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Research

# Two new species of *Miconia* s.lat. (Melastomataceae) from Espírito Santo, Brazil

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We here describe two new species endemic to the state of Espírito Santo, Brazil, that belong to different clades within *Miconia* s.lat. *Miconia quartzicola* is presumably part of the *Leandra* s.str. clade, as indicated by its terminal inflorescences and petals with an acute apex. It has been collected only once in the municipality of Vargem Alta in disturbed vegetation on loose quartzitic substrate ('morros de sal'). *Miconia spiritusanctensis* belongs to *Miconia* sect. *Cremanium*, as indicated by its small white and obovate anthers with four apical pores. The latter encompasses populations previously identified as *M. hirtella* that are morphologically, geographically and climatically segregated from typical populations of the species from more dry and inland regions of Brazil. In addition to the descriptions of the new species, we present comments, conservation status and plates for both, as well as climatic modelling analyses on the populations of *M. spiritusanctensis* and *M. hirtella*. We recommend that *Miconia quartzicola* and *M. spiritusanctensis* should both be considered as threatened, 'critically endangered' and 'endangered', respectively, according to the IUCN extinction risk criteria.

Keywords: Atlantic Forest, endangered species, *Leandra*, taxonomy

## Introduction

*Miconia* Ruiz & Pav. has, in its strict sense, around 1100 species distributed in tropical and subtropical areas in the New World, from Mexico and Antilles to Northern Argentina and Uruguay (Goldenberg et al. 2013). Homoplastic characters (Michelangeli et al. 2004, Goldenberg et al. 2008), such as inflorescence position and petal apex, have been used to distinguish *Miconia* s.str. from other traditionally recognized genera in the tribe Miconieae (Triana 1872, Cogniaux 1891). However, an alternative classification of Miconieae would be to recognize a broadly circumscribed *Miconia* s.lat., which would include about 2000 species and all other genera of the tribe (i.e. *Clidemia* D.Don, *Leandra* Raddi and *Ossaea* DC., *Pleiochiton* Naudin ex A.Gray and others; Michelangeli et al. 2016, 2019), all restricted to the Americas. Arguments in the opposite direction, i.e. to reorganize the traditional classification

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and to recognize newly circumscribed smaller genera, can be found in Kriebel (2016) and Reginato (2016).

The taxa described in this paper are only found in the state of Espírito Santo (Brazil), a well-known endemism center of melastomes in eastern Brazil (Goldenberg and Reginato 2006, Bacci et al. 2016a, Meyer et al. 2016). The two species belong to two distinct clades within *Miconia* s.lat. We describe here these new species, *M. quartzicola* and *M. spiritusanctensis*, and present diagnoses and comparisons among them and their relatives, and illustrations of living and dry specimens. We also present a modelling analyses on the populations of *M. spiritusanctensis* and its closest congener, *M. hirtella* Cogn.

## Methods

### Taxonomy, morphological data and species/subspecies concepts

This study was based on literature reviews, such as the revisions of Cogniaux (1886–1888, 1891), Reginato (2016) and the treatment for the 'Flora of Espírito Santo' of *Miconia* s.str. (Bacci et al. 2016b). We analyzed herbarium specimens of *Miconia* from the herbaria HUEFS, MBML, NY, RB, SPF, UPCB and VIES, with some of these collections accessed through CRIA (2019). Our study is based on the morphological-phenetic species concept (Judd 2007), according to which species are recognized as morphologically cohesive taxa separated by consistent morphological gaps.

### Conservation status

The conservation status was suggested following the IUCN recommendations (2012, 2019). The area of occupancy (AOO) and the extent of occurrence (EOO) were estimated through GeoCAT (Bachman et al. 2011).

### Geographical distribution, niche modelling and climatic envelopes

One of the new species described here (*M. spiritusanctensis*) includes some populations from Espírito Santo that were previously identified as *Miconia hirtella*, but have also previously been recognized as slightly different from typical populations of *M. hirtella* from drier areas in the states of Bahia, Goiás, Minas Gerais and also Distrito Federal (Bacci et al. 2016b, Goldenberg et al. 2020). We have been toiling with a decision on the status of these populations for a while, whether they would belong to a new species or a subspecies; these doubts about the distinction between the two population sets motivated the following analyses on niche modelling and climatic envelopes for all populations of *M. hirtella*, and the new species. In order to compare climatic preferences of *M. hirtella* and *M. spiritusanctensis*, we gathered data on their distribution from online data available in the biodiversity portal SpeciesLink (<http://splink.cria.org.br/>). The resulted database was then filtered in several ways. Briefly, we considered only identifications by specialists and, when possible (image available), we checked all the other identifications. All specimens lacking images or reliable identifications were removed. We also deleted all material without detailed location, but for the ones with a detailed description of the locality, despite lacking coordinates, we extracted the coordinates using Google Earth based on the label information. In order to reduce putative occurrence bias on the models, the data set was spatially thinned with the R package spThin ver. 0.1.0 (Aiello-Lammens et al. 2014). Only points with a minimum distance of 5 km apart from each other were used for further analyses.

The potential distribution of the taxa under current climatic conditions were modeled and evaluated by Maxent ver. 3.4.0 (Phillips and Dudík 2008) within the R package dismo (Hijmans et al. 2017). Climatic models were based on the 19 bioclimatic layers of the WordClim data set (Hijmans et al. 2005) under current conditions (30″ special resolution). For each taxon, a mask was created with a buffer of 1000 km of diameter around its known distribution. Additionally, to exclude the immediate area around the known localities from the background, a buffer of 100 km in diameter was generated for each known point and subtracted from the main mask. We extracted the values for all bioclim layers of each coordinate and calculated the mean of each species (Reginato and Michelangeli 2019). The area under the curve (AUC) of the receiver operating characteristic (ROC) was used as evaluation criterion. Climatic tolerances were compared between the species through climatic envelope profiles. The records were intersected to the layers using the R package raster (Hijmans 2020). The extracted climatic values were summarized with a principal component analysis (PCA) using the R package ade4 ver. 1.7.6 (Dray and Dufour 2007), and convex hulls were plotted per group under comparison (Reginato and Michelangeli 2019). Values of elevation of each specimen were extracted through the R package elevatr ver. 0.3.1 (Hollister 2020) and the median was calculated for both taxa.

