

Research Article

***Andropogon abyssinicus* R. Br. ex Fresen. (Andropogoneae, Panicoideae, Poaceae), another cryptic invader in La Palma (Canary Islands, Spain)**Filip Verloove¹, Frederik Leliaert¹, Thomas Gregor² and Rainer Otto³¹Meise Botanic Garden, Nieuwelaan 38, B-1860 Meise, Belgium²Senckenberg Research Institute and Natural History Museum, Senckenberganlage 25, D-60325 Frankfurt am Main, Germany³Lindenstraße 2, D-96163 Gundelsheim, GermanyCorresponding author: Filip Verloove (filip.verloove@botanicgardenmeise.be)

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Abstract

A species from the genus *Andropogon*, that has been known since 2011 from the island of La Palma (Canary Islands, Spain) and that was initially attributed to the putatively native species *A. distachyos*, is here identified as the African weed *A. abyssinicus*. The identification, based on morphological characteristics, was further supported by molecular data and ploidy estimation. In La Palma, *A. abyssinicus* is locally naturalized along roadsides and on slopes of ravines between La Dehesa and El Dorador (Santa Cruz de La Palma). The differentiation from morphologically similar species, in particular *A. amethystinus* and *A. distachyos*, is discussed. Until now, only one species of *Andropogon* was reported from the Canary Islands, *A. distachyos*, a widespread species from subtropical regions of the Old World. However, its presence in the archipelago requires confirmation, as apparently no herbarium material is available that unequivocally testifies its presence there. The limited bibliographic and other references are briefly discussed.

Key words: invasions, mistaken identity, molecular analysis, morphology, ploidy estimation

Introduction

Andropogon L. is a pantropical grass genus that currently comprises 133 species (POWO 2024). It is mainly distributed in the grasslands of Africa and the Americas (Clayton and Renvoize 1982; Nagahama and Norrmann 2012), with additional species found in Asia (Shouliang and Phillips 2006) and a single species in Europe, *A. distachyos* L. (Clayton 1980). Several *Andropogon* species are important pasture grasses, with the genus being dominant in savanna ecosystems, while others are used for erosion control, are grown for fodder (Mabberley 2008) or as ornamentals (Darke 2004). Some of these economically important species readily become weedy and now widely occur beyond their original distribution area, often as highly invasive environmental weeds, for example *A. gayanus* Kunth in Australia and South America or *A. virginicus* L. in Australia, Japan and France (Granereau and Verloove 2010; Setterfield et al. 2010; Barbosa 2016; EPPO 2019).

Andropogon is a morphologically heterogeneous genus whose generic boundaries have shifted significantly over time. Stapf (1919) delineated

four sections in the genus for African species, which remain widely accepted (Clayton 1967; Clayton and Renvoize 1986): section *Andropogon*, section *Leptopogon* Stapf, section *Notosolen* Stapf and section *Piestium* Stapf. Among these, section *Andropogon* comprises 33 species, mostly from the Mediterranean region and mountains of tropical Africa (Clayton 1967), with only two species occurring in the Americas (*A. gerardi* Vitman and *A. hallii* Hack.). *Andropogon distachyos*, the type of the genus, also belongs to this section. It naturally occurs in southern Europe, throughout the Mediterranean region, in parts of tropical and South Africa and Arabia. It is locally introduced and naturalized elsewhere, for instance in western Australia (Simon 2014). It is the only known species of the genus in the Canary Islands and is considered possibly native there. It is reportedly known from the islands of La Gomera and Tenerife (Acebes Ginovés et al. 2009), see Epilogue.

In March 2011, one of the authors (RO) discovered a population of a species of *Andropogon* in the Barranco del Carmen Dorador (Santa Cruz de La Palma; island of La Palma), initially identified as *A. distachyos* by the late Hildemar Scholz (Berlin, Germany). Upon closer examination, however, it clearly differed from that species in having basal leaf sheaths that were entirely glabrous (vs. silky pubescent, a typical feature of *A. distachyos*) and by its sessile spikelets that were not drawn out into a caudate tip. The plants were particularly reminiscent of some related species from East Africa, especially *A. abyssinicus* R. Br. ex Fresen. and, to a lesser extent, *A. amethystinus* Steud. This article discusses the correct identity of these Canarian plants, based on morphological traits, ploidy estimation and genetic research.

Materials and methods

Fieldwork and herbarium study

Numerous fieldwork sessions in La Palma have been undertaken in the past decades. Since the discovery of *Andropogon abyssinicus* in 2011, the area was further explored in order to assess the species' behaviour and to document its local distribution and ecological preferences.

Herbarium material that was offered for deposit in the herbarium of Meise Botanic Garden (BR; herbarium acronym according to Thiers 2024), was examined using numerous floras and papers relevant to the genus *Andropogon* (e.g. Stapf 1919; Anderson 1966; Clayton and Renvoize 1982; Phillips 1995; Campbell 2003; Shouliang and Phillips 2006; Simon 2014).

Nomenclature

As a rule, taxon names and their authorities are in accordance with WFO (2024).

