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Identifying conservation priorities of a pantropical plant lineage: a case study in *Scleria* (Cyperaceae)

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Identifying conservation priorities of a pantropical plant lineage: a case study in *Scleria* (Cyperaceae)

Abstract: *Scleria* is a pantropical genus of annual and perennial herbs and the sixth largest genus in the Cyperaceae family with around 261 species. In this study, we produced preliminary extinction risk assessments for the ~30% of *Scleria* species that do not yet have a global Red List assessment and followed the Evolutionarily Distinct and Globally Endangered (EDGE2) and Ecologically Distinct and Globally Endangered (EoDGE) protocols to identify evolutionary and ecologically unique Scleria species at greatest risk of extinction and hotspots of rare and endangered species. Our results indicate that 38 of the 78 *Scleria* species not yet included in the Red List, and 26% of species in the genus, are potentially threatened with extinction. The risk of extinction is not equally distributed across the phylogeny, and the Afrotropics and the Neotropics accumulate most threatened species. Eleven ecoregions mostly from four African (Madagascar, D.R. Congo, Zambia and Tanzania) and two South American (Brazil, Venezuela) countries accumulate almost half of Scleria species and stand out in terms of their sum of EDGE2 scores. Phylogenetic and functional distinctiveness metrics were largely uncorrelated, and the EcoDGE metric mostly points towards South American countries as reservoirs of ecologically distinctive and endangered species: Brazil, Venezuela, Bolivia, Peru, Colombia, Guyana and Dominican Republic. Recent methodological advances in the identification of species at-risk of extinction and the novel EDGE2 framework emerge as powerful tools to identify conservation priorities.

Keywords: conservation prioritization; EDGE; extinction risk; pantropical; sedges

Identificando prioridades en la conservación de taxones vegetales pantropicales: un estudio de caso en *Scleria* (Cyperaceae)

Resumen: *Scleria* es un género pantropical de plantas anuales y perennes. Es el sexto género más grande de la familia Cyperaceae con 261 especies. En este estudio hemos estimado el riesgo de extinción para aquellas especies de Scleria no incluidas en la Lista Roja de la Unión Internacional para la Conservación de la Naturaleza (~30% del género) y utilizado los protocolos EDGE2 (*Evolutionarily Distinct and Globally Endangered*) y EoDGE (*Ecologically Distinct and Globally Endangered*) para identificar especies únicas desde un punto de vista evolutivo y ecológico que se enfrentan a un mayor riesgo de extinción así como ecoregiones del mundo ricas en estas especies. Nuestros resultados indican que 38 de las 78 especies de Scleria aún no incluidas en la Lista Roja, y el 26% de las especies del género, están potencialmente en riesgo de extinción. Además, el riesgo de extinción no se distribuye por igual a lo largo de la filogenia. El Afrotrópico y el Neotrópico acumulan la mayoría de las especies amenazadas. Once ecorregiones, principalmente de cuatro países africanos (Madagascar, R.D. Congo, Zambia y Tanzania) y dos sudamericanos (Brasil, Venezuela), acumulan casi la mitad de las especies de Scleria y son reservorios de especies evolutivamente únicas y en peligro de extinción. Las métricas de distintividad filogenética y funcional no se encuentran correlacionadas en Scleria, y EcoDGE apunta sobre todo a países sudamericanos como reservorios de especies ecológicamente únicas y en peligro de extinción.

Palabras clave: ciperáceas; EDGE; priorización de la conservación, riesgo de extinción

Introduction

Scleria P.J.Bergius (1765: 142), commonly known as nut rushes or razor grasses, is the sixth largest genus in the Cyperaceae family with around 260 species (Bauters et al. 2016; Larridon et al. 2021; 2024), and the only genus of tribe Sclerieae Wight & Arn. (subfamily Cyperoideae) (Larridon 2022). *Scleria* has four subgenera and 17 sections (Bauters et al. 2016, 2018a, 2019). Most species occur in tropical areas but some occupy more temperate climatic regions (Larridon et al. 2021). *Scleria* is a functionally diverse genus that includes annual and perennial herbs, the latter often using stoloniferous rhizomes or tubers (Bauters et al. 2016; Galán Díaz et al. 2019). Nut rushes are ecologically important in wetlands and areas undergoing secondary succession (Bauters et al. 2016), and some species are reported to have local economic significance (Simpson y Inglis 2001; Galán Díaz et al. 2024).Recent studies have disentangled the evolutionary relationships among *Scleria* species (Bauters et al. 2016, 2018) and identified major dispersal and niche shift events (Larridon et al. 2021). Still, we lack a global assessment of species and world regions of remarkable interest for *Scleria* conservation.

In the current context of rapid global change, there is a need to adopt new tools to assess biodiversity and ecosystems to set conservation priorities (Cowell et al. 2022). Over the last two decades, the use of phylogenetic and functional indices has emerged as a powerful approach to support conservation assessments by identifying at-risk species and regions of great evolutionary and ecological uniqueness (Kondratyeva et al. 2019). The Evolutionarily Distinct and Globally Endangered (EDGE) metric can be used to rank species conservation priorities where species' evolutionary distinctiveness (ED) is used as a surrogate of their irreplaceability, and species' probability of extinction (GE) is used as a proxy of their vulnerability (Isaac et al. 2007). It has been successfully implemented in different groups such as corals (Huang 2012), mammals and amphibians (Safi et al. 2013), gymnosperms (Forest et al. 2018) and tetrapods (Gumbs et al. 2018). The EDGE metric has been recently revised to include new advances (EDGE2; Gumbs et al. 2023): (i) species' evolutionary distinctiveness (ED2) now considers the extinction risk of their close relatives; (ii) it allows the incorporation of uncertainty in the phylogeny and extinction risk. The latter allows the use of phylogenies which have been expanded using non-molecular information (e.g., see Ramos-Gutiérrez et al. 2023), and provides a flexible framework to assess Not Evaluated and preliminary assessed species rather than only depending on species published in the Red List of Threatened Species of the International Union for Conservation of Nature (IUCN) (e.g., Walker et al. 2023).

Machine learning approaches constitute efficient tools to produce extinction risk assessments and their implementation in different plant groups has provided promising results (Zizka et al. 2022; Bachman et al. 2023; Walker et al. 2023). The latest version of the Red List includes ~18% (62 666 species) of all known vascular plant species (IUCN 2023). In the case of *Scleria*, there are extinction risk assessments available for 183 species (26 of which are not yet publicly available in the latest version of the Red List), which accounts for 70% of the genus. Recent taxonomic revisions of the genus (Bauters et al. 2016, 2018a, 2019; Galán Díaz et al. 2019) and the availability of occurrence datasets curated using expert knowledge (Larridon et al. 2021) can help overcome some of the limitations and challenges that arise from using herbarium collections to support preliminary extinction risk assessments (Nic Lughadha et al. 2019). The genus *Scleria* is therefore a good study system to train machine learning algorithms and produce preliminary extinction risk assessments.

Finally, the phylogenetic and functional components of biodiversity are not necessarily correlated, especially when considering functional attributes which are highly dependent on the environment (Losos 2008). *Scleria* is an ecologically diverse clade that includes species with variable habits, from tiny annuals with small nutlets and fibrous roots to climbers or stout perennials with big buoyant propagules (Galán Díaz et al. 2019). The variation in functional traits across the genus *Scleria* therefore warrants independent evaluation. In this regard, the EDGE2 framework can incorporate species functional distinctiveness (FUD) as a measure of ecological irreplaceability. This metric is termed Ecologically Distinct and Globally Endangered (EcoDGE) (Hidasi-Neto et al. 2015).

Here, (i) we first produced preliminary extinction risk assessments for the ~30% of *Scleria* species that do not yet have a global Red List assessment, and then (ii) followed the EDGE2 protocol to identify evolutionary and ecologically distinct *Scleria* species at greatest risk of extinction and conservation priority areas. For this, we used extinction risk assessments from the global Red List and the most comprehensive phylogeny of *Scleria* to date (Larridon et al. 2021), as well as newly compiled occurrence and traits datasets.

Material and Methods

Taxonomy and species occurrences

We used the World Checklist of Vascular Plants (WCVP; Govaerts et al. 2021) and the latest taxonomic revisions of the genus *Scleria* P.J.Bergius (Bauters et al. 2016, 2019) to compile a dataset of 261 accepted species. Data relating to infraspecific taxa were incorporated at the species level. Species names and authorities are available in in **Table A1 of Appendix**.

Occurrence data was compiled using observations from the Global Biodiversity Information Facility (GBIF 2023), Red List (IUCN 2023), research-grade identifications from iNaturalist and records for collections from BR, K, GENT, L, MO, NY, P, US and WAG which were georeferenced using Google Earth. For each species, we filtered observations following several steps: (1) we removed duplicates and retained one observation per 1km^2 raster cell, (2) filtered observations based on the native ranges at the 'botanical country' scale, according to the WCVP, and (3) excluded observations 1.5 times outside the interquartile climatic range using the mean annual temperature and annual precipitation BIOCLIM variables (Booth et al. 2014). The final occurrence database included 22 759 observations from 248 species. We projected locality data using the Equal Earth map projection (Šavrič et al. 2019).

Traits measurements and calculation

We measured maximum height, maximum blade length, maximum blade width, nutlet length and nutlet width from 1254 specimens housed at Royal Botanic Gardens, Kew (K) and the Muséum National d'Histoire Naturelle in Paris (P). For species missing in these herbaria, we completed the dataset using information from protologues and descriptions from regional floras (e.g., Davidse et al. 1994; Simpson and Koyama 1998; Le Roux 2015). This information was used to estimate three traits informative of plant ecological strategies (Westoby 1998): maximum height (i.e., distance from the top inflorescence to the ground), leaf area and size of the propagule (i.e., nutlet volume). We estimated leaf area and nutlet volume using the formula of an ellipse and an ellipsoid, respectively. We also considered plant longevity (annual/perennial).

Extinction risk data and preliminary assessments

Previous studies have shown that the Red List is biased toward certain plant groups and species, for instance, woody perennials and useful plants (Nic Lughadha et al. 2020). Still, we used the Red List categories as indicators of species' extinction risk because (i) the Red List constitutes a consensual framework worldwide, (ii) the authors have been continuously involved in the production of several Red List assessments of *Scleria* over the last decade which facilitates the interpretation of the results, (ii) *Scleria* is nearly comprehensively assessed according to the Red List criterium (i.e., taxa with over 149 species with at least 80% of the species assessed) and (iv) recent advances in the EDGE protocol used Red List categories as proxies of species' probability of extinction (Gumbs et al. 2023)

We downloaded 157 extinction risk assessments from the Red List (version 2023-1) and considered the extinction risk category of other 26 species that have assessments in preparation. To supplement the 183 species with global (published and in preparation) Red List assessments we carried out preliminary assessments and predictions for the 67 Data Deficient (DD) and Not Evaluated (NE) species for which occurrence data was available so that we had an extinction risk assessment for all species. The extinct species *S. chevalieri* J.Raynal was excluded from the analyses. We followed two approaches:

- We estimated species extinction risk categories under IUCN Red List criterion B using the function 'ConBatch' from the R package 'rCAT' (Moat & Bachman 2020). Given a dataset of occurrences, this function provides preliminary extinction risk categories based on species' extent of occurrence (EOO). We did not consider the species' area of occupancy (AOO) because it can lead to an overestimation of extinction risk when using occurrence data derived from herbarium records (Nic Lughadha et al. 2019). To assess the accuracy of this method, we ran 'ConBatch' on the species included in the Red List and compared the actual assessments with the predicted categories.
- We implemented a machine learning algorithm (random forest, henceforth RF) using as predictors: EOO, AOO, mean of latitudinal range, elevation, minimum human population density in 2020 (HPD; CIESIN 2016), human footprint index in 2013 (HFI; Mu et a. 2022), proportion of observations located in protected areas (UNEP-WCMC y IUCN 2023), mean annual temperature, minimum temperature of the coldest month, temperature annual range, annual precipitation, precipitation of the driest month and precipitation seasonality. All predictors were resampled at 30 seconds. For HPD and HFI, we calculated the average index value within a 5 km circular buffer of each unique occurrence point. We used 10 repeats of 5-fold cross-validation to train and evaluate the model and retained 20% of data for external validation.

