The Biodiversity of Mont Kinguié

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The biodiversity of Mont Kinguié

Preliminary results and observations

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Missouri Botanical Garden
Gabon 2006

Prologue

Missouri Botanical Garden was awarded a Central African Regional Program for the Environment (CARPE) subcontract from the Smithsonian Institute (SI) to perform a series of tasks.

These tasks were defined accordingly:

1. Draft analysis of the Monts de Cristal work

2. Publication of new species discovered during the Monte Mitra work

3. A biodiversity assessment of Ivindo NP, and training of a para-taxonomist.

4. Participation and contribution to a capacity building workshop

5. Training of para-taxonomists in Waka NP

During this fiscal year Missouri Botanical Garden (MBG) has carried out two botanical missions to Ivindo NP, assessing the plant biodiversity of Mt Kinguié and Langoué Bai. The results and observations of the first mission to Mt Kinguié are presented here (task 3).

The results and conclusions here presented are preliminary in the sense that the full identification of the plants is still pending.

The author is a specialist in the Pleistocene Refuge Forest theory, in vegetation-climate dynamics and expert in the plant biodiversity of Gabon and central Africa.

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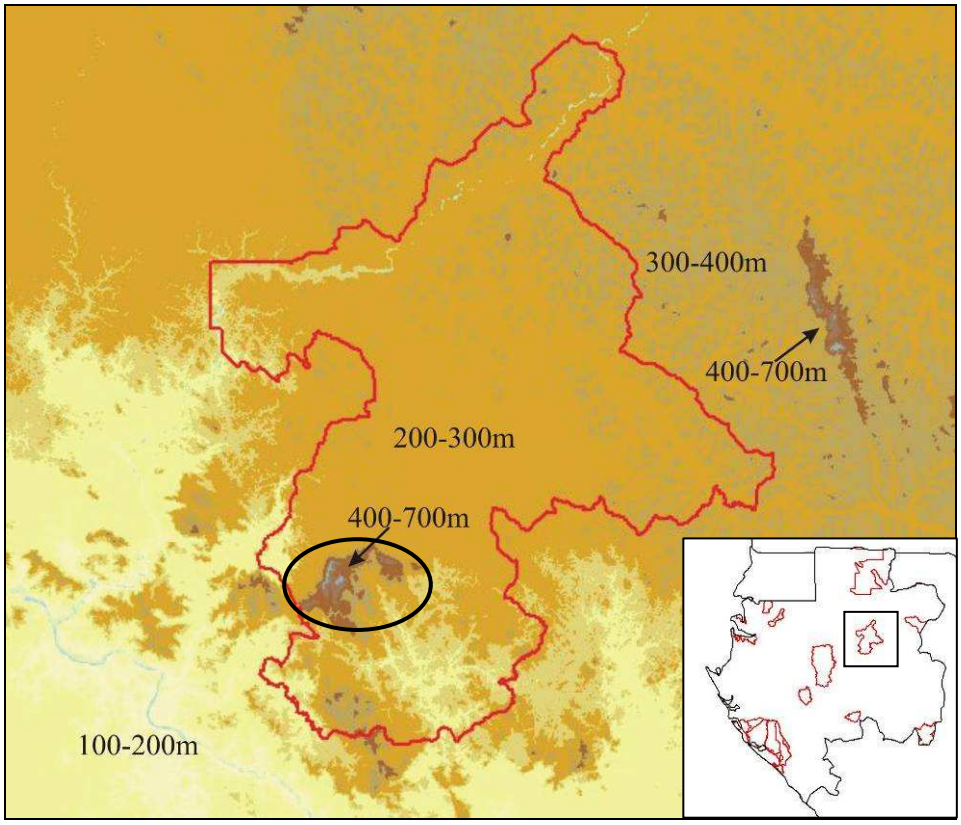
September 2006

The biodiversity of Mont Kinguié



The topography of Ivindo NP and study site (encircled)

