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ENDEMIC PLANT SPECIES OF THE EASTERN ARC MOUNTAINS OF KENYA AND TANZANIA: ANALYSIS AND REFINEMENT OF DISTRIBUTIONAL PATTERNS

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Abstract

The Eastern Arc Mountains of Tanzania and Kenya are known for their high level of endemism. GIS analysis of locality data for 32 endemic species and subspecies in 14 flowering plant families refines previously reported distributional patterns among the floristic subregions and mountain blocs of the Eastern Arc. The phylogeographic affinities of the Usambara and South Pare Mountains with the Uluguru and Nguru Mountains are much stronger than previously apparent. *Coffea fadenii* and *Millettia oblata* subsp. *teitensis*, heretofore thought endemic to the Taita Hills in Kenya, are reported from Tanzania for the first time.

Résumé

Espèces végétales endémiques des montagnes de l'arc est-africain, Kenya et Tanzanie: analyse et amélioration des modèles de distribution. Les montagnes de l'arc est-africain, Tanzanie et Kenya, sont connues pour leur haut taux d'endémisme. Des analyses SIG de données relatives aux localités pour 32 espèces et sous-espèces endémiques au sein de 14 familles d'angiospermes améliorent les modèles de distribution jusqu'alors envisagés parmi les sous-régions floristiques et les massifs montagneux de l'arc est-africain. Les affinités phytogéographiques des Monts Usambara et South Pare avec les Monts Uluguru et Nguru sont beaucoup plus fortes qu'il n'y paraissait jusqu'ici. *Coffea fadenii* et *Millettia oblata* subsp. *teitensis*, alors considérées comme endémiques des Monts Taita au Kenya, sont pour la première fois signalées en Tanzanie.

Key words: Eastern Arc, GIS, Kenya, phytogeography, Tanzania

1 Introduction

The Eastern Arc Mountains of Tanzania and Kenya (Fig. 1) are well known as a regional center of endemism for vascular plants (Lovett, 1985, 1988, 1990; Lovett & Friis, 1996). White (1983, 1993) treated this area as part of his continent-wide "Afromontane Archipelago-like Regional Center of Endemism", but Lovett (1988) documented it as a separate floristic region comprising areas above 1500 m in the ancient igneous mountains of southeastern Kenya (Taita Hills) through southern

Tanzania (Udzungwa Mountains). These mountains lie in the climatic influence of the Indian Ocean, and comprise dry montane forests, wet submontane forests, moist montane forests, cloud forests, heaths, and upland grasslands. Lovett & Friis (1996) attributed the high species richness and endemism of this region to its long history of geological and climatic stability, and Lovett (1998) has noted that the Eastern Arc is an area of conservation priority.

Recently Lovett (1998) analyzed the distributions of 223 tree species and subspecies from the Eastern Arc Mountains, finding 77.5% of them restricted to this floristic region and subdividing it into three subregions (Fig. 1): Northern, comprising the Taita Hills, North and South Pare Mountains, East and West Usambaras; Central, comprising the Nguu, Nguru, Ukaguru, Uluguru, and Rubeho Mountains; and Southern, comprising the Udzungwa and Mahenge Mountains. He presented detailed distributional data for a subset of 66 large trees restricted to the Eastern Arc and Tanzanian coastal forests.

2 Methods

Here, Lovett's subregions are evaluated based on recent botanical exploration of the Eastern Arc region. We analyze the distributions of 32 flowering plant species and subspecies (Table 1) that have new range extensions. These are all strictly endemic to the Eastern Arc and encompass a variety of life forms: small and large trees, understory shrubs, suffrutices, terrestrial and epiphytic herbs, herbaceous and woody climbers, and parasites. The newly documented ranges of these taxa are here used to analyze the patterns of endemism on the more fine-grained scale provided by the subregions noted by Lovett (1998).

Distributions of the 32 study taxa were compiled based on published records (e.g. Flora of Tropical East Africa, 1952–present; Iversen 1991) and new collections. Specimen records were compiled in the TROPICOS database (www.mobot.mobot.org/W3T/Search/vast.html) and mapped using ArcView. Only two of the 32 taxa analyzed here (*Polyscias stuhlmannii* and *Placodiscus amaniensis*) were included by Lovett (1998) in his sublist of 66 large trees; the range of 1 of these is modified here.

