

TWO NEW SPECIES OF *FREZIERA* (PENTAPHYLACACEAE) FROM COSTA RICA

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Abstract. Two new species of *Freziera* endemic to Costa Rica, *F. tarariae* from the Cordillera de Talamanca and *F. bradleyi* from the Cordillera Central, are described and illustrated. Their distribution, phenology, habitat, and relationship to allied species are discussed.

Resumen. Se describen e ilustran dos nuevas especies de *Freziera* endémicas de Costa Rica: *Freziera tarariae* de la Cordillera de Talamanca y *Freziera bradleyi* de la Cordillera Central. Se discuten sus afinidades, distribución, fenología y hábitat.

Keywords: Cordillera Central, Ericales, Mesoamerica, Talamanca, Theaceae

Freziera Willd. (Pentaphylacaceae) is a genus of ca. 57 trees and shrubs distributed from Mexico to Bolivia and in the Antilles, with the highest species diversity in the Andes mountains of western South America (Mabberley, 2008; Weitzman, 1987; Weitzman et al., 2004). Including the species described here, ten species of *Freziera* are known from Mesoamerica, eight of which occur in Costa Rica. Most Mesoamerican species are restricted to cloud forests, where they are associated with disturbed habitats including roadsides, steep slopes, and mountain peaks.

Species of *Freziera* are characterized by simple, alternate, distichously arranged leaves, usually with serrate

margins. Leaves begin in a rolled terminal bud, and in some cases a vernation scar or line remains on the undersurface of the leaf lamina at maturity. At senescence, the leaves turn red. The flowers are 5-merous with an urceolate corolla with pale petals that are connate or free at their base. The pedicels have a pair of bracteoles at their apex. The fruit is a berry bearing many foveolate seeds.

During the preparation of the treatment of *Freziera* for the Manual de Plantas de Costa Rica, two undescribed species, commonly misidentified as *Symplocos* Jacq. (Symplocaceae), were encountered. These are described herein.

MATERIALS AND METHODS

Herbarium specimens, including types, were examined at A, BM, CAY, CR, F, GH, INB, LPB, LSCR, MO, MOL, NY, PMA, SCZ and USM (herbarium abbreviation follows Thiers, 2014); images from the Global Plants Initiative website (<http://plants.jstor.org/>) were also consulted. Flowers were rehydrated in a solution of ammonia hydroxide for one

day and then placed in water until they were sufficiently soft and pliable to be examined under a dissecting microscope. After study, flowers were dried and returned to the herbarium sheet. Material was examined under a Leica StereoZoom 5 binocular microscope.

TAXONOMY

Freziera bradleyi D. Santam. & Q. Jiménez, *sp. nov.* TYPE: COSTA RICA. Heredia: Barva, Cordillera Volcánica Central, Parque Nacional Braulio Carrillo, Volcán Barva, sendero Laguna Copey, 10°08'20"N, 84°05'40"W, 2500 m, 07 November 1989 (♂ fl), G. Rivera 133 (Holotype: INB [1001570472]; Isotypes: INB, MO [1622285]). Fig. 1.

Freziera bradleyi is most similar to *F. forerorum* A. H. Gentry from which it can be distinguished by the petiolate (versus sessile) leaves with fewer secondary veins and

longer bracts, which together with the bracteoles, bear setae (versus absent).

Shrubs or trees, 3–9 m tall; leaf bearing branches cylindrical to weakly angulate in cross-section, straight, papillose and weakly striate, the bark of the twigs pale brown to reddish-brown, sericeous or glabrescent, golden or pale brown, hairs 0.5–1.5 mm, lenticels elliptic to round, white; terminal bud conduplicate-involute 2.6–5.5 cm long, sericeous, hairs 0.4–1.1 mm. *Leaves* petiolate, petiole

We thank A, BM, CAY, CR, F, GH, INB, LPB, MO, MOL, NY, PMA, SCZ, and USM for access to their collections, Claudia Aragón for her illustrations, Fabricio Carbonell-Torres and his team of the La Amistad-Pacífico (ACLA-P) Conservation Area for their help in making collections of *F. tarariae*, Carlos Godínez and his family for assistance with fieldwork, and Frank González for logistical support in the field. In addition, the senior author would like to thank the Missouri Botanical Garden and an Elizabeth E. Bascom Grant for supporting a visit to MO, Barry Hammel for help in preparing this manuscript, Kanchi Gandhi for nomenclatural advice, David E. Boufford for his helpful comments, and the curators and staff in the Harvard University Herbaria for their support and hospitality. We are also grateful to the Natural History Museum (London) Collections Enhancement Fund for funding a fieldtrip to the Talamanca Mountains.

