

Taxonomy of *Chlorocyathus* (Apocynaceae: Periplocoideae)

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Abstract

The genus name *Chlorocyathus* was coined by Oliver [Oliver, D., 1887. *Chlorocyathus monteiroae*. Hooker, Icones plantarum 16, t. 1557 and 1591.] for a specimen collected at Maputo, Mozambique. [Brown, N.E., 1907. *Raphionacme monteiroae*. In: Thiselton-Dyer, W.T. (Ed.), *Flora Capensis*, vol. 4. Lovell Reeve and Co, London, pp. 533–534.] sunk the monotypic *Chlorocyathus* into *Raphionacme* Harv. However, new information shows that Oliver was correct in regarding *Chlorocyathus* as different from *Raphionacme*. The name *Chlorocyathus* is thus reinstated, and the monotypic *Kappia* Venter, A.P. Dold and R.L. Verh., which resembles *Chlorocyathus* closely, becomes a synonym of it. *Chlorocyathus* will therefore include two species, *C. monteiroae* Oliv. and *C. lobulata* (Venter and R.L. Verh.) Venter. Nomenclature, descriptions, distribution patterns, ecology, and a key to the two species of *Chlorocyathus* are provided. *Chlorocyathus* is, furthermore, compared with selected African genera of Periplocoideae, and a key is provided to the tuberous-rooted African periplocoid genera. © 2008 SAAB. Published by Elsevier B.V. All rights reserved.

Keywords: Africa; Apocynaceae; *Chlorocyathus*; Periplocoideae; Taxonomy

1. Introduction

A living plant specimen was received at Kew, London from Mrs. Monteiro of Delagoa Bay (Maputo), Mozambique, in 1882. This plant flowered in July 1886 and was described and published as a new genus and species, *Chlorocyathus monteiroae* by Oliver in 1887 (“chloro”=green; “cyathus”=cup (Stearn, 1991)). In protologue Oliver described the “rootstock” as “tuberous”, but noted nothing about the type and number of tubers present, although a single erect tuber was depicted in the accompanying drawing. Twenty years later, in 1907, N.E. Brown sunk *Chlorocyathus* into *Raphionacme* Harv., and for the past century the species has been known as *Raphionacme monteiroae* (Oliv.) N.E. Br.

Raphionacme plants are characterized by being erect, prostrate or climbing suffrutescent geophytes, unique in the Periplocoideae in possessing a single spindle-shaped taproot tuber — only rarely is the tuber cylindrical. *R. lobulata* Venter and R.L. Verh. and *R. monteiroae*, two perennial, woody climbers, were included

because of their *Raphionacme*-like flowers. However, nothing was known about their tubers, except for Oliver’s drawing of *C. monteiroae*. In 2003 Tony Dold of Rhodes University, Grahamstown, South Africa, discovered that *R. lobulata* has numerous globose tubers on its lateral roots. Consequently *R. lobulata* was transferred to a new genus *Kappia* Venter, A.P. Dold and R.L. Verh. (Venter et al., 2006). In 2007, in a personal communication with the present author, Fanie Venter of Mareeba, Australia mentioned that he has seen plants of *R. monteiroae* having numerous potato-like tubers. This communication was followed up and it was indeed found that the species bears numerous tubers. *R. monteiroae* therefore, similarly does not belong in *Raphionacme*.

Oliver’s name *Chlorocyathus* is herewith reinstated and *Raphionacme monteiroae* is retransferred to its original genus. As *Kappia lobulata* reveals convincing similarities with *C. monteiroae* this species is transferred to *Chlorocyathus* as well.

2. Materials and methods

Herbarium specimens from the herbaria of B, BLFU, BM, BOL, BR, COI, G, GRA, NBG (SAM), PRE, K, M, MO, P, SRGH, UNIN, WAG, WIND (Holmgren et al., 1990), were

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studied. All specimens cited were seen by the author. Relevant literature from the libraries of K and PRE was consulted. The tubers found in *C. monteiroae* were studied in the field, photos were taken of these and herbarium specimens were made. Botanical names and author citations follow Germishuizen and Meyer (2003) and abbreviations of author names are after Brummitt and Powell (1992).

