



Two new species and a new record of *Digitaria* (Poaceae: Panicoideae) from western Tanzania and the Uzondo Plateau

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Summary. Two new species of *Digitaria* are described from two locations in western Tanzania, including the Uzondo plateau, following collecting trips by Kaj Vollesen and colleagues, *Digitaria laciniata* and *D. setarioides*. Line drawings accompany the descriptions and scanning electron micrographs show spikelet and trichome morphology. *Digitaria parodii* is recorded from Tanzania for the first time. All three species represent aspects of the central African flora in western Tanzania previously unrecorded due to low collecting effort in this area. The Uzondo plateau has been a notable area for recent, new species discoveries.

Key Words. Africa, Anthephorinae, grass, grassland, miombo, Paniceae, Scanning Electron Micrography

Introduction

Digitaria Haller is a common genus of grasses within the subfamily Panicoideae, tribe Paniceae (Poaceae), with an estimated 264 species characterised by their digitate inflorescences with cartilaginous, glabrous fertile lemmas which have membranous margins (Henrard 1950; Clayton & Renvoize 1982; POWO 2024). Across Africa and Madagascar there are around 115 species, including those cultivated for human consumption, *D. exilis* (Kippist) Stapf and *D. iburua* Stapf as Fonio; for livestock, *D. eriantha* Steud. as Pangola grass and notorious agricultural weeds, *D. sanguinalis* (L.) Scop. as Crab finger grass and *D. abyssinica* (Hochst. ex A.Rich.) Stapf as Abyssinian finger grass (POWO 2024; Randrianarimanana *et al.* 2024). Two notable hotspots of *Digitaria* species richness are found in Madagascar, 30 species, MacKinnon *et al.* *in press* and in East Africa, c. 60 species, Clayton & Renvoize 1982.

An early global taxonomic treatment of *Digitaria* was undertaken by Henrard (1950), who emphasised trichome morphology and spikelet arrangement as key characters useful for subdividing the genus. On the basis of these, Henrard divided *Digitaria* into four subgenera and 32 sections. Morphology-based phylogenetic work by Vega *et al.* (2009) and Lo Medico *et al.* (2017) found support for groups of species with binate spikelets (spikelets arranged in pairs) versus ternate (spikelets arranged in groups of three or more). A more recent study by Touafchia *et al.* (2023) confirmed this subdivision using DNA sequence data with a focus on Thai and Malagasy species, finding a distinct ternate spikelet clade nested between two larger binate

clades. The ternate clade contained species with trichomes that are commonly verrucose or capitate, while those of binate species are almost exclusively simple. Ancestral state reconstructions supported the ternate species as having shorter spikelets, while weediness traits were shown to evolve multiple times across the genus (Touafchia *et al.* 2023).

The majority of *Digitaria* species worldwide have not been included in molecular or morphological analyses and species boundaries also remain poorly understood. In spite of its common occurrence and economic significance, *Digitaria* is seen as a challenge taxonomically, partly as magnification of at least ×60 is required to see the taxonomically significant trichome morphology. Across continental Africa, flora treatments were written separately for the different floristic regions, and, therefore, incongruences remain.

The two species, described here as new, were collected from open canopy ecosystems native to western Tanzania. The Uzondo Plateau falls within the *Flora of Tropical East Africa's* T4 region (Clayton & Renvoize 1982). Due to its distance from the coast and former inaccessibility, this area has not been subjected to the same intensity of botanical investigations that the rest of the country has experienced. Indeed, it is difficult to find collections from Uzondo prior to Bernard Verdcourt's visit in 1962, although there are some collections by Bullock dating to 1950. Collections were made by Kahurananga, Kibuwa and Mungai in 1975 and it was then visited by the team of Hooper, Townsend and Mwasumbi in 1980. The intrepid butterfly expert, Colin Congdon, visited the plateau in

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1996 and early 1997. These were passing visits and it was not until Kew teams collected there from 1997 that its botanical significance began to be noticed. Expeditions, usually of about 3 months duration, were undertaken from Kew with participation from Dar es Salaam University, the National Herbarium of Tanzania and the Tropical Pesticides Research Institute (TPRI, Arusha). Five collecting trips to Uzungu were undertaken between 1997 and 2009 until the project was discontinued after the retirement of Kaj Vollesen in 2006 and Sally Bidgood in 2008. Main Kew participants were Sally Bidgood and Kaj Vollesen (all trips), as well as Iain Darbyshire, Kim Hoenseelaar, Gabriel Sanchez-Ken and Chris Whitehouse (single trips). Tanzanian participants were, from Dar es Salaam, Frank Mbago and from Arusha Raphael Abdallah, Godson Leliyo and Daniel Sitoni. Specimens are at Kew (K) as well as the University of Dar es Salaam (DSM) and Arusha (NHT). Many new species and first records for Tanzania (mostly records of species already known from central Africa) were

collected by this team (e.g. Lock 2002; Vollesen 2002) which served to encourage more collectors. In 2014, Quentin Luke, Maria Vorontsova, Canisius Kayombo and John Kimeu travelled to the Uzungu plateau to find the first species of *Barleria* with a tree habit in this genus (Darbyshire & Luke 2016). In the same year, a new species of *Tephrosia*, endemic to the plateau, was published (Crawford *et al.* 2016). The preliminary checklist for this area has over 600 taxa, with an estimated thirty collections still unmatched and likely to be described as new. This gives urgency to both the need to describe these plants and to prioritise conservation for this unique grassland and miombo woodland area.

