A new remarkable species of Scleria (Cyperaceae) from northern Madagascar

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Abstract

LARRIDON, I., K. BAUTERS, F. RASAMINIRINA, J. GALÁN DÍAZ, J.I. MÁRQUEZ-CORRO & L. GAUTIER (2024). A new remarkable species of Scleria (Cyperaceae) from northern Madagascar. *Candollea* 79: 107–116. In English, English and French abstracts. DOI: http://dx.doi.org/10.15553/c2024v791a6

New species to science are still being discovered and described, often from remote habitats. Madagascar is well known for its high species richness and exceptional levels of endemism across taxonomic groups. With an estimated 2,000 plant species still to be described from Madagascar, efforts are underway to gain better understanding of the *Cyperaceae* or sedges native to the island. Here, we describe and illustrate a new species of *Scleria* P.J. Bergius from a remote area in northern Madagascar. Using molecular data from the markers ITS, *ndh*F and *rps*16, we place the new species in *Scleria* sect. *Abortivae* Cherm. ex Bauters which is largely restricted in distribution to Madagascar. An identification key to the species of this section occurring in Madagascar is provided.

Résumé

LARRIDON, I., K. BAUTERS, F. RASAMINIRINA, J. GALÁN DÍAZ, J.I. MÁRQUEZ-CORRO & L. GAUTIER (2024). Une nouvelle espèce remarquable de Scleria (Cyperaceae) du nord de Madagascar. *Candollea* 79: 107–116. En anglais, résumés anglais et français. DOI: http://dx.doi.org/10.15553/c2024v791a6

Des espèces nouvelles pour la science sont encore découvertes et décrites, souvent dans des habitats éloignés. Madagascar est bien connu pour sa grande richesse en espèces et ses niveaux exceptionnels d'endémisme dans tous les groupes taxonomiques. Avec environ 2,000 espèces végétales restant à décrire à Madagascar, des efforts sont en cours pour mieux comprendre les *Cyperaceae* ou laîches originaires de l'île. Nous décrivons et illustrons ici une nouvelle espèce de *Scleria* P.J. Bergius provenant d'une région reculée du nord de Madagascar. Les données moléculaires des marqueurs ITS, *ndh*F et *rps*16 nous permettent de la placer dans *Scleria* sect. *Abortivae* Cherm. ex Bauters dont la distribution est principalement restreinte à Madagascar. Une clé d'identification des espèces de cette section présentes à Madagascar est fournie.

Keywords

CYPERACEAE – *Scleria* – Madagascar – New species

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Submitted on July 07, 2023 – Accepted on April 4, 2024 – First published online on June 28, 2024
ISSN : 0373-2967 (print), 2235-3658 (online) – Published by the Conservatoire et Jardin botaniques de Genève

Introduction

Since the start of 2020, more than 8,600 plant species have been described as new to science, often from remote habitats (Antonelli et al., 2023). Madagascar is well known for its high species richness and exceptional levels of endemism across taxonomic groups (Goodman, 2022). Up to now, c. 12,000 plant species have been described from Madagascar (POWO, 2024), however, it is estimated that as many as 14,000 vascular plant species occur on the island (Lowry et al., 2018). That means several thousand plant species remain to be discovered and described as new to science.

Efforts are underway to gain better understanding of the *Cyperaceae* or sedges native to Madagascar which has resulted in a series of publications on their evolutionary history (Larridon et al., 2018, 2021a), their habitat and ecology (Muasya et al., 2011), and the taxonomy and diversity at generic level (Rasaminirina & Larridon, 2023) and at species level in several genera including *Costularia* C.B. Clarke (Larridon et al., 2019), *Cyperus* L. (Griffiths et al., 2022), and *Scleria* P.J. Bergius (Galán Díaz et al., 2019). Currently, a project is underway to study the evolution, diversity and conservation of *Bulbostylis* Steven which has already resulted in the description of a new species of science from the Itremo Massif Protected Area (Rasaminirina et al., 2023).

