

Acmadenia kamdeboo (Rutaceae: Diosmeae)—A new species endemic to the Kamdebooberge, Sneeuwberg Massif (Eastern Cape, South Africa)

V. Ralph Clark^{a,*}, João de Deus Vidal Jr.^b, Nigel P. Barker^c

^a Afromontane Research Unit & Department of Geography, University of the Free State: Qwaqwa Campus, Private Bag X13, Phuthaditjhaba 9866, South Africa

^b LeipzigLab, University of Leipzig, Str. des 17. Juni 2, 04107, Leipzig, Germany

^c Department of Plant & Soil Sciences, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa

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ABSTRACT

Acmadenia Bartl. & H.L. Wendl. (Rutaceae: Diosmeae) is a genus of 33 aromatic shrub species, which—with the exception of at least three species—is endemic to the Core of the Greater Cape Floristic Region and contributes to the exceptional richness of the Core of the Greater Cape Floristic Region, which is also part of a biodiversity hotspot. We describe the 34th known species, *A. kamdeboo* V.R. Clark & J.D. Vidal—a narrow endemic confined to the Kamdebooberge (Camdeboo Mountains) in the south-western Sneeuwberg massif, near Aberdeen (Eastern Cape, South Africa). Morphologically, it is closest to *A. sheilae* I. Williams, but differs by the smaller, obovate-lanceolate leaves; alternate phyllotaxy; adpressed to patent leaf insertion; shorter sepals and bracts; and a rounded apical anther gland. Also, *Acmadenia kamdeboo* occurs primarily on Karoo Supergroup dolerites—rather than on Cape Supergroup sandstones. *Acmadenia kamdeboo* contributes to a local node of endemism in the western Sneeuwberg—including the other, highly localised Kamdebooberge endemic *Faurea recondita* Rourke & V. R. Clark—and is the only *Acmadenia* found north of the Great Karoo, on the Great Escarpment. *Acmadenia kamdeboo* is the second Eastern Cape endemic in the genus—both being in summer/bimodal autumn–spring climates—out of three species recorded in the province. The Kamdebooberge deserves further botanical exploration and may contain further novelties.

1. Introduction

Acmadenia Bartl. & H.L. Wendl. (Rutaceae: tribe Diosmeae) is a genus of 33 aromatic shrub species, which—with the exception of two species—is endemic to the Core of the Greater Cape Floristic Region (CGCFR) and—together with other Cape-concentrated Rutaceae genera such as *Agathosma* Willd. and *Diosma* L.—contributes to the exceptional biodiversity of the Cape Floristic Region Hotspot (e.g. Williams, 1982; Richardson et al., 2001; Mittermeier et al., 2004; Manning and Goldblatt, 2012; Victor and Bester, 2019). All *Acmadenia* species are endemic to South Africa, and comprise sclerophyllous shrubs or sub-shrubs, recognisable by the presence of clawed petals, staminodes (occasionally reduced), styles and filaments not exerted, and anthers with an apical gland (Williams, 1982; Victor and Bester, 2019). The flowers present a corolla constricted at the throat, which has been suggested as the only exclusive diagnostic trait for the genus (Victor and van Wyk, 1998). Many of these traits overlap with other closely related genera, such as *Diosma*, *Adenandra* Willd., and *Phyllosma* Bolus ex Schltr. (Victor

and van Wyk, 1998), and the pollen wall morphology is highly variable across species, suggesting that the genus may actually be polyphyletic (Victor and van Wyk, 1998). Trinder-Smith et al. (2007) found that plastid DNA sequence data resolved *Acmadenia* as closely related to *Adenandra*, a finding confirming Strid (1972). However, a number of characters can distinguish these two genera. The most obvious difference is the placement of an apical gland on the anthers, which is stalked in *Adenandra* and sessile in *Acmadenia* (Manning and Goldblatt, 2012). Although flower colour is not a reliable indicator of genus because of exceptions, flowers in *Adenandra* are usually white, rarely solitary (most often corymbs with up to 20 flowers), with a few exceptions (e.g. *A. dahlgrenii* Strid, *A. multiflora* Strid), vs. pink or lilac, often solitary or paired terminal flowers in *Acmadenia*.

