

A new species of *Chlorophytum* (Asparagaceae) from the succulent Karoo biome, Namibia – with an updated key for *Chlorophytum* of Namibia

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Background and aims – Following a revision of family Anthericaceae for Flora of Namibia, a new species is described from southern Namibia. To elucidate its taxonomic affinity, a molecular analysis is carried out on representative taxa of *Chlorophytum* subgroups.

Methods – Morphological study and molecular phylogenetic analysis.

Key results – *Chlorophytum boomense* Kativu sp. nov. is described. It is morphologically similar to *C. subpetiolatum*, particularly in its fusiform roots that are swollen at base and tapered towards the tips. The species differs in floral morphology and habitat. *Chlorophytum boomense* is found in a very dry area and is only known from the Ai-Ais Hotsprings Game Park in Namibia, while *C. subpetiolatum* is a wide-spread, semi-humid to humid tropical species. Phylogenetic analysis places the taxon in an isolated position, separate from taxa that superficially resemble it. A preliminary IUCN conservation status of VU D2 is assigned to the new species.

Key words – Ai-Ais Hotsprings Game Park, *Chlorophytum*, Anthericaceae, new species, morphology, southern Namibia.

INTRODUCTION

Until recently (Angiosperm Phylogeny Group 2009), the genus *Chlorophytum* Ker-Gawl. was referred to family Anthericaceae J.G. Agardh, a segregate of Liliaceae s. lat. (see Dahlgren et al. 1985). The genus, together with several others from related families, was recently placed in family Asparagaceae (subfam Agavoideae, Angiosperm Phylogeny Group 2009), and is now one of the largest genera of that family. With more than 200 species, and with a wide tropical and subtropical Old World distribution, *Chlorophytum* has its center of variation in tropical and subtropical Africa (Kativu & Nordal 1993, Bjourå 2008).

The generic circumscription of the group was reviewed for tropical African taxa by Obermeyer (1962), Marais & Reilly (1978), Nordal et al. (1990) and Kativu & Nordal (1993). The latter transferred most of the tropical African species previously referred to the genus *Anthericum* L. to *Chlorophytum*. In tropical and subtropical southern Africa, Kativu et al. (2008) enumerated 56 species of *Chlorophytum* for Flora Zambesiaca. Obermeyer (1962) had previously recorded 37 species (seventeen from *Anthericum* sensu Marais & Reilly (1978), and twenty from *Chlorophytum* s. str.) from South Africa. Recently, Kativu et al. (2012) presented twelve species for Flora of Namibia. Details on the taxonomic histo-

ry of *Chlorophytum* are provided in Marais & Reilly (1978), Kativu & Nordal (1993) and Bjourå et al. (2008).

Since its generic re-circumscription (Kativu & Nordal 1993), studies on *Chlorophytum* provided descriptions for several new taxa from across Africa: nine new species from the Horn of Africa in Nordal & Thulin (1993), four new species from central and East Africa in Kativu (1993a), one new species from south-eastern Africa in Nordal & Poulsen (1998), two new species from Ethiopia by Sebsebe & Nordal (in Sebsebe et al. 2005), four new species from Zambia and Malawi in Bjourå et al. (2008), and one new species from Burundi and Tanzania (Meerts 2011).

Information on phylogenetic relationships in genus *Chlorophytum* is limited. Kativu (1993b) presented preliminary results of a cladistic analysis on 93 species of the genus based on morphological, anatomical and cytological characters. The study poorly supported some of the traditional generic groups (*Dasystachys*, Baker 1878, *Anthericum* sensu Marais & Reilly 1978 and *Chlorophytum* sensu Marais & Reilly 1978), though with extensive homoplasy. Bjourå et al. (2008) carried out a DNA-based phylogenetic analysis of *Chlorophytum* from representative subgroups of the genus in which they evaluated the taxonomic affinities of some four newly described species. Meerts & Bjourå (2012) used DNA

markers to clarify the taxonomic position of some central African species.

