Photo: Cheplunguch wetland, North Nandi (Chesire)

Forest structure, regeneration and conservation status of Eastern Mau, Kaptagat, Lembus, North Nandi and South Nandi forests

A Progress Report

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Contents

Introduction

Forests in Kenya cover approximately 7% of the total land area, going by estimations made in the year 2010 (Chesire, 2018 citing KFS, 2013). They are mainly located within the approximately 15 % of the productive agro-ecological zones (AEZ) of the country, whereby the remainder is arid or semi-arid land. This is a low proportion compared to the total land area, and in relation to a high human population projected at about 47 million people and growing at an annual rate of 2.6%; who mainly reside in these productive AEZ (UNDP, 2017; Chesire, 2018). Sections of this human population highly depend on forest-sourced wood products as well as other non-wood forest products (NWFP). The importance of these forests also manifests in various indirect ways.

Over time spanning decades, there has been a progressive fragmentation of forests mainly due to settlement and agriculture. Harvesting of trees in these forests was also legally conducted to meet the country's timber demands and to raise revenue. However, Logging of indigenous forests in the past must have been so unsustainably exploitative and poorly managed to an alarming point that necessitated the decision of a nationwide logging ban (Chesire, 2018). Despite this ban, spontaneous illegal logging mainly by communities living near forests is continually experienced inside the reserves. Grazing and other human activities that interfere with forest growth are also common.

The extent at which the illegal harvesting, grazing of livestock and other human activities affect the forest's structure and regeneration is not yet clearly quantified or determined. In this report, the influences of these challenges are highlighted; following vegetation (trees) sampling, which were conducted between April and May 2018 in five forest reserves namely; Eastern Mau, Kaptagat, Lembus, North Nandi and South Nandi.

Objectives

This project aimed at evaluating the impacts of the continued usage (illegal logging) of the forests on their stability and their regeneration potential, with regards to the necessity of long-term sustainable utilization.

This work formed part of a M.Sc. research, which was successfully defended. Advanced details of structural characteristics and regeneration dynamics of these forests are contained in the masters thesis, which will be availed at the respective forests and later, online.

Study area

Sampling focused on five moist afromontane forests in the rift valley, west of Kenya. They occur on high altitudes and share similar climatic conditions, where mean annual rainfall is above 1500 mm and the low and high temperatures are approximately 9 °c and 20 °c respectively.