On the north-western coast of Madagascar, the region west of the Tsaratanana and Manongarivo massif, including the Sambirano river basin, the island of Nosy Be, the Galoko and Kalobinono massifs and the Ampasindava peninsula, experiences a humid climate with little or no dry season, an exception to the seasonal climate prevailing along the western coast. Natural vegetation is lowland moist evergreen forest, homologous to the forests of the eastern coast. However, these regions are separated by the cooler climates of the central mountain ridge, as well as by the seasonally dry climates of the North. Although they share a common flora, there is an important endemic element in the species which led French authors to consider it as a separate biogeographical entity: the Sambirano Region (Perrier de la Bâthie, 1921) or Sambirano Domain (Humbert, 1955). In the past decades, numerous botanical collections have accumulated due to the efforts of G and MO teams, with publications including a checklist of Manongarivo Special Reserve (Gautier, 2002) and a survey of its vegetation (Messmer et al., 2002). The percentage of local endemism was demonstrated to be maximum below 800 m elevation. It was measured to be 14% of tree species richness in a 1-ha forest plot at 220 m elevation (D'Amico & Gautier, 2000). Intensive collections were also made in Galoko-Kalobinono leading to several new species descriptions (e.g. Callmander et al., 2009, 2020). The Ampasindava peninsula was prospected intensively by during two years of botanical surveys by a team of three students from the Universities of Antananarivo and Geneva and a provisional checklist was prepared (Ammann, 2011).

It is during the preparation of this survey that Louis Nusbaumer from G collected a specimen of *Scleria* in an open 10–15 m high canopy degraded forest on the ridge of a hill (Fig. 1). A study of the relevant literature was conducted in order to try and identify the specimen, specifically in the *Flore de Madagascar et des Comores* (Chermezon, 1937) and a recent revision of the genus *Scleria* for Madagascar (Galán Díaz et al., 2019), as well as herbarium research comparing the newly collected specimen with existing collections at BR, G, GENT, K and TAN, was unsuccessful. In addition, when trying to place the unidentified specimen into the infrageneric classification of the genus *Scleria* (Bauters et al., 2015), there was uncertainty as to its sectional placement. To investigate whether the specimen represents a new species to science, and to confirm its phylogenetic and sectional placement in *Scleria*, a detailed morphological and molecular study need to be undertaken.

Materials and methods

Morphological studies were performed by the authors on the available plant material, that included detailed study and imaging of the inflorescence, spikelets and nutlets using dissecting microscopes at BR, G and K, and a Scanning Electron Microscope (SEM) at BR. Measurements were made with a ruler or using the graticule of a dissecting microscope. The material of the new species was compared with herbarium specimens of known species at BR, G, GENT, K and TAN in addition to specimens at the Kew Madagascar Conservation Centre, and with descriptions and illustrations in the literature including Galán Díaz et al. (2019) and the relevant flora treatments (Hoenselaar et al., 2010; Browning et al., 2020). Occurrences of *Scleria* sect. *Abortivae* Cherm. ex Bauters from Madagascar were derived from Larridon et al. (2021a), Digital Elevation Model from Fick & Hijmans (2017) and definition of protected areas from UNEP-WCMC (2024) in order to map species distributions.

Genomic DNA was extracted from c. 10–20 mg leaf tissue, obtained from the K herbarium specimen of *Nusbaumer 2619*, using a standard CTAB approach (Doyle & Doyle, 1987). We performed amplification and sequencing of the DNA regions ITS, *ndhF* and *rps16* following Bauters et al. (2018). Raw sequences were assembled using Geneious v.9 (Kearse et al., 2012). The newly generated sequences were incorporated in the gene alignments assembled for Larridon et al. (2021b) representing a cpDNA (*ndh*F and *rps*16) and nrDNA (ITS) alignment using MAFFT v.7 (Katoh et al., 2019) and PhyDE v.0.9971 (Müller et al., 2010). GenBank accessions for the newly generated sequence data are OR500609, OR520939, and OR520940 for ITS, *ndh*F and *rps*16, respectively.