A recent revision of family Anthericaceae for Flora of Namibia (Kativu et al. 2012) recognised twelve species of *Chlorophytum*. Nine of the species have a wide distribution in southern Africa, while *C. rangei* Engl. & Krause and *C. viscosum* Kunth are confined to Namibia and South Africa and *C. krauseanum* (Dinter) Kativu to Namibia, South Africa and Botswana. So far, there are no endemic species of *Chlorophytum* recorded for Namibia. The majority of Namibian species are distributed in the north and central districts of the country, e.g. *C. calyptrocarpum* (Baker) Kativu, a species used in our morphological comparison below. Only five are found south of the 26° latitude, namely *Chlorophytum cameranii* (Baker) Kativu, *C. krauseanum*, *C. longifolia* Schweinf. ex Baker, and the mentioned *C. rangei* and *C. viscosum*. Six species of *Chlorophytum* are recorded in the Northern Cape (South Africa), namely *C. acutum* (C.H. Wright) Nordal, *C. triflorum* Kunth, *C. namaquense* Schltr. ex Poelln., *C. crassinerve* (Baker) Oberm., *C. pauciphyllum* Oberm. and *C. lewisae* Oberm. None of these species, however, extends into Namibia.

The neighbouring South African province of Northern Cape has similar climatic conditions to those of southern Namibia. Ai-Ais Hotsprings Game Park is part of the Succulent Karoo biome, an arid ecoregion of high botanical diversity. This ecoregion is home to more than 5,000 higher plant species, nearly 40% of which are endemic, and 18% are threatened (Hilton-Taylor 1996). It has the richest succulent flora in the world, harboring about one-third of the world's approximately 10,000 succulent species. The ecoregion includes high diversity of miniature succulents (435 species) and geophytes (630 species), many with very limited distribution (Hilton-Taylor 1996). Many of them are threatened or endangered, largely because they occupy extremely small ranges

We aim to revise the new collections of *Chlorophytum* and update the key to species of *Chlorophytum* for Flora of Namibia.

MATERIAL AND METHODS

An unusual specimen of *Chlorophytum* was collected by L. Nyanyeni and A. Burke in September 2012 during a botanical survey of the Orange River Mountain (Ai-Ais Hotsprings Game Park) area in the extreme south of Namibia. Ai-Ais Hotsprings Game Park is a remote, inhospitable and under-collected area. Its climate is extremely arid, with rainfall averaging 0–50 mm per annum along the Orange River and southeastern portion of the park, increasing to 50–100 mm per annum towards the northeast (Burke 2011). The park lies within a transitional zone between summer and winter rainfall areas. It is characterised by cold and frosty winters, and high summer temperatures. Temperature maxima range between 34 and 36°C (Burke 2011). Annual average temperatures tend to mask these extremes, ranging between 16 and 18°C.

The specimen considered here was morphologically compared to all known *Chlorophytum* species from Namibia

and neighbouring Northern Cape Province from literature descriptions and herbarium material from B, BOL, CT, K, SRGH, WAG and WIND. To elucidate the taxonomic affinity of the specimen, a molecular analysis was carried out on representative taxa of all *Chlorophytum* subgroups of central and southern Africa.

Total genomic DNA was extracted from herbarium specimens or silica dried leaf samples using the DNeasy Plant mini kit (Qiagen, Hilden, Germany). This was PCR amplified and sequenced from one nuclear (nrITS1) and two plastid (*trnL*F, *rps16*) DNA regions. For the amplification of nrITS1, modified versions of primers ITS5 and ITS2 (White et al. 1990) were used. The *e* and *f* primers (Taberlet et al. 1991) and *rpsF* and *rpsR2R* (Oxelman et al. 1997) were used to PCR amplify the *trnL*F and *rps16*, respectively. All amplifications were performed on an Eppendorf Mastercycler EP gradient S. Prepared amplicons contained 1 µL purified PCR product, 1 µL of 10 µM primer (the same primer as used for the PCR), and 8 µL milliQ H₂O. Sequences were processed on an ABI 3730 DNA analyser (Applied Biosystems). Sequences were assembled and edited using the ContigExpress module in Vector NTI Advance™ 11.0 (Invitrogen Corporation, CA, USA). GenBank accession numbers of sequences included in the present study are presented in table 1. Sequences from the 38 accessions were manually aligned using BioEdit 7.0.9.0 (Hall 1999). Maximum parsimony analyses were performed using NONA (Goloboff 1999) in combination with WinClada v. 1.0 (Nixon 2002). Parsimony jack-knifing was undertaken with 1000 replicates and otherwise default setting. The nuclear (ITS) and the chloroplast (*trnL*F and *rps16*) regions were analyzed separately. The jack-knife support values of the nuclear analysis were placed above the branches and chloroplast values below.