## Results and discussion

### *Miconia quartzicola* R.Goldenb., Bacci & Bochorny sp. nov. (Fig. 1, 2).

#### *Diagnosis*

A species that differs from *Miconia fontanae* (Reginato & R.Goldenb.) R.Goldenb. (= *Leandra fontanae* Reginato & R.Goldenb.) by the leaves 3.3–6.7 cm long, lanceolate to elliptic-lanceolate or seldom oblong, with a rounded to obtuse base (versus blade 2.3–3.6 cm long, ovate to lanceolate, with a cordate base in *M. fontanae*); longitudinal veins 0.8–3.0 mm suprabasal (versus basal in *M. fontanae*); terminal inflorescences with 2–4(–5) pairs of paraclades and 7–20 flowers (versus lateral or terminal, formed by a simple triad or dichasium, with up to 3 flowers in *M. fontanae*);

and predominantly 5-merous flowers (versus predominantly 4-merous in *M. fontanae*).

**Type:** Brazil: Espírito Santo. Vargem Alta. Roadside*, on a slope on 'morro de sal' (thick-grained, loose quartz), 20°39′28.39″S, 40°00′20.03″. 18 Jan 2008 (fl. and fr.). L. Kollmann, A.P. Fontana, C.N. Fraga & M. Simonelli 10296 (holotype: UPCB 0036948, isotypes: MBML 00044936, NY 03189827, VIES 025996).

* Information on the precise locality, local vegetation and coordinates is not written on the specimen label, but kindly provided by the collector upon request from the authors.

### *Description*

Shrub, ca 1 m tall. Branches rounded or slightly flattened, 3.0–3.5 mm thick, with faint interpetiolar ridges. Branches, petioles, leaf abaxial surfaces (mostly on the nerves) and inflorescence axes sparsely to moderately covered with unbranched trichomes 0.5–1.2 mm long, reddish, erect but not straight, often curved towards the apex, mixed with sparse to moderate stellate, sessile trichomes up to 0.2 mm in diameter, also reddish, the trichomes sparser on the internodes and leaf abaxial surfaces and denser on nodes, petioles and inflorescence axes. Leaves opposite, isophyllous to slightly anisophyllous in each pair; petioles 0.4–1.2 cm long; blades 3.3–6.7 × 1.0–2.2 cm, slightly discolorous when dry (both surfaces brown, but the adaxial darker than the abaxial), lanceolate to elliptic-lanceolate or seldom oblong, acute to acuminate at apex, rounded to obtuse at base, with margin entire, ciliate (the cilia reddish, with a slightly enlarged base, and up to 2.2 mm long and longer than the trichomes elsewhere on the plant), chartaceous; longitudinal veins 3, the secondaries slightly suprabasal, joining the midrib 0.8–3.0 mm above the base, without membranes but usually with a slight concentration of trichomes that may act as domatia; adaxial surface glabrous but for a few trichomes on the very apex, these similar to the marginal cilia; abaxial surface glabrous, but with the main and secondary veins sparsely to moderately covered with the same kind of trichomes as the branches and petioles. Panicles with 7–20 flowers, in a mixed dichasial/monochasial pattern, 2.9–4.6 cm long, terminal and erect or pseudolateral and bending to one side (i.e. an older inflorescence is overtopped by a young branch that develops from a lateral vegetative bud), with trichomes similar to the ones described for the branches; paraclades 2–4(–5), each one with a first dichasial branch, with either a single flower or an additional one or two flowers in subsequent short monochasial sequences. Bracts and bracteoles sessile, 2.0–2.3 mm long (incl. the arista), lanceolate, long-aristate at apex, arista 1.0–1.2 mm long, with margin entire and eciliate or remotely ciliate; primary vein not visible; both surfaces glabrous. Flowers 5-merous, sessile. Hypanthium 2.2–2.4 × 2.0–2.2 mm, campanulate; abaxial surface sparsely to moderately covered with unbranched trichomes 0.5–1.0 mm long, reddish, mixed with moderate to dense stellate trichomes 0.1–0.2 in diameter, reddish; adaxial surface glabrous; torus fringed, with a single set of tiny triangular scales. Calyx persistent; tube ca 0.3 mm long, along with the sepals inner laminae with the abaxial surface covered with the same kind of trichomes as the hypanthium; adaxial surface with only stellate trichomes, these denser towards the margins; sepals perpendicular to the flower axis at anthesis, with an inner laminar portion 0.5–0.7 mm long, triangular, rounded at apex, with margin irregular, ciliate, membranaceous; outer teeth 2.0–2.5 mm long, subulate, acute at apex, usually with a single apical setum ca 0.5 mm long, the surface with the same kind of trichomes as the hypanthium but the stellate trichomes sparser and even absent toward the apex. Petals white, strongly deflexed at anthesis, glabrous, apparently divided into two portions, the first laminar, 1.5–1.8 × ca 0.8, narrowly triangular, truncate at base, acuminate at apex, with margins slightly denticulate; second portion a terete dorsal projection ca 0.5 mm long, acute, that resembles an apical setum but is similar to the sepals 'external teeth'. Stamens 10, isomorphic, glabrous, white; filaments 1.0–1.3 mm long, triangular, i.e. strongly flattened and much broader at base than at apex, its attachment perpendicular to the anther axis (i.e. on the connective, right at the anther's back); anthers 1.3–1.5 mm long, oblong in ventral/dorsal view, dorsally arched in lateral view, truncate at apex, dehiscing through a minute (its diameter ca 1/3 of the anther width), dorsally inclined apical pore; connective not prolonged below the thecae, thickened right above the filament insertion, where there is either a humped, tuberculate projection or a minute, perpendicular to slightly erect or slightly bent appendage ca 0.1 mm long, rounded. Ovary ca 2 mm long, half-inferior, 2–3-locular, the free portion slightly costate, glabrous or with a few very small stellate trichomes on the very apex, right around the base of the style; style ca 3.2 mm long, filiform (but a bit laterally, gradually expanded below the stigma), glabrous; stigma punctiform. Berries ca 3.7 × 3.0 mm, rounded, black when mature; seeds ca 0.9 × 0.5 mm, pyramidal; raphal portion as long as the whole seed; testa apparently rugose (i.e. not plane).