The final ITS dataset included 138 accessions, while the final *ndh*F and *rps*16 dataset included 137 accessions. The final

nrDNA (Supplementary material S1a) and cpDNA (Supplementary material S1b) matrices were analysed independently. These alignments were subjected to maximum likelihood analysis using IQ-TREE v.1.6.11 (Nguyen et al., 2015; Kalyaanamoorthy et al., 2017; Hoang et al., 2018), where the best substitution models were GTR+F+I+Γ_4, TVM+F+G4 and TIM+F+Γ_4 for ITS, *ndh*F and *rps*16, respectively. The analysis was set to run 10,000 UFBoot with NNI optimization and 10,000 SH-aLRT replicates to assess branch support and the tree topology. In addition, the alignments were analysed using a Bayesian approach in MrBayes v.3.2.6 (Ronquist et al., 2012). The substitution model was set to GTR, as suggested in the manual. The analysis ran four chains for 5,000,000 generations, sampling every 1,000 generations and with a 20 % burn-in parameter. Convergence of the runs and ESS values above 200 units were checked and confirmed using Tracer v.1.7.1 (Rambaut et al., 2018). Trees were summarized according to the 50 % majority rule consensus. The ITS phylogeny obtained is provided in Supplementary material S1c, and the *ndh*F and *rps*16 phylogeny is provided in Supplementary material S1d.

Systematics

A molecular phylogenetic study placing the new species within the datasets generated for earlier studies (Bauters et al., 2016; Larridon et al., 2021b) indicates that it belongs to *Scleria* sect. *Abortivae*, and is sister to a clade encompassing the other species of the section included in the phylogenetic study (Fig. 2). This phylogenetic placement reinforced the morphological limits of the section, as the following traits are apomorphic: robust perennials with subandrogynous and male spikelets, a paniculate inflorescence, a laciniate hypogynium (3-lobed in *S. baronii* C.B. Clarke ex Cherm.) and pseudopraemorse leaves (Bauters et al., 2016). Further analysis with more comprehensive phylogenies can help detecting additional apomorphic characters in the genus and continue to shed light into the sectional circumscriptions. Section *Abortivae* includes five species native to Madagascar, i.e., *S. angusta* Nees ex Kunth, *S. baronii*, *S. madagascariensis* Boeckeler, *S. rosea* Cherm., and *S. trialata* Poir. in addition to the new species described below. All species are endemic or near-endemic to Madagascar; only *S. angusta* occurs in Mozambique and South Africa as well as in Madagascar (POWO, 2024). In addition, *S. sieberi* Nees, which is restricted to Seychelles and the Mascarenes, has also been placed in sect. *Abortivae* (Bauters et al., 2016), however, its correct placement remains uncertain (Galán Díaz et al., 2019).

Key to the species of Scleria sect. Abortivae in Madagascar

[adapted from Galán Díaz et al., 2019]

1. Hypogynium with laciniate lobes 2
1a. Hypogynium never laciniate 5
2. Nutlet surface undulate-rugose with tufts of hair-like trichomes on the ridges ..... ***S. nusbaumeri***
2a. Nutlet surface smooth, not hairy 3
3. Lateral panicles longer than the internode .... ***S. trialata***
3a. Lateral panicles shorter than the internode 4
4. Culms > 1.5 m; peduncles very short, almost entirely inside the sheath ..... ***S. angusta***
4a. Culms < 1.5 m; peduncle of lateral panicles only visible in the basal panicles, generally < 5 cm long ..... ***S. rosea***
5. Hypogynium without distinctive lobes; leaf sheaths not winged ..... ***S. baronii***
5a. Hypogynium clearly trilobed; leaf sheaths winged ..... ***S. madagascariensis***

Scleria nusbaumeri Bauters, **sp. nov.** (Fig. 1, 3, 4).

