SPARSE DISTRIBUTION PATTERN OF SOME PLANT SPECIES IN TWO AFROMONTANE RAIN FORESTS OF THE EASTERN ARC MOUNTAINS OF TANZANIA

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ABSTRACT

Mountain forests play major roles in biodiversity; containing many endemics and species of conservation concern. The diversity and distribution patterns of plants in mountain ecosystems are influenced by various environmental and anthropogenic factors that exhibit heterogeneity over space and time. This study analysed species diversity and distribution patterns on two afromontane rain forests of the eastern Arc Mountains of Tanzania in the west Usambaras and Ulugurus to assess any possible threats to biodiversity conservation in this region. A hundred sample plots (0.02 ha) were established on each of the two mountain ranges in such a way as to cover as much variations as possible from valley bottoms to ridge tops. The analysis was based on species importance values computed from the average of the relative basal area and relative density as well as species frequency. Using different diversity indices, the study showed that the mountains have high species diversity. Eighteen endemic species were identified in the Usambaras and thirty-two in the Ulugurus. These endemics are fairly shared between the two mountains and other mountain massifs of the Eastern Arc. Based on our analysis of species distribution, it was found that the proportion of sparsely (rarely) distributed species was over 30% and 49% for the woody species and total vascular plants, respectively. These findings are important in alerting on possible decline of biodiversity in the region and prompting the development of policies to address rare, threatened, and endangered plant species, which are non-existence in Tanzania. We suggest further surveys in the forests of the Eastern Arc Mountains to determine whether the apparently sparse distribution of some species may be found in reasonable abundances elsewhere and quantify the manner and type of use of the forest resources by surrounding local communities to determine their possible impacts on species distribution.

INTRODUCTION

The rain forests of Tanzania occupy small areas mostly confined to isolated mountains. More than half is found in the Eastern Arc Mountains, old crystalline mountains that extend from southern Tanzania to southern Kenya. Most of these remaining forests are gazette reserves managed as catchment forests - forests managed for rainwater capture. Most lowlands are either dry or have been deforested for agriculture and there are no alternatives to catchment forests for capturing water (Kalaghe *et al.* 1988, Nsolomo and Chamshama 1990, Bjøndalen 1992, Munishi and Temu 1992, Rodgers 1993).

The Eastern Arc Mountain forests are recognized for their unique and diverse

biota and floristically rich forest vegetation that range from lowland rain forests to elfin montane forests (Rodgers & Homewood 1982, MLNRT 1988, Steiner 1990, Iversen 1991, Bj⇑ndalen 1992, Lovett 1993). The level of endemism of the 2,100 known species of vascular plants has been estimated at 25-39%. About six families have high endemism ranging from 31% for Orchidaceae to 73% for Gesneriaceae, and more than 10 genera are considered endemic or near endemic (Lovett 1988, 1989). The mountains are one of the 24 top biodiversity hot spots in the world (TFCG 1999, Mittermeier *et al*. 1999). Their flora is much higher in richness by the number of endemics and species than equivalent areas of forests outside them from the Horn of Africa to the Cape (Fjeldså *et al.* 1998).

Rare plant species may exert a dominant influence on species richness of the Eastern Arc Mountain forests. High species diversity occurs under divergent conditions favoring the growth of rare species. Rare species therefore can serve as a pivotal group for quantifying richness patterns. Assessment of vegetation patterns, species associations and rare species distribution patterns are important tools for land management, restoration, and conservation (Munishi 1996). Such studies first will alert on possible decline of biodiversity in a given region with possible anthropogenic influences, secondly, may be used to prompt the development of policies to address this decline (e.g. rare, threatened, and endangered plant species) if not existent, thirdly prompting the development of alternative strategies, policies and management objectives for sustainable use of the forest resources for the benefit of the local communities adjacent to the forests, and fourth designing off-forest alternative interventions that may help reduce negative impacts on the forest resources, and developing an environment for sustainable community based forest resource management.

Past quantitative assessments of variations in plant communities and species associations and distribution patterns in the Eastern Arc Mountains have mainly been based on environmental factors that contributed to the observed patterns (Lovett 1990 & 1996, Pócs *et al*. 1990). Quantitative assessments of the status of plant species distribution that address rarity in the Eastern Arc forests are inadequate if non existence though such studies are important in influencing conservation policies with regard to the forests resources of these mountains.

The objective of this study was to evaluate plant species abundance, diversity and distribution patterns in some forests of the Eastern Arc Mountains and to assess the existence of possible threats to biodiversity conservation in the region**.**

MATERIALS AND METHODS

Study Sites

The Eastern Arc Mountains are a chain of crystalline mountains near the Indian Ocean coast from southern Tanzania to southern Kenya (8^{o} 51' S 34 ^{o} 49' E to 3 ^{o} 2' S 38 ^{o} 20' E). This chain is several mountain ranges separated by lowlands that originated by block faulting dating back to the Karoo period, approximately 300 million years (Griffiths 1993, Lovett 1996). The mountains support some of the most luxuriant montane and sub-montane rain forests of eastern and central Africa. The most important Eastern Arc Mountains in Tanzania with rain forests include South Pare, West Usambara, East Usambara, Nguu, Nguru, Ukaguru, Uluguru, Rubeho, Malundwe, Udzungwa, Mahenge, Njombe, and Matengo. This study was located in the Mazumbai and Kisimagonja forest reserves in West Usambaras and Uluguru north Forest Reserve in the Ulugurus (Figures 1 & 2).

The West Usambara range is in the northern part of the Eastern Arc Mountains (4 ^{o} 25' – 5 ^{o} 07' S and 38 ^{o} 10' – 38 ^{o} 35' E). The geology is composed of late Pre-Cambrian rocks of the Usagara System, metamorphic rocks of gneiss type with two main highland soil types; the Humic Ferrisols in the drier areas and Humic Ferralitic soils in the more humid and wet areas (Hall 1980). The climate is oceanic with bimodal rainfall, partly determined by their proximity to the Indian Ocean and the equator. Rainfall peaks in April and November with a mean annual rainfall maximum of 2,000 mm in the wettest areas, falling to less than 600 mm in the drier areas. Moist forests cover extensive areas of the wetter eastern, southern, and northern sides of the mountains (van der Willingan & Lovett 1979, Lovett 1996).