An unknown species of *Acmadenia* was first discovered on Goermentsberg (Kamdebooberge, near Aberdeen, Eastern Cape) by VRC in April 2008—during what might have been one of the first focused botanical collecting expeditions to the south-eastern side of Kamdebooberge (Rourke et al., 2013), as part of the Great Escarpment

* Corresponding author.

E-mail address: clarkvr@ufs.ac.za (V.R. Clark).

Biodiversity Programme (GEBP) under NPB at Rhodes University at that time. This is despite nearby activities by earlier botanical explorers: William Burchell passed further west of the Kamdebooberge in 1812, heading north and later back south nearer Middelburg and Graaff-Reinet (Burchell, 1822); and William Tyson—who in 1879 discovered the western Sneeuwberg endemic *Euryops dentatus* B. Nord. and the enigmatic *Selago crassifolia* (Rolfe) Hilliard (the latter still only known from the type collection; Clark et al., 2009). Thus, there are no known botanical collecting trips to the Kamdebooberge in the 19th and 20th centuries, until 2008. A detailed overview of the biophysical environment of the Kamdebooberge is provided by Clark et al. (2012).

2. Material and methods

Acmadenia material was collected by VRC on three trips to the Kamdebooberge, viz. 4 April 2008, 9–10 September 2008, and 23–25

January 2011. An additional trip on 16 June 2008 did not pick up additional material, as the focus of this trip was lower elevation, wooded areas. Material was collected using standard herbarium voucher collecting techniques, with material pressed and dried, and later labelled and mounted for accession in GRA. *In situ* photographs were also taken during the field trips, as well as data on distribution, abundance, and ecology. The GRA material was later databased into a GEBP Botanical Research and Herbarium Management System (BRAHMS) database and made available on the Global Biodiversity Information Facility (GBIF) (Barker et al., 2020), and imaged. Prior and subsequent intensive botanical collecting by VRC in adjacent parts of the Sneeuwberg (2006 in the Toorberg–Meelberg–Koudeveldberge, and 2011 in that section of the Kamdebooberge north-east of Aberdeen) did not detect any additional populations.

In 2008 and 2011, duplicate material from April 2008 and January 2011 was sent to the Bolus Herbarium (BOL), where the then Curator,



Fig. 1. Holotype of *Acmadenia kamdeboo* V.R. Clark & J.D. Vidal (Clark & O'Connor 2, GRA). Image by A.P. Dold.

Mr T. Trinder-Smith, kindly ascribed it to *Acmadenia* as a potentially new species allied to *A. sheilae* I. Williams. The species was never formally described, however, and remained “sp. nov. aff. *sheilae*” in Clark et al.’s (2009) description of the Sneeuberg Centre of Floristic Endemism and published summary of the South African Society for Systematic Biology (SASSB) post-congress Kamdeboo field expedition (Clark et al., 2012). In 2025, the GRA specimens were accessed again, with characters being formally detailed and compared against similar species of *Acmadenia* to rule out a geographic range extension rather than being a new species. Because of apparent variation in floral morphology, especially of the staminodes, a total of seven flowers were dissected using flowers from three (viz. Clark & Crause 130, Clark & O’Connor 2, Clark, Stirton & Weston 80) of the four known collections; such floral characters were also compared with available high-resolution photographs (VRC, Nick Helme). Characters were also used to rule out the plants being species in any related genera.

3. Taxonomy

Acmadenia kamdeboo V.R. Clark & J.D. Vidal sp. nov. Type: South Africa, Eastern Cape, Aberdeen (3223): ‘Goewermetsberg’, Kamdebooberge, Sneeuberg (—BD), 9 Sep. 2008, Clark & O’Connor 2 (GRA, holo.!, barcode GRA0182785; BOL, iso.!) (Figs 1, 2, 3).