Molecular phylogenetic analysis

DNA sequence data were analyzed to confirm morphology-based species identification and assess geographical origins. Analyses were based on the

plastid *atpB-rbcL* spacer and *matK* gene, as well as the nuclear rDNA internal transcribed spacer (ITS) of two samples: *R. Otto* 21020 (<https://www.botanicalcollections.be/specimen/BR0000033229232>) and *R. Otto* 23505 (<https://www.botanicalcollections.be/specimen/BR0000025861037V>). Total genomic DNA was extracted from silica-dried leaf material using a modified CTAB protocol. The *atpB-rbcL* spacer was amplified using primers *rbcL1* (5'-AAC ACCAGCTTTRAATCCAA-3') and *atpB1* (5'-ACATCKARTACKGGACC AATAA-3') (Chiang et al. 1998). The *matK* gene was amplified using primers *matK-MALPR1* (5'-ACAAGAAAGTCGAAGTAT-3') and *matK-xF* (5'-TAAT TTACGATCAATTCATTC-3') (Ford et al. 2009; Dunning and Savolainen 2010). The ITS region was amplified using primers ITS4 (5'-TCCTCCGCT TATTGATATGC-3') and ITS5 (5'-GAAGTAAAAGTCGTAACAAGG-3') (White et al. 1990). PCR conditions are described in Verloove et al. (2020), and PCR quality control was performed with a BioAnalyzer (Agilent Inc.). After purification using ExoSAP-IT (ThermoFisher Scientific), PCR products were sequenced by Macrogen (Seoul, South Korea). Forward and reverse sequences were assembled using Geneious Prime v2023.2.1. (Biomatters, Auckland, New Zealand). Sequences have been deposited in EMBL/GenBank under study number PRJEB73329 and accession numbers OZ020473–OZ020478.

For the plastid marker alignments, taxon sampling was based on the complete plastid genome datasets of Arthan et al. (2017) and McAllister et al. (2018), supplemented with closest BLAST hits of the *atpB-rbcL* and *matK* sequences.

The *atpB-rbcL* and *matK* sequences were aligned separately using MUSCLE (Edgar 2004) and subsequently concatenated. Phylogenetic relationships were reconstructed using maximum likelihood and 1000 ultrafast bootstrap replicates in IQ-TREE 2.2.2.7 (Nguyen et al. 2015) on the CIPRES Science Gateway portal (Miller et al. 2010). Alignments and tree files are available on Zenodo (<https://zenodo.org/records/10774900>).

Flow cytometry

Two accessions were analysed: *Andropogon spec.* from La Palma (collection *R. Otto* 21284; for details, see Collections examined) and—for comparison—*A. virginicus* (collection *R. Otto* 21426, originating from the Ecological-Botanical Garden of the University of Bayreuth, Germany, acc. 140012). DNA-ploidy levels were estimated by flow cytometric analyses of fresh leaves using a Partec CyFlow space (Partec, Germany) fitted with a high-power UV LED (365 nm). Leaf tissues of the analysed sample and internal standard – *Glycine max* cv. “Polanka” (Doležel et al. 1994) or *Solanum lycopersicum* cv. Stupické polní tyčkové rané (Doležel et al. 1992) – were co-chopped using a razor blade in a plastic Petri-dish containing 1 ml of ice-cold Otto I buffer [0.1 M citric acid, 0.5% Tween 20; Otto (1990), Doležel et al. (2007)]. The suspension was filtered through Partec CellTrics®

30 µm (Partec, Germany) to remove tissue debris and incubated for at least 10 minutes at room temperature. Isolated nuclei in filtered suspension were stained with 1 ml of Otto II buffer (0.4 M Na₂ HPO₄ × 12H₂O) containing the AT-specific fluorochrome 4',6-diamidino-2-phenylindole (DAPI; 4 µg ml⁻¹) and β-mercaptoethanol (2 µg ml⁻¹). The relative fluorescence intensity was recorded for 3.000 particles. Sample/standard ratios were calculated from the means of fluorescence histograms visualised using the FloMax v2.4d software (Partec, Germany). Only histograms with coefficients of variation (CVs) < 5 % for the G0/G1 peak of the sample were considered. The sample/standard ratios based on internal standard *Solanum lycopersicum* were adjusted to those from *Glycine max* using a coefficient of 0.803 based on twelve repeats of ratios among the two standards.

Results

Species identity

Morphological characteristics (Figures 1–10)

The following description is entirely based on characters observed in the plants found in La Palma or cultivated in Germany originating from seeds from La Palma:

