



Short Communications

On the identity of *Justicia* (Acanthaceae) with 3-verticillate leaves in southeastern Brazil, and a lectotypification

Denise Monte Braz^{1,3,5}, Willa Cardoso de Araújo^{1,4} & Luís Adriano Funez²

Abstract

Justicia citrina, *J. minensis*, and *J. trifoliata* are species with 3-verticillate leaves in southeastern Brazil, a characteristic rarely found in the family and genus. In addition, they share other morphological similarities, such as the same habit, a dense terminal inflorescence, and a showy corolla. As a result, they are often misidentified in herbarium collections and in publications. An analysis of nomenclatural types, original descriptions, and other publications revealed distinctions between these species, the need for a lectotypification, and an improper citation of a misapplied name. The species are easily distinguished by their pilosity, inflorescences, color of the corolla, and shape of the anthers. We provide nomenclatural updates, certify the correct application of the name *Justicia trifoliata*, and distinguish the species with an identification key and diagnostic characters that are easy to observe in herbarium collections. Illustrations of types and photographs of plants in the field and other material examined are also included.

Key words: *Justicia citrina*, *Justicia minensis*, *Justicia trifoliata*, nomenclature, taxonomy.

Resumo

Justicia citrina, *J. minensis* e *J. trifoliata* são espécies do sudeste brasileiro que apresentam folhas 3-verticiladas, uma característica pouco encontrada na família e no gênero. Além disso, compartilham outras similaridades morfológicas como o hábito, a inflorescência terminal densa e a corola vistosa. Em função disso, são frequentemente identificadas incorretamente nas coleções de herbários e em publicações. A análise dos tipos nomenclaturais, das descrições originais e de outras obras revelou as distinções entre essas espécies, a necessidade de uma lectotipificação e uma citação indevida de nome mal aplicado. As espécies se distinguem facilmente pela pilosidade, pelas inflorescências, pela cor da corola e pela forma das anteras. Apresentamos as atualizações nomenclaturais, certificamos a correta aplicação do nome *Justicia trifoliata*, e a distinção das espécies através de uma chave de identificação com base em caracteres diagnósticos de fácil observação nas coleções herborizadas. Estão ainda contidos ilustração dos tipos e das plantas em campo e outros materiais examinados.

Palavras-chave: *Justicia citrina*, *Justicia minensis*, *Justicia trifoliata*, nomenclatura, taxonomia.

Justicia is the largest genus in the family Acanthaceae, comprises ca. 1,000 species distributed throughout most of the world, and is especially rich in the Neotropics (Ezcurra 2002;

Kiel *et al.* 2018; Manzitto-Tripp *et al.* 2022). Although current phylogenetic studies support the genus as non-monophyletic, the New World lineage (NW ‘justicioid’ lineage) is strongly

¹ Universidade Federal Rural do Rio de Janeiro, Inst. Ciências Biológicas e da Saúde, Depto. Botânica, Biodiversidade, Herbário RBR, Seropédica, RJ, Brazil.

² Universidade do Vale do Itajaí, Herbário Barbosa Rodrigues, Itajaí, SC, Brazil. ORCID: <<https://orcid.org/0000-0002-0008-1061>>.

³ ORCID: <<https://orcid.org/0000-0001-6104-1971>>.

⁴ ORCID: <<https://orcid.org/0009-0002-8400-3315>>.

⁵ Author for correspondence: dmbraz@ufrj.br

supported as monophyletic provided that five other related genera are included (Kiel *et al.* 2018). Morphologically, NW ‘justicioid’ (*Justicia* and the five smaller genera) can be distinguished from the other genera of the New World by the presence of a rugula on the corolla, the modified anthers (the anther complexity of McDade *et al.* 2000), and the type of pollen grain, but morphological synapomorphies are not known for this strongly supported group based on DNA data (Kiel *et al.* 2017, 2018).

In Brazil, *Justicia* is represented by 157 herbaceous, subshrub, shrub, or less commonly climbing species (Chagas & Costa-Lima 2023). In general, these are recognized by the flowers with a bilabiate corolla, with a short bilobed upper lip and a trilobed lower lip, and an androecium of two stamens with bithecous, modified anthers, and no staminodes. Unlike most of the family and genus, which have decussate leaves, some species of *Justicia* that occur closely and/or in sympatry in southeastern Brazil can have 3-verticillate leaves. In addition to the verticillate leaves, these species share a shrubby habit, dense terminal inflorescence, and flowers with large (more than 3 cm long) and colorful (red or yellow) corollas. This has resulted in misidentifications of these plants in herbaria and, therefore, in treatments of the family.

