The biodiversity of Monte Mitra

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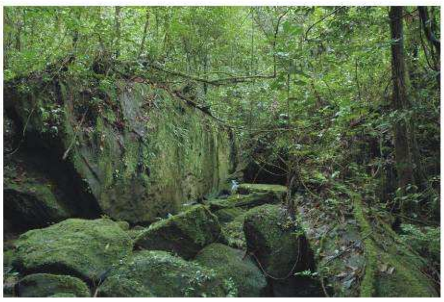

Missouri Botanical Garden

The biodiversity of Monte Mitra

Preliminary results and observations

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Prologue

Missouri Botanical Garden was awarded a Central African Regional Program for the Environment (CARPE) subcontract from the Conservation International (CI) to perform a biodiversity assessment (RAP).

During this fiscal year Missouri Botanical Garden (MBG) has executed botanical activities in the Pleistocene forest landscape assessing the plant biodiversity of the Monte Mitra. The first results and observations are presented here.

The conclusions drawn from this biodiversity assessment in combination with a GIS-analysis will help to identify areas with similar physio-geographical characteristics as Mt Mitra outside the park system worth to protect in the future.

The results and conclusions here presented are preliminary in the sense that the full identifications of the plants are still pending. Also the scientific rigor of the conclusions drawn is constrained by the limited number of transects, but general trends are clear and useful for conservation management.

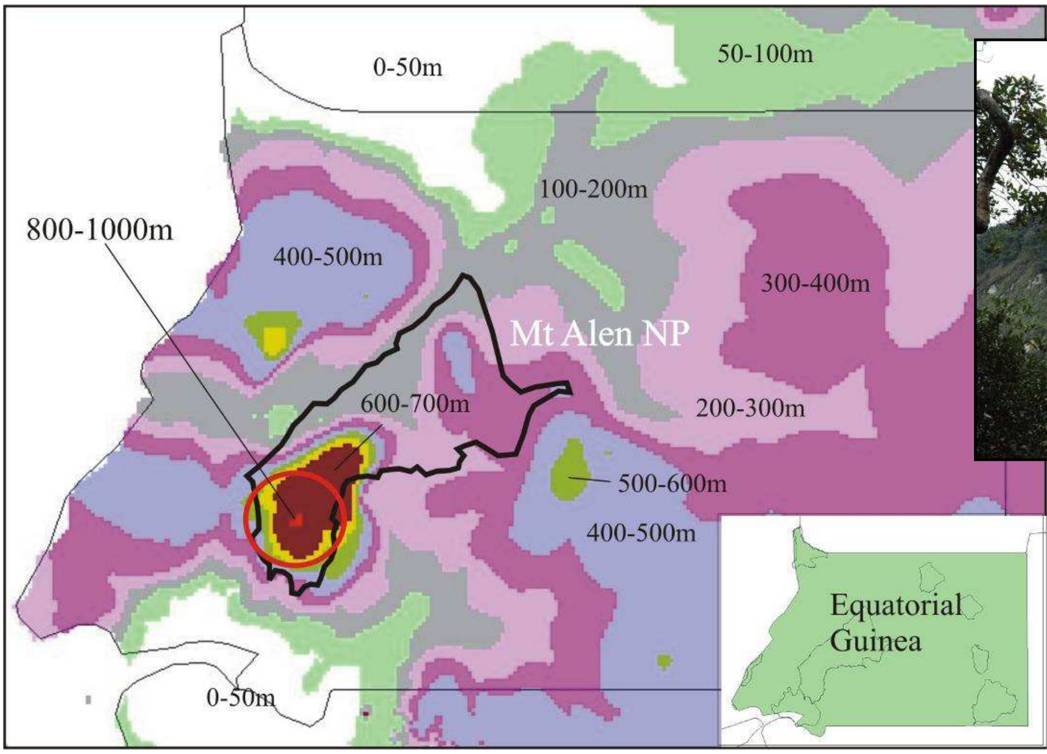
The author is a specialist in the Pleistocene Refuge Forest theory, a connoisseur in vegetation-climate dynamics and expert in the plant biodiversity of Gabon and central Africa.