Among the new Tanzanian collections, we encountered a specimen of the rare *Digitaria parodii* Jacq.-Fél. This species, known from Chad, the Central African Republic, the Democratic Republic of the Congo and Zambia, is here recorded from Tanzania for the first time (Fig 1; Map 1). It is a highland wet grassland annual species with verrucose and apically

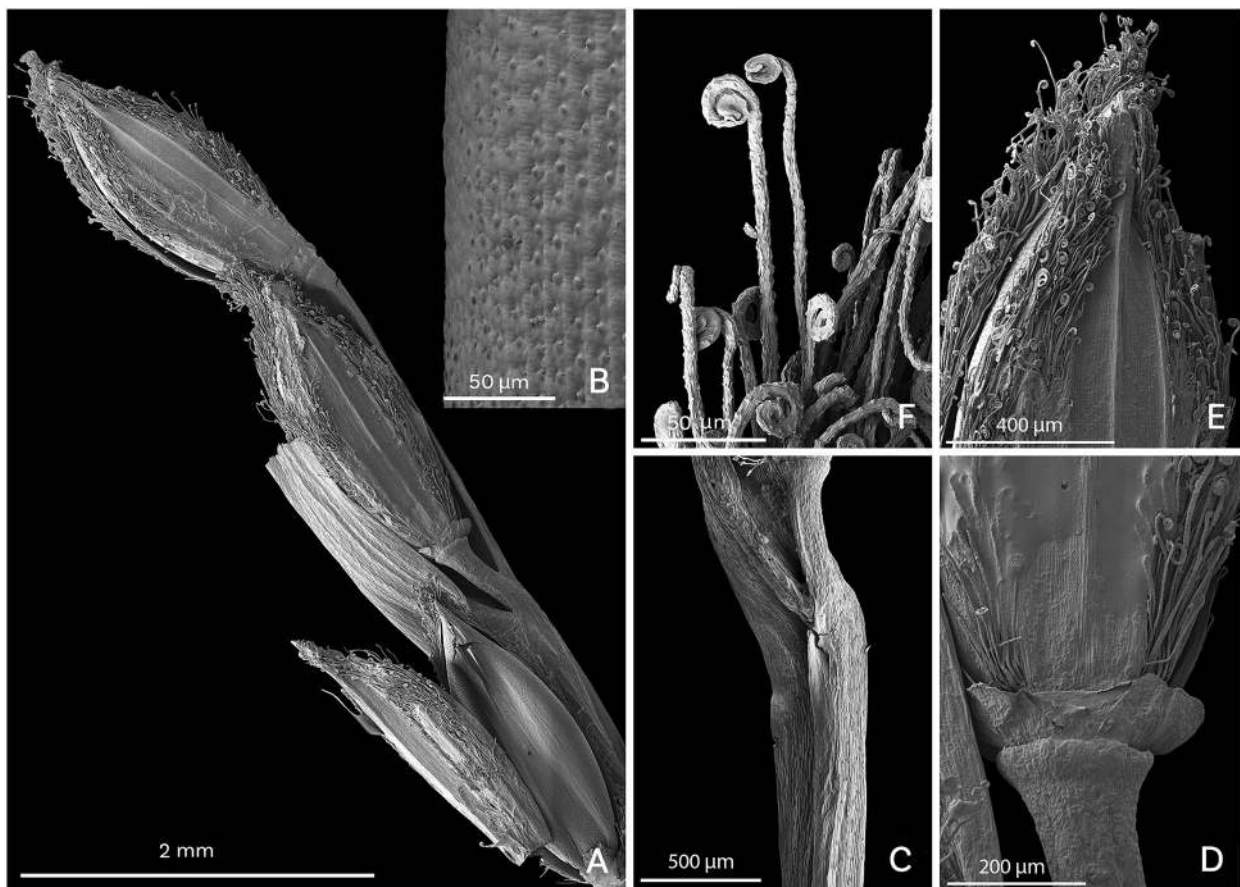
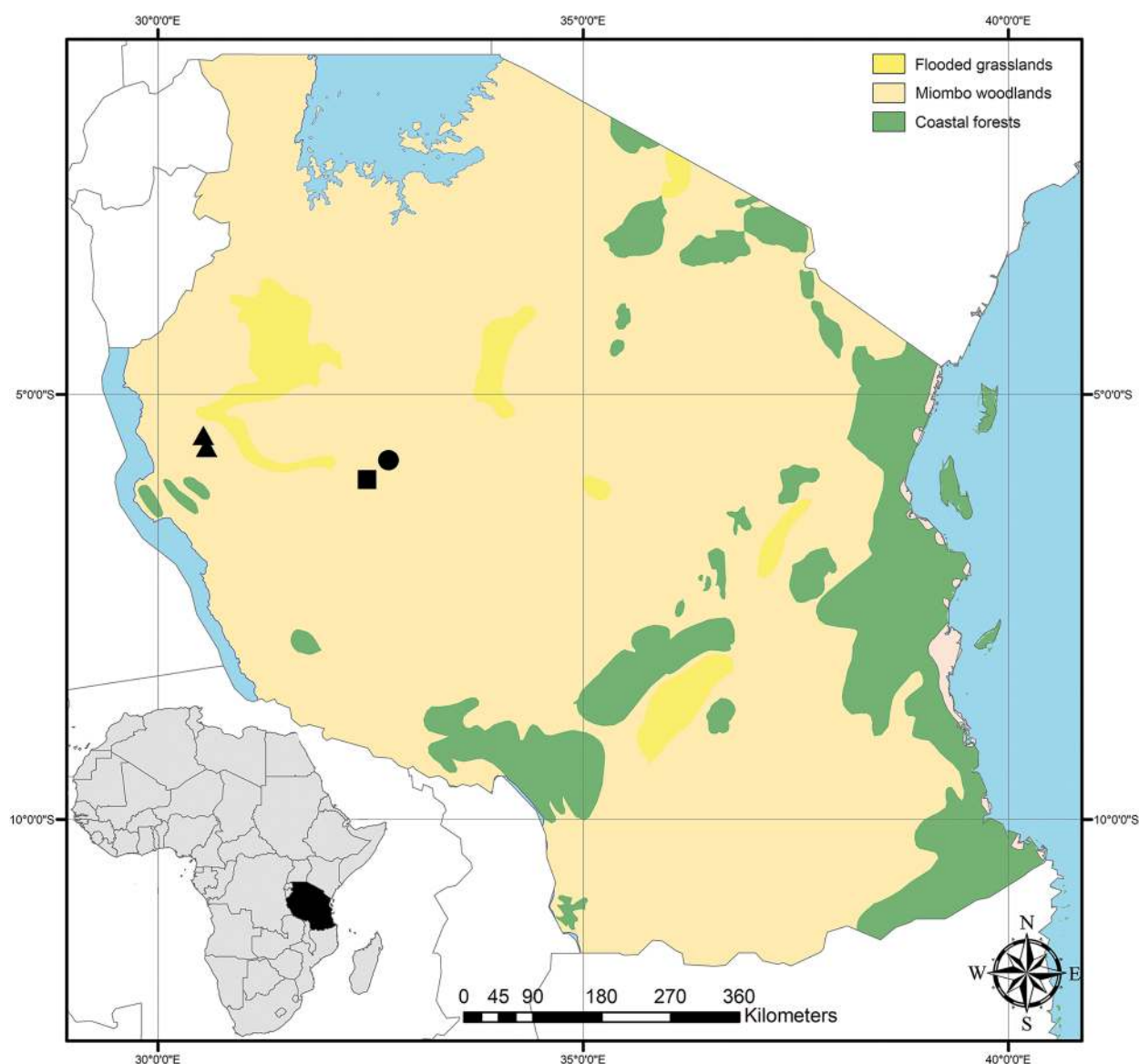