EDGE2 and EcoDGE calculation and species lists

We computed two metrics that combine species extinction risk with their evolutionary or functional distinctiveness to prioritize at-risk *Scleria* species and world regions of special interest for conservation: the Evolutionarily Distinct and Globally Endangered metric (EDGE2) (Gumbs et al. 2023) and the Ecologically Distinct and Globally Endangered metric (EcoDGE) (Hidasi-Neto et al. 2015). To compute ED2, we used the latest phylogenetic inference of the genus from Larridon et al. (2021b), which included 136 species. We used the R package 'randtip' (Ramos-Gutiérrez et al. 2023) to impute 111 species missing in the phylogeny but for which infrageneric information (i.e., section) was available. We excluded 14 species for which infrageneric information was not available. Trees were expanded following several criteria: species were imputed in their sections at random, the probability of branch selection was set as equiprobable, and the stem branch was considered as a candidate for binding. This step was repeated to generate a distribution of 500 randomly imputed phylogenetic trees.

To calculate FUD, we adapted the EcoDGE framework proposed by Hidasi-Neto et al. (2015) to the new EDGE2 protocol following Griffith et al. (2022). We generated a dendrogram by calculating pairwise species dissimilarities with a generalized Gower's distance matrix (Gower 1971) using the four traits (i.e., longevity, maximum height, leaf area and size of the propagule) and an unweighted pair group method with arithmetic mean (UPGMA). We repeated the dendrogram construction 11 times (all possible combinations of two, three and four traits) to reduce the impact of specific traits on the results. Finally, we multiplied FUD scores by 100 to balance the weighting of the two component values of the EcoDGE metric.

The EDGE2 and EcoDGE protocols allow the incorporation of uncertainty in the quantification of extinction probabilities by associating each Red List category to a distribution of extinction probabilities based on a 50-year time horizon (Mooers et al. 2008). For species not included in the Red List and classified as threatened by the preliminary assessments, the extinction risk component (GE) was randomly drawn from CR, VU and EN categories. For species classified as non-threatened, GE values were randomly withdrawn from those of NT and LC categories.

Finally, for each species, we calculated a distribution of EDGE2 and EcoDGE scores (N=500) which were used to sort *Scleria* species in three lists as proposed by Gumbs et al. (2023): a 'priority or main EDGE2 species list' that includes threatened species whose distribution of EDGE2 scores rank above the median of the entire genus at least 95% of the times; a 'borderline EDGE2 species list' that includes threatened species whose distribution of EDGE2 scores rank above the median of the entire genus at least 80% of the times; and a 'watch EDGE2 species list' that includes nonthreatened species whose distribution of EDGE2 scores rank above the median of the entire genus at least 95% of the times. We further discuss the results in the context of the countries and world terrestrial ecoregions (Olson et al. 2001), which are good descriptors of plant distribution (Smith et al. 2018) and can be used as informative units for conservation planning (Dinerstein et al. 2017).

All analyses were performed in R (version 4.3.2).

Results

Preliminary assessments

rCAT and RF yielded different results (**Table A2 of Appendix**). Under criterion B, rCAT classified 53 out of the 67 non-assessed species as threatened according to their EOO (44 CR, 5 EN, 4 VU, 4 NT, 10 LC). *Scleria* rCAT assessments correctly classified 79.31% of threatened species (high sensitivity) and 91.39% of non-threatened species (high specificity). RF classified 39 species as threatened and 28 as non-threatened. It achieved an accuracy of 97.22%, correctly classifying 96.55% of non-threatened species and all threatened species (higher sensitivity and specificity than rCAT). The single most important predictor for RF was EOO, followed by AOO. Because of its greater performance, we retained the results of RF for the EDGE2 and EcoDGE calculations. Combined Red List results (published, unpublished and preliminary) are available in **Table A1 of Appendix**.

Considering the published (Red List version 2023-1; IUCN 2023) and preliminary (RF) results, we found that the Afrotropics and the Neotropics had the highest number and proportion of threatened species (**Fig. 1a**). The sections with the greatest proportion of threatened species were *Hypoporum* (41.54%), followed by Abortivae, Browniae, Schizolepsis and Foveolidia (28.57%) (**Fig. 1b**).

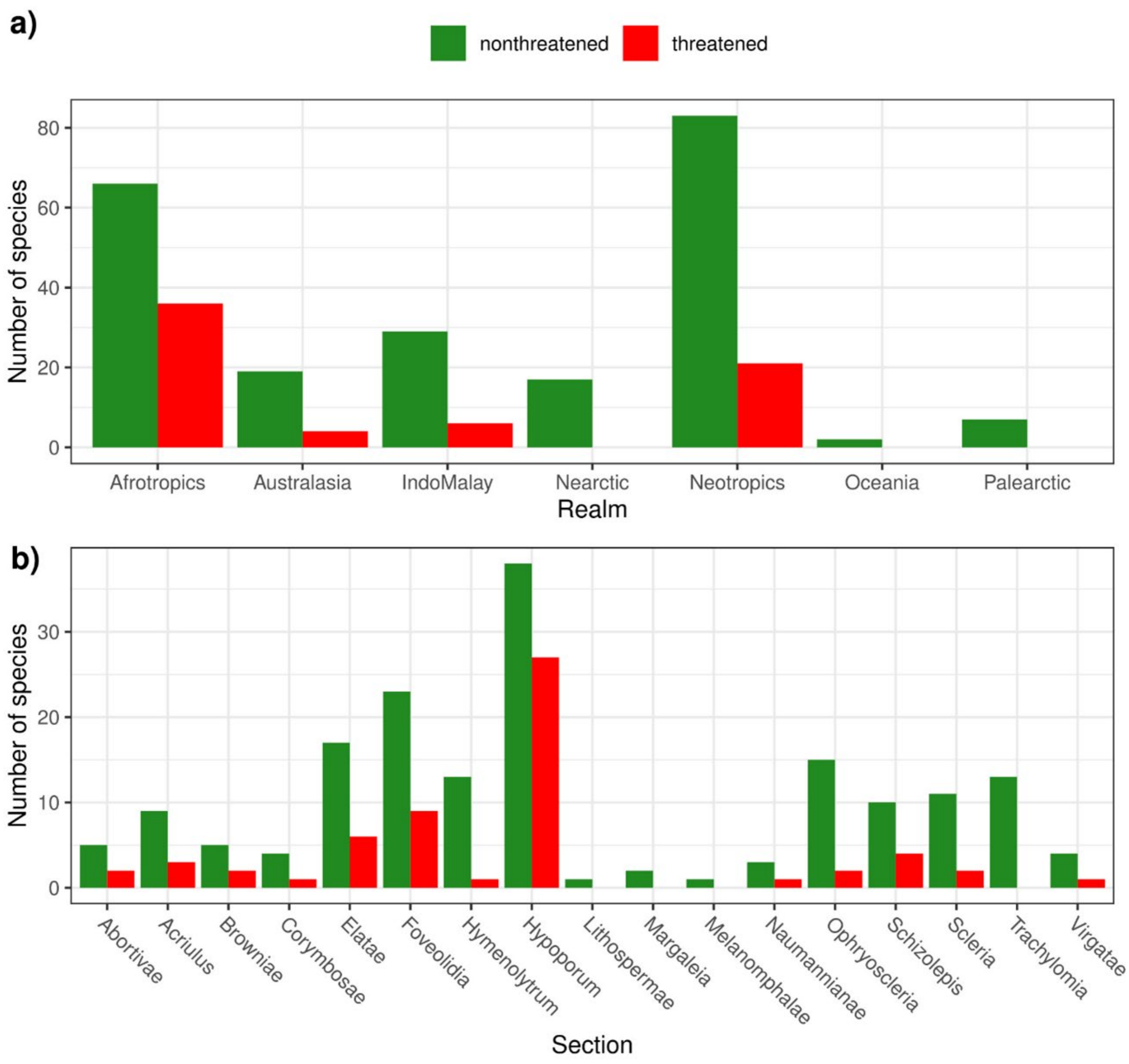

Figure 1. Number of threatened and non-threatened *Scleria* species grouped by **(a)** Realm (Olson et al. 2001) and **(b)** Section. Threatened refers to species classified as Vulnerable (VU), Endangered (EN) and Critically Endangered (CR) in the Red List, as well as Data Deficient (DD) and Not Evaluated (NE) species classified as threatened by the random forest approach. Non-threatened refers to species classified as Least Concern (LC) and Near Threatened (NT) in the Red List, as well as Data Deficient (DD) and Not Evaluated (NE) species classified as non-threatened by the random forest approach.

Figura 1. Número de especies de *Scleria* amenazadas y no amenazadas agrupadas por **(a)** Reino biogeográfico (Olson et al. 2001) y **(b)** Sección. Amenazadas agrupa especies clasificadas como Vulnerable (VU), En Peligro (EN) y En Peligro Crítico (CR) en la Lista Roja, así como especies en las categorías No Evaluado (NE) y Datos Insuficientes (DD) clasificadas como amenazadas por el random forest. No amenazadas se refiere a las especies clasificadas como Preocupación Menor (LC) y Casi Amenazado (NT) en la Lista Roja, así como a las especies en las categorías No Evaluado (NE) y Datos Insuficientes (DD) clasificadas como no amenazadas por el random forest.

Evolutionarily and ecologically distinct species at greatest risk of extinction

The phylogenetic diversity (PD) across trees was 900.96 ± 24.01 MY (mean ± SD). Species with the highest mean ED2 scores were *Scleria corymbosa*, *Scleria lithosperma* and *Scleria melanomphala* with 22.28, 20.89 and 19.04 MY, respectively. The species with the greatest mean EDGE2 score was *Scleria porphyrocarpa* with 3.97 MY of avertable expected PD loss, followed by *Scleria zambesica* (2.53 MY), *Scleria pulchella* (2.25 MY) and *Scleria madagascariensis* (2.04 MY).

We detected 45 EDGE2 *Scleria* species (17.24% of species in the genus). Safeguarding these species, we would secure 68.24% (41.49 MY) of avertable expected PD loss in a 50-year time horizon. The main list included 23 species (**Table 1**), of which 17 belong to section *Hypoporum*, three to section *Acriulus*, two to section *Abortivae* and one to *Corymbosae*. The EDGE2 borderline and watch lists included 17 and 5 species respectively (**Table A2 of Appendix**). The watch list included widespread and locally abundant species that belong to evolutionary distinctive sections such as *S. lithosperma*, *S. melanomphala* and *S. tonkinensis*.

Table 1. EDGE2 main list, i.e., threatened species that scored above the median EDGE2 score of the entire genus at least 95% of the time. Species are ranked based on their EDGE2 score. IUCN RL: Red List category of published species (RL IUCN: DD Data Deficient, VU Vulnerable, EN Endangered, CR Critically Endangered), and preliminary assessment of Not Evaluated species (i.e., Threatened). EDGE2: Evolutionarily Distinct and Globally Endangered metric, ED2: evolutionary distinctiveness.

