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Research article

A new Angolan species from the *Triaspis hypericoides* complex (Malpighiaceae) based on macromorphology and palynology

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Triaspis hypericoides currently comprises three accepted subspecies endemic to woodland savannas of southern continental Africa. After an unusual population belonging to this complex was collected in southwestern Angola, we re-evaluated the classification of this group. This study was based on the analysis of type specimens, protologues, field photographs and herbarium sheets of all subspecies within *T. hypericoides*. We reinstate *T. canescens*, *T. hypericoides* and *T. nelsonii* based on differences in leaf, flower and fruit traits. Additionally, the Angolan population is proposed here as a new species of *Triapis* endemic to the dry miombo woodlands of Bicuar National Park, Huíla Province, southwestern Angola. *Triaspis bicuarensis* sp. nov. is easily distinguished from *T. nelsonii* by its alternate (versus opposite) leaves, ovate to widely ovate (versus widely ovate to very widely ovate) leaf laminas, rounded (versus sagittate) leaf base, flat (versus undulate) margins, sparsely white-tomentose (versus glabrous to glabrescent) abaxial leaf surface, petiole 4–8 mm long (versus 2–3 mm long), compound inflorescences in thyrses (versus corymbs) and bracteoles inserted below apex of peduncles (versus in the middle of peduncles). An identification key to all species belonging to this species complex is presented alongside a complete morphological description for the new species, photographic plates and comments on the distribution, ecology, palynology and taxonomy. These results underline the need for continued revisions of the taxonomy of the neglected African genera of Malpighiaceae.

Keywords: Angola, Malpighiales, Malpighioid clade, savanna, tropical Africa

Introduction

Malpighiaceae is a tropical to subtropical family of flowering plants comprising ca 75 genera and 1300 species worldwide (Almeida et al. 2023a). Most of its richness is confined to the globe's Neotropical region (i.e. America), with just 15 genera occurring in the Paleotropics (i.e. Africa, Asia and Oceania; POWO 2023). From this total, 12 genera occur in continental Africa and Madagascar, ten of them (i.e. *Diaspis*

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Nied., *Digoniopterys* Arènes, *Flabellaria* Cav., *Flabellariopsis* R.Wilczek, *Madagasikaria* C.Davis, *Microsteira* Baker, *Philgamia* Baill., *Rhynchophora* Arènes, *Sphedamnocarpus* Planch. ex Benth. and Hook.f. and *Triaspis* Burch.) being endemic to this region (Anderson et al. 2006, POWO 2023). The conspicuous floral conservatism of Neotropical Malpighiaceae (i.e. zygomorphic flowers with glandular sepals, connective oil glands and pantocolporate pollen grains) was lost in these paleotropical genera due to a shift in their pollination system as an evolutionary adaptation to the absence of oil-collecting bees outside the Neotropics (Cameron et al. 2001, Davis et al. 2014, Almeida et al. 2023a). Consequently, paleotropical genera frequently show actinomorphic flowers with eglandular sepals and pantoporate pollen grains (Cameron et al. 2001, Davis et al. 2014).

Triaspis is the third largest genus of African Malpighiaceae, comprising 15 species of lianas or shrubs occurring in dry forests, savannas and rainforests (POWO 2023). The genus was described by Burchell (1824; *Triaspis hypericoides* Burch.) based on specimens collected in South Africa and named after its three shielded samaras (i.e. winged mericarps). At the time, this author considered *Triaspis* to be morphologically similar to the Neotropical genus *Hiraea* Jacq. due to its mericarps bearing an orbicular lateral wing (Burchell 1824). Since then, several species have been published by different authors, such as Jussieu [1838, 1840; *Triaspis odorata* (Willd.) A.Juss., *T. mozambica* A.Juss.], Oliver [1868; *T. lateriflora* Oliv., *T. macropteron* Welw. ex Oliv. and *T. stipulata* Oliv.], Engler (1905; *T. glaucophylla* Engl. and *T. niedenzuiana* Engl.), De Wildeman (1915; *T. emarginata* De Wild. and *T. sapinii* De Wild.), Ernst (1935; *T. schliebenii* Ernst), Exell and Mendonça (1939; *T. mooreana* Exell and Mendonça) and Launert (1961; *T. dumeticola* Launert, *T. suffulta* Launert and *T. letestuana* Launert). Niedenzu (1928) made some initial attempts to monograph *Triaspis*, but no modern revision is currently available for this genus.

The first infrageneric classification system for *Triaspis* was proposed by Niedenzu (1928), who divided it into two subgenera (*T.* subg. *Athysanis* Nied. and *T.* subg. *Thysanopetalis* Nied., nom. illeg. [valid name *T.* subg. *Triaspis*] based on the zygomorphy or actinomorphy of flowers, petals with margins fimbriate or denticulate, and homomorphic or heteromorphic stamens (i.e. all filaments almost equalling in length or those opposite the posterior petals longer) and styles (i.e. all styles equalling in length; Niedenzu 1928). Despite the molecular phylogenetic study of Davis and Anderson (2010) evidencing the monophyly of *Triaspis*, its subgenera were not recovered as monophyletic, leading to questions over its infrageneric classification.