### *Distribution, habitat and conservation status*

*Miconia quartzicola* has been collected only once, in disturbed vegetation covering a coarse, loose quarzitic substrate locally known as 'morros de sal' ('salt hills', in a free translation). The vegetation on this kind of substrate is very peculiar (Brade 1956), with a few narrowly endemic species such as *Pleroma quartzophila* (Brade) P.J.Guim. & Michelang. (Melastomataceae) and *Paepalanthus capixaba* Trovó, Fraga & Sano (Eriocaulaceae, Trovó et al. 2016). All vegetation on the 'morros de sal' is under severe threat due to quartz extraction, which is sold as an ornamental paver material (Dutra et al 2020). These areas have already been mentioned as prioritary for conservation purposes, since none of them are within protected areas (Fraga 2020). One of the authors (RG) has been twice in the topotypic locality, including the precise point where it was collected, as oriented by the type collector, but did not find the species. Since this species has been collected only once, it would be regarded as DD (data deficient), as per IUCN (2019) categories, but the above cited conditions

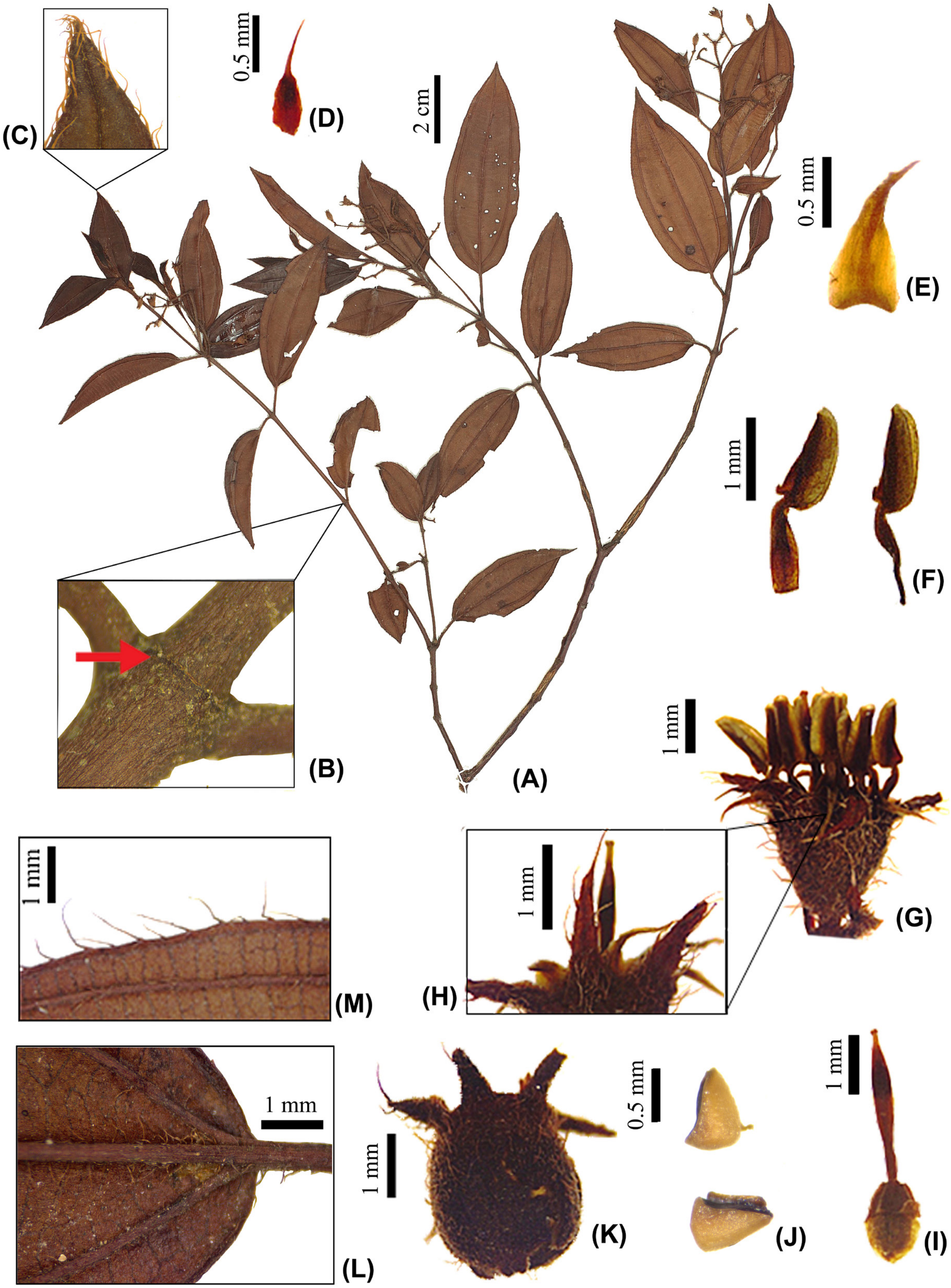

Figure 1. *Miconia quartzicola* R.Goldenb., Bacci & Bochorny sp. nov. (A) fertile branch, (B) nodal region of a branch, (C) leaf, adaxial surface, detail of the apex, (D) bracteole, adaxial view, (E) petal, adaxial view, (F) stamens, lateral view, (G) flower, lateral view, (H) detail of the flower apex, stamens removed, showing sepals and petals, (I) ovary, style and stigma, lateral view, (J) seeds, lateral view, (K) fruit, lateral view, (L) leaf base, abaxial surface, detail of the surface along the midrib and secondary nerves, (M) leaf, abaxial surface, detail of the margin. All from Kollmann 10296 (UPCB).