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FIGURE 1. *Freziera bradleyi* D. Santam. & Q. Jiménez. **A**, branch with flowers and leaves showing venation patterns, with detail of the leaf margin and hairs on the abaxial surface; **B**, bracts with the margin with small setae; **C**, inflorescence. **A** from *G. Varela 155*; **B** and **C** from the holotype. Drawing by Claudia Aragón-Quesada.

0.3–0.8 cm long, abaxially rounded, adaxially caniculate, weakly winged, the wings usually erect or involucrate without setae on their margins, sericeous or glabrescent, hairs golden or pale brown, hairs 0.3–1 mm; colleter 1, in petiole base or absent; *lamina* 8.2–19.5 × 2.5–7.1 cm, elliptic, base cuneate, weakly revolute and symmetrical to markedly asymmetrical and lobed (one side sagittate, the lobe overlapping petiole), margin serrate, with 48–54 teeth per side, each tooth with a black, curved caducous seta, apex long acuminate to cuspidate, coriaceous, adaxial surface strigose-sericeous to glabrescent, hairs <0.1 mm long, abaxial surface sparsely substrigose-sericeous, hairs <0.5 mm long; midrib weakly elevated, crest- or thread-like, strigose-sericeous to pilose or glabrous, papillose its full length on adaxial surface, prominent, rounded in cross section, abaxial surface substrigose-sericeous to pilose, secondary veins 15–18 pairs, sunken or flat on adaxial surface, rounded on abaxial surface, tertiary venation reticulate, prominent, raised. *Inflorescences* fasciculate, bearing 2–5 flowers per axil. *Flowers* pedicellate, pedicel 1.5–6 mm long, erect, terete, strigose, hairs 0.2–0.5 mm; *bracts* ca. 3–5.8 × 1–3 mm, narrowly deltate, margin with small setae, especially below midpoint, apex acuminate and with a black, straight or curved terminal seta, adaxial surface strigose-sericeous or glabrescent, abaxial surface glabrous; *bracteoles* 2, persistent, opposite or subopposite, at apex of pedicel, 4.5–5.2 × 2.7–4 mm, unequal, broadly ovate to deltate, margin with small setae below midpoint, apex acute to mucronate, outer surface strigose-sericeous, hairs 0.2–0.8 mm, inner surface glabrous; *sepals* 5, imbricate; outer sepals 5–6.1 × 4–4.5 mm, abaxially strigose-sericeous, margins with small setae below midpoint; inner sepals obovate or more or less deltate, 4.2–4.9 × 3–3.2 mm, glabrescent or strigose, abaxially pubescent on central portion, margins entire, ciliate, apex acuminate or rounded; *petals* 5, 4.1–7 × 3–3.5 mm, white, free, ovoid to oblong-elliptic, margins entire, apex rounded. *Staminate flowers*: stamens 29 or 30, ± uniseriate, free, unequal, filaments 0.4–1.8 mm long, flat or rounded, anthers 1–1.5 mm long, ovoid-lanceolate, base weakly cordate or truncate, apex apiculate. *Pistillate*

flowers: gynoecium narrowly ellipsoid to conical, ca. 3.8 mm long, glabrous, ovary 4-locular, stigma 4-lobed. *Fruit* ca. 8 × 6 mm, globose to ovoid, walls ca. 0.2 mm thick, green when immature; *seeds* 135–150 per fruit, 0.5–1 mm long, reddish brown, foveolate.

Etymology: It is an honor to dedicate this species to a great friend, botanist, and founder of the herbarium at George Mason University, Dr. Ted Ray Bradley (1940–). Bradley's support of the first author during his formative years at INBio is greatly appreciated and acknowledged. Bradley has also greatly contributed to the botanical community in Costa Rica via several years of volunteer work in the herbarium at INBio.