Perennial (or rather pluri-annual and flowering in the first year), laxly to densely caespitose, with short rhizomes. Culms strictly erect (but with age some of the outer culms procumbent and rooting at the nodes), up to 135 cm tall and ca. 3 mm wide at base, terete to slightly flattened, often branched (with up to 4 branches, each bearing one terminal inflorescence), somewhat glossy and purple tinged near the nodes (Figures 1, 6–10). Internodes 4–6(–8), glabrous, often tinged purplish (especially with age). Leaf sheaths flattened but not keeled; surface glabrous or with scattered, readily deciduous hairs; margin (particularly of the lowermost sheaths) with a row of clearly tubercle-based cilia up to 3 mm long (Figure 2). Ligule membranous, truncate to rounded, ca. 3 mm long and wide, glabrous or abaxially sparsely hairy. Leaf-blades variable in length, width and hairiness, flat with sunken midvein, upper surface green, lower surface slightly to clearly glaucous, up to 60 cm long (mostly shorter) and 2–6 mm wide; both surfaces with rather numerous, white hairs ca. 1–2 mm long on tiny tubercles (Figure 6). Inflorescence composed of 2 terminal up to 13 cm long racemes (Figures 1, 3). Rachis fragile, ciliate on margins, internodes slightly flattened (Figure 4). Spikelets appressed, in pairs, straw coloured at maturity, often suffused pink (Figure 4). Pedicelled spikelet well-developed, sterile, lanceolate or narrowly ovate, dorsally compressed, (5–)6–8(–8.5) mm long; lower glume as long as the spikelet, (1.8–)2,3(–2.5) mm wide, with two lateral keels, chartaceous to thinly coriaceous, asymmetrically winged on keels in upper 1/2–2/3, unevenly 9–11-veined (or more, but then indistinct) between the lateral keels, acute, slightly falcate at tip, with awn up to 3.5 mm long; upper glume membranous,



Figure 1. Herbarium specimen of *Andropogon abyssinicus* R. Br. ex Fresen. from La Palma, Sta. Cruz de La Palma, Barranco del Carmen Dorador, priv. herb. R. Otto 17717b, March 2011 (Photograph: R. Otto).

subequal to lower glume but narrower, 3-veined, shortly mucronate or awned, mucro 1–2.5 mm long, glabrous on both surfaces. Lemma membranous, veinless, $(1/3-1/2-3/4)$ as long as upper glume, glabrous on both surfaces. Pedicel linear, slightly clavate and flattened, ciliate (Figure 4). Sessile spikelet fertile, lanceolate or narrowly ovate, dorsally compressed, $(6-7-8(-8.5))$ mm long, including callus ca. 1–1.5(–2 mm) long, callus hairs 0.5–2 mm; lower glume as long as the spikelet, $(2-3-3.2)$ mm wide, with two lateral keels, chartaceous to thinly coriaceous, asymmetrically winged on keels in upper $1/2-2/3$, unevenly 9–11-veined (or more, but then indistinct)



Figure 2. Comparison of the lower leaf sheaths of *Andropogon distachyos* L. (left) and *A. abyssinicus* R. Br. ex Fresen. (right). Provenance *A. distachyos*: France, Alpes-Maritimes, November 1948, sheet BR0000033228686 (<https://www.botanicalcollections.be/specimen/BR0000033228686>); *A. abyssinicus*: La Palma, Barranco del Carmen Dorador, March 2014, sheet priv. herb. R. Otto 21020 (Photographs: R. Otto).

between the lateral keels, acute, bidentate, slightly falcate at tip (Figure 5), in front on either side near the wings with one oblong yellowish pit 0.2–2 mm long; upper glume 6–7 mm long, 3-veined, strongly keeled, membranous to chartaceous, straw-coloured, tips bidentate for 0.3–0.6 mm, in the notch with an awn up to 3–5(–6) mm long. Lower lemma reduced. Upper lemma membranous, widest just below the middle, ca. 6–7 mm long and 2.2 mm wide, abaxial surface minutely hairy, ciliate on the edges, awn geniculate slightly below middle, 20–27 mm long, with twisted column. Palea 5–7 mm long, membranous, veinless, abaxially sparsely long hairy, adaxially hairless. Lodicules 2, glabrous, +/- rectangular, ca. 0.3 × 0.2 mm, truncate, straw-coloured. Anthers 3, yellowish, tinged purplish at maturity, ca. 3–3.5 mm long. Style ca. 3 mm long, stigma ca. 3.5 mm long. Caryopsis +/- triangular in cross-section, 3.5–5 × 1.1–1.6 mm, brownish, embryo ca. 1/2 length of caryopsis.

Based on these characteristics, in particular the glabrous basal leaf sheaths, the acute tip of the lower glume of the sessile spikelet, the strictly erect culms exceeding 100 cm in length, the long racemes (up to 13 cm long), the wide leaves (up to 6 mm wide) and the long lemma awns (up to 27 mm long), the plants from La Palma correspond morphologically best to *Andropogon abyssinicus*.



Figure 3. Comparison of the lower part of two racemes of *Andropogon distachyos* L. (left) and *A. abyssinicus* R. Br. ex Fresen. (right). Provenance as for Figure 2. In the former the spikelets are drawn out into a caudate tip whereas they are acute to slightly falcate at apex in *A. abyssinicus* (Photographs: R. Otto).

