



# A new species of *Uvariopsis* (*Annonaceae*), endemic to the Eastern Arc Mountains of Tanzania

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## Key words

*Annonaceae*  
endemism  
IUCN conservation status  
monoecy  
taxonomy  
Udzungwa Mountains  
Usambara Mountains

**Abstract** The Eastern Arc Mountains of Tanzania enclose high levels of plant and animal diversity with many yet to be described species. Here we describe a new species of the pan-tropical plant family *Annonaceae* named *Uvariopsis lovettiana*. It closely resembles another Eastern Arc endemic species, *U. bisexualis*, and its possible relationships with this species are discussed. A description with illustrations is presented as well as a suggestion for the IUCN conservation status of this new taxon.

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## INTRODUCTION

The Eastern Arc Mountains of Tanzania and Kenya are a chain of 13 ancient mountains stretching from southern Kenya to south-central Tanzania (Lovett 1993). The isolation, age and high degree of forest fragmentation in these mountains have combined to produce outstanding levels of biodiversity and high levels of endemism in both animals and plants, earning them the status of biodiversity hotspot (Lovett 1993, Myers et al. 2000, Burgess et al. 2007). Within the Eastern Arc Mountains, the Udzungwa Mountains stand out as having the largest cover of rain forest (1 350 km<sup>2</sup>) supporting the highest number of endemic vertebrates and the second highest for plant endemics per km<sup>2</sup> (Burgess et al. 2007). Yet, the biodiversity of the Udzungwa Mountains is still poorly known, with numerous new species of animals and plants being regularly described. Recently, two new mammal species (the highland mangabey, *Lophocebus kipunji* (Jones et al. 2005) and the Udzungwa elephant shrew, *Rhynchocyon udzungwensis* (Rovero et al. 2008)) and a new slug genus (Verdcourt 2003) were described from the Udzungwa Mountains stressing once again the biological importance of this region as well as showing how little we know from these forests. The new species described here adds up to the list of c. 70 known endemic or near endemic tree species from the Eastern Arc Mountains (Burgess et al. 2007) and increases the list of new plants described recently from the Udzungwa range (Luke & Beentje 2003, Knox et al. 2004, Luke & Deroin 2005).

*Uvariopsis* is a strictly African genus of 17 known species belonging to the *Annonaceae* (Magnoliales), a pan-tropical family of trees, shrubs and lianas with c. 120 genera and c. 2 500 species (Chatrou et al. 2004). *Uvariopsis* is one of the rare genera in which monoecious flowers occur within this generally bisexual family (Van Heusden 1992). Within *Uvariopsis* only *U. bisexualis*

Verdc. (Verdcourt 1986) and *U. tripetala* (Kenfack et al. 2003) have bisexual flowers. Additionally, *Uvariopsis* deviates from the typical trimerous floral structure found in *Annonaceae* flowers (3 sepals, and 2 whorls of three petals) in having 2 sepals and one whorl of 4 petals (except for *U. tripetala* with 3 sepals and 3 petals and *U. congolana* with 2 sepals and 3 petals). Most of the species are found in lowland or montane rain forests of Lower Guinea and the Congolian basin with just two species occurring in Upper Guinea and three in East Africa (Kenfack et al. 2003) and at least one still remains to be described from Kenya.

A molecular phylogenetic study of the *Annonaceae* (Couvreur et al. 2008) indicated that *Uvariopsis* clustered within the so-called 'long-branch clade' (LBC, Richardson et al. 2004), one of the two major clades identified in the family. Within the LBC, *Uvariopsis* was nested in a large clade of African genera (Couvreur et al. 2008) and was recovered as sister to the pan-African genus *Uvarioidendron*. This African clade of 12 genera is characterized by tetrad pollen grains and sessile monocarps (Couvreur et al. 2008).