Distribution and Habitat: Endemic to Costa Rica, where it is found in cloud and oak forests on the Pacific slopes of the Continental Divide of the Volcán Barva sector of Braulio Carrillo National Park, Cordillera Central at 1800–2500 m.

Phenology: Collected with staminate flowers in November, pistillate flowers in August, and fruit from June to August.

Discussion: *Freziera bradleyi* is known from only three collections, but is easily recognized among Costa Rican species by its sessile leaves with weakly asymmetrical laminae (one side ca 0.5 cm broader than the other), very asymmetrical leaf base and long acuminate or cuspidate apex. *Freziera bradleyi* is also unique among Costa Rican *Freziera* for bearing small setae on its bracts, bracteoles and outer sepals. *Freziera bradleyi* is most similar to the Bolivian *F. angulosa* Tul and *F. forerorum* A. H. Gentry from the border between Panama and Colombia. It is distinguished from them by stem, leaf, bract and bracteole morphology, as summarized in Table 1.

Additional specimens examined: COSTA RICA. Heredia: Cantón de Barva. Parque Nacional Braulio Carrillo, Cordillera Volcánica Central, around the Barva research station, Paso Llano, Sacramento y Quebrada Honda, 10°09'00"N, 84°09'00"W, 1800 m, 15 August 1990 (♀ fl, fr), *B. Apú 160* (INB, MO); Parque Nacional Braulio Carrillo, Estación Barva, 10°07'22"N, 84°27'15"W, 2300 m, 26 June 1990 (fr), *G. Varela 155* (CR, INB, MO).

TABLE 1. Comparison of distinguishing characters of *Freziera bradleyi*, *F. angulosa*, and *F. forerorum*.

CHARACTER	<i>F. BRADLEYI</i>	<i>F. ANGULOSA</i>	<i>F. FORERORUM</i>
Leaf-bearing stems	cylindrical to weakly angular in cross-section, sericeous to glabrescent	flattened in cross-section, glabrous or sericeous	strongly angular in cross-section, glabrous
Laminae dimensions	8.2–19.5 × 2.5–7.1 cm	15.5–18 × 6.7–7.4 cm	8–18 × 1.8–5.2 cm*
Secondary venation	15–18 pairs	20–33 pairs	20–30 pairs
Petiole	0.3–0.8 cm long	sessile or 0.5 cm long	sessile
Leaf margins	serrate with 48–54 teeth per side	lightly serrulate, with 60–116 teeth per side	serrulate with 54–95 teeth per side
Leaf apex	long-acuminate to cuspidate	acuminate to apiculate	acuminate
Bract and bracteole margin setae	present	absent	absent
Bracts	3–5.8 mm, margin with small setae	2–3 mm, margin entire	to 1 mm, margin entire