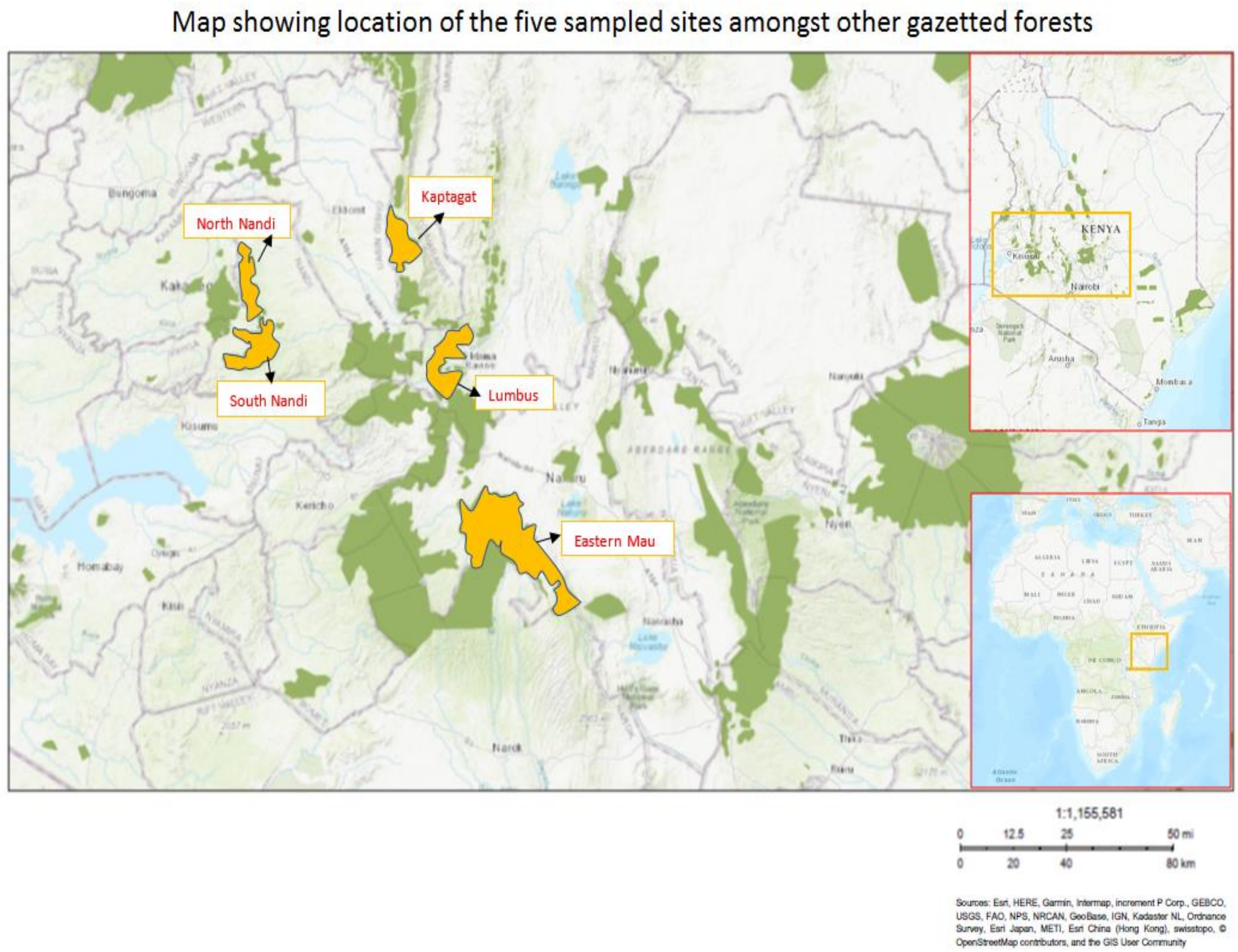

Figure 1 Map of the project sites. Source (Chesire, 2018)

Data collection and analysis

Stratified systematic sampling method was employed to capture data that could sufficiently represent each of the forests and that could also allow comparative analysis. Sampling specifically focused on trees, woody saplings and seedlings of woody species. Major data collected included tree heights, diameter at breast height (DBH), percentage crown cover, number of seedlings, number of saplings and number of indicators of disturbance. Other useful data for instance georeferencing and site description were recorded on field data sheets.

The most “important” species as well as the majorly targeted tree species that produce valuable wood products and timber were evaluated so as to tell whether they display desirable developmental transition and healthy regeneration patterns. Calculation of importance value index (IVI) informed on the most “important” trees. This information would guide forest restoration programs or inform on species specific perspective concerning their utilization, when implementing conservation measures. The information would also guide the debate on way forward for communities regarding the necessity of forest utilization for wood and NWFP. Specifically, the information is needful for designing and implementation of sustainable forest management (SFM).

From the collected data the following aspects were analyzed: - Biodiversity measures (species diversity, richness and evenness indices), species similarity and plant communities, population density of trees, saplings and seedlings; frequency and distribution ratios of trees, saplings and seedlings; important value index (IVI), tree basal area, tree population structure, height structure, DBH- height relationship, regeneration index and estimation of levels of disturbance.

Conservation roles of the forests

The five forests surveyed play very vital roles in nature protection, production and for various ecosystem services. Besides hosting other forms of biodiversity, 132 species of woody plants belonging to over 50 families were recorded from them. Highest number of tree species (77) was recorded in North Nandi whereas Eastern Mau was least diverse (33). The significance of these ecosystems’ diversity, be it low or high, has unique importance for the management, use and functionality of the forests. South Nandi, Lembus and Kaptagat, tree diversity was 58, 57 and 56 species respectively.

Some of the most frequent species included *Olea capensis, Podocarpus latifolius, Cassipourea malosana, Rapanea melanophloeos, Nuxia congesta, Allophylus abyssinicus, Syzygium guineense, Albizia gummifera, Maytenus undata* and *Macaranga kilimandscharica.*

From ground observation, the widely used tree species included *Juniperus procera, Olea sp., Podocarpus sp., Trichocladus ellipticus, Bersama abyssinica, Rhus natalensis, Scutia myrtina, Nuxia congesta, Fagaropsis angolensis and Syzigium guineense*. Extensive and selective logging of some of these species was seen to negatively affect their transitional development.

Rubiaceae (coffee family) contributed the highest number of species (figure 2). Other highly diverse plant families included Euphorbiaceae, Flacourtiaceae, Rutaceae and Araliaceae.