Tabla 1. Lista principal EDGE2: especies amenazadas que obtuvieron una puntuación superior a la mediana de la puntuación EDGE2 de todo el género al menos el 95% de las veces. Las especies están ordenadas en función de su puntuación EDGE2. IUCN RL: categoría de la Lista Roja de las especies publicadas (RL IUCN: DD Datos Insuficientes, VU Vulnerable, EN En Peligro, CR En Peligro Crítico), y evaluación preliminar de especies No Evaluadas. EDGE2: índice de Especies Evolutivamente Distintas y Globalmente Amenazadas, ED2: distintividad evolutiva.

Scientific name	Section	IUCN RL	EDGE2 (mean ± sd)	ED2 (mean ± sd)
S. porphyrocarpa E.A.Rob.	*Corymbosae*	Threatened	3.97 ± 6.26	8.89 ± 8.27
S. zambesica E.A.Rob.	*Hypoporum*	Threatened	2.53 ± 1.46	5.1 ± 0.87
S. pulchella Ridl.	*Hypoporum*	CR	2.25 ± 0.45	2.44 ± 0.42
S. madagascariensis Boeckeler	*Abortivae*	EN	2.04 ± 0.66	4.62 ± 1.01
S. ankaratrensis Bauters	*Hypoporum*	DD (Threatened)	1.45 ± 0.82	2.77 ± 0.48
S. maypurensis Bauters	*Hypoporum*	CR	1.45 ± 0.35	1.65 ± 0.34
S. pachyrrhyncha Nelmes	*Acriulus*	EN	1.37 ± 1.68	2.81 ± 3.32
S. induta Turrill	*Acriulus*	Threatened	1.35 ± 2.43	2.73 ± 3.53
S. thwaitesiana Boeckeler	*Acriulus*	Threatened	1.2 ± 2.4	2.56 ± 3.33
S. fulvipilosa E.A.Rob.	*Hypoporum*	EN	1.07 ± 0.3	2.31 ± 0.38
S. richardsiae E.A.Rob.	*Hypoporum*	EN	0.96 ± 0.27	2.09 ± 0.37
S. nusbaumeri Bauters	*Abortivae*	Threatened	0.96 ± 1.34	1.92 ± 1.76
S. pantadenia Meganck & Bauters	*Hypoporum*	VU	0.94 ± 0.26	4.17 ± 0.75
S. tricristata Meganck & Bauters	*Hypoporum*	EN	0.84 ± 0.29	1.85 ± 0.44
S. calcicola E.A.Rob.	*Hypoporum*	EN	0.82 ± 0.22	1.74 ± 0.29
S. burchellii C.B.Clarke	*Hypoporum*	EN	0.81 ± 0.26	1.83 ± 0.39
S. liberica Bauters	*Hypoporum*	VU	0.59 ± 0.16	2.57 ± 0.43
S. polyrrhiza E.A.Rob.	*Hypoporum*	EN	0.57 ± 0.16	1.24 ± 0.21
S. mongomoensis Bauters	*Hypoporum*	EN	0.41 ± 0.16	0.87 ± 0.27
S. pedicellata Bauters	*Hypoporum*	EN	0.4 ± 0.16	0.88 ± 0.27
S. pseudohispidior Bauters	*Hypoporum*	VU	0.31 ± 0.1	1.39 ± 0.29
S. tricholepis Nelmes	*Hypoporum*	VU	0.28 ± 0.08	1.18 ± 0.24
S. spicata (Spreng.) J.F.Macbr.	*Hypoporum*	VU	0.27 ± 0.08	1.14 ± 0.23

Scleria species with the highest mean FUD scores were *Scleria skutchii*, the tallest species in the genus, and *Scleria depressa*, the species with the largest nutlet. Overall, 6 of 10 species with the highest FUD scores belonged to the sections *Ophryoscleria* and *Schizolepis* which include stout perennials with large leaf areas and climbers. The species with the greatest mean EcoDGE score was *Scleria porphyrocarpa*, followed by *Scleria tropicalis*, *Scleria williamsii* and *Scleria chlorantha*. We found 38 EcoDGE species, 6 in the main list (**Table 2**) and 32 in the borderline EDGE2 species list (**Table A3 of Appendix**). These species (14.56% of species of the genus) account for 64.28% of avertable expected functional diversity loss in the genus in a 50-year time horizon.

The evolutionary distinctiveness (ED2) metric was a poor explanatory variable of functional distinctiveness (FUD) in *Scleria* ($F_{1,237}$=0.03, p=0.86).

Table 2. EcoDGE main list, i.e., threatened species that scored above the median EcoDGE score of the entire genus at least 95% of the time. Species are ranked based on their EcoDGE score. IUCN RL: Red List category of published species (RL IUCN: CR Critically Endangered), and preliminary assessment of Not Evaluated species (i.e., Threatened). EcoDGE: Ecologically Distinct and Globally Endangered metric, FUD: functional distinctiveness.

Tabla 2. Lista principal de EcoDGE: especies amenazadas que obtuvieron una puntuación superior a la mediana de la puntuación EcoDGE de todo el género al menos el 95% de las veces. Las especies están ordenadas en función de su puntuación EcoDGE. IUCN RL: categoría de la Lista Roja de las especies publicadas (RL IUCN: CR En Peligro Crítico), y evaluación preliminar de especies No Evaluadas. EcoDGE: Especies Ecológicamente Distintas y Globalmente Amenazadas, FUD: distintividad funcional.

Scientific name	Section	IUCN RL	EcoDGE (mean ± sd)	FUD (mean ± sd)
S. tropicalis M.T.Strong	*Ophryoscleria*	Threatened	1.05 ± 1.22	2.34 ± 1.46
S. rubrostriata A.C.Araújo & N.A.Brummitt	*Schizolepis*	Threatened	0.61 ± 0.98	1.09 ± 1.36
S. orchardii C.D.Adams	*Schizolepis*	CR	0.35 ± 0.19	0.38 ± 0.21
S. chasmema Bonet Mayedo & W.W.Thomas	*Virgatae*	Threatened	0.35 ± 0.3	0.66 ± 0.34
S. junghuhniana Boeckeler	*Elatae*	Threatened	0.21 ± 0.83	0.44 ± 1.17
S. ovinux J.Raynal ex Fosberg	*Elatae*	Threatened	0.19 ± 0.26	0.48 ± 0.34

Regions of special interest for conservation

The countries with the highest cumulative EcoDGE scores were Brazil, Venezuela, Bolivia, Democratic Republic of the Congo, Peru and Colombia. The countries with the greatest number of listed EcoDGE species were Democratic Republic of the Congo, Brazil and Madagascar (**Table 3**). The ecoregions with the highest sum of EDGE2 scores and the greatest number of listed EDGE2 species were the Central Zambezian Miombo woodlands, Madagascar subhumid forests, Cerrado, East Sudanian savanna, Llanos, Guinean forest-savanna mosaic and Madagascar lowland forests (**Table 4**; **Fig. 2a**).

The countries with the highest cumulative EcoDGE scores were Brazil, Venezuela, Bolivia, Democratic Republic of the Congo, Peru and Colombia. The countries with the greatest number of listed EcoDGE species were Democratic Republic of the Congo, Brazil and Madagascar (**Table 3**). The ecoregions with the highest sum of EcoDGE scores and number of listed EcoDGE species were Central Zambezian Miombo woodlands, Southwest Amazon moist forests, Bahia coastal forests, Cerrado and Western Congolian forest-savanna mosaic (**Table 4**; **Fig. 2b**).

According to the assessment of the extent of remaining natural habitat and protected land in the world ecoregions by Dinerstein et al. (2017), there are 22 *Scleria* species which are restricted to 'Nature Imperiled' ecoregions (i.e., ecoregions where the percentage of natural habitat remaining and the amount of the total ecoregion that is protected is less than or equal to 20%) and 34 species only occur in ecoregions where 'Nature Could Recover (i.e., ecoregions where the percentage of natural habitat remaining and area protected is less than 50% but more than 20% and that require restoration programs to reach the 50% of natural habitat).

Table 3. Top 20 countries in which *Scleria* is present ranked by their sum of EDGE2 scores. Richness: number of species present, N: number of EDGE2 and EcoDGE species, Main: number of species included in the main EDGE2 and EcoDGE lists, Sum: sum of EDGE2 and EcoDGE scores. Expanded results can be found in **Table A4 of Appendix**.

Tabla 3. Los 20 países con mayor riqueza de *Scleria* ordenados por la suma de sus puntuaciones EDGE2. Riqueza: número de especies presentes, N: número de especies EDGE2 y EcoDGE, Main: número de especies incluidas en las listas principales EDGE2 y EcoDGE, Sum: suma de las puntuaciones EDGE2 y EcoDGE. Los resultados ampliados se encuentran en la **Tabla A4 del Apéndice 4**.

Country	Richness	EDGE2			EcoDGE		
		N	Main	Sum	N	Main	Sum
Madagascar	24	7	3	10.11	3	0	1.24
Dem. Rep. Congo	26	5	2	9.85	5	0	1.94
Brazil	63	6	2	9.43	4	2	3.08
Zambia	29	5	4	8.95	1	0	0.79
Tanzania	30	5	3	8.23	2	0	0.63
Venezuela	31	3	1	5.94	1	1	2.00
South Africa	17	2	0	5.23	0	0	0.17
Thailand	20	3	1	5.18	0	0	0.28
China	15	3	0	4.76	0	0	0.24
Bolivia	34	1	0	4.33	1	0	1.98
Guinea	15	4	2	4.29	1	0	0.22
Ghana	20	2	0	4.20	0	0	0.68
Ethiopia	16	4	1	4.20	0	0	0.29
Côte d'Ivoire	20	2	0	4.05	0	0	0.66
Philippines	13	3	0	3.96	1	0	0.32
Gabon	19	3	1	3.95	2	0	0.66
Angola	11	2	1	3.83	1	0	0.32
Nigeria	20	2	0	3.74	0	0	0.63
Guyana	21	1	0	3.58	1	0	1.26
Cameroon	18	3	0	3.56	2	0	0.89

Table 4. Top 20 ecoregions in which *Scleria* is present ranked by their sum of EDGE2 scores. Richness: number of species present, N: number of EDGE2 and EcoDGE species, Main: number of species included in the main EDGE2 and EcoDGE lists, Sum: sum of EDGE2 and EcoDGE scores. Expanded results can be found in **Table A5 of Appendix**.

Tabla 4. Las 20 principales ecorregiones en las que está presente *Scleria* clasificadas por su suma de puntuaciones EDGE2. Riqueza: número de especies presentes, N: número de especies EDGE2 y EcoDGE, Main: número de especies incluidas en las listas principales EDGE2 y EcoDGE, Sum: suma de las puntuaciones EDGE2 y EcoDGE. Los resultados ampliados se encuentran en la **Tabla A5 del Apéndice 5**.