Holotypus: Madagascar. Reg. DIANA [Prov. Antsiranana]: Ampasindava, forêts d'Ambilanivy et Rangoty, 13°48'46"S 48°10'52"E, 288 m, 29.XI.2007, *Nusbaumer 2619* (BR [BR0000256861]!; iso-: G [G00180755]!, K [K001417494]!, MO!, P!, TAN or TEF see below).

Scleria nusbaumeri Bauters is clearly distinct morphologically from the other species of section Abortivae by having densely paniculate partial inflorescences; lateral panicles longer than the internodes; pistillate glumes with slightly recurved acuminate tip and nutlets with remarkable hair-like trichomes on the ridges.

Herb, perennial. *Culm* erect, trigonous, up to 2 m long, 2–3 mm wide below inflorescence, up to 5 mm at its widest. *Leaves* up to 5; blades green and iridescent reflections when fresh, 36–50 cm long, 11–16 mm wide at widest point, glabrous; margins scabrous especially towards the apex; midrib slightly scabrous, pseudopraemorse with long acuminate tip of 10–26 cm. *Sheaths* winged; wings 2.3–3 mm wide, glabrous, scabrous on margins. *Ligule* absent or inconspicuous. *Contraligule* triangular with rounded tip, 3 mm long, 3 mm wide at base, lacking appendages, slightly pubescent. *Inflorescence* 35–50 cm long, with one panicle at each node; partial inflorescences densely paniculate; axes green at first, turning purplish red when fresh; primary bracts foliaceous, not pseudopraemorse, 13–31 cm long, 0.5–1.8 cm wide, glabrous, scabrous on margins, long acuminate tip. *Staminate spikelets* 3.5–5.2 mm long, red-brown; pedicel 3–4 mm long or sessile; staminate glumes 3–4.5 mm long, abruptly acuminate tip, sparsely pubescent, scabrous on midrib. *Stamens* 3; anthers

Fig. 1. – *Scleria nusbaumeri* Bauters. **A.** Habitat; **B.** Partial infructescence; **C.** Nutlet.
[Photos: L. Nusbaumer]

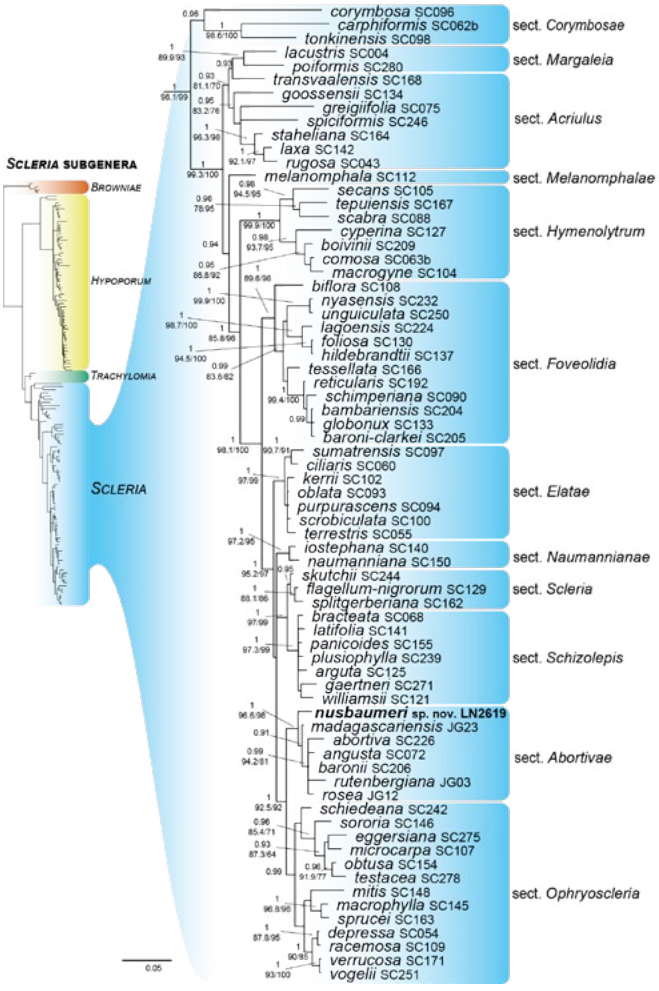

Fig. 2 – ITS maximum likelihood phylogenetic tree showing the placement of *Scleria nusbaumeri* Bauters in section *Abortivae* Cherm. ex Bauters following the infrageneric classification of Bauters et al. (2016). Values above the branches represent the Posterior Probability values (0–1) of the Bayesian analysis, and the SH-aLRT and UFBoot values (0–100 %) of the maximum likelihood analysis below the branches.