3 Results

The distributions of these 32 taxa within the Eastern Arc region are summarized by floristic subregion and mountain bloc in Table 1. The following distributional patterns can be seen:

3.1 Widespread Eastern Arc

Ten of our 32 taxa are found in all three floristic subregions (Fig. 2), corresponding to the Eastern Arc floristic region delimited by Lovett (1988). Lovett reported this distribution for 23 or 35% of his large trees, vs. 31% of our taxa with varied habits. The most widespread of our taxa are *Chassalia discolor* subsp. *discolor*, *Parapentas silvatica*, *Dicranolepis usambarica*, and *Cynorkis buchwaldiana* subsp. *braunii*, which are known from 8, 8, 8, and 6 mountain blocs respectively. *Sorindeia calantha*, previously considered endemic to the Ngurus, is now known from 4 mountain blocs and all 3 subregions; and *Psychotria brucei* and *Psychotria pandurata* are each known from 1 mountain bloc in each of the 3 floristic subregions. Surprisingly, in the Northern subregion each of the latter two taxa has been collected from the South Pare Mountains but not in the floristically similar West Usambaras (see discussion under “Single Eastern Arc Subregion” below).

Endemic plant species of the eastern Arc Mountains of Kenya and Tanzania

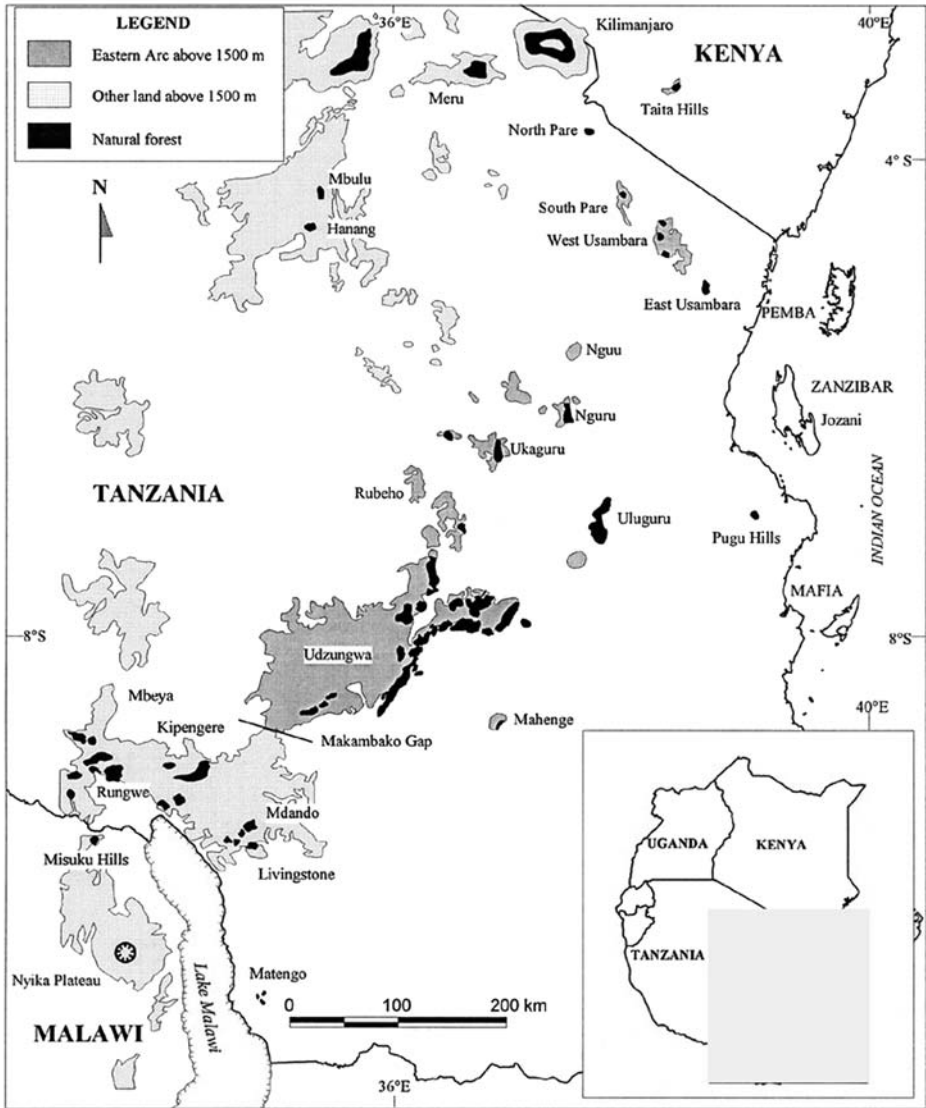


FIG. 1. Map showing highlands (above 1500 m elevation) of Tanzania and southeastern Kenya, their forested portions, and the Eastern Arc floristic region as delimited by Lovett (1998).

TABLE 1. Distributions of Eastern Arc endemic plant taxa by floristic subregion (Lovett, 1998) and by mountain bloc: TA = Taita, NP = North Pare, SP = South Pare, WU = West Usambara, EU = East Usambara, NU = Nguu, NG = Nguru, UK = Ukaguru, UL = Uluguru, RU = Rubeho, UD = Udzungwa, MA = Mahenge. 12 mountain blocs are noted here, 5 in the Northern subregion, 5 in the Central subregion, and 2 in the Southern subregion.