Ecoregion	Richness	EDGE2			EcoDGE		
		N	Main	Sum	N	Main	Sum
Central Zambezian Miombo woodlands	39	8	7	15.32	3	0	2.04
Madagascar subhumid forests	22	7	3	9.50	2	0	1.09
Cerrado	45	3	1	7.09	2	0	1.72
East Sudanian savanna	22	5	1	5.76	1	0	0.85
Llanos	24	3	1	5.68	0	0	0.86
Guinean forest-savanna mosaic	28	4	1	5.61	1	0	0.81
Madagascar lowland forests	16	2	1	5.48	1	0	0.65
Northwestern Congolian lowland forests	20	4	1	5.28	2	0	0.37
Zambezian and Mopane woodlands	15	3	1	5.28	0	0	0.18
Mato Grosso seasonal forests	28	2	1	4.87	1	0	1.05
Western Congolian forest-savanna mosaic	18	3	1	4.87	3	0	0.80
Tenasserim-South Thailand semi-evergreen rain forests	13	3	1	4.82	0	0	0.19
Zambezian flooded grasslands	13	2	0	4.76	0	0	0.24
Eastern Arc forests	14	3	1	4.70	1	0	0.39
South China-Vietnam subtropical evergreen forests	12	3	0	4.70	0	0	0.19
Guianan savanna	21	2	0	4.61	0	0	0.73
Drakensberg montane grasslands, woodlands and forests	13	2	0	4.33	0	0	0.11
Eastern Guinean forests	21	2	0	4.28	0	0	0.70
West Sudanian savanna	21	2	0	4.23	0	0	0.64
Western Guinean lowland forests	20	3	2	4.15	0	0	0.69

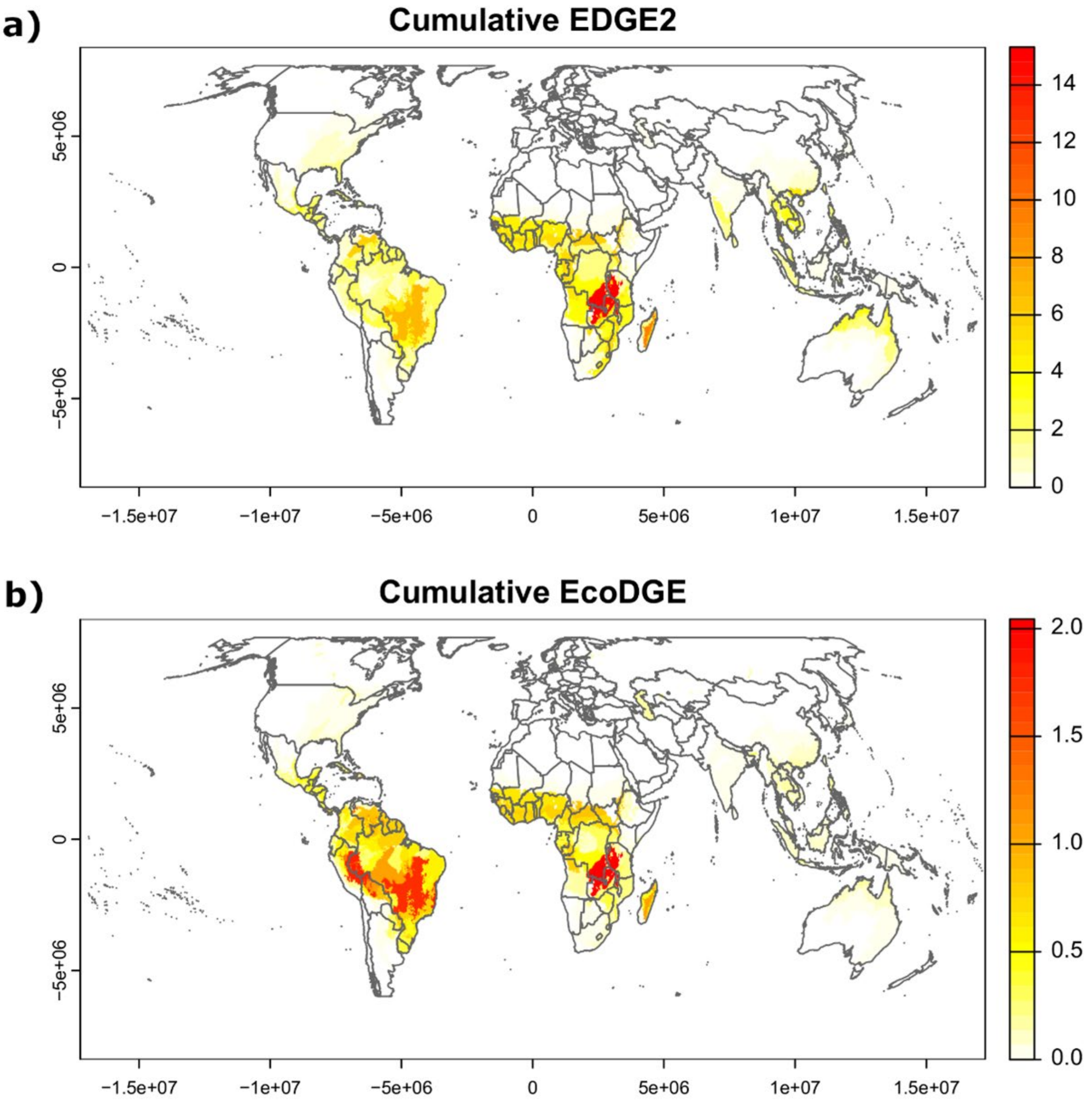

Figure 2. Ecoregions of notable conservation concern for Scleria according to their sum of EDGE2 scores (**a**) and sum of EcoDGE scores (**b**). The definition of ecoregion follows Olson et al. (2001).

Figura 2. Ecorregiones de notable interés para la conservación de *Scleria* según su suma de puntuaciones EDGE2 (**a**) y suma de puntuaciones EcoDGE (**b**). La definición de ecorregión se basa en Olson et al. (2001).

Discussion

In this study, we estimated the extinction risk for all species of the genus *Scleria*, as well as identified regions of special interest for its conservation. Our results suggest that half of *Scleria* species (49%, N=38) not yet included in the Red List are potentially threatened with extinction. Evolutionary and ecologically distinct and endangered *Scleria* mostly occur across African and South American regions.

Preliminary assessments

Similar to previous studies, RF outperformed the method that explicitly followed Red List criterion B (Nic Lughadha et al. 2019) and distribution range properties were the best predictors for RF (Nic Lughadha et al. 2019; Bachman et al. 2023; Walker et al. 2023). Up to 15 species were classified as threatened by rCAT and non-threatened by RF; thus, RF set lower thresholds of extent of occurrence (EOO) to classify *Scleria* species as threatened. This seems a sensible approach to assess *Scleria* because the size of the distribution range as estimated from herbarium collections is potentially underestimated in most cases (see below), and widespread and locally dominant species are common (Holm et al. 1979; Galán Díaz et al. 2019).

Considering species included in the Red List and the results of RF, 26% of all *Scleria* species are potentially threatened with extinction. In a recent study, Bachman et al. (2023) obtained a similar estimate for Cyperaceae. They also found that, of the 21 families with more than 3000 species, Cyperaceae showed the smallest proportion of threatened species. Whereas 18% of *Scleria* species currently included in the Red List are threatened, we found that 49% of unassessed species are potentially threatened with extinction. This could be because several Madagascan and South American *Scleria* species discovered over the last four decades were classified as threatened by RF, which might support that newly described species are geographically restricted and therefore less likely to be encountered in the wild (Brown et al. 2023). This is the case of *Scleria nusbaumeri*, *Scleria ankaratrensis*, *Scleria attenuatifolia*, *Scleria chasmema*, *Scleria millespicula*, *Scleria pernambucana*, *Scleria rubrostriata* and *Scleria tropicalis*. It is therefore necessary to prioritize the assessment of all unassessed species to get realistic estimates of extinction risk in the genus and to galvanize conservation support for these species.

Evolutionarily distinct and globally endangered *Scleria*

Our analysis identified 23 species that met the criteria to be included in the EDGE2 main list. *Scleria porphyrocarpa* was the species with the highest EDGE2 and ED2 scores due to its high vulnerability (i.e., it was classified as threatened by both rCAT and RF) and high evolutionary distinctiveness. *Scleria porphyrocarpa* belongs to section *Corymbosae*, the oldest lineage in subgenus *Scleria* (crown age 22.28 Ma) which only includes four other species (Bauters et al. 2016, Larridon et al. 2021). Section *Hypoporum* was represented in the EDGE2 main list by 17 species. This is due to two reasons: (i) molecular analyses indicated that section *Hypoporum* originated 8.4 Ma and showed a rapid increase in its diversification rate soon after (Larridon et al. 2021) to become the richest section in *Scleria* (Bauters et al. 2019); (ii) it holds the highest percentage of threatened species among *Scleria* sections according to the Red List and our preliminary assessments (42%; **Fig. 1b**). This is important in the context of the new EDGE formulation, that accounts for the extinction risk of closely related species, because the deeper branches of a clade with a high proportion of threatened species will have a greater probability of being at risk, thus resulting in species belonging to it having higher EDGE scores (Gumbs et al. 2023). Finally, the three threatened species of section *Acriulus* were also included in the main list, as well as two Madagascan endemics from section *Abortivae*.

Almost half of *Scleria* species (129 species) are present in the 11 ecoregions with the greatest cumulative EDGE2 scores. Four African (Madagascar, D.R. Congo, Zambia and Tanzania) and two South American (Brazil, Venezuela) countries mainly covered these areas of special interest for conservation. Madagascar comprises 24 species of *Scleria* in two ecoregions (i.e., subhumid and lowland forests), including five threatened and two recently described species. Madagascan species belong to 11 sections out of the 17 sections recognized in *Scleria*, which highlights the importance of this country as a reservoir of *Scleria* diversity and the importance of long-distance dispersal in the genus (Galán Díaz et al. 2019). Four other ecoregions from the Afrotropics (i.e., Central Zambezian Miombo woodlands, East Sudanian Savanna, Guinean forest-savanna mosaic, and Northwestern Congolian lowland forests and Zambezian and Mopane woodlands; Olson et al. 2001) are identified as important conservation areas for *Scleria*. These ecoregions contain 67 species (26% species of *Scleria,* from 12 sections) of which 19 are endangered.

Brazil has the greatest *Scleria* richness (63 species) and ranks second in terms of cumulative EDGE2 scores. Two Brazilian ecoregions are shown as areas of special interest for the conservation of the evolutionary history of *Scleria*: Cerrado and Mato Grosso seasonal forests. These ecoregions include 49 species from 11 sections, of which 4 are endangered. The Venezuelan Llanos is another important ecoregion for evolutionary distinct and endangered *Scleria*. Unlike the Colombian Llanos, which also includes over 30 species, it includes species from old *Scleria* lineages (i.e., sections *Lithospermae* and *Foveolidia*; Larridon et al. 2021) and two threatened species.

According to the revision of the world ecoregions of Dinerstein et al. (2017), which considered the World Database of Protected Areas (UNEP-WCMC y IUCN 2023) along with habitat assessments based on tree cover and human land use, two of the above-mentioned ecoregions (i.e., Madagascar subhumid forests and Guinean forest-savanna mosaic) are classified as 'nature imperiled' because the percentage of natural habitat remaining and protected area is less than 20%. Other ecoregions of interest for *Scleria* conservation that need active restoration programs to reach the 50% of protected natural habitat are Madagascar lowland forests, Central Zambezian Miombo woodlands and East Sudanian savanna.

Ecologically distinct and globally endangered *Scleria*

We expect uncertainty in the identification of EcoDGE species because the results are largely dependent on the selection of traits, whereas the evolutionary relationship among *Scleria* species is well resolved at least at the section level (Bauters et al. 2016, 2018a). In this study we used traits which are informative of species ecological strategies (Westoby 1998): plant longevity, leaf area, height and nutlet size. These traits indicate how plants cope with environmental nutrient stress and disturbances, the position of the species in the vertical light gradient of the vegetation, competitive vigor, dispersal distance and seed persistence in the soil bank (Pérez-Harguindeguy et al. 2013). We found ED2 and FUD were largely orthogonal; thus, EcoDGE based prioritizations yielded complementary results to the EDGE2 approach.