RESULTS AND DISCUSSION

Material of the putative new taxon did not morphologically match any of the taxa so far recorded in central and southern Africa. A close examination of the specimen against four of the Namibian species not included in a DNA analysis, namely *Chlorophytum viscosum*, *C. calyptrocarpum*, *C. krauseanum* and *C. rangei* led to the following observations. *Chlorophytum calyptrocarpum* is characterised by wiry roots that bear elongated tubers or occasionally has its roots reduced to elongated tubers. Its inflorescence is a wiry, glandular panicle. These characters are in contrast to the fusiform roots and non-glandular, condensed racemes of the putative new taxon. *Chlorophytum viscosum* is glandular on all parts with a laxly branched panicle. *Chlorophytum krauseanum* and *C. rangei* are tufted, grass-like species with wiry leaves and paniculate inflorescences, and are thus significantly different from the putative new taxon.

The nuclear DNA analysis placed the Orange River taxon in an isolated position, separate from taxa that superficially resemble it (fig. 1). The analysis resolved the putative new taxon as sister to the *Dasystachys* sensu Baker and *Euchlorophytum* sensu Bjořa (2008) clades, however, with low support (JK = 65). In the chloroplast analysis, the taxon also resolved as sister to the *Dasystachys* sensu Baker clade (JK = 78). The taxon thus does not appear to have any close

Table 1 – Specimens included in molecular analyses of *Anthericum* and *Chlorophytum*, with voucher information and GenBank sequence accession numbers indicated.

Geographical divisions following the regional African Floras are indicated after country. Abbreviations: *A.* = *Anthericum*; *C.* = *Chlorophytum*; Herb. = voucher-holding herbarium acronym; nrITS1 = nuclear ribosomal internal transcribed spacer 1; n/a = not available; *rps16* = *rps16* intron; *trnLF* = *trnL-trnF* intergenic spacer. When more than one specimen of the same species, these are separated by numbers.