Fig. 1. Scanning Electron Micrographs of *Digitaria parodii* Jacq.-Fél. **A** spikelet pair; **B** surface of the upper lemma; **C** glabrous pedicel of the shorter spikelet; **D** spikelet with the lower lemma at the front; **E** trichomes at the apex of the glumes; **F** apices of the trichomes. From Bidgood *et al.* 7185.



Map 1. Distribution of *Digitaria laciniata* R.F.Almeida, G.P.Burton & Voronts., sp. nov. (circle); *D. setarioides* R.F.Almeida, G.P.Burton & Voronts., sp. nov. (triangles) and *D. parodii* (square) in Tanzania.

curled trichomes, requiring a magnification of at least $\times 60$ to observe fully (Table 1).

Tanzanian collections of *Digitaria* which could not be easily identified to species at the Kew herbarium were examined in detail as part of the current projects on the *Digitaria* of Madagascar and edible *Digitaria* of west Africa. Investigations of spikelet and trichome morphology were conducted using a scanning electron microscope, line drawings and maps were made and descriptions were drawn up.

Materials and Methods

Specimen comparisons were carried out at BR, K, and P (acronyms according to Thiers 2024) herbaria for the best coverage of diversity across the African continent. Morphological data are based on the sheets at K, digital type specimens (JSTOR 2024) and protologues. Vegetative and reproductive terminology follows Clayton & Renvoize (1982) and MacKinnon *et al.* (in press). Provisional conservation assessments follow IUCN (2024) guidelines.

Table 1. Comparison of *Digitaria parodii* and *Digitaria laciniata* R.F.Almeida, G.P.Burton & Voronts., sp. nov. to morphologically similar species and the common *D. longiflora*.

	<i>D. laciniata</i> sp. nov.	<i>D. maniculata</i>	<i>D. tenuifolia</i>	<i>D. parodii</i>	<i>D. longiflora</i>
Leaf blade	flat	flat	involute, filiform	flat	flat
Leaf blade surface	scaberulous	scaberulous to smooth	papillate to smooth	hirsute to smooth	hirsute to smooth
Rachis margin	scaberulous	smooth	scaberulous	smooth	scabrous
Spikelet trichomes	wavy, apically curled	wavy, apically curled	wavy, apically curled	verrucose, apically curled	verrucose, not apically curled
Trichome tufts at glume apices	present	present	present	absent	absent
Lower glume	reduced to a narrow scale	0.5 – 1 mm long, clearly obscuring the base of the trichome tufts	0.5 – 1 mm long, clearly obscuring the base of the trichome tufts	absent or reduced to narrow scale	reduced to a narrow scale
Occurrence	Sikonge District, Tanzania	Tropical Africa, not including Tanzania	Zambia	Chad, Central African Republic, Democratic Republic of the Congo, Tanzania, Zambia	Pantropical

For scanning electron microscopy (SEM), spikelets were sampled from herbarium sheets at K 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 on a Hitachi 8230 microscope under a 5 kV electron beam, and the images were digitised. Maps were created using Arc-GIS 9.3 software (ESRI 2010) based on geographical coordinates obtained from the herbarium sheets and shapefiles of base maps obtained from WWF (2024).

Results

Spikelet indumentum has proven to be the most challenging aspect of the morphology of this genus to understand and describe, due to its complex nature, the need for SEM to visualise it fully, and inconsistent terminology used by past workers. This would be a fruitful subject for a future, genus-wide study in a phylogenetic context.

New Record

Digitaria parodii Jacq.-Fél.

SPECIMENS EXAMINED. TANZANIA. T4, District of Sikonge, 41 km on Ipole-Inyonga road, 6°02'S 32°29'E, 975 m elev., fl., 2 June 2008, G. S. Bidgood, G. Leliyo & K. Vollesen 7185 (DSM, K [K001615654, K001615655], MEXU, MO, NHT, P and WAG).