Our analysis identified six species in the main EcoDGE list. Unlike EDGE2, EcoDGE mostly points towards South American countries as reservoirs of distinctive and endangered species. This is because many EDGE2 species are phylogenetically restricted to section *Hypoporum* which has its center of diversity in tropical Africa, whereas EcoDGE species (i.e., those with great blade area and nutlet size) belong to different sections mostly restricted to South America. Eight South and Central American countries are ranked among the top 10 countries with the highest cumulative EcoDGE scores: Brazil, Venezuela, Bolivia, Peru, Colombia, Guyana, Dominican Republic and Costa Rica. This is due to the occurrence of stout species from three sections that are restricted or almost restricted to the Neotropics (Bauters et al. 2016): sections *Schizolepsis* (12 species), *Ophryoscleria* (11 species) and *Hymenolytrum* (13 species). Within these countries, the ecoregions that showed the greatest cumulative EcoDGE scores were Southwest Amazon moist forests, Bahia coastal forests, Cerrado and Iquitos Varzeá (87 species in total). The percentage of natural habitat remaining in these ecoregions is less than 50%, with restoration programs needed to exceed this threshold (Dinerstein et al. 2017). D. R. Congo and Madagascar were the African countries with the highest cumulative EcoDGE score.

Limitations

Preliminary assessments are biased by the uncertainty and coverage of the taxonomic and geographical dimensions of the occurrence datasets (Meyer et al. 2016). We expect little uncertainty in the taxonomic dimension of our occurrence dataset because the records have been manually curated and homogenized using the latest list of accepted species names. Yet, there is a bias in the geographical coverage of *Scleria* collections, where the available resources for each country vary greatly and affect the density of observations as well as the number of specimens collected and digitized. For instance, the United States of America and Australia are the countries with the highest average number of *Scleria* observations per species with 276 and 273 respectively, which is five times more than the third and fourth countries in this ranking (Brazil and Mexico). However, the United States of América and Australia rank 33rd and 11th in terms of *Scleria* richness, whereas Brazil and México rank first and thent. This affects the assessments of species from less explored regions by potentially leading to an underestimation of the size of their distribution ranges and a subsequent overestimation of their extinction risk (Nic Lughadha et al. 2019). In addition, the United States of America and Australia harbor two nearly endemic *Scleria* subgenera (subgenera *Trachylomia* and *Browniae*, respectively). Thus, the quality and quantity of *Scleria* collections do not only impact the comprehensiveness of regional floras but it is also unevenly distributed across the phylogeny. This uncertainty must be considered in biogeographical studies.

There are also substantial differences in the completeness of our knowledge of the genus *Scleria* among neighboring countries. The identification of regions from Africa as areas of special interest for the conservation of Scleria reflects their great diversity as centers of diversification (Larridon et al. 2021), but also our more comprehensive taxonomic knowledge of this group in particular countries. For instance, Scleria from Zambia, South Africa and Madagascar are better studied compared to other African countries thanks to the work of E.A. Robinson (Robinson 1966), E.F. Franklin Hennessy (Franklin Hennessy 1985) and H. Chermezon (Chermezon 1937). Thus, remarkable patterns of species richness in these countries might reflect different botanical collection efforts rather than true species accumulation.

Finally, this study evaluates species and ecosystems as individual elements, but modern biodiversity conservation strategies will benefit from a thorough analysis of the eco-social landscape (Butler et al. 2022). On the one hand, the taxonomy of nut rushes is well-resolved (Bauters et al. 2016), but it still is a little-studied genus in terms of its ecological and economic value. In a recent bibliographical research, we found that nut rushes reported to have ecological and economic values tend to be widespread (Galán Díaz et al. 2024), sometimes even weeds that thrive in disturbed areas (Holm et al. 1979). Thus, we would hypothesize that the conservation of these species will not be imperiled by human activity. Still, the genus encompasses many narrow endemics and new species are continuously discovered in poorly explored areas (Bauters et al. 2015; Mayedo y Thomas 2016; Bauters et al. 2018a; Bauters et al. 2018b; Galán Díaz et al. 2019; Schneider y Gil 2021; Larridon et al. 2024). This geographical bias in the coverage of Scleria collections previously commented on can be tackled by collaborating with local researchers and communities in its collection and taxonomic study (Heywood 2017). In regard, it is worth mentioning that Scleria is mainly distributed across tropical areas but articles are often published in subscription journals (for instance Lye y Pollard 2003; Strong 2007; Araújo y Brummitt 2011; Bauters et al. 2018b). This makes access to new findings challenging for researchers from the Global South (Pettorelli et al. 2021). Thus, researchers from the Global North have the responsibility to make papers and data freely available worldwide for the sake of biodiversity conservation.

Conclusions

We provided the first global assessment of species and world regions of remarkable interest for *Scleria* conservation. We show that recent methodological advances in the identification of species at-risk of extinction in combination with herbarium data allow the implementation of the novel EDGE2 and EcoDGE frameworks in plant groups with well-resolved taxonomies. We found that half of Scleria species not yet included in the Red List are potentially at risk of extinction, and 21.5% of the species in the genus are restricted to ecoregions where the percentage of natural habitat is less than 50%. Phylogenetic and functional distinctiveness metrics were largely uncorrelated and EDGE2 and EcoDGE metrics point toward tropical regions of Africa and South America, respectively, as reservoirs of distinctive and endangered species.

Data Accessibility

The data used to produce this study are publicly available at Zenodo (Galán Díaz et al. 2024).

The codes generated during the current study are available at GitHub (https://github.com/galanzse/Scleria_EDGE).

Authors' contributions

JGD and IL originally formulated the idea. JGD, HR and IL gathered and curated the data. JGD, SPB, FF and ME performed statistical analyses. JGD, SPB, FF, ME, HR and IL wrote the manuscript. JGD and IL acquired funding.

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The authors declare that they have no conflict of interest.

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Appendix

Table A1. Combined Red List results. This includes assessments published in the Red List of the IUCN version 2023-1 (RL IUCN: NE Not Evaluated, DD Data Deficient, LC Least Concern, NT Near Threatened, VU Vulnerable, EN Endangered, CR Critically Endangered, EX Extinct), unpublished assessments ('Assessed but not published') and preliminary assessments (Threatened: T, Non-threatened: NT) of 67 species for which occurrence data was available. Preliminary assessments followed two approaches.

(i) Random forest approach (RF). We used as predictors: EOO, AOO, mean of latitudinal range, elevation, minimum human population density in 2020 (HPD; Center for International Earth Science Information Network - CIESIN 2016), human footprint index in 2013 (HFI; Mu et al. 2022), proportion of observations located in protected areas (UNEP-WCMC and IUCN 2023), annual mean temperature, minimum temperature of the coldest month, temperature annual range, annual precipitation, precipitation of the driest month and precipitation seasonality. We performed 10 repeats of 5-fold cross-validation to train and evaluate the model and retained 20% of data for external validation.

(ii) rCAT. We implemented the function 'ConBatch' from the R package 'rCAT' (Moat & Bachman 2020) to assess species' extinction risk following IUCN Criterion B based on EOO.

Tabla A1. Resultados combinados de riesgo de extinción. Esto incluye evaluaciones publicadas en la Lista Roja de la UICN versión 2023-1 (RL UICN: NE No evaluado, DD Datos insuficientes, LC Preocupación menor, NT Casi amenazado, VU Vulnerable, EN En peligro, CR En peligro crítico, EX Extinto), evaluaciones no publicadas ('Assessed but not published') y evaluaciones preliminares (Amenazado: T, No amenazado: NT) de 67 especies para las que se disponía de datos de presencia. Las evaluaciones preliminares siguieron dos enfoques.

(i) Enfoque de bosque aleatorio (RF). Se utilizaron como predictores EOO, AOO, media del rango latitudinal, elevación, densidad mínima de población humana en 2020 (HPD; Center for International Earth Science Information Network - CIESIN 2016), índice de huella humana en 2013 (HFI; Mu et al. 2022), proporción de observaciones localizadas en áreas protegidas (UNEP-WCMC and IUCN 2023), temperatura media anual, temperatura mínima del mes más frío, rango anual de temperatura, precipitación anual, precipitación del mes más seco y estacionalidad de la precipitación. Realizamos 10 repeticiones de validación cruzada con 5 particiones para entrenar y evaluar el modelo y retuvimos el 20% de los datos para la validación externa.

(ii) rCAT. Implementamos la función 'ConBatch' del paquete R 'rCAT' (Moat & Bachman 2020) para evaluar el riesgo de extinción de las especies siguiendo el Criterio B de la UICN basado en EOO.

Scientific name	RL IUCN	RF	Rcat	Notes
S. acanthocarpa Boeckeler	LC			Included in RL 2023-1.
S. achtenii De Wild.	LC			Included in RL 2023-1.
S. adpressohirta (Kük.) E.A.Rob.	NE	T	T	Preliminary assessment.
S. afroreflexa Lye	EN			Included in RL 2023-1.
S. alpina Core	NE	NT	T	Preliminary assessment.
S. amazonica Camelb., M.T.Strong & Goetgh.	LC			Included in RL 2023-1.
S. anceps Liebm.	NE	T	T	Preliminary assessment.
S. andringitrensis Cherm.	EN			Included in RL 2023-1.
S. angusta Nees ex Kunth	LC			Included in RL 2023-1.
S. angustifolia E.A.Rob.	LC			Included in RL 2023-1.
S. ankaratrensis Bauters	DD	T	T	Included in RL 2023-1.
S. annularis Steud.	LC			Assessed but not published.
S. anomala (Steud.) J.Raynal	NE	T	T	Preliminary assessment.
S. arcuata E.A.Rob.	NE	T	T	Preliminary assessment.
S. arenaria T.Koyama	NE	T	T	Preliminary assessment.
S. arguta (Nees) Steud.	LC			Included in RL 2023-1.
S. aromatica Core	NE	NT	NT	Preliminary assessment.
S. atroglumis D.A.Simpson	LC			Included in RL 2023-1.
S. attenuatifolia M.T.Strong	NE	T	T	Preliminary assessment.
S. aurantiaca Lye	CR			Included in RL 2023-1.
S. aureovillosa Kiaos. & K.Wangwasit	NE	T	T	Preliminary assessment.
S. balansae Maury ex Micheli	LC			Included in RL 2023-1.
S. baldwinii (Torr.) Steud.	LC			Included in RL 2023-1.
S. bambariensis Cherm.	LC			Assessed but not published.
S. baroni-clarkei De Wild.	EN			Included in RL 2023-1.
S. baronii C.B.Clarke ex Cherm.	LC			Included in RL 2023-1.
S. bellii LeBlond	NE	NT	NT	Preliminary assessment.
S. benthamii C.B.Clarke	NE	NT	T	Preliminary assessment.
S. bequaertii De Wild.	LC			Included in RL 2023-1.
S. biflora Roxb.	LC			Included in RL 2023-1.
S. boivinii Steud.	LC			Included in RL 2023-1.
S. boniana Boeckeler	NE	NT	T	Preliminary assessment.

