



# *Sanjappa*, a new genus in the tribe Ingeae (Leguminosae: Mimosoideae) from India

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## Abstract

*Sanjappa* E.R. Souza & Krishnaraj (Mimosoideae: Ingeae), a new genus is described here to accommodate a species excluded from *Calliandra* Benth. Morphological data were obtained from literature, herbarium specimens (ASSAM, CAL, DD, K, P, TBGT and W) and fresh collections made from Western Ghats of Kerala, India. Nuclear (ETS and ITS) and plastid (*trnL*, *trnL-trnF* and *trnD-trnT*) sequences were obtained from the genera belonging to *Viguieranthus* clade of tribe Ingeae including *Calliandra cynometroides* Bedd., to establish the phylogenetic relationships. Cladistic analyses based on morphological and molecular data show that *C. cynometroides* does not nest with the currently recognised species of *Calliandra*. However, *C. cynometroides* forms a well-supported distinct monophyletic lineage with *Faidherbia* A. Chev. and *Thailentadopsis* Kosterm. that share the same polyad type. Therefore, *C. cynometroides* is excluded from *Calliandra* and is established as a new genus.

**Keywords:** *Calliandra*, *Faidherbia*, *Inga*, Southern Western Ghats, *Thailentadopsis*, *Viguieranthus*

## Introduction

The circumscriptions of many genera of mimosoid legumes were primarily based on the fruit morphological characters (Benthams, 1865; Brenan, 1955, 1963; Barneby & Grimes, 1996). More recently these morphology based genera have been tested using phylogenetic analyses (Barneby & Grimes, 1996, 1997; Luckow *et al.*, 2003; Jobson & Luckow, 2007; Souza *et al.*, 2013a). *Calliandra* is one such example whose morphological diagnostic character, i.e., apically and elastically dehiscent fruits has turned out to be homoplastic in the light of molecular phylogenetic analyses (Souza *et al.*, 2013a).

Benthams (1840) described *Calliandra* to include species of tribe Ingeae from the New World and Asia, that are characterised by oblanceolate fruits with narrow base, thickened margins and open elastically from apex. Later the discovery of many new taxa from continental Africa and Madagascar (Harms, 1921; Thulin *et al.*, 1981) greatly expanded the circumscription of *Calliandra*. However, Hernández (1986) subsequently segregated the

genus *Zapoteca* H.M. Hern. to accommodate species of *Calliandra* ser. *Laetevoirentes* Benth. and two species of ser. *Macrophyllae* Benth. (*C. amazonica* Benth. and *C. aculeata* Spruce ex Benth.) based on its 16-celled acalymmated polyads (i.e., each pollen grain having an individual exine) as opposed to the highly distinctive ellipsoid 8-celled calymmate polyads (i.e., with a common exine for the entire polyad).

Barneby (1998) redefined the limits of *Calliandra* and included only the New World taxa. However, he has not assigned the excluded Old World taxa to any other genus. Subsequently, several other genera were described to accommodate the species from Asia or Africa, which were formerly assigned to *Calliandra*. Villiers (2002) established the genus *Viguieranthus* to include 18 species that are endemic to Madagascar. Lewis & Schrire (2003) resurrected *Thailentadopsis* Kosterm. to include three species of tribe Ingeae, including *Calliandra geminata* (Wight & Arn.) Benth. (= *Thailentadopsis nitida* (Vahl) G.P. Lewis & Schrire) from India. However, none of these taxonomic changes were tested in an explicit phylogenetic framework. The recent phylogenetic

studies with comprehensive sampling of *Calliandra* species and related genera supported the views of Barneby's (1998) that the *Calliandra* species are restricted only to the New World (Souza *et al.*, 2013a). The genus *Guinetia* L. Rico & M. Souza (Rico-Arce *et al.*, 2000) described after Barneby's (1998) revision, was shown to be nested within *Calliandra* (Souza *et al.*, 2013a), in line with its calymmate and ellipsoid polyads and absence of extrafloral nectaries. In contrast, the paleotropical species that have previously been included in *Calliandra* (*C. cynometroides* Bedd. and *C. umbrosa* Benth.) have acalymmate polyads and (usually) possess extrafloral nectaries. They are sister to the American *Calliandra* lineage which includes *C. gilbertii* Thulin & Asfaw and *C. redacta* (J.H. Ross) Thulin & Asfaw, both from continental Africa, and having the symplesiomorphic condition of acalymmate polyads. Both these two species were ascribed to a new genus, *Afrocalliandra* E.R. Souza & L.P. Queiroz (Souza *et al.*, 2013a).