* information from protologue

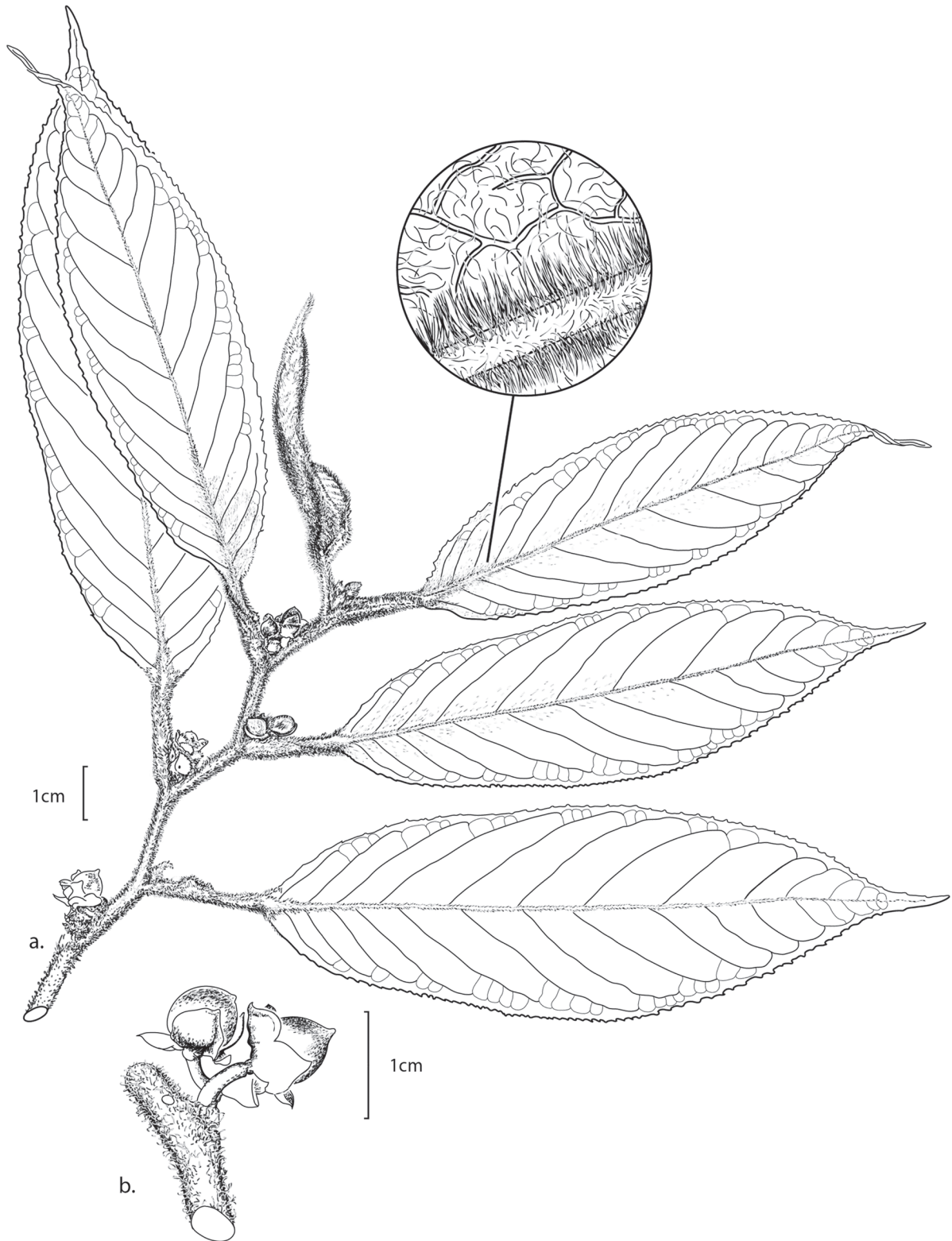


FIGURE 2. *Freziera tarariae* Q. Jiménez, D. Santam. & A.K. Monro. **A**, branch with floral buds and immature fruit, with detail of midrib with hairs on the abaxial surface; **B**, fruit. Drawing by Claudia Aragón-Quesada based on the holotype.