3. Results

3.1. Genus description

Chlorocyathus Oliv. in Hooker's Icones Plantarum 16: t. 1557 (1887); Schltr. : 314 (1896) (*non Cryptolepis monteiroae* Oliv.: t. 1591 (1887)); N.E.Br.: 534 (1907). Type species: *C. monteiroae* Oliv.

Kappia Venter, A.P.Dold, R.L.Verh., syn. nov.: 530 (2006). Type species: *K. lobulata* (Venter and R.L.Verh.) Venter, A.P. Dold and R.L.Verh.

Perennial liana with white latex. *Roots* branched, tubers numerous. *Stems* twining, nodes swollen. *Interpetiolar stipules* fleshy, sub-spherical, dentate. *Leaves* simple, opposite, petiole, margins undulate. *Inflorescences* many-flowered dichasia and/or monochasia. *Flowers* actinomorphic, bisexual, pentamerous, semi-epigynous. *Sepals* free. *Corolla* greenish, semi-succulent. *Corona* inserted in corolla mouth, 5-lobed; lobes broadly obcordate or obtriangular, laterally fused pocket-like to corolla lobes. *Stamens* inserted directly beneath corona lobes

and fused to their inner bases; anthers fused to style-head, pollen in tetrads, grains 4–16-porate. *Interstaminal nectaries* pocket/disc-like near base of corolla tube. *Style-head* pentangular-ovoid; translators from upper surface, spatulate, alternating with anthers. *Gynostegium* base in corolla mouth. *Follicles* paired, divergent, narrowly ovoid or narrowly ellipsoid. *Seeds* narrowly ovate to oblong-ovate, flattened, concavo-convex, with distal coma of hairs.

3.2. Key to the species of *Chlorocyathus*

Stems, leaves, peduncles, sepals and corolla abaxially glabrous; corolla lobes hirsute adaxially; corona lobes broadly obcordate and finely hirsute. *C. lobulata*

Stems, leaves, peduncles, sepals and corolla abaxially pubescent; corolla lobes glabrous adaxially; corona lobes tri-segmented, glabrous to minutely papillose, central segment filiform to subulate, lateral segments obtriangular or corniculate. *C. monteiroae*

3.3. Species descriptions

Chlorocyathus lobulata (Venter and R.L.Verh.) Venter, comb. nov. *Raphionacme lobulata* Venter and R.L. Verh.: 603 (1988). *Kappia lobulata* (Venter and R.L. Verh.) Venter, A.P. Dold and R.L. Verh.: 530 (2006). Type: South Africa, Eastern Cape Province, Bathurst District, 6.4 km from Fish River mouth near Kap River, Dyer 3381 (PRE!, holo.; GRA!, PRE!, iso.).