## MATERIALS AND METHODS

### Morphology

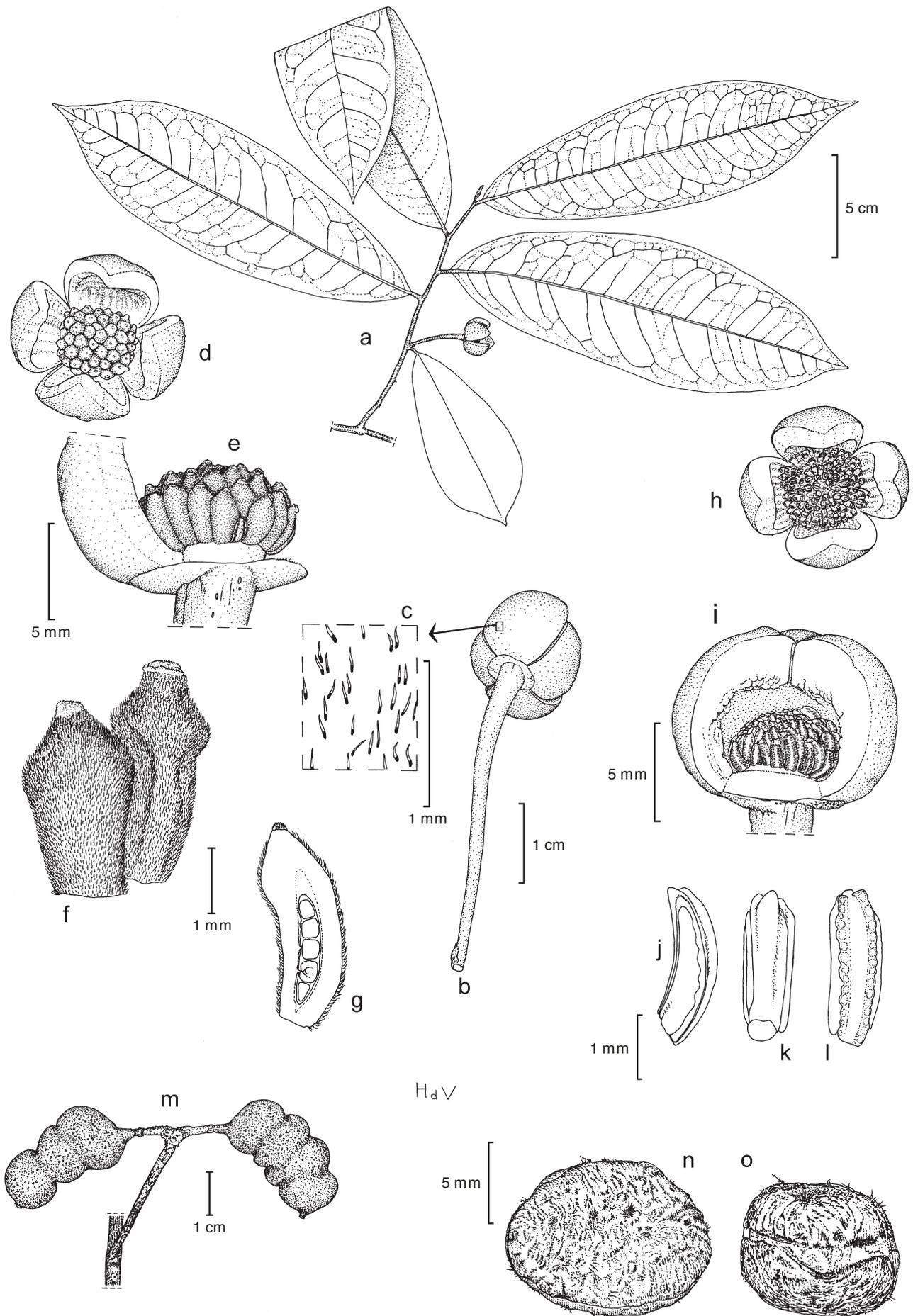
This study is based on specimens from the DSM, MO and WAG herbaria. For one collection spirit material was also available (Couvreur 97b, WAG).