Despite these advance, the taxonomic affinities of two Asian *Calliandra* species, *C. cynometroides* Bedd. and *C. umbrosa* Benth. remain unresolved. Both these species were originally described under *Inga* and subsequently transferred to *Calliandra* by Bentham (1875) because of presence of spinescent stipules and elastically dehiscent fruits from the apex downwards. Although they show similarities with *Thailentadopsis* by having similar foliage and occasionally lignescent stipular spines, Lewis & Schrire (2003) did not include them in *Thailentadopsis* because of the absence of the notable diagnostic characters i.e., sub-moniliform fruits that are not elastically dehiscent from the apex downwards. Here we explore the phylogenetic relationships within the *Viguieranthus* clade based on multilocus analyses to shed light on the position of the enigmatic *C. cynometroides*.

## Materials and Methods

### Taxa sampling and molecular markers

Leaves of *Calliandra cynometroides* were collected from the Western Ghats of Kerala (Kollam and Thiruvananthapuram districts) and stored in silica gel and their voucher specimens were deposited at TBGT. Morphological data were sourced from Paul (1979), Barneby (1998), Lewis & Schrire (2003), Souza (2007) and Souza *et al.* (2013b), and herbarium specimens deposited at ASSAM, CAL, DD, K, P, TBGT and W, as well as from fresh specimens. Data on pollen morphology of *Calliandra* and related genera [*Afrocalliandra*, *Thailentadopsis*, *Viguieranthus*, and *Zapoteca*] were compiled from

published literature (Guinet, 1965; Niezgodna *et al.*, 1983; Guinet & Hernández, 1989; Souza, 2007; Santos & Romão, 2008; Souza *et al.*, 2013b).

DNA sequences of 5.8S subunit and flanking Internal Transcribed Spacers (ITS), ITS1 and ITS2, and part of the External Transcribed Spacer (ETS) from nrDNA, and the *trnL* intron, and *trnL-trnF* and *trnD-trnT* spacers from plastid genome were sourced for phylogenetic analyses. DNA data of *Calliandra cynometroides*, *Faidherbia albida* (the only species of *Faidherbia*), 1 of 3 species of *Thailentadopsis*, and 6 of 17 species of *Viguieranthus* representing all the genera of *Viguieranthus* clade (Souza *et al.*, 2013b) were included for the present analysis. Unfortunately, it was not possible to include *Calliandra umbrosa* [the last remaining member of the genus *Calliandra* not yet re-assigned following Barneby's (1998) revision] since good quality DNA could not be obtained. Data of sequences and vouchers of the sampled taxa of the *Viguieranthus* clade are presented in Appendix 1. Accessions of *Cathormion umbellatum*, *Inga capitata*, *I. laurina*, *Zapoteca filipes* (tribe Ingeae) and *Senegalia bahiensis* (tribe Acacieae) were used as outgroups.

### DNA extraction, amplification and sequencing

Laboratory procedures were performed at Plant Molecular Systematics Laboratory (LAMOL), Feira de Santana State University (UEFS) and Jodrell Laboratory, Royal Botanic Gardens, Kew. Total genomic DNA was extracted from silica gel dried leaves and herbarium material using a modified 2× CTAB protocol (Doyle & Doyle, 1987). The ITS and *trnL-trnF* regions were amplified and sequenced using the protocols described by Souza *et al.* (2013b), and for ETS region by Ariati *et al.* (2006). The *trnD-trnT* regions were amplified in two reactions, using a combination of the primers *trnD* and *trnE*, and *trnY* and *trnT* (Shaw *et al.*, 2005) or by using the internal primers *trnDti* and *trnDtiR* (Pennington, RBG–Edinburgh, unpublished data) in combination with the external primers *trnT* and *trnD*, respectively. Polymerase Chain Reactions (PCR) for the *trnD-trnT* regions were conducted in a total final volume of 15 µL containing: ~5–20 ng of a DNA template, 1× Buffer, 0.5 M/L of betaine, 1.5 mM/L of MgCl<sub>2</sub>, 0.1 mM/L of each dNTP, 0.5 µM/L of each primer, and 0.6 U of Taq DNA polymerase (Yorkshire Bioscience, UK). PCR conditions were: 94°C for 5 min.; 36 cycles of 50s at 94°C, 50s at 54°C, and 1.30 min. at 72°C; followed by a final extension of 5 min. at 72°C. All reactions were carried out in a 9700 Gene Amp Thermocycler (Applied Biosystems, Singapore). PCR products were purified using the QIAquick kit (Qiagen, Hilden, Germany) or by enzymatic treatments with

Exonuclease I and alkaline shrimp phosphatase (kitExoSapIT, GE Healthcare, Buckinghamshire, UK). Sequencing reactions were carried out with the same primers used for amplifications and the Big Dye Terminator kit version 3.1 (Applied Biosystems, Foster City, California, USA). Complementary strands for each region were sequenced using Spectrum edix SCE9624 and ABI3130XL automatic sequencers (Applied Biosystems/Life Technologies Corporation, Carlsbad, California, USA) following the manufacturer's protocols.