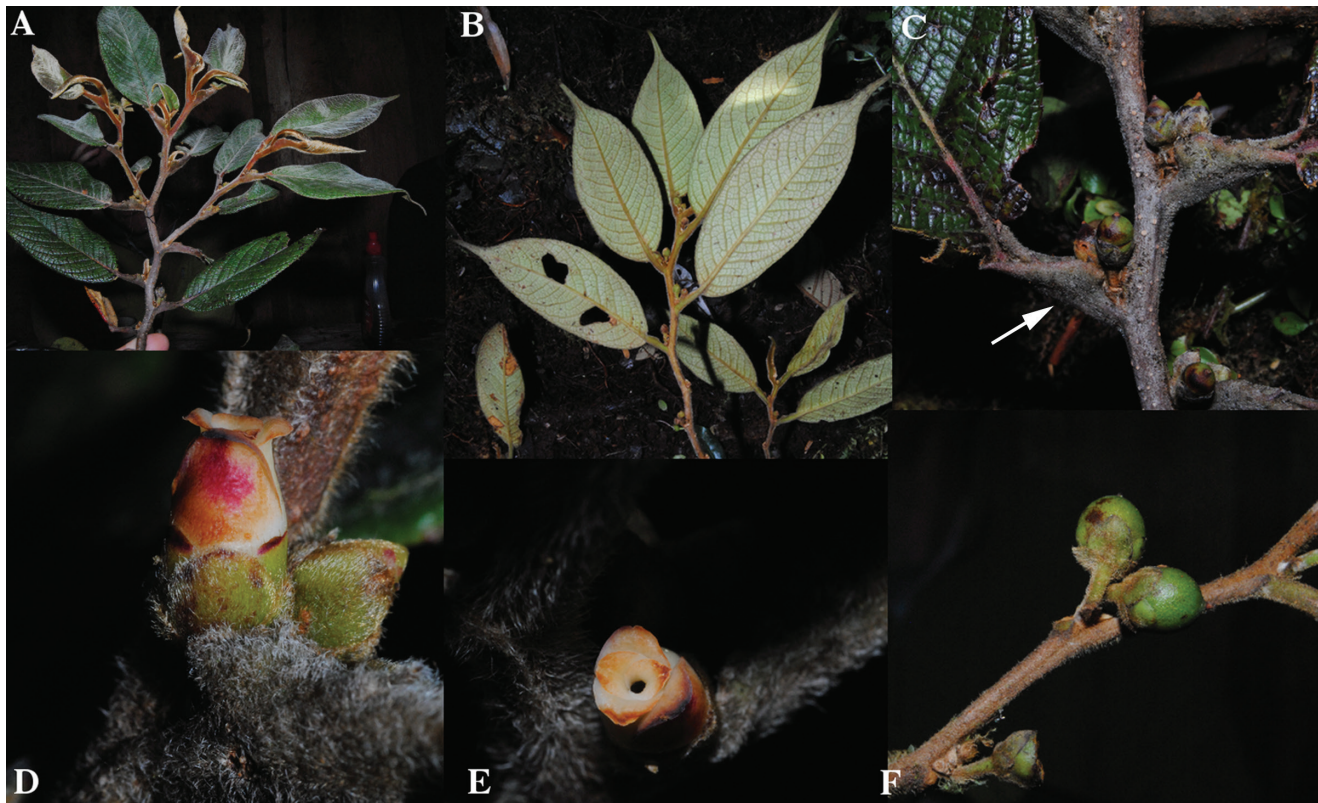


FIGURE 3. *Freziera tarariae* Q. Jiménez, D. Santam. & A.K. Monro. **A**, branch showing adaxial surface of leaves and conduplicate-involute terminal bud; **B**, abaxial leaf surface; **C**, winged petiole; **D**, flower (lateral view); **E**, flower (top view); **F**, immature fruit. **A** and **F** are of the holotype; **B** is of *D. Santamaria et al.* 9162; **C**–**E** are of *D. Santamaria et al.* 9167. Photographs by A.K. Monro.

Freziera tarariae Q. Jiménez, D. Santam. & A.K. Monro, *sp. nov.* TYPE: COSTA RICA. Limón: Talamanca. Bratsi. Cordillera de Talamanca. Parque Internacional La Amistad, Cerros Tararias minor. Secondary peak of Cerros Tararia, 09°08'53"N, 082°57'55"W, 2650 m, 14 February 2012 (♀ fl, fr), *D. Santamaria, A.K. Monro & N.A. Brummitt 9191* (Holotype: CR; Isotypes: BM, GH, INB, K, MO, NY, USJ). Fig. 2–3.

Freziera tarariae most closely resembles *F. reticulata* Bonpl., from which it can be distinguished by its stem which is round (versus square) in cross section, long acuminate (versus acute) leaf apex and gold or copper-gold, shiny (versus ferruginous and matte) pubescence on the abaxial surface of the laminae.

Shrubs or trees, 3–12 m tall; leaf-bearing branches rounded to weakly angulate in cross-section, occasionally zig-zag, papillate; bark of twigs dark reddish brown or almost black, densely ferruginous, golden or pale brown, sometimes whitish gray, tomentose to glabrescent, hairs 0.5–2.5 mm long, lenticels sparse, round to elliptic, white; terminal bud conduplicate-involute, 3.8–6.3 cm long, densely ferruginous-tomentose, hairs >1 mm long. *Leaves* petiolate; petiole 0.5–2 (–2.4) cm long, usually winged, when winged, the wings involucrate or erect, occasionally bearing black setae on their margins, the setae erect or weakly curved, adaxially caniculate, abaxially rounded, densely