Triaspis hypericoides Burch. is the type species of the genus and currently comprises three accepted subspecies endemic to woodland savannas and other seasonally dry environments of southern Africa: *T. hypericoides* subsp. *canescens* (Engl.) Immelman, *T. hypericoides* subsp. *hypericoides* and *T. hypericoides* subsp. *nelsonii* (Oliv.) Immelman (POWO 2023).

Angola is one of the least well-documented countries in tropical Africa (Sosef et al. 2017, Goyder and Gonçalves 2019), but a checklist compiled by Figueiredo and Smith (2008) serves as a useful baseline. Most collections come from the western parts of the country, but even here, plant inventories are few and far between. Quiçama National Park in Bengo Province is the only protected area listed by Huntley et al. (2019) in Angola to have a published checklist (Monteiro et al. 2022). Plant diversity in two areas of conservation concern in Cuanza Sul, Kumbira Forest and Mt Namba, was summarised by Gonçalves and Goyder (2016) and Goyder et al. (2023), while the headwaters of the Cuito catchment of the Okavango system in Moxico Province were documented by Goyder et al. (2018).

The Huíla plateau of southwestern Angola has long been known as an area of diversity and endemism, with much of this endemism associated with the high escarpment zone of the Serra da Chela (Goyder and Gonçalves 2019). Bicuar National Park is situated 100–200 km east of the escarpment zone, on a lens of sand which supports a mosaic of seasonally dry miombo woodlands (Gonçalves et al. 2021). There is no complete plant inventory to date, but surveys and analyses of the woody vegetation of the park and surrounding area have been conducted by Chisingui et al. (2018), Godlee et al. (2020), Silva et al. (2020) and Gonçalves et al. (2021). During fieldwork in the dry miombo woodlands of Bicuar National Park, one of us (FMPG) encountered an unusual population of *Triaspis* that did not fall within any accepted taxon in the genus. After a thorough analysis of relevant literature and herbarium material of *Triaspis*, we found out that it falls within the *T. hypericoides* species complex. Furthermore, based on our analysis, we propose re-establishing *T. canescens* Engl. and *T. nelsonii* Oliv. as entities separate from *T. hypericoides*, alongside proposing the specimens from this Angolan population as a new species. Additionally, we present an identification key to all taxa of this species complex, alongside a complete morphological description for the new species, photographic plates and comments on its distribution, ecology, palynology and taxonomy.

Material and methods

Taxonomy

Morphological data were principally collected from herbarium material from G, K and LUBA, although Malpighiaceae collections housed at BM, COI and LISC were also consulted either in person or via their electronic catalogues to check for any additional records of the new species. Vegetative terminology follows de Almeida and Morais (2022), inflorescence terminology and morphology follow Weberling (1965, 1989) and fruit terminology follows Spjut (1994) and Anderson (1981). The conservation status was proposed following the recommendations of IUCN Red List Categories and Criteria, ver. 3.1 (IUCN 2012).

Palynology

Pollen grains were treated with the acetolysis method (Erdtman 1960), following the modifications proposed

by Melhem et al. (2003). Measurements and photomicrographs were performed under a light microscope (Leica LMD7 microdissection microscope with a video camera Leica DFC 7000T and LAS software). Axis 1 and axis 2 were measured on 25 randomly chosen pollen grains, and these measurements were statistically analysed for the arithmetic mean (x), average SD (Sx) and 95% confidence interval (CI) (Zar 2010, Vieira 2011). Ten measurements of the main pollen morphometric parameters were also made (dimension 1 and dimension 2 of the pore, the thickness of the nexine and sexine layers), and the arithmetic mean was calculated. Permanent light microscopy (LM) slides were deposited in the pollen reference collection of the Bioimaging Lab, Royal Botanic Gardens, Kew, UK. For scanning electron microscopy (SEM), acetolysed pollen grains were washed and placed on a metal stub with carbon cement and sputter coated with platinum (10 nm) using a quorum-Q150t es Series. Samples were observed under a Hitachi 8230 under a 5 kV electron beam, and the images were digitised. Pollen terminology is based on Punt et al. (2007) and Halbritter et al. (2018).

Taxonomy

Triaspis Burch., (Burchell 1824, Trav. S. Afr. 2: 280). Type: *T. hypericoides* Burch. (Fig. 1–4)