Taxon	Specimen voucher (Herb)	Localities	nrITS1	trnLF	rps16
<i>Agave chrysantha</i> Peebles	92-207S (O)	Cult.	KU880782	KU880881	KU880827
<i>Agave</i> sp.	96-195S (O)	Cult.	KU880781	KU880880	KU880826
<i>A. angustifolium</i> Hochst. ex A.Rich.	<i>Sebsebe</i> 5041 (ETH, O)	Ethiopia: Tigray	KU880774	KU880873	KU880819
<i>A. corymbosum</i> Baker	<i>Nordal</i> 4601 (ETH)	Kenya K6: Mua Hills, SW of Nairobi	EU128949	EU128939	EU128959
<i>A. neghellense</i> (Cufod.) Bjorå & Sebsebe	<i>Nordal</i> 2218 (ETH, O)	Ethiopia: Sidamo, 39 km S of Agere Maryam	KU880777	KU880876	KU880822
<i>A. ramosum</i> L.	1968-810-S (O)	Sweden, Stenåsa, Öland	KU880779	KU880878	KU880824
<i>C. affine</i> Baker	<i>Nordal & Bjorå</i> 4552 (O)	Zambia N: Ntumbachusi falls	EF999985	EU000019	KU880830
<i>C. africanum</i> Engl.	<i>A. Bjørnstad</i> 2054 (O)	Tanzania T7: Mbeya D., Magangwe	EF999986	EU000020	n/a
<i>C. alismatifolium</i> Baker	<i>Scott</i> 1 s-4-04 (O)	Cultivated plants ex W.Africa	KU880912	KU880931	KU880922
<i>C. anceps</i> (Baker) Kativu	<i>Kativu</i> 344 (K, O, SRGH)	Zimbabwe C: Harare, Epworth Mission area	KU880913	KU880939	KU880923
<i>C. andongense</i> Baker	<i>Nordal & Bjorå</i> 5013 (O)	Tanzania T3: Pare D., SW of N Pare, near Lembeni	EU128950	EU128940	EU128960
<i>C. angustissimum</i> (Poelln.) Nordal	<i>I. Bjørnstad</i> 891 (O)	Tanzania T2: Musoma Distr.: Serengeti National Park	KU880914	KU880932	KU880924
<i>C. blepharophyllum</i> Schweinf. ex Baker	<i>Hoell & Nordal</i> 24 (O)	Zambia B: Lukulu road	EF999989	EU000023	EU128961
<i>C. boomense</i> Kativu sp. nov.	<i>L. Nanyeni</i> 380 (WIND)	Namibia: Ai-Ais Hotsprings GP, Orange River Mountain	KU880920	KU880937	KU880928
<i>C. brachystachyum</i> Baker	<i>Bjorå</i> 615 (O)	Zambia E: Luangwa valley	KU880915	KU880933	KU880925
<i>C. cameronii</i> (Baker) Kativu	<i>Sebsebe et al.</i> 6093 (ETH)	Ethiopia, Benshangul-Gumuz Region	KU880788	KU880885	KU880834
<i>C. clarae</i> Bjorå & Nordal	<i>Nordal & Bjorå</i> 4542 (O)	Zambia N: Mansa	EU000016	EU000049	KU893898
<i>C. colubrinum</i> Engl.	<i>Nordal & Bjorå</i> 4535 (O)	Zambia C: Kasanka	EF999991	EU000025	KU880835
<i>C. comosum</i> (Thunb.) Jacques	<i>Nordal</i> 3803 (O)	South Africa: Cape, Grootvatersbosch	EF999992	EU000026	EU128962
<i>C. fasciculatum</i> (Baker) Kativu	<i>Stedje</i> 881 (BOL, O)	South Africa: Natal	KU880916	n/a	KU880926
<i>C. fischeri</i> Baker	<i>Hoell & Nordal</i> 170 (O)	Zambia N: Near Kapišhya hot springs	KU880917	KU880934	n/a
<i>C. floribundum</i> Baker	<i>Hoell & Nordal</i> 14 (O)	Zambia B: Sesheke	EF999995	EU000029	EU128970
<i>C. gallabatense</i> Schweinf. ex Baker	<i>Hoell & Nordal</i> 25 (O)	Zambia B: Lukulu road	EF999996	EU000030	EU128971
<i>C. galpinii</i> (Baker) Kativu var. <i>norlindhii</i> (Weim.) Kativu	<i>Hoell & Nordal</i> 17 (O)	Zambia B: Liyoyelo to Mongu	EF999997	EU000031	KU893896
<i>C. longifolium</i> Schweinf.	<i>Nordal</i> 1507 (O)	Zimbabwe S: Masvingo, Near Great Zimbabwe	EU000001	EU000034	KU880851
<i>C. macrorrhizum</i> Poelln.	<i>Nordal & Bjorå</i> 4521 (O)	Malawi N: Nyika, nr. Zambian border	EU000003	EU000036	EU128976
<i>C. macrosporum</i> Baker	<i>Kativu</i> 255 (O, SRGH)	Zimbabwe C: Chegutu	EU000004	EU000037	KU880853
<i>C. pauper</i> Poelln.	<i>Hoell & Nordal</i> 13 (O)	Zambia B: Sesheke	EU000005	EU000038	KU893897

Table 1 (continued) – Specimens included in molecular analyses of *Anthericum* and *Chlorophytum*, with voucher information and GenBank sequence accession numbers indicated.

Taxon	Specimen voucher (Herb)	Localities	GenBank accession no			
			nrITS1	trnLF	rps16	
<i>C. polystachys</i> Baker	Hoell & Nordal 7 (O)	Zambia S: S of Zimba, Monachongwe farm	EU000006	EU000039	KU880856	
<i>C. psammophilum</i> Engl. & Gilg	Kativu 321 (O, SRGH)	Zimbabwe E: Nyanga Dist. Nyanga National Park	KU880918	KU880935	KU880927	
<i>C. pubiflorum</i> Baker	Nordal 4561 (O)	Zambia N: E of Mununga Bridge	KU880807	KU880903	KU880859	
<i>C. pusillum</i> Schweinf. ex Baker	Nordal & Bjorå 4567 (O)	Zambia N: E of Mununga Bridge	EU000007	EU000040	EU128979	
<i>C. rubribracteatum</i> (De Wild) Kativu	Bjorå 657 (O)	Zambia C: 32 km from Chipata towards Lusaka	KU880808	KU880904	KU880860	
<i>C. sphacelatum</i> (Baker) Kativu var. <i>sphacelatum</i>	Hoell & Nordal 2 (O)	Zambia S: S of Zimba, Monachongwe farm	EU000009	EU000042	KU880866	
<i>C. sphacelatum</i> (Baker) Kativu var. <i>milanjianum</i> (Rendle) Nordal	Hoell & Nordal 18 (O)	Zambia B: Mongu to Mufwaya, Loyi	KU880919	KU880936	KU880929	
<i>C. subpetiolatum</i> (Baker) Kativu	Hoell & Nordal 15 (O)	Zambia B: Road to Mouyo	EU000011	EU000044	KU880867	
<i>C. suffruticosum</i> Baker (1)	A. Bjørnstad 2804 (O)	Kenya K7: Teita D., 51 km NW of Voi	EU000010	EU000043	KU880868	
<i>C. suffruticosum</i> Baker (2)	Nordal & Bjorå 5014 (O)	Tanzania T2: North Pare	KU880921	KU880938	KU880930	
<i>C. viridescens</i> Engl.	Nordal & Bjorå 5012 (O)	Tanzania T2: Moshi-Arusha Rd.	EU000012	EU000045	EU128981	