Figure 2. *Miconia quartzicola* R.Goldenb., Bacci & Bochorny sp. nov. (A) fertile plants, (B) fertile branch with inflorescence, (C) flower, lateral view. Photos by Ludovic Kollmann.

regarding the vegetation on the 'morros de sal' force us to recognize *Miconia quartzicola* as 'critically endangered' [CR B2ab(iii)]. It was collected with flowers and fruits in January.

### *Etymology*

The epithet refers to the coarse quartzitic substrate on which the plant was found. A similar epithet has already been given to *Pleroma quartzophila* (Brade) P.J.Guim. & Michelang., which is endemic to the same region and substrate.

### *Discussion*

*Miconia quartzicola* is likely to be part of the *Leandra* s.str. clade, given some morphological features, such as non-scorpioid terminal inflorescences, acute petals and non-tuberculate seeds lacking an appendage, and its geographical distribution in eastern Brazil (details in Reginato 2016, Reginato and Michelangeli 2016). According to the traditional classification of Melastomataceae, it would belong in the genus *Leandra*, due to the terminal inflorescences and petals with acute apex (Cogniaux 1886–1888, 1891). Among the species in the *Leandra* s.str. clade it is morphologically similar to *Miconia fontanae* (former *Leandra fontanae*; Reginato and Goldenberg 2013). The latter belongs in a small subclade mainly composed by species endemic to the Espírito Santo state (Capixabae clade, following Reginato and Michelangeli 2016). Morphological similarities between *M. quartzicola* and *M. fontanae* include: flower size and shape of petals, anthers and style, the 2-celled ovary (a feature seldom found in *Leandra* s.str. clade; *M. quartzicola* may have also 3-celled ovaries), as well as seed size and shape (pyramidal). Additionally, both species share habitat preferences, and are found on rocky outcrops, although from different geological origins (granitic for *M. fontanae*, quartzitic for *M. quartzicola*). Morphological differences between *M. quartzicola* and *M. fontanae* include the size of leaves, petioles and inflorescences, as well as in number of flowers per inflorescence and flower merosity. *Miconia quartzicola* has leaves 3.3–6.7 cm long, lanceolate to elliptic-lanceolate or seldom oblong, with a rounded to obtuse base (versus blade 2.3–3.6 cm long, ovate to lanceolate, with a cordate base in *M. fontanae*); the longitudinal veins are slightly suprabasal, joining the midrib 0.8–3.0 mm above the base (versus basal in *M. fontanae*). The inflorescences are terminal, with 2–4(–5) pairs of paraclades and 7–20 flowers (versus lateral or terminal, formed by a simple triad or dichasium, with up to 3 flowers in *M. fontanae*); and the flowers are predominantly 5-merous (versus predominantly 4-merous in *M. fontanae*).

The Capixabae subclade presents relatively high morphological disparity among its species, given its small size (Reginato and Michelangeli 2016). The only other species in this subclade that shows some morphological resemblance with *M. quartzicola* is *Miconia diffusa* (Cogn.) R.Goldenb. (former *Leandra diffusa* Cogn.). Nonetheless, several features might be used to separate *M. quartzicola* and *M. diffusa*, as the latter has a different habitat (forest or forest edges) and habit (sometimes scandent), denser indument on branches, inflorescences and hypanthia, linear to lanceolate leaves, and larger inflorescences (up to 12 cm). Among other subclades in *Leandra* s.str. just a few species could be confused with *M. quartzicola*, such as *M. dolichostachya* (Naudin) R.Goldenb. (former *L. glabrata* (Bunb.) Cogn.) and *M. ribesiiflora* (Cham.) R.Goldenb. (former *L. ribesieaeflora* (Cham.) Cogn.). The former differs by having larger petioles (up to 4 cm), leaves (up to 15 cm long) and inflorescences (up to 15 cm) and a very characteristic triangular calyx external tooth. *Miconia ribesiiflora* is endemic to São Paulo state, and differs from *M. quartzicola* by habitat (found in highland vegetation of 'campos de altitude'), the usually ovate leaves (although lanceolate and oblong are also observed), and the larger petals (up to 5 mm long). In addition, both *M. dolichostachya* and *M. ribesiiflora* have 3-celled ovaries.

As described above, the petals of *M. quartzicola* have what appears to be, depending on the interpretation, either an apical appendix or maybe a double apex. It would be similar to the calyx in Miconieae and also other Melastomataceae, in which each sepal is divided into two portions (one ventral and the other dorsal), both portions vascularized and with a distinct shape (Basso-Alves et al. 2017). Although this feature has not been addressed for the petals in the literature, it has also been observed in other species of *Leandra* s.str. (MR, pers. obs.), including some of the species to which *M. quartzicola* has been compared here (*M. fontanae*, *M. diffusa* and *M. ribesiiflora*). This issue deserves a more detailed anatomical and ontogenetic study, in order to explain its development, whether it is homologous with the double calyx, and what is its function.

The decision to place this species in *Miconia* follows Michelangeli et al. (2016, 2019). We think it is important to declare that one of the authors of this study (MR) does not agree with this option, and would prefer to name this species in *Leandra*, according to the traditional generic classification in Miconieae (Cogniaux 1891, Reginato 2016).

## *Miconia spiritusanctensis* R.Goldenb., Bacci & Bochorny, sp. nov. (Fig. 3, 4)

### *Diagnosis*

A species that differs from *Miconia hirtella* Cogn. by longer, 0.5–1.0 mm long, stellate-stipitate trichomes (i.e. slender trichomes shortly branched at the apex) on the branches, and glomerulate inflorescences, i.e. with long lateral (secondary) branches, each one with up to 4 subsequent glomerules, and lacking 3rd order branches. *Miconia hirtella* has shorter, up to 0.5 mm long, unbranched trichomes on the branches, and lax inflorescences, i.e. lacking glomerules and with short lateral branches, these with distinct 3rd or even 4th order branches.