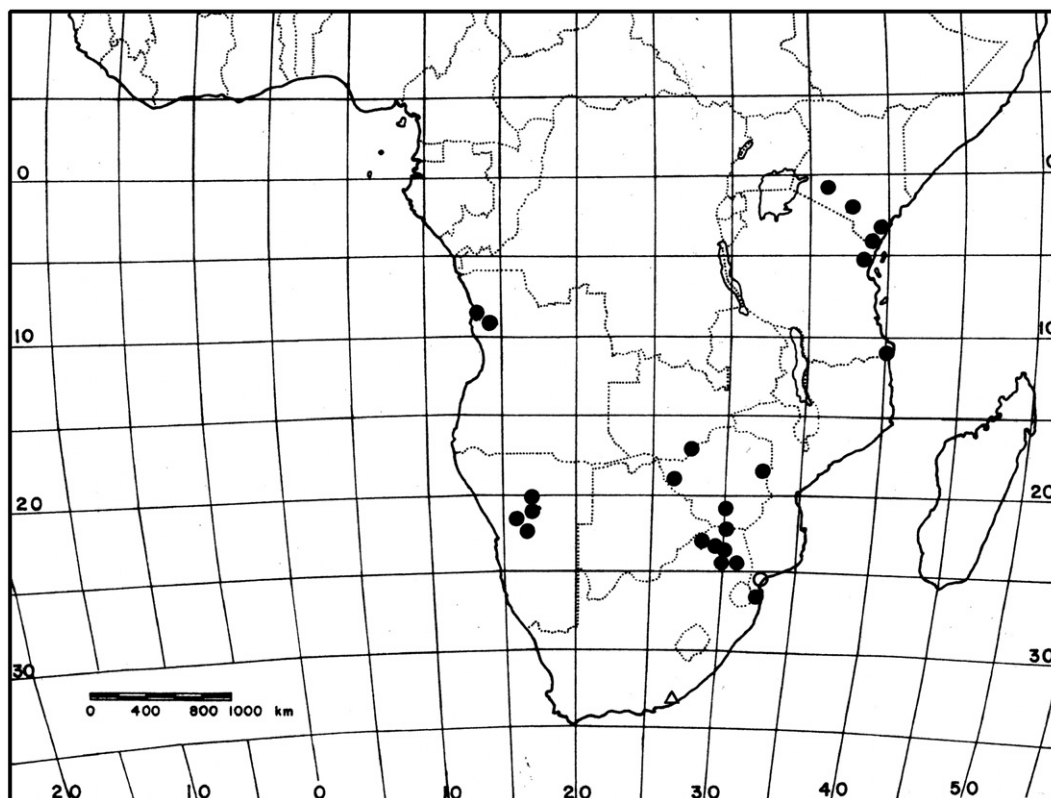


Fig. 1. Known distribution of *Chlorocyathus lobulata* (Δ) and *C. monteiroae* (\bullet) [(\circ) type locality].