Woody lianas to scandent shrubs; indumentum throughout the plant varying from sericeous, tomentose to hispid-velutine; stipules minute, triangular, interpetiolar, persistent to deciduous. Leaves usually opposite, sometimes subopposite to alternate, often reduced in florescences; petioles canaliculate, eglandular; leaf blade narrowly lanceolate to elliptic to very widely ovate, obtuse or rounded at base, rounded to mucronate at apex, usually bearing two pairs of glands impressed abaxially, near midvein, base or margins. Thyrsi (pseudoracemes), corymbs or umbels, axillary to terminal; cincinni 1-flowered, subopposite to alternate; bracts erect, elliptic to ovate, eglandular; peduncles short to elongate; bracteoles borne below the apex, middle or near base of peduncles, opposite to subopposite, elliptic to ovate, eglandular. Flowers bisexual, zygomorphic, chasmogamous; pedicels elongate; sepals leaving petals exposed during enlargement of bud, erect, flat, glabrescent to glabrous, eglandular; petals clawed, pink to lilac, turning whitish at age, at both sides glabrescent to glabrous; limb elliptic to obovate, hastate to truncate at base, with margin erose, denticulate to fimbriate, rounded at apex; claw plane to canaliculate; posterior petal erect; lateral petals patent. Stamens ten, all fertile; filaments free at base, straight, erect, homo- to heteromorphic; connectives eglandular, glabrous; anthers monomorphic, rarely dimorphic, glabrous. Gynoecium with carpels connate for their whole length in the ovary; styles cylindrical, erect in floral bud to diverging in anthesis, the anterior shorter; apex of styles curved, truncate; stigma lateral, crateriform. Fruits dry, splitting into three winged mericarps; mericarp with a single lateral, orbicular wing, chartaceous with many fine parallel veins and entire margin; dorsal wing distinct, minute; nut smooth; ventral areole narrowly elliptical.

Comments

The *T. hypericoides* species complex has a convoluted taxonomic history, with *T. hypericoides* being the first species in this genus to be described by Burchell (1824) based on specimens collected in South Africa. In the following years, Oliver (1868) described *T. nelsonii* as the second species of this complex, also based on South African specimens. Finally, Engler (1905) described *T. canescens* as the third species, based on specimens collected in the extreme south of Mozambique. In the same year, Engler also described *T. glaucophylla* based on specimens from South Africa. Nonetheless, while preparing the taxonomic monograph for Malpighiaceae in South Africa, Immelman et al. (1982) proposed the combination of both *T. canescens* and *T. nelsonii* as subspecies of *T. hypericoides* based on leaf shape and geographical distribution. Additionally, these authors differentiated *T. glaucophylla* from the remaining species of the *T. hypericoides* complex by the grey (versus green) and reniform (versus ovate, lanceolate or sagittate) leaves, petioles 5–20 mm long (versus 1–5 mm long) and green sepals at anthesis (versus pink to lilac).

In this study, we re-evaluated the species limits within *T. hypericoides,* finding several macromorphological characters useful for differentiating *T. bicuarensis* from the remaining species of this species complex (Table 1). An identification key is provided below for the species belonging to the *T. hypericoides* complex.

1. Scandent shrubs; synflorescences thyrses or corymbs; bracteoles subopposite 2
– Lianas; synflorescences umbelliform; bracteoles opposite 3
2. Leaves alternate, ovate to widely ovate, rounded at base, with flat margin, abaxially sparsely white-tomentose; petiole 4–8 mm long; synflorescence a thyrse; bracteoles inserted below the apex of peduncles ..... ***T. bicuarensis***
– Leaves opposite, widely ovate to very widely ovate, sagittate at base, with undulate margin, abaxially glabrous to glabrescent; petiole 2–3 mm long; synflorescence forming corymbs; bracteoles inserted at the middle of peduncles ..... ***T. nelsonii***
3. Leaves chartaceous, narrowly ovate to ovate, rounded to cordate at base, with undulate margin and mucronate apex, abaxially densely white-tomentose; petiole 0.8–1.5 mm long; bracteoles inserted near base of peduncles; mericarps up to 30 mm in diam. ..... ***T. canescens***
– Leaves coriaceous, narrowly lanceolate, acute to obtuse at base, with flat margin and rounded apex, abaxially glabrous; petioles 4.5–8.0 mm long; bracteoles inserted below apex of peduncles; mericarps up to 45 mm in diam. ..... ***T. hypericoides***