**Type:** Brazil, Espírito Santo. Castelo. Parque Estadual do Forno Grande. Trilha para o Forninho. Floresta Ombrófila Densa Altomontana com inselbergues. Elev. 1100–1500 m a.s.l. 20°30′58″S, 41°05′01″W, 14 Oct 2008 (fl). C.N. Fraga, R.C. Forzza & P.H. Labiak 2225 (holotype: UPCB 0015495; isotypes: CEPEC 00130418, HUEFS 000141265, MBML 00037989, NY 00880272, RB 00549066, SPF 00205830).

### *Description*

Shrub, 2.5–4.0 m tall. Branches rounded to quadrangular or slightly flattened, 3.0–3.5 mm thick. Branches, petioles and adaxial surface of the leaf blade densely covered with unbranched trichomes 0.5–1.0 mm long, these mostly curled (not straight) towards the apex, topped with an eglandular, branched and caducous head, mixed with much shorter, stellate and dendritic trichomes underneath. Leaves opposite, isophyllous in each pair; petioles 0.6–2.2 cm long; blades 5.3–12.0 × 2.2–3.0 cm, slightly discolorous (both surfaces green, but the adaxial darker than the abaxial), lanceolate to narrowly ovate, acute to acuminate at apex, rounded to acute at base, with margin serrate to denticulate, ciliate, membranaceous; longitudinal veins 3+2, the inner pair basal, joining the midrib without membranes (domatia), its adaxial surface sparsely covered with caducous unbranched trichomes, sometimes with sessile glands, and abaxial surface sparsely covered with the same kind of trichomes as on branches and petioles, these usually denser on the main and secondary veins. Panicles regular-glomerulate, 4–10 cm long, terminal; bracteoles sessile, 1.8–2.0 mm long, linear to narrowly lanceolate, acute to cuspidate at apex, with entire margin, not ciliate, with primary vein visible, on both surfaces covered with sessile and stalked glands. Flowers 5-merous, sessile. Hypanthium 1.2–2.0 × 0.8–1.6 mm, campanulate, its outer surface covered with sessile glands or glabrous, near the base sometimes with unbranched trichomes with caducous branched heads. Calyx persistent, glabrous; tube ca 4 mm long; sepals erect at anthesis, with an inner laminar portion 0.5–0.7 mm long, widely triangular, rounded to acute at apex, with margin entire, membranaceous; outer teeth ca 0.2 mm long, triangular, acute at apex. Petals 1.0–1.6 × 0.8–1.3 mm, white, obovate, asymmetrically emarginate at apex, truncate at base, sometimes slightly uncinate, with margin entire, not