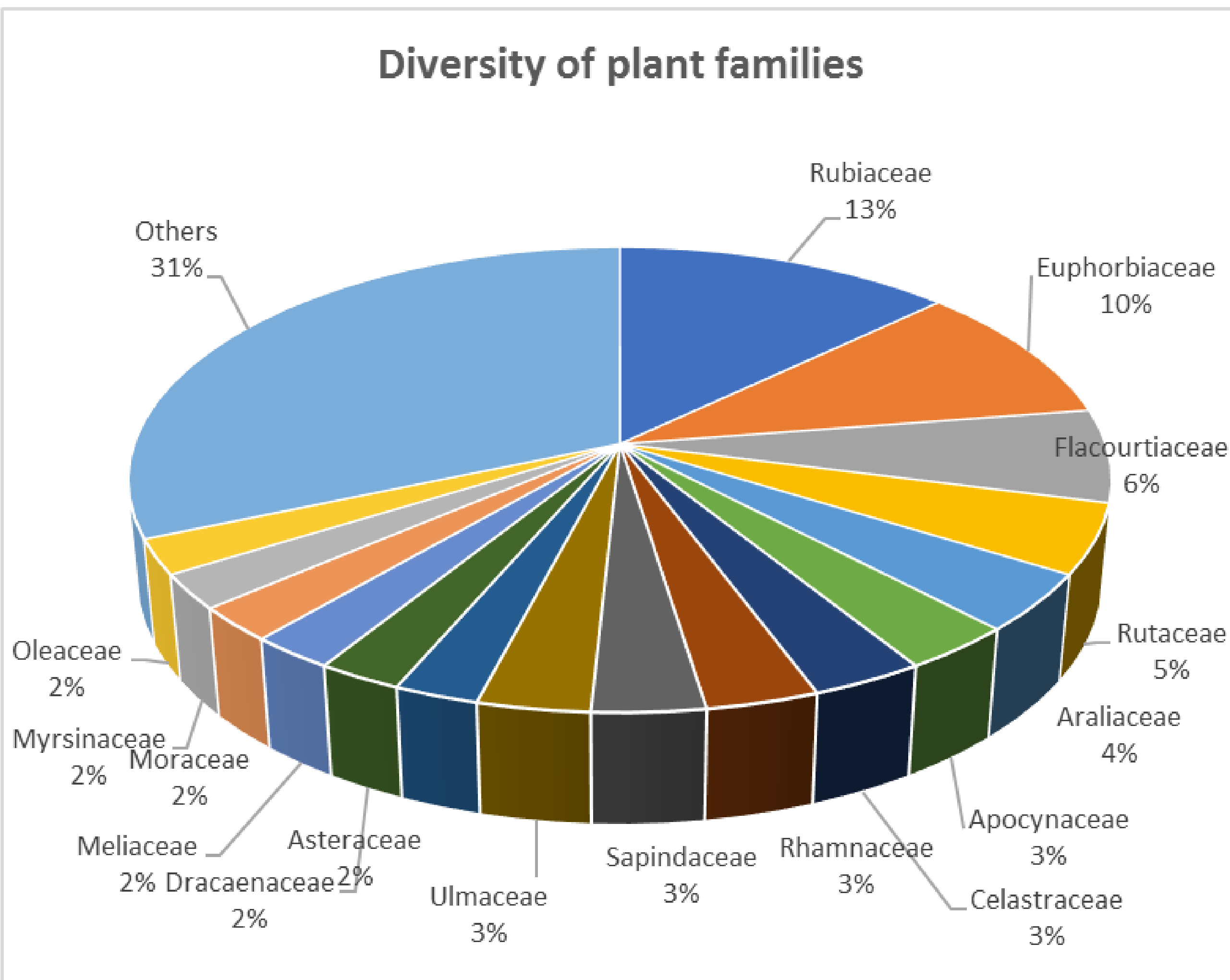

Figure 2 Diversity of plant families- source (Chesire, 2018)

Most important trees

Using an ecological measure called important value index (IVI), recorded trees were ranked by their significance, in their role of forest structure formation. The index is achieved by combining the contribution of three attributes namely, relative dominance, relative frequency and relative density. Selected 10 most important species in overall included, *Podocarpus latifolius, Juniperus procera, Podocarpus falcatus, Olea capensis, Trichocladus ellipticus, Nuxia congesta, Prunus africana, Cassipourea malosana Rapanea melanophloeos and Allophylus abyssinicus.* Their population structures were also analyzed so as to understand whether the existing (illegal) harvesting regime is negatively affecting their growth or not. Some species were affected and some were not.