Miguel E. Leal

October 2005

The biodiversity of **Monte Mitra**

Monte Alen National Park

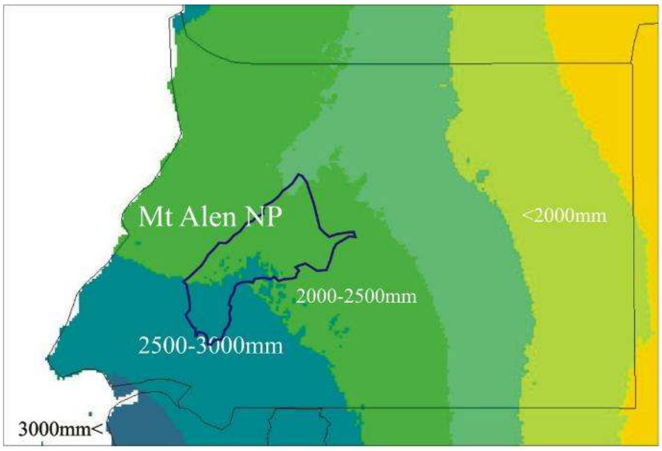


▲
Cliffs

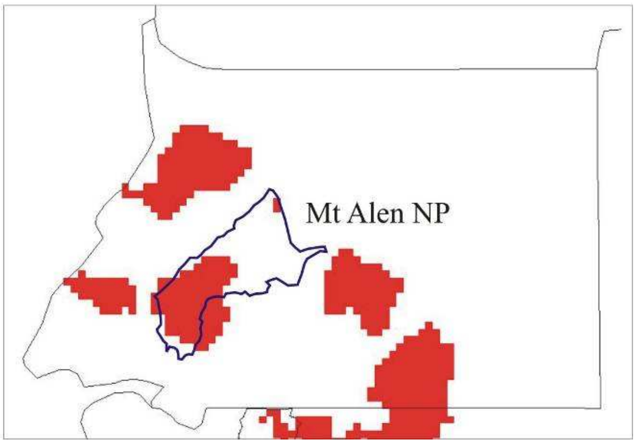
The geographical position of the Mt Mitra area (red encircled), clearly distinguishable within the regional by its higher altitude.

Monte Mitra

Mont Mitra is the highest part of the Niefang Mountain Range (see above encircled in red) which is orientated more less parallel to the coast. West of the range stretches the coastal plain and at the other side to the east is the inland plateau. Both the plain and the plateau have a gentler topography than the range it self.
The Niefang Mountain range obtained its higher altitude and rougher topography, because since the Eocene this part of the pre-Cambrian shield became uplifted as the African continent drifted northward and collided with the European plate. As it uplifted it also became exposed to erosion. In time only the most resistant geological formations persisted. The summits of the range now consist of large rocky blocks some times creating cliffs of 50 m and more (see above). Together with the misty conditions a mystical atmosphere is created and local folklore tells that dragons roam these mountains.



Rainfall over Equatorial Guinea

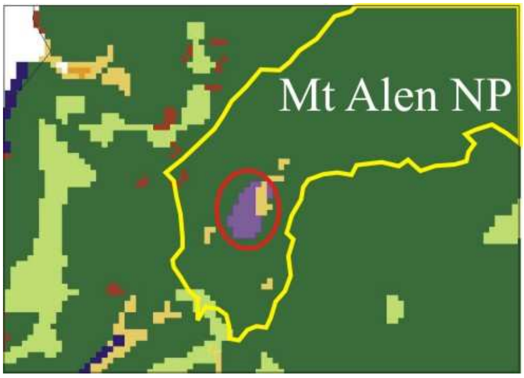


Postulated Pleistocene refuges area (red)

Biological significance
Mainland Equatorial Guinea (Rio Muni) is botanically poorly known. The two countries between it is wedged, Cameroon and Gabon, are much better known and both are rich in plant species. Therefore, Equatorial Guinea is probably equally rich and perhaps even more, because of its rugged topography in combination with a high rainfall and the absence of a distinct and severe dry season (see above left).

The rugged topography creates a diversity in habitats, which contributes to a high biodiversity. Each type of habitat has its unique environmental characteristics which will only fit the requirements of certain species; the more habitats the more different species.