### Sequence alignment and phylogenetic analyses

Complementary strands were combined and base-calling verified with the Staden package (Staden *et al.*, 2003). Alignments were performed in PAUP version 4.0b10 visually (Swofford, 2002). Gaps were treated as missing data. The statistical congruence between nuclear and plastid datasets was assessed by the Incongruence Length Test (ILD) (Farris *et al.*, 1994), based on Partition Homogeneity Tests (PHT) implemented in PAUP version 4.0b10 (Swofford, 2002) with 1,000 replicates, simple addition of taxa, tree bisection-reconnection (TBR) branch swapping, and multrees option, saving 10 trees per replicate. As there were no significant incongruences between nuclear and plastid datasets (data not shown), all data were concatenated in a combined data matrix including eight taxa of the *Viguieranthus* clade. Maximum Parsimony (MP) analyses were carried out in PAUP v. 4.0b10 for Windows (Swofford, 2002) using Fitch parsimony (all characters unordered and equally weighted; Fitch, 1971). Search for the most parsimonious trees (MPTs) were carried out using a heuristic search with 1,000 random taxon-additions, and tree bisection-reconnection (TBR) branch swapping, saving 15 trees per replicate. Trees saved in this first round were used as starting trees in a second search employing the same parameters, but saving a maximum of 10,000 trees. Clade support was estimated with non-parametric bootstrapping (BS; Felsenstein, 1985) with 1,000 pseudo-replications, simple taxon addition, and TBR branch swapping, saving 15 trees per pseudoreplicate.

Maximum Likelihood (ML) analyses were carried out using RAxML (Stamatakis, 2006) as implemented on Cyber infrastructure for Phylogenetic Research (Cipres Science Gateway; Miller *et al.*, 2010). We used the GTR + CAT model for all regions, which were treated as separate partitions following program recommendations (Stamatakis, 2006). Clade support was assessed using 1,000 replicates and the rapid bootstrap option. Bayesian analyses were carried out using MrBayes 3.2 (Ronquist *et al.*, 2012) using Cipres Science Gateway. Based on the Akaike information

criterion as implemented in Mr Model test 2.3 (Nylander, 2004), GTR+ $\Gamma$  was the best fit nucleotide substitution model for the *trnDtrnT*, *trnL*, *trnL-F*, and 5.8S regions, and GTR+I+ $\Gamma$  for the ETS, ITS1, and ITS2 regions. These analyses were performed with uniform priors and a random starting tree.

Two simultaneous Monte Carlo Markov Chains (MCMC) were run for  $18 \times 10^6$  generations, sampling one tree every 1000th generation. Convergence of runs was tested by inspecting whether the standard deviations of the split frequencies of the runs were  $<0.01$ , and by using effective sample sizes (ESS)  $>200$ , as calculated with Tracer v.1.5 (Rambaut & Drummond 2007). We used MrBayes v. 3.1.2 (Huelsenbeck & Ronquist, 2001; Ronquist *et al.*, 2012) to summarize trees sampled from post burn-in generations in a majority rule consensus tree that included Posterior Probabilities (PP) as branch support estimates.

## Results

The combined nuclear dataset (ETS and ITS) included 1444 base pairs with 935 variable characters of which 710 (49.2%) were parsimony-informative. The combined plastid dataset (*trnD-trnT* and *trnL-trnF*) contained 3269 base pairs including 1024 variable characters and 488 (31.3%) were parsimony-informative. The concatenated alignment comprised 4700 base pairs after the exclusion of regions of ambiguous alignment. A total of 1921 (41%) of the characters were variable, and 1219 (25.9%) were parsimony-informative.

In the concatenated nuclear and plastid phylogeny *C. cynometroides* is nested with high support in a clade with the Old World genera *Faidherbia* and *Thailetantadopsis* in all analyses (PP = 1.0; BS-ML = 86; BS-MP = 100). This clade is robustly supported as sister to the Malagasy genus *Viguieranthus* and is highly supported as sister to *Thailetantadopsis nitida* only in the Maximum Parsimony Analysis (BS-MP = 0.99; Fig. 1). The majority rule consensus trees of the nuclear and plastid data sets shows conflicting relationships of *C. cynometroides* with *Faidherbia* or *Thailetantadopsis* but none had high support (Fig. 1).

