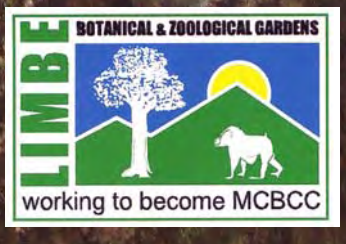
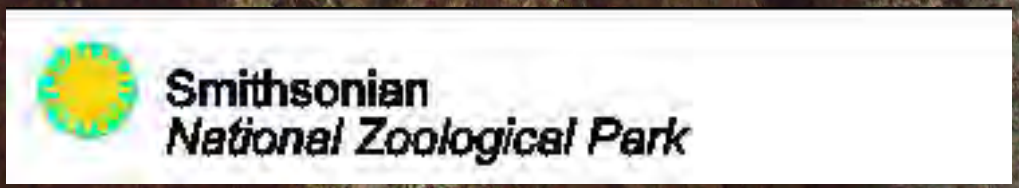
# A PRELIMINARY VEGETATION ASSESSMENT OF THE MBÉ NATIONAL PARK, MONTS DE CRISTAL, GABON

*June 2004*





# A PRELIMINARY VEGETATION ASSESSMENT OF THE MBÉ NATIONAL PARK, MONTS DE CRISTAL, GABON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**June 2004**

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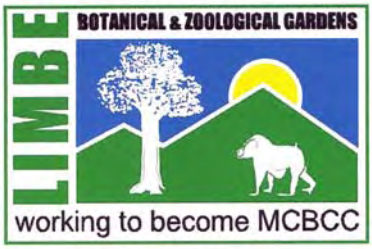


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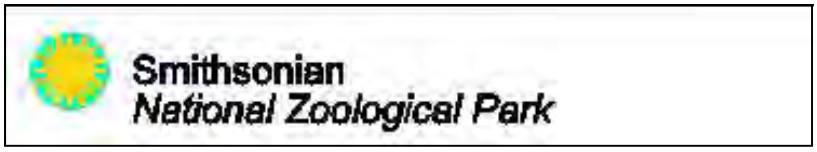



Terry Sunderland

## EXECUTIVE SUMMARY

Gabon is one of tropical Africa's biologically richest countries, supporting several mountain chains where plant diversity is purported to be very high. Of all of the CARPE landscapes, the Monte-Alen-Monts de Cristal landscape of Equatorial Guinea and Gabon probably possess the greatest botanical wealth. Though severely underdocumented to the point of not knowing how many plant species are in the Monts or in Gabon proper, many have cited the Monts as a Pleistocene Refugium as evidenced by it being a center of regional plant diversity for several taxa and rich in endemic species. Rainfall is approximately 3,000mm per annum, and the substrate part of the ancient Precambrian basement rising to just over 900m. Logging, gold mining, and hunting are considered to be the main threats in the Monts de Cristal, but the recent creation of two national parks (Mt. Seni and Mbé National Parks) in the area potentially lessens these threats once a management structure is in place.

A multi-national botanical team of four institutions came together from Limbe Botanic Garden, l'Herbier National du Gabon, Smithsonian Institution, and the Missouri Botanical Garden and installed permanent Biodiversity Plots (BDP's) at two sites in the Mbé National Park. Placement of the plots was undertaken in consultation with Gabonese botanists familiar with the area and through the implementation of reconnaissance ("reccé") surveys. Prior to this assessment, few data were available to fully evaluate the Park's diversity. In order to fill in this gap, this project employed standard Smithsonian Institution methodology used elsewhere in Central Africa and the wider humid tropics, to place five BDP's within the Mbé National Park to assess the plant diversity contained therein and to provide baseline information for future forest monitoring.

Despite being the most high profile area for plant collecting in Gabon, due to its proximity to Libreville and its famed diversity, this monitoring project added almost 100 taxa to the existing checklist for the area list by virtue of the use of quantitative assessment methods in which every tree species in a given area is collected. The use of a full time expert tree climber, often under-used in botanical fieldwork throughout Central Africa, made this possible. The beta diversity of the Mbé National Park is extraordinarily high with the species composition in BDP's separated by less than one kilometre changing significantly.

