A New Combination for Hawksworth’s Dwarf Mistletoe (Viscaceae)

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Abstract. Morphological and molecular analyses of Honduran dwarf mistletoe (Arceuthobium hondurense Hawksworth & Wiens) and Hawksworth’s dwarf mistletoe (A. hawksworthii Wiens & C. G. Shaw bis) indicate these taxa are closely related but can be distinguished based on a few morphological differences. They can also be distinguished by their phenology and host range. Because there are only a few morphological differences between these dwarf mistletoes and because the DNA sequences that have been examined for them are nearly identical, Hawksworth’s dwarf mistletoe is reclassified as a subspecies of Honduran dwarf mistletoe: Arceuthobium hondurense subsp. hawksworthii (Wiens & C. G. Shaw bis) Mathiasen.

Key words: Arceuthobium, Honduran dwarf mistletoe, Viscaceae.

Two of the rarest dwarf mistletoes known occur in Central America and southern Mexico: Honduran dwarf mistletoe (Arceuthobium hondurense Hawksworth & Wiens) and Hawksworth’s dwarf mistletoe (A. hawksworthii Wiens & C. G. Shaw bis). Honduran dwarf mistletoe was described in 1970 from populations southeast of Tegucigalpa, Honduras (Hawksworth & Wiens, 1970), and for many years it was only known from two locations in Honduras (Hawksworth & Wiens, 1996). At one time it was thought to be in danger of extinction because of the extensive harvesting of Honduran pine forests (Hawksworth & Wiens, 1977, 1996), but it has now been found in Chiapas and Oaxaca, Mexico (Mathiasen et al., 2001, 2002b). However, its distribution in Honduras and southern Mexico is still poorly known, as it has only been discovered in five areas of Honduras, two in Chiapas, and two in Oaxaca (Beatty et al., 1998; Mathiasen et al., 2001, 2002b, 2003; Mathiasen & Melgar, 2006). It has also been recently reported from Nicaragua near the border with Honduras (Mathiasen et al., 2006).

Hawksworth’s dwarf mistletoe is known only from the Mountain Pine Ridge Region (MPR) of western Belize (Wiens & Shaw, 1994; Mathiasen et al., 1999) and from one location in central Honduras (Mathiasen et al., 2002a). Hawksworth’s dwarf mistletoe had been collected by various investigators from the MPR since 1959, but it was not described until 1994 (Wiens & Shaw, 1994). It was previously thought to represent disjunct populations of Arceuthobium globosum Hawksworth & Wiens (Hawksworth & Wiens, 1972) and later was classified as A. aureum Hawksworth & Wiens subsp. aureum (Hawksworth & Wiens, 1977). However, a detailed analysis of the MPR populations by Wiens and Shaw (1994) indicated these populations were distinct from the A. aureum subsp. aureum populations found in the western and central highlands of Guatemala; therefore, the Belizean populations were described as a new species: A. hawksworthii.

I have been collecting data on the morphological characteristics, flowering and seed dispersal periods, and host ranges of Honduran and Hawksworth’s dwarf mistletoes since 1993 (Mathiasen et al., 1999; Mathiasen et al., 2003). Based on the morphological similarities between these dwarf mistletoes and recent molecular evidence that indicates nuclear ribosomal internal transcribed spacer and chloroplast trnL region sequences for these two taxa are nearly identical (Nickrent et al., 2004), there is now sufficient evidence to support the close taxonomic affinities of these dwarf mistletoes and to support a new combination for Hawksworth’s dwarf mistletoe as a subspecies of Arceuthobium hondurense.


Plants 9–34 cm in height (mean ca. 16 cm); basal diam. of dominant plants 2–3 mm (mean 3.8 mm); third internode length 6–21 mm (mean 12 mm) and 1.7–4.7 mm (mean 2.8 mm) wide; staminate and pistillate plants primarily green-brown, but some yellow-green or light green; staminate flowers primarily 3-partite, occasionally 4-partite, and rarely 5-partite, frequently dark red on adaxial surface of