The Mazumbai and Kisimagonja Forest Reserves are among those areas with the highest rainfall in the West Usambaras. The monthly rainfall average is over 50 mm and the mean annual rainfall is 1300mm (Redhead 1979, Hall 1980, Munishi 2001). The elevation ranges from 1,300 to 1,910 m. The vegetation consists of lower montane, sub-montane, and montane evergreen rain forests (Redhead 1981, Hall 1990).

The Uluguru range (7 ^{o} 02' - 7 ^{o} 16' and 38 ^{o} 0' - 38 ^{o} 12') is in the central part of the Eastern Arc Mountains. The Uluguru bedrock is made up of Precambrian metamorphic rocks dominated by hornblende-pyroxene granulites with injections of granite and gneiss (Rapp *et al.* 1972). The climate is oceanic with bimodal rainfall peaking in April and November. Annual rainfall is 2,900 - 4,000 mm on the windward slopes and 1,200 - 3,100 mm on the leeward slopes. The eastern windward slopes have over 100 mm of rainfall every month (Lovett & Pocs 1993). The elevation ranges from 1600 to 2300 m and the vegetation consists of submontane, montane rain forests, and elfin forests.

Data collection

One hundred 0.02 ha (20 m x 10 m) plots were established in each of the two ranges distributed over an area of about 300 ha in each forest. The plots were established along parallel lines whose starting points were subjectively chosen to cover as much variation as possible from valley bottoms to ridge tops. Plots were laid with their long axis perpendicular to the slope. The distance between plots along transects was based on elevation differences. The minimum elevation difference between two adjacent plots was 5m and the maximum was 30m. The following information was collected at each plot: diameter at breast height (dbh, 1.4 m) of all trees >6 cm (for buttressed trees, diameter was measured above the buttress); occurrence of all other plant species (trees < 6 cm dbh, shrubs, and herbs). Species were identified in both the local and botanical names. Botanical names were confirmed at the Lushoto Silvicultural Station Herbarium in Tanzania.

Data analyses

Species importance values (IV) for each plot were computed for each species as the average of the relative basal area and relative density. Species richness was computed as the total number of species in each plot. The index of dominance was computed as $C = \sum(n_i/N)^2$ where n_i = importance value of a species, N = total importance value of all species (Ambasht 1988, Misra 1989).