## Discussion

### Relationships within the *Viguieranthus* clade

Broad taxon sampling across tribe Ingeae recovered a highly supported *Viguieranthus* clade (Souza *et al.*, 2013a). This clade includes representatives of *Viguieranthus*, *Thailetantadopsis*, and *Faidherbia*, together with *Calliandra cynometroides* (Fig. 1). This clade is restricted to the Old World and is distributed



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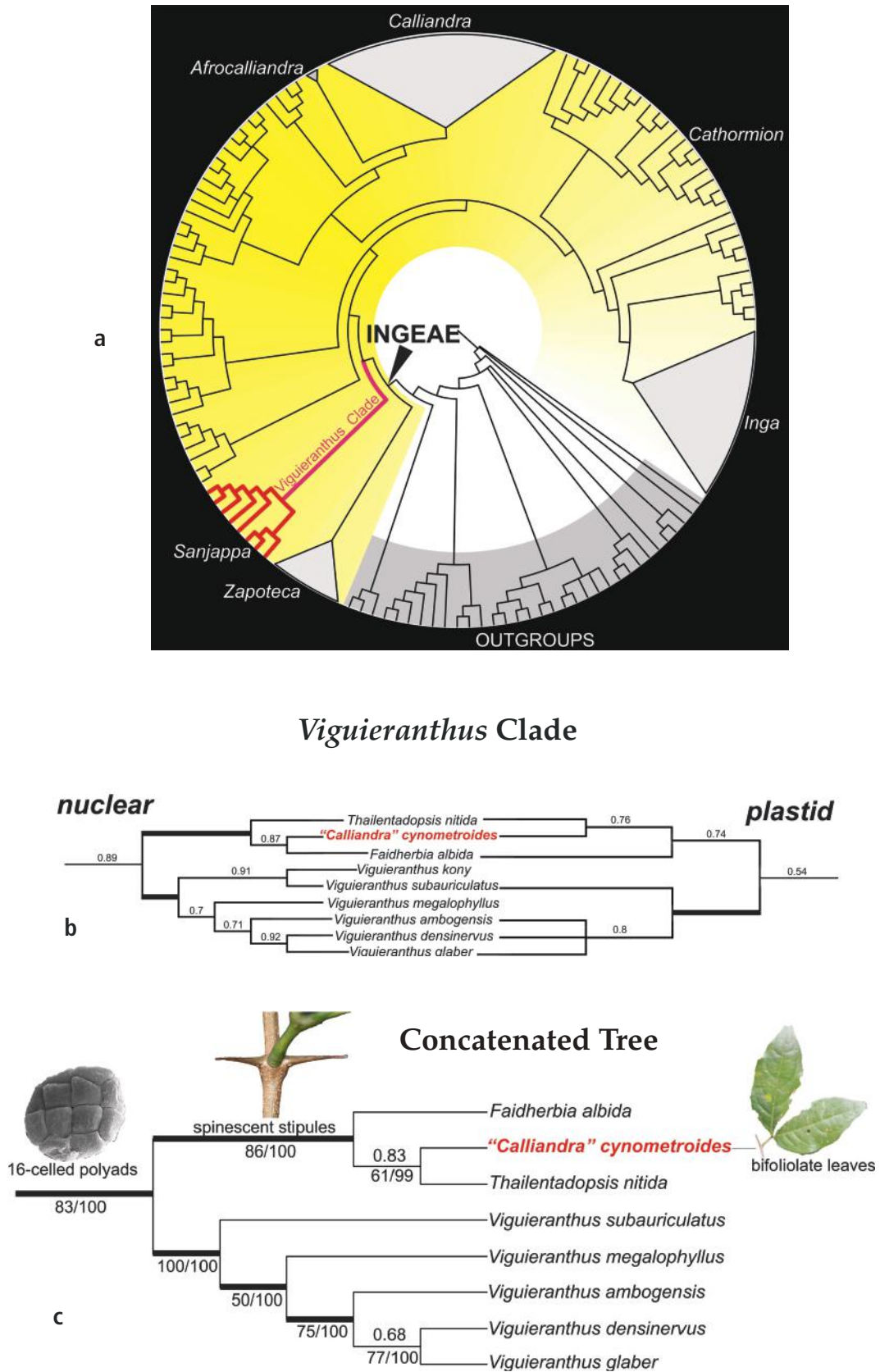


Fig 1. a. Summary tree of the Bayesian analysis of the tribe Ingeae using molecular characters; b. Combined nuclear (ITS and ETS) and combined plastid (*trnD-trnT* and *trnL-trnF*) gene trees for the *Vigueranthus* clade; c. Phylogeny of *Vigueranthus* clade using concatenated dataset (ITS, ETS, *trnD-trnT* and *trnL-trnF*) and optimization of morphological characters.

in continental Africa (*Faidherbia*), Madagascar (*Viguieranthus*) and tropical Asia from India to Vietnam (*C. cynometroides* and *Thailentadopsis*). Apart from *Faidherbia*, the rest of the taxa of *Viguieranthus* clade have unijugate leaves (either bipinnate or bifoliolate) and 16-celled acalymmate polyad pollen grains (Zinderen & Coetzee, 1959; Guinet, 1965; Souza et al., 2013b). Previous analyses with sparser sampling based on nuclear ITS and plastid *trnL-F* sequences also suggested a sister group relationship between *Thailentadopsis* and *Viguieranthus* (Souza et al., 2013b), but with low support.