### Conservation status

In absence of detailed population information, it has been shown that herbarium collections constitute a valuable source of data and can be used to determine categories of threat using criterion B (Schatz 2002, Willis et al. 2003). The software ArcView v3.3 (ESRI 2002) was used to produce the distribution map. The add-in script provided by IUCN (Justin Moat, Royal Botanic Garden Kew) allowed the calculation of the Extent Of Occurrence (EOO) and the Area Of Occupancy (AOO). The cell area was always set to the largest permissible value which is just under 10 km<sup>2</sup> (cell width = 3.16 km). Setting a cell size width of 3.2 km or larger will not allow any taxa to be listed as Critically

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**Fig. 1** *Uvariopsis lovettiana*. a. Flowering branch; b. male flower; c. detail of indumentum; d. female flower, top view; e. detail of female flower with three petals removed; f. details of two carpels; g. longitudinal section of carpel showing uniseriate ovules; h. male flower, top view; i. detail of male flower with one petal removed; j–l. stamen, lateral, back and front view respectively; m. fruits; n. seed, top view; o. seed side view showing hilum (from Couvreur & F. Mbago 97b (WAG) except fruits from W.R.Q. Luke, T. Butynski, C. Ehardt, T. Jones 10369 (MO)). — Drawing by Hans de Vries.

Endangered where the threshold AOO under criterion B is 10 km<sup>2</sup> (Standards and Petitions Working Group 2006).

## DESCRIPTION

*Uvariopsis lovettiana* Couvreur & Q. Luke, *sp. nov.* — Fig. 1, 2

Haec species *Uvariopsidi bisexuali* Verdc. simillima, sed ab ea pedicello sub anthesi 3–5 cm longo, petalis crassis ovatis, flore femineo ad basem carpellorum staminibus paucis tantum praedito atque ovulis uniseriatis in quoque carpello 4 vel 5 distinguitur. — Typus: *T.L.P. Couvreur 97b & F. Mbago* (holo WAG; iso DSM, MO), Tanzania, Morogoro, Iringa District, East Udzungwa National Park, Mwanihana hill, 1400 m, 7°48.5'S, 36°49.4'E, 30 November 2006.

Monoecious tree 3–7 m tall, dbh 7–30 cm. Young branches sparsely covered with short appressed hairs. Leaves 15–28 by 4.5–7 cm, length : width ratio 3–3.6, narrowly elliptic, base acute, apex acute to acuminate, acumen 0.5–1 cm long, glabrous, coriaceous, dark green above, lighter green below; midrib sunken above, raised below; sparsely appressed-pubescent when young, the hairs rapidly disappearing with age, secondary veins 11–14, moderately curved upwards, looped towards margin, glabrous on both sides; tertiary venation reticulate. Male and female flowers borne on leafy branches (no cauliflory observed), axillary, single. Flowering pedicels 3–5 cm long, 2–3 mm diam, sparsely puberulous, green. Bract basal, 1 by 1 mm, covered with short erect hairs. Hairs of flowers with conspicuously dark red base and translucent apex. Sepals 2, 2–3 by 4–5 mm, length : width ratio 0.5–0.6, depressed ovate, base fused, apex rounded, densely appressed-pubescent hairs outside, sparsely so inside, green. Petals 4, free, in one

whorl, 12–15 by 8–10 mm, 2–3 mm thick, length : width ratio 1.5, ovate, base truncate, apex acute, coriaceous, sparsely appressed-pubescent outside, glabrous inside, light green outside, white inside. Male and female receptacle globose, c. 5 mm diam. Female flowers with numerous tightly packed carpels; these 2.5–3 by c. 1 mm, densely appressed-pubescent; ovules 4 or 5, uniseriate; stigma 0.2 mm diam, sessile, glabrous; with 1–5 fertile minute stamens of c. 1 mm long present at the base of receptacle. Male flowers with numerous stamens, c. 2 mm long, apex of connective not prolonged. Fruiting pedicels 3–3.5 cm long, 2–2.5 mm diam, sparsely appressed-puberulous. Monocarps 2–4, 2.5–3 cm long, 1–1.5 cm diam, oblong, markedly constricted between seeds in dried material, glossy yellow turning orange red at maturity, very sparsely puberulous; stipe c. 1 cm long, c. 2 mm diam, sparsely puberulous; apex rounded with the clear presence of the stigma. Seeds 2–4 per monocarp, uniseriate, c. 1.5 by c. 1 cm, c. 8 mm thick; testa smooth, very thin papery, peeling off, light cream; raphe sunken; hilum c. 4 by 1.5 mm, narrowly elliptical.

