

## A NEW ENDEMIC SPECIES OF *POLYSTACHYA* (POLYSTACHYINAE) FROM EASTERN TANZANIA

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**ABSTRACT.** *Polystachya nguruensis*, a new endemic species from the isolated Nguru Mountains of eastern Tanzania, is described here, and its affinities and conservation status are discussed. *Polystachya nguruensis* differs from *P. lukwangulensis* in having much longer, more obviously several-noded pseudobulbs, shorter, narrowly oblong-elliptic, coriaceous leaves, and a longer, more densely many-flowered, branching inflorescence with smaller flowers and ecallose lip with a narrowly oblong a midlobe with a broadly obovate to subcircular, apiculate, lip midlobe. Unlike most allied species, it is a lithophyte, growing on sloping slabs of crystalline rock, a highly vulnerable habitat that has already been partly destroyed by fire. Consequently, it is assessed to be Critically Endangered and in need of immediate conservation attention.

**KEYWORDS / PALABRAS CLAVE:** amenazas, conservation suggestions, Critically Endangered, endemism, endemismo, Montañas Nguru, new species, Nguru Mountains, nuevas especies, peligro crítico, *Polystachya nguruensis*, sugerencias de conservación, threats

**Introduction.** The Nguru Mountains lie inland from the Tanzanian coast almost midway between Dar-es-Salaam and Tanga. They form part of the Eastern Arc Mountains of East Africa and comprise ancient crystalline Precambrian rocks that were uplifted over millions of years along fault lines. The most recent period of uplift started 30 million years ago, but the fault system and uplift process may be far older. The soils derived from these rocks are not as fertile as those younger volcanic soils of mountains to the north and west. Separated by plains or low hills, the better-known Uluguru Mountains lie to the southeast, and the infrequently visited Ukaguru Mountains lie to the southwest (Doggart & Loserian 2007).

The Nguru Mountains, running roughly north-east-southwest, cover an area of ca. 1673 km<sup>2</sup> and rise to 2400 m in the South. The range lies in the watershed of the Wami River. The mountains intercept moisture-laden winds from the Indian Ocean, which provide most of the rainfall. Rainfall averages 1800 mm annually, most of which falls in the November-to-May wet season, although mist and light rain occur at higher elevations during the dry season months. Rainfall is higher on the southern and eastern slopes (Burgess *et al.* 2007).

The Eastern Arc Mountains are rich in endemic animals and plants, including 48 endemic species of orchids (Cribb 1984, 1989, Summerhayes 1968). Thirteen orchid species are endemic to the Uluguru and an equivalent number to the Usambaras. The Nguru Mountains are less rich, but the monotypic genus *Thulinia* (*T. albolutea* P.J.Cribb) and five other orchid taxa (*Brachycorythis tanganyikensis* Summerh., *Mystacidium nguruense* P.J.Cribb, *Polystachya canaliculata* Summerh., *P. rugosilabia* Summerh., and *Zeuxine lunulata* P.J.Cribb & Bowden) are all endemic to the region (Cribb 1984, 1989, Summerhayes 1968).

Recent phylogenetic studies on arthropods (Orthoptera) have shown that the high proportion of endemic species is not due to great age and ecoclimatic stability of these forests but, on the contrary, to repeated variation in climatic conditions (Hemp *et al.* 2014, 2015). These climatic variations allowed the dispersal of forest species during repeated wet periods and promoted speciation during dry periods when the forests were isolated (Hemp & Hemp 2018).

According to Pocs *et al.* (1990), the following vegetation belts are present: 1) bamboo forests and thickets on the Mafulumula summit area at 2000–2400

m altitude; 2) Afroalpine elfin forests and ericaceous heaths at 2000–2300 m on the more rainy southeastern side; 3) montane evergreen forests at 1400–2000 m, with a mossy forest character with many epiphytes on the rainy side rainforest above 1800 m; 4) submontane (intermediate) rainforests on the eastern slopes and mesic forests on the western slopes at 800–1400 m; 5) lowland rainforests in the east-facing valley; and 6) miombo woodland and dry semi-evergreen forest on the drier and more open slopes between 300 and 800 (on the west up to 1200 m).