The Ivindo Plateau

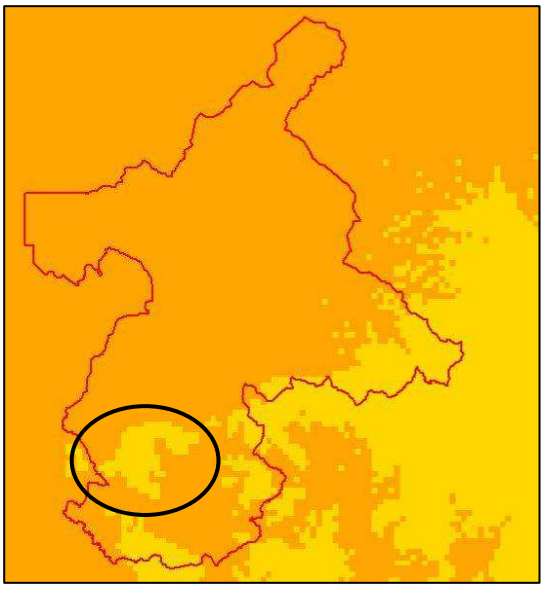
Ivindo National Park is part of the interior plateau and it is topographically flat with an altitude not exceeding more than 300m. The only two exceptions in and close to the park is the Ivindo Plateau with Mt Kinguié in the SW in the park and the Belinga Hills east of the park (see above).

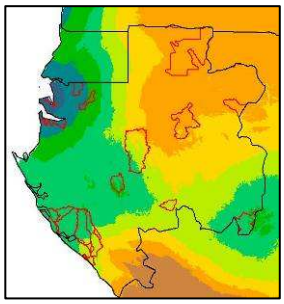
Both uplands lay isolated within the interior plateau and such a geographical position may potentially predict higher levels of endemism compared the flatter surrounding lowland, i.e. species only found on those isolated uplands.

The Ivindo plateau is botanically not very well known, but the Belinga Hills have been studied for many years by French botanists in the past. Their botanical efforts show that many species collected in Belinga Hills have not been found anywhere else in Gabon. This may also be true for the Ivindo plateau, but this needs to be verified by collecting trips.

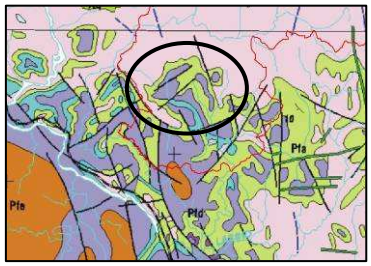
These upland species are often restricted to the hills, because of a prevalent difference in environment. These hills being higher than the surrounding lowland often receive more moisture which creates wetter circumstances.

Often such hills consist of harder rock-formations which erode less quickly and create particular substrate conditions. These are conditions which require a special adaptation of plant species, like iron core or ultra-basic rocks.





◀ **Mean rainfall over Gabon, (gradient from blue-green-orange= wet to dry) showing that north-eastern interior plateau is one of the drier areas in the country.**



◀ **Geological formations in the southern part of Ivindo NP which extent further south.**

▲
Ivindo NP (red line) showing the difference of mean annual rainfall between the plateau with Mt Kinguié (encircled in black) and the surrounding lowland.

Patterns of Biodiversity

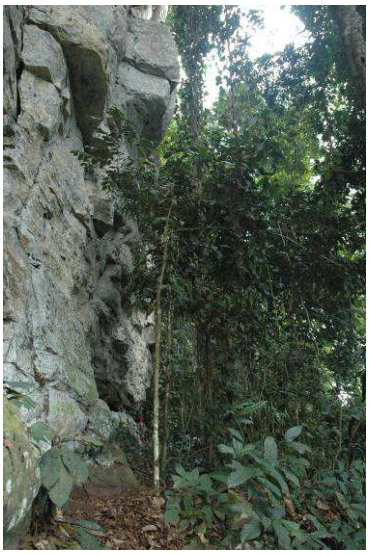
Species are not distributed at random within the rain forest and as already mentioned except for common species most other species are restrained to a certain habitat or environment. Within such a geographically bound environment, e.g. the hills mentioned only the most competitive species will be able to co-exist. The repeated co-occurrence of species at a spatial scale is an indication for underlying environmental arranging forces.

Mean annual rainfall is one of the stronger forces arranging species distributions when there is little topographical change, like for the flattish Ivindo NP. Under these circumstances species will show a gradual increase or decrease in abundance with the rain fall gradient. This may be the case for the interior plateau of Gabon, including Ivindo NP (see small map top left).