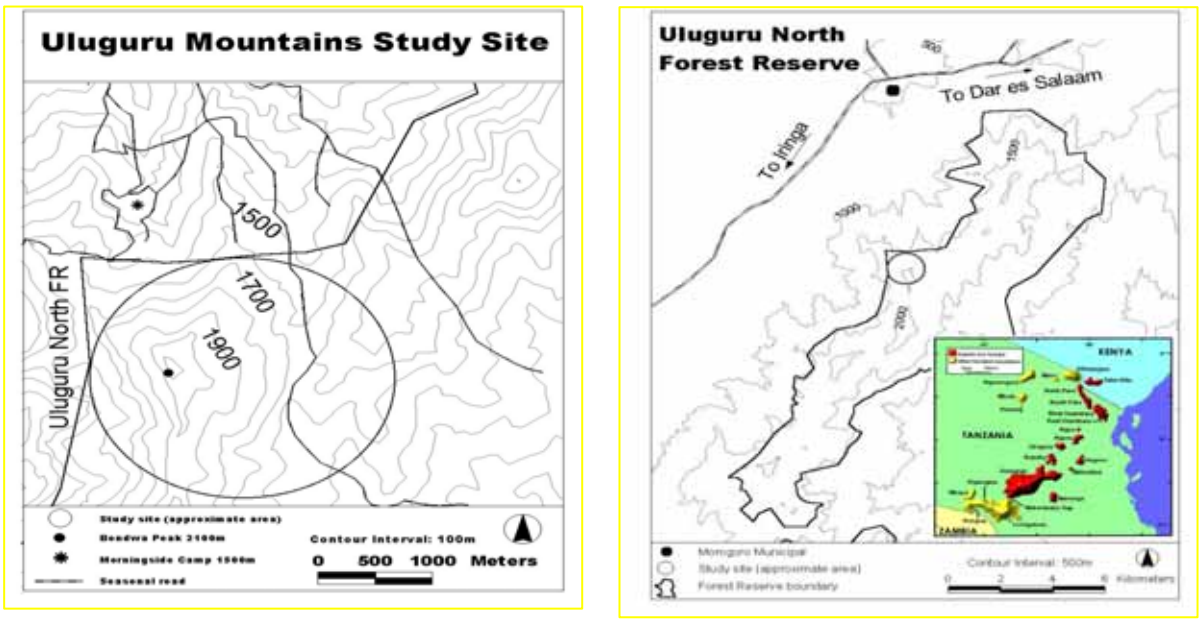

Figure 1. Uluguru mountains study site in the Eastern Arc Mountains of Tanzania

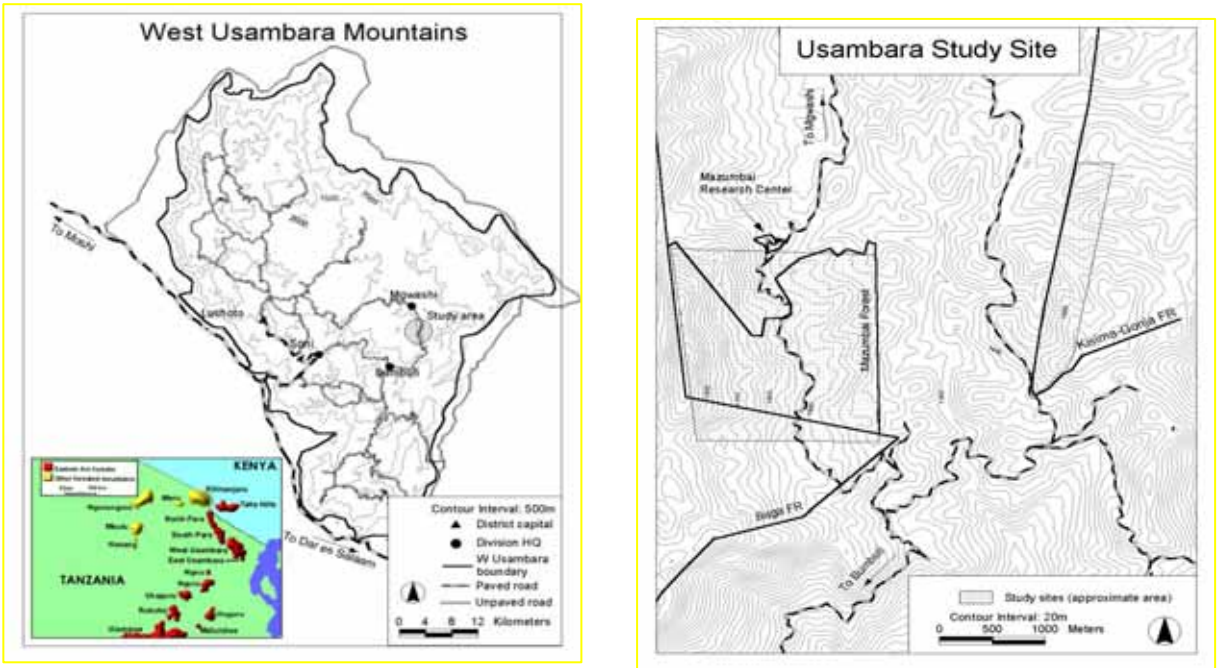

Figure 2. West Usambara Mountains Study Site in the Eastern Arc Mountains of Tanzania

The Simpson's and the Shannon's Diversity Indices were computed as $C = 1 - \sum (p)^2$ and $H = - \sum (p*\ln(p))$, respectively, where p = species relative basal area (Barbour *et al*. 1987, McGarigal & Marks 1995).

A rare species may be rare due to a naturally low number of individuals (either on absolute or regional basis) or due to rarity of locations in which the individuals can occur (Miller 1986), or sometimes due to decline related to anthropogenic influences (Munishi 2001). Since rarity can be defined in relation to variability in both site and individual distribution and abundance, no absolute and universally applicable definition of rarity can be

expected (Dowham & Craig 1976, White 1980). In our analysis a species was defined as rare if it occurred in only 1-2% of the plots; those with medium distribution occurred in 3%-30% of the plots; those occurring in more than 30% of the plots were considered widely distributed.

RESULTS

Forest characteristics

The numbers of tree species, vascular plant species, and families are higher in the Ulugurus than in the Usambaras (Table 1). This may be attributed to the wider elevation range sampled in the Ulugurus (1120 m vs. 550 m in the Usambaras). The plots in the Usambaras generally had bigger trees, which accounts for the higher basal area and lower stem density found there (Table 1). Twelve species in the Usambaras and seventeen species in the Ulugurus accounted for 78-79% of the basal area of the plots (Table 2). *Ocotea usambarensis, Syzygium guineense, Parinari excelsa*, and *Newtonia buchananii* are common dominants of both ranges.

Species Diversity, Richness, Endemism, and Distribution Pattern in the Usambaras

A total of 262 vascular plant species, 69 of which are tree species ≥ 6cm dbh were encountered in this study. The index of dominance in the Usambaras was 0.05. This low value shows that each species contributes to the community relatively evenly (Table 3) (Edward 1996). The index of dominance reflects species dominance in a plant community. The lower the index value the lower the dominance of a single or few species (Edward 1996, Ambasht 1988, Simpson 1949). The Shannon's Diversity Index (2.93) and Simpson's Diversity Index (0.90) are relatively high (Table 3), indicating high species diversity. The Simpson's diversity index (SIDI) represents the probability that any species encountered at random would be different species, and its range is $0 < SIDI < 1$. The Shannon's diversity index represents the amount of "information" per individual (or species in this case) and its range is > 0, without limit (Barbour *et al*. 1987, McGarigal & Marks, 1995). The higher the values, the higher the diversity. For Shannon's Index, values > 2 have been assigned medium to high diversity (Barbour *et al*. 1987).

The proportions of rare species were higher for the total vascular plants than for tree species alone (Table 3, Appendix 1a). Eighteen endemic species were identified in the Usambaras, 72% of which were shared with the Ulugurus, and 17% with other mountain massifs of the Eastern Arc (Table 4).

Species diversity, richness, endemism, and distribution pattern in the Ulugurus

A total of 445 species of vascular pants of which 90 were tree species > 6 cm dbh were encountered in this study (Table 1). The index of dominance in the Ulugurus was 0.04, even lower than in the Usambaras showing that no one particular species dominates over the others (Table 3). The Shannon's Diversity Index (3.31) and Simpson's Diversity Index (0.93) are high (Table 3), meaning high species diversity. Like in the Usambaras, the proportions of rare species were higher for the total vascular plants than for tree species alone (Table 3, Appendix 1b), and the percentage of widely distributed species was even lower.

Table 1. Characteristics of two afromontane rain forests in the Eastern Arc Mountains of Tanzania

Afromontane rain forest	Usambaras	Ulugurus
Elevation range (m)	1360 - 1910	1160 - 2280
Total Number of Species (vascular plants)	262	445
Number of Tree Species	69	90
Number of Families	81	97
Basal Area (m^2 ha^{-1})	104	83
Density (stems ha-1)	988	1161

Table 2. Basal area contribution (%) by the dominant species in two afromontane rain forests of the Eastern Arc Mountains of Tanzania. Species are ordered with increasing contribution to basal area except for the species common to both ranges in the Ulugurus

Species	Afromontane rain forest	
	Usambaras	Ulugurus
Ocotea usambarensis	25	18
Syzygium guineense	12	7
Parinari excelsa	8	5
Newtonia buchanani	8	2
Dicranolepis usambarica	4	
Agauria salicifolia	4	
Isoberlinia scheffleri	4	
Sorindeia usambarensis	3	
Drypetes usambarica	3	
Allanblackia stuhlmanii	3	
Pachystela msolo		2
Aningeria adolfi-friedercii	2	
Ficalhoa laurifolia		11
Symphonia globulifera		6
Allanblackia ulugurensis		4
Macaranga kilimandscharica		4
Albizia gummifera		3
Strombosia scheffleri	3	
Trichocypha ulugurensis		3
Afrocrania volkensii		3
Myrianthus arboreus	2	
Chrysophyllum gorungosanum		2
Cassipourea congoensis		2
Polycias fulva		2
Dasylepis leptophylla		2
Total	78	79

Table 3. Species diversity and distribution in two afromontane rain forests of the Eastern Arc Mountains of Tanzania. Computations are based on species importance values.