During ecological field work in the Nguru Mountains between 2021 and 2023, one of the authors (AH) discovered a new species of *Polystachya*. It is described here and appears to belong to section *Superpositae*, characterised by producing a new pseudobulbous several-noded stem from one of the upper nodes of the preceding year's growth, producing a sympodium that hangs from the substrate or creeps along it. The lower stem nodes produce a sheath while the upper two to four produce leaves. In most species of the section the leaves are less coriaceous. DNA analyses of *Polystachya* (Mytnik-Ejmsmont 2011, Russell *et al.* 2010, 2011) have shown that the sectional treatment provided by earlier authors (e.g., Cribb 1984) is largely artificial but no satisfactory new infrageneric classification has yet been proposed.

**Material and methods.** Herbarium material was dissected and examined under a Zeiss binocular microscope and compared with herbarium collections in K, BR, P. The Extent of Occurrence (EOO), the Area of Occupancy (AO), and the Conservation Status were assessed using the IUCN criteria for Red List Categories and Criteria (IUCN 2022).

#### TAXONOMIC TREATMENT

*Polystachya nguruensis* P.J.Cribb & Hemp, *sp. nov.* Fig. 1–2.

TYPE: Tanzania. Eastern Arc Mountains: Nguru Mountains, 23.11.2021, *A. Hemp* 7769 (holotype K; isotype NHT, B, UBT)

DIAGNOSIS: *Polystachya nguruensis* differs from *P. lukwangulensis* P.J.Cribb in section *Superpositae* in being a lithophyte (vs. epiphyte in *P. lukwangulensis*) and

in having much longer, more obviously several noded pseudobulbs (30–70 × 56 mm vs. 15–25 × 4 mm), shorter, narrowly oblong-elliptic, coriaceous leaves (20–45 × 9–24 mm vs 40–55 × 8–9 mm), and a longer, more densely many-flowered, branching inflorescence (densely 10- or more-flowered with up to two branches vs laxly few-flowered and unbranched) with smaller flowers with a 4.5–6.0 × 2–3 mm dorsal sepal, 6.5–7.0 × 3.5–4.5 mm lateral sepals, 4.5–5.5 × 0.8–1.0 mm petals and a 4.0–5.5 × 3 mm lip (vs 11 × 5.5 mm dorsal sepal, 11 × 7 mm lateral sepals, 10 × 9 mm petals, and a 10 × 9 mm lip) and ecallose lip with a narrowly oblong midlobe and rather than a callose one with a broadly obovate to subcircular, apiculate, lip midlobe (Table 1).

A creeping lithophytic *herb* up to 45 cm long; *roots* basal, clustered, cylindrical, branched, 1.5–2.5 mm in diameter. *Stems* 3- to 9-noded, superposed, 20–120 mm long, 2–5 mm in diameter, broadest towards the apex, the new stem arising from the middle or one of the upper nodes, drying orange-yellow, covered when young by papery red-brown tubular sheaths, drying grey. *Leaves* coriaceous, 3–4 from the upper nodes of each stem, imbricate at the base, oblong-elliptic, subacute, 20–50 × 10–16 mm, sheathing at the base, the sheaths covering the young stem. *Inflorescences* simple or sparsely branched, 1–2 from the uppermost leaf sheaths, 40–60 mm long, the branches 10–20 mm long; peduncle and rachis pubescent; bracts spreading, ovate-lanceolate, acuminate, 1–3 mm long. *Flowers* non-resupinate, not opening widely, yellow, pubescent on outer surfaces; pedicel and ovary 6–8 mm long, densely pubescent. *Dorsal sepal* ovate, acute, 4.5–6.0 × 2–3 mm; lateral sepals obliquely ovate, acuminate, 6.5–7.0 × 3.5–4.5 mm, spreading at an acute angle to expose the lip, forming a 3 mm tall obconical mentum with the column foot. *Petals* oblanceolate, acuminate, 1-veined, 4.5–5.5 × 0.8–1.0 mm. *Lip* fleshy, long-clawed, strongly recurved in upper part, 4.0–5.5 × 3 mm when flattened, ecallose; side lobes obliquely obovate, 1 mm high, strongly erect on either side of the column; midlobe strongly recurved, 2 × 1.5 mm, with a rugulose surface, ovate, acuminate. *Column* 1 mm long; column-foot 3 mm long.