Distribution & Habitat — *Uvariopsis lovettiana* is endemic to the Eastern Arc Mountains of Tanzania, most collections coming from the Udzungwa Mountains National Park and two from the West Usambara Mountains. It mainly grows on rocky soils in wet submontane forests between 1 300 and 1 700 m altitude.

*Associated species recorded with Uvariopsis lovettiana.*

DW Thomas 3921 – *Aframomum laxiflorum* Lock; *Agarista salicifolia* (Lam.) G. Don; *Alsodeiopsis schumannii* (Engl.) Engl.; *Coffea mufindiensis* Bridson ssp. *mufindiensis*; *Crotonogynopsis usambarica* Pax; *Cyperus pseudo-leptocladus* Kuek.; *Diospyros whyteana* (Hiern) F. White; *Drypetes* sp. aff. *arguta* (Müll. Arg) Hutch.; *Duhaldea stuhlmannii* (O. Hoffm.) Anderb.; *Garcinia kingaensis* Engl.; *Garcinia volkensii* Engl.; *Lijndenia brenanii* (A. Fern. & R. Fern.) Jacq.-Fel.; *Ochna afzelioides* N. Robson; *Ocotea kenyensis*

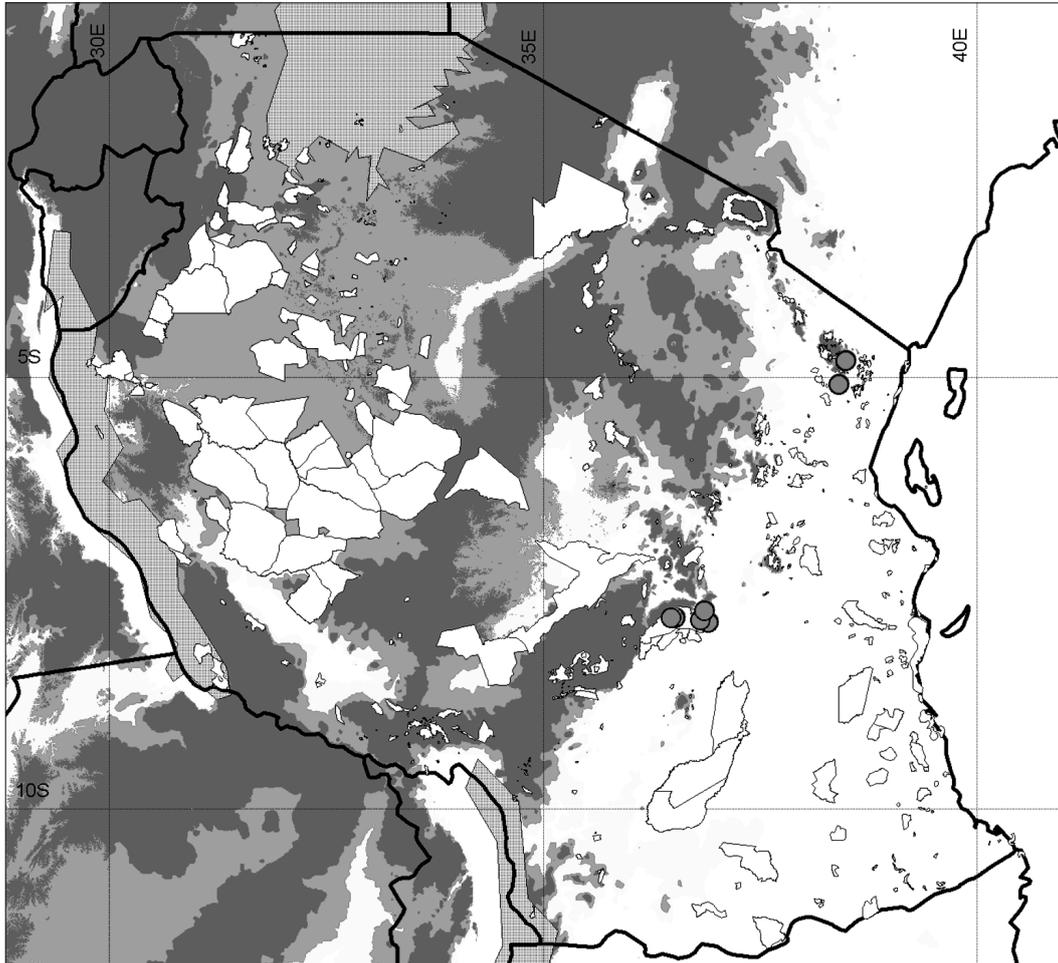


Fig. 2 Distribution of *Uvariopsis lovettiana*. Grey scale represents altitude: white: 0–800 m; light grey: 800–1000; grey: 1000–1200; dark grey: > 1200 m; white polygons represent borders of protected areas in Tanzania.

(Chiov.) Robyns & R. Wilczek; *Pauridiantha coalescens* Ntome & Dessein; *Psychotria megalopus* Verdc.; *Saintpauliopsis lebrunii* Staner; *Sclerochiton glandulosissimus* Vollesen; *Solanecio epidendricus* (Mattf.) C. Jeffrey; *Tiliacora funifera* (Miers) Oliv.; *Vepris nobilis* (Delile) Mziray.

Luke 6722 – *Craibia brevicaudata* (Vatke) Dunn ssp. *schliebenii* (Harms) J.B. Gillett; *Craterispermum longipedunculatum* Verdc.; *Dicliptera laxata* C.B. Clarke; *Isolona heinsenii* Engl. & Diels; *Isolona linearis* Couvreur; *Justicia asystasioides* (Lindau) M.E. Steiner; *Monodora globiflora* Couvreur; *Plectranthus alboviolaceus* Guerke; *Pyrostria uzungwaensis* Bridson; *Rytigynia bugoyensis* (K. Krause) Verdc. ssp. *glabriflora* Verdc.; *Rytigynia lichenoxenos* (K. Schum.) Verdc.; *Rytigynia pseudolongicaudata* Verdc.; *Vernonia calvoana* (Hook.f.) Hook.f. ssp. *leucocalyx* (O. Hoffm.) C. Jeffrey; *Vernonia pteropoda* Oliv. & Hiern.