| | Northern | | | Central | | | Southern | | |
|--|----------|----|----------------|----------------------|----------|----------------|----------|----------------|----------|
| ANACARDIACEAE <i>Sorindeia calantha</i> Mildbr. | TA | | SP | | | NG | | | UD |
| APIACEAE <i>Cryptotaenia calycina</i> C. C. Towns. | | | | WU | | NG | | UL | UD |
| ARALIACEAE <i>Polyscias stuhlmannii</i> Harms | TA | | SP | WU | EU | | | UL | |
| ASTERACEAE <i>Bothriocline argentea</i> (O. Hoffm.) Wild & G. V. Pope | TA | NP | SP | | | NG | UK | | |
| BALSAMINACEAE <i>Impatiens engleri</i> Gilg subsp. <i>engleri</i> | | | | WU | EU | NG | | UL | |
| DIOSCOREACEAE <i>Dioscorea longicuspis</i> R. Knuth | | | | WU | EU | | | UL | MA |
| FABACEAE <i>Millettia oblata</i> Dunn subsp. <i>teitensis</i> J. B. Gillett | TA | | SP | WU | | | | | |
| MELASTOMATACEAE <i>Lijndenia procteri</i> (A. & R. Fern.) Borhidi <i>Medinilla engleri</i> Gilg <i>Memecylon cogniauxii</i> Gilg <i>Memecylon deminutum</i> Brenan | | | SP | WU WU WU WU | EU EU | NG NG | | UL UL | UD |
| ORCHIDACEAE <i>Cynorkis buchwaldiana</i> Kraenzl. subsp. <i>braunii</i> (Kraenzl.) Summerh. <i>Neobenthamia gracilis</i> Rolfe <i>Polystachya caespitifica</i> Kraenzl. subsp. <i>caespitifica</i> | TA | | | WU WU | | NU NG NG | UK | UL UL UL | RU UD |
| RANUNCULACEAE <i>Clematis dolichopoda</i> Brenan | TA | | SP | WU | EU | | | | |
| RUBIACEAE <i>Chassalia albiflora</i> K. Krause <i>Chassalia discolor</i> K. Schum. subsp. <i>discolor</i> <i>Coffea fadenii</i> Bridson <i>Mitriostigma usambarense</i> Verdc. <i>Mussaenda microdonta</i> Wernham subsp. <i>microdonta</i> | TA | | SP SP SP | WU WU WU WU | EU | | NG NG | UK UL | UD MA |