Diversity Measure /Species Distribution		Usambara	Uluguru
Diversity:			
Simpson's Index (C)		0.10	0.06
Simpson's Diversity Index (D=1-C)		0.90	0.93
Index of Dominance		0.05	0.04
Shannon's Diversity Index		2.93	3.31
Distribution:			
Rare	Woody species > 6cm dbh (%)	30	41
	Total vascular plants (%)	49	54
Medium	Woody species > 6cm dbh (%)	57	48
	Total vascular plants (%)	38	40
Wide	Woody species > 6cm dbh (%)	13	11
	Total vascular plants (%)	13	6

Table 4. Some endemic plant species identified in two afromontane rain forests of the Eastern Arc Mountains Tanzania

Usambara	Uluguru	Shared Usambara/Uluguru
Allanblackia stuhlmanii	*Allanblackia ulugurensis*[2]	*Drypetes usambarica*
Dasylepis leptophylla	*Uvariodendron oligocarpum*	*Cryptocarya liebertina*
Isoberlinia scheffleri	*Lasianthus pendunculatus*[2]	*Dicranolepis usambrarica*[2]
Sorindeia usambarensis	*Dasylepis integra*	*Cola greenwayii*
Greenwayodendron suaveolens[1]	*Milletia sacleuxii*	*Leptonychia usambarensis*
	Ouratea scheffleri	*Syzygium guineense subsp. afromontana*
	Polysphaeria multiflora	*Memecylon feruculosum*[6]
	Porterandia penduliflora	*Pavetta holstii*
	Alsodeiopsis schumanii	*Danais xanthorhoea*
	Vitex amaniensis	*Brachystephanus holstii*
	Dyschoriste subquadrangularis[3]	*Chrossandra tridentata*
	Rhipidantha chloranther	*Justicia anisophylla*
	Justicia sp. [1]	*Mimulopsis kilimandscharica*
	Thunbergia hamata[3]	
	Asystasia sp.	
	Justicia inaequalis[4]	
	Phaulopsis sp.	
	Impatiens hamata	
	Pavetta lynesii[5]	

Key:

1 Earlier listed as occurring only in the east Usambaras (Rufo *et al* 1989)
2. Shared with Nguru Mountains (Pòcs *et al* 1990)
3. Earlier listed as strict endemics to the Usambaras (Steiner 1990).
4. Known to be coastal near-endemics (Steiner 1990)
5 Reaches its north most distribution in the Ngurus and extends south to Udzungwa, Usagara, Mufindi escarpments, and Mahenge plateau (Pòcs *et al* 1990)
6. Earlier known to be a narrow endemic restricted to the Ngurus (Pòcs *et al* 1990)

DISCUSSION

Although a wider elevation range was covered in the Uluguru than in the Usambaras (Table 1), the Ulugurus had the lowest number of widely distributed vascular plants (Table 3, Appendix 1a & b). This may suggest that species in the Ulugurus are more restricted in distribution than in the Usambaras. Species that have a restricted distribution are very fragile in an ecosystem and can easily be driven to extinction. This calls for a very careful conservation attention to such species. Thirty-two endemic species were identified in the Ulugurus, 41% of which were shared with the Usambaras and 28% shared with other mountain massifs of the Eastern Arc (Table 4). The shared species may suggest the different mountain massifs to have the same origin geologically and possibly a recent separation between the ranges where each one acts as refugia.

Basal area distribution and various diversity measures (Tables 2 & 3) show a relatively low species dominance, showing that each species contribute evenly in the composition of the forests. This is also an indication of high species diversity as has been shown by other authors (Lovett 1988, 1993 & 1996, MLNRT 1989, Iversen 1991, Rodgers & Homewood 1982). The diversity of microhabitats, higher heterogeneity in the environment and their influence on species distribution in many of the eastern arc forests (Munishi 2001) will likely allow as many plant species as possible to establish in an area. The resulting species composition will as well be high given the possible adaptation of different species in these microhabitats (micro sites) heterogeneous conditions.

The nature of the strength and long time environmental interactions and influence on the floristic composition of the forests can be considered to have allowed species to be broadly associated with the range of their environmental factors. Each of these gradients occupies an appreciable range in the eastern arc forests and any tree species measured may be considered as viable in these forests. The sparse (rare) distribution of some species as observed in this study (table 3, appendix 1a & b) may be either a biological characteristic (restricted range), or outlier individuals of populations whose ranges are outside these sites, but most likely represent populations in advanced stages of decline. Hall (1990) observed 15 species (some of which are in this study) that showed very low abundance at Mazumbai forest. Such species should be candidates for immediate conservation.

The topographic and climatic conditions that favored the isolation of endemics within the Eastern Arc mountains have been discussed elsewhere (Lovett 1988 & 1989, Pócs 1989, Pócs *et al.* 1990, Bj∩ndalen 1992), with some observers pointing out that endemism in the flora of the Eastern Arc Mountains lies between 25%-30% of the known species of vascular plants. Eighteen (7%) and thirty-two (7%) endemic species were found in the Usambara and Uluguru respectively, which is below this range, but with some species earlier believed not to be shared by other mountain massifs in the region (Table 4). For example, *Memecylon feruculosum* was earlier believed to be restricted to the Nguru Mountains (Pócs *et al.* 1990). *Dyschoriste subquadrangularis, Justicia interupta,* and *Thunbergia hamata* were earlier listed as Usambara strict endemics (Steiner 1990). The endemic species found are either strict endemics to individual mountain ranges, or shared endemics between the different mountain massifs. Many of these endemic and sub-endemics belong to genera with species restricted to other massifs of the Eastern Arc (examples being *Impatiens*, *Milletia*, *Polystachya*, *Memecylon*, and *Pavetta*).