Table A1 continued / **Continuación Tabla A1**

Scientific name	RL IUCN	RF	Rcat	Notes
S. borii D.M.Verma	NE	NT	T	Preliminary assessment.
S. bourgeaui Boeckeler	LC			Included in RL 2023-1.
S. bracteata Cav.	LC			Included in RL 2023-1.
S. bradei Gross	NE	T	T	Preliminary assessment.
S. brownii Kunth	LC			Included in RL 2023-1.
S. bulbifera Hochst. ex A.Rich.	LC			Included in RL 2023-1.
S. burchellii C.B.Clarke	EN			Included in RL 2023-1.
S. calcicola E.A.Rob.	EN			Assessed but not published.
S. camaratensis Core	NE	NT	NT	Preliminary assessment.
S. canescens Boeckeler	LC			Assessed but not published.
S. carphiformis Ridl.	LC			Included in RL 2023-1.
S. castanea Core	LC			Included in RL 2023-1.
S. catophylla C.B.Clarke	LC			Included in RL 2023-1.
S. chasmema Bonet Mayedo & W.W.Thomas	NE	T	T	Preliminary assessment.
S. cheekii Bauters	VU			Included in RL 2023-1.
S. chevalieri J.Raynal	EX			Included in RL 2023-1.
S. chlorantha Boeckeler	NE	T	T	Preliminary assessment.
S. chlorocalyx E.A.Rob.	NE	NT	T	Preliminary assessment.
S. ciliaris Nees	LC			Included in RL 2023-1.
S. ciliata Michx.	LC			Included in RL 2023-1.
S. clarkei Lindm.	NE	T	T	Preliminary assessment.
S. clathrata Hochst. ex A.Rich.	NE	NT	NT	Preliminary assessment.
S. colorata Core	NE	NT	T	Preliminary assessment.
S. comosa (Nees) Steud.	LC			Included in RL 2023-1.
S. composita (Nees) Boeckeler	LC			Included in RL 2023-1.
S. corymbosa Roxb.	LC			Assessed but not published.
S. cuyabensis Pilg.	LC			Included in RL 2023-1.
S. cyathophora Holttum	NE	NT	T	Preliminary assessment.
S. cyperina Kunth	LC			Included in RL 2023-1.
S. delicatula Nelmes	NT			Included in RL 2023-1.
S. densispicata (C.B.Clarke) J.Kern	NE	T	T	Preliminary assessment.
S. depressa (C.B.Clarke) Nelmes	LC			Included in RL 2023-1.
S. didina Bonet Mayedo & W.W.Thomas	NE	NT	NT	Preliminary assessment.
S. distans Poir.	LC			Included in RL 2023-1.
S. dregeana Kunth	LC			Included in RL 2023-1.
S. dulungensis P.C.Li	NE	NT	T	Preliminary assessment.
S. eggersiana Boeckeler	LC			Included in RL 2023-1.
S. erythrorrhiza Ridl.	LC			Included in RL 2023-1.
S. filiculmis Boeckeler	NE	T	T	Preliminary assessment.
S. flagellum-nigrorum P.J.Bergius	LC			Included in RL 2023-1.
S. flexuosa Boeckeler	LC			Included in RL 2023-1.
S. foliosa Hochst. ex A.Rich.	LC			Included in RL 2023-1.
S. foveolata Cav.	NE	T	T	Preliminary assessment.
S. fulvipilosa E.A.Rob.	EN			Included in RL 2023-1.
S. gaertneri Raddi	LC			Included in RL 2023-1.
S. georgiana Core	LC			Included in RL 2023-1.
S. glabra Boeckeler	LC			Included in RL 2023-1.
S. globonux C.B.Clarke	LC			Included in RL 2023-1.
S. glomerulata Oliv.	CR			Included in RL 2023-1.
S. goossensii De Wild.	LC			Included in RL 2023-1.
S. gracillima Boeckeler	LC			Included in RL 2023-1.
S. greigiifolia (Ridl.) C.B.Clarke	LC			Included in RL 2023-1.
S. guineensis J.Raynal	CR			Included in RL 2023-1.
S. harlandii Hance	LC			Included in RL 2023-1.
S. havanensis Britton	LC			Included in RL 2023-1.
S. hildebrandtii Boeckeler	EN			Included in RL 2023-1.
S. hilsenbergii Ridl.	LC			Included in RL 2023-1.

Table A1 continued / **Continuación Tabla A1**

Scientific name	RL IUCN	RF	Rcat	Notes
S. hirtella Sw.	LC			Included in RL 2023-1.
S. hispidior (C.B.Clarke) Nelmes	LC			Included in RL 2023-1.
S. hispidula Hochst. ex A.Rich.	LC			Included in RL 2023-1.
S. huberi C.B.Clarke	LC			Assessed but not published.
S. indica D.M.Verma & Veena Chandra	NE	NT	T	Preliminary assessment.
S. induta Turrill	NE	T	NT	Preliminary assessment.
S. interrupta Rich.	LC			Included in RL 2023-1.
S. iostephana Nelmes	LC			Included in RL 2023-1.
S. junghuhniana Boeckeler	NE	T	T	Preliminary assessment.
S. kerrii Turrill	LC			Included in RL 2023-1.
S. khasiana Boeckeler	NE	T	T	Preliminary assessment.
S. lacustris C.Wright	LC			Included in RL 2023-1.
S. lagoensis Boeckeler	LC			Included in RL 2023-1.
S. latifolia Sw.	LC			Included in RL 2023-1.
S. laxa R.Br.	LC			Included in RL 2023-1.
S. laxiflora Gross	LC			Included in RL 2023-1.
S. leptostachya Kunth	LC			Included in RL 2023-1.
S. levis Retz.	LC			Assessed but not published.
S. liberica Bauters	VU			Included in RL 2023-1.
S. lingulata C.B.Clarke	LC			Assessed but not published.
S. lithosperma (L.) Sw.	LC			Included in RL 2023-1.
S. longispiculata Nelmes	LC			Included in RL 2023-1.
S. lucentinigricans E.A.Rob.	NE	NT	T	Preliminary assessment.
S. macbrideana Gross	LC			Included in RL 2023-1.
S. mackaviensis Boeckeler	LC			Included in RL 2023-1.
S. macrogyne C.B.Clarke	LC			Included in RL 2023-1.
S. macrophylla J.Presl & C.Presl	LC			Included in RL 2023-1.
S. madagascariensis Boeckeler	EN			Included in RL 2023-1.
S. martii (Nees) Steud.	LC			Assessed but not published.
S. maypurensis Bauters	CR			Included in RL 2023-1.
S. melanomphala Kunth	LC			Included in RL 2023-1.
S. melanotricha Hochst. & A.Rich.	LC			Included in RL 2023-1.
S. microcarpa Nees ex Kunth	LC			Included in RL 2023-1.
S. mikawana Makino	LC			Included in RL 2023-1.
S. millespicula T.Koyama	NE	T	T	Preliminary assessment.
S. minor (Britton) W.Stone	LC			Included in RL 2023-1.
S. mitis P.J.Bergius	LC			Included in RL 2023-1.
S. mongomoensis Bauters	EN			Included in RL 2023-1.
S. monticola Nelmes ex Napper	NE	NT	T	Preliminary assessment.
S. motleyi C.B.Clarke	NE	NT	NT	Preliminary assessment.
S. mucronata Poir.	LC			Included in RL 2023-1.
S. muehlenbergii Steud.	LC			Included in RL 2023-1.
S. multilacunosa T.Koyama	NE	T	T	Preliminary assessment.
S. myricocarpa Kunth	LC			Assessed but not published.
S. natalensis Boeckeler ex C.B.Clarke	LC			Included in RL 2023-1.
S. naumanniana Boeckeler	LC			Included in RL 2023-1.
S. neesii Kunth	LC			Included in RL 2023-1.
S. neocaledonica Rendle	NE	T	T	Preliminary assessment.
S. neogranatensis C.B.Clarke	LC			Included in RL 2023-1.
S. novae-hollandiae Boeckeler	LC			Assessed but not published.
S. nusbaumeri Bauters	NE	T	T	Preliminary assessment.
S. nyasensis C.B.Clarke	LC			Included in RL 2023-1.
S. oblata S.T.Blake ex J.Kern	LC			Included in RL 2023-1.
S. obtusa Core	LC			Assessed but not published.
S. oligantha Michx.	LC			Included in RL 2023-1.
S. oligochondra Nelmes	NE	T	T	Preliminary assessment.
S. orchardii C.D.Adams	CR			Included in RL 2023-1.

Table A1 continued / **Continuación Tabla A1**

Scientific name	RL IUCN	RF	Rcat	Notes
S. ovinux J.Raynal ex Fosberg	NE	T	T	Preliminary assessment.
S. pachyrrhyncha Nelmes	EN			Included in RL 2023-1.
S. panicoides Kunth	LC			Included in RL 2023-1.
S. pantadenia Meganck & Bauters	VU			Included in RL 2023-1.
S. parallella C.B.Clarke	NE	NT	NT	Preliminary assessment.
S. parvula Steud.	LC			Included in RL 2023-1.
S. patula E.A.Rob.	NE	T	T	Preliminary assessment.
S. pauciflora Muhl. ex Willd.	LC			Included in RL 2023-1.
S. paupercula E.A.Rob.	LC			Assessed but not published.
S. pedicellata Bauters	EN			Included in RL 2023-1.
S. pergracilis (Nees) Kunth	LC			Included in RL 2023-1.
S. pernambucana Luceño & M.Alves	NE	T	T	Preliminary assessment.
S. perpusilla Cherm.	EN			Included in RL 2023-1.
S. pilosa Boeckeler	NE	T	T	Preliminary assessment.
S. pilosissima Britton	NE	NT	T	Preliminary assessment.
S. plusiophylla Steud.	LC			Included in RL 2023-1.
S. poeppigii (Nees) Steud.	NE	T	T	Preliminary assessment.
S. poiformis Retz.	LC			Included in RL 2023-1.
S. polycarpa Boeckeler	LC			Included in RL 2023-1.
S. polyrrhiza E.A.Rob.	EN			Included in RL 2023-1.
S. pooides Ridl.	LC			Included in RL 2023-1.
S. porphyrocarpa E.A.Rob.	NE	T	T	Preliminary assessment.
S. procumbens E.A.Rob.	NE	NT	T	Preliminary assessment.
S. pseudohispidior Bauters	VU			Included in RL 2023-1.
S. psilorrhiza C.B.Clarke	LC			Assessed but not published.
S. pulchella Ridl.	CR			Included in RL 2023-1.
S. purdiei C.B.Clarke	LC			Included in RL 2023-1.
S. purpurascens Steud.	LC			Assessed but not published.
S. pusilla Pilg.	LC			Included in RL 2023-1.
S. racemosa Poir.	LC			Included in RL 2023-1.
S. radula Hance	LC			Assessed but not published.
S. ramosa C.B.Clarke	LC			Included in RL 2023-1.
S. rehmannii C.B.Clarke	LC			Included in RL 2023-1.
S. remota Ridl.	NE	T	T	Preliminary assessment.
S. reticularis Michx.	LC			Included in RL 2023-1.
S. richardsiae E.A.Rob.	EN			Included in RL 2023-1.
S. robinsoniana J.Raynal	NT			Included in RL 2023-1.
S. robusta Camelb. & Goetgh.	LC			Included in RL 2023-1.
S. rosea Cherm.	LC			Included in RL 2023-1.
S. rubrostriata A.C.Araújo & N.A.Brummitt	NE	T	T	Preliminary assessment.
S. rugosa R.Br.	LC			Included in RL 2023-1.
S. rutenbergiana Boeckeler	NT			Included in RL 2023-1.
S. scabra Willd.	LC			Included in RL 2023-1.
S. scabriuscula Schltdl.	NE	NT	NT	Preliminary assessment.
S. schiedeana Schltdl.	LC			Included in RL 2023-1.
S. schimperiana Boeckeler	LC			Included in RL 2023-1.
S. schulzii Barros	NE	NT	T	Preliminary assessment.
S. scrobiculata Nees & Meyen	LC			Assessed but not published.
S. secans (L.) Urb.	LC			Included in RL 2023-1.
S. sellowiana Kunth	LC			Assessed but not published.
S. setulosociliata Boeckeler	LC			Included in RL 2023-1.
S. sheilae J.Raynal	CR			Included in RL 2023-1.
S. sieberi Nees ex Kunth	NE	NT	T	Preliminary assessment.
S. skutchii M.T.Strong & J.R.Grant	LC			Included in RL 2023-1.
S. sobolifera E.F.Franklin	LC			Included in RL 2023-1.
S. sororia Kunth	LC			Included in RL 2023-1.
S. sphacelata F.Muell.	LC			Included in RL 2023-1.