Taxonomic Treatment

***Digitaria setarioides* R.F.Almeida, G.P.Burton & Voronts. sp. nov.** Type: Tanzania. Mpanda District,

Uzondo Plateau, 5°29'S 30°32'E, 1550 m elev., 15 April 2006, G. S. Bidgood, I. Darbyshire, K. Hoenselaar, G. Leliyo, G. Sanchez-Ken & K. Vollesen 5499 (holotype K [K001765795!]; isotypes DSM, EA, K [K000190729!], NHT).

<http://www.ipni.org//urn:lsid:ipni.org:names:77377009-1>

Annual; semi-prostrate, rooting at the nodes, reaching up to 20 – 30 cm above the ground. *Culm* smooth, glabrous. *Nodes* dark, glabrescent. *Leaf sheaths* pilose, not overlapping. *Ligule* membranous, truncate, c. 1 mm long, glabrous. *Leaf blades* 4 – 6 × 0.2 – 0.3 cm, flat, linear-lanceolate, rounded at base; apex acute; margins minutely scabrid; margins ciliate and both surfaces pilose, sometimes becoming glabrous at maturity. *Peduncle* 1 – 8 cm long; densely pilose. *Racemes* 5 – 12, solitary along a common axis of 1 – 2.5 cm, alternate, obliquely ascending to horizontally spreading at maturity, 1 – 3.5 cm long, stipitate, with glandular patches at the base of the stipe. *Rhachis* 0.3 – 0.4 mm wide, triquetrous, sparsely pilose with tubercle-based trichomes up to 13 mm long; trichomes often with glandular tissue at base; margins scabrid, with frequent regular teeth; spikelets paired, on a long and a short pedicel; spikelet arrangement loose. *Pedicels* slender, flattened, scabrid, with regular teeth; short pedicels 0.3 – 0.6 mm long, long pedicels 1.8 – 1.9 mm long. *Spikelets* paired, 1.9 – 2.0 × 0.7 – 0.9 mm, diverging from the rhachis at maturity, elliptic, apically obtuse, dorsally compressed, with white sinuous trichomes curling towards the tips. *Lower glume* a rounded scale to cuff, 0.2 – 0.3 mm long, less



Fig. 2. *Digitaria setarioides* R.F.Almeida, G.P.Burton & Voronts., sp. nov. **A** habit; **B** raceme; **C** spikelet pair; **D** spikelet; **E** spikelet showing upper glume; **F** upper glume, ventral view; **G** lower lemma, dorsal view; **H** lower lemma, ventral view; **J** upper lemma; **K** lodicules; **L** upper palea. Scalebar: **A** = 3 cm. **B** = 3.3 mm. **C** = 1.4 mm. **D** – **K** = 0.7 mm. From Bidgood *et al.* 5499. DRAWN BY LUCY T. SMITH.