Dwarf, dense shrublet, aromatic, 150–300(–500) mm tall, lax, multi-stemmed from base, spreading and shaping over boulders, floribund.

Branches dark-brown, short, slender, opposite, pubescent with non-glandular, dense velvety, white hairs—where not pubescent (in patches), resinous shiny; branchlets chestnut, pubescent. Leaves shortly petiolate, petioles 0.3 mm long, pinkish-green; 3.5 (younger)–4.5 (older) mm long $\times$ (0.5)–0.75–0.9 mm wide, green, simple, alternate, adpressed in young branches, shifting to patent in older branches, strongly overlapping, with the impression of being fascicled toward the branchlet ends, lanceolate to obovate-lanceolate, slightly acute to blunt apex, short-petiolate; strongly but bluntly keeled, keel and margins thickened, lamina concave with upper quarter regularly navicular (lamina folded inwards in a boat-shape); entire leaf densely covered in translucent, triangular/pyramidal glandular hairs, no pellucid dots, adaxially densely pubescent with short white hairs towards petiole, strongly aromatic. Flowers 5–6 mm in diameter, solitary, terminal, bright pink, surrounded at the base by two pairs of bract-like leaves. Bracts in pairs at base of calyx, 2.5 mm long $\times$ 0.5 mm wide, narrow elongate, acute. Sepals five, 3 mm long $\times$ 0.6 mm wide, keel green, elliptic, abruptly apiculate (apiculate section dark green, 0.9 mm long), outside shortly pubescent-pearly, translucent membranous, fringed with long white hairs. Calyx deeply divided, persistent. Corolla constricted into a lax throat. Petals five, indistinctly tapering-clawed, 4–5 mm long $\times$ 2.5 mm wide, pink to purple with claw darker pink, obovate-acute, glabrous except for soft white pubescence at corolla throat/top of claw. Filaments five, 2 mm long $\times$ 0.5 mm at widest, narrowing towards the anthers, globular swollen below connection with anthers, lax.