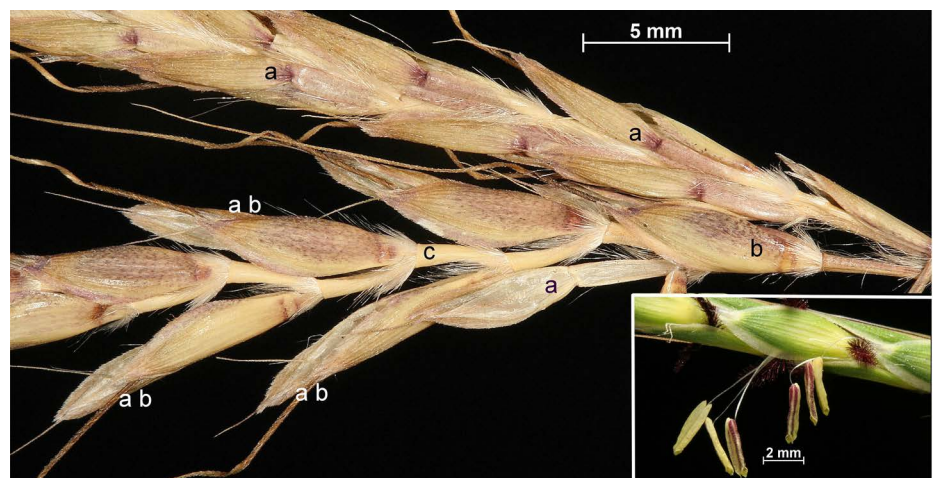


Figure 4. Top: *Andropogon abyssinicus* R. Br. ex Fresen. (provenance as for Figure 2), lower part of the racemes near their point of attachment: a) pedicelled spikelets, b) sessile spikelets, a b) pair of spikelets (the sessile spikelet always on the right), c) rachis internode. Bottom: Top view of the winged asymmetrical lower glume of the fertile, sessile spikelet at flowering time. May 2015, plant cultivated in Germany (Photographs: R. Otto).

Specimens examined:

1. SPAIN, Canary Islands, La Palma, Sta. Cruz de La Palma, between La Dehesa and El Dorador, bridge over the Barranco del Carmen Dorador, a several years old fill in of the slope of the LP-401 road (excavated material?) at km 2 of the road, 28.703057, -17.778604, ca. 264 m above sea, 09.03.2011, R. Otto 17717 (BR0000033229249; private herbarium R. Otto) and 24.09.2013, R. Otto 20702 (private herbarium R. Otto);



Figure 5. *Andropogon abyssinicus* R. Br. ex Fresen.: lower glume of the sessile spikelet in top view (in transmitted light). For its glabrous glumes with numerous veins, such plants were formerly ascribed to *A. multinervis* Hochst. ex Steud., a heterotypic synonym of *A. abyssinicus*. Provenance as for Figure 2 (Photograph: R. Otto).

2. SPAIN, Canary Islands, La Palma, Sta. Cruz de La Palma, between La Dehesa and El Dorador, at the bridge over the Barranco del Carmen Dorador, rocky slope below a small dirt parking lot along the LP-401 road at km 1,9 of the road, 28.703311, -17.778947, ca. 257 m above sea, 08.03.2014, R. Otto 21020 and 21284 (BR0000033229232; private herbarium R. Otto);

3. SPAIN, Canary Islands, La Palma, Sta. Cruz de La Palma, El Dorador, Barranco del Carmen Dorador, roadside and slope at km 1,4 of the LP-401 road, approx. 300 m from the Centro de estancia diurna El Dorador, 28.703140, -17.774897, ca. 265 m above sea, numerous specimens, 06.04.2018, R. Otto 23165 (BR0000025519891V; private herbarium R. Otto);

4. SPAIN, Canary Islands, La Palma, Sta. Cruz de la Palma, near La Dehesa, at km 2,14 of the Carretera Las Nieves (LP-101 road), ca. 150 m above the former Hospital de las Nieves, temporarily damp water channel along the road, a population of about 20 m long, ca. 220 m above sea, ca. 28.695848, -17.773192, 30.03.2017, R. Otto 22483 (BR0000025338355V; private herbarium R. Otto);

5. SPAIN, Canary Islands, La Palma, Sta. Cruz de la Palma, near La Dehesa, at km 2,2 of the Carretera Las Nieves (LP-101 road), ca. 200 m above the former Hospital de las Nieves, temporarily damp water channel along the road, a small population, ca. 28.696252, -17.773801, ca. 230 m above sea, 27.03.2019, R. Otto 23505 (BR0000025861037V; private herbarium R. Otto).

Molecular analysis

The *atpB-rbcL* alignment included 35 sequences and 924 positions, with 71 variable positions, of which 27 were parsimony informative. The *matK* alignment included 35 sequences and 897 positions, with 57 variable positions of which 21 were parsimony informative. The concatenated alignment included 36 sequences. The concatenated phylogeny (Figure 11) clearly placed the sequences from the two La Palma specimens in a clade with *Andropogon abyssinicus* sequences from specimens of various eastern African localities (Ethiopia, Kenya, Tanzania) with high support (bootstrap value = 96), with



Figure 6. Top: *Andropogon abyssinicus* R. Br. ex Fresen. Leaf surfaces with rather numerous, white hairs (March 2019, plant cultivated in Germany). Bottom, left: In young plants leaves are more or less glaucous, whereas the ligular region and adventitious roots are suffused purplish (August 2015, plant cultivated in Germany); right: With age, stems and nodes often turn purplish (December 2014, plant cultivated in Germany) (Photographs: R. Otto).

all sequences in that clade being identical. This clade was sister to *A. mannii* Hook. f. MH181231 from Kenya, and together, this clade was on its turn sister to a clade containing *A. distachyos* MH181203 (Ethiopia) and *A. pusillus* MH181175 (Cameroon). Due to limited available ITS sequences of *Andropogon* in public sequence databases (e.g. no public ITS sequences available for *A. abyssinicus* or *A. distachyos*), this phylogenetic analysis was not informative



Figure 7. Top: Habitat of *Andropogon abyssinicus* R. Br. ex Fresen. in the Barranco del Carmen Dorador on the edge of an unpaved car park on the LP-101 road, September 2013. Bottom: Plants at this location in April 2016 (left) and September 2013 (right) with leaves and stems suffused purple (Photographs: R. Otto).

regarding species identity. We therefore do not further discuss the ITS tree in the Results, but the ITS tree is made available on Zenodo (<https://zenodo.org/records/10774900>) for reference.