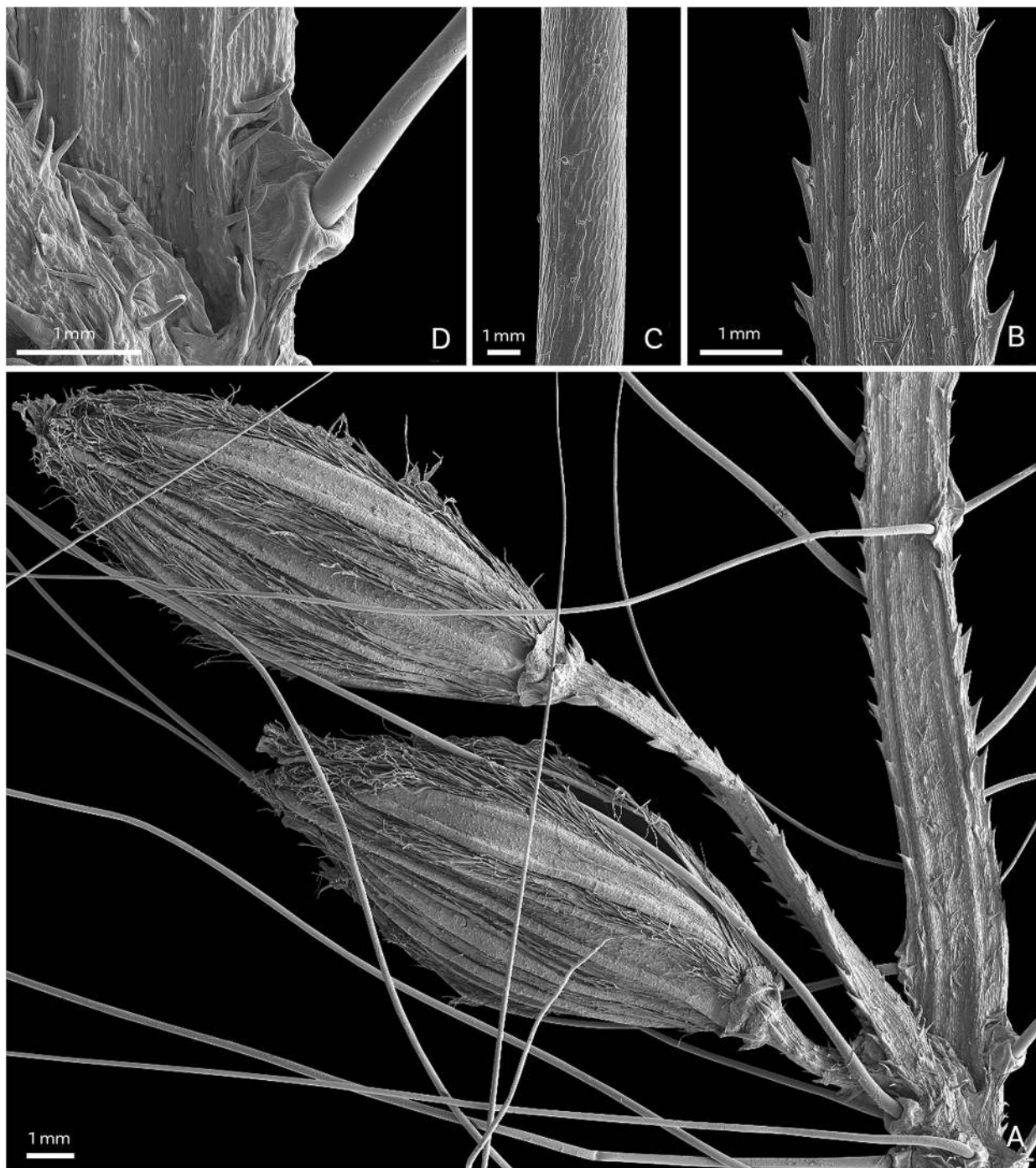


Fig. 3. Scanning Electron Micrographs of *Digitaria setarioides* R.F.Almeida, G.P.Burton & Voronts., sp. nov. **A** inflorescence main axis and spikelets; **B** scabrous margins of the main axis; **C** surface of a bulbous-based trichome; **D** bulbous base of a trichome on the inflorescence main axis. From Bidgood *et al.* 5499.

than $\times 0.1$ of spikelet length, hyaline, truncate. *Upper glume* elliptic; c. 2.2 mm long, as long as the spikelet, membranous, 5-veined; surface pilose between the veins; margins pilose at apex only, hairs white, apex

acute. *Lower floret* sterile, with no palea. *Lower lemma* 1.7 – 1.8 mm long, as long as the spikelet, elliptic-obovate, membranous, 7-veined, veins equidistant, pilose between most veins but the central interstices

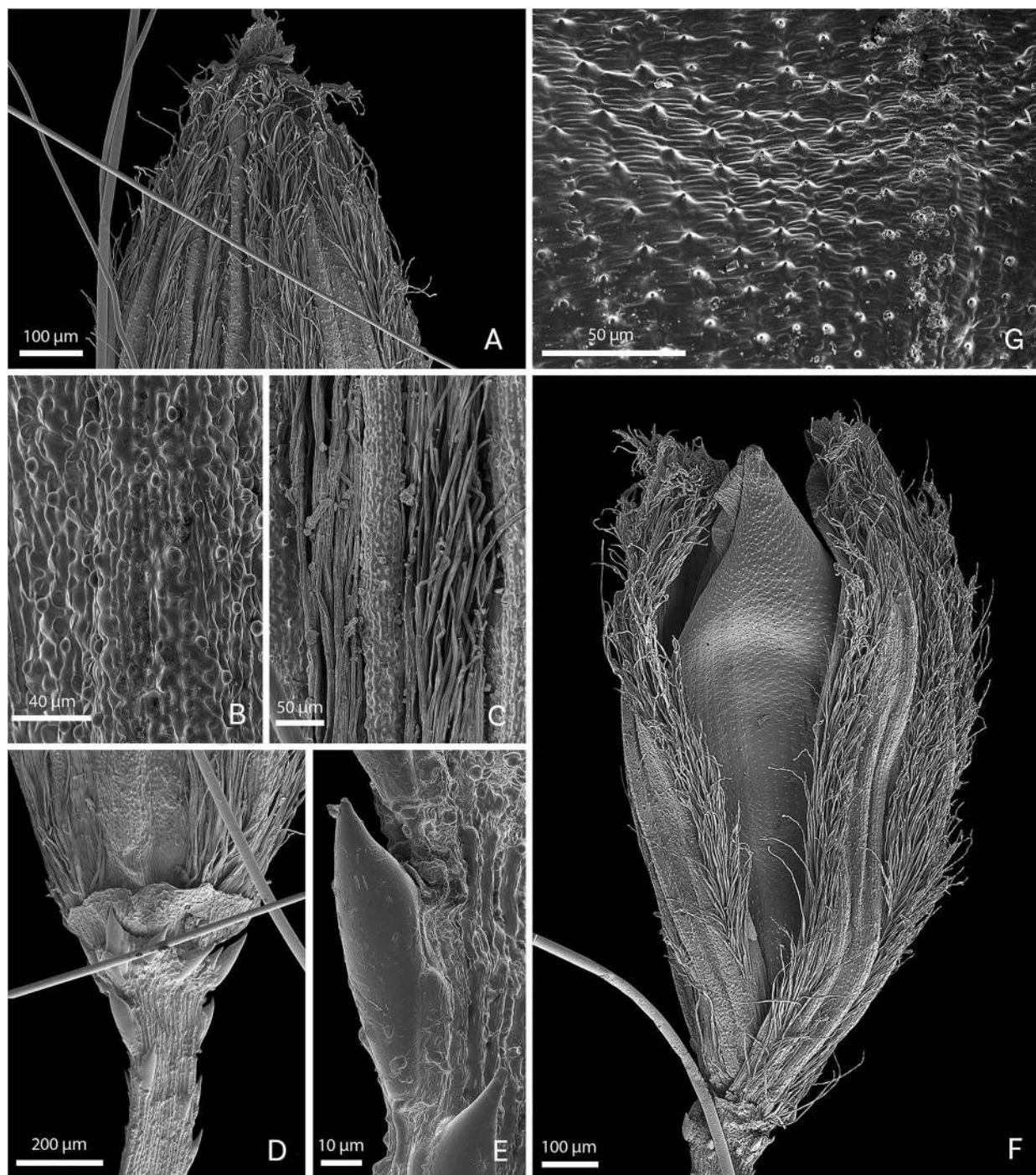


Fig. 4. Scanning Electron Micrographs of *Digitaria setarioides* R.F.Almeida, G.P.Burton & Voronts., sp. nov. **A** apex of a spikelet; **B** surface of a lower lemma; **C** surface of the upper glume; **D** scabrous pedicel and the base of the spikelet; **E** scabrous margin of the pedicel; **F** spikelet, lateral view; **G** surface of the upper lemma. From Bidgood *et al.* 5499.

glabrous, margins pilose near apex; apex acute. *Upper lemma* 1.65 – 1.70 mm long, grey-violet when dried, elliptic-obovate; apex acute. *Upper palea* 1.5 – 1.65

mm long, hyaline, elliptic to ovate-elliptic. *Lodicules* 0.20 – 0.25 mm long. *Anthers* c. 1 mm long. *Caryopsis* not seen. Figs 2, 3, 4.