ferruginous-tomentose to strigose, golden, pale brown or whitish gray, hairs 0.1–2 mm long; colleter 1, in the petiole base, or absent; *laminae* (8–) 11.7–16.6 (–21) × (2.3–) 3.8–5.6 (–6.5) cm, oblong-elliptic, base cuneate to rounded, not revolute, weakly asymmetrical, margin strongly serrate with ca. 24–43 teeth per side, each tooth bearing a terminal black, curved caducous seta, apex long acuminate, coriaceous, adaxial surface subsericeous-tomentose to glabrescent, hairs <0.1 mm long, abaxial surface tomentose to pilose, occasionally subsericeous, hairs 0.5–3 mm; midrib on abaxial surface elevated and round in cross section, midrib on adaxial surface planar or weakly sulcate, tomentose to pilose, secondary veins 9–18 pairs, rounded in cross-section on abaxial surface, weakly impressed on adaxial surface, tertiary venation reticulate, prominent and raised on abaxial surface. *Inflorescences* fasciculate, bearing 1–5 flowers per axil. *Flowers* pedicellate, pedicel 1–5 (–9) mm long, erect, cylindrical, densely sericeous, hairs 0.5–1 mm; *bracts* ca. 2–3.3 × 1–1.5 mm, triangular to obovate-lanceolate, margins entire, apex acute or acuminate, without setae, outer surface densely sericeous, inner surface glabrous; *bracteoles* 2, persistent, opposite or subopposite, at apex of pedicel, 2.3–4 × 0.8–4 mm, unequal, broadly obovate or triangular, margin entire, apex acute or rounded, abaxial surface densely sericeous or tomentulose, hairs 0.4–0.6 mm, adaxial surface glabrous; *sepals* 5, imbricate, outer sepals 3.1–4 ×

3.9 (–5) mm, densely sericeous or sericeous-tomentulose outside, margins entire; inner sepals 3–4 × 3–4.1 mm, glabrescent or strigose, pubescent only across central external portion, margins entire, ciliate, ovate to broadly ovate, apex acute to rounded; *petals* 5, 6–6.2 × 2.5–3.5 mm, white or yellowish cream lightly flushed red, free or weakly connate toward base, ovate to oblong-elliptic, margins entire, apex acute, apiculate or rounded. *Staminate flowers*: stamens 18–20, ± uniseriate, free or weakly adnate to base of petals, unequal, filaments 1–2 mm long, flat, anthers 1–2.1 mm long, ovoid-lanceolate, base subcordate, apex apiculate. *Pistillate flowers*: gynoecium globose to conical, ca. 10 mm long, glabrous, locules 2–4, stigma 3- or 4-lobulate. *Fruit* 9–10 × 5–7 mm, ovoid or globose, walls ca. 1.1 mm thick, green when immature, deep purple when mature; *seeds* ca. 65–180 per fruit, ca. 0.8–1 mm long, dark reddish brown, foveolate.

Etymology: The specific epithet refers to the type locality, Cerros Tararia, Cordillera de Talamanca, Limón, Costa Rica.

Distribution and Habitat: Endemic to Costa Rica, where it is found in cloud, elfin, and oak forests at elevations of (2200–) 2400–2900 m on the Caribbean slopes of the Talamanca mountains in La Esperanza del Guarco del Parque Nacional Tapantí-Macizo de La Muerte and the Valle del Silencio sectors on the flanks of rocky outcrops which make up the Cerros Tararia. Within the La Amistad International Park *Freziera tarariae* is associated with trees of *Clusia* L., *Myrsine* L., *Podocarpus* L'Hér. ex Pers., and *Drimys granadensis* L.f. *Freziera tarariae* is known from few localities, where it has been observed at the edge of trails in oak forests and in early successional vegetation. It is likely that *Freziera tarariae* also occurs in northern Panama within the Bocas del Toro sectors of the La Amistad International Park, though it has yet to be collected there.

Phenology: Collected with staminate flowers in September, pistillate flowers in February, April and September, and fruit in February.

Discussion: *Freziera tarariae* is distinctive among *Freziera* in leaf and fruit morphology. The lower surface of the leaf lamina has distinct, raised tertiary veins, the leaf apex is long acuminate and the petioles are usually winged, the wings occasionally bearing black, erect or weakly curved setae. Additionally, dense ferruginous-tomentose pubescence on the leaves and young stems gives the abaxial surface of the dried leaves a shiny copper-gold appearance. The fruit wall is relatively thick (ca. 1.1 mm). While these morphologies are usually constant, *G. Davidse* et al. 29054 is unusual in having larger leaf laminae with much longer apices (2.5–3.5 cm long) and margins with more conspicuous teeth.