Luke 7730 – *Acmella caulirhiza* Delile; *Aeschynomene schimperii* A. Rich.; *Ammannia prieuriana* Guill. & Perr.; *Carvalhoa campanulata* K. Schum.; *Celosia schweinfurthiana* Schinz; *Chamaecrista telfairiana* (Hook.f.) Lock; *Cyathula uncinulata* (Schrad.) Schinz; *Dracaena steudneri* Engl.; *Erythrococca ulugurensis* Radcl.-Sm.; *Fleroya rubrostipitata* (K. Schum.) Y.F. Deng; *Ipomoea wightii* (Wall.) Choisy var. *obtusisepala* Verdc.; *Kalanchoe* sp. aff. *crenata* (Andrews) Haw.; *Plectranthus trullatus* A.J. Paton; *Polygonum setulosum* A. Rich.; *Psychotria cryptogrammata* E.M.A. Petit; *Pycrus mundtii* Nees; *Sclerochiton glandulosissimus* Vollesen; *Sida rhombifolia* L.; *Solanum giganteum* Jacq.; *Solanum indicum* L.; *Sphaeranthus suaveolens* (Forssk.) DC.

Luke 10369 – *Chlorophytum pusillum* Baker; *Clerodendrum cephalanthum* Oliv. ssp. *swynnertonii* (S. Moore) Verdc. var. *schliebenii* (Mildbr.) Verdc.; *Craterispermum longipedunculatum* Verdc.; *Justicia* sp. nov. aff. *Inaequifolia*; *Lasiodiscus usambarensis* Engl.; *Metarungia pubinervia* (T. Anderson) C. Baden; *Monanthes schweinfurthii* (Engl. & Diels) Verdc.; *Pavetta nitidissima* Bridson; *Plectranthus leptophyllus* (Baker) A.J. Paton; *Polyceratocarpus scheffleri* Engl. & Diels; *Rinorea angustifolia* (Thouars) Baill. ssp. *ardisiiflora* (Oliv.) Grey-Wilson; *Rytigynia lichenoxenos* (K. Schum.) Robyns ssp. *glabrituba* Verdc.; *Sclerochiton obtusisepalus* C.B. Clarke; *Vernonia calvoana* (Hook.f.) Hook.f. ssp. *leucocalyx* (O. Hoffm.) C. Jeffrey; *Vernonia luhomeroensis* Q. Luke & Beentje; *Vernonia* sp. nr. *pteropoda* Oliv. & Hiern.