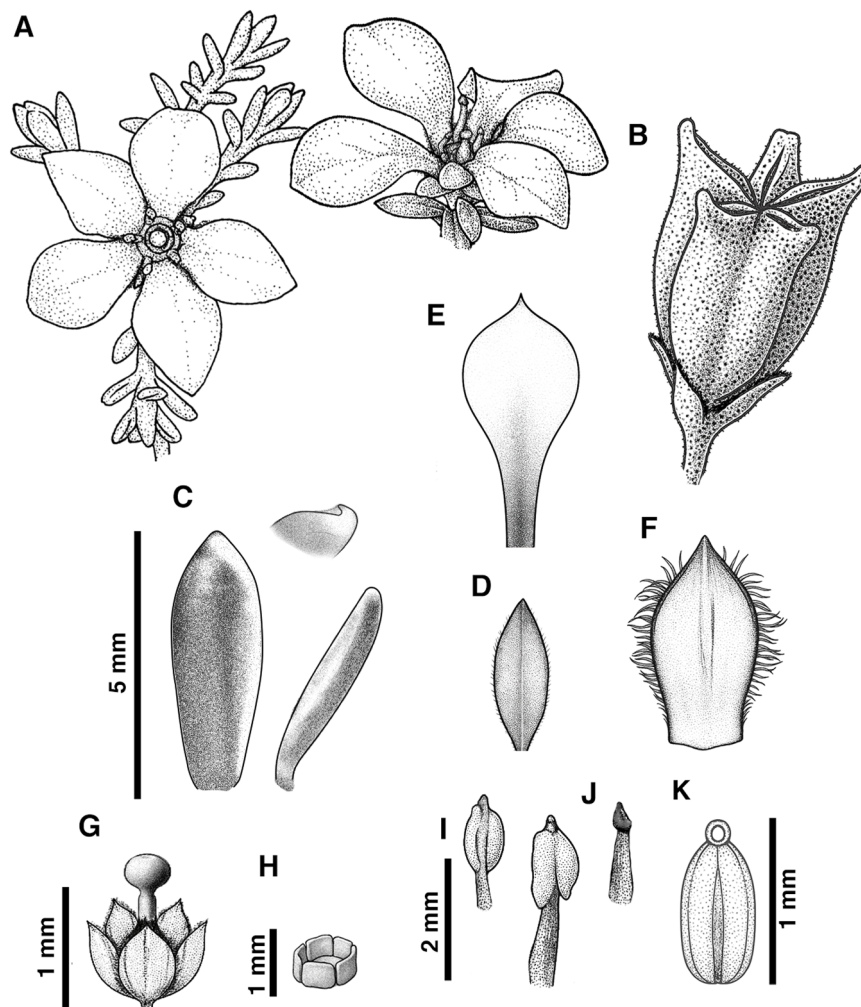


Fig. 2. Morphological characters of *Acmadenia kamdeboo* V.R. Clark & J.D. Vidal: (A) flower, (B) capsule, (C) leaf, (D) bract, (E) petal, (F) sepal, (G) gynoecium, (H) disc, (I) stamen and anther, (J) staminode, (K) anther detail showing apical gland. Digital art by J.D.D. Vidal, Jr, based on dissections by V.R. Clark using Clark & Crause 130, Clark & O’Connor 2, Clark, Stirton & Weston 80 (GRA), and photographs by V.R. Clark and N. Helme.



Fig. 3. *In situ* photographs of capsules (A on left, B), flowers (A on right, C, D), and growth form (E) of *Acmadenia kamdeboo* V.R. Clark & J.D. Vidal. Photographs by V.R. Clark (A, B, D, E) and N. Helme (C).

Anthers prominent but seem to be easily broken off, five, 1 mm long $\times$ 0.8 mm wide, ovate, globose, fluted, striped yellow-pink, protruding occasionally between gaps in petals (exserted in dried material); apical gland round/knobbed, not minute, yellow. Stamines 5, free above, fused at base, 0.7–1 mm long, apical gland variable from spherical to elliptical-tapered (possibly depending on the maturity stage of the flower), lax. Disk cupular, 5 lobes, surrounding and $\pm$ same height as ovary, 1 mm tall from base, tough, brown, dark brown on the thickened, blunt apical rims, covered in scattered pearl bodies. Stigma 0.4 mm in diameter, bulbous, very evident, dark violet, densely covered in round translucent pearl bodies. Style 0.5–1 mm long, pale pink, erect, with occasional translucent glandular hairs. Ovary five-carpellate, 1 mm in diameter (at apical points), dark grey-brown, wider above than below, with irregularly shaped apical points. Fruit five-carpellate, 5 mm long $\times$ 5 mm across the widest part at fruit apex, each carpel bi-knobbed, protuberant, elongate-flattened, chestnut brown, pitted, pubescent. Seeds were not available in the material (carpels empty).

3.1. Diagnosis

Acmadenia kamdeboo is morphologically similar and most closely related to *A. sheilae* but differs by having lanceolate to obovate-lanceolate leaves (vs. oblong in *A. sheilae*), alternate phyllotaxy (vs. opposite in *A. sheilae*), adpressed to patent leaf insertion (vs. adpressed in *A. sheilae*), shorter sepals (3 mm long vs. 5 mm long in *A. sheilae*),

shorter bracts (2.5 mm long vs. 5 mm long in *A. sheilae*), and a rounded apical anther gland (vs. pointed in *A. sheilae*). Furthermore, *A. kamdeboo* occurs primarily on dolerite (rather than Cape Supergroup sandstones in *A. sheilae*). The new species is also morphologically similar to *A. baileyensis* I. Williams but differs by having alternate phyllotaxy (vs. opposite in *A. baileyensis*), adpressed to patent leaf insertion (vs. adpressed in *A. baileyensis*), obovate-acute petals (vs. broadly obovate, rounded apically in *A. baileyensis*), and filaments and stamens lax (vs. pubescent in *A. baileyensis*). *Acmadenia baileyensis* is an erect shrublet vs. spreading, compact *A. kamdeboo*.