The only exception is the Ivindo plateau which sticks out and receives more rainfall (see big map above). Because of its higher altitude it also, it is able to intercept rainfall from higher clouds. This also known as the orographic effect and it creates a local anomaly within the regional gradient.

Geology is also a force which is able determine species distributions. Different geological formations create different substrates. Ivindo NP consists of two main rock formations (see above small map bottom). The Ivindo plateau consists of a different rock formation (all except pink) than the lowland to the north (pink).

The Ivindo plateau is different in environment both geologically and in terms of rainfall. Therefore, by the means of transects species composition was recorded below the plateau and on the plateau at different sites.



A rare occasion that one has a clear view over the rain forest, taken from above the cliffs

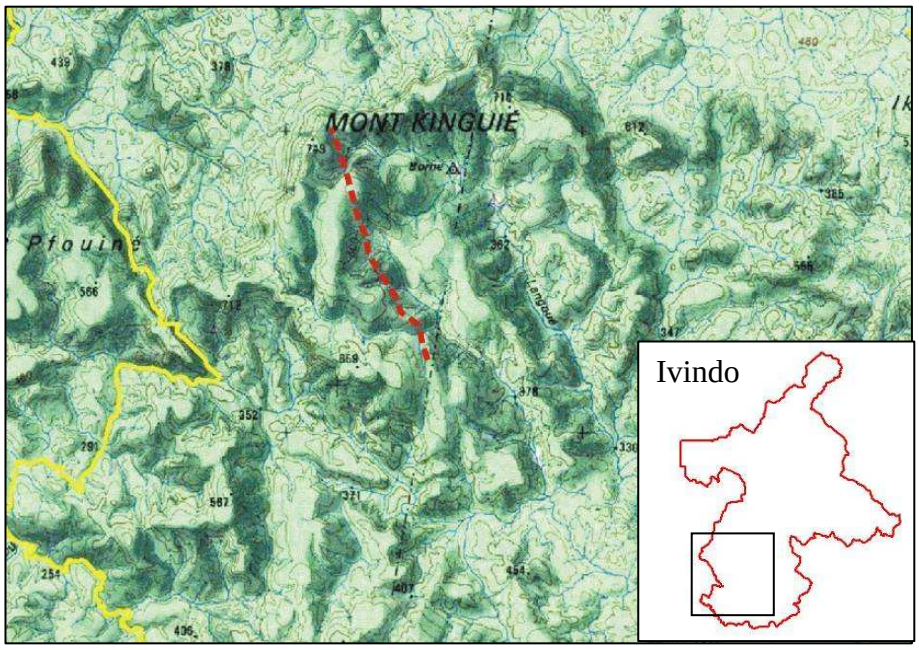
The latter is necessary because there is a phenomenon, known as “ecological drift”, where the species composition of the forest changes without a distinctive change in environment. These changes in species abundances over a relatively short distance (<2 km) are attributed to population fluctuations but over longer distances (>10km) depending on topography may reflect forest history since the last ice age.

A gab in the forest due to hard bedrock at the surface

Mont Kinguié

Mont Kinguié is the highest part of the plateau reaching an altitude of 700m. There is no clear top as this part of the plateau is slightly inclined towards the south. The soils are shallow; the bed rock is close to the surface and impermeable, but cracks in the rock formations cause the streams to go underground and surface else where. The environmental circumstances on the plateau are varied. In depressions on the plateau where drainage is low marshes develop, whereas higher on the plateau where dry conditions prevail due to rocks surfacing gabs in the closed forest cover occur.

A marsh on the plateau



A map showing the geographical position of the site, to the north the plateau end in cliff faces

Results

Species richness

The total recorded species was 161 species which is relatively low compared to the Monts de Cristal and Waka sites. But these latter sites are among most species rich in central Africa.