Flow cytometry

Table 1 summarizes the results of our flow cytometric analyses of *Andropogon abyssinicus* (originating from La Palma, Barranco del Carmen Dorador, Sta. Cruz de la Palma / Spain) and, for comparison, *A. virginicus* (originating from the Ecological-Botanic Garden Bayreuth / Germany).

Andropogon virginicus has a somatic chromosome number of $2n = 20$ which corresponds to diploid in *Andropogon* (Gould 1956). The *Andropogon* plants from La Palma are, according to the results of our flow cytometric analyses, tetraploid.

Table 1. Results of flow cytometric analyses of *Andropogon abyssinicus* R. Br. ex Fresen. from La Palma and, for comparison, *A. virginicus* L.

Date	Sample	Sample peak	Sample CV	Standard	Standard peak	Standard CV	Coeff. Glycine	Coeff. Solanum	Ploidy level	Voucher
21/01/2015	<i>Andropogon virginicus</i> L.	104.85	1.72	Glycine	192.69	1.72	0.54		2	R. Otto 21426
21/01/2015	<i>Andropogon virginicus</i> L.	201.21	2.87	Solanum	290.96	1.48	0.55	0.69	2	R. Otto 21426
21/01/2015	<i>Andropogon</i> _La Palma	206.28	2.46	Glycine	206.28	2.46	1.00		4	R. Otto 21284
21/01/2015	<i>Andropogon</i> _La Palma	380.76	1.66	Solanum	300.33	1.66	1.02	1.27	4	R. Otto 21284



Figure 8. *Andropogon abyssinicus* R. Br. ex Fresen. in a temporarily wet roadside ditch on the Carretera Las Nieves (LP-101) in mid-October 2016. At this time, only non-flowering plants were observed which were subsequently mowed. Flowering started at the end of March 2017 (small photo) (Photographs: R. Otto).

Distribution and habitat

On La Palma, *Andropogon abyssinicus* is only known from the municipality of Sta. Cruz de La Palma in the eastern part of the island. The species is particularly frequent between the districts of La Dehesa (alt. ca. 200 m) and El Dorador (alt. ca. 270 m) on the sides of the LP-101 and LP-401 roads. It is also found on some adjacent unpaved car parks and farm tracks, as well as on the partially wooded slopes and bottom of the Barranco del Carmen Dorador, which is bordered there by the LP-401 road and represents, so to speak, the center of its occurrence in La Palma (about 28.70318, -17.77877). Some smaller occurrences along the LP-101 road are found in and along occasionally wet roadside ditches (or small water channels) in agricultural areas with residential development (Figures 7–10).

In the Barranco del Carmen Dorador, *Pinus canariensis* C. Sm. reaches the lower limit of its altitudinal distribution, the loose pine forest being interspersed with many elements of the xerophytic scrub. On the rocky slopes and roadsides species characteristic for disturbed habitats are found. *Andropogon abyssinicus* is associated with native species like: *Achyranthes aspera* L. var. *sicula* L.,



Figure 9. *Andropogon abyssinicus* R. Br. ex Fresen. at the LP-401 road near El Dorador. Access to the Barranco with numerous *Andropogon* individuals that are barely recognizable in the lush vegetation. April 2018 (Photograph: R. Otto).



Figure 10. Top: Shady forest path in the Barranco del Carmen Dorador with numerous tall *Andropogon* individuals at the edge of the path. Bottom: A vigorous individual from this location. Plants can have up to 20 stems that easily exceed 100 cm in length. April 2014 (Photographs: R. Otto).

