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 1998 (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*.

Arceuthobium hondurense Hawksworth & Wiens subsp. **hawksworthii** (Wiens & C. G. Shaw bis) Mathiasen, comb. nov. Basionym: *Arceuthobium hawksworthii* Wiens & C. G. Shaw bis, J. Idaho Acad. Sci. 30: 25. 1994. TYPE: Belize. Cayo District: Mountain Pine Ridge Region, 2.4 km S of Cooma Cairn Lookout, 940 m, 26 Feb. 1994, *Wiens & Shaw 7768* (holotype, US; isotypes, BRH, K, MO, UC).

Plants 9–34 cm in height (mean ca. 16 cm); basal diam. of dominant plants 2–8 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 2-partite, frequently dark red on adaxial surface of

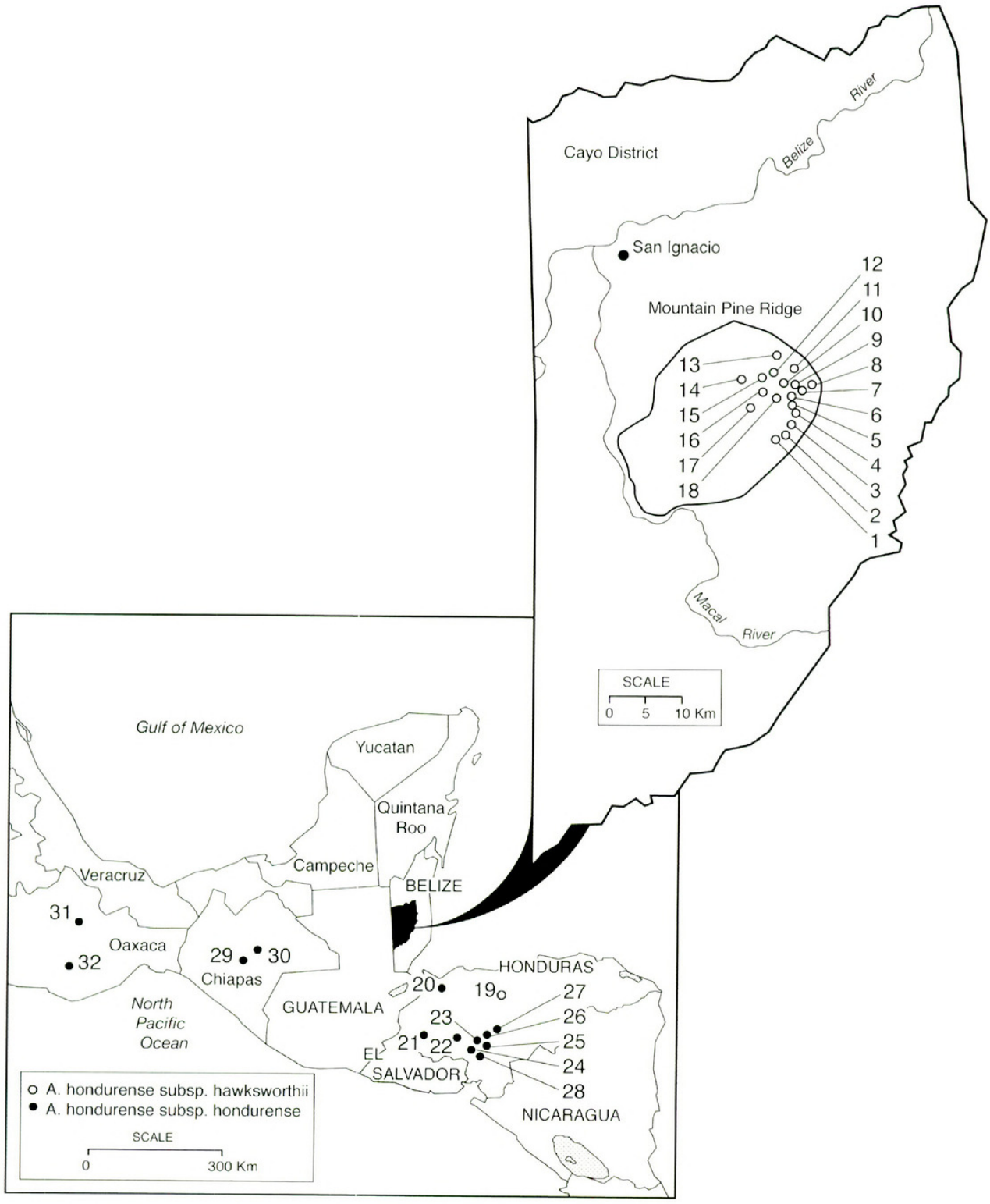

Figure 1. Approximate locations of populations sampled for *Arceuthobium hondurense* subsp. *hawksworthii* (open circles) in Belize and Honduras and for *A. hondurense* subsp. *hondurense* (dark circles) in Honduras and Mexico. BELIZE. Cayo District: Mountain Pine Ridge: —1. Lower Brunton Trail. —2. 2.5 km south of Cooma Cairn road on Brunton Trail. —3. Upper Brunton Trail. —4. 1.5 km south of Cooma Cairn road on Brunton Trail. —5. 1 km south of Cooma Cairn road on Brunton Trail. —6. Junction of Cooma Cairn road and Brunton 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. 2.4 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 Orchid Hill Line. —16. 0.3 km west of Cooma Cairn road on Orchid Hill Line. —17. Lower Granite Cairn road. —18. 2 km east of Augustine road on the Oak Burn Line. HONDURAS. Department Olancho: —19. 10 km east of Gualaco on road to San Esteban. Department Cortes: —20. 4 km north of Buenos Aires on road into Cusuco National Park. Department Lempira: —21. Celaque 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 exserted 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 hondurense* subsp. *hawksworthii* is parasitic principally on *Pinus caribaea* Morelet var. *hondurensis* (Sénéclauze) W. H. Barrett & Golfari, but secondarily parasitic on *P. tecunumanii* Eguiluz & J. P. Perry.

Morphological Measurements

Eighteen populations of *Arceuthobium hondurense* subsp. *hawksworthii* were measured from Belize and one from Honduras (Fig. 1). Nine populations of *A. hondurense* 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 7× 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 hondurense* 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. hondurense* 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. tecunumanii*, 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* Schiede ex Schlechtendal in Honduras, but it also severely parasitizes *P. tecunumanii* at two locations in Honduras: in Celaque and Cusuco National Parks (Mathiasen et al., 2000). In Mexico, its principal host is *P. tecunumanii*. 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 *trnL* region DNA sequences have demonstrated that *Arceuthobium hondurense* subsp. *hawksworthii* and *A. hondurense* are very closely related; they are