Figure 1. Approximate locations of populations sampled for Arceuthobium hondurensis subsp. hawksworthii (open circles) in Belize and Honduras and for A. hondurensis subsp. hondurensis (dark circles) in Honduras and Mexico. BELIZE, Cayo District: Mountain Pine Ridge: —1. Lower Bruton Trail. —2. 2.5 km south of Cooma Cairn road on Bruton Trail. —3. Upper Bruton Trail. —4. 1.5 km south of Cooma Cairn road on Bruton Trail. —5. 1 km south of Cooma Cairn road on Bruton Trail. —6. Junction of Cooma Cairn road and Bruton Trail. —7. 2.2 km east of Cooma Cairn road on Baldy Beacon road. —8. 3.2 km east of Cooma Cairn on Baldy Beacon road. —9. 2.1 km north of Cooma Cairn on Cooma Cairn road. —10. 0.5 km south of Hidden Valley Falls road on Cooma Cairn road. —11. 1 km east of Cooma Cairn road on the road to Hidden Valley Falls. —12. Tiger Creek Falls overlook. —13. 1.2 km south of road to Hidden Valley Inn on Cooma Cairn road. —14. 0.4 km west of Cooma Cairn road on Thompson Line. —15. 5 km west of Cooma Cairn road on Orchard Hill Line. —16. 0.3 km west of Cooma Cairn road on Orchard Hill Line. —17. Lower Granite Cairn road. —18. 2 km east of Augustine road on the Oak Barn Line. HONDURAS, Department Olancho: —19. 10 km east of Guadalupe on road to San Esteban. Department Cortes: —20. 4 km north of Buenos Aires on road into Cusuco National Park. Department Lempira: —21. Gelaque National Park, 6 km
perianth lobes, but occasionally only the margins of lobes are red, and rarely lobes are the same color as the staminate plants, staminate flower diam. 2–3.6 mm (mean 2.8 mm); mature fruit length 3.9–5.2 mm (mean 4.6 mm) and 2.3–3.8 mm wide (mean 2.9 mm). Some mature fruits have slightly exerted stigmas (0.1–0.3 mm), but this character is variable. Fruits are markedly glaucous, but lose this character when dried. Seeds 2.6–3.4 (mean 3) mm long and 1–1.6 (mean 1.3) mm wide.

Sexual dimorphism between the male and female plants is extreme; male plants are openly branched and spreading while female plants are densely clustered with shorter internodes toward the terminus of plants.

Phenology. Anthesis from mid December through early March with the peak in mid January to early February; seed dispersal from mid November to early January with the peak in early December. Field observations indicate there are only one period of anthesis and one period of seed dispersal annually.

Habit. Arceuthobium hondurensis subsp. hawksworthii is parasitic principally on Pinus caribaea Morelet var. hondurensis (Seneclanze) W. H. Barrett & Golfr, but secondarily parasitic on P. tecunumani Eguiluz & J. P. Perry.

MORPHOLOGICAL MEASUREMENTS

Eighteen populations of Arceuthobium hondurensis subsp. hawksworthii were measured from Belize and one from Honduras (Fig. 1). Nine populations of A. hondurensis have been sampled from Honduras and two populations each were sampled from Chiapas and Oaxaca, Mexico. From each population, 20 to 60 infections (10 to 30 males and 10 to 30 females) were collected and the tallest shoot from each infection was used for morphological measurements. Plant measurements were made within 24 hours of collection. The dwarf mistletoe plants were measured using digital calipers, a dissecting microscope with a micrometer, or a Bausch and Lomb 7X magnifying hand lens (Rochester, New York) with a micrometer.

The dwarf mistletoe plant characters measured were those used by Hawksworth and Wiens (1996) for taxonomic classification. The following morphological characters were measured: (1) height, basal diameter, third internode length and width, and color of the tallest male and female shoot from each infection collected; (2) mature fruit length, width, length of distal end, length of stigma, and color; (3) seed length, width, and color; (4) staminate flower diameter; (5) number, color of adaxial surface, length and width of staminate perianth lobes; (6) anther distance from the perianth lobe tip; and (7) anther diameter.

PHYSIOLOGICAL DATA

Observations of flowering and seed dispersal for Arceuthobium hondurensis subsp. hawksworthii were conducted during March, May, and August 1998; November 2000; February and December 2001; and January 2002 in Belize; and in November 2001 and September 2005 in Honduras. Observations were conducted for A. hondurensis in March and August 1998; November 2000; March and December 2001; and in September 2005 in Honduras; in December 2000 in Oaxaca, Mexico; and in March 2000 and September 2005 and 2006 in Chiapas, Mexico.