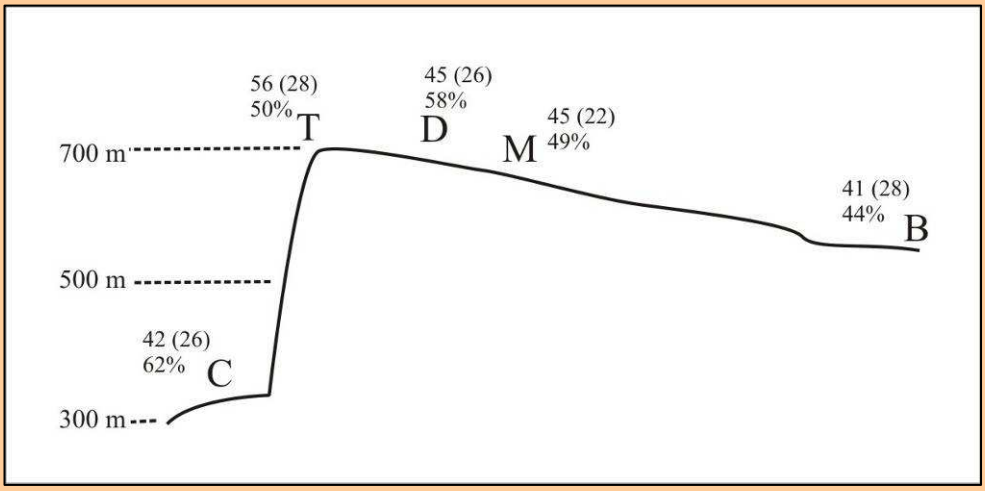
The transect on Mont Kinguié was the most species rich (56 species). The transects below the cliffs and at the bottom of the plateau were least species rich (42 and 41 species, respectively). The transect in the open area was despite the drier circumstances equally species rich as the one in the middle (each 45 species).

Species turnover

The level of "endemism" is defined here as the number of species restricted to a single transect. This number depends on the total number of transects in a site. A small number of transects will overestimate the level of endemism. When more transects will be put in the same site more species will turn out to be less restricted to a single transect.

The proportion of species which changes from transect to transect is also known as species turnover. Species turnover can change with environment, like altitude, but also with distance which is a non-environment factor. The latter is not well understood, but it has a strong influence on the turnover rate; the larger the distance the larger the turnover.

The absolute number of transect-endemics is fairly constant among the transects on average 26 species, ranging from 22 to 28. Species turnover is on average is 53%. It is lowest at the bottom transect (B) 44% and highest at the other end below the cliffs, 62%.



Profile of the plateau showing the distribution of the transects (C, T,etc), the figures at each transect are the total number of species, between brackets the number of species restricted to that transect (endemic) and the percentage. C: cliff, T: top Mt Kinguié, D: dry, M: middle, B: bottom.

Methods

The transects used to record species composition were 200 m long and 5 m wide. Every individual with a diameter at breast height (dbh) of 5 cm and greater was recorded and identified. For each species which remained unidentified a voucher specimen was taken for further examination in the herbarium of Libreville or Wageningen. Often these specimens were without flowers or fruits in which case species were identified only on sterile e.g. leaf characteristics. Such identifications are less confident and revered to as morpho-species.

One transect were placed below the cliffs at 300m (C) and 4 transects along the very gentle slope of the plateau from 700m at the top (T) to the bottom (B) a few km further away at 450m with one transect in the middle (M). One transect was put in around an open area in the forest (D). Transects were put in after the altitudinal zone was prospected to estimate the heterogeneity of the environment, and habitat diversity. This procedure ensures to record maximum species diversity present within a certain altitudinal zone and avoids replication, i.e. transects with a similar species composition.

General characteristics

In total species 161 (morpho-) species were recorded on the 5 transects. On average 46 species were recorded per transect. The lowest number was 41 species at the far end of the cliffs and the highest number was 56 species on the top of Mont Kinguié at 700 m. The vast majority of the 130 species (81%) were restricted to a single transect.

	mid	dry	cliff	top	bottom
mid		0.571	0.457	0.429	0.634
dry	0.571		0.2	0.486	0.333
cliff	0.457	0.2		0.486	0.486
top	0.429	0.486	0.486		0.512
bottom	0.634	0.333	0.486	0.512	

Similarity between the transects was calculated by using the Sørensen index. Sørensen index is $S_{12}/[0.5(S_1+S_2)]$ where S_{12} is the number of shared species between two transects and S_1 is the total number of species in transect 1 and similarly S_2

Similarity index values

Another way of measuring species turnover is by calculating the similarity between transects. In this case the Sørensen index was used. This index does not overestimate the absence of species, which in the case of 5 transects is a better measure. In calculating the index only species present in more than one transects was used. Using all species would have resulted in very low similarities which would obscure any relationship between the transects.