CONCLUSION

Species diversity, richness, and endemism are high in both the Usambaras and Ulugurus. On the other hand, the proportions of sparsely distributed species "rare species" were high, raising a concern as to whether it is a natural characteristic or a possible state of declining species. Further studies in the Eastern Arc forests are proposed to determine whether the apparently sparse distribution of some species can be found in reasonable abundances elsewhere. Local communities around these forests are believed to play major roles as determinants of the forest vegetation condition through various uses. Together with surveys of plant species abundances and distribution, we concurrently need to develop an understanding of how the local people around these forests depend on, interact with, and utilize the forest biological resources for survival, and to reflect this understanding in future policies and management objectives. This calls for quantification of the manner and type of use of the forest resources by surrounding local communities and possible impacts on species distribution. Close attention to the species with rare occurrence is specifically important.

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Appendix Ia A list of species assessed as having rare (sparse) distribution pattern in the west Usambaras (Mazumbai and Kisimagonja Forest Reserves), Eastern Arc Mountains of Tanzania

	Local Name	Botanical Name	Family
1		*Acridocarpus alopecurus* Sprague	Malpighiaceae
2	Shaza	*Alchornea hirtella* Benth.f. (Pain) Pax & K. Hoff.	Euphorbiaceae
3	Tongotongo	*Ampelocissus grantii* (Bak.) Planch.	Vitaceae
4		*Anthospermum usambarense* K. schum.	Rubiaceae
5	Mlazi	*Arundinaria tolange* K. Schum.	Gramineae
6	Kishimto	*Asplenium eliottii* C. H. Wright	Aspleniaceae
7		*Asplenium friesiorum* C.Chr.	Aspleniaceae
8	Kishimto	*Asplenium megalura* Hieron.	Aspleniaceae
9		*Asplenium theciferum* (Kunth.) Mett.	Aspleniaceae
10		*Balthazaria schliebenii* (Melchior.) Verdc. var. *greenwayi* (Verdc.) Verdc.	Theaceae
11		*Bulbostylis filamentosa* Roen. & Schultz.	Cyperaceae
12		*Carex chlorosaccus* L.B.CL.	Cyperaceae
13	Shikizi	*Chassalia umbraticola* (Vatke) ssp. *umbraticola*	Rubiaceae
14		*Chlorophytum filipendulum* Baker	Liliaceae
15		*Christella dentata* (Forssk) Brownsey & Jermy	Thelipteridaceae
16		*Cissampelos parura* L.	Menispemaceae
17		*Cissus oliveri* (Engl.) Kilg.	Vitaceae
18		*Cissus rotundifolia* Vahl.	Vitaceae
19		*Clerodendrum cephalanthum* Oliv.	Verbenaceae
20		*Clerodendrum myricoides* (Thumb) Blakelock	Verbenaceae
21	Mzuma	*Clerodendrum scheffleri* Guerke	Verbenaceae
22		*Commelina latifolia* (A. Rich.)	Commelinaceae
23		*Conyza aegyptiaca* (L.) Ait	Compositae
24		*Crotolaria lukwangulensis* (Harms.)	Papilionaceae
25	Ong'e	*Cyathea maniana* Hieron.	Cyatheaceae
26		*Cynorhis pleistadenia* Reichbf.	Orchidaceae
27	Siga	*Cyperus maranguensis* K. Schum.	Cyperaceae
28	Mzuma	*Cyphostema braunii* (Gilg. &Br.) Gilg Br.	Vitaceae
29		*Desmodium adscendens* (Sw.) DC.	Papilionaceae
30		*Didymochlaena truncatula* (Schwarb.) JSM.	Aspidiaceae
31		*Dioscorea longicuspis* K. Kunth.	Dioscoreaceae
32		*Dorstenia schlechteri* Engl.	Moraceae
33		*Dryopteris inaequalis* (Schlecht) Kuntze	Aspidiaceae
34		*Dryopteris manniana* (Hook) C. Chr.	Aspidiaceae
35		*Drypetes gerrardii* Hutch.	Euphorbiaceae
36	Monko	*Ekebergia capensis* Sparm.	Meliaceae
37		*Ellaphoglosum milbraedii* Hieron.	Umbelliferae
38		*Eragrostis usambarensis* Napper	Graminae
39		*Erythroxylum emarginatum* Schinz. & Thorn.	Erythroxylaceae
40	Mkunguni	*Fagaropsis angolensis* (Engl.) Dale	Rutaceae
41	Mkuka	*Ficalhoa laurifolia* Hiern.	Theaceae
42		*Fruthrophyllun emargimatum* Schine & Thorn.	Erythroxylaceae
43		*Habenaria micrandra* Lindl.	Orchidaceae
44		*Helichrysum cymosum* ssp. *fruticosum* (L.) Less, (Forsk.) Hedb.	Compositae
45		*Justicia anisophylla* (Mildbr.) Stumm.	Acanthaceae
46	Tikini	*Justicia whytei* Moore	Acanthaceae
47		*Keetia queinzii* (Sonder) Bridson	Rubiaceae
48	Ugoroto	*Landolphia kirkii* Dyer	Apocynaceae
49		*Lobelia holstii* Engl.	Lobeliaceae
50		*Lycopodium clavatum* (L.)	Lycopodiaceae
51	Fuiza	*Melothria microsperma* (Hook.f.) Cogn.	Cucurbitaceae
52		*Memecylon verruculosum* Brenan	Melastomataceae
53		*Microglossa angolensis* O. & H.	Compositae