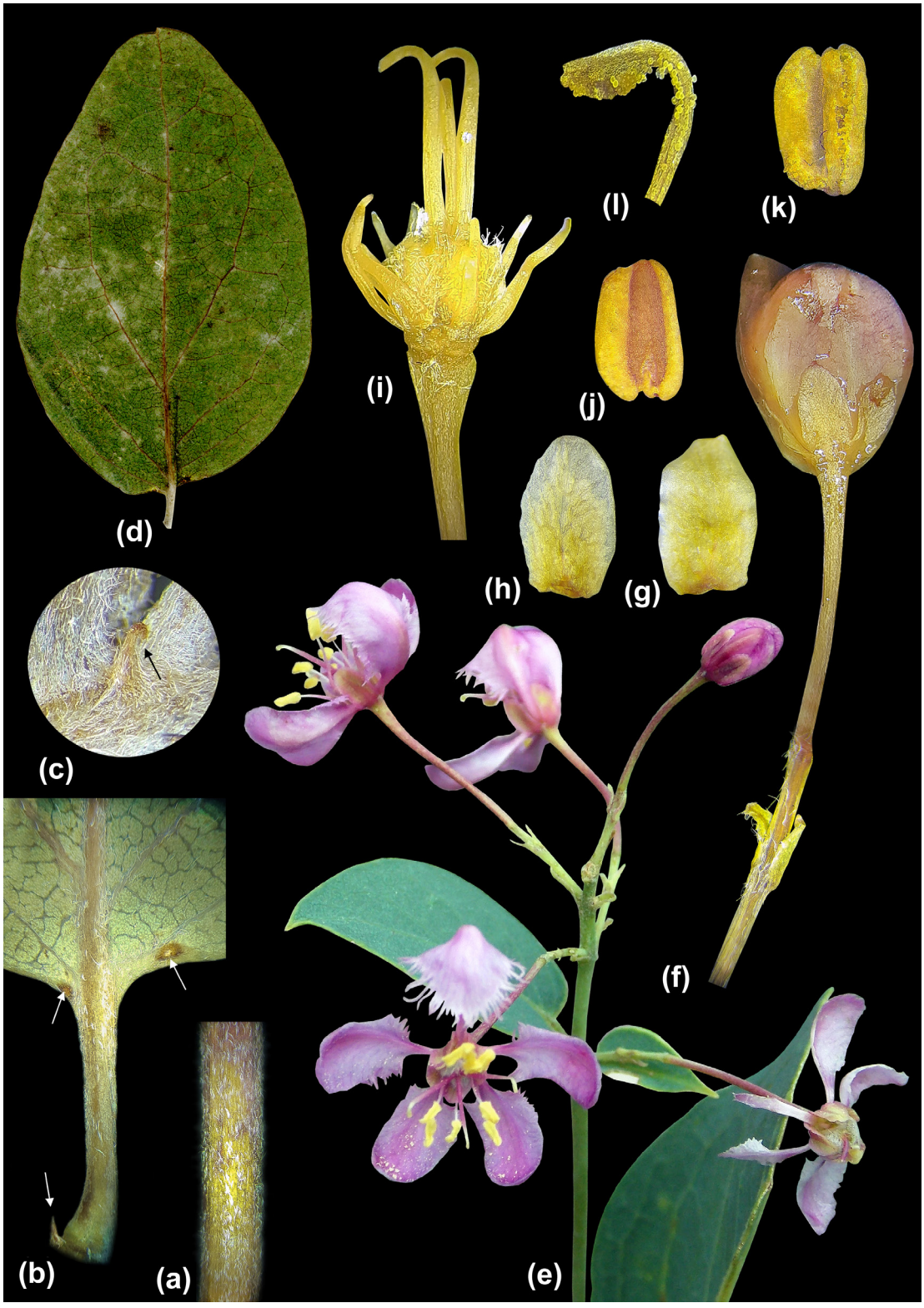


Figure 1. *Triaspis bicuarensis* sp. nov. R.F.Almeida and Goyder. (a) Detail of the whitish-tomentose indumentum of a branch. (b) Detail of a stipule, petiole and base of the leaf blade evidencing two glands near the base. (c) Detail of the stipule. (d) Vegetative leaf on the abaxial side. (e) Thyrse side view. (f) 1-flowered cincinnus. (g) Sepal abaxial view. (h) Sepal adaxial view. (i) Detail of the flower without sepals and petals, showing pedicel, floral receptacle, filaments and gynoecium. (j) Anther dorsal view evidencing the connective. (k) Anther frontal view evidencing thecae. (l) Detail of the curved apex of a style showing the lateral stigma covered in pollen grains. All photographs by R. F. Almeida, except (e) by F. Maiato.