3.2. Etymology

The specific epithet *kamdeboo* is the Latinised version of “Kamdeboo”, after the Kamdebooberge to which the species is endemic. The name “Kamdeboo” (=“Camdeboo”) is apparently derived from a phonetically similar Khoi word meaning “green hollow/place of green hills or pools”, which fits the relatively lush habitat of *A. kamdeboo* (arising from the orographic effect of the Kamdebooberge) compared to the arid Karoo plains surrounding these mountains.

3.3. Common names

As for *Agathosma*, *Acmadenia* species are commonly known as *buchu* (Victor and van Wyk, 1998). We suggest the common name ‘Camdeboo Buchu’ (English) and ‘Kamdeboo-boegoe’ (Afrikaans) for this species (Nienaber, 1963); we could not find any recorded indigenous African names for *Acmadenia*.

3.4. Distribution and ecology

Acmadenia kamdeboo is confined to the Kamdebooberge (Figs 4,5), in the far south-western Sneeuwberg mountain complex, where it is locally abundant in rocky areas between 1600 and 1710 m along the south-east and east-facing plateau edges and summits where it receives the orographic effect from moist south-easterly winds (Clark et al., 2009). It was not detected further north or north-east along the same mountains and seems to have a very narrow climatic envelope in this area at the very southern tip of the Kamdebooberge.

It occurs in montane grassy fynbos (Fig. 5) that has a unique community that combines typical summer rainfall Afromontane grassland elements (e.g. *Clutia alaternoides* L., *Erica leucopelta* Tausch, *Kniphofia caulescens* Baker, *Themeda triandra* Forssk.) with elements otherwise endemic to the winter rainfall CGCGR (e.g. *Rhodocoma capensis* Steud., *R. fruticosa* (Thunb.) H.P. Linder, *Tetradlea fourcadei* Turrill & Schönland) (see Clark et al., 2012 for full details). *Acmadenia kamdeboo* occurs on dolerite substrates with loamy, rich soil; dolerite forms the bulk of the summit plateaus of the Kamdebooberge as a series of thick, inclined dolerite sills typical of the Sneeuwberg (Clark et al., 2009). The plant often grows among the rocks in cracks.

Broadly, the vegetation unit in which *A. kamdeboo* occurs are Mucina and Rutherford’s (2006) Karoo Escarpment Grassland (Gh 1), Grassland Biome—although it could be considered a variant of azonal Drakensberg-Amathole Afromontane Fynbos (part of the Grassland Biome) that stretches along the eastern Great Escarpment (Mucina and Rutherford, 2006), with particular Cape elements not known from other summer rainfall mountains in the Cape Midlands Escarpment/eastern Great Escarpment.

3.5. Abundance and conservation status

The current known Area of Occupancy of *A. kamdeboo* is very small, being ca. 8 km² in the southernmost components of the Kamdebooberge, in the far south-western part of the Sneeuwberg mountain complex. The species is common in this small area (probably >1000 individuals), but it occupies a very localised niche as a summit plateau endemic. The