54		*Milletia bussei* Harms.	Papilionaceae
55	Kishimto	*Mohria caffrorum* (L.) Desv.	Schizaeaceae
56		*Monodora junadii* Engl. et. Diels. Vel. Aff.	Annonaceae
57	Msoo	*Mucuna quadrialata* Bak.,	Papilionaceae
58	Mshegeshe	*Myrica salicifolia* Hochst. ex A. Rich.	Myricaceae
59		*Pancovia holtzii* Radlk.	Sapindaceae
60		*Panicum robynsii* A. Camus.	Gramineae
61		*Panicum trichocladum* K. Schum.	Gramineae
62		*Paspalum scrobiculatum* L.	Gramineae
63		*Pavetta amaniensis* Bremek.	Rubiaceae
64	Mtasanya	*Pavetta mazumbaiensis* (Bridson)	Rubiaceae
65		*Peponium vogelii* (Hook. F.) Engl.	Cucurbitaceae
66	Sheruti	*Philippia usambarensis* Arm & Th.Fr.	Ericaceae
67	Mkeche	*Phyllanthus inflatus* Hutch.	Euphorbiaceae
68		*Psychotria alsophila* K. Schum.	Rubiaceae
69		*Psychotria cryptogrammata* Petit.	Rubiaceae
70		*Pteridium aquilinum* (L.) Kuhn.	Polypodiaceae
71	Kishimto	*Pteris usambarensis* Hieron.	Adianthaceae
72		*Rhamnus prinoides* (L. Herit)	Rhamnaceae
73		*Ritchira albersii* Calg.	Capparidaceae
74	Mshaa	*Rubus apetalus* Poir.	Rosaceae
75		*Rubus steudneri* Schweinf.	Rosaceae
76		*Rytigynia bagshawei* (S. Moore) Robyns.	Rubiaceae
77		*Rytigynia uhligii* (K..Schum. & K.Krause) Verdc.	Rubiaceae
78		*Sapium ellipticum* (Hochst.) Pax.	Euphorbiaceae
79		*Schefflera barteri* (Seem) Harms.	Araliaceae
80		*Schrebera alata* (Hochst.) Welw.	Oleaceae
81		*Sckrochiton boivini* C. B. U	Acanthaceae
82	Meya	*Setaria megaphylla* (Steud) Th. Dun. & Schim.	Gramineae
83	Jeni	*Sphacophyllum africanum* (Oliv.) O. Hoffm.	Compositae
84		*Sporobolus agrostoides* Chiov.	Gramineae
85		*Tacazzea galactagoga* Bullock.	Asclepiadaceae
86		*Teclea nobilis* Del.	Rutaceae
87		*Tephrosia vogellii* Hook. F	Papilionaceae
88		*Vangueria apiculata* K. Schum.	Rubiaceae
89	Mvilu	*Vangueria tomentosa* Hochst.	Rubiaceae
90		*Vepris ngamensis* Verdoon.	Rutaceae
91		*Vernonia holstii* O. Hoffman	Compositae
92		*Vernonia hymenolepis* A. Rich.	Compositae
93		*Vitaria guineensis* Desv.	Vitariaceae
94		*Xylopia parviflora* (A. Rich.) Benth.	Annonaceae
95		*Zanthoxylum deremensis* (Engl.) Kokw.	Rutaceae
96	Muambe	*Zenkerella caparidaceae ssp. grotei* (Harms) Temu.	Caesalpiniaceae

Appendix I b A list of species assessed as having rare (sparse) distribution pattern in the north Uluguru Forest Reserve, Eastern Arc Mountains of Tanzania.

#	Local Name	Botanical Name	Family
1		*Achyranthes aspera* L.	Amaranthaceae
2		*Achyrospermum carvalhi* Giirke	Labiatae
3		*Achyrothalamus marginatus* O. Hoffm.	Compositae
4		*Acalypha fructosa*	Euphorbiaceae
5	Myunguvo	*Agauria salicifolia* (Comm. ex Lam.) Hook. ex Oliv.	Ericaceae
6		*Ageratum conyzoides* L.	Compositae
7		*Aidia micrantha* (K. Schum.) F. White	Rubiaceae
8		*Alchornea hirtella* Benth.	Euphorbiaceae
9		*Alchornea laxiflora* (Benth.) Pax. ex K. Hoffm.	Euphorbiaceae
10		*Allophylus ferrugineus* Taub.	Sapindaceae
11		*Ansellia africana* Lindau	Orchidaceae
12	Lengolengo	*Anthocleista grandiflora* Gilg.	Loganiaceae
13		*Anthyrium scandicinum* (Willd) C. Presl.	Anthyriaceae
14		*Asplenium aethopicum* (Burm.f) Becherer	Aspleniaceae
15		*Asplenium linckii* Kuhn.	Aspleniaceae
16		*Asplenium megalura* Hieron.	Aspleniaceae
17		*Asplenium rutifolium* (Berg) Kunze	Aspleniaceae
18		*Baquaertiodendron natalensis* (Sond.) Hiern. & Hemsl.	Sapotaceae
19		*Barringtonia racemosa* (L) Roxb.	Lecythidaceae
20		*Basella alba* L.	Basellaceae
21		*Begonia johnstonii* Oliv. Ex Hook.f	Begoniaceae
22		*Blighia unijugata* Baker	Sapindaceae
23		*Blotiella stipitata* (Alston) Faden.	Dennstaedtiaceae
24		*Brachystephanus africanus* S. Moore	Acanthaceae
25		*Brillantaisia madagascariensis* (T. Anders) Lindau	Acanthaceae
26		*Brillantaisia ulugurica* Lindau	Acanthaceae
27		*Canna indica* L.	Cannaceae
28		*Cardamone africana* L.	Cruciferae
29		*Cenecio syringifolius* O. Hoff.	Compositae
30		*Chassalia albiflora* K. Krause	Rubiaceae
31		*Chazaliella abrupta* (Hiern) Petit & Verdc.	Rubiaceae
32		*Chionanthus niloticus* (Oliv.) Stearn.	Oleaceae
33		*Chlorophytum heynei* Baker	Liliaceae
34	Kibamandu	*Clematis dolichopoda* Bren.	Ranunculaceae
35		*Clenitis lanuginosa* (Kaulf.) Lopel.	Aspidiaceae
36		*Clerodendrum incisum* Klotzch.	Verbenaceae
37		*Clerodendrum sansibarense* Guerke	Verbenaceae
38		*Coccinia mildbraedii* Gilg.. ex Harms.	Cucurbitaceae
39	Mtunu	*Coffea mongensis* Bridson	Rubiaceae
40		*Conyza newii* Oliv. & Hiern.	Compositae
41		*Craibia braunii* Dunn.	Papilionaceae
42		*Craterispermum schweinfurthii* Hiern.	Rubiaceae
43		*Cremaspora triflora* (Thonn. K. Schum).	Rubiaceae
44		*Crossandra tridentata* Lindau.	Acanthaceae
45	Msembe	*Cyathea maniana* Eng.	Cyatheaceae
46		*Cynanchum altiscandens* K. Schum.	Asclepidiaceae
47		*Dalbergia lactea* Vatke	Papilionaceae
48		*Dicliptera umbellata* (Vahl.) Juss.	Acanthaceae
49	Msizizi	*Dicranolepis usambarica* Gilg.	Annonaceae
50		*Didymochlaena truncatula* (Schwarb) JSM.	Aspidiaceae
51	Ludelega	*Dioscorea dumentorum* (Kunth.) Pax.	Dioscoreaceae
52	Ludelega	*Dioscorea longicuspis* Kunth.	Dioscoreaceae
53		*Diospyros abyssinica* (Hiern.) F. White	Ebenaceae
54	Lukwezi	*Dombeya leucoderma* K. Schum.	Sterculiaceae
55		*Dorstenia alta* Engl.	Moraceae
56		*Dorstenia schlechteri* Engl.	Moraceae