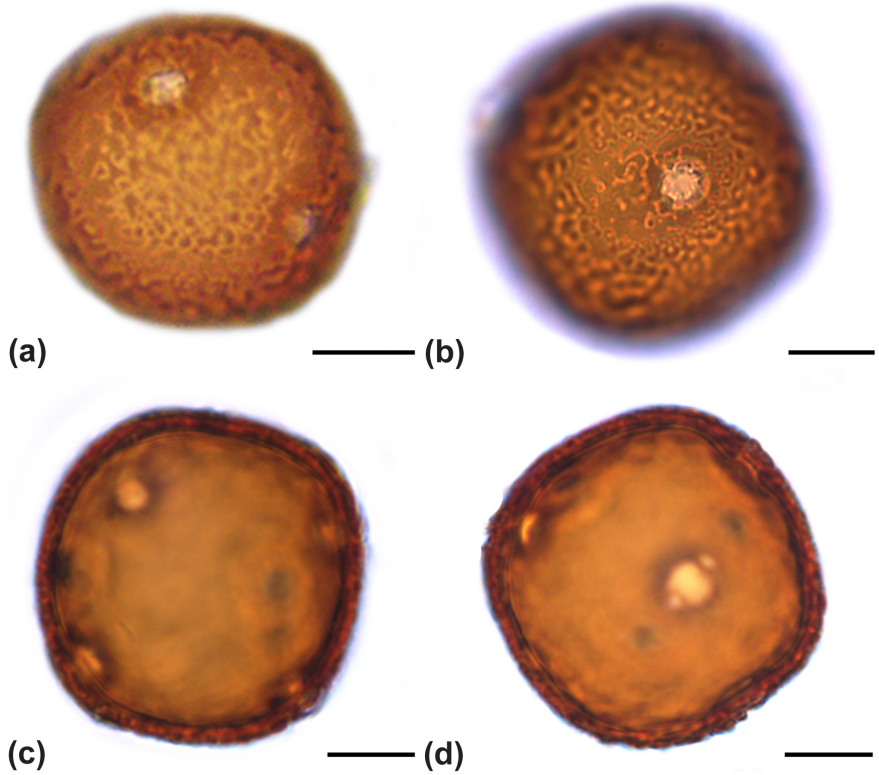


Figure 2. Light microscopy of *Triaspis bicuarensis* sp. nov. R.F.Almeida and Goyder. (a) Detail of the pore, endoaperture, operculum and surface. (b) Detail of the exine ornamentation. (c) Optical section showing 7-pantocolporate apertures. (d) Optical section showing details of the sexine and exine. Scale bars – 10 µm.

Taxonomic treatment

Triaspis bicuarensis R.F.Almeida and Goyder, sp. nov. (Fig. 1–4)

Diagnosis

A species differing from *T. nelsonii* due to its alternate (versus opposite) leaves, with ovate to widely ovate (versus widely ovate to very widely ovate) lamina, rounded at base (versus sagittate), with flat margin (versus undulate), abaxially sparsely white-tomentose (versus glabrous to glabrescent), petiole 4–8 mm long (versus 2–3 mm long), flowers in thyrses (versus corymbs) and bracteoles inserted below apex of peduncles (versus inserted at the middle of peduncles).

Type: Angola, Huíla: Bicuar National Park, fl., 8 Dec. 2016, F. Maiato et al. FM1832 (holotype: LUBA; isotypes: K, PRE).

Etymology

The epithet refers to the restricted distribution of the new species, known only from Bicuar National Park in Huíla Province, southwestern Angola.

Description

Scandent shrub. Branches densely whitish-tomentose; malpighiaceous hairs with significantly reduced foot; internodes 2.1–4.1 cm long. Stipules 0.80–1.00 × 0.20–0.25 mm, interpetiolar, free, with both sides glabrous. Leaves subopposite at base in vegetative branches, becoming distichously alternate at mid-length and in flowering branches; petioles 0.4–0.8 cm long, canaliculate, densely whitish-tomentose, eglandular; blades 4.3–7.4 × 2.5–4.3 cm, narrowly to widely ovate to elliptic, chartaceous, with 1–2 pairs of impressed glands at or near base, usually on margins, obtuse to rounded at base, with entire margins, plane, apiculate at apex, adaxially glabrous, abaxially sparsely whitish-tomentose, glabrescent with age. Synflorescence terminal, consisting of 3–7 pairs of florescences; leaves associated with the inflorescence slightly reduced, petiolated. Thyrsi 7–12-flowered, lateral, pedunculate, unbranched; main axis 0.8–2.5 cm long, smooth, densely whitish-tomentose; bracts 1.0–1.5 × 0.4–0.5 mm, triangular, plane, patent, eglandular, adaxially glabrous, abaxially sparsely whitish-tomentose; cincinni alternate, 1-flowered; peduncle 5.0–7.0 mm long, sparsely whitish-tomentose; bracteoles subopposite, inserted at 1/3 below the apex of the peduncle, 2.0–2.6 × 0.4–0.5 mm, oblong, plane, patent, adaxially glabrous, abaxially sparsely whitish-tomentose. Flowers 1.4–1.8 cm in diameter at anthesis; floral buds 3.0–4.5 × 5.0–6.0 mm, globose to oblongoid; pedicel 8.0–16 mm long, pinkish, sparsely whitish-tomentose. Sepals 1.8–2.0 × 0.5–1.0 mm, pink in bud and anthesis, straight, smooth, rounded at apex, erect at anthesis, adaxially glabrous, abaxially glabrescent, all eglandular. Petals pink at anthesis, white postanthesis, dorsally smooth in bud, persistent at anthesis; limb