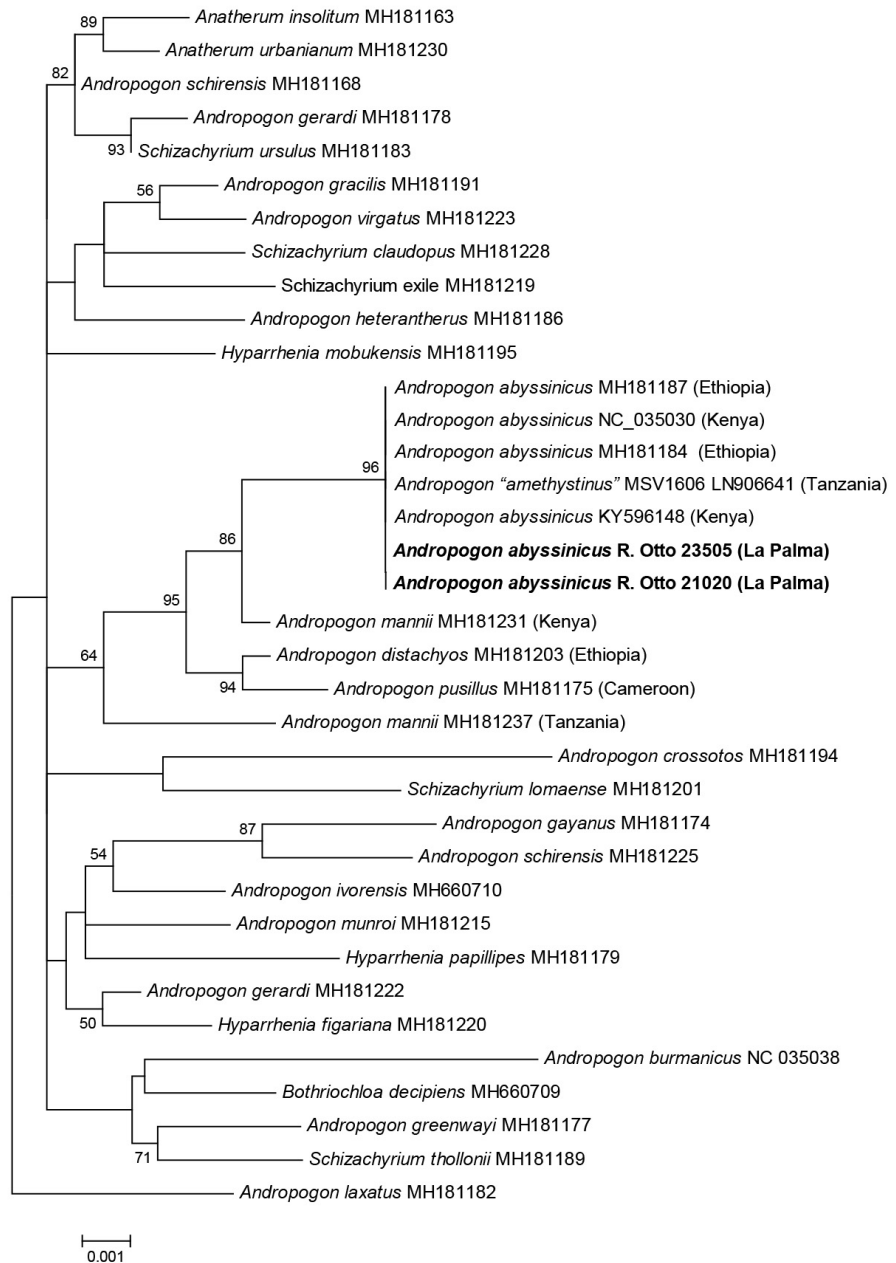


Figure 11. Maximum likelihood trees (IQ-TREE) inferred from the concatenated plastid atpB-rbcL intergenic spacer and matK gene sequences, showing the position of the La Palma *Andropogon abyssinicus* plants. Values at branches correspond to UFBoot2 supports (1000 replicates). Scale represents estimated substitutions per site.

Bituminaria bituminosa (L.) C.H. Stirt., *Crassula tillaea* Lest.-Garl., *Dracunculus canariensis* Kunth, *Euphorbia lamarckii* Sweet, *Globularia salicina* Lam., *Hemionitis gluckuk* Christenh., *Hyparrhenia sinaica* (Delile) G. López, *Kleinia neriifolia* Haw., *Periploca laevigata* Aiton, *Pteridium aquilinum* (L.) Kuhn, *Rumex lunaria* L., etc. Many of the other accompanying species are of Mediterranean origin and/or cosmopolitan or pantropical weeds such as *Ageratina adenophora* (Spreng.) R.M. King & H. Rob., *Avena barbata* Pott ex Link, *Bidens pilosa* L., *Cenchrus ciliaris* L., *Cynodon dactylon* (L.) Pers., *Cynosurus echinatus* L., *Echium plantagineum* L., *Eleusine indica* (L.) Gaertn., *Erigeron bonariensis* L., *E. sumatrensis* Retz., *Gastridium phleoides*

(Nees & Meyen) C.E. Hubb., *Geranium purpureum* Vill., *G. rotundifolium* L., *Hirschfeldia incana* (L.) Lagr.-Foss., *Foeniculum vulgare* Mill., *Helminthotheca echioides* (L.) Holub, *Sonchus oleraceus* L., *Solanum nigrum* L. subsp. *nigrum*, *Torilis arvensis* (Huds.) Link subsp. *neglecta* (Schult.) Thell., etc. All sites, even those in relatively remote locations in the forest, are highly invaded by exotic species, mainly escapes from cultivation, e.g.: *Agave americana* L., *A. attenuata* Salm-Dyck, *Aloe maculata* All., *Cardiospermum grandiflorum* Sw., *Ipomoea indica* Merr., *Kalanchoe daigremontiana* Raym.-Hamet & H. Perrier, *K. ×houghtonii* D.B. Ward, *Lycianthes rantonnetii* (Carrière) Bitter, *Opuntia dillenii* (Ker Gawl.) Haw., *O. ficus-indica* (L.) Mill., *Oxalis pes-caprae* L., *Paspalum urvillei* Steud., *Cenchrus purpureus* (Schumach.) Morrone, *Ricinus communis* L. and *Urochloa mutica* (Forssk.) T.Q. Nguyen. The area is seriously affected by human disturbance: the roadsides, forest tracks and the *barranco* slopes near the roads were serving as illegal deposits for construction and garden debris, excavated material and garbage.