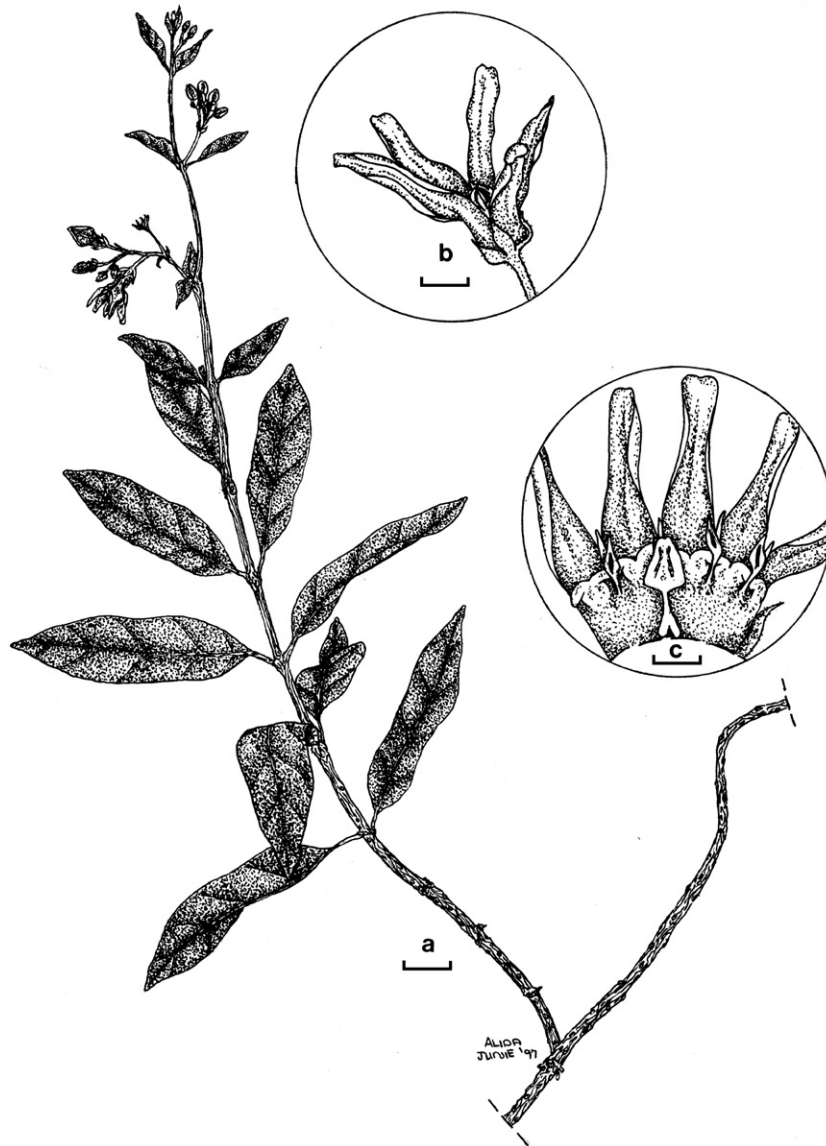


Fig. 2. *Chlorocyathus monteiroae*: (a) flowering stem, (b) flower, (c) corolla opened showing corona lobes, stamens and style with style-head. Scale bars: (a)=10 mm, (b and c)=2 mm. ((a, b and c) Faulkner 1479).

Tubers sub-globose, 50–200 mm diameter. *Stems* slender, up to 12 m long, glabrous; young bark pale mauve, old bark mottled grey. *Leaves* glabrous, blade ovate to elliptic, 60–70×20–35 mm, upper surface glossy, dark green, margins revolute. *Inflorescences* glabrous. *Sepals* broadly triangular, glabrous. *Corolla* tube funnel-shaped, 2–3 mm long, glabrous; lobes ovate, 4–7×3–5 mm, glabrous abaxially, green flushed pale maroon towards base, adaxially green and hirsute. *Corona lobes* broadly obcordate, 0.5–1.0×2 mm, yellow–green tinged pale maroon, minutely hirsute. *Anthers* ±1 mm long, angular-ovate, lower half infertile with basal callosities, upper half fertile, pollen grains 4–8-porate. *Nectaries* strap-shaped above pockets, erect around style. *Style* ±1.5 mm long; style-head broadly ovoid, ±0.5×1.0–1.5 mm, translators with receptacle broadly ovate, stipe shorter than receptacle, viscidium obovate. *Follicles* 45° divergent,

narrowly ellipsoid with round and retuse apices, 65–80×23–25 mm, straw-coloured when ripe. *Seeds* oblong-ovate, 10–13×3–5 mm, flattened, yellow–brown becoming dark brown; coma 20–30 mm long, white. (Full description and figures in Venter et al.: 530–531 (2006)).

Distribution and ecology: At present *Chlorocyathus lobulata* is only known from the Kap River Reserve in the Eastern Cape Province, South Africa and is a component of coastal riverine forest (Fig. 1). The species is classified as “vulnerable” (VUD2) (Victor, 2002).

C. monteiroae Oliv. in Hooker’s *Icones Plantarum* 16: t. 1557 (1887). Type: Mozambique, Delagoa Bay (Maputo) *Monteiro s.n.*, 1882/00/00 (K!, holo.).

Raphionacme loandae Schltr. and Rendle: 679 (1898); N.E. Br.: 275 (1902); Meve et al.: 225 (2002). Type: Angola, Boa Vista, *Welwitsch 4274* (BM!, holo.).



Fig. 3. *Chlorocyathus monteiroae*: subterranean roots and tubers (photo by H.J.T. Venter).

R. monteiroae (Oliv.) N.E. Br.: 533 (1907); Meve et al.: 226 (2002); Venter: 212 (2003).

Few-stemmed perennial climber. *Tubers* globoid to cylindrical-ovoid, somewhat flattened, 100–300 × 30–70 mm diameter. *Stems* slender, up to 8 m long, branching lateral, pubescent, interpetiolar ridges sometimes with blackish colleters. *Leaves* petiolate; petiole 1–10 mm long, sometimes with blackish colleters adaxially; blade narrowly ovate, ovate, elliptic, sub-orbicular, obovate or narrowly obovate, 10–45 (–60) × 5–30 mm, apex acute to obtuse, base cuneate to obtuse, semi-succulent, above dark green, sparsely pubescent to pubescent, beneath pale green, pubescent. *Inflorescences* racemose with 1–5-flowered, monochasial branches, pubescent to puberulous, peduncles 5–20 mm long, pedicels 2–10 mm long; bracts 1–3 mm long, ovate. *Sepals* ovate, 2–4 × 1–2 mm, apex acute, abaxially pubescent. *Corolla* bright green to light green, abaxially pubescent; tube cylindrical-campanulate, 4–6 mm long, ribbed; lobes ovate to narrowly ovate, 6–12 × 3–5 mm, sub-spreading, margins folded back, apex obtuse to acute. *Corona* lobes fleshy, glabrous to minutely papillose, fused pocket-like to corolla lobes, rim trifid; median segment filiform to subulate, 2–3 mm long, creamy white to white; lateral segments obtriangular to corniculate, ±1 mm long, pinkish to purplish. *Stamens*: filaments filiform, 1–2 mm long; anthers narrowly ovate, 2–3 mm long, cells full length fertile, apex attenuate. *Nectaries* lobular around style. *Ovaries* ±1 mm long; style terete, 2–4 mm long; style-head ovoid, 2–3 mm long, apex obtuse; translators with receptacle broadly ovate, stipe longer