When studying Acanthaceae in Parque Nacional do Itatiaia (Itatiaia National Park), Rizzini (1957) recognized *Beloperone trifoliata* and *Cyrtanthera citrina* and highlighted the similarity between the two species due to their 3-verticillate leaves. *Cyrtanthera citrina* was renamed *Justicia citrina* Costa-Lima & Chagas (2019: 127), while *B. trifoliata* was the name given by Nees von Esenbeck (1847a: 141) for the species previously described as *Justicia trifoliata* Roem. & Schult. Recently, when studying Acanthaceae in Serra Negra, Braz *et al.* (2022) treated these two species and incorrectly named the species *J. trifoliata* as *J. minensis* Profice. Serra Negra is in the state of Minas Gerais, which borders the state of Rio de Janeiro, in an area in the Atlantic Forest domain. An analysis of the cited specimens, original descriptions, and type material verified that the two species recorded by Braz *et al.* (2022) are the same ones studied by Rizzini (1957).

On the other hand, the species described as *Beloperone lanceolata* Mart. *ex* Nees (1847a) was renamed *Justicia minensis* by Profice

(2010). Among the syntypes mentioned in the description of the basionym, there is material with 3-verticillate leaves. However, this character is not present in all specimens. Nees von Esenbeck (1847a) weakly distinguished *Beloperone lanceolata* (*J. minensis*) and *B. trifoliata* (*J. trifoliata*), highlighting the similarity between both. Profice (2010) properly renamed the species, but a lectotype was not indicated. Diagnostic aspects were not mentioned, just like they were not provided in the publication of the new name *J. citrina* by Costa-Lima & Chagas (2019).

In addition, and as a result, specimens of these three species are misidentified in many herbaria. While conducting studies to update the flora of Parque Nacional do Itatiaia, in the state of Rio de Janeiro, and surrounding areas, we verified the need to correct the identities of these species and for an additional taxonomic treatment.

The investigation was based on the ongoing review of the family Acanthaceae in Parque Nacional do Itatiaia (Rizzini 1957), and the species treated in a nearby area, Serra Negra, in the state of Minas Gerais (Braz *et al.* 2022). A review of literature and specimens of Acanthaceae, mostly at CESJ, R, RB and RBR, as well as online images of specimens at B, BHC, C, F, G, GZU, K, M, NY, OUPR, P, SP, SPF, US, and W (herbarium acronyms according to Thiers, continuously updated), was made. Nomenclatural updates follow the Melbourne Code (Turland *et al.* 2018). The types and other specimens were accessed through virtual herbaria and the plant databases TROPICOS (Missouri Botanical Garden, <<https://www.tropicos.org/home>>), International Plant Names Index (IPNI, <<https://www.ipni.org/>>), JACQ (Universitat Wien, <<https://www.jacq.org/#>>), REFLORA (Instituto de Pesquisas Jardim Botânico do Rio de Janeiro-JBRJ, <<https://floradobrasil.jbrj.gov.br/reflora/>>), GBIF-the Global Biodiversity Information Facility (<<https://www.gbif.org/>>), and JSTOR Global Plants (<<https://plants.jstor.org/>>). The morphological terminology follows Ezcurra (2002) and Wasshausen & Wood (2003). Distribution data for the species, as well as Brazilian phytogeographic domains and vegetation types, were obtained from Flora e Funga do Brasil 2023 (continuously updated). Phenological data and collection sites were obtained from the herbarium specimens.

Taxonomic treatment

Identification key to species of *Justicia* L. with 3-verticillate leaves in southeastern Brazil

1. Corolla yellow, anthers with thecae strongly separated, not superposed, connective enlarged and curved..... 1. *Justicia citrina*
- 1'. Corolla red to bright pink, anthers with thecae approximate, superposed, connective narrow or slightly enlarged at the base, not curved..... 2
2. Stems cylindrical, sometimes slightly angular at the apex, inflorescence a spike, with one pair of bracts at the inflorescence base..... 3. *Justicia trifoliata*
- 2'. Stems markedly furrowed on both sides, inflorescence a thyrses, with pairs of bracts along the inflorescence rachis..... 2. *Justicia minensis*

1. *Justicia citrina* (Wawra) Costa-Lima & E.C.O. Chagas, Phytotaxa 393: 127. 2019. Basionym: *Cyrtanthera citrina* Wawra (1881: 281). Typus: BRAZIL. MINAS GERAIS: Juiz de Fora, an gerodeten Stellen, 1879 (fl.), H Wawra von Fernsee [in Reisen des Prinzen August und Ferdinand von Sachsen-Coburg nach Brasilien] 194 (lectotypus W 1880-0000845 [designated by Costa-Lima & Chagas 2019], image!; isolectotypus W 1880-0000846, image!).