ADDITIONAL MATERIAL STUDIED: Tanzania. Eastern Arc Mountains: Nguru Mountains, 18.3.2023, *A. Hemp* 7983 (K, NHT).

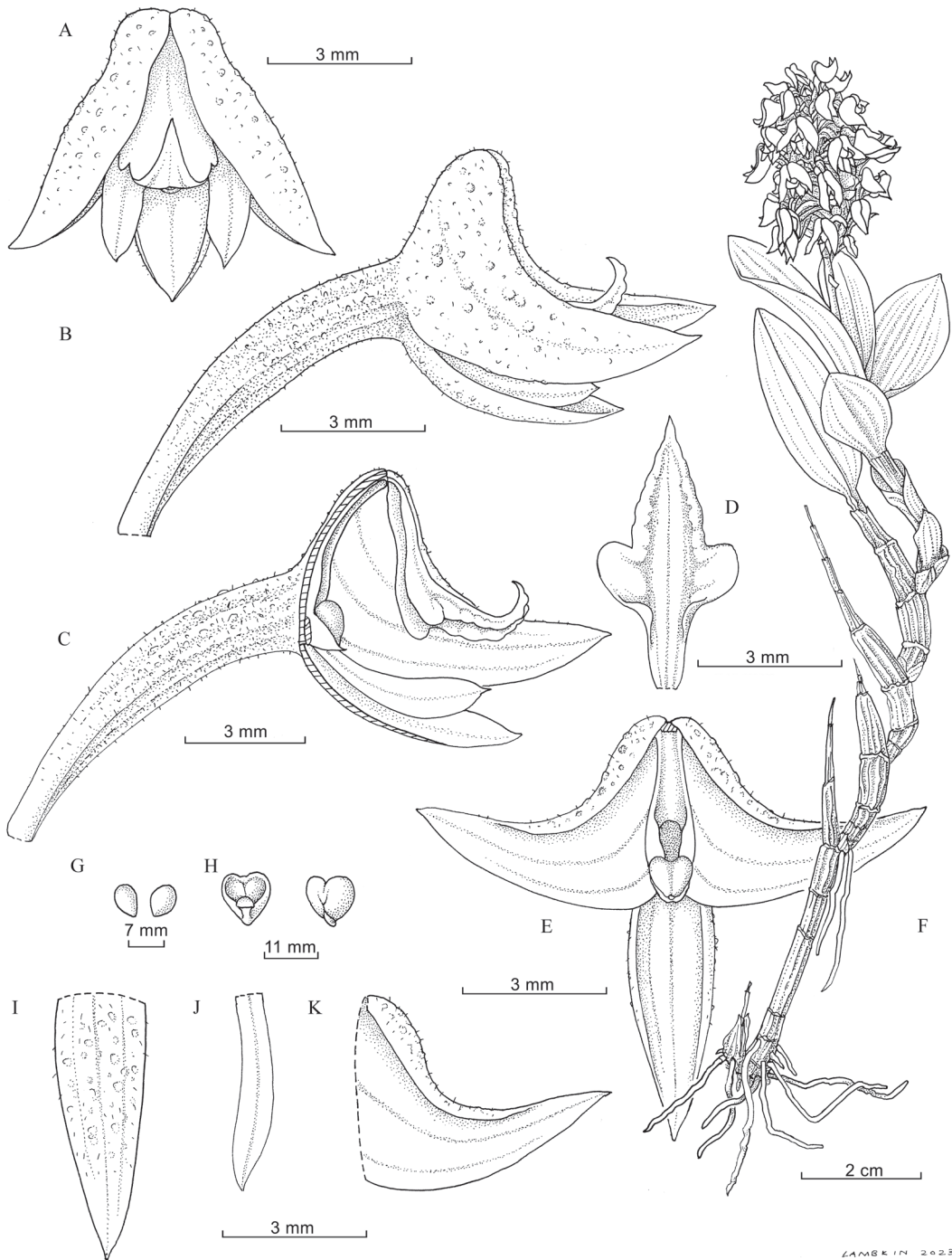


FIGURE 1. *Polystachya nguruensis*. A. Flower from front. B. Flower from side. C. Flower with nearside lateral sepal and petal removed. D. Lip, flattened. E. Flower with lip removed. F. Habit. G. Pollinia. H. Anther cap, two views. I. Dorsal sepal. J. Petal. K. Lateral sepal. Drawing by Deborah Lambkin from the type collection.