Observations of host susceptibility were made in the field in Belize, Honduras, and southern Mexico. The principal host of Hawksworth’s dwarf mistletoe in Belize and Honduras is Pinus caribaea var. hondurensis. In Belize it also infects P. tecunumani, but this host is less susceptible to infection than P. caribaea and has been tentatively classified as a secondary host of Hawksworth’s dwarf mistletoe (Mathiasen et al., 2003). Honduran dwarf mistletoe primarily parasitizes P. oocarpa Schroeder ex Schlechtendal in Honduras, but it also severely parasitizes P. tecunumani at two locations in Honduras: in Celaque and Cuscoo National Parks (Mathiasen et al., 2001). In Mexico, its principal host is P. tecunumani. Both dwarf mistletoes cause the stimulation of large witches’ brooms on their hosts.

MOLECULAR DATA

Maximum parsimony analyses of nuclear ribosomal transcribed spacer (ITS) DNA sequences and chloroplast tral region DNA sequences have demonstrated that Arceuthobium hondurensis subsp. hawksworthii and A. hondurensis are very closely related; they are

southern Park Headquarters on trail to Campo Don Thomas. Department Francisco Morazán: —22. 5 km east of Lepaterique on road to Tegucigalpa. —23. 2.5 km from main highway to Tegucigalpa on road to La Estancia. —24. Junction of main highway to Tegucigalpa and road to Tumac, and —25. 22 km southeast of Tegucigalpa on main highway to Zamorano. —26. 2 km south of Valle de Angeles on road to Tegucigalpa. —27. 7.5 km south of Valle de Angeles on road to Tegucigalpa. Department El Paraiso: —28. 22 km southwest of Zamorano on road to San Lucás. MEXICO, Chiapas: —29. 6.6 km west of San Cristobal de las Casas on Mexico Route 190. —30. 11 km west of Oxluc on Route 186, Oaxaca: —31. 32 km east of Ixilán on Route 175. —32. 1.4 km north of Suchitepec on Route 175.
Table 1. Principal morphological and physiological differences between *Arceuthobium hondurensis* subsp. *hawnsworthii* and *A. hondurensis* subsp. *hondurensis*.

<table>
<thead>
<tr>
<th>Characters</th>
<th><em>A. hondurensis</em> subsp. <em>hawnsworthii</em></th>
<th><em>A. hondurensis</em> subsp. <em>hondurensis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean plant height, cm</td>
<td>16.5</td>
<td>18.9</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>13.8</td>
</tr>
<tr>
<td>Mean basal diam., mm</td>
<td>3.8</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>3.7</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Mean length and width of third internode, mm</td>
<td>12 × 2.6</td>
<td>15.6 × 3.8</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>12.1 × 2.8</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td>Mean flower diam., mm</td>
<td>2.8</td>
<td>2.5</td>
</tr>
<tr>
<td>Inside perianth label color</td>
<td>dark red to green</td>
<td>dark red</td>
</tr>
<tr>
<td>Mean fruit length and width, mm</td>
<td>4.6 × 2.9</td>
<td>5.4 × 3.5</td>
</tr>
<tr>
<td>Plant color</td>
<td>green-brown/green/yellow-brown</td>
<td>dark green-brown/black/green</td>
</tr>
<tr>
<td></td>
<td>green/brown</td>
<td>dark green-brown/black</td>
</tr>
<tr>
<td>Host susceptibility¹</td>
<td>unknown</td>
<td>principal host</td>
</tr>
<tr>
<td><em>Pinus oocarpa</em></td>
<td>principal host</td>
<td>unknown</td>
</tr>
<tr>
<td><em>Pinus caribaea</em></td>
<td>secondary host</td>
<td>principal host</td>
</tr>
<tr>
<td><em>Pinus tecumamamii</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anthesis</td>
<td>December–March</td>
<td>August–November</td>
</tr>
<tr>
<td>Seed dispersal</td>
<td>November–January</td>
<td>September–October</td>
</tr>
</tbody>
</table>

¹ Host susceptibility system follows Hawksworth and Wiens (1972, 1996).

only separated by two base changes in their ITS sequences (Nickrent et al., 2004). Uncorrected “p” distances calculated using PAUP (Swofford, 2002) for these taxa were < 0.005 (Nickrent, unpublished data). These taxa are so closely related based on both ITS and trnL region DNA sequences, that Nickrent et al. (2004) considered them to be conspecific. Molecular data have also demonstrated that the southern Mexican populations sampled in this study are representative of Honduran dwarf mistletoe (Mathiasen et al., 2001, 2002a) and not black dwarf mistletoe (*A. nigra* (Hawksworth & Wiens) Hawksworth & Wiens) as reported earlier by Hawksworth and Wiens (1977, 1996).