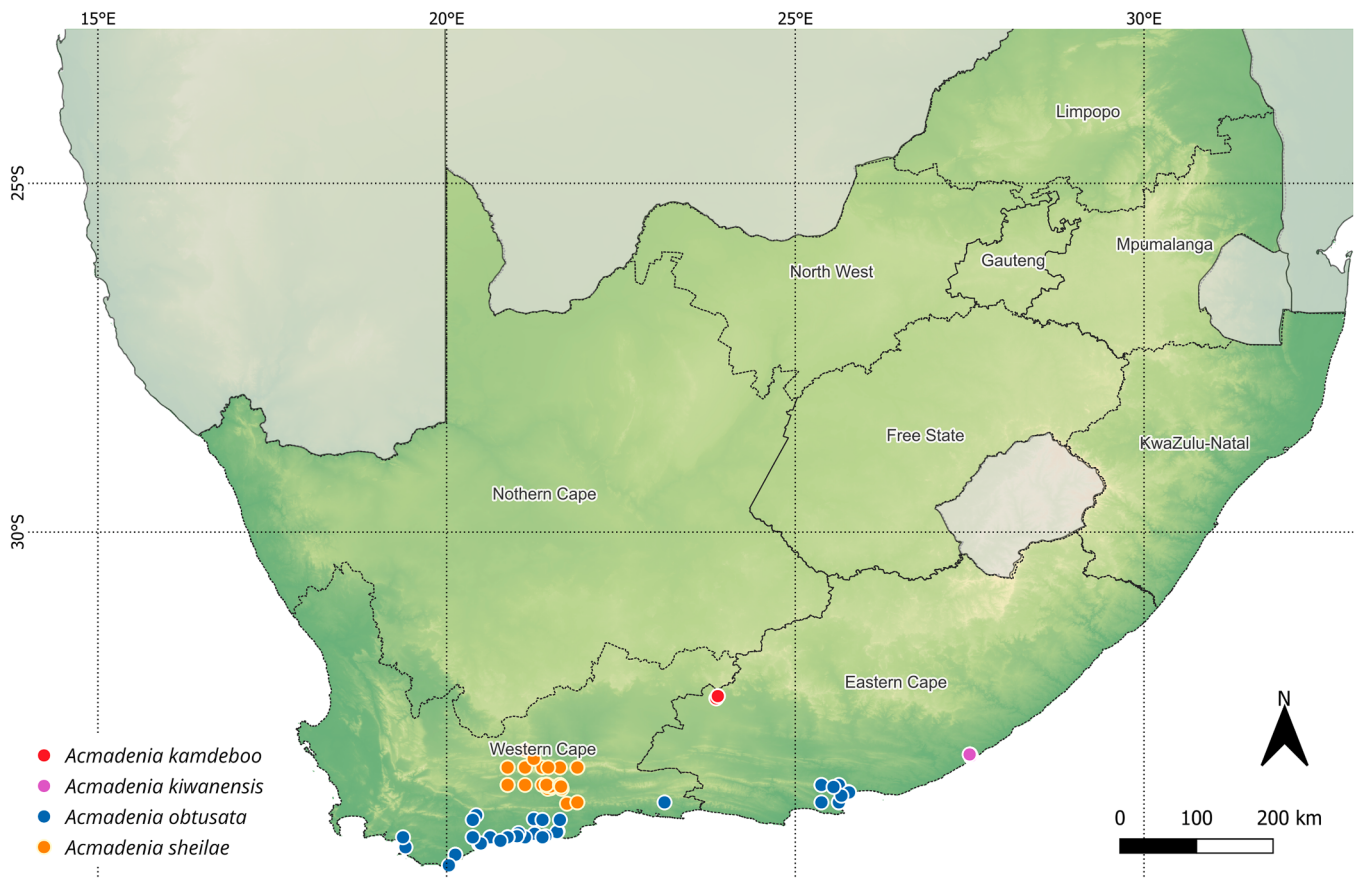


Fig. 4. The distribution of *Acmadenia kamdeboo* V.R. Clark & J.D. Vidal, the closest morphologically similar species *A. sheilae* I. Williams, and the two other species in the genus that occur in the Eastern Cape: *A. kiwanensis* I. Williams and *A. obtusata* (Thunb.) Bartl. & H.L. Wendl.. Basemap colours represent elevation. Contours represent national (continuous lines) and provincial (dotted lines) boundaries. Cartographer: J.D.D. Vidal, Jr.

