parasitizes five pines as principal hosts (Table 1). It is probably that it will eventually be found in Chihuahua, Nayarit, northern Jalisco, and western Zacatecas because its principal hosts are widely distributed in these states also. Populations of *A. rubrum* near Altares in Durango have plants that are much larger than those in other areas of Durango, and thus further taxonomic study of these populations is warranted (Hawksworth and Wiens 1996). Little is currently known about the effects *A. rubrum* has on its hosts, and because this mistletoe is so widely distributed in Durango, and occurs on some of the most economically important pines in this region, studies of its effects on host mortality and growth should be initiated.

ARCEUTHOBium STRICTUM HAWKSW. & WIENS

This dwarf mistletoe is endemic to Durango, but because it occurs very close to the borders with Nayarit, Jalisco, and Zacatecas it will undoubtedly be discovered in these states (Fig. 1). This is particularly true for western Zacatecas because several populations of *A. strictum* have been collected near its border with Durango. Although *A. strictum* principally parasitizes *Pinus chihuahuana* which is distributed throughout the Sierra Madre Occidental, this dwarf mistletoe has only been found on the far eastern side of these mountains in central and southern Durango. It is noteworthy that the other dwarf mistletoes parasitizing *P. chihuahuana*, *A. gillii* subsp. *gillii* and *A. gillii* subsp. *nigrum*, occur more extensively through the Sierra Madre Occidental. Why *A. strictum* appears to be restricted to a small part of the geographic range

of its principal host is an interesting question. It appears to be limited by elevation, occurring below 2500 m, but its hosts commonly occur below 2500 m throughout the Sierra Madre Occidental. This dwarf mistletoe is a distinctive species that can easily be identified by its flowers, which have up to 7 perianth lobes, and by its staminate plants, which are typically a single spike when it flowers in the late summer and early fall (Hawksworth and Wiens 1965, 1996). Our field observations support those of Hawksworth and Wiens (1996) which indicate that *A. strictum* is often associated with mortality of severely infected trees in southern Durango.

ARCEUTHOBIUM VAGINATUM (WILLD.) PRESL
AND *A. VAGINATUM* (WILLD.) PRESL SUBSP.
DURANGENSE HAWKSW. & WIENS

Arceuthobium vaginatum subsp. *vaginatum* is one of the most widespread and locally abundant dwarf mistletoes in Durango (Fig. 1) where it parasitizes several species of pines (Table 1). It is probably the most economically damaging dwarf mistletoe in the state (Hawksworth and Wiens 1996). *Arceuthobium vaginatum* subsp. *vaginatum* is not only the most widely distributed dwarf mistletoe in Durango, but is common throughout northern and central Mexico. Because of its local abundance, widespread distribution, and parasitism of more than 10 species of pines, it is considered to be the most economically damaging dwarf mistletoe in Mexico (Hawksworth and Wiens 1996). Additional research is needed on its economic impact throughout the country and particularly in Durango.

Hawksworth and Wiens (1972, 1996) reported that *Arceuthobium vaginatum* subsp. *durangense* only occurs in the extreme western regions of Durango on the west side of the Sierra Madre Occidental, but we have found it north of El Salto parasitizing both *P. engelmannii* and *P. cooperi* (Fig. 1) (Mathiasen 2007). Both of these hosts are severely parasitized and we have classified them as principal hosts (Table 1). The distributions of the two subspecies of *A. vaginatum* overlap in Durango northeast of El Salto where they occur within 6 km of each other southeast of San Miguel de las Cruces (Fig. 1). The distribution of *A. vaginatum* subsp. *durangense* is still poorly known, but it appears to be more common in Sinaloa along the western slopes of the Sierra Madre at elevations <2000 m (Hawksworth and Wiens 1996). It is likely that it will be found in Nayarit because it has been collected in western Jalisco (Hawksworth and Wiens 1996).

Although Hawksworth and Wiens (1989, 1996) treated subsp. *durangense* at the specific level (*A. durangense* (Hawksw. & Wiens) Hawksw. & Wiens), we prefer their earlier classification of this mistletoe as a subspecies of *A. vaginatum*

(Hawksworth and Wiens 1965, 1972). Again, recent molecular data indicate that *A. vaginatum* and *A. durangense* are closely related; these subspecies can not be distinguished using the molecular markers examined thus far (Nickrent et al. 2004). These two subspecies are only distinguished by their plant color (bright orange versus dark brown to black) and perhaps their host range because *Pinus teocote* is reported to be immune to infection by *A. vaginatum* subsp. *durangense*, but *P. teocote* is a secondary host for *A. vaginatum* subsp. *vaginatum* (Hawksworth and Wiens 1996). Because of the molecular data currently available and the morphological similarity of these taxa, we believe the classification of the bright orange populations of *A. vaginatum* in Durango as subspecies *durangense* is the most appropriate treatment.