connection with any of the species included in the phylogenetic analyses.

In the genus *Chlorophytum*, subterranean organs usually represent a useful character for assigning species to informal subgroups. The roots of the specimen (fig. 2D) resemble those of *C. subpetiolatum* in being swollen at base and tapering at the tips, not commonly found in the genus. The similarity in the root system apparently does not reflect any phylogenetic relationship as seen in the molecular analyses and deviating morphological characters. In addition, *C. subpetiolatum* is a semi-humid to humid tropical species that has its most southerly extent in neighbouring Angola and Zambia, more than a thousand kilometres to the north, and separated from the putative taxon by the dry Namib Desert. The phylogenetic analysis places the species in a position separate from all other analysed central and southern African species, hence supporting its recognition as a distinct taxon.

Chlorophytum boomense Kativu, sp. nov.

Type: Namibia, Luderitz Distr., Ai-Ais Hotsprings Game Park, Orange River Mountain (Boom River), on a granite mountain, in mid-slope, on well drained soils that overly a stony/rocky substrate, 12 Sept. 2012, fl., fr., *L. Nanyeni* 380 (holo-: WIND; iso-: WIND, SRGH). Species is only known from the type locality and is listed as occasionally occurring. Efforts should be made to collect more material from the area.

Plant erect, up to 32 cm high. **Rhizome** short, bearing fibrous remains of old leaf bases. **Roots** many, swollen at base, without tubers. **Leaves** (sub-)distichous, 2-several, lowermost reduced to cataphylls, linear to linear-lanceolate, clasping, soft, flat, glabrous, 5–12.5 × 0.8–1.2 cm. **Peduncle** slightly arcuate at base, terete, glabrous, 2–3 bracteate, with lowermost bract 1.9 cm long, linear, acuminate, upper ones smaller. **Inflorescence** a loose, simple raceme, exerted above the leaf rosette. **Floral bracts** broad and clasping at base, acute, 4–5 brownish veined, 2 mm long. **Pedicels** 2-several per node, articulated below the middle, c. 9 mm long in fruit. **Perianth** white, star-shaped, **tepals** free, 3-veined, c. 10 × 1.5 mm. **Filaments** terete, sparsely papillate, longer than the anthers. **Style** exerted, slightly declinate. **Young capsule** longer than broad, sharply trigonal, smooth, c. 6.5 mm long. Seeds unknown. Figure 2.

Etymology – *Chlorophytum boomense* borrows its name from Boom River, where it grows in the vicinity.

Habitat and phenology – The species occurs on a granite mountain, in mid-slope, at altitude 257 m, on well drained soils that overly a stony/rocky substrate. It flowers and fruits in September.

Distribution – *Chlorophytum boomense* is endemic to southern Namibia and appears to be of limited distribution. The type locality lies in a protected national park area.

Preliminary IUCN Conservation Status – The species is given a Red List status of Vulnerable [VU D2]. The extent of occurrence (EOO) of *Chlorophytum boomense* was not estimated since it is only known from one subpopulation, whereas its area of occupancy (AOO) is estimated to be 4 km² (estimated using a cell size of 2 km × 2 km as recommended