Forest management and utilization

The Kenya Forest Service (KFS) may be experiencing various challenges including inadequate rangers but their presence and influence in the forests is definite. In the perception of the author, one of their greatest challenges could be striking a balance between forest protection and facilitating the genuine needs and pressure from the communities to use particular resources in the forests. For example, firewood, medicine and fodder collection; grazing of livestock and timber/wood needs are still highly sought for from indigenous forests. Some of these needs may harbor passive influence or are very essential going by traditional usage but others can possess harmful effects if not utilized in conservative means. For better control and use of forest resources, an inclusive sustainable forest management (SFM) may be the most workable solution to be adopted. In this way, necessary knowledge pertaining SFM will be appreciated by the local communities and hence, harmful practices such as over-exploitation and destructive harvesting can be substituted. Community forest associations (CFA) were noted to be actively participating in forest management. But since there can be a few exceptions, the CFA's which may be less active need to be motivated through facilitation and better involvement. One of the participatory forest management (PFM) drivers behind CFA's success is the '**Plantation Establishment and Livelihood Improvement Scheme'** (PELIS), since it is a source of livelihoods for the CFA members. In this regard, CFA's that operate in areas with limited plantations and therefore are out of PELIS need to be involved in alternative ways that can incentivize their active participation.

Other opportunities offered by the indigenous forests for instance landscapes and serenity, can be tapped for maximized utilization of the reserves and for revenue collection.

Pictures: Some assorted photos from the forests

Figure 3 Sampling in an old growth section of Kaptagat forest

Figure 4 Edible indigenous fruit tree (Dovyalis abyssinica) in North Nandi forest

Figure 5 Members of the CFA actively participating in tree planting facilitated by KFS in Sawich area of Lembus forest

Figure 6 Tree nursery with indigenous species in Kaptagat forest

Figure 7 A drive-through in Lembus forest during rain

Figure 8 Tree ferns (Cyathea manniana) in South Nandi forest

Influence of harvesting

The population structures of the most important species were analysed so as to understand whether they depict healthy transition from young tree stage to maturity, and weather existing harvesting regime is posing as challenge. The trees were categorized based on user preference, as either highly valuable or lowly valuable. It became apparent that some species especially the high value species were being affected by harvesting. Logging was seen to target specific age bracket of the tree individuals. Some species were however seen to be less affected. Details of these observations are elaborated in the thesis document (Chesire, 2018).

Forest regeneration

Seedling bank potential of the forests was also analysed. Whereas Eastern Mau was found to have the lowest number of seedlings of about 400 individuals per hectare, the other forests averaged at over 12,000. Number of saplings and that of mature trees ranged at similar densities, meaning that there is a poor transition rate from seedling into sapling stage.

Conservation state

It was found out that the common indicators of disturbance such as logging and livestock grazing was rampant and present in a greater majority of the sampled area of the five forests. Heavy past logging was also recorded in some areas, going by the aged stumps observed.

Pictures: Some of the noted disturbances in the forests

Charcoal kiln

Logging targeting easy-to-carry stems

Fresh Logging

Past logging affects present-day tree composition

Key observations and recommendations

There is a potential risk of future population destabilization among some of the most important species due to the current selective logging of individuals belonging to specific age brackets. A management plan that is aimed at stabilizing the population of these species across the various age groups should be considered. The plan could include species-specific protection or communities-targeted sensitization that could discourage over-utilization of the species, particularly of the vulnerable ages.

Heavy grazing of livestock within the reserves was blamed on poor seedling survival. Other speculative ecological or environmental factors could also be affecting the seedling survival. Control of livestock grazing and strict zonation among other alternative remedies may be adopted by the forest management, in consultation with the resident communities.

Past logging was also observed to be causing great destabilization of the forest formation as well as alteration of species composition. Silvicultural approaches may be used to restore former vegetation types, improve plant community combinations and to enhance the populations of specific species noted for poor regeneration.