Also the relatively high humidity year around favors the presence of many small understorey plants species. These smaller plant species make up the bulk of central African's biodiversity. They are absent in areas with less rainfall, because they are sensitive to moist deficiencies as the upper layer is more easily depleted from its moisture in the absence of rain.

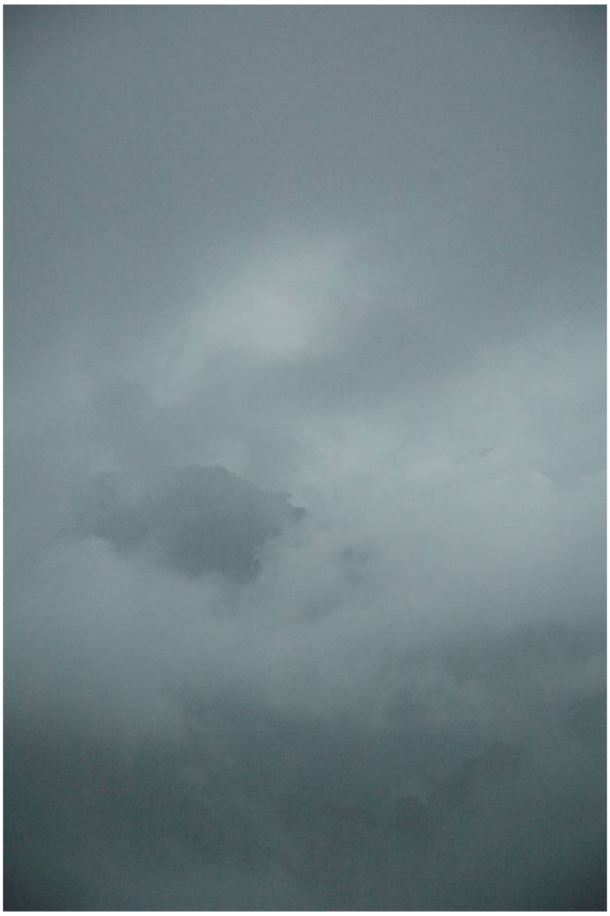


Montane forest (purple) in Equatorial Guinea (vegetation map Africa 2000 Mayaux et al., 2003).

Within Rio Muni Monte Mitra is particularly interesting, since it is the only area with montane forest. The only other montane forests in the region are the Rumpi Hills in north-western Cameroon (see above). Montane forests usually also contain unique species (endemics).

The area may be especially rich in endemics as the area is also a postulated Pleistocene forest refuge. These are areas where the rain forest persisted during the last glacial maximum when climate was much drier (see above right). At Monte Mitra there may be many species which went locally extinct elsewhere.

The mystical atmosphere of the Niefang Range ►



A new species of the genus *Scaphopetalum* has been discovered at the base of Monte Mitra. It is the only species with white flowers all the other species have yellow flowers.