species was not obviously being affected by human activities or grazing pressure in 2011, but it could be at risk from climate change, given that it is already at the upper elevational limits of available habitat in the Kamdebooberge. We propose the South African National Red List Category of Rare, given the “Species is restricted to a specialized microhabitat so that it has a very small Area of Occupancy (AOO), typically smaller than 20 km²”, and “Small global population: <10,000 mature individuals” (Raimondo et al., 2009). ‘Rare’ is part of the International Union for Conservation of Nature (IUCN) category ‘Least Concern’ (IUCN, 2012).

3.6. Additional specimens examined

South Africa. EASTERN CAPE: 3223 (Aberdeen): Farm Annex Buffelskloof 60, Goewermentsberg, Kamdebooberge, Sneeuwberg, upper slopes and rocky summit edges in grassy fynbos (—BD), 4 Apr. 2008, Clark & Crause 130 (GRA!, BOL!); Farm Annex Buffelskloof 60, Goewermentsberg, Kamdebooberge, Sneeuwberg (—BD), 14 Jan. 2011, Helme 6897 (BOL); Farm Ossehoek 99, Kamdebooberge, Sneeuwberg, rocky dolerite sheets on hillslope, (—BD), 24 Jan. 2011, Clark, Stirton & Weston 80 (GRA!, BOL!).

4. Biogeography & significance

Acmadenia kamdeboo—along with *Faurea recondita* Rourke & V.R. Clark—is one of only two plants currently known to be locally endemic to the Kamdebooberge (Clark et al., 2009, 2012; Rourke et al., 2013). It also forms part of a suite of endemics confined to the western part of the Sneeuwberg massif—a recognised Centre of Floristic

Endemism—including *Erica passerinoides* (Bolus) E.G.H. Oliv., *Euryops dentatus* B. Nord, and *Indigofera magnifica* Schrire & V.R. Clark (Clark et al., 2009, 2015).

It is also the only species of *Acmadenia* known to occur so far into the interior of South Africa, and the only species to occur on the interior (inland) side of the arid Great Karoo that separates the Cape Fold Mountains/CGCFR from the southern Great Escarpment—in this case the Witteberg (north-east of Willowmore, Eastern Cape) are the most significant closest Cape Fold Mountains to the Kamdebooberge, the direct distance being 70 km. All other *Acmadenia* species occur in the CGCFR (mostly Western & Eastern Cape; Manning and Goldblatt, 2012), with one species reaching the Thicket Biome at Coega (Gqeberha/Port Elizabeth; *A. obtusata* (Thunb.) Bartl. & H.L. Wendl.; Eastern Cape) and one occurring as a local endemic along the climatically subtropical Eastern Cape coast south-east of East London (*A. kiwanensis* I. Williams) (Victor and Bester, 2019).

The location of this new species occurring outside of the CGCFR on the south-eastern Great Escarpment is interesting, as numerous Cape lineages (*sensu* Linder, 2003) have species that extend northwards along the mesic eastern African mountain chain—some of these taxa have been very successful, with widespread representation in the Afrotemperate flora (e.g. Valente et al., 2010; Pirie et al., 2011; du Preez et al., 2025). In most cases studied to date, this spread has generally been out of the CGCFR northwards (e.g. Galley and Linder, 2006; Galley et al., 2007; Shaik et al., 2023, 2024), with the possible exception of *Alchemilla* (Gehrke et al., 2016) and *Erica* (Pirie et al., 2011). Whether *A. kamdeboo* is a recently evolved species with ancestors having fynbos distributions can only be determined by a comprehensive molecular study on this and related genera. The Kamdebooberge may be an example of combined



Fig. 5. The Kamdebooberge (Aberdeen area, Eastern Cape), Sneeu Berg Massif: (A) 'Sleeping Giant' summit, showing the unusual local grassy fynbos, and (B) Goewermensberg, where the species was discovered in 2008. Note the dominant dolerite substrate. Photographs by V.R. Clark.

summer- and winter-rainfall associated refugial endemism, given the *Faurea* (summer-rainfall genus) and *Acmadenia* (winter-rainfall genus) endemic species, together with the mix of other co-occurring species from both rainfall regimes (see Clark et al., 2012).