Population of the lone indigenous bamboo species (*Sirarundinaria alpina*) was noted to be dwindling in its native sites in Eastern Mau, Kaptagat and Lembus forests. The two former forests are by far extent affected more and the situation may be 'catastrophic' because the species as observed, is on the path of extermination. Evidence of past massive clear cut and burning of bamboo sites in Eastern Mau was recorded but unlike the other forests, regeneration was active there.

Sustainable forest management (SFM) may become one of the most effective form of management that safeguards community needs and at the same time enhancing forest conservation. Based on the analysis of forest production, valuable trees within the merchantable bracket contribute the highest basal areas and potentially, high timber volumes. However, the production sufficiency may need monitoring and evaluation. This can be done through introduction of small scale SFM trial plots in selected forests to be managed under silvicultural treatments, and monitored over a reasonable period.

References

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Appendix- Checklist of woody species

Species	Family	Eastern Mau	Kaptagat	Lembus	North Nandi	South Nandi
Afrocrania volkensii (Harms) Hutch.	Cornaceae	×				
Albizia gummifera (J.F.Gmel.) C.A.Sm.	Mimosaceae		×	×	×	×
Alchornea hirtella Benth.	Euphorbiaceae					×
Allophylus abyssinicus (Hochst.) Radlk.	Sapindaceae	×	×	×	×	×
Baissea multiflora A.DC.	Apocynaceae					×
Bersama abyssinica Fresen.	Melianthaceae	×	×	×	×	×
Bridelia micrantha (Hochst.) Baill.	Euphorbiaceae				×	×
Caesalpinia decapetala (Roth) Alston	Caesalpiniaceae				×	
Calodendrum capense (L.f.) Thunb.	Rutaceae			×		
Canthium oligocarpum Hiern	Rubiaceae		×			
Casearia battiscombei R.E.Fr.	Flacourtiaceae			×	×	×
Cassipourea malosana (Baker) Alston	Rhizophoraceae		×	×	×	×
Cassipourea ruwensorensis (Engl.) Alston	Rhizophoraceae				×	
Celtis gomphophylla Baker	Ulmaceae					×
Celtis africana Burm.f.	Ulmaceae			×	×	×
Celtis mildbraedii Engl.	Ulmaceae				×	×
Cestrum aurantiacum Schltdl.	Solanaceae		×			
Chionanthus mildbraedii (Gilg & Schellenb.) Stearn	Oleaceae				×	
Coffea eugenioides S.Moore	Rubiaceae				×	
Croton megalocarpus Hurch.	Euphorbiaceae				×	×
Croton macrostachyus Delile	Euphorbiaceae			×	×	×
Cussonia holstii Harms ex Engl.	Araliaceae		×			
Cussonia spicata Thunb.	Araliaceae		×	×		
Cyathea manniania Hook.	Cyatheaceae					×
Deinbollia kilimandscharica Taub.	Sapindaceae				×	×
Diospyros abyssinica (Hiern) F.White	Ebenaceae			×	×	×
Dombeya torrida J.F.Gmel.(Bamps)	Sterculiaceae	×	×	×		
Dovyalis macrocalyx (Oliv.) Warb.	Flacourtiaceae				×	×

Dovyalis abyssinica (A.Rich.)Warb.	Flacourtiaceae		×	×	×	×
Dracaena steudneri Engl.	Dracaenaceae				×	×
Drypetes gerrardii Hutch.	Euphorbiaceae					×
Ehretia cymosa Thonn.	Boraginaceae			×	×	×
Ekebergia capensis Sparrm.	Meliaceae		×	×		×
Erythrococca bongensis Pax	Euphorbiaceae				×	×
Erythrococca fischeri Pax	Euphorbiaceae		×	×		×
Euclea divinorum Hiern	Ebenaceae		×	×		
Fagaropsis angolensis (Engl.) Dale	Rutaceae				×	
Faurea saligna Harv.	Proteaceae		×			
Ficus sur Forssk.	Moraceae					×
Ficus thonningii Blume	Moraceae		×	×		
Flacourtia indica (Burm.f.) Merrill	Flacourtiaceae				×	
Galiniera saxifraga (Hochst.) Bridson	Rubiaceae		×			
Gouania longispicata Engl.	Rhamnaceae				×	×
Hagenia abyssinica (Bruce) J.F.Gmel.	Rosaceae	×				
Halleria lucida L.	Scrophulariaceae		×			
Heinsenia diervilleoides K.Schum.	Rubiaceae				×	×
Hippocratea africana (Willd.) Loes.	Celastraceae					×
Ilex mitis (L.) Radlk.	Aquifoliaceae	×				
Juniperus procera Endl.	Cupressaceae	×	×	×		
Kigelia africana (Lam.) Benth.	Bignoniaceae					×
Landolphia buchananii (Hallier f.) Stapf	Apocynaceae				×	×
Lepidotrichilia volkensii (Gürke) J.-F.Leroy	Meliaceae			×	×	×
Macaranga kilimandscharica Pax	Euphorbiaceae			×	×	×
Maesa lanceolata Forssk.	Myrsinaceae					×
Maytenus heterophylla (Eckl. & Zeyh.) N.Robson	Celastraceae	×	×	×		
Maytenus senegalensis (Lam.) Exell	Celastraceae		×			
Maytenus undata (Thunb)Blakelock	Celastraceae	×	×	×		
Mimulopsis arborescens C.B. Clarke	Acanthaceae					×