The highest similarity in species composition is found between the Bottom transect and the Middle transect (0.634 or 63.4%). The lowest similarity exists between the Dry and Cliff transect (20%). The Top transect shows equal similarity with the Cliff and the Dry transect (48.6%) but a lower similarity with the Middle transect (42.9%) and a higher similarity with the Bottom transect (51.2%).

Local diversity

Alpha diversity is a measure of local species diversity. It also takes into account differences in the number of individuals recorded per standard sampled area, because with more individuals there is also a higher change in more species.

Local diversity (alpha) is highest on the Dry transect with a value of 33.4 and lowest on the Bottom transect (28). Alpha diversity is equally high on the highest part of the plateau on the Top transect and just below it at the bottom of the cliffs on the Cliff transect 32.8 and 32.4, respectively. The Middle transect has an intermediate value of 31.4. From transect to transect alpha diversity does not change dramatically and is on average 31.6.

Overall the Top transect has the highest species (56), the highest number of endemics (28) and second highest alpha value (32.8). It is closed related to the most distant Bottom transect, least related to the nearest Middle transect and equally related to the two most extreme transect Cliff and Dry transect, which are least related. Except for the Top and Cliff transects, the other transect are strongly dominated by a single species.

161	**Cliff**	**Top**	**Bottom**	**Mid**	**Dry**
n	86	148	93	100	95
s	42	56	41	45	45
fisher-alpha	32.4	32.8	28.0	31.4	33.4
end	26	28	18	22	26
end%	61.9	50.0	43.9	48.9	57.8

Alpha-diversity is the index for species richness calibrated for individuals.

Discussion

There is no clear distinction between the transects on and of the plateau or the transect with locally drier conditions (transect D). Hence, the difference in rainfall on and of the plateau does not create a very different environment to cause differences in species composition. Another hand transects on the plateau tend to most similar two the transects nearest to one other, i.e. B-M-D-T. The fact that the forest of transect D is situated around the gab does not seem to cause very big differences.

Data from the second mission around Langoué Bai and camp may shed some more light on what determines the species composition of the forest on the plateau. The observation that the forest in the lowland around the plateau is not very distinctive from the forest on the plateau may be partially explained by the seed rain from the seed rain from the plateau. Similarity between transects is however overestimated since the transect endemics were not included in the calculation, and this should not obscure the observation that the endemism on and close to the plateau is high, which is characteristic for isolated hills or plateaus.

Conclusions

This study was carried out to find out how distinctive the species composition on the plateau was compared to the surrounding lowland and whether it was a centre of endemism comparable to the Belinga Hills east to the Ivindo Park. Alpha diversity is intermediate compared to other sites in Central Africa. Also total species richness and species richness per transect is lower compared to Monts de Cristal and Waka, but the percentage of endemism is high with over more than 80% of the total species restricted to a single transects. This is higher than observed in Monts de Cristal and Waka. The difference in rainfall or geology between the plateau and surrounding lowland do not clearly create a very different environment which causes a distinct change in the species composition. More data from the plateau and lowland are needed to gain more insight what triggers species distributions.