(not seen). *Subandrogynous spikelets* 2.9–3.6 mm long; pistillate glumes 2.6–3.4 mm long, with slightly recurved acuminate tip, chestnut brown with dark purple midrib. *Style* (not seen). *Nutlet* globose-subglobose, 2.5 mm long (incl. hypogynium), 3 mm wide, body white (dried), undulate-rugose, with tufts of hair-like trichomes on the ridges, apex acuminate and smooth. *Hypogynium* inconspicuous, more or less 3-lobed, margins weakly laciniate. *Cupule* 3-lobed, remaining attached to the spikelet.

Distribution, ecology and phenology. – The species is currently known only from the type locality (Fig. 5). It was collected on a hill ridge, at c. 300 m altitude, in an environment of degraded lowland moist evergreen forest with an open canopy 10–15 m high, in the Sambirano phytogeographical domain (sensu Humbert, 1955). Contrary to all other species in sect. *Abortivae* which are generally widely distributed island endemics, *Scleria nusbaumeri* is the only species with restricted geographically to a single phytogeographical domain. It was collected in flower and fruit in late November.

Conservation status. – Although the lowland moist evergreen forests of the Sambirano have received much recent attention (e.g. Manongarivo: Gautier, 2002; Galoko-Kalobinono: Callmander et al., 2009, 2020) it is apparently the first time that this species has been collected. As degraded forests with open canopies are generally given low collecting priority, we suggest that it is not necessarily rare, but rather overlooked. Furthermore, it is by no means demonstrated that the deforestation occurring in the region (Tahinarivony et al., 2017) will represent a habitat decline for this species and cannot exclude that it might be expanding. In this perspective, its location outside the protected areas network should probably not be interpreted as detrimental as for other single-collection species. In any case, it is clear that more fieldwork is needed to assess its distribution range, population size and trend, as well as the nature and intensity of its threats. As a result, it is currently assessed as Data Deficient according to the IUCN Red List Categories and Criteria (IUCN, 2012).

Etymology. – The new species is dedicated to Louis Nusbaumer, now curator at the Conservatoire et Jardin botaniques de Genève, who was conducting his Ph.D. under the supervision of LG at the time of the discovery. Passionate in the field as well as in the herbarium, he is deeply involved in the research on and conservation of the Madagascan flora and vegetation, as well as in the training of Malagasy and foreign botanical students.

Notes. – *Scleria nusbaumeri* forms the basal branch of *Scleria* sect. *Abortivae*, making it sister to all other species included in this study. Its placement in *Scleria* sect. *Abortivae* can be confirmed by its morphology, a robust perennial with subandrogynous and male spikelets; a paniculate inflorescence; a laciniate hypogynium; and pseudopraemorse leaves. The combination of a laciniate hypogynium and pseudopraemorse leaves restricts it to *Scleria* sect. *Abortivae* or *Scleria* sect. *Schizolepis* (Schrad. ex Nees) C.B. Clarke. However, the latter section only occurs in Central and South America, while *Scleria* sect. *Abortivae* is restricted to Madagascar and mainland Africa in the case of *S. angusta*. Furthermore, species in section *Abortivae* have unwinged or narrowly winged leaf sheaths, while all species in section *Schizolepis* have broadly winged leaf sheaths.