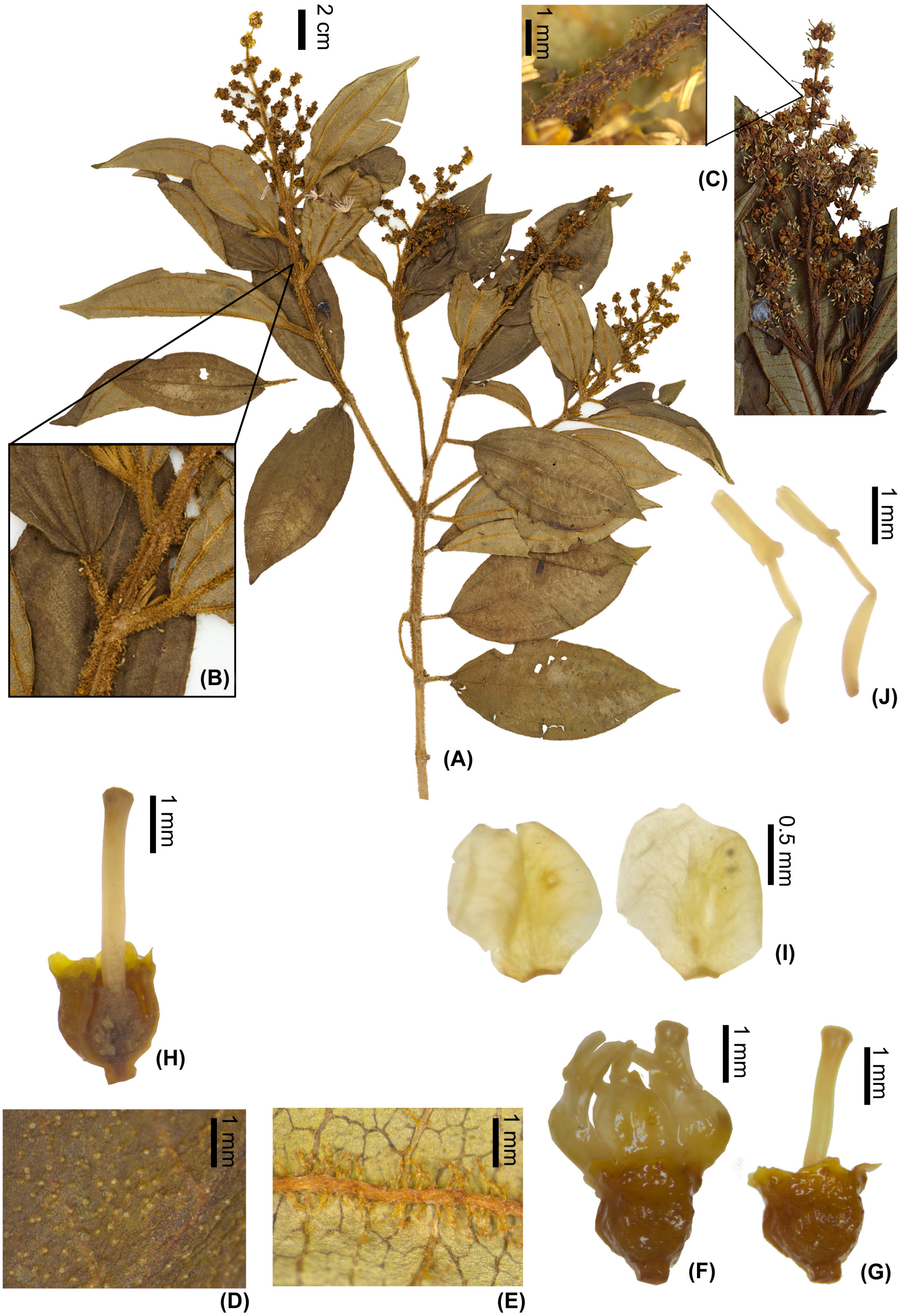

Figure 3. *Miconia spiritusanctensis* R.Goldenb., Bacci & Bochorny, sp. nov. (A) fertile branch, (B) detail of the indument on the young branches, (C) inflorescence, with the trichomes on the inflorescence axis, (D) leaf, detail of the adaxial surface, (E) leaf, detail of the abaxial surface, (F) flower, lateral view, (G) flower, petals and stamens removed, lateral view, (H) flowers, petals and stamens removed, longitudinal section, (I) petals, (J) stamens, antepetalous (left), antesepalous (right). All from Fraga 2225 (A–B from NY, C–J from UPCB).

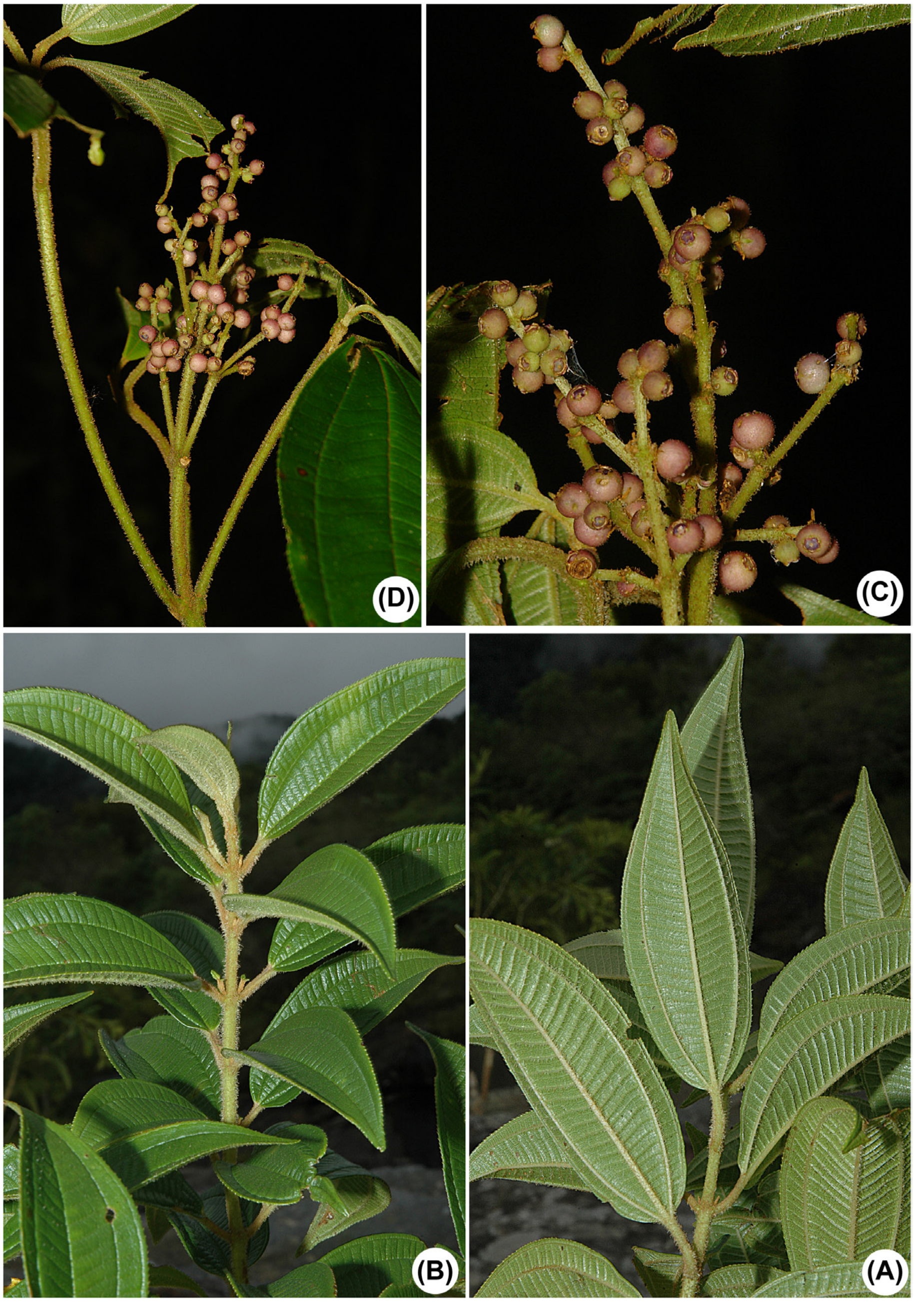

Figure 4. *Miconia spiritusanctensis* R.Goldenb., Bacci & Bochorny, sp. nov. (A) sterile branch with a view of the adaxial surface of the leaves, (B) sterile branch with a view of the abaxial surface of the leaves, (C) fruiting branch, (D) glomerulate inflorescence. Photos (A), (B) Renato Goldenberg, (C), (D) Cláudio Nicoletti de Fraga.

ciliate, glabrous at both surfaces. Stamens 10, isomorphic; filaments 1.7–2.4 mm long, glabrous; anthers 0.6–1.2 mm long, oblong to narrowly obcuneate, truncate at apex, with a protruding septum arising from the anther central axis, right between the 4 apical pores through which the anther dehisces, white; connective prolonged ca 0.5 mm below the thecae, with a dorsal, rounded spur and sometimes minutely ventrally bilobate. Ovary with glabrous apex, 2–4-locular; style 2.5–3.0 mm long, filiform, glabrous. Berry 1.8–2.5 mm in diameter, globose, light pink when immature, blue when mature; seeds 0.5–0.8 mm diam./long, hemispheric to shortly oblong; raphe plane and sometimes projecting ca. 0.1 mm to the sides and then broader than the seed diameter/length, testa shortly papillate.