Table 2. Comparison of *Digitaria setarioides* R.F.Almeida, G.P.Burton & Voronts., sp. nov. to *D. appropinquata*, the only other species of African *Digitaria* to display similar trichomes on its inflorescence rachis.

	<i>D. setarioides</i> sp. nov.	<i>D. appropinquata</i>
Raceme rachis	with elongated white trichomes	with elongated white trichomes
Spikelet apex	obtuse	acute to acuminate
Upper glume length	as long as the spikelet	c. ×0.6 of the spikelet length
Lower lemma central veins	distance visible between veins	veins almost touching
Spikelet indumentum	indumentum between nerves of the upper glume and lower lemma	glabrous
Occurrence	Mpanda District, Tanzania	Mozambique

RECOGNITION. This species is similar to the Mozambique endemic *Digitaria appropinquata* Goetgh., which shares overall appearance and the elongated white trichomes on the raceme rhachis, but with the spikelets apically obtuse (vs apically acute to acuminate in *D. appropinquata*), and the upper glume as long as the spikelet (vs upper glume c. ×0.6 of the spikelet length). *Digitaria appropinquata* is known from a single collection and is the only species found to display similar, distinctive trichomes on its rachis. Table 2.

DISTRIBUTION. Only known from the Uzondo Plateau, Mpanda District, Tanzania. Map 1.

ADDITIONAL SPECIMENS EXAMINED. TANZANIA. T4, Mpanda Distr., Uzondo Plateau, 5°29'S 30°32'E, 1550 m elev., 2 May 2008, *Bidgood, Leliyo & Vollesen* 6608 (DSM, K [K001615656], MO, NHT, P, WAG); *ibid.*, 3 km S of Uzondo camp, 5°31'S, 30°32'E, 1600 m elev., 10 March 2009, *Bidgood, Leliyo & Vollesen* 8074 (C, DSM, K [K001615657], MEXU, MO, NHT, P, UPS, WAG).

HABITAT. Miombo woodlands, in areas of short seepage in *Loudetia* grassland, on shallow sandy-peaty soil, over sandstone rocks, at 1550 – 1600 m elevation.

CONSERVATION STATUS. Provisionally assessed here as Endangered [EN B2ab(iii)] as area of occupancy is under 500 km² and the species is known from only three locations, all outside of protected areas (IUCN 2024). A continuing decline of this species is highly likely due to environmental degradation following human migration in the Mpanda district (Silangwa 2018). Further information, regarding the AOO in particular, is required to confirm this assessment.

ETYMOLOGY. Named due to the racemes resembling *Setaria* P.Beauv. with its long trichomes.

***Digitaria laciniata* R.F.Almeida, G.P.Burton & Voronts. sp. nov.** Type: Tanzania. Sikonge District, 13 km from Sikonge-Ipole Road, 5°43'S 32°44'E, 1050 m, 20 May 2008, *G. S. Bidgood, G. Leliyo & K. Vollesen* 6938 (holotype K [K001765798!]; isotype NHT).

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Annual; semi-prostrate, rooting at the nodes, reaching up to 10 – 15 cm above the ground. *Culm* smooth, glabrous. *Nodes* dark, glabrescent. *Leaf sheaths* sparsely pilose abaxially when young, with bulbous based hairs, rapidly becoming glabrous, overlapping for c. half their length. *Ligule* membranous, truncate, 1.5 – 2 mm long, surface glabrous, apically minutely hirsute. *Leaf blades* 1.5 – 5.0 × 0.2 – 0.4 cm, flat, ovate-lanceolate, rounded at base; apex acute; surface smooth, glabrous; margins thickened, basally pilose with long bulbous based hairs, scaberulous. *Peduncle* 1 – 5 cm long, glabrous. *Racemes* paired, 3.5 – 4.0 cm long, obliquely ascending, stipitate. *Rhachis* 0.2 – 0.3 mm wide, narrowly winged, triquetrous, glabrous; margins scabrous, with regular teeth, spikelet arrangement distant with almost no overlap; spikelets single or paired, on a long and a short pedicel. *Pedicels* slender, sinuous, triquetrous, scabrid, with regular teeth; short pedicels 0.8 – 0.9 mm long, long pedicels 3.0 – 3.5 mm long. *Spikelets* 2.0 – 3.0 × 0.7 – 0.8 mm, narrowly-elliptic; apically shortly acuminate, with yellowish-white wavy trichomes curling towards the tips. *Lower glume* a minute scale or absent. *Upper glume* narrowly elliptic, c. 2 mm long; ×0.7 length of spikelet; membranous; 5-veined; surface sparsely pubescent between the veins; margins pubescent to subglabrous; apex acute; with two tufts of prominent trichomes at the base c. 1 mm in length, trichomes white, wavy, curved at the apex, of somewhat uneven length. *Lower lemma* 2.0 – 2.3 mm long, narrowly elliptic, as long as the spikelet, membranous, 5 – 7-veined, central interstices widest, pubescent between the veins but central interstices glabrous, margins pubescent, rarely subglabrous; apex acuminate. *Upper lemma* 2.1 – 2.3 mm long, light coloured, narrowly elliptic; apex acuminate. *Upper palea* 1.5 – 1.6 mm long, elliptic to narrowly elliptic, hyaline, smooth. *Lodicules* 0.20 – 0.25 mm long. *Anthers* 1.0 – 1.2 mm long. *Caryopsis* not seen. Figs 5, 6.