*Viguieranthus* was recovered as monophyletic with high support (PP = 1.0). This genus was established by Villiers (2002) to include all the species formerly ascribed to *Calliandra* from Madagascar and Asia. Villiers (2002) stated that the genus include 23 species from Madagascar and Asia, but presented valid names for only the 18 Malagasy species of *Viguieranthus*. Additionally, Villiers (2002) stated in his original description of *Viguieranthus* that its species had either spinescent stipules or lacked spines; but all 18 species described by him lacked spines. This suggests that the five remaining species considered by Villiers (2002) as belonging to *Viguieranthus* are the three Asian species currently assigned to *Thailentadopsis*, together with *C. cynometroides* and *C. umbrosa*, all of which have spinescent stipules. Our results thus agree with a narrow definition of *Viguieranthus* restricted to Madagascar characterized by bipinnate unijugate leaves, stipules not modified into spines, flowers clustered in short spikes or heads, and *Calliandra*-like fruits (i.e., oblanceolate and elastically dehiscent from apex).

*Calliandra cynometroides*, *Faidherbia albida*, and *Thailentadopsis nitida* compose a high supported lineage characterized by paired stipular spines. Lewis & Schrire (2003) reinstated *Thailentadopsis* to include three species segregated from *Calliandra* by Barneby (1998) that are native to tropical Asia (Thailand, Sri Lanka and Vietnam). The genus, so circumscribed, embraces species with spinescent stipules, unijugate leaves, and sub-moniliform, indehiscent fruits with leathery valves (G.P. Lewis, RBG–Kew, pers. comm.). Lewis & Schrire (2003) highlighted this distinct fruit morphology of *Thailentadopsis* and hypothesized that the genus could be more closely related to the monospecific genus *Cathormionm* from Southeast Asia and Australia that also has spinescent stipules and sub-moniliform fruits but breaking up into hard, woody, indehiscent, one-seeded units.

The inclusion of *Faidherbia* within *Viguieranthus* clade is unexpected in terms of vegetative, inflorescence, and fruit morphologies. This is

the only genus in the clade with multipinnate leaves, elongate spicate inflorescences, and fleshy, spirally twisted indehiscent fruits (Wickens, 1969; Barnes & Fagg, 2003). Additionally, the stamens in *Faidherbia* are connate only at base and with aggregate pollen of 30-celled polyads. *Faidherbia albida* has previously been viewed as an atypical species of *Acacia* (as *Acacia albida* Del.) or an anomalous genus of the tribe Acacieae (Guinet & Lugardon, 1977; Vassal, 1981; Barnes & Fagg, 2003). However, the first molecular phylogenetic analyses of mimosoid legumes indicated that *Faidherbia* should be included in tribe Ingeae (Luckow et al., 2000, 2003), but its relationships there have remained uncertain. The multilocus analyses performed here place *Faidherbia* in a clade with *Thailentadopsis* and *Calliandra cynometroides*, with shared presence of spinescent stipules as a possible synapomorphy for this clade.

#### Taxonomy of *Calliandra cynometroides*

Bentham (1875) included this species in *Calliandra* because of its elastically and apically dehiscent fruits with thickened margins. However, it is now clear that this fruit type has evolved independently in several other genera of Ingeae (*Calliandra-Afrocalliandra* lineage, *Viguieranthus* and *Zapoteca*) as well as in tribe Mimoseae (*Calliandropsis* H. Hernández & Guinet). This shared fruit type occurring across these independent lineages requires at least four independent gains and should be considered convergent homoplasy rather than evidence of common ancestry.

The inclusion of *C. cynometroides* in *Inga* by Gamble (1919) was based on leaf morphology. *C. cynometroides* possess bifoliolate leaves in which the two leaflets are attached directly at the petiole apex, a feature shared only with species of *Inga* (Pennington, 1997) among mimosoid legumes. Some species of the American genus *Zygia* P. Browne have leaves with only two leaflets but in this case the leaves are bipinnate with only one leaflet per pinna, as could be found in *Z. bifoliola* (Rusby) L. Rico and *Z. confusa* L. Rico (Barneby & Grimes, 1997). *C. cynometroides* is differentiated from *Inga* by the stipules spinescent versus non-spinescent and fruits woody and elastically dehiscent versus fleshy and indehiscent (Pennington, 1997).