Table A1 continued / **Continuación Tabla A1**

Scientific name	RL IUCN	RF	Rcat	Notes
S. spicata (Spreng.) J.F.Macbr.	VU			Included in RL 2023-1.
S. spiciformis Benth.	LC			Included in RL 2023-1.
S. splitgerberiana Henrard ex Uittien	LC			Included in RL 2023-1.
S. sprucei C.B.Clarke	LC			Included in RL 2023-1.
S. staheliana Uittien	LC			Included in RL 2023-1.
S. stipitata Uittien	NE	NT	NT	Preliminary assessment.
S. stipularis Nees	LC			Included in RL 2023-1.
S. stocksiana Boeckeler	NE	NT	T	Preliminary assessment.
S. suaveolens Nelmes	LC			Included in RL 2023-1.
S. suffulta C.B.Clarke	NE	T	T	Preliminary assessment.
S. sumatrensis Retz.	LC			Included in RL 2023-1.
S. tenacissima (Nees) Steud.	LC			Assessed but not published.
S. tenella Kunth	LC			Included in RL 2023-1.
S. tepuiensis Core	LC			Included in RL 2023-1.
S. terrestris (L.) Fassett	LC			Included in RL 2023-1.
S. tessellata Willd.	LC			Included in RL 2023-1.
S. testacea Nees ex Kunth	LC			Included in RL 2023-1.
S. thwaitesiana Boeckeler	NE	T	NT	Preliminary assessment.
S. tonkinensis C.B.Clarke	LC			Included in RL 2023-1.
S. transvaalensis E.F.Franklin	NT			Included in RL 2023-1.
S. trialata Poir.	LC			Included in RL 2023-1.
S. tricholepis Nelmes	VU			Included in RL 2023-1.
S. tricristata Meganck & Bauters	EN			Assessed but not published.
S. tricuspidata S.T.Blake	LC			Assessed but not published.
S. triglomerata Michx.	LC			Included in RL 2023-1.
S. triquetra M.T.Strong	LC			Assessed but not published.
S. tropicalis M.T.Strong	NE	T	T	Preliminary assessment.
S. tryonii Domin	NE	T	T	Preliminary assessment.
S. uleana Boeckeler	NE	NT	NT	Preliminary assessment.
S. unguiculata E.A.Rob.	LC			Included in RL 2023-1.
S. vaginata Steud.	LC			Assessed but not published.
S. variegata (Nees) Steud.	LC			Assessed but not published.
S. *venezuelensis* Core	NE	T	T	Preliminary assessment.
S. verrucosa Willd.	LC			Included in RL 2023-1.
S. verticillata Muhl. ex Willd.	LC			Included in RL 2023-1.
S. veseyfitzgeraldii E.A.Rob.	LC			Assessed but not published.
S. violacea Pilg.	NE	NT	NT	Preliminary assessment.
S. *virgata* (Nees) Steud.	LC			Included in RL 2023-1.
S. vogelii C.B.Clarke	LC			Included in RL 2023-1.
S. warmingiana Boeckeler	NE	T	T	Preliminary assessment.
S. welwitschii C.B.Clarke	LC			Included in RL 2023-1.
S. williamsii Gross	EN			Assessed but not published.
S. woodii C.B.Clarke	LC			Included in RL 2023-1.
S. wrightiana Boeckeler	NE	NT	NT	Preliminary assessment.
S. xerophila E.A.Rob.	NE	T	T	Preliminary assessment.
S. zambesica E.A.Rob.	NE	T	T	Preliminary assessment.

Species without occurrence data / Especies sin datos de presencia: *S. assamica* (C.B.Clarke) D.M.Verma, *S. depauperata* Boeckeler, *S. elongatissima* Piérart, *S. hirta* Boeckeler, *S. jiangchengensis* Y.Y.Qian, *S. lateritica* Nelmes, *S. macrolomioides* H.Pfeiff., *S. mutoensis* Nakai, *S. papuana* J.Kern, *S. scandens* Core, *S. schenckiana* Boeckeler and *S. swamyi* Govind.

Table A2. *Scleria* EDGE2 borderline and watch lists (Gumbs et al. 2023). Borderline list: threatened species whose distribution of EDGE2 scores rank above the median of the entire genus at least 80% of the time. Watch list: nonthreatened species whose distribution of EDGE2 scores rank above the median of the entire genus at least 95% of the times. EDGE2: Evolutionarily Distinct and Globally Endangered metric, ED2: evolutionary distinctiveness.

Tabla A2. Listas límite y de vigilancia EDGE2 de *Scleria* (Gumbs et al. 2023). Lista límite: especies amenazadas cuya distribución de las puntuaciones EDGE2 se sitúa por encima de la mediana de todo el género al menos el 80% de las veces. Lista de vigilancia: especies no amenazadas cuya distribución de las puntuaciones EDGE2 se sitúa por encima de la mediana de todo el género al menos el 95% de las veces. EDGE2: Métrica de distintividad evolutiva y en peligro de extinción a escala mundial, ED2: Métrica de distintividad evolutiva.

List	Scientific name	Section	EDGE2 (mean ± sd)	ED2 (mean ± sd)
Borderline	*S. chasmema* Bonet Mayedo & W.W.Thomas	*Virgatae*	0.76 ± 1.85	1.57 ± 2.53
	S. guineensis J.Raynal	*Hypoporum*	0.76 ± 0.85	0.85 ± 0.9
	S. glomerulata Oliv.	*Hypoporum*	0.74 ± 0.85	0.85 ± 0.9
	S. sheilae J.Raynal	*Hypoporum*	0.74 ± 0.81	0.81 ± 0.88
	S. baroni-clarkei De Wild.	*Foveolidia*	0.59 ± 0.33	1.34 ± 0.6
	S. poeppigii (Nees) Steud.	*Hymenolytrum*	0.58 ± 1.16	1.16 ± 1.58
	S. densispicata (C.B.Clarke) J.Kern	*Browniae*	0.45 ± 3.04	0.88 ± 5.1
	S. bradei Gross	*Hypoporum*	0.43 ± 0.77	0.83 ± 0.99
	S. neocaledonica Rendle	*Browniae*	0.42 ± 3.61	0.9 ± 5.34
	S. andringitrensis Cherm.	*Hypoporum*	0.42 ± 0.45	0.86 ± 0.87
	S. oligochondra Nelmes	*Ophryoscleria*	0.41 ± 0.94	0.91 ± 1.39
	S. perpusilla Cherm.	*Hypoporum*	0.41 ± 0.47	0.87 ± 0.93
	S. afroreflexa Lye	*Hypoporum*	0.4 ± 0.54	0.86 ± 1.02
	S. chlorantha Boeckeler	*Naumannianae*	0.4 ± 1.68	0.86 ± 2.42
	S. remota Ridl.	*Hypoporum*	0.39 ± 0.67	0.77 ± 0.94
	S. filiculmis Boeckeler	*Hypoporum*	0.38 ± 0.59	0.89 ± 0.92
	S. tropicalis M.T.Strong	*Ophryoscleria*	0.37 ± 0.91	0.72 ± 1.29
Watch	*S. transvaalensis* E.F.Franklin	*Acriulus*	1.52 ± 0.57	13.88 ± 4.08
	S. corymbosa Roxb.	*Corymbosae*	1.29 ± 0.59	22.28 ± 2.18
	S. lithosperma (L.) Sw.	*Lithospermae*	1.22 ± 0.52	20.89 ± 0
	S. melanomphala Kunth	*Melanomphalae*	1.15 ± 0.5	19.04 ± 0
	S. tonkinensis C.B.Clarke	*Corymbosae*	0.82 ± 0.36	13.91 ± 1.63

Table A3. *Scleria* EcoDGE borderline list (Griffith et al. 2022; Gumbs et al. 2023): threatened species whose distribution of EcoDGE scores rank above the median of the entire genus at least 80% of the time. EcoDGE: Ecologically Distinct and Globally Endangered metric, FUD: functional distinctiveness.

Tabla A3. Lista límite EcoDGE de *Scleria* (Griffith et al. 2022; Gumbs et al. 2023): especies amenazadas cuya distribución de puntuaciones EcoDGE se sitúa por encima de la mediana de todo el género al menos el 80% de las veces. EcoDGE: Métrica de distintividad ecológica y en peligro de extinción a escala mundial, FUD: distintividad funcional.

List	Scientific name	Section	EcoDGE (mean ± sd)	FUD (mean ± sd)
Borderline	*S. porphyrocarpa* E.A.Rob.	*Corymbosae*	1.14 ± 1.45	2.05 ± 2.1
	S. williamsii Gross	*Scleria*	0.86 ± 1.33	1.83 ± 2.56
	S. chlorantha Boeckeler	*Naumannianae*	0.84 ± 1.29	1.8 ± 1.78
	S. attenuatifolia M.T.Strong	*Schizolepis*	0.54 ± 1.01	1.13 ± 1.36
	S. foveolata Cav.	*Schizolepis*	0.46 ± 1.44	0.75 ± 2.07
	S. khasiana Boeckeler	*Elatae*	0.31 ± 0.47	0.62 ± 0.63
	S. madagascariensis Boeckeler	*Abortivae*	0.24 ± 0.15	0.49 ± 0.28
	S. bradei Gross	*Hypoporum*	0.23 ± 0.4	0.67 ± 0.55
	S. induta Turrill	*Acriulus*	0.2 ± 0.3	0.63 ± 0.38
	S. nusbaumeri Bauters	*Abortivae*	0.2 ± 0.25	0.42 ± 0.35
	S. aurantiaca Lye	*Foveolidia*	0.18 ± 0.15	0.2 ± 0.16
	S. warmingiana Boeckeler	*Scleria*	0.17 ± 0.26	0.54 ± 0.35
	S. burchellii C.B.Clarke	*Hypoporum*	0.15 ± 0.12	0.28 ± 0.24
	S. densispicata (C.B.Clarke) J.Kern	*Browniae*	0.13 ± 0.15	0.27 ± 0.2
	S. pachyrrhyncha Nelmes	*Acriulus*	0.12 ± 0.07	0.27 ± 0.14
	S. hildebrandtii Boeckeler	*Foveolidia*	0.12 ± 0.07	0.21 ± 0.13
	S. adpressohirta (KÃ¼k.) E.A.Rob.	*Foveolidia*	0.11 ± 0.2	0.18 ± 0.27
	S. arcuata E.A.Rob.	*Foveolidia*	0.1 ± 0.3	0.2 ± 0.42
	S. suffulta C.B.Clarke	*Elatae*	0.1 ± 0.12	0.21 ± 0.16
	S. glomerulata Oliv.	*Hypoporum*	0.1 ± 0.05	0.1 ± 0.05
	S. oligochondra Nelmes	*Ophryoscleria*	0.1 ± 0.14	0.18 ± 0.21
	S. patula E.A.Rob.	*Foveolidia*	0.09 ± 0.08	0.2 ± 0.09
	S. pulchella Ridl.	*Hypoporum*	0.08 ± 0.06	0.09 ± 0.06
	S. neocaledonica Rendle	*Browniae*	0.07 ± 0.1	0.13 ± 0.13
	S. anomala (Steud.) J.Raynal	*Elatae*	0.06 ± 0.21	0.11 ± 0.29
	S. guineensis J.Raynal	*Hypoporum*	0.06 ± 0.04	0.06 ± 0.04
	S. cheekii Bauters	*Hypoporum*	0.06 ± 0.04	0.24 ± 0.17
	S. aureovillosa Kiaos. & K.Wangwasit	*Foveolidia*	0.05 ± 0.05	0.11 ± 0.06
	S. baroni-clarkei De Wild.	*Foveolidia*	0.05 ± 0.12	0.1 ± 0.24
	S. multilacunosa T.Koyama	*Foveolidia*	0.04 ± 0.04	0.08 ± 0.05
	S. mongomoensis Bauters	*Hypoporum*	0.04 ± 0.07	0.07 ± 0.14
	S. sheilae J.Raynal	*Hypoporum*	0.03 ± 0.01	0.03 ± 0.01

Table A4. Countries in which *Scleria* is present ranked by their sum of EDGE2 scores. Richness: number of species present, N: number of listed EDGE2 and EcoDGE species, Main: number of species included in the main EDGE2 and EcoDGE lists, Sum: sum of EDGE2 and EcoDGE scores.