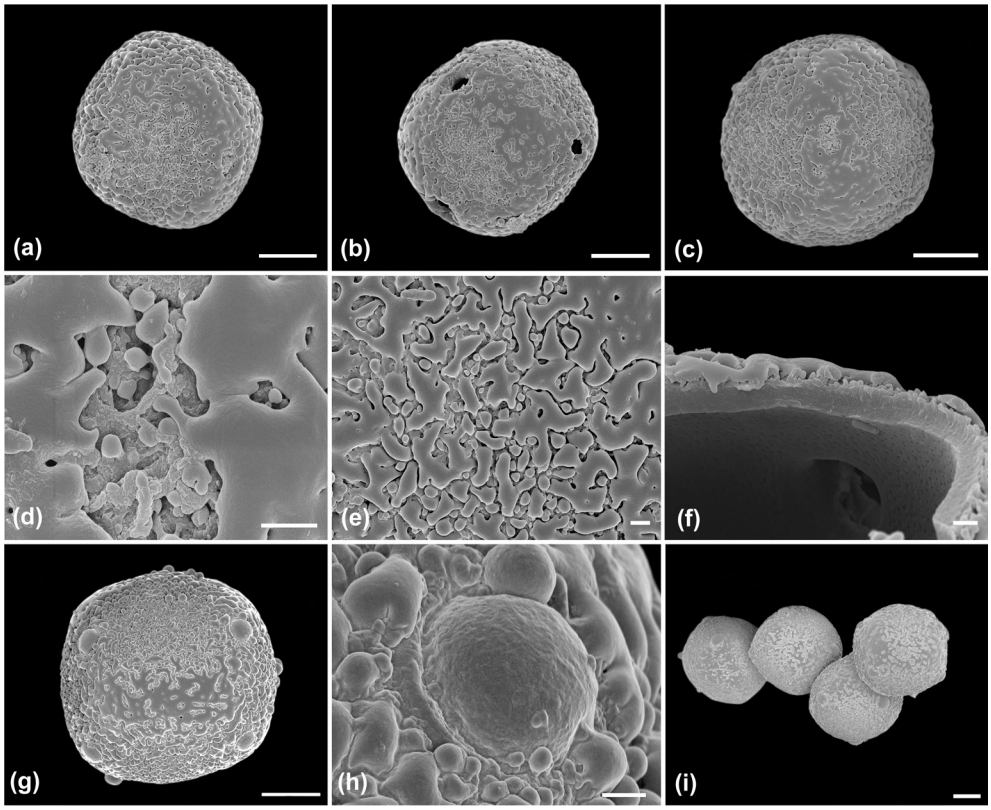


Figure 3. Scanning electron microscopy of *Triaspis bicuarensis* sp. nov. R.F.Almeida and Goyder. (a) Detail of the fossulate exine. (b) Detail of the pores. (c) Detail of the endoaperture membrane. (d) Detail of the ornamentation of the endoaperture membrane. (e) Detail of the fossulate-granulate exine ornamentation. (f) Detail of the sexine and nexine layers. (g) Detail of the non-acetolysed pollen grain showing opercula. (h) Detail of an operculum in a non-acetolysed pollen grain. (i) Detail of the non-acetolysed pollen grains with scarce to no pollenkitt. (a), (b), (c), (g) and (i) scale bars – 10 µm. (d), (e), (f) and (h) scale bars – 1 µm.

6.0–8.0 × 3.0–9.0 mm, ovate to elliptic, plane, patent, with long- to short-fimbriate to denticulate margins, eglandular; claws 1.0–2.0 × 0.5–0.8 mm, at both sides glabrescent near base. Stamens 10, all fertile, 2-serial (1 internal and 1 external); filaments 2.0–2.5 × 0.2–0.3 mm, pale pink, free at base, cylindrical, thicker at base, tapering towards apex; connective eglandular, yellow, darker than thecae, glabrous; thecae 1.9–2.1 × 0.7–0.8 mm, yellow, glabrous. Pollen grains in monads, medium-sized [40.1 (40.7 ± 0.3) 41.3 × 41.0 (41.5 ± 0.2) 42.0] µm, radially asymmetrical, apolar, spherical, circular to quadrangular in outline; apertures (6-)7-pantoporate, slightly elongated (4.2 × 4.6 µm), with granulate membrane; exine fossulate with granulae inside the fossulae to psilate-perforate close to the apertures, ca 2.4 µm thick, with nexine thicker than sexine (1.4 × 1.0 µm), tectum tectate-perforate to semitectate, and endexine endocrack perforate. Ovary 1.4–1.5 × 0.5–0.7 mm, globose, densely whitish-tomentose, with primordial wing projections; styles 3, erect, 3.50–4.00 × 0.30–0.35 mm, cylindrical, divergent at apex, pubescent at base, rounded at apex, deflexed; anterior style slightly shorter than posterior ones; stigmas lateral, pointing towards the centre of the flower. Fruits not seen, according to the ovary primordia winged, with lateral wings more developed than dorsal wing, probably orbicular. Seeds not seen.

Distribution, habitat and phenology

Triaspis bicuarensis is known only from dry miombo woodlands within Bicuar National Park, Huíla Province, southwestern Angola (Fig. 1). It blooms in December, and the fruits are unknown.

Conservation status

Triaspis bicuarensis is known only from a single collection (i.e. specimen) within the limits of the Bicuar National Park in Huíla Province, southwestern Angola. Until additional fieldwork can be done in this region of southwestern Angola, this species is best categorised as 'Data Deficient' (DD). Bicuar National Park is mostly protected from human negative impacts, except from natural seasonal fires observed during field surveys. The occurrence of fires characterises most savannic habitats, especially during the dry season when most of the trees lose their foliage.