The presence of stipular spines in *C. cynometroides* is a character shared with several other genera formerly included in *Calliandra*, including *Afrocalliandra* and *Thailentadopsis*, but only rarely found in *Calliandra* s.s. and always absent in *Inga*. The discoid, radially symmetrical, 16-celled, acalymmate polyads of *C. cynometroides* are similar

to those of *Thailentadopsis*, *Viguieranthus*, and *Zapoteca*, and are quite distinct from the polyads of the *Calliandra-Afrocalliandra* lineage, which have ellipsoid, bisymmetric, 7 or 8-celled polyads (Souza *et al.*, 2013a). *Afrocalliandra*, however, retains the plesiomorphic condition of an acalymmate polyad while *Calliandra* has calymmate polyads (Table 1).

*Calliandra cynometroides* shows strong morphological affinities to the Malagasy genus *Viguieranthus* by sharing 16-celled acalymmate polyads and leaves with extrafloral nectaries. These two genera can readily be differentiated by their leaves (bifoliolate in *C. cynometroides* versus bipinnate in *Viguieranthus*) and the stipular spines (present versus absent). To account for these differences, we propose the new genus *Sanjappa* E.R. Souza & M.V. Krishnaraj based on *C. cynometroides*.

The generic affinities of *C. umbrosa* remain unresolved. This species has stipular spines, leaves bipinnate; pinnae usually unijugate with extrafloral nectaries and three leaflets per pinna (with a pair of sessile leaflets at apex and an odd much smaller below on outside), 16-celled acalymmate polyads and, flowers with calyx and corolla 4-lobed, a stipitate ovary and apically and elastically dehiscent pods. This set of characters does not fall within the circumscription of any other genera of the *Viguieranthus* clade: *Sanjappa* has bifoliolate leaves and 3-lobed calyx and corolla, *Thailentadopsis* has indehiscent, coriaceous pods, and *Faidherbia* has spicate flowers, indehiscent pods and 30-celled polyads. *Calliandra umbrosa* shows morphological similarities to *Viguieranthus*, with which it shares bipinnate leaves with a single pair of pinnae, flowers with calyx and corolla 4-lobed, basifixed anthers, stipitate ovary, and apically and elastically dehiscent pods (Villiers, 2002). However, *Viguieranthus* is known only from Madagascar and in the absence of molecular evidence it is premature to place it under *Viguieranthus*.

## Taxonomy

***Sanjappa*** E.R. Souza & M.V. Krishnaraj, **gen. nov.**

Typus: *Sanjappa cynometroides* (Bedd.) E.R. Souza & Krishnaraj [*Calliandra cynometroides* Bedd.]

*Sanjappa* can be differentiated from other mimosoid legumes (except some *Inga* species) by its bifoliolate leaves. It is similar to *Viguieranthus* in having apically and elastically dehiscent pods with thickened margins and woody valves but differs in having stipular spines and trimerous flowers. It also resembles *Thailentadopsis* in having spinescent stipules, but differs by apically dehiscent fruits.

Tree, c. 6 m high; stems 30–35 cm in girth; young branches brown, lenticellate; bark greyish black. Stipular spines unequal, straight, 3–10 mm long. Leaves bifoliolate; pulvinus 2–4 mm long, glabrous; petioles stout, 1.8–3.5 cm long, glabrous, shortly appendaged below, wrinkled; extrafloral nectary at petiole apex, circular, c. 1 mm, slightly raised; mucro deltoid, c. 1 × 0.7 mm, pointing downward; leaflets asymmetric, oblong-elliptic, elliptic-obovate or obovate, 5–12 × 3–6 cm, entire at margins, acute or slightly acuminate acumen at apex, subcoriaceous, glabrous; lateral secondary veins 5–7 pairs, inter-costae reticulate; petiolules c. 2 mm long, glabrous. Inflorescences umbellate, 7–15-flowered; peduncles 2–4 cm long. Flowers white; flower buds 0.9–1 × c. 0.2 cm, obtuse at apex; flowers at anthesis c. 2 cm long; calyx 3-lobed, c. 2 × 2 mm; corolla 3-lobed, tube 3–4 × 1–2 mm; lobes ovate, 2.25 × 1–2 mm, acute at apex; stamens numerous, joined in a 6–7 mm long tube at base; filaments free, 1.5–1.7 cm long; anthers c. 0.5 × 1 mm; ovary c. 2 mm long, glabrous; ovules 5–7; style c. 2 cm long, glabrous; stigma discoid. Pods falcate, 8–12 × 1.5–2 cm, narrowed at base, thickened at sutures, with a hooked beak at apex, woody, glabrous, pale brown, dehiscent elastically from apex downwards, valves coiled around each other. Seeds 5 or 6 per pod, trapezoid, c. 12.5 × 8 mm, compressed, brown.