Endemic plant species of the eastern Arc Mountains of Kenya and Tanzania

TABLE 1. continued

| | Northern | | | Central | | | | Southern | | | | |
|---|----------|---|----|---------|----|---|----|----------|----|----|----|----|
| <i>Parapentas silvatica</i> (K. Schum.) Bremek. | | | SP | WU | EU | | NG | UK | UL | | UD | MA |
| <i>Pavetta diversicalyx</i> Bridson | | | SP | WU | | | | | | | | |
| <i>Pavetta mazumbaiensis</i> Bridson | | | SP | WU | | | | | | | | |
| <i>Pentas longituba</i> K. Schum. | | | | WU | | | NG | UK | UL | RU | | |
| <i>Psychotria brucei</i> Verdc. | | | SP | | | | | | UL | | | UD |
| <i>Psychotria griseola</i> K. Schum. | | | | WU | EU | | NG | | UL | | | UD |
| <i>Psychotria pandurata</i> Verdc. | | | | | EU | | | | UL | | | UD |
| <i>Rytigynia longicaudata</i> Verdc. | | | SP | WU | | | | | | | | |
| <i>Rytigynia xanthotricha</i> (K. Schum.) Verdc. | | | | | EU | | | | UL | | | |
| SAPINDACEAE | | | | | | | | | | | | |
| <i>Placodiscus amaniensis</i> Radlk. | | | | | EU | | | | | | | UD |
| THYMELAEACEAE | | | | | | | | | | | | |
| <i>Dicranolepis usambarica</i> Gilg | TA | | SP | WU | EU | | NG | | UL | | | UD |
| TURNERACEAE | | | | | | | | | | | | |
| <i>Staphiella usambarica</i> J. Lewis | | | SP | WU | | | | | | | | |
| TOTAL | 9 | 1 | 22 | 27 | 15 | 1 | 17 | 6 | 19 | 2 | 8 | 4 |

3.2 Partial Eastern Arc

Ten of our 32 taxa are restricted to the Northern and Central floristic subregions (Fig. 3). Lovett (1998) reported this distribution for 6 or 9% of his large trees, vs. 31% of our taxa with varied habits. The most widespread of our taxa are *Bothriocline argentea* and *Chassalia albiflora*, which are known from 5 and 4 mountain blocs respectively. Of more restricted distribution are *Psychotria griseola*, only in the West and East Usambaras and the Ngurus; *Rytigynia xanthotricha*, only in the East Usambaras and the Ulugurus; and *Polystachya caespitifica* subsp. *caespitifica*, only in the West Usambaras and the Ulugurus. The Usambaras and Ulugurus probably share more floristic elements than has previously been reported, and further examples of this disjunction can confidently be expected.

None of our 32 taxa studied were shared between the Central and Southern subregions. Lovett (1998) did document this distribution for 5 or 8% of his large trees. This may in part be an artifact the recent concentration of collecting activities in the Northern subregion by Missouri Botanical Garden staff and associates.

Only one of our taxa, *Placodiscus amaniensis* (Fig. 4), showed a disjunct distribution between the Northern and Southern floristic subregions. This species is only known from its type locality in the East Usambaras and a single collection from the Udzungwas. Lovett (1998) documented 3 additional taxa with this disjunct distribution: *Isolona heinsenii*, subsequently reported (Q. Luke pers. comm.) from the Ngurus in the Central subregion; *Pterocarpus mildbraedii* subsp. *usambarensis*; and *Diospyros occulta*. However in this same study he reported *Placodiscus amaniensis* only from the Northern subregion. In view of the inadequacy of biodiversity inventories to date in parts of the Central subregion, especially the Nguu and Rubeho Mountains, it seems likely that all of these taxa will eventually be found in all three subregions.