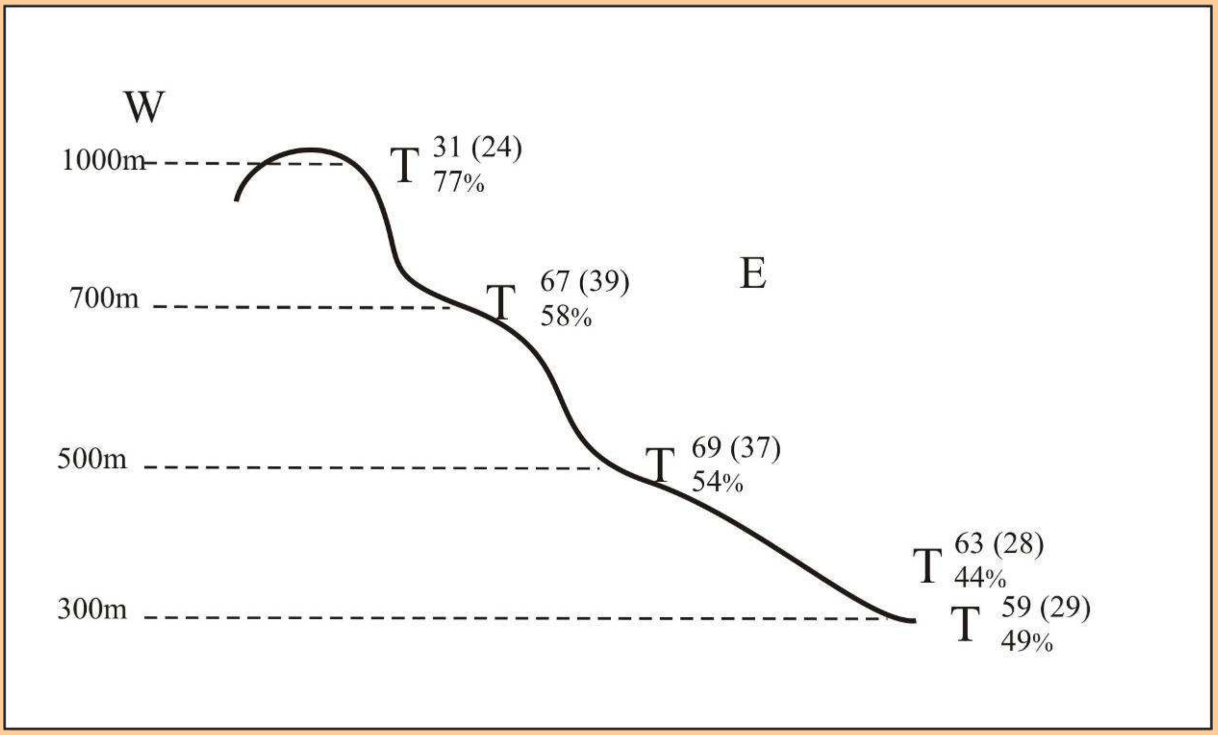
Patterns of biodiversity

Species are not distributed at random within the rain forest and except for common species most other species are restrained to a certain habitat or environment. Within such a geographically bound environment 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. In hilly area two well known arranging forces are altitude and aspect.

In temperate regions the impact of these two forces on the distributions of plant species is clearly visible. With increasing altitude the vegetation changes from oak/beech-dominated forest to pine forest and finally alpine pastures. The impact of aspect is evident when comparing south and north facing slopes. The southern slopes are covered by xeric (drought resistant) shrubby/grassy vegetation and north slopes by forest.

In tropical regions the impact of these arranging forces are less clear and the outer appearance of the rain forest changes little along slopes with altitude and aspect. But actually recording plant species along hill slopes or at two opposing sides reveals differences in species composition. How big these differences are, is an indication for the biodiversity of the area in general: “the bigger the differences, the greater the biodiversity”.

Therefore, by the means of transects species composition was recorded in the montane forest and tropical rain forest covering Mt Mitra along the slopes from the base (300m) to the summit (1000m). The influence of aspect could not be studied since all transects are located at the eastern slope of Mt Mitra.



Profile of the Monte Mitra range showing the distribution of the transects (T) from bottom to summit, 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.

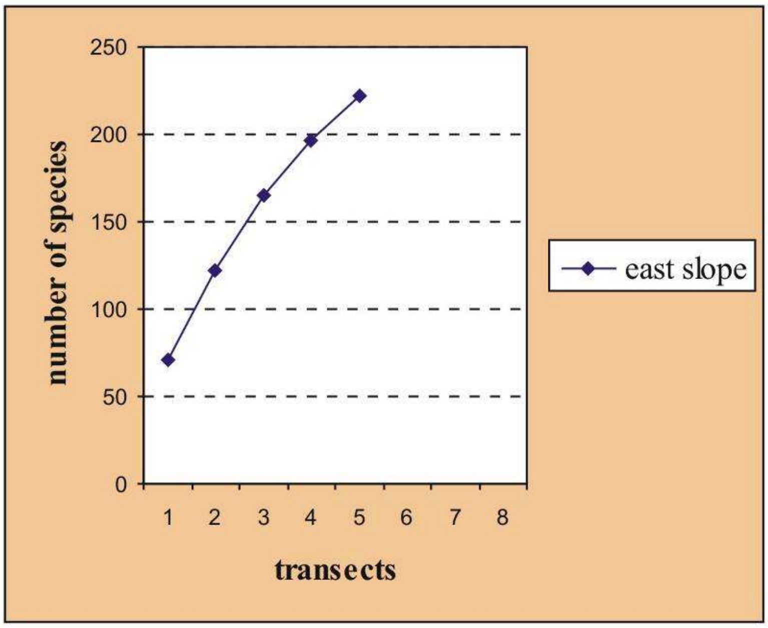
Methods

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.