**Distribution:** INDIA, Kerala (Kollam and Thiruvananthapuram districts). **Endemic.**

**Etymology:** This genus is named in honour of Dr. M. Sanjappa, former Director of the Botanical Survey of India, for his significant contributions to the taxonomy of legumes of Asia, particularly India.

***Sanjappa cynometroides*** (Bedd.) E.R. Souza & Krishnaraj, **comb. nov.**

*Calliandra cynometroides* Bedd., Fl. Sylv. S. India: t. 317. 1873. **Typus:** South Travancore, 3000–3500 ft, R.H. Beddome 288 (Holotypus, K000791232!). **Figs. 2, 3**

**Flowering & Fruiting:** August–January.

**Habitat:** *Sanjappa cynometroides* inhabits evergreen to semi-evergreen forests of southern India in association with *Gymnacranthera farquhariana* (Wall. ex Hook.f. & Thomson) Warb. (Myristicaceae), *Ochlandra wightii* (Munro) C.E.C. Fisch. (Poaceae), *Syzygium chavaran* (Bourd.) Gamble (Myrtaceae) and *Xanthophyllum arnottianum* Wight (Polygalaceae) and also with other arboreal legume species such as *Archidendron bigeminum* (L.) I.C. Nielsen, *Bauhinia racemosa* Lam., *Cynometra travancorica* Bedd., *Saraca asoca* (Roxb.) De Wilde,

Table 1. Comparative morphological characters of the genera *Afrocalliandra*, *Calliandra*, *Faidherbia*, *Sanjiappa*, *Thailentadopsis* and *Viguieranthus*

Characters	<i>Sanjiappa</i>	<i>Calliandra</i>	<i>Afrocalliandra</i>	<i>Thailentadopsis</i>	<i>Viguieranthus</i>	<i>Faidherbia</i>
Stipular spines	Present	Usually absent	Present	Present	Absent	Present
Leaves	Bifoliolate	Bipinnate	Bipinnate	Bipinnate	Bipinnate	Bipinnate
Extra floral nectarines	Present	Absent	Present	Present	Present	Present
Inflorescence	Axillary	Axillary or terminal	Axillary	Axillary	Axillary or terminal	Axillary
Polyads	16-grained, discoid, symmetric, acalymmate	8-grained, ellipsoid, bisymmetric, calymmate	7-grained, ellipsoid, bisymmetric, acalymmate	16-grained, discoid, symmetric, acalymmate	16-grained, discoid, symmetric, acalymmate	30-grained, discoid, symmetric, acalymmate
Fruits	Oblanceolate, elastically dehiscent from the apex downwards.	Oblanceolate, elastically dehiscent from the apex downwards.	Oblanceolate, elastically dehiscent from the apex downwards.	Sub-moniliform and indehiscent	Oblanceolate, elastically dehiscent from the apex downwards	Falcate, curled in to a circular coil or variously twisted, indehiscent





Fig. 2. *Sanjappa cynometroides* (Bedd.) E.R. Souza & Krishnaraj. a. Habit; b. Extrafloral nectary; c. Spinescent stipules; d. Flower buds; e. Inflorescence; f. Immature fruit; g. Dehiscent fruit; h. Immature seeds (photographs by K.P. Dintu from M.V. Krishnaraj 71501, TBGT).