than receptacle, viscidium oblong. *Follicles* paired, horizontally divergent, very narrowly ovoid with tapering apex, 70–110 × 7 mm. *Seeds* narrowly ovate or rhomboid, 7 mm long; coma 25–30 mm long, white. (Figs. 2 and 3).

Vernacular name: ‘matamela’ (Mozambique).

Distribution and ecology: *C. monteiroae* is widely spread across southern Africa in Angola, Mozambique, Namibia, South Africa (Provinces of KwaZulu–Natal, Mpumalanga and Limpopo) and Zimbabwe, and may be quite common where found (Fig. 1). This species also occurs in Kenya and Tanzania, but in these two countries it is uncommon and its flowers are sometimes smaller than in southern Africa. *C. monteiroae* inhabits dry deciduous savanna together with species such as *Euclea divinorum* Hiern, *Grewia* spp., *Colophospermum mopane* (J. Kirk ex Benth.) J. Kirk ex J. Léonard, *Androstachys johnsonii* Prain, *Terminalia* spp., *Bauhinia* spp. and *Swartzia* spp. on soils that vary from sandy to loamy to gritty clay-loam. Altitude ranges from 0–1700 m. The tubers are unearthed and eaten by wild animals.

Representative specimens:

ANGOLA:

- 08°30' S, 13°20' E: Loanda, Gossweiler 264 (BM, K, P).
- 09°03' S, 14°36' E: Boa Vista, Welwitsch 4274 (BM).

KENYA:

- 00°45' S, 36°17' E: 13 km N of Mukutan, Luke 908 (K).
- 03°59' S, 39°32' E: Kwale District, Mwachi Forest Reserve, Robertson and Luke 6167 (K).

MOZAMBIQUE:

- 10°43' S, 40°38' E: Cabo Delgado, Pemba, Groendijk and Dungo 585 (MO).
- 25°58' S, 32°35' E: Maputo (Lourenço Marques), Schlechter 11965 (BM, BR, COI, G, K, SAM, WAG).
- 26°17' S, 32°32' E: Porto Henrique, Cheugale, Gomes and Sousa 3948 (COI).

NAMIBIA:

- 20°04' S, 16°09' E: 3 km E of Outjo, Anon s.n. (BOL).
- 21°41' S, 15°52' E: Karibib, Erongo, Bruyns 3620 (BOL).
- 21°13' S, 16°43' E: Okahandja, Omatako, Giess 11521 (M).

SOUTH AFRICA:

- 22°27' S, 28°55' E: Limpopo Province, Zoutpansberg, Magalakwin River, Kitching 3090 (PRE).
- 22°55' S, 29°26' E: Limpopo Province, Wyliespoort, Parkfields 725, Venter F. 12432 (UNIN); Wyliespoort, Farm Marius, Venter H.J., Venter A.M. and Hahn, N. 10757 (BLFU).
- 22°44' S, 30°06' E: Limpopo Province, Musina, hills of Nzhelele Dam, Bruyns 7468 (BOL).