Festo 2014 – *Chassalia* sp. cf. *subochreatea* (De Wild.) Robyns; *Clerodendrum cephalanthum* Oliv. ssp. *swynnertonii* (S. Moore) Verdc. var. *schliebenii* (Mildbr.) Verdc.; *Coffea mufindiensis* Bridson ssp. *Mufindiensis*; *Cola stelechantha* Brenan; *Crotonogynopsis usambarica* Pax; *Erythrococca sanjensis* Radcl.-Sm.; *Gravesia riparia* A. Fern. & R. Fern.; *Heinsenia diervilleoides* K. Schum. ssp. *Diervilleoides*; *Lagynias rufescens* (E.A. Bruce) Verdc. ssp. *angustiloba* Verdc.; *Leptonychia usambarensis* K. Schum.; *Mimulopsis solmsii* Schweinf.; *Pauridiantha paucinervis* (Hiern) Bremek. ssp. *holstii* (K. Schum.) Verdc.; *Pavetta lynesii* Bridson; *Peperomia rotundifolia* (L.) Kunth; *Psychotria megalopus* Verdc.; *Rytigynia pseudolongicaudata* Verdc.; *Sclerochiton glandulosissimus* Vollesen; *Streptocarpus inflatus* B.L. Burt; *Tiliacora funifera* (Miers) Oliv.; *Vernonia holstii* O. Hoffm. vel. sp. aff.; *Zanthoxylum deremense* (Engl.) Kokwaro.

**Phenology** — Mature flowers collected end October and in November. Mature and immature fruits collected in November.

**Etymology** — This species is named in honour of Jon Lovett (University of York, UK) for his pioneering work towards the recognition and conservation of the Eastern Arc Mountains.

**ICUN Conservation status** — NT. *Uvariopsis lovettiana* is represented by a fairly low number of herbarium specimens to date, representing just 7 localities with an AOO of c. 70 km<sup>2</sup> and an EOO of c. 9 700 km<sup>2</sup>. Under the AOO with just 7 localities, *U. lovettiana* would qualify for the 'endangered' category. However, the Udzungwa Mountains National Park is a well protected region with the central part hard to access. In 2006, the first author located over 30 mature individuals on Mwanihana hill generally dominating the understorey forest indicating no obvious continuous decline of that existing population. As indicated above, the Udzungwa Mountains are poorly collected, and we would expect the values of AOO, EOO and number of localities to increase (and not decline) in the future with additional collections or identification of existing collections from different herbaria that we have not had on loan (e.g. NHT). We thus consider that the category 'Near Threatened' is appropriate for now.

**Additional specimens examined.** TANZANIA, B.J. Harris 6257 (EA), Tanga region, T3, West Usambara Mountains, Mwazumbai, 6 April 1972; D.W. Thomas 3921 (EA, MO), Iringa region, Mwanihana Forest Reserve, above Sanje village, forest on steep slope with small streams and swamps, and patches of elfin forest on ridge top, 10 October 1984; W.R.Q. & P.A. Luke 5084 (EA, K), Iringa region, Udzungwa Mountains National Park (UMNP), Sonjo – Mwanihana Route, 8 November 1997; C.J. Kayombo 1406 (MO), Tanga region, Forest Reserve 5 km W of Ambangulu Tea Factory above Estate road to Makunga, 3 November 1998. W.R.Q. Luke, B. Bytebier, T. Butynski, C. Ehardt, A. Perkins, G. Kimaro 6722 (BR, EA, K, MO, NHT, US), Iringa region, UMNP, Mt Luhomero Pt 129–131, 27 September 2000; W.R.Q. Luke, R. Mwangulango, T. Butynski, C. Ehardt, J. Kingdon, G. Kimaro 7730 (EA, K, NHT), Tanzania, Iringa region, UMNP, Pt 211, 23 September 2001; W.R.Q. Luke 7842 (EA, K), Iringa region, UMNP, Below Camp 212, 26 September 2001; W.R.Q. & P.A. Luke, A. Mtui, T. Jones, F. Rovero, G. Laizer 9195 (EA, K), Tanzania, Iringa region, UMNP, Pt 370–371, 16 October 2002; W.R.Q. Luke, T. Butynski, C. Ehardt, T. Jones 10369 (EA, K, MO, NHT), Iringa region, Ndundulu Forest Reserve, Camp 589 – Camp 590, 6 September 2004; L. Festo, M.A. Mwangoka, C.A. Manongi, W.R.Q. Luke 2014 (EA, K, MO, NHT), Iringa region, Udzungwa forest, c. 10 km from Msolwa village at source of Msolwa stream, 24 October 2005.