Tabla A4. Países en los que *Scleria* está presente ordenados por su suma de puntuaciones EDGE2. Richness: número de especies presentes, N: número de especies incluidas en las listas EDGE2 y EcoDGE, Main: número de especies incluidas en las listas principales EDGE2 y EcoDGE, Sum: suma de las puntuaciones EDGE2 y EcoDGE.

Country	Richness	EDGE2			EcoDGE		
		N	Main	Sum	N	Main	Sum
Madagascar	24	7	3	10.11	3	0	1.24
Dem. Rep. Congo	26	5	2	9.85	5	0	1.94
Brazil	63	6	2	9.43	4	2	3.08
Zambia	29	5	4	8.95	1	0	0.79
Tanzania	30	5	3	8.23	2	0	0.63
Venezuela	31	3	1	5.94	1	1	2.00
South Africa	17	2	0	5.23	0	0	0.17
Thailand	20	3	1	5.18	0	0	0.28
China	15	3	0	4.76	0	0	0.24
Bolivia	34	1	0	4.33	1	0	1.98
Guinea	15	4	2	4.29	1	0	0.22
Ghana	20	2	0	4.20	0	0	0.68
Ethiopia	16	4	1	4.20	0	0	0.29
Côte d'Ivoire	20	2	0	4.05	0	0	0.66
Philippines	13	3	0	3.96	1	0	0.32
Gabon	19	3	1	3.95	2	0	0.66
Angola	11	2	1	3.83	1	0	0.32
Nigeria	20	2	0	3.74	0	0	0.63
Guyana	21	1	0	3.58	1	0	1.26
Cameroon	18	3	0	3.56	2	0	0.89
Australia	22	1	0	3.51	1	0	0.30
Zimbabwe	8	2	1	3.50	1	0	0.21
Colombia	32	1	0	3.47	0	0	1.41
Mozambique	7	2	0	3.45	0	0	0.23
India	13	2	0	3.45	2	0	0.51
Mexico	23	1	0	3.39	0	0	0.54
Cuba	22	1	0	3.26	0	0	0.36
Indonesia	15	1	0	3.14	1	1	0.40
Belize	16	1	0	3.03	0	0	0.42
eSwatini	6	2	0	2.94	0	0	0.07
Guatemala	13	1	0	2.83	0	0	0.44
Nicaragua	15	1	0	2.82	0	0	0.45
Honduras	16	1	0	2.80	0	0	0.46
Costa Rica	17	1	0	2.70	0	0	0.98
Trinidad and Tobago	13	1	0	2.62	1	1	0.74
Liberia	10	2	1	2.58	0	0	0.18
Burkina Faso	11	1	0	2.51	0	0	0.53
Benin	18	1	0	2.50	0	0	0.61
Peru	24	1	0	2.45	1	0	1.53
Eq. Guinea	9	2	1	2.42	1	0	0.31
Uganda	11	1	0	2.36	0	0	0.27
Botswana	8	1	0	2.27	0	0	0.08

Table A4 continued / Continuación Tabla A4

Country	Richness	EDGE2			EcoDGE		
		N	Main	Sum	N	Main	Sum
Togo	12	1	0	2.16	0	0	0.56
Dominican Rep.	8	2	0	2.08	1	0	1.01
United States of America	14	1	0	2.06	0	0	0.12
Malawi	6	1	1	2.01	0	0	0.21
Taiwan	8	1	0	1.95	0	0	0.09
Sri Lanka	6	1	0	1.84	0	0	0.04
Argentina	12	1	0	1.83	0	0	0.39
Puerto Rico	11	1	0	1.77	0	0	0.25
Sierra Leone	8	1	1	1.68	0	0	0.10
Panama	15	0	0	1.65	1	0	0.96
Congo	11	1	0	1.64	1	0	0.33
Jamaica	6	1	0	1.55	0	0	0.16
Kenya	5	1	0	1.48	0	0	0.17
Paraguay	12	0	0	1.47	0	0	0.40
Central African Rep.	10	0	0	1.31	0	0	0.16
Fiji	2	1	0	1.29	0	0	0.01
Tonga	2	1	0	1.29	0	0	0.01
Suriname	17	0	0	1.25	0	0	0.70
Rwanda	2	1	0	1.24	0	0	0.02
Bahamas	1	1	0	1.22	0	0	0.01
Timor-Leste	1	1	0	1.22	0	0	0.01
Cayman Is.	1	1	0	1.22	0	0	0.01
Ecuador	16	0	0	1.17	0	0	0.47
Guinea-Bissau	5	0	0	1.00	0	0	0.09
Niger	2	0	0	0.76	0	0	0.03
S. Sudan	1	1	0	0.74	1	0	0.10
New Caledonia	4	1	0	0.72	2	1	0.28
Chad	4	0	0	0.50	0	0	0.15
Japan	6	0	0	0.49	0	0	0.07
Mali	7	0	0	0.48	0	0	0.47
Lesotho	3	0	0	0.43	0	0	0.01
Senegal	9	0	0	0.41	0	0	0.50
Nepal	3	0	0	0.41	0	0	0.03
Burundi	5	0	0	0.40	0	0	0.16
Myanmar	2	0	0	0.40	0	0	0.02
El Salvador	5	0	0	0.34	0	0	0.06
Vietnam	5	0	0	0.32	0	0	0.07
Papua New Guinea	3	0	0	0.25	0	0	0.02
Cambodia	3	0	0	0.23	1	0	0.08
Seychelles	2	0	0	0.19	0	0	0.04
Mauritius	1	0	0	0.19	1	0	0.06
Vanuatu	2	0	0	0.15	0	0	0.01
Laos	2	0	0	0.09	0	0	0.02
Uruguay	1	0	0	0.08	0	0	0.00
Malaysia	1	0	0	0.02	0	0	0.01
French Guiana	0	0	0	0.00	0	0	0.00

Table A5. Top 50 ecoregions in which *Scleria* is present ranked by their sum of EDGE2 scores. Richness: number of species present, N: number of EDGE2 and EcoDGE species, Main: number of species included in the main EDGE2 and EcoDGE lists, Sum: sum of EDGE2 and EcoDGE scores.

Tabla A5. Las 50 principales ecorregiones en las que *Scleria* está presente según su suma de puntuaciones EDGE2. Richness: número de especies presentes, N: número de especies EDGE2 y EcoDGE, Main: número de especies incluidas en las listas principales EDGE2 y EcoDGE, Sum: suma de las puntuaciones EDGE2 y EcoDGE.

Ecoregion	Richness	EDGE2			EcoDGE		
		N	Main	Sum	N	Main	Sum
Central Zambezian Miombo woodlands	39	8	7	15.32	3	0	2.04
Madagascar subhumid forests	22	7	3	9.50	2	0	1.09
Cerrado	45	3	1	7.09	2	0	1.72
East Sudanian savanna	22	5	1	5.76	1	0	0.85
Llanos	24	3	1	5.68	0	0	0.86
Guinean forest-savanna mosaic	28	4	1	5.61	1	0	0.81
Madagascar lowland forests	16	2	1	5.48	1	0	0.65
Northwestern Congolian lowland forests	20	4	1	5.28	2	0	0.37
Zambezian and Mopane woodlands	15	3	1	5.28	0	0	0.18
Mato Grosso seasonal forests	28	2	1	4.87	1	0	1.05
Western Congolian forest-savanna mosaic	18	3	1	4.87	3	0	0.80
Tenasserim-South Thailand semi-evergreen rain forests	13	3	1	4.82	0	0	0.19
Zambezian flooded grasslands	13	2	0	4.76	0	0	0.24
Eastern Arc forests	14	3	1	4.70	1	0	0.39
South China-Vietnam subtropical evergreen forests	12	3	0	4.70	0	0	0.19
Guianan savanna	21	2	0	4.61	0	0	0.73
Drakensberg montane grasslands, woodlands and forests	13	2	0	4.33	0	0	0.11
Eastern Guinean forests	21	2	0	4.28	0	0	0.70
West Sudanian savanna	21	2	0	4.23	0	0	0.64
Western Guinean lowland forests	20	3	2	4.15	0	0	0.69
Southern Rift montane forest-grassland mosaic	14	2	1	3.94	0	0	0.29
Angolan Miombo woodlands	11	2	1	3.90	1	0	0.20
Cardamom Mountains rain forests	11	3	1	3.89	1	0	0.18
Southern Congolian forest-savanna mosaic	15	2	1	3.83	1	0	0.52
Guinean montane forests	17	3	2	3.52	0	0	0.22
Petén-Veracruz moist forests	21	1	0	3.52	0	0	0.54
Eastern Miombo woodlands	9	2	0	3.29	0	0	0.22
Alto Paraná Atlantic forests	23	1	0	3.28	0	0	0.77
Central Indochina dry forests	11	2	0	3.22	0	0	0.15
Bahia coastal forests	27	1	0	3.21	2	2	1.82
Atlantic Equatorial coastal forests	16	2	1	3.20	1	0	0.39
Arnhem Land tropical savanna	18	1	0	3.20	0	0	0.18
Southern Miombo woodlands	9	2	2	3.19	1	0	0.35
Southern Africa bushveld	6	2	0	3.05	0	0	0.07
Guianan piedmont and lowland moist forests	22	1	0	3.03	0	0	0.85
Queensland tropical rain forests	15	1	0	2.99	1	0	0.24
Cape York Peninsula tropical savanna	16	1	0	2.96	0	0	0.17
Central American pine-oak forests	18	1	0	2.94	0	0	0.47
Western Java rain forests	12	1	0	2.93	1	1	0.36
KwaZulu-Cape coastal forest mosaic	12	1	0	2.91	0	0	0.10
Caqueta moist forests	21	1	0	2.90	0	0	0.72

Table A5 continued / **Continuación Tabla A5**

Ecoregion	Richness	EDGE2			EcoDGE		
		N	Main	Sum	N	Main	Sum
Maputaland coastal forest mosaic	10	1	0	2.90	0	0	0.11
Pantanal	14	1	0	2.81	0	0	0.39
Southeastern Indochina dry evergreen forests	7	2	1	2.80	0	0	0.09
Bolivian Yungas	18	1	0	2.69	0	0	0.57
Kimberly tropical savanna	13	1	0	2.68	0	0	0.13
Einasleigh upland savanna	12	1	0	2.65	0	0	0.12
Tocantins/Pindare moist forests	18	1	0	2.59	0	0	0.55
Southern Pacific dry forests	12	1	0	2.58	0	0	0.23
Chiquitano dry forests	26	0	0	2.57	0	0	0.83