Table 1
Chlorocyathus compared with selected genera of the African Periplocoideae

	<i>Chlorocyathus</i>	<i>Baseonema</i>	<i>Batesanthus</i>	<i>Mondia</i>	<i>Petopentia</i>	<i>Raphionacme</i>	<i>Sacleuxia</i>	<i>Sarcorrhiza</i>	<i>Schlechterella</i>	<i>Stomatostemma</i>
Tubers:										
many	x	?	?	–	x	–	x	x	–	x
single	–	?	?	–	–	x	–	–	x	–
Tuber type:										
Lateral roots	x	?	?	–	x	–	x	x	–	x
Taproot	–	?	?	–	–	x	–	–	x	–
Growth form:										
Liana	x	x	x	x	x	–	–	–	–	x
Shrub	–	–	–	–	–	–	x	–	–	–
Herb	–	–	–	–	–	x	–	–	x	–
Epiphyte	–	–	–	–	–	–	–	x	–	–
Nodes fleshy	x	x	x	–	x	–	–	–	–	–
Stipules:										
fleshy	x	x	x	–	–	–	–	–	–	–
fringe-like	–	–	–	x	–	–	–	–	–	–
Corolla:										
campanulate	x	–	–	–	–	x	x	–	x	x
rotate	–	–	–	x	x	–	–	x	–	–
inverted	–	x	x	–	–	–	–	–	–	–
Corona present	x	–	x(s)	x	x	x	–	x	x	x
Corona at:										
corolla base	–	x	x	x	x	–	–	x	–	–
corolla middle	–	–	–	–	–	–	x(s)	–	–	–
corolla mouth	x	–	–	–	–	x	–	–	x	–
corolla sinus	–	–	–	–	–	–	–	–	–	x
Stamens at:										
corolla base	–	x	x	x	x	–	–	x	–	x
corolla middle	–	–	–	–	–	–	x	–	–	–
corolla mouth	x	–	–	–	–	x	–	–	x	–
Pollen in:										
tetrads	x	x	x	x	x	x	x	x	–	x
pollinia	–	–	–	–	–	–	–	–	x	–
Pollen grains:										
4–6-porate	–	–	x	x	x	–	x	x	–	x
8–16-porate	x	x	–	–	–	x	–	–	x	–

[x = yes, x(s) = sometimes, – = no].

– 24°20' S, 31°20' E: Limpopo Province, Timbavati Game Reserve, Vlakgezicht, *Venter F. 12783* (UNIN).

TANZANIA:

– 05°26' S, 38°02' E: Handeni, *Faulkner 1479* (K).
 – 05°25' S, 38°29' E: 35 km S of Korogwe on road to Dar es Salaam, *Wingfield 3677* (K).

ZIMBABWE:

– 17°09' S, 27°49' E: Kariba, Sinamwenda, *Jarman 479* (SRGH).
 – 17°54' S, 32°53' E: Nyanga District, 3 km S of Regina Coeli Mission, *Brummitt and Pope 19577* (K).
 – 22°13' S, 30°00' E: Beitbridge, Nuli Hills, *Rushworth 463* (K, PRE, SRGH).

4. Discussion

Chlorocyathus, like *Baseonema* Schltr. and Rendle, *Batesanthus* N.E.Br., *Raphionacme*, *Stomatostemma* N.E.Br.,

Mondia Skeels and *Petopentia* Bullock are all perennial climbers native to Africa (Table 1; Venter et al., 1990, 2006). With *Baseonema* and *Batesanthus*, furthermore, there is the common occurrence of fleshy interpetiolar stipules that are unusual in the Periplocoideae, and with *Stomatostemma* in leaf shape and texture, and in the strings of root tubers, (Table 1). Lesser resemblance is found with *Mondia* in the large interpetiolar fringe-like stipules, and with *Petopentia* in the strings of root tubers (Table 1).

As far as morphology of their flowers is concerned, *Chlorocyathus* differs markedly from *Baseonema*, *Batesanthus*, *Mondia*, *Stomatostemma* and *Petopentia*. However, the flowers of *Chlorocyathus* are closely similar to the African genera *Raphionacme* and *Schlechterella* K.Schum. with regard to shape of the corolla, position and fusion of the corona and stamens in the corolla tube, and in number of pollen grain pores (Table 1). It is thus understandable why Brown (1907) transferred *C. monteiroae* to *Raphionacme*.