Acmadenia kamdeboo is also the only species in the genus known to occur exclusively on intrusive dolerite (Karoo Supergroup); according to Victor (2023), *A. kiwanensis* occurs on (Karoo Supergroup) quartzitic sandstone-derived soils. Whether *A. kamdeboo* has an actual edaphic preference for dolerite—or that the massive dolerite sills are simply providing an elevated, more erosion-resistant platform for an orographic effect—is not clear. Certainly, throughout the Sneeu Berg massif (and much of the Cape Midlands Escarpment), massive dolerite sills form the dominant and highest elevations and provide the topographic context for the orographic effect that would otherwise be absent in this arid region (e.g. Clark et al., 2009, 2014). The role of dolerite in driving endemism in the interior of the Eastern Cape is thus probably more geomorphological than edaphic (see Clark and Barker, 2014; Carbutt, 2023).

However, it is significant that so many typical Cape elements—including genera (*Acmadenia*) and species (e.g. *Rhodocoma capensis*), otherwise almost completely confined to nutrient-poor Cape sandstones, quartzites, silcretes and coastal sediments (van Wyk and Smith, 2001; Mucina and Rutherford, 2006; Victor and Bester, 2019)—can be found in both highly mineral- and carbon-rich (humic) doleritic soils, further augmented by their presence in an essentially summer-/bimodal rainfall area compared to exclusively winter rainfall in their primary distribution ranges. This edaphic and climate transgression is

probably not so surprising when considering the number of 'Cape' clad species found across the highly variable geological substrates of the Afrotropical region outside of the CGCFR (as discussed above).

5. Conclusion

Following Victor & Bester (2019), *A. kamdeboo* is only the third species recorded from the Eastern Cape and is only the second Eastern Cape endemic to be recorded, although—as evidenced from iNaturalist observations—others are likely in the poorly explored interior mountains of the eastern Core of the Greater Cape Floristic Region bordering the Great Karoo. *Acmadenia kamdeboo* co-occurs with at least two other Rutaceae in the Kamdebooberge: the Albany Thicket-centred *Agathosma venusta* (Eckl. & Zeyh.) Pillans (Victor and Bester, 2019), and an *Agathosma*—collected by VRC at the same time as *A. kamdeboo* and tentatively placed in *A. capensis* (L.) Dummer by Terry Trinder-Smith—but which requires further taxonomic exploration (Clark et al., 2012); it might be the same species as an unidentified *Agathosma* recorded by Brian du Preez (on iNaturalist) on the Witteberg mountains to the south of the Kamdebooberge, and suggested as such by Nick Helme. Certainly, a careful revision of Rutaceae: Diosmeae in the *Flora of Southern Africa* region is overdue and would help place these novelties more precisely taxonomically.

The Kamdebooberge themselves are still overall poorly explored botanically, and there is the potential of additional new species being discovered, new locality records for other Sneeu Berg endemics, and further range extensions from the Core of the Greater Cape Floristic Region across the arid Great Karoo. *Acmadenia kamdeboo* contributes to a growing number of endemics centred on the Cape Midlands Escarpment that includes the Sneeu Berg, Great Winterberg–Amatholes, and Stormberg (Clark et al., 2009, 2014).

CRedit authorship contribution statement

V. Ralph Clark: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **João de Deus Vidal:** Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing. **Nigel P. Barker:** Conceptualization, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no conflicts of interest.

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