57	Luhenga	*Dracaena afromontana* Engl.	Agavaceae
58		*Dryopteris maniana* (Hook) C. Chr.	Aspidiaceae
59		*Ekebergia capensis* Sparrm.	Meliaceae
60		*Elaphoglossum milbraedii* Hieron.	Lomariopsidaceae
61		*Erythrococa usambarica* Prain.	Euphorbiaceae
62		*Euphorbia engleri* Pax.	Euphorbiaceae
63		*Fagaropsis angolensis* (Engl.) Dale	Rutaceae
64		*Ficus ingens* (Miq.) Miq.	Moraceae
65	Mkuyu	*Ficus sycomorus* L.	Moraceae
66	Mgogandima	*Flacourtia rukam* Zoll. & Mor.	Flacourtiaceae
67		*Garcinia huillensis* Walw. ex Engl.	Guttiferae
68		*Gerrardanthus lobatus* (Logm.) C. Jeffrey	Cucurbitaceae
69		*Glycine wightii* (Wight & Arn) Verdc	Papilionaceae
70		*Gomphocarpus rostratus* N.E. Br. Bullock	Aspleniaceae
71		*Gongronema angolense* N.E. Br. Bullock.	Asclepiadaceae
72		*Grandidiera boivinii* Taub.	Flacourtiaceae
73		*Gravesia pulchra* (Gilg.) Wickens	Melastomataceae
74		*Hilleria latifolia* (Lam.) H. Watt.	Phytolacaceae
75		*Huperzia ophioglossoides* (Lam.) Rothm.	Lycopodiaceae
76		*Hypoestes forskaolii* (Vahl) R. Br.	Acanthaceae
77		*Hypoestes triflora* (Forsk.) Roem. & Schult.	Acanthaceae
78		*Hypolepis sparsisora* (Schrad.) Kuhn.	Dennstaedtiaceae
79		*Impatiens engleri* Gilg.	Balsaminaceae
80		*Impatiens walleriana* Hook.f.	Balsaminaceae
81		*Ipomoea shupangensis* Bak.	Convolvulaceae
82		*Isoglosa gregorii* (S. Moore) Lindau	Acanthaceae
83		*Isoglossa cestediana* Lindau	Acanthaceae
84		*Justicia inaequalis* Brumiff.	Acanthaceae
85		*Justicia interupta* (Lindau) C. B. CC.	Acanthaceae
86		*Justicia pinguior* (Lindau) C.B. CC	Acanthaceae
87		*Justicia pseudorungia* Lindau	Acanthaceae
88		*Kanahia laniflora* (Fowk.) R. Br.	Asclepidiaceae
89		*Keetia gueinzii* (Sonder.) Bridson	Rubiaceae
90		*Landolphia kirkii* Dyer	Apocynaceae
91		*Lasianthus glomentiferus* K. Schum.	Rubiaceae
92		*Leptactina platyphylla* (Hiern.) Vernh.	Rubiaceae
93		*Leptonychia usambarensis* K. Schum.	Sterculiaceae
94		*Liparis bowkeri* Harv.	Orchidaceae
95		*Loeseneriella africana* (Willd) N. Halle	Celastraceae
96		*Loxogramme lanceolata* (Swartz) C. Presl.	Polypodiaceae
97		*Lycopodium clavatum* L.	Lycopodiaceae
98		*Maytenus acuminata* (L.f.) Loes	Celastraceae
99		*Mellera lobulata* S. Moore	Acanthaceae
100		*Memecylon erubescens* Gilg.	Melastomataceae
101		*Memecylon procteria* A. et R. Fernandes	Melastomataceae
102		*Memecylon sansibaricum* Taub.	Melastomataceae
103		*Memecylon verruculosum* Brenan	Melastomataceae
104		*Microglosa densiflora* Hook.f.	Compositae
105		*Microsorium pappei* (Mett. Ex Kuhn.) Tard.	Polypodiaceae
106		*Milletia sacleuxii* Dunn.	Papilionaceae
107		*Mimulopsis solmsii* Schweinf.	Acanthaceae
108		*Monanthotaxis buchananii* (Engl.) Verdc.	Annonaceae
109		*Monanthotaxis poggei* Engl. & Diels	Annonaceae
110	Kivumba	*Myrica salicifolia* Hochst. ex A Rich.	Myricaceae
111	Mfuta	*Mystroxylon aethiopicum* (Thumb) Loes.	Celastraceae
112	Mnyasungu	*Ochna mossambicensis* Klotzch.	Ochnaceae
113		*Oleandra distenta* G. Kunze	Oleandraceae
114		*Oplismenus hirtellus* P. Beauv.	Gramineae
115		*Orthosiphon suffrutescens* (Thonn.) Morton.	Labiatae
116		*Ouratea scheffleri* Engl.	Ochnaceae