The pollen grains of *Chlorocyathus*, *Raphionacme* and *Schlechterella* are very similar with 8–16 pores (4–8 in *Chlorocyathus lobulata*) per grain (Venter et al., 2006; Verhoeven and Venter, 1988, 1998). The only other genus with this high number

of pores per grain (8–10) is the monotypic *Baseonema* Schltr. and Rendle (Taoana, 2001). The rest of the taxa in the Periplocoideae have 4–6 pores per pollen grain (Verhoeven and Venter, 2001).

DNA data suggest a weak phylogenetic bond between *Chlorocyathus* [= *Kappia*] *lobulata* and *Stomatostemma* (Venter et al., 2006), and between the *Mondia*/*Stomatostemma* clade and the *Raphionacme* clade (Meve and Liede, 2004). However, thus far no DNA data is available for *Chlorocyathus monteiroae* which may shed more light on phylogenetic relationships.

A recently discovered new Periplocoideae species from South Africa reveals the same type of root tubers as that found in *Chlorocyathus*, *Petopentia* and *Stomatostemma* and may perhaps be related. So far no flowers were found on this new species and its true affinity, at present, remains unsure. DNA analysis, however, indicates affinity to *Petopentia* (Gretchen Ionta, University of Florida, Gainesville, U.S.A., pers. comm.).

Raphionacme is a taxon of erect suffrutescent geophytic herbs. However, a few climbing and one prostrate species are also included in the genus. After transfer of *R. lobulata* and *R. monteiroae* to *Chlorocyathus* the remaining climbing species are: *R. longifolia* N.E.Br and *R. angolensis* (Decne.) Benth., small suffrutescent climbers in grassland; *R. flanaganii* Schltr., a species with stems up to 2 m long and that may be suffrutescent or the aerial parts may be perennial; and *R. sylvicola* Venter and R.L. Verh., a climber in forest. The latter two species may be considered for transfer to *Chlorocyathus*, but *R. flanaganii* has the typical solitary turnip-shaped taproot tuber of *Raphionacme* and resembles *R. angolensis* strongly. At present nothing is known of the subterranean parts of *R. sylvicola*, although its corona is not typical of *Raphionacme* and compares quite well with that found in *Chlorocyathus*. The prostrate *R. procumbens* Schltr. is undoubtedly a *Raphionacme*.

Seven of the African genera are known to have tubers, of which five have numerous root tubers, the remaining two having single taproot tubers (Table 1).

Four of the genera with numerous tubers are perennial climbers, but the fifth, *Sarcorrhiza* is an epiphyte. The two genera with single taproot tubers are suffrutescent plants.

5. Key to the known tuberous genera of Africa

- 1. Plants with a single taproot tuber. 2
Plants with more than one tuber, usually in strings on lateral roots. 3
- 2. Pollen in tetrads; corona lobes free from one another (rarely fused into an annulus); tuber spindle-shaped (radish-like), rarely cylindrical-ovoid. *Raphionacme*
Pollen in pollinia; corona lobes fused into an annulus; tuber potato-like. *Schlechterella*
- 3. An erect shrub; flowers very small, corolla 2–3 mm long. *Sacleuxia*
Climbers or epiphytes; flowers fairly large, corolla (6–)10–22 mm long. 4
- 4 An epiphyte; corolla adaxially yellow or greenish with middle zone of lobes dark crimson or carmen. *Sarcorrhiza*

- Lianas; corolla adaxially white, creamy-white, yellowish-green or green, centre may be maroon, purple or brownish-purple 5
- 5. Leaves broadly oblong, cuspidate, secondary venation patent; corolla rotate, corolla lobes narrowly triangular, acuminate. *Petopentia*
Leaves linear, narrowly ovate, ovate, elliptic, obovate, narrowly obovate or orbicular, secondary venation arching towards blade apices; corolla tube campanulate or funnel-shaped, corolla lobes narrowly oblong ovate, narrowly ovate or ovate, obtuse or acute. 6
- 6. Stamens arising at base of corolla tube; corona lobes clavate (match-like) from corolla lobe sinuses. *Stomatostemma*
Stamens and corona lobes arising from corolla tube mouth, basally fused; corona lobes obcordate or obtriangular *Chlorocyathus*

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