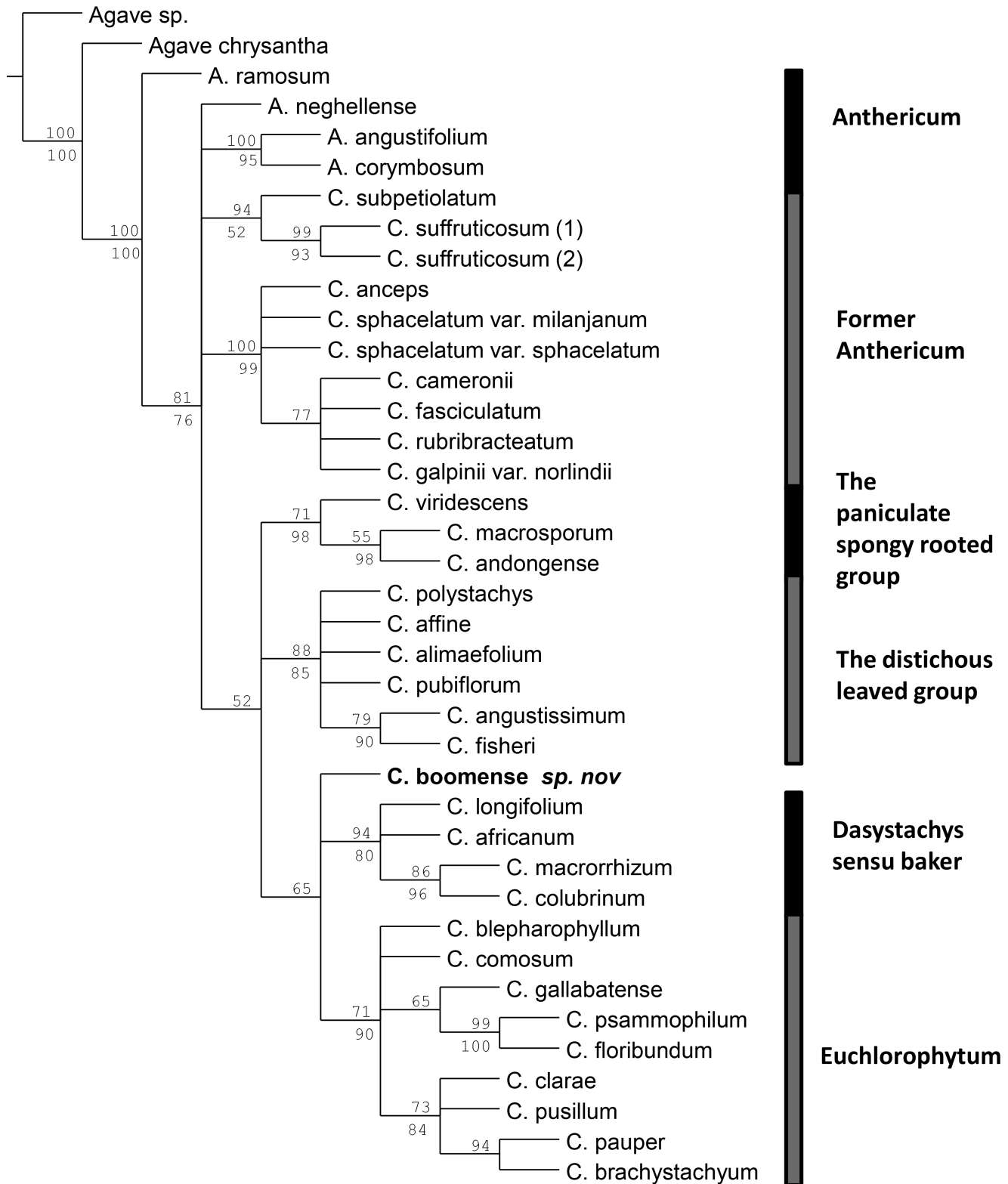


Figure 1 – Strict consensus tree based on ITS1 data from representative groups of Anthericaceae illustrating the position of *Chlorophytum boomense* from among central and southern African *Chlorophytum* taxa. Parsimony jackknife values above 50% are shown above the branches. Below the branches, jackknife support values for the concatenated chloroplast *trnL*F and RPS16 regions are included.

by IUCN 2014), which falls within the limits for Critically Endangered status under the subcriterion B2. The species is endemic to south Namibia, and is known from one specimen, representing one subpopulation, which thus represents a total of one “location” (sensu IUCN 2014). This number falls within the limits for Critically Endangered status under the condition ‘a’ of B2. The species was collected in 2012 in the Ai-Ais Hotsprings Game Park. Despite extensive herbarium and field studies made for Flora of Namibia in 2012, and additional herbarium studies for this publication, this species was not observed elsewhere, so it apparently occurs only in this protected area. No previous decline of population has been observed, and in absence of threats, we cannot anticipate a degradation of the quality of its habitat or a decline in the number of subpopulations, mature individuals, EOO, AOO. Since the conditions for applying condition b under subcriterion B2 are not met, *Chlorophytum boomense* cannot be regarded as threatened following Criteria B.