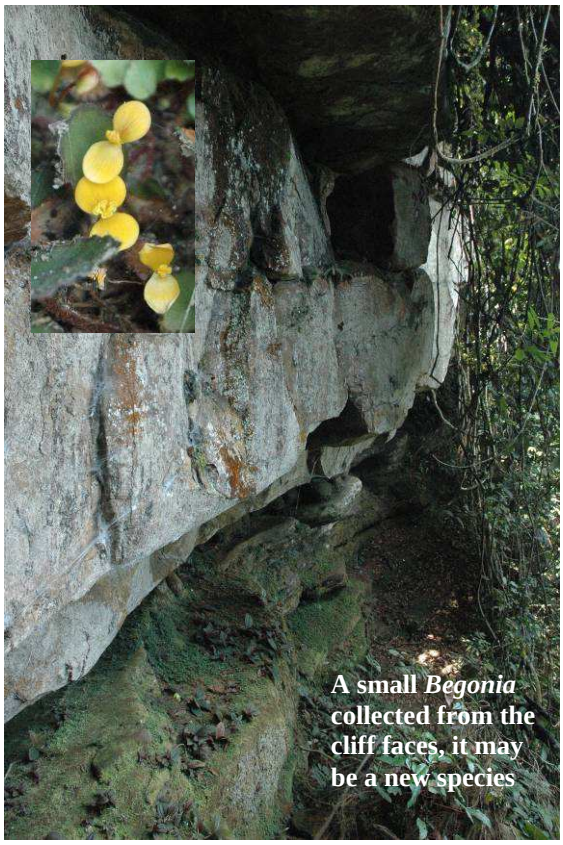
General collecting

In between the transects plants were collected to obtain more information on plant biodiversity in general. Botanically the plateau is still fairly unknown and the only collecting in the past took place around the Langoué Bai. Full identification of the collected specimens is still ongoing, but already a new species has been found *Baphia megaphylla*. The status of a potentially new *Begonia* is still pending.

As already mentioned isolated hills and plateaus may harbor a higher level of endemism than the surrounding lowland. To obtain more botanical information from the Ivindo plateau, a WCS field assistant was trained in collecting plants. His near permanent presence in the research camp will allow collecting plants year around.

The Belinga Hills east of the Ivindo NP have already proven that they are special in terms of endemism. For the Ivindo plateau such detailed botanical information is yet unavailable, but with time as the para-taxonomist is active in the area is will change.

During this mission a rather peculiar *Baphia* was collected. Back in the herbarium of Wageningen in the Netherlands the specialist was able to tell that this was a new species only found in around the southern part of the Ivindo NP, which he will soon publish; *Baphia megaphylla*



A small *Begonia* collected from the cliff faces, it may be a new species

Acknowledgements
This project was funded by USAID's Central African Regional Program for the Environment and the Smithsonian Institution in collaboration with the Wildlife Conservation Society, the Herbier National, and Ivindo National Park. The project thanks the following for their support: Ludovick Ngok Banak, Madame Koumba, Lee White, Nigel Orbel, and Ruth Starkey. Photo's were taken by Miguel Leal. Fieldwork was assisted by Diosdado Nguema, Prince Bissimou, Etienne Mounoumoulossi, and Alain Moundounga.

Appendix 1

Species	C	T	B	M	D
Neochevalierodendron stephanii	2	1	8		
Greenwayodendron suavelens	1	3	1		
Diogoa zenkeri	13	2	1	3	
Scorodophloeus zenkeri	6		2	1	
Plagiostyles africana	4		3	1	
Strombosia pistulata	4	1		1	
Santiria trimera	2	7	6	6	1
Coula edulis	3	3	4	1	2
Diospyros iturensis	2	18	1	3	8
Diospyros melocarpa	2		1	3	2
Oddoniodendron micranthum	1	10		1	2
Tessmannia africana		2	1		1
Gilletiodendron pierreanum		2		5	4
Centroplacus glaucinus		1		5	1
Fillaeopsis discophora		2	1	1	
Tetraberlinia bifoliolata		4	1	2	
Dialium pachyphylium			3	1	4
Oncoba glauca			1	1	1
Crudia gabonensis	3	3			
Hypodaphnis zenkeri	3	1			
Bikinia pellegrinii		2	2		
Aphanocalyx margininervatus		2	1		
Mareyopsis longifolia		6	4		
Trichoscypha oddonii		1	1		
Anthonotha cf lamprophylla			1	1	
Masularia acuminata			2	2	
Calpocalyx dinklagei			7	4	
Craterispermum 30b				4	1
Klaineanthus gabonii				1	1
Afrostyrax lepidophylus	6		1		
Scyphocephalium mannii	1		1		
Dacryodes normandii	2			1	
Sorindeia cf juglandifolia		1		2	
Enantia chloranta		1		2	
Hymenostegia mundungu		1			4
Aphanocalyx cynometroides		5			1
Diospyros hoyleana		1			2
Xylopia aetiopica		1			1
Millettia laurentii		1			1
Tessmannia lescrawetii		5			1
Aphanocalyx microphyllus		4			1