ARCEUTHOBIUM VERTICILLIFLORUM ENGELM

This distinctive dwarf mistletoe is more widely distributed in Durango than previously reported. At one time it was thought to be extremely rare in Durango (Hawksworth and Wiens 1972), but it has now been collected from several areas of the state (Fig. 1). We are certain it will continue to be collected throughout Durango and possibly in northern Nayarit and southern Chihuahua because its principals hosts are widespread in these areas. This dwarf mistletoe is easily identified by its whorled arrangement of flowers (usually 6 flowers per whorl), its very large mature fruits (>1 cm in length), and its thick staminate spikes which are 4–6 mm in width (Hawksworth and Wiens 1965, 1972, 1996). It causes the formation of large witches' brooms that often have main branches with much larger diameters than uninfected branches in the same whorl, particularly on *P. engelmannii*.

The distribution of *A. verticilliflorum* within pine stands is interesting in that it is often only found on one or a few trees in small groups, and these will be scattered at distances supporting the suggestion that this dwarf mistletoe may only be bird disseminated (Hawksworth and Wiens 1996). We have also observed dense stands of small *P. cooperi* growing directly under infected, large trees with no infection whatsoever on the understory pines ca. 20 km northeast of El Salto along the road to San Miguel de las Cruces. This also suggests this dwarf mistletoe is completely, or at least primarily, bird disseminated. The biology of this dwarf mistletoe warrants further study because of its possible dependence on birds for seed dispersal.

ARCEUTHOBIUM YECORENSE HAWKSW. & WIENS

The distribution and abundance of this dwarf mistletoe is still poorly known. Currently it is

only known from one area of Durango, southwest of Altares (Fig. 1), and we have not observed it in any other locations in Durango thus far. It is also known from a small region on the Chihuahua/Sonora border near the town of Yecora, Sonora (Hawksworth and Wiens 1989, 1996). The Sonora and Durango populations are approximately 400 km apart and this species probably occurs in additional populations in northern Durango through western Chihuahua and eastern Sonora because it occurs on several pine species that occur in these states (Table 1).

ADDITIONAL RESEARCH NEEDS

Field observations indicate that several of the dwarf mistletoes in Durango are associated with increased mortality of severely infected trees, particularly *A. blumeri*, *A. globosum*, *A. strictum*, and *A. vaginatum*. Furthermore, these mistletoes may be associated with significant reductions in the growth of severely infected trees, but this relationship has not been studied in Mexico to the extent it has been in the United States and Canada (Geils and Hawksworth 2002). A cooperative research project funded by the USDA Forest Service, the Comisión Nacional Forestal, and CIIDIR has been initiated in Durango to examine the effects of *A. vaginatum* subsp. *vaginatum* on the growth of *Pinus cooperi* (which is treated as a variety of *P. arizonica* by Farjon and Styles 1997) using stem analysis techniques. This study should provide data that can be used to guide management decisions related to dwarf mistletoe mitigation efforts in Durango. Additional research on the effects dwarf mistletoes have on their pine hosts in the Sierra Madre is needed as is research on the ecological relationships of the dwarf mistletoes with insects, birds, and other animals throughout Mexico.

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REVIEW

California Native Plants for the Garden. By CAROL BORNSTEIN, DAVID FROSS AND BART O'BRIEN. 2005. Cachuma Press, Los Olivos, CA. 2nd Printing February 2006. 271 pp. ISBN 0-9628505-8-6, \$27.95, paperback

California Native Plants for the Garden is a truly valuable contribution to the somewhat limited, although increasingly available references on the topic of cultivating California native plants. The science of horticulture is critical to the success of landscape projects, including not only residential landscape design, but wildlands restoration and management. *California Native Plants for the Garden* capably and thoroughly addresses the many aspects of growing native plants well.

This book was written by three renowned California horticulturists: Carol Bornstein (Horticulture Director at Santa Barbara Botanic Garden) Dave Fross, (Landscape Architect, Cal Poly San Luis Obispo Instructor, and Native Sons Wholesale Nursery Owner) and Bart O'Brien (Senior Staff Research Associate at Rancho Santa Ana Botanic Garden, heralding previously from Yerba Buena Nursery in Palo Alto, CA). In combination, they offer considerable expertise on the subject, although their background experience leads to a slight partiality towards coastal rather than interior regions of the state.

Produced by California's own, Cachuma Press, *California Native Plants for the Garden* is in a similar format to two of its other beautiful publications: *Oaks of California* and *Conifers of California*. Like its predecessors, the book is visually gripping with over 450 glossy color photographs, informative, thorough and well organized. While clearly its greatest appeal is for gardeners, landscape designers and native plant aficionados, it also benefits botanists and ecologists in their efforts to revegetate or restore land by providing horticultural essentials such as plant establishment, irrigation, care and maintenance. In the "Plant Profiles" section, it offers a depth of information demystifying the many genera as well as cultivated varieties available commercially today. Derivation, description, as well as cultural requirements are given for hundreds of plants. Each genus is illustrated with a colorful photograph—often depicted in an instructive landscape context.

Additionally, concerns associated with wild-land-urban interfaces, such as exotic plant invasions, genetic contamination of endangered native plants, fire-safe landscaping, sustainability, drought, and erosion—are fundamentally, yet definitively addressed.

—MELANIE BAER-KEELEY, Restoration Horticulturist, Sequoia & Kings Canyon National Parks, 47050 Generals Hwy, Three Rivers, CA 93271; Melanie_Baer-Keeley@nps.gov.



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