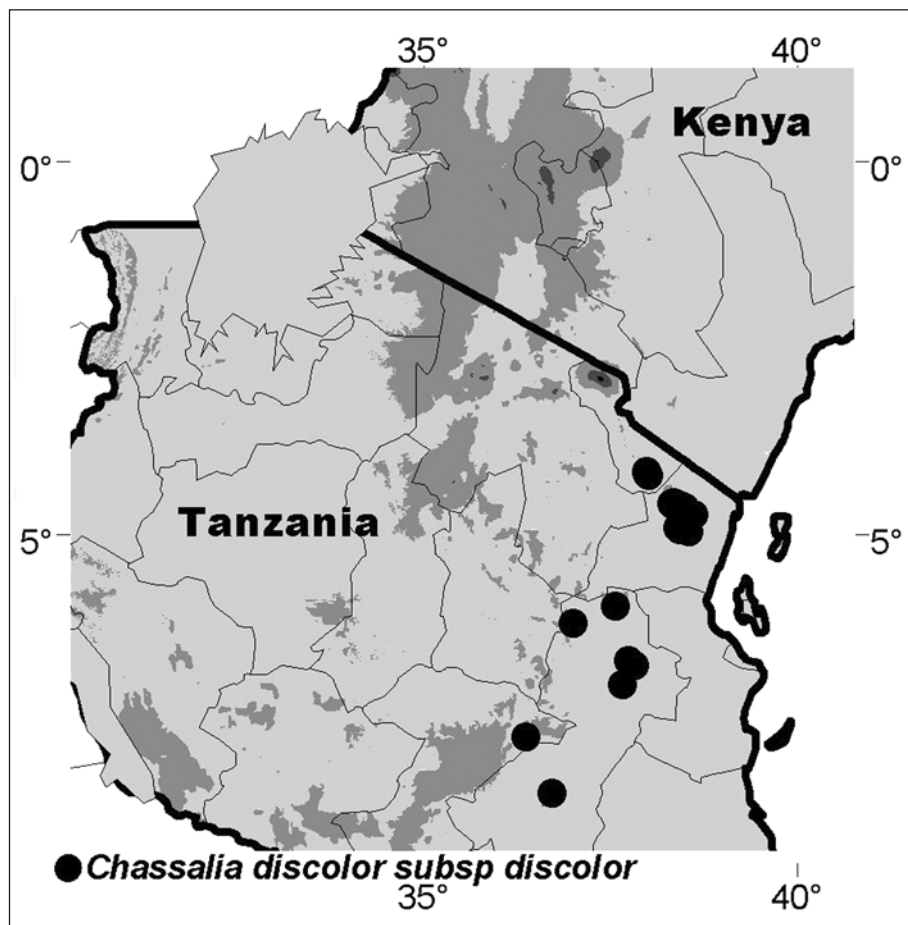


FIG. 2. Widespread Eastern Arc Distribution: *Chassalia discolor* subsp. *discolor* is found in 8 of the 12 Eastern Arc mountain blocs and all 3 of Lovett's subregions.

3.3 Single Eastern Arc Subregion

Ten of our 32 taxa are restricted to the Northern floristic subregion (Fig. 5). The most widespread is *Clematis dolichopoda*, which is known from 4 of its 5 mountain blocs. Lovett (1998) reported this distribution for 21% or 32% of his 66 large trees, although *Placodiscus amaniensis* is now known from the Southern subregion as well, vs. 31% of our taxa with varied habits. Recent exploration has expanded the range within this subregion of several taxa: *Lijndenia procteri*, *Mitriostigma usambarense*, and *Stapfiella usambarica* were all previously thought endemic to the West Usambaras but are now known from the South Pares. This South Pare-West Usambara distribution is shared by *Memecylon deminutum*, *Pavetta diversicalyx*, *Pavetta mazumbaiensis*, and *Rytigynia longicaudata*. *Coffea fadenii* and *Milletia oblata* subsp. *teitensis* (Fig. 5), previously considered endemic to the Taita Hills, are now known from the South Pares, and *Milletia oblata* subsp. *teitensis* is additionally known from the West Usambaras.