### *Additional specimens examined (paratypes)*

Brazil, Espírito Santo: Alegre, 19 Oct 2000, W. Forster 781 (ESA, RB). Cachoeiro de Itapemirim, 31 Aug 2008, D.R. Couto 865 (MBML). Castelo, 12 Oct 2000, L. Kollmann 3143 (MBML, RB, UFU, UPCB); 27 Jan 2004, L. Kollmann

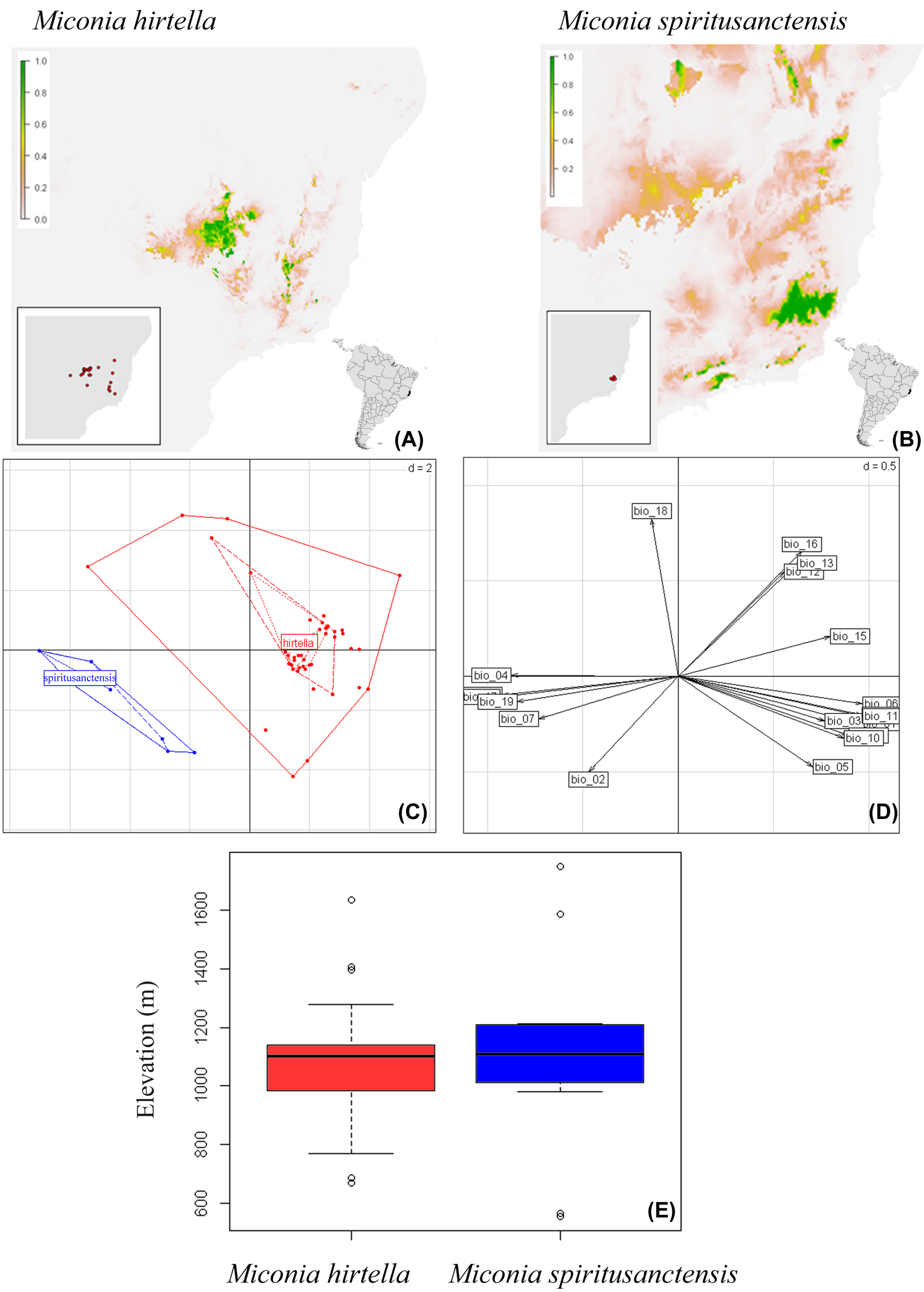

Figure 5. (A–C) Niche models and climatic space of *Miconia hirtella* and *Miconia spiritusanctensis*. (A) niche modelling of *Miconia hirtella* with green areas as the most climatic suitable for occurrence of the taxon; occurrence points on the inferior left corner. (B) niche modelling of *Miconia spiritusanctensis* with green areas as the most climatic suitable for occurrence of the taxon; occurrence points on the inferior left corner. (C) climatic space based on the two first component of the PCA analysis of the 19 bioclim variables. (D) all bioclim variables and their contribution with the ordination recovered on the PCA analysis. (E) elevation values (y axis) for each occurrence point of both taxa (x axis).