Discussion

Our first herbarium collections were ascribed to *Andropogon distachyos*—the only species from that genus hitherto known from the Canary Islands—by the late Hildemar Scholz. However, morphologically, the plants from La Palma differed clearly from that species in a number of important respects: firstly, the basal leaf sheaths were not densely and persistently silky hairy and, secondly, the wings on the lower glume of the sessile spikelet were not confluent to a caudate tip. On closer examination and after consultation of numerous Floras covering the whole distribution area of the genus, it became clear that Scholz' assumption was wrong. The La Palma plants obviously belong to section *Andropogon*: inflorescences are terminal (not spathate) and paired and rachis internodes and pedicels are linear (Clayton 1967). Morphologically, they are most closely similar to *A. distachyos*, *A. abyssinicus* and *A. amethystinus*, with which species they share several diagnostic features. In some respects, the La Palma plants display a more or less intermediate morphology between these species. It should be emphasized that, in section *Andropogon*, hybridization is a regularly occurring event in sympatric areas and these hybrids are frequently interfertile (Wipff 1996). A possible hybrid could therefore not be completely ruled out.

Andropogon distachyos has silky-pubescent basal leaf sheaths (Figure 2) and a long drawn out tip of the lower glume of the sessile spikelet (Figure 3). Linnaeus (1753) did not emphasize these characters in his detailed species description. However, they are commonly accepted as diagnostic for this species (Clayton 1980; Clayton and Renvoize 1982; Phillips 1995) and clearly visible in the type specimen as well (as seen on digital images, received from the UPS herbarium). Compared with *A. distachyos*, the La Palma plant has glabrous leaf sheaths (Figure 2) and is furthermore slightly smaller in most floral parts (sessile and pedicelled spikelet length, awn length, etc.).

Andropogon abyssinicus and *A. amethystinus* share the glabrous basal leaf sheaths and the acute tip of the lower glume of the sessile spikelet with the La Palma plant and are obviously closer matches. Nonetheless, the La Palma plant subtly differs from *A. abyssinicus* in being perennial, or at least pluri-annual (vs. annual). Spikelets are also subglabrous while they often are villous in *A. abyssinicus*. From *A. amethystinus* our plant is separated by its strictly erect culms (vs. straggling to geniculately ascending), the much taller habit (exceeding 100 cm; vs. 8–60 cm), longer racemes (up to 13 cm long; vs. 2–8 cm long), wider leaves (up to 6 mm wide; vs. 1–4 mm wide) and longer lemma awns (up to 27 mm long; vs. 10–15 mm long).

Based on the above, it was subsequently speculated that the La Palma plant might be an undescribed cryptic species, more or less intermediate between *A. abyssinicus* and *A. amethystinus*. Additional study of heterotypic synonyms of these two species (as enumerated and keyed out by Steudel 1854 and Stapf 1919), however, threw new light on their morphological variation. In particular, our plants showed great resemblance to *A. multinervis* Hochst. ex Steud., especially for their less hairy, nearly glabrous spikelets and lower glumes with more numerous veins (Figure 5). An isotype of the latter species, preserved at BR (*Schimper W.H.* 805 from Ethiopia; <https://www.botanicalcollections.be/specimen/BR0000008252098>), is a good match for the La Palma plant. *Andropogon multinervis* is now treated as a synonym of *A. abyssinicus* (Clayton and Renvoize 1982; Phillips 1995). However, the problem of the life form remained, as *A. abyssinicus* is usually qualified as being annual, at least in standard floras (e.g. Phillips 1995). While sifting through herbarium labels, it turned out that the species is sometimes also reported as perennial, which seems to suggest that life form is not easily assessed or indeed variable.

Our molecular phylogenetic analysis conclusively identified the plants from La Palma as belonging to *A. abyssinicus*. The plastid *atpB-rbcL* spacer and *matK* gene were identical to those of specimens from Ethiopia, Kenya, Tanzania, identified as *A. abyssinicus* by Arthan et al. (2017) and McAllister et al. (2018), with voucher specimens housed in MO. Our phylogenetic analyses strongly suggest an East African origin for the La Palma plants. Phylogenetic relationships among *A. abyssinicus*, *A. mannii*, *A. distachyos*, and *A. pusillus* Hook. f. were consistent with the plastid phylogenomic analyses conducted by McAllister et al. (2018).

Gould (1956) and Nagahama and Norrmann (2012) published the following chromosome numbers for the species relevant to our study: *Andropogon abyssinicus* ($n = 16$), *A. amethystinus* ($2n = 20$ or ca. 30), *A. virginicus* ($2n = 20$), and *A. distachyos* ($n = 18$, resp. $2n = 36$ or 40). The ploidy, as measured on the La Palma plant material, is thus in line with previous measurements for that species.