Three transects were placed along the east facing slope of Mt Mitra at 1000m, 700m, 500m and two at 300m (see above). 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.

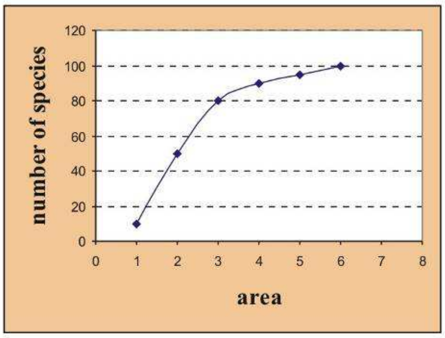
Results

In total species 213 (morpho-) species were recorded on the 5 transects, on average 60 species were recorded per transect. The lowest number was 31 species at 1000m and the highest number was 69 species at 500m, closely followed by the transect at 700m with 67 species. The majority of the species (157) were restricted to a single transect. The high number of restricted species will most likely decrease when more transects are put in along these slopes.



Species-area curve for the east side of Mt Mitra (left)

Generally, a maximum of total species is reached for an area after a certain area (below)



Species richness

Species richness generally tends to increase with sampled area until after a certain surface area a “ceiling” (maximum) is reached, i.e. the species-area curve (above right). Such curves are used to estimate the potential maximum number of species within a certain area. To do the same for Mt Mitra has its limitations, because the total surface area (number of transects) only represents 5,000m^2 (0.5 ha) of the Mt Mitra area, an area which itself comprises several km^2.

Species richness seems lowest on the summit (31 species), highest below the top at the mid-altitudes (67 and 69 species) and gradually decreasing to the base (63 and 59 species). This may be a genuine trend, at last for the summit as exploration walks showed that the summit and ridges almost all had the same forest type and species composition. Further sampling has to show whether the mid-altitudes are more species rich than the lower-altitudes. But the difference is only a few species.

The species-area curves for the east side is steep, but already slightly bending which suggests a high maximum number of species for Mt Mitra (above left). However, the sampling procedure used here was designed to maximize species recording and avoid replication. Additional transects may not necessarily lead to more species. The curve could also start bending with increased sample area without significantly changing the total number of species already recorded.

Which of the two possibilities is most plausible is difficult to say, because the differences between the transects are large. Although the two base transects at 300 m, which are the most similar transects in habitat and environment, have 20 species in common. This is 31 and 32 % of the total number of species recorded on each transect and not a very large difference in species composition. Species richness will still increase but probably level off after a few more transects.

species	300m	300m	500m	700m	1000m
Garcinia 3a2	1			1	
Scytopetalum klaineanum	1			1	
Symphonia globuliflora	2			2	
Sorindeia	3			1	
Strombosiopsis tetandra	4			2	
Dialium 4a	1	2			
Xylopia quintasii	1	2			
Cyrtogonone argentea	1	1			
Drypetes moulunduana	1	1			
Hymenostegia pellegrinii	1	1			
Klaineanthus gaboniae	3	2			
Dacryodes 4b	2	1			
Aptandra zenkeri	3	1			
Centroplacus glaucinus	3	1			
Garcinia 4a	3	1			
Greenwayodendron suaveolens	4	3			
Coula edulis	1	1	1		
Diogea zenkeri	3	3	2		
Oubangia africana	1	10	1		
Bridelia atroviridis	1		1		
Octoknema affinis	3		2		
Berlinia congolensis	1		1	5	
Coelocaryon preusii	1		1	4	
Scaphopetalum blackii	9		3	1	
Dacryodes klaineana	3	1		2	
Heisteria parvifolia	3	1		2	
Dichostemma glaucescens	10	11	7	17	
Garcinia smeathmannii	1	3		4	1
Santiria trimeria	5	6	4	2	4
Plagiosiphon emarginatus		5	1		
Cleistanthus 2a		2	2		
Pausinystalia macrocera		2	1		
Caloncoba glauca		1	1		
Diospyros melocarpa		1	1		
Heisteria trillesiana		1	1		
Hylodendron gabonensis		1	1		
Strombosia pustulata		3	1		
Strombosia grandifolia			3	3	
Piptostigma glabrescens			1	3	
Vepris spp			1	2	
Chrysophyllum boukokou			1	1	
Calpocalyx 2c			2	1	
Eriocoelum petiolare			2	1	
Rhabdophyllum biseratum			1	1	
Xylopia aethiopica			1	1	
Tetraberlinia bifoliolata		3	4	5	
Strombosia scheffleri		2	2	3	
Anisophyllea purpurescens		1	2	5	
Dialium pachyphyllum		1	3	2	
Garcinia 3a		2		3	
Drypetes gross feullies		1		1	
Coffea 1d			1		1
Trichoscypha 1c				1	3
Scytopetalum 1a			1		6
Pellegriniodendron diphyllum	1	1			17
Garcinia conraunana		1			48