117	Mmbugi	*Oxyanthus speciosus* DC	Rubiaceae
118		*Panicum maximum* Jacq	Gramineae
119		*Panicum trichocladum* K. Schum.	Gramineae
120		*Pavetta bruceana* Bremek.	Rubiaceae
121		*Pavetta constipulata* Bremek	Rubiaceae
122		*Pavetta filistipulata* Brem.	Rubiaceae
123		*Pavetta gardeniifolia* var *gardeniifolia* A. Rich.	Rubiaceae
124		*Pavetta holstii* K. Schum.	Rubiaceae
125		*Pavetta hymenophylla* Brem.	Rubiaceae
126		*Pentas bussei* Krause	Rubiaceae
127		*Peperomia abyssinica* Miq.	Piperaceae
128		*Phaulopsis longifolia* T. Thoms.	Acanthaceae
129		*Pilea rivularis* Wedd.	Urticaceae
130		*Pilea usambarensis* Engl	Urticaceae
131		*Platycerium angolense* Engl.	Polypodiaceae
132	Kinyanziri	*Podocarpus usambarensis* Engl.	Podocarpaceae
133		*Polysphaeria multiflora* Hiern.	Rubiaceae
134		*Polystachya adansoniae* Reichb.f.	Orchidaceae
135		*Polystachya tesselata* Lindley	Orchidaceae
136		*Polystichum fuscopaleacum* Alston	Aspidiaceae
137		*Porterandia penduliflora* (K. Schum.) Keay.	Rubiaceae
138		*Pristimera andongensis* N. Halle	Celastraceae
139		*Pseudolachnostylis maprouncifolia* Pax.	Euphorbiaceae
140		*Pseudospondias microcarpa* (A. Rich) Engl.	Anacardiaceae
141		*Psychotria brevicaulis* K. Schum	Rubiaceae
142	Mbabala mweusi	*Psychotria griseola* K. Schum.	Rubiaceae
143		*Psychotria orophyla* Petit.	Rubiaceae
144		*Psychotria peteri* Petit	Rubiaceae
145		*Psychotria punctata* Vatke	Rubiaceae
146		*Psychotria tanganyikensis* Verdc.	Rubiaceae
147		*Psychotria usambarensis* Verdc.	Rubiaceae
148		*Pteris dentata* Forsk.	Adiantaceae
149		*Pteris usambarensis* Hieron.	Adiantaceae
150		*Pupalia cappacea* (L) Juss	Amaranthaceae
151		*Ranunculus multifidus* Forsk.	Ranunculaceae
152	Mgeremamondo	*Rapanea rhododendroides* (Gilg.) Mez.	Myrsinaceae
153	Fifi	*Rubus apetalus* Poir.	Rosaceae
154		*Rutidea orientalis* Bridson	Rubiaceae
155		*Rytigynia celastroides* (Baillon.) Verdc.	Rubiaceae
156		*Rytigynia uhligii* (K. Schum & K. Krause) Verdc.	Rubiaceae
157		*Saintpaulia* sp.	Gesneriaceae
158		*Salacia elegans* Oliv.	Celastraceae
159		*Salacia madagascariensis* (Lam) DC	Celastraceae
160		*Schefflera barteri* (Seem.) Harms.	Araliaceae
161		*Schefflera lukwangulensis* (Tennant) Bernard	Araliaceae
162		*Schizozygia coffaeoides* Baill.	Apocynaceae
163	Mwanganapalu	*Scolopia rhamniphylla* Gilg.	Flacourtiaceae
164		*Selaginella kraussiana* (Kunze) A. Abraham	Selaginellaceae
165		*Senecio syringifolius* O. Hoffm.	Compositae
166		*Solanum bifurcatum* A. Rich.	Solanaceae
167		*Solanum indicum* L.	Solanaceae
168		*Solanum kitivuensis* Dammer	Solanaceae
169		*Spirostachys africana* Sond.	Euphorbiaceae
170		*Stellaria sennii* Chiov.	Caryophylaceae
171		*Streptocarpus caulescens* Vatke.	Gesneriaceae
172		*Streptocarpus glandulosissimus* Engl.	Gesneriaceae
173		*Suregoda zanzibarensis* (Baill.) Muell. Arg.	Euphorbiaceae
174	Mngobwe	*Symphonia globulifera* L.f.	Guttiferae
175	Mmusu	*Syzygium cordatum* Hochst	Myritaceae
176		*Tacazzea apiculata* Oliv.	Asclepiadaceae

177	Lubuli	*Tacazzea galactagoga* Bullock.	Asclepiadaceae
178	Kigomvu	*Tabernaemontana ventricosa* (Hochst.) ex A.D.C.	Apocynaceae
179		*Tarrenna quadrangularis* Bremek.	Rubiaceae
180	Lugongandima	*Teclea amaniensis* Engl	Rutaceae
181	Lugongandima	*Teclea trichocarpa* (Engl.) Engl.	Rutaceae
182		*Tectaria gemmifera* (Fee) Alston	Aspidiaceae
183		*Thalictrum rhynchocarpum* A. Rich.	Ranunculaceae
184	Msingizi	*Tricalysia anomala* E.A. Bruce	Rubiaceae
185	Msingizi	*Tricalysia elegans* Robrecht	Rubiaceae
186	Msingizi	*Tricalysia myrtifolia* S. Moore	Rubiaceae
187	Msingizi	*Tricalysia ovalifolia* Hiern.	Rubiaceae
188	Msingizi	*Tricalysia pallens* Hiern.	Rubiaceae
189	Mnyagengu mweupe	*Trichoscypha ulugurensis* Mildbr.	Anacardiaceae
190		*Tylophora gracillima* Markgraf.	Asclepiadaceae
191		*Uvariodendron oligocarpum* Verdc.	Annonaceae
192		*Vepris ngamensis* Verdoon.	Rutaceae
193		*Vepris stolzii* Verdoon	Rutaceae
194	Mfulu	*Vitex doniana* Sweet	Verbenaceae
195	Mtati mweupe	*Zenkerella schliebenii* (Harms.) J. Leonard	Caesalpiniaceae