Fig. 1a-c

Justicia citrina was richly illustrated in the publication of its basionym (*Cyrtanthera citrina* Wawra) (Wawra 1881), where the 3-verticillate leaves are shown (Fig. 1a). It is characterized by the dense terminal spike, with linear-lanceolate, lanuginose, green bracts, and flowers with a yellow to greenish-yellow corolla (Braz *et al.* 2022). Furthermore, it has non-appendiculate anthers with thecae separated by an enlarged and slightly curved connective, which Rizzini (1954) called a semilunar connective. This characterized the species of *Cyrtanthera*, the genus in which *J. citrina* was described.

Among the sections delimited by Graham (1988) for *Justicia*, *J. citrina* is in agreement with the section *Cyrtanthera* (Nees) V.A.W. Graham, especially based on the inflorescence composed of spike units with 2 flowers at some nodes and arranged along a main axis, the yellow corolla, up to 6 cm long, the anthers with equal and non-appendaged thecae, and the pubescent fruit. In the phylogenetic study by Kiel *et al.* (2018), it was not possible to verify the monophyly of the section because only one species of this group was sampled. Pollen and seed morphology, which are also important diagnostic features in the delimitation of sections and phylogenetic clades, are not known for the three species treated here.

Specimens examined: MINAS GERAIS: Lima Duarte, Fazenda Serra Negra, trilha em direção à gruta da Bromélia, 9.V.2008, fl., *L Menini Neto & NL Abreu* 577 (CESJ); 20.XI.2009, fl., *AC Mezzonato et al.* 50 (CESJ); Mata da Dona Lúcia, 12.X.2007, fr., *SA Roman et al.* 05 (CESJ). Monte Verde de Cima, estrada para Santa Bárbara do Monte Verde, 15.X.2011, fl., *FRG Salimena & PH Nobre* 2842 (CESJ). Olaria, Sítio do Degredo, 1.XII.2012, fl., *FRG Salimena & PH Nobre* 3557 (CESJ). Rio Preto, Cânion do Funil, 29.IX.2012, fl., *LL Justino et al.* 12 (CESJ); 20.VIII.2004, fl., *CN Matozinhos et al.* 10 (CESJ); Fazenda da Tiririca, Serra da Caveira Danta, 3.XI.2003, fl., *FRG Salimena & PH Nobre* 1132 (CESJ); RPPN Mato Limpo, Mata da Cachoeira, 6.X.2007, fl., *FRG Salimena* 2498 & *PH Nobre* (CESJ); Serra do Funil, 3.X.1987, fl., *FRG Salimena & MC Brügger* 168 (CESJ); trilha para Água Amarela, 29.IX.2012, fl., *GA Souza et al.* 12 (CESJ); trilha para Cachoeira do Marciano, 30.VIII.2008, fl., *CN Matozinhos et al.* 408 (CESJ). RIO DE JANEIRO: Itatiaia, Morro da Capelinha, IX.1935, *C Porto* 2850 (RB 0635702); fl., *C Porto* 2850 (RB 0635698).

Justicia citrina occurs in rain and semideciduous forests and flowers predominantly during the dry season (mainly between August and November). It was recently studied by Braz *et al.* (2022) in Serra Negra, Minas Gerais state, where it was abundantly collected (see specimens examined). Records of occurrence are still based on very old collections from the Itatiaia mountain range, in the state of Rio de Janeiro, and the municipality of Juiz de Fora, in the state of Minas Gerais, where the type material was collected. Studies of herbarium collections, especially of unidentified specimens, and new collections, may reveal new records of the species. As mentioned by Costa-Lima & Chagas (2019), on the SpeciesLink network (<<https://specieslink.net/>>) there are many specimens named *Cyrtanthera citrina*, especially in the OUPR and MOSS herbaria, which are not collections of *Justicia citrina*.