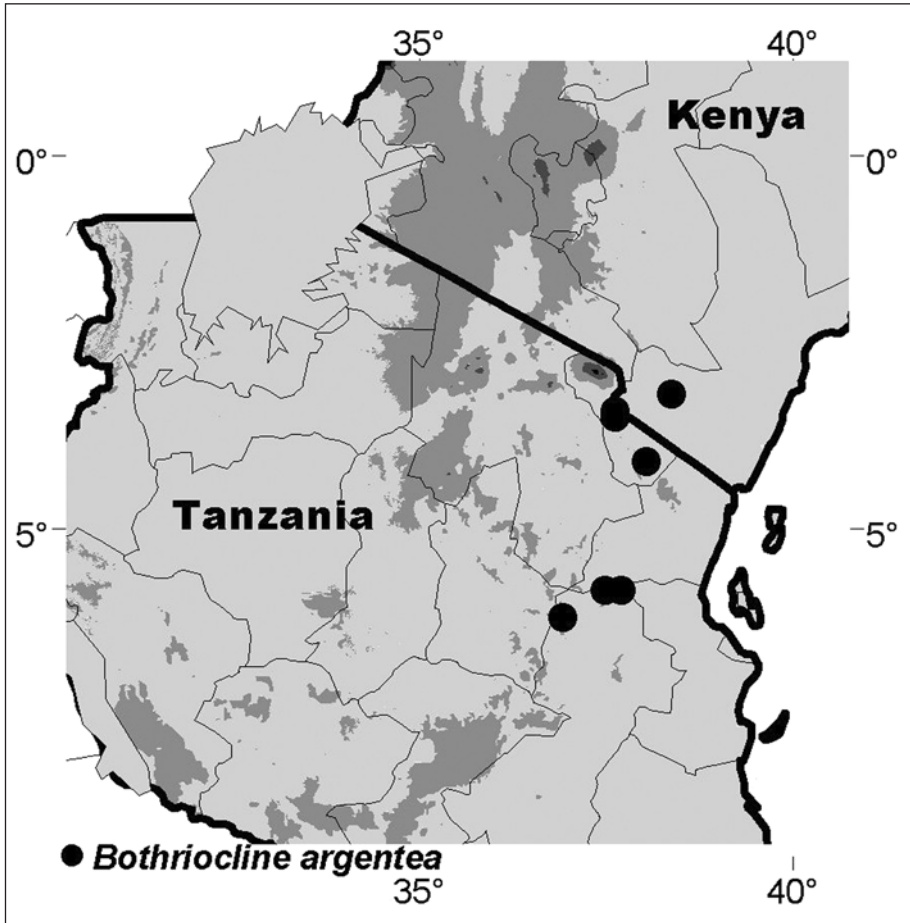


FIG. 3. Partial Eastern Arc Distribution: *Bothriocline argentea* is found in both the Northern and Central subregions, in 3 mountain blocs in the former and 2 in the latter subregion.

Neobenthamia gracilis is the only one of our 32 taxa that is restricted to the Central subregion, where it is known from 4 of the 5 mountain blocs (Fig. 6). Similarly Lovett (1998) found only one of his 66 taxa of large trees to be restricted to this subregion. Thus this subregion does not appear to be rich in narrow endemics. However, our sampling is directed at floristic relations among the various mountain blocs, thus we excluded taxa known from only 1 mountain bloc; a more representative sample including, e.g. endemic species of *Lasianthus* (Rubiaceae) from the Ulugurus would modify this result.

None of our 32 taxa is restricted to the Southern subregion. Lovett (1998) reported this distribution for 5% or 8% of his 66 taxa of large trees. Thus similarly to the Central subregion, the Southern subregion does not appear to be rich in narrowly endemic species. Although a more complete sample might modify this result in some measure, the Southern subregion appears to be characterized by an admixture of widespread Eastern Arc endemics with floristic elements shared with areas outside the Eastern Arc, rather than by a coherent set of endemic species of its own.