Common species along the eastern slope Mt Mitra

The figures in the row after the species name are the number of individuals

Aspect and altitude

In hilly or mountainous area altitude and aspect are strong arranging forces determining species distributions. On Mt Mitra only the force of altitude could not be assessed as the opposing slope has not been sampled. But the force of altitude is apparent. There are two basic group the more common species (see table above) and the altitude endemics (see appendix 1).

Among the common species altitude is is the principle force causing a gradient in species composition from bottom to summit (see table above). At one end of the gradient are species like restricted to the bottom like *Cyrtogonone argentea*, and at the other end species like restricted to the summit like *Xylopia rubescens* with intermediate species in between like *Santiria trimeria*, which are unaffected by altitude. The second group of species (74 %) consists of species which are restricted to one transect or altitude. Because of the low number of transects several of these altitude restricted species may turn out to be more common, that is also along other altitudes.

Endemism and species turnover

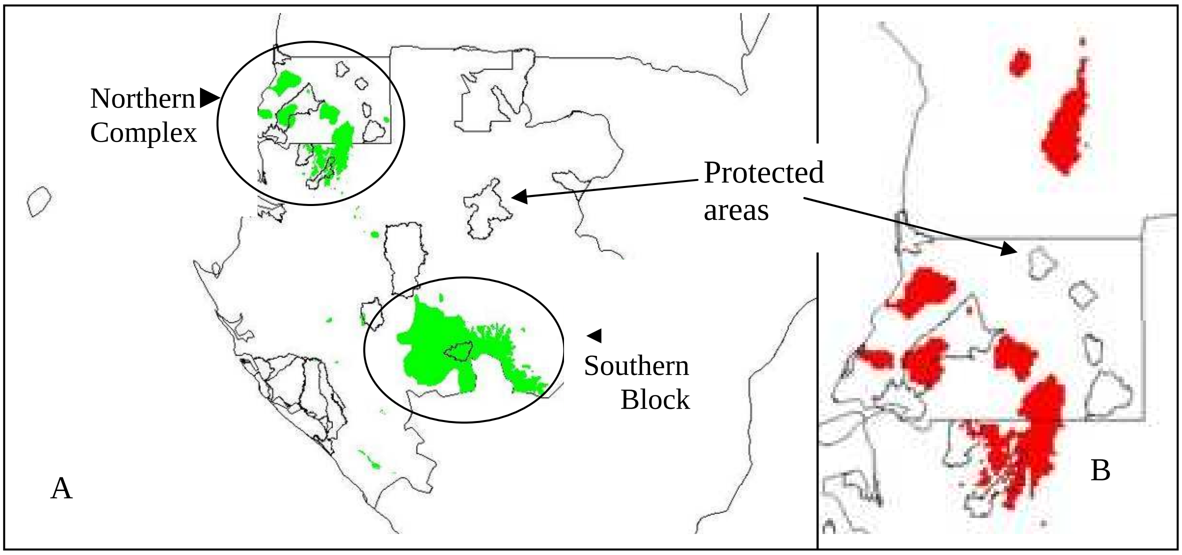
The level of endemism (defined here as species restricted to a single transect) is high partially due to the small number of transects which overestimates endemism. More species may turn out to be less restricted as concluded from this data when more transects are put in along these slopes. This would also change the size of the common group as they will become larger at the expense of the group of endemics.