Figure 1 – a. illustration of the basionym of *Justicia citrina* (*Cyrtanthera citrina*) in Wawra (1881) (image available on the internet). b. lectotype of *Justicia citrina* (Herb. W/GBIF image). c. *Justicia citrina* in nature (Photo: L. Menini Neto). d. *J. minensis* – lectotype (here designated) of *Justicia minensis* (GZU image).

2. *Justicia minensis* Profice, Rodriguésia 61(Sup.): S87. 2010. Basionym: *Beloperone lanceolata* Mart. ex Nees, *Fl. bras.* 9: 141. 1847a, non *Justicia lanceolata* (Chapm.) Small. Typus: BRAZIL. MINAS GERAIS, “In umbrosis Serra da Piedade, Prov. Min. Ger., Maio”, C.F.P. von Martius (lectotypus GZU000250464, here designated, image!). Figs. 1d; 2a-b

Justicia minensis was described as *Beloperone lanceolata* Mart. ex Nees in *Flora brasiliensis* (Nees von Esenbeck 1847a: 141) based on two specimens, one collected by Martius in *Serra da Piedade*, and another collected by F. Sellow in *Morro do Pilar*, both from the state of Minas Gerais. Later, Nees von Esenbeck (1847b: 421) indicated two collections of Sellow, which were numbered 27 and 37. In accordance with Art. 53.1 of the International Code of Botanical Nomenclature (Turland *et al.* 2018), Profice (2010) renamed this species *J. minensis* because the epithet “lanceolata” was already used for another species of the genus. Despite the new name, Profice (2010) cited the same syntypes determined by Nees von Esenbeck (1847a; 1847b) and did not designate a lectotype.

Among the syntypes, we choose the material collected by C.F.P. von Martius (GZU000250464) as the lectotype, which is the most complete and has plenty of reproductive structures (Fig. 1d). Although this specimen does not have 3-verticillate leaves, this characteristic can be seen in the isosyntype Sellow (K000529340) (Fig. 2a).

Nees von Esenbeck (1847a) pointed out the strong similarity between *J. minensis* and *J. trifoliata*, which he defined as “a possible luxurious form” of the first, although *J. trifoliata* had been described before. In addition to the habit, the leaves, and the usually terminal and dense inflorescence, these two species also share subulate bracts, a long reddish corolla (more than 3 cm long), and anthers with an appendiculate lower theca. Besides the different pilosity and inflorescence already mentioned by Nees von Esenbeck, *Justicia minensis* has a stem with longitudinal furrows on both sides, leaves that are commonly bright on the adaxial surface, terminal inflorescence in a thyrse, with short and dense basal branches, leafy lanceolate bracts along the inflorescence, at the base of the lateral rachis, sparse pilosity on the bracts, bracteoles and calyx, and pubescent leaves that are tomentose on the veins on the abaxial surface. Differently, *J. trifoliata* has a cylindrical stem, terminal inflorescence in a simple spike, with

only a pair of bracts at the base, and a red to bright pink corolla, in addition to a distinct, dense, hirsute, and white pilosity on the young stem, young leaves, and floral bracts.

Based on the sections delimited by Graham (1988), *Justicia minarum* has similarities with the section *Plagiacanthus* (Nees) V.A.W. Graham, including the composite inflorescence, with congested spike units, subulate bracts, red corolla, 4 cm or more in length, anthers with superposed thecae that are appendiculate at the base, and pubescent capsule. Although some of the species sampled from this section were grouped in the *Dianthera* / *Sarotheca* / *Plagiacanthus* (DSP) clade in the phylogeny by Kiel *et al.* (2018), these were in smaller and distinct clades. Also, other species from the same section were in clades other than DSP.

Specimens examined: MINAS GERAIS: Caeté, Serra da Piedade, V, fl., CFP von Martius Obs. 1218 (M0186140). Conceição do Mato Dentro, F Sellow. 1431 (GZU000262390). Diamantina, Serra do Gavião, 20.XI.1937, fl., M Barreto 9917 (BHCB, HB, US). Santo Antônio do Itambé, subida para o Pico do Itambé, 18.III.1993, fl. and fr., C Kameyama 30 & GL Esteves (SPF, US); near river, South-eastern drainage of Pico de Itambé, about 5 km directly west and north of Santo Antônio Itambé, 9.II.1972, fl., WR Anderson 35716 (UB). Serro, Cruzeiro, Mato Grosso, 11.I.1998, fl., MF Vasconcelos (US 3374836, US02883235). fr., F Sellow (K 0529343); F Sellow (B, image, F 0BN008932); fl., F Sellow (K000529339); F Sellow (K000529340); fl., F Sellow (K000529341); fl., F Sellow (K000529342); fl., F Sellow (K000529343).