FIGURE 2. *Polystachya nguruensis* inflorescence *in situ* in the Nguru Mountains. Photo by A. Hemp.

ETYMOLOGY: The species epithet “*nguruensis*” denotes that this species is, so far as is known, endemic to the Nguru Mountains of Tanzania.

DISTRIBUTION. Known only from two localities on the western slope of the Nguru Mountains (Mkingu Nature Reserve) above Maskati, Morogoro Region from the floristic region T6, Tanzania, our novelty is restricted in its range to a single massif. With its limited range, occurring in a small area on only one mountain, it fits into the typical pattern of endemism exhibited by some other species of the section *Superpositae* and several plants recently described (Cribb & Hemp 2022, Gavin-Smyth & Gereau 2022, Hemp 2015, Hemp & Crouch 2018) and various other biota in the Eastern Arc Mountains (with flightless grasshoppers being a striking example, Hemp *et al.* 2015).

HABITAT: This lithophytic herb grows on gently to more steeply inclined, but not vertical bare rock sections at



FIGURE 3. Habitat of *Polystachya nguruensis*. This lithophytic herb grows on gently to more steeply inclined, but not vertical, bare rock sections at around 2100 m. Such larger crystalline rock slabs, some several hectares in size, are typical of many parts of the Ngurus and other Eastern Arc Mountains. Photo by A. Hemp.



FIGURE 4. The largest site of *Polystachya nguruensis*, also the type locality, was destroyed completely by a large fire in October/November 2022. When revisiting the site in December 2022, all specimens of the orchid were dead. Photo by A. Hemp.

around 2100 m (Fig. 3). Such larger crystalline rock slabs, some several hectares in size, are typical of many parts of the Ngurus and other Eastern Arc Mountains. They are obviously, at least in part, naturally old forest-free sites as a result of poorly weathering rock with inhibited soil formation. Another factor for the absence of forest seems to be natural fires, which have increased greatly in recent times due to human disturbance.

The climate is humid with a mean annual rainfall of about 1760 mm (data of 2 years), and a mean annual relative humidity of 83% with a minimum of 14% and a maximum of 100%. The mean annual temperature is 15.3°C, with a minimum of 6.1°C and a maximum of 35.1°C. The relatively wide range in temperature and humidity reflects the open, exposed conditions of the habitat, which is unprotected from strong radiation on sunny days and radiation on clear nights (A. Hemp, unpub. Data).

The vegetation consists of a moss and lichen layer covering about 30–40% (disregarding the crustose

lichens) and a sparse cover (30–40%) of vascular plants. Growing together with *Polystachya nguruensis* we found *P. longiscapa* Summerh., *Aeollanthus densiflorus* Ryding (Lamiaceae), *Albucca abyssinica* Murr. (Asparagaceae), *Aloe brachystachys* Baker (Asphodelaceae), *Coleochloa microcephala* Nelmes (Restionaceae), *Crassula globularioides* subsp. *illichiana* (Engl.) Toelken (Crassulaceae), *Crassula vaginata* Eckl. & Zeyh. × *C. alba* Forssk. (= Hybrid D of FTEA) (Crassulaceae), *Cyrtanthus sanguineus* (Lindl.) Walp. (Amaryllidaceae), *Kleinia amaniensis* (Engl.) A. Berger (Asteraceae), *Pellaea dura* var. *schweinfurthii* (Hieron.) Verdc. (Pteridaceae), *Phyllica emirnenensis* (Tul.) Pillans. (Rhamnaceae), *Sarcorrhiza epiphytica* Bullock (Apocynaceae), and *Streptocarpus saxorum* Engl. (Gesneriaceae).

DISTINGUISHING FEATURES: *Polystachya nguruensis* appears to be most closely related to *P. lukwangulensis* P.J.Cribb in section *Superpositae*, endemic to the adja-

TABLE 1. Comparison of *Polystachya lukwangulensis* and *Polystachya nguruensis* characteristics, habitat, and locality.