Andropogon abyssinicus of course is not a native species in La Palma, its native area being from Eritrea, Ethiopia, Kenya, Tanzania and Uganda in

East Africa (Clayton and Renvoize 1982; Phillips 1995). Rather disjunct, it is also known from Angola (Figueiredo and Smith 2008). In his revision of the southern African species of the genus, Anderson (1966) reported *A. abyssinicus* from the Drakensberg in South Africa. According to the species description in his key (annual, etc.), this claim indeed seemed plausible, especially since there is only one other annual (but quite different) species found in South Africa, *A. fastigiatus* Sw. (Mashau et al. 2022). Nevertheless, more recent authors (Gibbs Russell et al. 1990; Fish et al. 2015; Mashau et al. 2022; etc.) referred the collections cited by Anderson to the closely related but perennial *A. amethystinus*. In any case, claims of *A. abyssinicus* outside East Africa require confirmation. The species grows primarily in the seasonally dry tropical biome: open grasslands, disturbed grounds and as a weed in pasture and arable land. Despite being weedy, to our knowledge, it has never been recorded before outside of its native range (e.g. Randall 2017). In La Palma, it appears to be a recent newcomer of unknown provenance: no historical records of any species of *Andropogon* are known from the island (Santos-Guerra 1983). The introduction vector is unclear and can only be speculated upon. The species may have been introduced for use as a pasture grass (but then only on an experimental basis), as a tall-growing ornamental grass (although it is unknown in the horticultural trade), as a lawn grass (from pure seed or as a contaminant) or as a component of seed mixtures for various purposes, e.g. grain for poultry. Whatever the initial introduction vector, the plant most likely arrived at this location with green waste. Where the seeds ultimately came from and for which purpose they were used, remains unknown: no commercial source has yet been found.

Since the end of the last decade, the number of individuals seems to be declining. This is probably due to road construction works or, even more likely, due to the more intensive cleaning of roadsides, in order to control the highly invasive grass *Cenchrus setaceus* (Forssk.) Morrone (Da Re et al. 2020) that occurs in the same habitat.

Conclusion

Based on morphological characters, a molecular analysis and flow cytometric measurements, naturalized populations of a species of *Andropogon* from La Palma are here assigned to the predominantly East African species *Andropogon abyssinicus*. The Canarian plants slightly differ from that species in life form: the La Palma plants are, provided there is sufficient water, clearly perennating, while in Africa *A. abyssinicus* is generally considered an annual species. However, this may be related to the specific growing conditions in La Palma, where the species occurs in a habitat different from that in its area of origin. In La Palma, *A. abyssinicus* is very locally established in a relatively small and, to some extent, rather remote region where it is, however, occurring in abundance since at least 2011. It remains a mystery why, how and when the species was introduced to La Palma.

Epilogue: what about *Andropogon distachyos* in the Canary Islands?

Berthelot (1840) probably was the first to mention this species from the archipelago; it was only mentioned in passing from the southern flank of the Goleta (i.e., Anaga) Mountains in Tenerife. This species was not (yet) mentioned in “Histoire naturelle des Iles Canaries” that was published a few years before (Webb and Berthelot 1836). It therefore appears that this reference from 1840 either is an error, or else that Webb and Berthelot discovered this species after 1836. The Webb herbarium (Herbarium Webbianum) is housed at FI; it contains one collection labelled as *Andropogon distachyos* from Tenerife, with four specimens, all collected by Bourgeau after 1840 (C. Nepi and A. Donatelli, April 2023, *pers. comm.*). They clearly belong to *Hyparrhenia hirta* (L.) Stapf s.l., most likely to *H. sinaica*. At that time, *H. hirta* was sometimes considered to be a mere variety of *A. distachyos*, which may explain historical claims of *A. distachyos* from Tenerife. Lindinger (1926) also referred to the presence of *A. distachyos* in Tenerife but this was apparently solely based on Berthelot (1840). As a consequence, there does not seem to be any solid basis for the historical presence of *A. distachyos* in Tenerife. However, in 2002, *A. distachyos* was reported from the Barranco del Infierno ravine, in the extreme southern part of the island (Danton 2002), a well-studied locality and therefore rather surprising. In this publication, the species was not depicted and none of the participants apparently took photographs or collected a herbarium specimen (B. Bock, January 2024, *pers. comm.*). On the same occasion and from the same locality *Hyparrhenia hirta* was reported and thus confusion with the latter species seems unlikely.

Kunkel (1975) reported *Andropogon distachyos* from La Gomera (Ancón de Agulo). He referred to his collection Kunkel 18535 that, unfortunately, could not be traced (it is not, for instance, in LPA where part of the Kunkel herbarium is housed; Á. Marrero Rodríguez, February 2023, *pers. comm.*). Since then, it apparently has never been recorded in La Gomera, which means that its presence cannot be verified there either.

In a recent, very comprehensive photo guide on Canarian plants (Sauerbier et al. 2023), *A. distachyos* is treated and illustrated. However, the photo was not taken in the Canary Islands (T. Muer, February 2024, *pers. comm.*). The genuine occurrence of *A. distachyos* in the Canary Islands thus requires confirmation, also taking into account that confusion with *A. abyssinicus* cannot be completely ruled out.

Authors' contribution

Research conceptualization: FV and RO. Sample design and methodology: FV and RO. Data collection: RO. Molecular analysis and interpretation: FL. Flow cytometry and interpretation: TG. Writing first draft: FV and RO. Reviewing and editing first draft: FL and TG.

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