The principal morphological and physiological differences between *Arceuthobium hondurensis* subsp. *hondurensis* and *A. hondurensis* subsp. *hawnsworthii* are summarized in Table 1. Hawksworth and Wiens (1996: 146) defined subspecies in *Arceuthobium* as “geographically restricted populations delimited by a few relatively small but consistent variations.” Whether or not the distributions of Hawksworth’s dwarf mistletoe and Honduran dwarf mistletoe overlap in Honduras remains unknown, but their currently known distributions do not coincide. Furthermore, their range in elevation does not overlap: Hawksworth’s dwarf mistletoe occurs between 500 and 1000 m in Belize and Honduras, while Honduran dwarf mistletoe occurs between 1200 and 1300 m in Honduras and 2400 to 3000 m in southern Mexico. These dwarf mistletoes have consistent morphological differences between them, have different flowering and seed dispersal periods, and parasitize different principal hosts: *Pinus oocarpa* versus *P. caribaea* (Table 1). However, they have many similar morphological characteristics, have nearly identical ITS and trnL region DNA sequences, and are capable of parasitizing *P. tecumamamii*, all of which clearly demonstrates that these mistletoes are closely related. Hence, the new combination: *A. hondurensis* subsp. *hawnsworthii* is proposed. Differences in plant size, phenology, and host range are the principal characters used by Hawksworth and Wiens (1972, 1996) to separate subspecies of *Arceuthobium*, and these are the suite of characters that distinguish Hawksworth’s dwarf mistletoe from Honduran dwarf mistletoe.

Additional specimens examined. All citations based on *Pinus caribaea* var. *hondurensis*, except as noted, BELIZE, Cayo District: Mountain Pine Ridge, 24.1 km N of Goma Cairn on Coonan Road, 1996, Mathiasen 9602, 96001 (male & female) (ASO); 3.2 km E of Goma Cairn on Baldy Road, 1998, Mathiasen 9801 (male & female) (ASO);
1 km S of Cooma Cairn rd. on Brunton Trail, 1998, Mathiasen 9817 (male & female) (ASC); 0.5 km S of Hidden Valley Falls rd. on Cooma Cairn rd., 1998, Mathiasen 9819 (female) (ASC); jct. of Cooma Cairn rd. and Brunton Trail, 1998, Mathiasen 9820 (male & female), on P. tecunumani, Mathiasen 9821 (male & female) (ASC); upper Brunton Trail, 1998, Mathiasen 9822 (male & female) (ASC); lower Granite Cairn rd., 1998, Mathiasen 9823 (male & female) (ASC); upper Brunton Trail, 1998, Mathiasen 9824 (male & female) (ASC); upper Brunton Trail, 1998, Mathiasen 9825 (female) (ASC); 1.2 km S of rd. to Hidden Valley Inn on Cooma Cairn rd., 1998, Mathiasen 9833 (male & female) (ASC); Tiger Creek Falls overlook, 1998, Mathiasen 9835 (male & female) (ASC); 0.3 km W of Cooma Cairn rd. on Orchard Hill Line, 1998, Mathiasen 98102 (male & female) (ASC), on P. tecunumani, Mathiasen 98103 (male) (ASC); 5 km W of Cooma Cairn rd. on Orchard Hill Line, 1998, Mathiasen 98104 (male & female) (ASC); 0.4 km W of Cooma Cairn rd. on Thompson Line, 1998, Mathiasen 98105 (male & female) (ASC); 2.2 km E of Cooma Cairn rd. on Baldy Beacon rd., 2000, Mathiasen 0044 (male & female) (ASC); 1.5 km S of Cooma Cairn rd. on Brunton Trail, 2001, Mathiasen 0148 (male) (ASC); 1 km E of Cooma Cairn rd. on the rd. to Hidden Valley Falls, 2001, Mathiasen 0141 (male & female) (ASC); 2.5 km S of Cooma Cairn rd. on Brunton Trail, 2001, Mathiasen 0133 (male & female) (ASC), HONDURAS, Department Olancho: 10 km E of Guayaco on rd. to San Esteban, 2001, Mathiasen 0133 (male & female) (ASC).

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