RECOGNITION. Related to *Digitaria maniculata* Stapf and *D. tenuifolia* Goetgh., with similar trichome tufts,

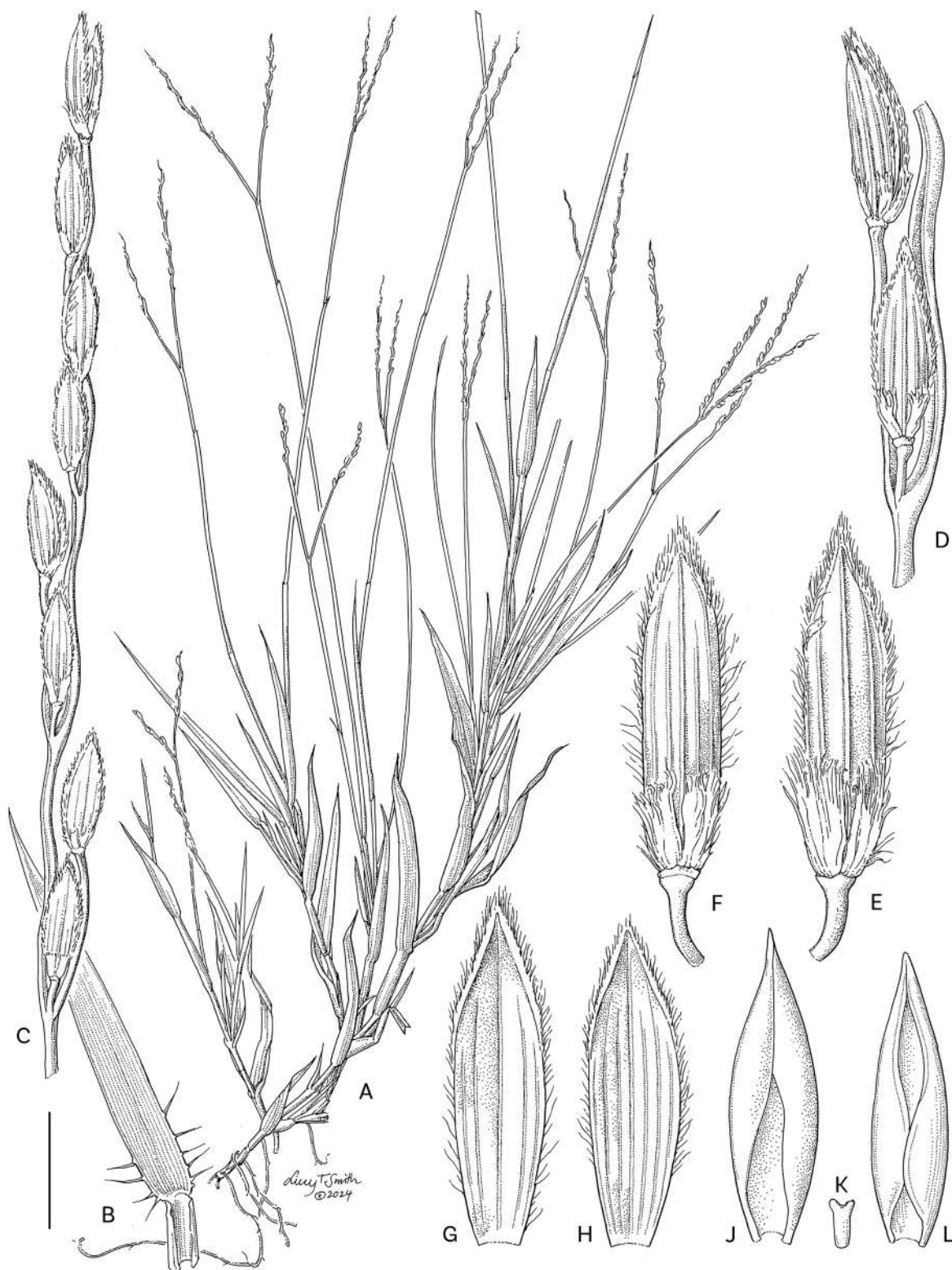


Fig. 5. *Digitaria laciniata* R.F.Almeida, G.P.Burton & Voronts., sp. nov. **A** habit; **B** leaf; **C** raceme; **D** spikelet pair; **E** spikelet showing the upper glume with the basal fringe; **F** spikelet showing lower lemma with the basal fringe and a reduced lower glume; **G** upper glume, ventral view; **H** lower lemma, ventral view; **J** upper lemma; **K** lodicule; **L** upper palea. Scalebar: **A** = 2 cm. **B** = 3.3 mm. **C** = 2.5 mm. **D** = 1.4 mm. **E** – **K** = 0.8 mm. From Bidgood *et al.* 6938. DRAWN BY LUCY T. SMITH.