However, the species is only known from the type locality, the Orange River Mountain (Boom River), where it was collected on a granite mountain, in mid-slope, on well drained soils that overly a stony/rocky substrate. It was also listed as occasionally occurring. Due to this the very limited distribution in a rather harsh environment, the species could

be vulnerable to rapid stochastic events. On the basis of what is known, an assessment of Vulnerable under D2 reflects the fact that it is only known from a single locality with a small population. *Chlorophytum boomense* is thus assigned a preliminary status of VU D2. The species should be reassessed if additional survey reveals further records outside the protected area.

Recognition – The species is morphologically similar to *C. subpetiolatum* (Baker) Kativu (Kativu & Nordal 1993), particularly in its spongy, fusiform roots that are characteristically swollen at base and tapered towards the tips. It differs, however, through its filaments that are longer than the anthers (anthers longer than filaments in *C. subpetiolatum*) and leaves that clasp at base. The morphologically similar *C. subpetiolatum* is a tropical species that is confined to the north of the Tropic of Capricorn and so far has never been recorded in Namibia.

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L. Nyanyeni and A. Burke discovered this exiting plant at the Ai-Ais Hotsprings Game Park. Nyanyeni collected the specimen and availed it to the National Herbarium of Namibia (WIND) for study and Burke made photographs of