Palynology

Triaspis bicuarensis shows pollen grains from 41 to 42 µm in diameter, the largest pollen grains recorded so far within *Triaspis*. In the last taxonomic revision of Malpighiaceae, Niedenzu (1928) described the pollen diameter of eight (out of 15) species of *Triaspis* (i.e. *T. canescens*, *T. hypericoides*, *T.*

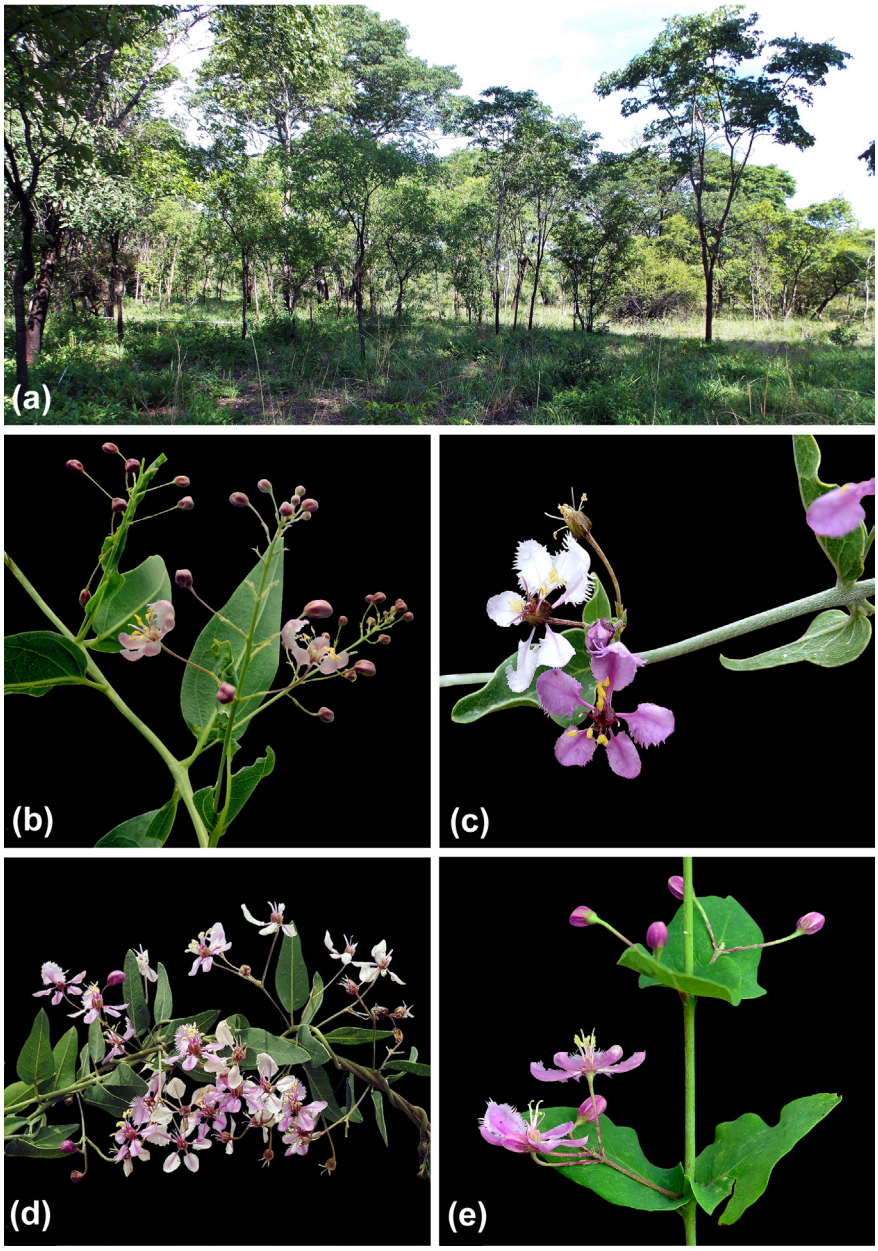


Figure 4. Field photographs of the species belonging to the *Triaspis hypericoides* species complex. (a) Dry miombo woodlands at Bicuar National Park. (b) *Triaspis bicuarensis* sp. nov. (c) *Triaspis canescens*. (d) *Triaspis hypericoides*. (e) *Triaspis nelsonii*. Photographs (a) and (b) by Francisco Maiato, (c) by Warren McCleland, (d) by Amelia Ryan and (e) by Nick Helme.

laterifolia, *T. macropteron*, *T. mozambica*, *T. nelsonii*, *T. odorata* and *T. stipulata*) as varying from (15–)25 to 40 µm in diameter. More specifically, the pollen grains of species related to the *T. hypericoides* complex were reported to be 35 µm (*T. canescens*), 40 µm (*T. hypericoides*) and 39 µm in diameter (*T. nelsonii*), corroborating the taxonomic distinctness of *T. bicuarensis* with pollen grains 42 µm in diameter. Future palynological studies are needed for an in-depth analysis of the diameter and general relevance of pollen morphology for the taxonomy of *Triaspis*.