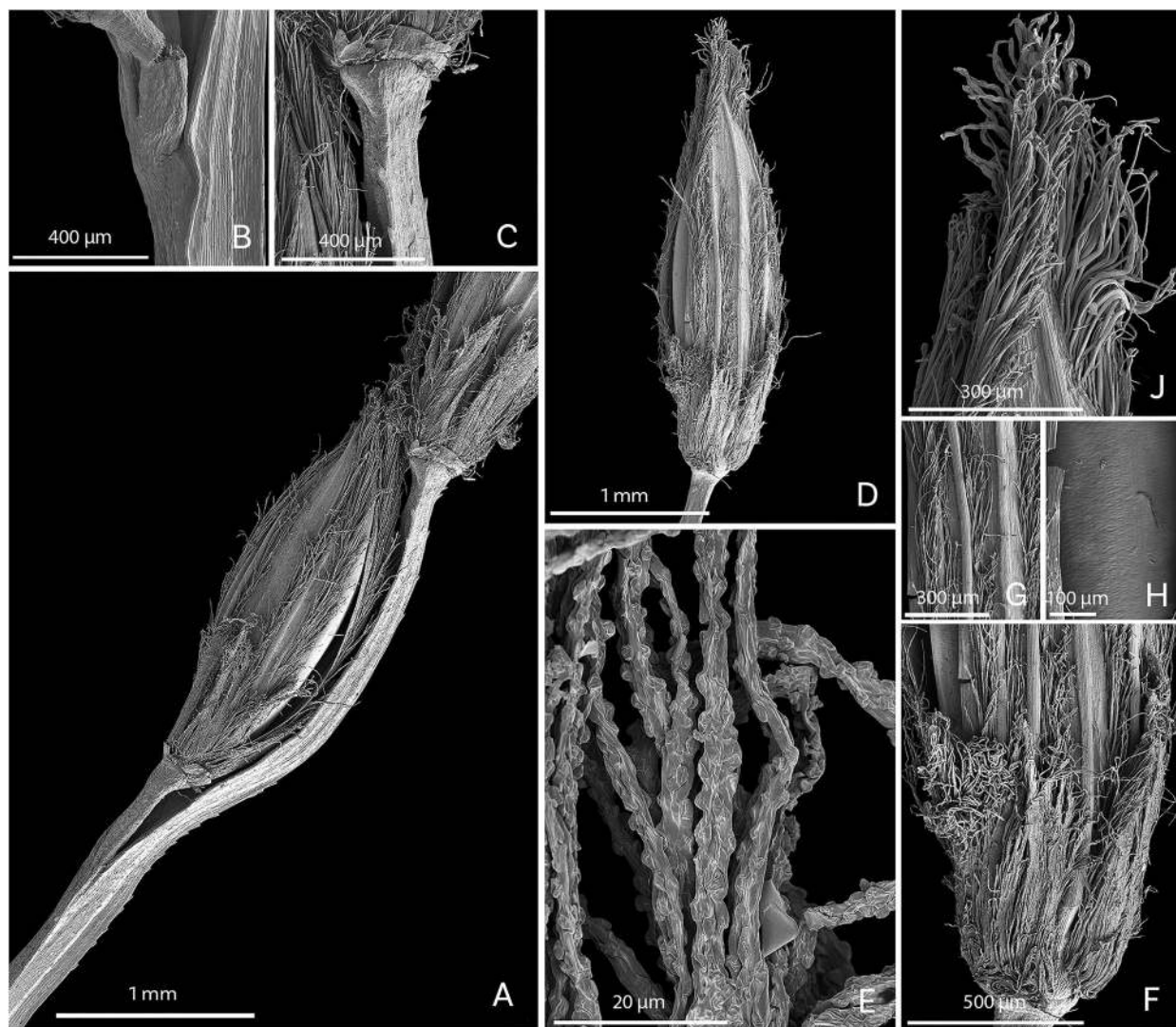


Fig. 6. Scanning Electron Micrographs of *Digitaria laciniata* R.F.Almeida, G.P.Burton & Voronts., sp. nov. **A** spikelet pair; **B** glabrous pedicel of the shorter spikelet; **C** scabrous margins of the pedicel of the longer spikelet; **D** spikelet with the lower lemma at the front; **E** trichomes at the base of the glumes; **F** base of the spikelet; **G** surface of the glume; **H** surface of the lemma; **J** apex of the spikelet. From Bidgood *et al.* 6938.

D. laciniata differs by its lower glume reduced to a narrow scale (vs lower glume 0.5 – 1 mm long, clearly obscuring the base of the trichome tufts in *D. maniculata* and *D. tenuifolia*). Additionally, it differs from *D. maniculata* by its scaberulous rachis margins (vs smooth in *D. maniculata*) and from *D. tenuifolia* by its flat leaves (vs not involute, filiform in *D. tenuifolia*) with a scaberulous (vs papillate) surface. Compared to the common, and superficially similar, *D. longiflora* (Retz.) Pers., *D. laciniata* is strictly annual (vs longer lived in *D. longiflora*), with straight racemes (vs usually gently curved) and the lower quarter to half of the raceme is barren of spikelets (vs spikelets covering the full length of the racemes). Table 1.

DISTRIBUTION. Known from a single collection in the Sikonge District, Tanzania. Map 1.

HABITAT. Miombo woodlands in seasonally wet short grassland, on sandy-loamy soil, at 975 – 1050 m elevation.

CONSERVATION STATUS. Provisionally assessed here as Critically Endangered [CR B2ab(iii)] as the area of occupancy is under 100 km² and the species is known from a single location, outside a protected area (IUCN 2024). A continuing decline of this species is highly likely due to contraction of its habitat in the miombo woodland (Masanja 2013). Further information, regarding the AOO in particular, is required to confirm this assessment.

ETYMOLOGY. Named due to the upper glume and lower lemma bearing a laciniate fringe of long and somewhat connate hairs at base, resembling a skirt.

NOTES. Spikelet indumentum is purple-tinged when young and fresh, and dries a yellowish-white colour, different from the bright white colour of the trichome tufts at the spikelet base. It seems likely that the trichome tufts have a role in seed dispersal.

In the notes accompanying his description of *Digitaria maniculata*, Henrard (1950: 427) states that “the spikelets are unique in the whole genus, the lower glume is very peculiar with its tuft of hairs protruding from underneath”. It seems clear that the new species, as well as the later described *D. tenuifolia*, are related to *D. maniculata* Stapf.

Acknowledgements

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Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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