Endemism is highest at the top (77%) and gradually decreases towards the base (44%). It is curious to see that the forest at the summit is most unique in species (endemics) but is also the species poorest. Comparing the two 300m transects gives an idea of species turnover with distance (beta-diversity). These two transects differ from each other by roughly 2/3 of their species composition which is high considering that they are only one km apart from each other. Another interesting observation is the find of *Korupodendron songweneanum* previously endemic to Korup National Park, recently it was found in the Monts de Crystal and now also in between in Monte Mitra.

Conclusions

Mt Mitra was before this biodiversity assessment identified as a potential species rich area. The assessment has shown that biodiversity and endemism is high, but exceptional. Endemism ranged from 47to 78%, especially the last figure is high. Most of the biodiversity recorded is represented by endemic species at the higher altitudes, which supports the unique characteristic of this mountainous area. This is confirmed by the new record for Rio Muni of *Pseudagrostistachys africana*, a high altitude species (above 1000m). Botanical collections also promise a few potentially new species, at least one new *Scaphopetalum* (Sterculiaceae). The analysis has indisputably shown that altitude is important arranging forces in this hilly to mountainous area. Therefore, it would be interesting and imperative to see whether biodiversity and endemism continues along nearby slopes. This area is especially important for conservation as new endemic species have been found and which are susceptible to permanent extinction by any form of human disturbance.

Identification of Biodiversity Sanctuaries



The West Central Africa (Southern Lower Guinea) showing the Pleistocene forest refuge landscape in green (A) and the Nothern Complex in more detail in red (B) and the park system.

Biodiversity Sanctuaries

During the last ice age, 20,000 years ago, central Africa looked very much different from today. The vast tropical rain forest now covering central Africa had been reduced to several larger fragments, so-called forest refugia. Presently, these forest refugia lay hidden within the present-day rain forest.

One way to high-light them is by overlapping elevated areas with a relatively high rainfall (see above in green). This is however an estimation based on knowledge how the climate was during the last ice age. Since it is an estimation, these former forest refugia still have a postulated status. Therefore, it is important to verify their status in the field.

One of the indicators are the presence of so-called narrow endemics, like for instance the newly found *Scaphopetalum* species. Another example is the distribution of *Korupodendron sogweanum*, which seems to overlap with the former Pleistocene forest landscape.

Their presence and the data collected here confirm that Mount Mitra is a former forest refuge area and that conservation money, time and efforts are justified.

However, the detailed map of Equatorial Guinea (above B) also shows that quite some postulated forest refugia are situated in between the parks. The status of these areas should be verified, because these are potentially very valuable parts of the present-day forest.

Another observation is the high concentration of postulated refuge areas in Equatorial Guinea, more than in adjacent Gabon. Gabon is known for its botanical richness, which is partially attributed to the presence of forest refuge areas.

Seen the high number of refuge areas main land Equatorial Guinea (Rio Muni) could be potentially richer than Gabon. However, this baseline information is missing for Equatorial Guinea, since it does not have a flora, unlike Gabon or Cameroon.

Acknowledgements
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Appendix 1 altitude endemics

species	300m
Tricalysia macrophylla	2
Alstonia boonei	1
Anisophyllea 5d	2
Anisophyllea myristica	2
Annonidium 5d	1
Anopixis klaineana	1
Baphia 5b	1
Dacryodes macrophylla	2
Daniellia klaineana	1
Dicranolepis distachis	1
Drypetes 5c	1
Drypetes arborescens	1
Duquetia staudtii	1
Euph 5d	1
Gilbertiodendron ogoouensis	1
Irvingia gabonensis	2
Lovoa trichiloides	2
Mamea africana	1
Newtonia griffionia	1
Ochtocosmus 5a	1
Odyendia gabonensis	3
Pancovia pedicellaris	1
Pycnanthus angolense	2
Rhabdophyllum 5a	1
Strephonema sericeum	2
Treculia africana	1
Trichilia 5d	1
Warneckia 5c	1
Xylopia staudtii	1