The first set of the collection was deposited at TEF herbarium in Antananarivo (Madagascar) by the collector. We have managed to trace that the specimen, together with other non-woody collections, was later transferred to the TAN

Fig. 3. – *Scleria nusbaumeri* Bauters. **A.** Culm with cauline leaves; **B.** Inflorescence; **C.** Partial inflorescence with details of spikelets and fruits; **D.** Male spikelet; **E.** Spikelet bract; **F.** Female spikelet with mature nutlet; **G.** Nutlet with persistent cupule.
[*Nusbaumer 2619*, BR, G, K] [Drawings: M. Griffiths]

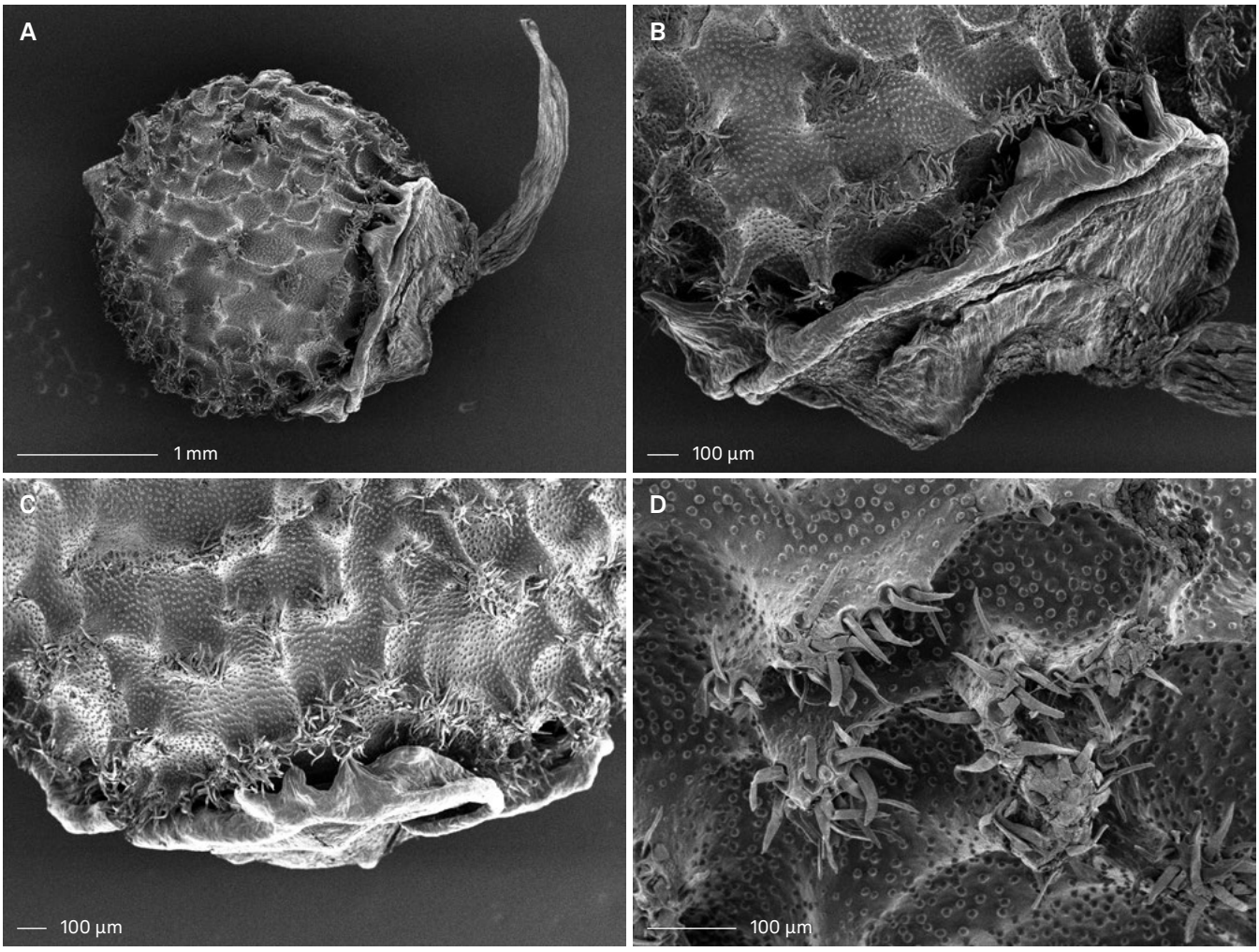

Fig. 4. – Scanning electron microscope image of the nutlet of *Scleria nusbaumeri* Bauters.
[*Nusbaumer 2619*, BR]