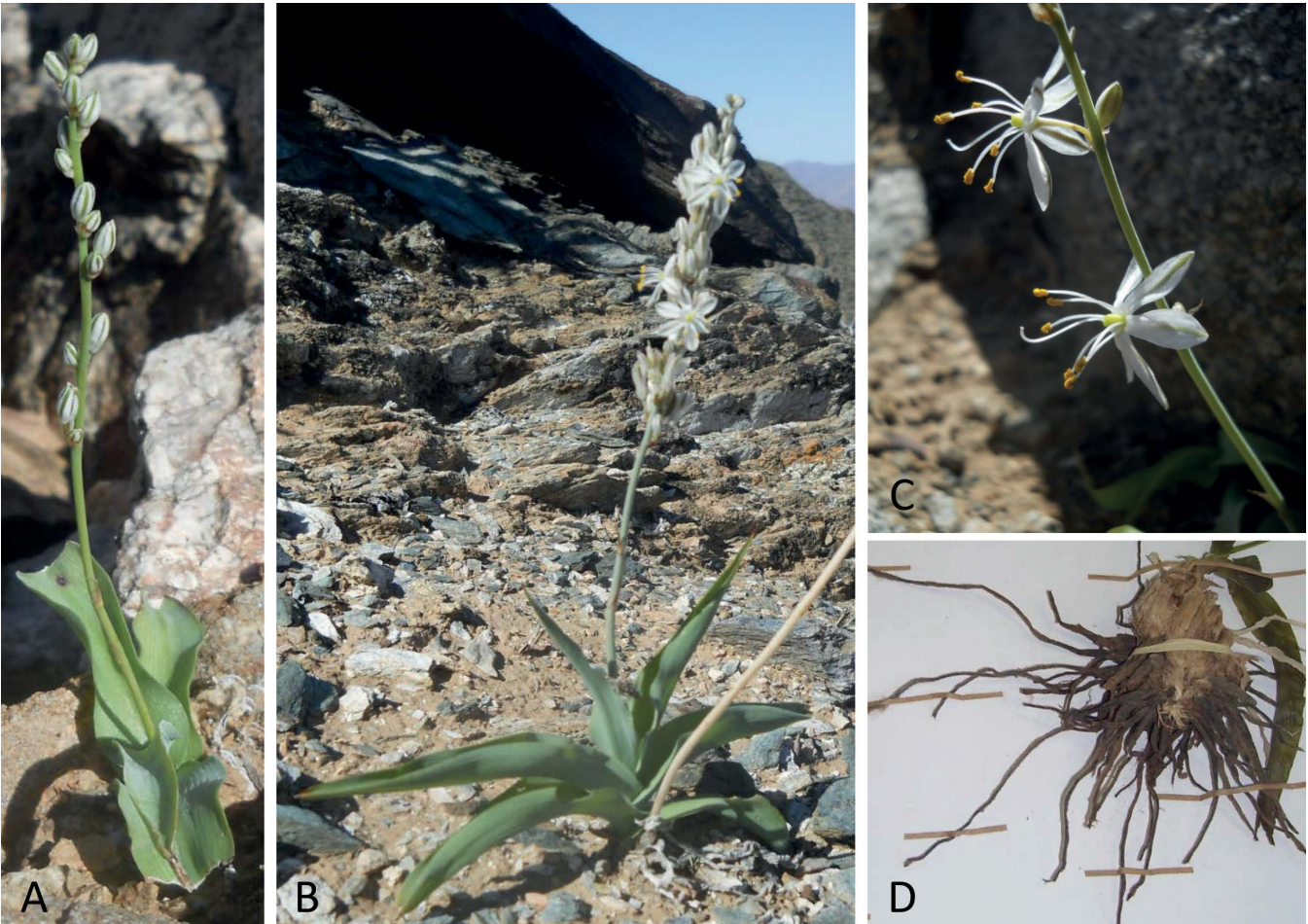


Figure 2 – Photographic illustrations of *Chlorophytum boomense* from type locality (specimen L. Nanyeni 380): A, plant in bud; B, flowering plant in habitat; C, part of inflorescence and flower detail; D, rhizome and root system. All photographs by A. Burke.

Updated key for *Chlorophytum* of Namibia

1. Pedicels articulated above the middle or at apex.....2
- 1'. Pedicels articulated below the middle or near base.....4
2. Perianth enclosing the ovary, tepals glandular-papillate; peduncle papillate-pubescent above; seeds flat, disk-shaped.....*C. longifolium*
- 2'. Perianth with ovary exposed, tepals glabrous; peduncle glabrous; seeds saucer-shaped.....3
3. Leaves fimbriate and crisped on the ciliate margins; floral bracts ciliate; perianth greenish-white to white, tepals 3–5-veined; ovary papillate.....*C. brachystachyum*
- 3'. Leaves undulate on margins, glabrous; floral bracts glabrous; perianth white, tepals 3-veined, scabrid; ovary glabrous.....*C. psammophilum*
4. Plants glandular.....5
- 4'. Plants without glands.....6
5. Glands shortly stipitate, on all parts of plant, making plant viscid; plants without plantlets on inflorescences; capsule deeply lobed, 3-angled; seeds flat.....*C. viscosum*
- 5'. Glands spotted on leaves and peduncles only, not stipitate; plants occasionally bearing small plantlets at tip of inflorescence branches (viviparous); capsule shallowly deltoid; seeds irregularly folded.....*C. calypetrocarpum*
6. Peduncle flat to sub-terete, distinctly winged.....7
- 6'. Peduncle terete, without wings.....10
7. Cataphylls and outer leaf bases with reddish-brown stripes; tepals 3–7-veined, outer ones pinkish.....*C. cameronii*
- 7'. Cataphylls and outer leaf bases without colouration; tepals white.....8
8. Leaves densely pubescent on lamina, rarely glabrous (but then scabrid or ciliate on margins); tepals 5–9-veined, scabrid on margins, outer ones with dark tips; filaments dilated at the middle.....*C. sphacelatum*
- 8'. Leaves glabrous; tepals 3–5-veined, glabrous, without dark tips.....9
9. Tepals 3-veined; floral bracts dark brownish; inflorescence divaricately branched, with racemes bearing spreading branches that emerge from axillary fascicles.....*C. galpinii*
- 9'. Tepals 5-veined; floral bracts without colouration; inflorescence congested.....*C. anceps*
10. Plants grass-like, leaves up to 3 mm broad.....11
- 10'. Plants not grass-like, leaves more than 0.8 mm broad.....*C. boomense*
11. Filaments papillate rough; style papillate below, smooth above; inflorescence a branched, loose panicle; outer leaves curved, inner ones erect, margins and midrib prominent; capsule deltoid, 3.5 × 4 mm.....*C. krauseanum*
- 11'. Filaments smooth; style smooth; inflorescence simple, or with ascending branches; leaves straight or spirally curved, margins dentate; capsule ovoid, 5 × 8 mm, bearing remains of style.....*C. rangei*

the plant and habitat and commented on the unusual characteristics of the specimen. Many thanks for sharing your discovery with us. We thank the Curators of B, BOL, CT, K, SRGH, WAG and WIND for making material available for this study. Thanks to E. Klaassen and S. Rügheimer for commenting on an earlier version of the manuscript. The authors are grateful to Dr. Tariq Stévant for his kind contribution to the IUCN assessment. Thanks also to two anonymous reviewers and the editor whose comments considerably improved this manuscript.

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