Triaspis shows pantoporate pollen grains, an unusual pollen character in Malpighiaceae. In the palynological literature, this family is commonly described as having pantosyncolporate to pantocolporate pollen grains (Lobreau-Callen 1968, Lowrie 1982). Pantoporate pollen grains are restricted to genera from the early diverging Barnebyoid and Bunchosioid clades and most paleotropical lianescent genera of Malpighiaceae (i.e. *Diaspis* Nied., *Flabellaria* Cav., *Flabellariopsis* R.Wilczek, *Philgamia* Baill., *Sphedamnocarpus* Planch. ex Benth. and Hook.f. and *Triaspis* Burch.) (Lobreau-Callen 1968, Lowrie 1982). Changes in pollen grain aperture type from colporate to porate are often mentioned in the literature as an ecological adaptation over evolutionary time to avoid water loss in the ancestor of lineages colonising and

Table 1. Morphological traits distinguishing the species of the *Triaspis hypericoides* species complex.

Morphology/Species	*Triaspis bicuarensis* sp. nov.	*T. canescens*	*T. hypericoides*	*T. nelsonii*
Habit	scandent shrub	liana	liana	scandent shrub
Phyllotaxis	distichously alternate	opposite	opposite	opposite
Leaf blade, 2D shape	ovate to widely ovate	narrowly ovate to ovate	narrowly lanceolate	widely ovate to very widely ovate
Leaf blade, base, shape	rounded	rounded to cordate	acute to obtuse	sagittate
Leaf blade, margin, shape	flat	undulate	flat	undulate
Leaf blade, apex, shape	mucronate	mucronate	rounded	mucronate
Leaf blade, texture	chartaceous	chartaceous	coriaceous	chartaceous
Leaf blade, indumentum	sparsely white-tomentose	densely white-tomentose	glabrous	glabrous
Leaf blade, glands	1–2 pairs near midvein near base	1 pair near base	1–2 pairs near midvein near base	1–2 pairs near midvein near base
Petiole length	4.0–8.0 mm long	0.8–1.5 mm long	4.5–8.0 mm long	2.0–3.0 mm long
Inflorescence type	thyrsus	umbel	umbel	corymb
Bracteoles, position in the peduncle	below apex	near base	below apex	middle
Bracteoles phyllotaxis	subopposite	opposite	opposite	subopposite
Mericarp diameter	unknown	ca 30 mm	ca 45 mm	ca 20 mm

diversifying in drier environments (Thanikaimoni 1986). This seems to be the case for *Triaspis* since this genus is placed within the Malpighioids (Almeida et al. 2017, 2023a, b), a clade comprising early diverging lineages endemic to the Neotropical region showing pantocolporate pollen grains (*Amorimia* W.R.Anderson, *Calcicola* W.R.Anderson, *Ectopopterys* W.R.Anderson, *Malpighia* L. and *Mascagnia* (Bertero ex DC) Bertero) and a Paleotropical clade showing pantoporate (*Aspidopterys*, *Caucanthus*, *Diaspis* and *Triaspis*) to unapertured (*Digoniopterys* Arènes, *Madagasikaria* C.Davis, *Microsteira* Baker and *Rhynchophora* Arènes; Lobreau-Callen 1968, 1983, Lowrie 1982, Silva et al. 2023) pollen grains.

Another aspect that might play an essential role in the morphology of pollen grains in Malpighiaceae is related to their pollination syndromes. Neotropical Malpighiaceae show a distinctive floral conservatism (i.e. zygomorphic flowers, sepal oil glands and connective oil glands) due to their specific mutualism with oil-collecting bees endemic to this region of the world. They also produce a significant amount of pollenkitt, a rich electron-dense, homogeneous oily pollen coat spread all over the exine surface of pollen grains transported by insects (Hesse 1981, Buchmann 1987). On the other hand, due to the lack of oil-collecting bees in the Old World, Paleotropical lineages of Malpighiaceae have lost this floral conservatism due to a shift in their pollination syndrome from oil-offering to pollen-offering flowers. An interesting pattern in the pollen grains of almost all lineages of Paleotropical Malpighiaceae is a conspicuous change from pantocolporate or pantosyncolporate to pantocolpate or unapertured pollen grains (Lobreau-Callen 1968, 1983, Lowrie 1982, Cameron et al. 2001). Curiously, most Old World genera of Malpighiaceae have lost their sepal and connective oil glands and show a reduced amount of pollenkitt (Guesdon et al. 2019, Almeida et al. 2023b). Future studies are needed to test this possible correlation between pollen ultrasculpture, pollenkitt production, floral glands and different pollination syndromes.

Similar species

Triaspis bicuarensis resembles *T. canescens* and *T. hypericoides* in vegetative traits and *T. nelsonii* in inflorescence architecture. A complete morphological comparison between these four species is presented in Table 1.

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Author contributions

Rafael Felipe de Almeida: Conceptualization (equal); Formal analysis (equal); Methodology (equal); Writing – original draft (equal). **Higor Antonio-Domingues**: Investigation (equal); Methodology (equal); (equal); Software (equal); Validation (equal); Writing – review and editing (equal). **Francisco Maiato P. Gonçalves**: Data curation (equal); Funding acquisition (equal); Methodology (equal); Resources (equal); Writing – review and editing (equal). **David J. Goyder**: Investigation (equal); Writing – review and editing (equal).

Data availability statement

There are no additional data for this paper.

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