species	300m
Afrostyrax kamerunensis	1
Allanblackia floribunda	1
Allophyllus cobbe	1
Cleistanthus 4c	3
Cola ficifolia	1
Diospyros 4a	2
Diospyros 4a2	1
Diospyros 4d	1
Diospyros spp 2	1
Drypetes 4a	1
Drypetes 4c	1
Drypetes 4d	1
Homalium letestui	1
Napoleanea vogelii	1
Ochnaceae 4d	1
Ochtocosmus africana	1
Plagiostyles africana	1
Prioria joveri	1
Rothmannia spp (Rub 4d)	1
Soyauxia 4a	3
Staudtia gabonensis	1
Strephonema 4b	1
Syzygium 4a	1
Trichilia tessmannii	1
Trichoscypha 4a	1
Trichoscypha 4b	1
Vitex grandifolia	1
Warneckia 4b	1

species	500m
Dacryodes edulis	4
Afrostryx lepidophyllum	1
Anisophyllea polyneura	1
Chrysobalanaceae 2d	1
Chrysophyllum africana	1
Cola 2b	2
Cola 2c	1
Cola altisima	2
Croton 2d	1
Diospyros 2b	1
Diospyros 2b2	1
Diospyros spp	1
Drypetes 2a	3
Drypetes 2b	1
Drypetes 2d	1
Drypetes 2d2	1
Drypetes spp	1
Enantia chlorantha	1
Eriocoelum 2b	1
Euphorbia 2a	1
Euphorbia 2a2	1
Garcinia mannii	3
Hymenostegia 2d	1
Korupodenderon sogweneanum	1
Lecomtadoxa heitziana	2
Pauridiantha callicarpoides	2
Piptadeniastrum africana	1
Plagiosiphon gabonensis	2
Sapindaceae spp	1
Sapium ellipticus	1
Soyauxia floribunda	1
spp 2a	2
Strephonema 2d	1
Strephonema pseudocola	1
Trichilia 2b	1
Trichilia welwitschii	1
Zanthoxyllum heitzii	3

Appendix 1 continued

species	700m
Anisophyllea 3a	1
Anisophyllea 3c	3
Anonaceae 3a	2
Anthonotha 3a	6
Anthonotha accuminata	3
Aphanocalyx microphyllus	1
Beilschiedia 3d	1
Berlinia 3a	1
Caes 3c	1
Cola 3a	2
Cola 3c	1
Dacryodes 3b	4
Dactyladenia laevis	2
Diospyros 3c	1
Diospyros 3d	2
Drypetes 3?	1
Drypetes 3a	1
Drypetes 3a2	1
Drypetes 3d	1
Drypetes spp 2	1
Erismadelphus excul	2
Euph 3b	2
Euph waka	1
Grewia coreacea	1
Isolona 3c	1
Maesobotrya 3c	1
Maesobotrya 3b	1
Maesobotrya 3b2	1
Marypsis 3d	2
Memecylon 3d	1
Rhabdophyllum 3d	1
Rub 3c	1
Rub 3c2	1
Rub 3c3	1
Souyauxia grandifolia	2
Trichoscypha eugong	2
Uapaca staudtii	1
Warneckia 3c	2
Warneckia 3d	1

species	700m
Amanoa strobilacea	1
Anthonotha lamprophylla	1
Carapa 1c	1
Dactyladenia 1d	1
Drypetes 1d	2
Duquetia 1b	2
Garcinia 1c	1
Garcinia 1d	2
Manilkara 1b	3
Memecylon 1c	1
Ochtocosmus 1b	1
Pentadesma grandifolia	39
Pseudagrostistachys africana	1
Psychotria 1a	5
Psychotria 820	1
Rub 1a	3
Sapotaceae 1b	1
Sapotaceae 809	1
Syzygium 1a	9
Syzygium 1a2	5
Trichoscypha 1b	1
Uapaca 1d	5
Warneckia 1c	1
Xylopia rubescens	12