Character	<i>Polystachya lukwangulensis</i>	<i>Polystachya nguruensis</i>
Pseudobulbs	4- to 5-noded, obclavate-conical, 1.00 × 0.45 cm	clavate, 3-to 9-noded, 2–12 × 0.2–0.5 cm
Leaves	2–4, linear-tapering, c. 6.30 × 0.85 cm	3–4, oblong-elliptic, 2–5 × 1.0–1.6 cm
Inflorescence	simple, up to 4-flowered	1–2-branched, 20- or more-flowered
Bracts	ovate-lanceolate, 1–3 mm long	lanceolate, 7 mm long
Flowers	yellow	greenish yellow edged with crimson and a crimson callus
Ovary	densely pubescent	pubescent
Dorsal sepal	4.5–5.0 × 2 mm	8 × 4 mm
Lateral sepals	11 × 7 mm	6.5–7.0 × 3.5–3.8 mm
Petals	11 × 7 mm	4.5 × 0.8 mm
Lip	11 × 9 mm, with a central fleshy callus, sparsely glandular papillose around callus, midlobe subcircular	4 × 3 mm, ecallose, lacking any papillae, midlobe narrowly ovate
Mentum	5 mm high	3 mm high
Habit	epiphyte	lithophyte
Locality	Tanzania: Nguru Mountains only	Tanzania: Uluguru Mountains only

cent Ulugurus. It differs in being a lithophyte and in having much longer, more obviously several noded, 30–70 × 56 mm pseudobulbs, shorter, narrowly oblong-elliptic, 20–45 × 9–24, coriaceous leaves and a longer, more densely 10- or more-flowered, occasionally branching inflorescence (with up to two branches) with small flowers with a 6 × 3 mm dorsal sepal, 6.5 × 4.5 mm, lateral sepals, 5.5 × 1.0 mm petals and a 5.0–5.5 × 3 mm lip and ecallose lip with a narrowly oblong midlobe. The Ethiopian endemic *Polystachya aethiopica* P.J.Cribb is superficially similar but our species differs in having swollen pseudobulbous stems (*vs* slender cylindrical ones), broader, shorter leaves (*vs* 4.0–8.5 × 0.6–0.85 cm ones), yellow flowers (rather than pale green flowers marked with crimson), and a smaller, glabrous, ecallose lip (*vs* a 6.5–6.6 × 4.0 mm callose, papillose lip).

**CONSERVATION STATUS.** This species is known only from a single collection from two isolated sites. The suitable habitat area for this species of *Polystachya* is estimated to be 13 ha (A. Hemp, pers. obs.). The largest (estimated 12 ha) site of this species, also the type locality, was destroyed completely by a large fire in October/November 2022 (Fig. 4). When revisiting the site in December 2022, all specimens of *Polystachya nguruensis* were dead. Therefore, the species now survives at a single site in the same location. Here, less than 1 ha of habitat, with up to about 50 mature individuals remains. This

area we take as, both the EOO and AO for this species (IUCN 2022). The area where the species occurs is officially protected as a Nature Reserve. However, there is a very plausible future threat from forest fires at this site which have already destroyed all plants of this species at what was the main site. Such fires have been observed to be highly damaging to the open vegetation where *Polystachya* grows. Given that the number of global individuals is less than 50, *Polystachya nguruensis* is here assessed as Critically Endangered (CE) under criterion D1. The extremely small range size and this threat of further fires that might destroy all the remaining individuals at the last known site globally are also major concerns. We advise that *Polystachya nguruensis* be included in the management plan of the Nature Reserve in which it is contained and that actions are taken specifically to reduce the risk of fire in the open, montane, rock-based habitat to which it is unique globally. Given the relative ease of growing orchids from seed, an *ex situ* breeding programme is recommended.

Extensive botanical survey work over the Eastern Arc Mountains, including the Nguru Mountains, suggests that this species occurs at no other site. However, this cannot be ruled out and further searches are advised to discover an additional locality(ies) for this species. Should this be possible and produce successful results, re-evaluation of the extinction risk assessment would be necessary.

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