Mimulopsis solmsii Schweinf.	Acanthaceae					×
Myrica salicifolia Hochst. ex A.Rich.	Myricaceae	×				
Neoboutonia macrocalyx Pax	Euphorbiaceae				×	×
Nuxia congesta Fresen.	Loganiaceae	×	×	×		
Ochna insculpta Sleumer	Ochnaceae				×	
?*Ocotea usambarensis* Engl.	Lauraceae			×		
Olea capensis L.	Oleaceae	×	×	×	×	×
Olea europaea L.	Oleaceae	×				
Olinia rochetiana A.Juss.	Oliniaceae	×	×	×		
Oncoba spinosa Forssk.	Flacourtiaceae					×
Oxyanthus speciosus DC.	Rubiaceae				×	
Pittosporum viridiflorum Sims	Pittosporaceae		×			
Podocarpus falcatus Mirb.	Podocarpaceae		×	×		
Podocarpus latifolius (Thunb.) Mirb.	Podocarpaceae	×	×	×		
Polyscias fulva (Hiern) Harms	Araliaceae				×	×
Polyscias kikuyensis Summerh	Araliaceae		×	×		
Prunus africana (Hook.f.) Kalkman	Rosaceae	×	×	×	×	×
Psychotria orophila Petit	Rubiaceae					×
Psychotria mahonii C.H.Wright	Rubiaceae				×	
Psydrax parviflora (Afzel.) Bridson	Rubiaceae		×			
Psydrax schimperiana (A.Rich.) Bridson	Rubiaceae			×		
Rapanea melanophloeos (L.) Mez	Myrsinaceae	×	×	×		
Rhamnus prinioides L'Herit	Rhamnaceae		×	×		
Rhus natalensis Krauss	Anacardiaceae	×	×	×		
Ritchea albersii Gilg	Capparaceae				×	×
Schefflera volkensii (Engl.) Harms	Araliaceae	×				
Scolopia theifolia Gilg	Flacourtiaceae		×			
Scutia myrtina (Burm.f.) Kurz	Rhamnaceae	×	×	×	×	
Solanacio manii (Hook.f.) C. Jeffrey	Asteraceae			×		×
Solanum mauritianum Scop.	Solanaceae			×	×	×
Strombosia scheffleri Engl.	Olacaceae			×	×	×

Syzygium guineense (Willd.) DC.	Myrtaceae		×	×	×	×
Tabernaemontana stapfiana Britten	Apocynaceae			×	×	×
Tiliacora funifera (Miers) Oliv.	Menispermaceae					×
Toddalia asiatica (L.) Lam.	Rutaceae			×		
Trichocladus ellipticus Eckl. & Zeyh.	Hamamelidaceae		×	×		
Trilepisium madagascariensis DC.	Moraceae					×
Trimeria grandifolia (Hochst.) Warb	Flacourtiaceae		×			
Turraea holstii Gürke	Meliaceae				×	×
Urera hypselodendron (A.Rich.) Wedd.	Urticaceae	×		×	×	×
Vangueria apiculata K. Schum.	Rubiaceae				×	
Vangueria volkensii K.Schum.	Rubiaceae		×	×	×	×
vepris nobilis (Delile) Mziray	Rutaceae		×		×	
Vepris simplicifolia (Engl.) Mziraj	Rutaceae			×		
Warburgia ugandensis Sprague	Canellaceae			×		
Xymalos monospora (Harv.) Warb.	Monimiaceae		×			×
Zanthoxylum gilletii (De Wild.) P.G.Waterman	Rutaceae					×