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south of Park Headquarters on trail to Campo Don Thomas. Department Francisco Morazan: —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 Tatumbla. —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 Lucas. MEXICO. Chiapas: —29. 6.6 km west of San Cristobal de las Casas on Mexico Route 190. —30. 11 km west of Oxchuc on Route 186. Oaxaca: —31. 32 km east of Ixtlan on Route 175. —32. 1.4 km north of Suchixtepec on Route 175.

Table 1. Principal morphological and physiological differences between *Arceuthobium hondurense* subsp. *hawksworthii* and *A. hondurense* subsp. *hondurense*.

Characters	*A. hondurense* subsp. *hawksworthii*	*A. hondurense* subsp. *hondurense*
Mean plant height, cm		
Male	16.5	18.9
Female	15.8	25.8
Mean basal diam., mm		
Male	3.8	5.8
Female	3.7	5.2
Mean length and width of third internode, mm		
Male	12 × 2.6	15.6 × 3.8
Female	12.1 × 2.8	13.7 × 4.2
Mean flower diam., mm	2.8	2.5
Inside perianth lobe color	dark red to green	dark red
Mean fruit length and width, mm	4.6 × 2.9	5.4 × 3.5
Plant color		
Male	green-brown/green/yellow-brown	dark green-brown/black/green
Female	green/green-brown	dark green-brown/black
Host susceptibility[1]		
Pinus oocarpa	unknown	principal host
Pinus caribaea	principal host	unknown
Pinus tecunumanii	secondary host	principal host
Anthesis	December–March	August–November
Seed dispersal	November–January	September–October

[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. nigrum* (Hawksworth & Wiens) Hawksworth & Wiens) as reported earlier by Hawksworth and Wiens (1977, 1996).

The principal morphological and physiological differences between *Arceuthobium hondurense* subsp. *hondurense* and *A. hondurense* subsp. *hawksworthii* 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 1800 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. tecunumanii*, all of which clearly demonstrates that these mistletoes are closely related. Hence, the new combination: *A. hondurense* subsp. *hawksworthii* 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, 2.4 km N of Cooma Cairn on Cooma Cairn rd., 1998, *Mathiasen 9802, 98101* (male & female) (ASC); 3.2 km E of Cooma Cairn on Baldy Beacon rd., 1998, *Mathiasen 9804* (male & female) (ASC);

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. tecunumanii*, *Mathiasen 9821* (male & female) (ASC); lower Brunton Trail, 1998, *Mathiasen 9822* (male & female) (ASC); lower Granite Cairn rd., 1998, *Mathiasen 9823* (male & female) (ASC); 2 km E of Augustine rd. on the Oak Burn Line, 1998, *Mathiasen 9824* (male & female) (ASC); upper Brunton Trail, 1998, *Mathiasen 9828* (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 Orchid Hill Line, 1998, *Mathiasen 98102* (male & female) (ASC), on *P. tecunumanii*, *Mathiasen 98103* (male) (ASC); 5 km W of Cooma Cairn rd. on Orchid 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 0108* (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 0143* (male & female) (ASC). HONDURAS. **Department Olancho:** 10 km E of Gualaco on rd. to San Esteban, 2001, *Mathiasen 0133* (male & female) (ASC).

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