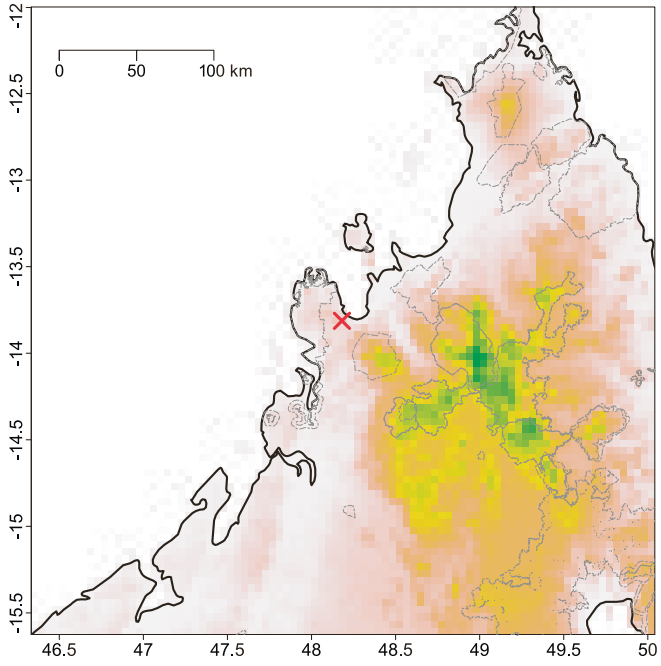

Fig. 5. – Type locality of *Scleria nusbaumeri* Bauters (red cross) and Digital Elevation Model of Madagascar. Dot-dash line denotes protected areas (UNEP-WCMC, 2024).

herbarium in Antananarivo. Sadly, the isotype at TAN has not been re-located yet. However, a project [https://www.kew.org/science/our-science/projects/flora-tomorrow-madagascar] is underway to reduce the backlog of unmounted specimens at the TAN herbarium, and initiate a digitisation programme to make the TAN herbarium specimens available to the global scientific community. It is expected the isotype will be recovered during these efforts.

Acknowledgements

We are grateful to Iris Van Der Beeten (Meise Botanic Garden) for taking the SEM images. LG expresses his gratitude to the Malagasy official and traditional authorities for permission to conduct research, sample in the field and export duplicate specimens.

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Supplementary material
The Supplementary material for this article can be found online at:
http://dx.doi.org/10.15553/c2024v791a6.s1

Supplementary material S1a. – ITS sequence alignment including 138 accessions based on Bauters et al. (2016) and Larridon et al. (2021b) plus a newly ITS sequence for *Scleria nusbaumeri* Bauters.

Supplementary material S1b. – *ndh*F and *rps*16 sequence alignment including 137 accessions based on Bauters et al. (2016) and Larridon et al. (2021) plus a newly ITS sequence for *Scleria nusbaumeri* Bauters.

Supplementary material S1c. – ITS maximum likelihood phylogeny using IQ-TREE showing all included accessions overlaid with the infrageneric classification of Bauters et al. (2016). Values above the branches represent the Posterior Probability values (0–1) of the Bayesian analysis, and the SH-aLRT and UFBoot values (0–100 %) of the maximum likelihood analysis below the branches.

Supplementary material S1d. – *ndh*F and *rps*16 maximum likelihood phylogeny using IQ-TREE showing all included accessions overlaid with the infrageneric classification of Bauters et al. (2016). Values above the branches represent the Posterior Probability values (0–1) of the Bayesian analysis, and the SH-aLRT and UFBoot values (0–100 %) of the maximum likelihood analysis below the branches.