6393 (MBML, UPCB); 30 Oct 2004, L. Kollmann 7190 (MBML, UPCB); 2 May 2008, R. Goldenberg 1058 (RB, UPCB); 20 Jan 2009, R. Goldenberg 1271 (CEPEC, MBML-two specimens, RB, UPCB); 8 Apr 2009, J. Meirelles 293 (UPCB); 2 Mar 2013, D.T. Iglesias 128 (VIES); 2 Mar 2013, D.T. Iglesias 129 (VIES). Conceição do Castelo, 18 Oct 1985, G. Hatschbach 49900 (MBM). Ibitirama, 22 Oct 2012, T.B. Flores 1449 (UEC). Iúna, 1 Dec 2013, L.F. Bacci 124 (RB, VIES); 1 Dec 2013, L.F. Bacci 126 (RB, UPCB, VIES). Muniz Freire, 10 Oct 1992, G. Hatschbach 57941 (MBM). Venda Nova do Imigrante, 20 Oct 2000, G. Hatschbach 71469 (MBM).

### *Distribution, habitat and conservation status*

*Miconia spiritusanctensis* is endemic to Espírito Santo, where it occurs in montane to high montane Atlantic Forest. It has been collected with flowers in October and fruits from January to March. It has an AOO of 36 km$^2$ and a EOO of 1773 km$^2$. Most of its known populations occur outside conservation units, in private properties; the only exceptions are specimens collected inside the 'Parque Estadual do Forno Grande' (Meirelles and Goldenberg 2012), in the municipality of Castelo. Therefore, according to the IUCN (2019) criteria, we suggest categorizing *M. spiritusanctensis* as Endangered [EN B1ab(i) + 2ab(ii)].

### *Etymology*

The epithet refers to that these plants were collected in the Brazilian state of Espírito Santo.

### *Discussion*

*Miconia spiritusanctensis* is presumed to belong to the *Miconia* III clade, with only other two species occurring in eastern Brazil (Goldenberg et al. 2008). *Miconia* III is a large clade that includes three traditional sections of *Miconia* (according to the classification by Cogniaux 1891) that are highly diverse in the Andes and Central America: *Miconia* sect. *Amblyarrhena* (Naudin) Triana ex Hook.f., *Miconia* sect. *Chaenopleura* (Rich. ex DC.) Triana ex Hook.f. and *Miconia* sect. *Cremanium* (D.Don) Triana ex Hook.f. The Brazilian species of *Miconia* III have traditionally been placed in *M.* sect. *Cremanium*, due to their short, obovate, white anthers that open through 2–4 broad pores.

The only species of *Miconia* s.lat. in eastern Brazil that share these staminal features are *Miconia hirtella* Cogn., *M. spiritusanctensis* and *M. theaezans* (Bonpl.) Cogn. While *M. theaezans* has glabrous branches, leaves and inflorescences, *M. hirtella* and *M. spiritusanctensis* have a mixed indument, i.e. with two types of trichomes: a basal layer with very short, stellate to dendritic trichomes, and emergent, slenderer trichomes that can be either simple/unbranched or stellate-stipitate. These two types of emergent trichomes are one of the features that distinguish the two species: while *M. hirtella* has them shorter and unbranched, and its inflorescences are dichasial (not glomerulate), *M. spiritusanctensis* has longer emergent trichomes with a few branches at the apex (then the trichomes are stellate-stipitate), and its inflorescences are glomerulate. We understand that these differences may not be sharp enough to define two species (Bacci et al 2016b), but their distribution and climatic niches are quite distinct (see below), which lead us to recognize the two taxa as different species.

## Niche modelling and climatical envelopes

We compared the modeled distributions of *M. hirtella* and *M. spiritusanctensis* under current climatic conditions (Fig. 5). All models presented high AUC values (0.9370 and 0.8927, respectively). Principal component analysis (PCA) of climatic variables of both taxa captured 89.8% of the variation in the first three axes ($PC1 = 0.61$, $PC2 = 0.17$, $PC3 = 0.10$). Most of the variation recovered in PC1 and PC3 was related to temperature variables, the highest loadings being: mean temperature of driest quarter (0.9657) and mean temperature of coldest quarter (0.9670) for the first and temperature annual range (−0.6276) and mean diurnal range (−0.5938). Precipitation values were recovered as most explanatory on the PC2, mainly precipitation of warmest quarter (0.8280) and precipitation of wettest quarter (0.6524). The climatic spaces with the envelopes of both species are presented in Fig. 5C.

The two species are both climatically and geographically isolated (Fig. 5A–B). They have different climatic envelopes that do not overlap. The responses of organisms to climate variation are thought to be important drivers of speciation (Hua and Wiens 2013). For example, under the hypothesis of speciation via niche conservatism, differences in climatic preferences over space could serve as a barrier between allopatric populations (Wiens 2004). Our analyses show that the two species have different climatic niches, with *Miconia hirtella* widely distributed on more inland regions, more adapted to drier and warmer areas, mostly occurring on the Cerrado, and *Miconia spiritusanctensis* restricted to the Atlantic Forest in Espírito Santo state, adapted to moister areas. Both species occur on similar moderately high elevation ranges (mostly between 900 and 1300 m; Fig. 5E), but in different mountains ranges in eastern and central Brazil. Together with the morphological differences described above, climatic and distribution data provided support for the recognition of two distinct taxa.

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## Author contributions

**Renato Goldenberg**: Conceptualization (equal); Data curation (equal); Formal analysis (equal); Investigation (equal); Methodology (equal); Validation (equal); Writing – original draft (equal); Writing – review and editing (equal). **Lucas F. Bacci**: Conceptualization (equal); Data curation (equal); Formal analysis (equal); Investigation (equal); Methodology (equal); Validation (equal); Writing – original draft (equal); Writing – review and editing (equal). **Thuane Bochorny**: Conceptualization (equal); Data curation (equal); Formal analysis (equal); Investigation (equal); Methodology (equal); Validation (equal); Writing – original draft (supporting); Writing – review and editing (supporting). **Marcelo Reginato**: Conceptualization (equal); Data curation (equal); Formal analysis (equal); Investigation (equal); Methodology (equal); Validation (equal); Writing – original draft (supporting); Writing – review and editing (supporting).

### Data availability statement

Data are available from the Dryad Digital Repository: <https://doi.org/10.5061/dryad.v15dv41x2> (Goldenberg et al. 2021).

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