Justicia minensis is endemic to Minas Gerais, where it occurs in the central region of that state, in more arid areas and open vegetation, on the limits of the of the Atlantic Forest, Cerrado, and Caatinga phytogeographic domains. It has been collected with flowers in the rainy season (between November and March).

3. *Justicia trifoliata* Roemer & Schultes, *Syst. Veg.*, ed. 15, 1: 166. 1817. Typus: BRAZIL. s.l., s.d., Vandelli 458 (holotypus F s.n., image!; isotypus GZU 25040363, image!).

Beloperone trifoliata (Roemer & Schultes) Nees, *Fl. bras.* 9: 141. 1847a. Fig. 2c-d

In the largest survey of the family in Brazil, *Flora brasiliensis* by C.F.P. von Martius, Nees von Esenbeck (1847a) treated the species *Justicia trifoliata* Roem. & Schult. (1817: 166) under the genus *Beloperone* (1847a: 141). Since *Beloperone* was later synonymized under *Justicia* (Graham



Figure 2 – a. syntype of the basionym of *Justicia minensis* (Herb. K/GBIF image). b. *Justicia minensis* in nature (collection Kameyama 30). c. holotype of *Justicia trifoliata* (F image). d. *Justicia trifoliata* in nature (Photo: P.H. Nobre).

1988), *J. trifoliata* was naturally reinstated. This species was referred to by Chagas & Costa-Lima (2023) as a misapplied name; however, it was properly published. We confirm its circumscription here based on the original description and type material.

Based on an analysis of nomenclatural types, it was found that *Justicia trifoliata* was recently collected and treated in studies conducted by Braz *et al.* (2022), which incorrectly identified it as *Justicia minensis*. This was verified by the typical characteristics of *J. trifoliata*, such as the cylindrical stem, which is rarely slightly angular near the inflorescence, dense terminal spike, hirsute, dense and white pilosity on the stem, petiole, veins of young leaves, floral bracts and calyx, and oldest leaves becoming glabrous, with sparse hairiness restricted to the veins (Fig. 2b-d).

Justicia trifoliata has similarities with the section *Drejerella* (Lindau) V.A.W. Graham (Graham 1988), which is especially based on the spike inflorescence, subulate to lanceolate bracts, 4.5–5.5 cm long, red corolla, and anthers with overlapping, slightly oblique, equal thecae, with an appendage less than 1/5 of its length. In the phylogenetic study with New World species of the genus (Kiel *et al.* 2018), this section was also not supported as monophyletic.

Specimens examined: MINAS GERAIS: Olaria, Serrinha, Sítio do Rinaldo Degredo, poços do Sr. Altair, 22.VIII.2009, fl., *JHC Ribeiro et al. 203* (CESJ); Sítio do Degredo, 1.XII.2012, fl., *FRG Salimena 3552 & PH Nobre* (CESJ). RIO DE JANEIRO: Itatiaia, IX.1934, fl., *AC Brade 14021* (RB); 1918, fl., *C Porto 758* (RB); Parque Nacional do Itatiaia, Itaoca, 15.VIII.1948, fl., *P Occhionni 1117* (RB); encosta nas margens do Rio Campo Belo, abaixo do Lago Azul, 25.VIII.1995, fl., *JMA Braga et al. 2778* (RB); Lote 21, área da parcela, interior da linha 7, 12.VIII.1997, fl., *SJ Silva-Neto et al. 1210* (RB).

Justicia trifoliata occurs in rain and semideciduous forests and has been collected with flowers during the dry season (predominantly in August). Like the other two species, so far *J. trifoliata* has a restricted area of occurrence and few recent records for some locations, and identifying other specimens in herbarium collections and new collections may expand its distribution area and assist in assessing its conservation status.

The specimens collected in the states of Espírito Santo, Mato Grosso, and Rio Grande do Norte, available on the REFLOA and the SpeciesLink virtual herbaria, are not collections of *J. trifoliata*.

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Data availability statement

In accordance with Open Science communication practices, the authors inform that all data are available within the manuscript.

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