Freziera tarariae has frequently been misidentified as the widespread *F. candicans* Tul., from which it can be distinguished by the smaller leaf laminae with entire to subentire margins, abaxial copper-gold pubescence, less apparent secondary and tertiary venation, and unwinged petioles, or the wing very short. See Table 2.

Freziera tarariae, however, most closely resembles *F. reticulata* Bonpl. from Colombia and Ecuador, with which it shares leaves that are densely pubescent abaxially, with strongly impressed, reticulate venation and prominently serrate margins. For differences between these species see Table 2.

Additional specimens examined: COSTA RICA. Cartago: El Guarco, Tapantí-Macizo de La Muerte National Park, catchment of Río Reventazón, to the left-hand side at the cross-roads on the path to towers 21 and 22, 09°41'35"N, 83°52'03"W, 2800–2900 m, 01 September 2011 (st), *D. Santamaria* & *L. Lagomarsino* 8983 (GH, INB, MO); El Guarco, Tapantí-Macizo de La Muerte National Park, catchment of Río Reventazón, to the left-hand side at the

TABLE 2. Comparison of distinguishing characters of *Freziera tarariae*, *F. candicans*, and *F. reticulata*.

CHARACTER	<i>F. TARARIAE</i>	<i>F. CANDICANS</i>	<i>F. RETICULATA</i>
Leaf-bearing branch	rounded to weakly angulate	rounded or square	square
Lamina dimensions	(8–) 11.7–16.6 (–21) × (2.3–) 3.8–5.6 (–6.5) cm	7–14.1 × 2.8–4.6 cm	14.2–22.1 × 7.3–9.3 cm
Leaf margin	strongly serrate	entire, sinuous to serrulate	strongly serrate
Leaf apex	long acuminate	acuminate	acute
Petiole	0.5–2 (–2.4) cm; usually winged	0.5–1.8 cm; unwinged or the wing very short	1.6–2.7 cm; winged
Abaxial lamina pubescence	ferruginous, golden or pale brown copper-gold	silver, gold or whitish	ferruginous
Adaxial venation	prominent, raised	flat or slightly raised	prominent, raised
Length of inflorescence bract relative to pedicel	shorter	shorter or equal	equal or longer
Fruit diameter	5–7 mm	5–9 mm	7–11 mm

cross-roads on the path to towers 21 and 22, 09°41'35"N, 83°52'03"W, 2800–2900 m, 01 September 2011 (♂ fl), *D. Santamaria* & *L. Lagomarsino* 8984 (BM, CR, GH, INB, K, MO, NY, US); El Guarco, Tapantí-Macizo de La Muerte National Park, catchment of Río Reventazón, La Esperanza del Guarco, 09°41'35"N, 83°52'03"W, 2800–2900 m, 15 May 2004 (but fl), *R. Kriebel* 4683 (GH, INB); El Guarco, Tapantí-Macizo de La Muerte National Park, catchment of Río Reventazón, La Esperanza del Guarco, 09°41'35"N, 83°52'03"W, 2840 m, 21 April 1999 (fl, fr), *M. Alfaro* 124 (INB); Cantón Cartago, Cuenca del Reventazón, Río Queverí, camino al ICE, 09°42'50"N, 83°50'10"W, 2200 m, 22 April 1998 (fl, fr) *E. Alfaro* 1545 (CR, INB,

MO). **Limón.** Talamanca, Bratsi, Cordillera de Talamanca. La Amistad International Park, secondary peak of Cerros Tararias minor, 09°08'53"N, 082°57'55"W, 2650 m, 14 February 2012 (but fl), *D. Santamaría* et al. 9162 (BM, GH, INB, K, MO, NY); Talamanca, Bratsi, Cordillera de Talamanca. La Amistad International Park, secondary peak of Cerros Tararias minor, 09°08'53"N, 082°57'55"W, 2650 m, 14 February 2012 (♀ fl, fr), *D. Santamaría* et al. 9167 (BM, CR, GH, INB, K, MO, NY); Cordillera de Talamanca, Atlantic slope, unnamed cordillera between the Río Terbi and the Río Siní, 09°11'00"N, 82°58'30"W, 2400–2750 m, 13 September 1984 (but fl), *G. Davidse* et al. 29054 (CR, GH).

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