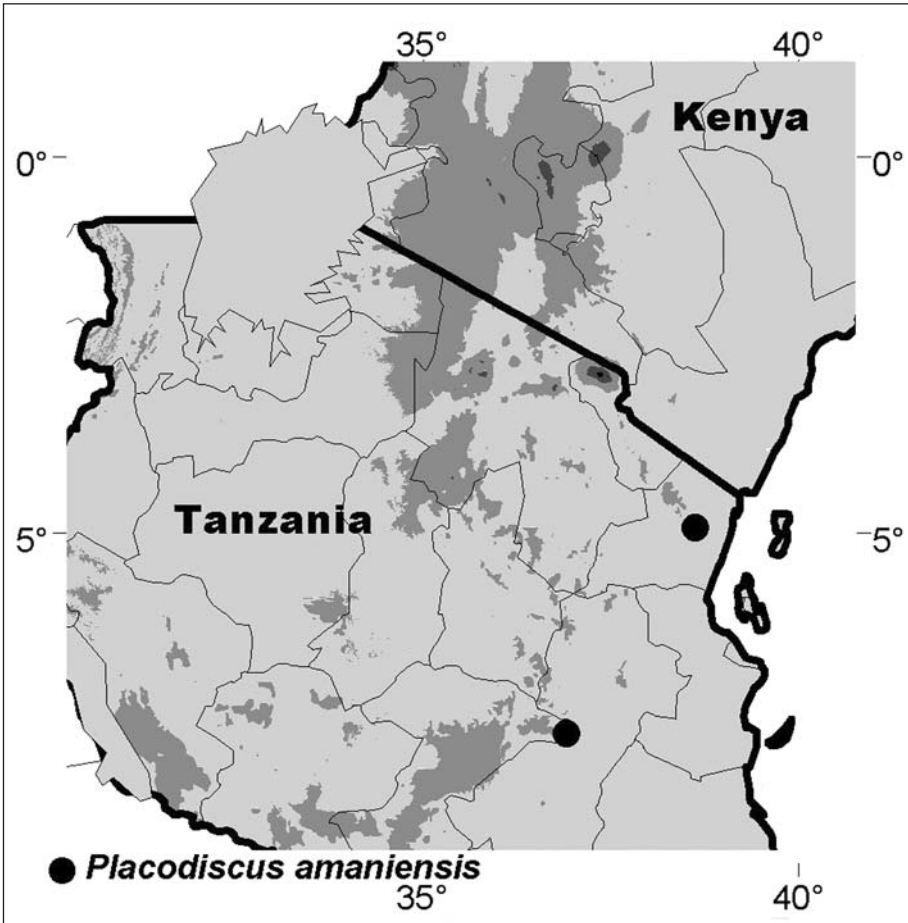


FIG. 4. Partial Eastern Arc Distribution: *Placodiscus amaniensis* is the only species found in the disjunct Northern and Southern subregions, in 1 mountain bloc in each region.

4 Conclusions

Plants endemic to the Eastern Arc floristic region are more widespread within this region than previously known, and future exploration will find range extensions for many more. Of the subregions recognized by Lovett, the Northern has notable endemism of its own, but narrow endemism is less in the Central subregion and relatively low in the Southern subregion. The distribution of several taxa in the Northern and Southern but not Central subregions is notable but unexplained. Both Lovett's and our data sets are incomplete; a more thorough understanding of Eastern Arc phytogeography awaits distributional analysis of all its endemic taxa.