## DISCUSSION

Within *Uvariopsis* two main groups can be distinguished (Kenfack et al. 2003): species in which the male flowers are strictly cauliflorous (a state that concerns the majority of taxa), and species in which the male flowers are strictly axillary or ramiflorous (six species). *Uvariopsis lovettiana* belongs to the latter group. Morphologically the new species is most similar to *U. bisexualis*, the only other *Uvariopsis* species occurring in Tanzania and endemic to the Udzungwa Mountains (Couvreur et al. 2006). However, they are clearly differentiated by a number of morphological characters as presented in Table 1. The most obvious one is the occurrence of male and female flowers in *U. lovettiana*, while in *U. bisexualis* the flowers are bisexual (Verdcourt 1971, Kenfack et al. 2003). As indicated above, the majority of species within *Uvariopsis* are monoecious. Monoecy in *U. lovettiana* is, however, not perfect because a few inconspicuous stamens (1–5, Fig. 1e), smaller than in male flowers but fertile, can be found at the base of the receptacle within the female flowers. A few such stamens in female flowers were also observed in the West African species *U. globiflora* (Jongkind 1804, WAG), although they are not mentioned in the protologue by Keay (1952). These species are, strictly speaking, androdioecious (male and bisexual flowers). However, because the few small stamens occurring in the bisexual flowers probably play no significant role in reproduction, we consider these flowers as functionally female. This point of view was apparently also adopted by Verdcourt (1971: 69) who noted the presence of these few stamens in female flowers, but nevertheless considered *Uvariopsis* as monoecious. It is unclear up to now how many other species exhibit this character. In *U. bisexualis* the stamens are numerous and present in many rows topped by six carpels (Verdcourt 1986), providing little doubt about the true bisexual nature of this species.

One other strikingly different character between the two species is the number and disposition of ovules. *Uvariopsis* is characterized by a biseriate placentation (Le Thomas 1969, Verdcourt 1971). In *U. lovettiana*, however, the ovules are uniseriate which is to our knowledge unique within the genus. *Uvariopsis bisexualis* is also characterized by a large number of ovules per carpel (22–24) while *U. lovettiana* has only 4 or 5 per carpel. Finally, these characters related to the carpels allowed us to identify the fruiting specimens belonging to *U. lovettiana*, in that the seeds were uniseriate and few in numbers per monocarp (1–3).

**Table 1** Principal morphological differences between *Uvariopsis lovettiana* and *U. bisexualis*.

Character	<i>U. lovettiana</i>	<i>U. bisexualis</i>
petal shape	ovate	narrowly oblong
sex distribution	monoecious	bisexual
flowering pedicel length	3–5 cm	1.2–1.5 cm
ovule arrangement	uniseriate	biseriate
ovule number	4 or 5	22–24

The main centre of distribution of *U. lovettiana* is found in the Udzungwa Mountains. However, two specimens have been identified from the West Usambaras, in north-eastern Tanzania (Fig. 2). Disjunct distributions between the Udzungwa and Usambara Mountains is a common pattern for Eastern Arc endemics (Lovett 1993, Burgess et al. 2007), and can also be found in other *Annonaceae* species such as *Isolona heinsenii* Engl., *I. linearis* Couvreur and *Polyceratocarpus scheffleri* Engl. & Diels (Couvreur 2009).

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