Common species

Appendix 2

Endemics on transects Cliff, Top and Bottom

Species	C
Panda oleosa	3
Tabernaemontana crassa	3
Annonaceae 32b	2
Alstonia boonei	1
Annonaceae 32a	1
Anthonotha 32d	1
Beilchmiedia 32b	1
Canarium schweinfurthii	1
Carapa 32c	1
Chytranthus talbotii	1
Dacrydes klaineana32b	1
Dacryodes heterotricha	1
Dactyladenia bellayana	1
Diospyros mannii	1
Drypetes 32b	1
Duboscia macrocarpa	1
Entandrophragma utile	1
Uvariastrum pierreanum	1
Chrysophyllum boukokoense	1
Napoleonaea vogelii	1
Octolobus spectabilis	1
Pausinystalia macrocera	1
Prioria oxyphylla	1
Pycnanthus angolensis	1
Tricoschypha acuminata	1
Xylopia parvifolia	1

Species	T
Drypetes 33a	9
Gilbertiodendron dewevrei	5
Synsepalum 33a	4
Synsepalum congolense	7
Anthonotha 33d	2
Calpocalyx 33c	2
Cleistanthus polystachyus	2
Pentadesma grandifolia	2
Pinacopodium 33c	2
Sorindeia winkleri	2
Synsepalium 33a	2
Xylopia staudtii	2
Beilchmiedia 33c3	1
Beilschmiedia calcitranthera	1
Placodiscus 33d	1
Dialium angolense	1
Diospyros simulans	1
Drypetes 33a3	1
Drypetes 33c	1
Eriocoelum kerstingii	1
Garcinia mannii	1
Maranthes kerstingii	1
Odjiendjia gabonensis	1
Plagiosiphon gabonensis	1
Sorindeia 33b	1
Sorindeia gabonensis	1
Xylopia milbraedii	1
Uvariastrum cf pynaertii	1

Species	B
Aulacocalyx subata	12
Hymenostegia neoaubrevillei	6
Aucumea klaineana	4
Dialium angolense	3
Afrostyrax camerunensis	1
Bikinia grisea	1
Bikinia evrardii	1
Carapa cf parviflora	1
Dialium corbisieri	1
Irvingia gabonensis	1
Mareya cf brevipes	1
Marquesia exelsa	1
Pausinystalia johimbe	1
Pentacletra advedeana	1
Pterocarpus soyauxii	1
Sapindaceae 34d	1
Pseudospondias longifolia	1
Warneckea sapinii	1

Appendix 2 (continued)

Species	M
Baphia opsis30a	18
Dialium guineense	3
Drypetes 30c	3
Baphia buethneri	2
Berlinia auriculata	2
Diospyros zenkeri	2
Euphorbiaceae 30a	2
Newtonia glandulifera	1
Baphia 30c	1
Baphia 30d	1
Bikinia le-testui	1
Coelocarion preusii	1
Citropsis cf gabunensis	1
Drypetes cf gilgiana	1
Eriocoelum macrocarpum	2
Euphorbiaceae 30c	1
Garcinia 30b	1
Garcinia conranana	1
Irvingia grandifolia	1
Pentacletra macrophylla	1
Sapi 30a	1
Cf Sibangea arborecens	1

Endemics on transects Middle and Dry

Species	D
Plagiosiphon cf emarginatus	12
Cola cf acuminata	4
Drypetes 31b	3
Hymenostegia felicis	3
Manilkara obovata	3
Rubiaceae 31b	3
Synsepalum 31b	3
Newtonia griffoniana	2
Aulococalyx jasminiflora	2
Baphia 31c	2
Baphiopsis 31a	2
Beilschmiedia klainei	2
Garcinia aff.brevipedicellata	2
Aphanocalyx heitzii	1
Drypetes 31c	1
Eriocoelum 31d	1
Inc 31b	1
Lecontedoxa klaineana 31b	1
Rubiaceae 31a	1
Sapindaceae 31b	1
Cf Chytranthus edulis	1
Synsepalum 31a	1
Strephonema 31a	1
Strombosiopsis tetandra	1
Trichoscypha cf ealaensis	1
Xylopia rubescens	1