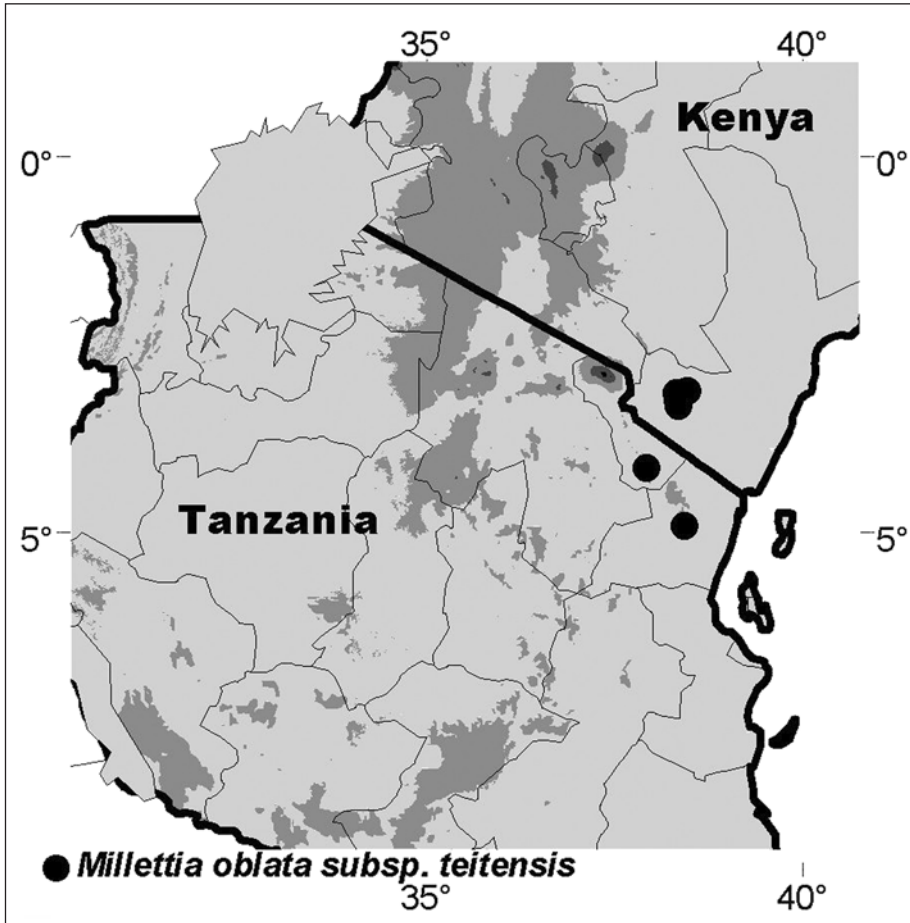


FIG. 5. Single Eastern Arc Subregion Distribution: *Millettia oblata subsp. teitensis* is found in 3 mountain blocs in the Northern subregion; it is here newly reported from Tanzania, in the South Pare and the West Usambaras.

Although in general the flora of East Africa is reasonably well known, its detailed floristic patterns are still being delimited. Accurate and reliable distributional data are a prerequisite to both elucidation of floristic affinities and assessment of conservation priorities. The most inadequately explored parts of the Eastern Arc (Nguu, Nguru, Ukaguru, and Rubeho) need intensive inventory, and the conservation status of all endemic and near-endemic Eastern Arc needs assessment.

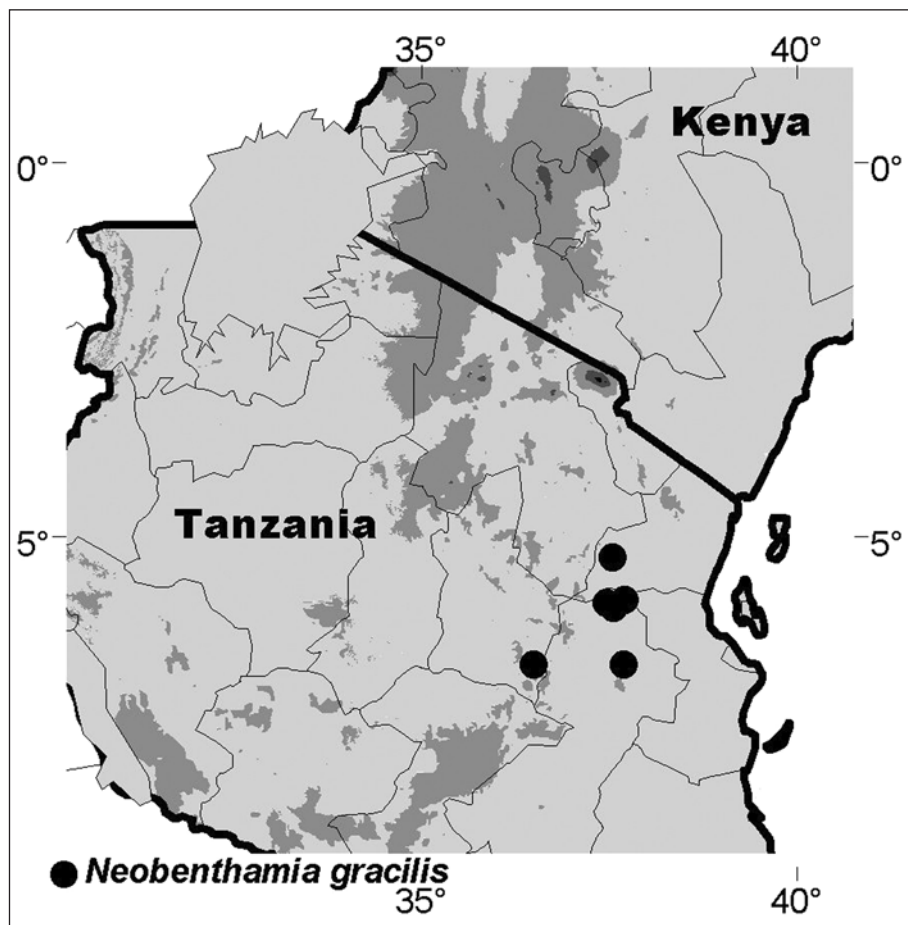


FIG. 6. Single Eastern Arc Subregion Distribution: *Neobenthamia gracilis* is found in 4 mountain blocs of the Central subregion.

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