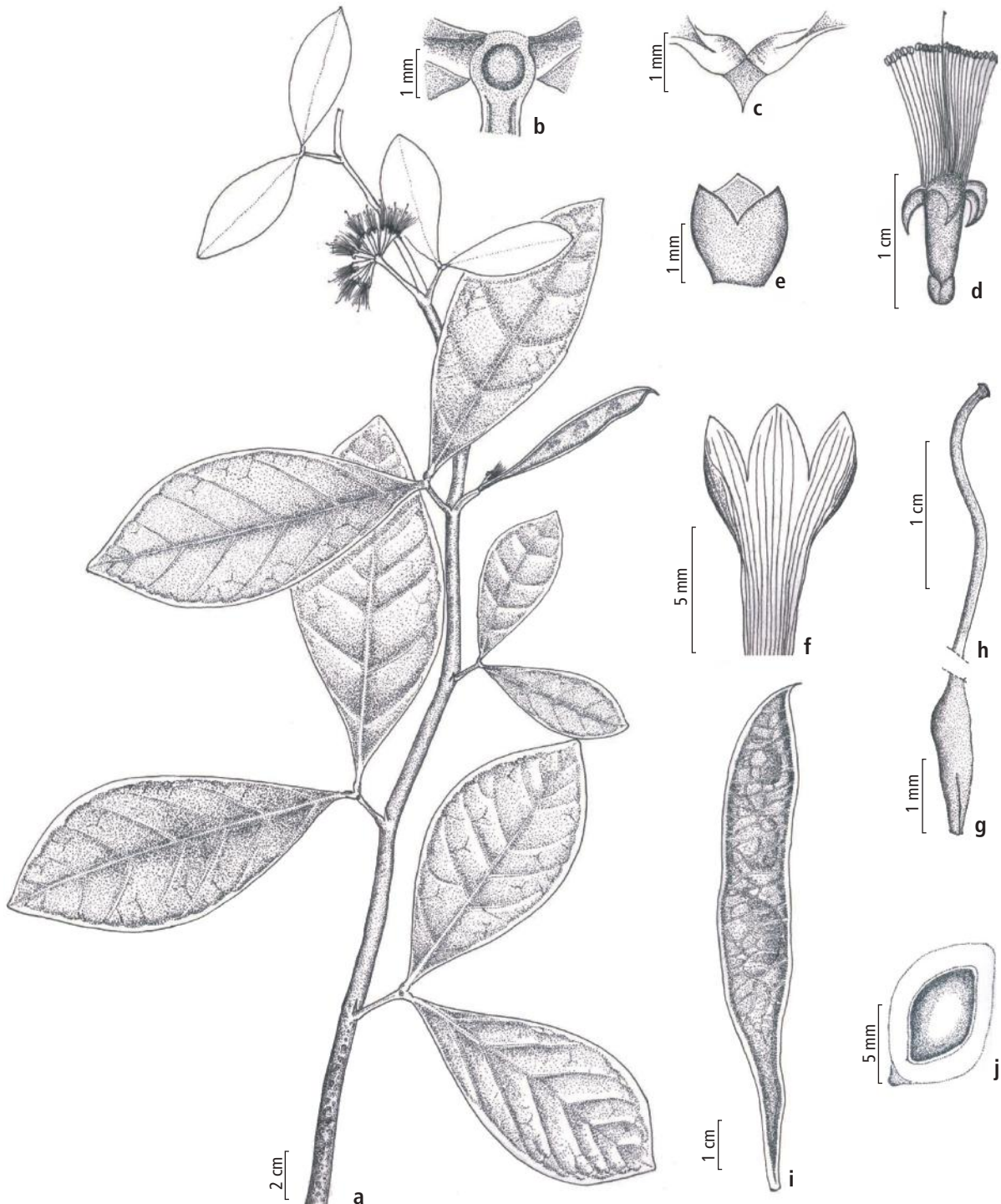


Fig. 3. *Sanjappa cynometroides* (Bedd.) E.R. Souza & Krishnaraj. a. Habit; b. Extrafloral nectary; c. Mucro at the apex of the petiole, between the leaflets; d. Flower; e. Calyx; f. Corolla; g. Ovary; h. Style and Stigma; i. Fruit; j. Seed (a–c & h–j, from M.V. Krishnaraj 71501 (TBGT); d–f from Usha & Deepthy 76255, 75118 (TBGT), drawn by M. V. Krishnaraj).

*Senna montana* (B. Heyne ex Roth) V. Singh, and *Spatholobus parviflorus* (Roxb.) Kuntze.

**Conservation Status:** The total number of individuals at Rosemala, Kallar and Ponnudi are found to be less than 100. Hence, this species is categorized

as Critically Endangered [CR B1b(i,ii) + C1(a)] as per Red List Categories and Criteria Version 3.1 (IUCN, 2012). Nayar (1997) reported it as possibly extinct in the wild. Sasidharan (1998) recollected it from Rosemala, after a lapse of 128 years. The

populations at Rosemala, Ponmudi and Kallar were found growing near streams. Although regular flowering and fruiting has been observed for the past five years, seedling regeneration was very poor. Nevertheless, Sasidharan (1998) reported 80% seed germination in *ex situ* conditions.

*Additional specimens examined:* INDIA. **Kerala:** Kollam district, 17.12.1992, N. Sasidharan 10003 (K); 20.1.1994, N. Sasidharan 10807 (K); Rosemala, 10.1.2012, 08°54'52" N, 077°10'51" E, 300 m, M.V. Krishnaraj 71501 (TBGT); Rosemala, 29.6.2012, Deepthi & Usha 75118, 76255 (TBGT).

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