Recce transects prior to the park establishment used *Begonia* and Caesalpiniod legumes as indicators of diversity. Comparisons of these results substantiate the beta diversity of the area since these two taxa do not have overlapping centres of diversity. The dominant families when considering relative frequency, dominance, and density, are the Burseraceae, Euphorbiaceae, Caesalpiniaceae and Olacaceae, in rank order. The total basal area per hectare is relatively high reaching 45 $m^2$/ha and included many important commercially valuable timber trees. The mean number of trees per hectare was 539. In terms of species diversity, when compared with Smithsonian Institution's BDP's elsewhere in Central Africa, the Monts de Cristal ranked the most diverse site assessed to date with a mean number of 97 species per hectare (trees >10cm dbh).

This was substantiated by the Missouri Botanical Garden African dataset where the Central Africa subset of plots ranked the Monts de Cristal only second to Banyang Mbo, Cameroon. Through the collaboration with Smithsonian's Center for Tropical Forestry Science, the presence of *Korupodendron* was documented for the first time outside of Korup National Park, Cameroun. This range extension is significant in that it was made possible by the rare opportunity for regional botanists to be in the field together and that this monotypic genus of conservation concern was not originally believed to have a distribution outside of Southwestern Cameroon. The simultaneous support of a Congo Basin wide monitoring program in conjunction with south-south collaboration makes for a sustainable future in the landscapes where the understanding, conservation, and management of the forest are essential for its survival.

Monitoring networks are still a relatively new idea in the long established national parks, even in the United States. By contrast, creating such a network at the inception of the newly-created Gabonese national parks constitutes a rare opportunity that will be highly valuable over time. It is hoped that future assessment and monitoring endeavours will take place in Republic of Congo, Equatorial Guinea, and southern Gabon to broaden the collaboration and monitoring network.

## INTRODUCTION

Gabon is one of the most botanically diverse tropical African countries (Pomeroy, 1993). Covering an area of 267,660 km², it is home to an estimated 6,000-10,000 plant species (Breteler, 1989; Christy *et al*., 2003). Relatively little is known about Gabon plant diversity and it is probably the least botanically known area in tropical Africa (Campbell and Hammond 1989). Closed canopy forest still covers an estimated 21,190,000 ha (over 80% of the country) (Mayauux et al., 2004), although up to 70% of these remaining forests are currently allocated as logging concessions (Collomb *et al*., 2000). Timber exploitation represents a major contribution to the country's economy, valued at some 190 milliards CFA per annum (Christy *et al*., 2003). Reports as to how commercial logging is contributing to the loss in forest cover are somewhat unreliable, with the annual deforestation rate estimated at between 0.1% (Christy *et al*., 2003) and 0.5% (FAO, 1999), the latter figure being one of the highest for the region.

Plant endemism is high in Gabon at an estimated 22% (Breteler, 1989) and new species are still being regularly discovered (see Breteler, 2001). Many species are limited to remote mountain ranges such as the Monts de Cristal, Monts Doudou and the Massif du Chaillu. A recent analysis of collecting density in Gabon shows that many such areas are poorly known botanically and have no known collections (Sosef, 2001). With only a few trained Gabonese botanists and limited resources, such areas will likely remain largely unexplored for the foreseeable future unless partnerships aimed at building the capacity of local institutions are further developed (Morat and Lowry 1997).

In late 2002, the Government of Gabon, working in close collaboration with the Wildlife Conservation Society, established 13 new National Parks, an unprecedented initiative in the region aimed at protecting a significant swathe of Central African forests and the biodiversity they contain (Quammen 2003). Despite one of the lowest population densities in the Congo Basin (4.3 people per km² (FAO, 1999), the challenge now is to manage these parks and this will require the provision of extensive biological, ecological and socio-economic baseline information as well as management capacity and financial commitment. Until recently, however, these latter two functions have often been considered lacking within the region (Wilkie *et al*., 2001) and it is hoped the CARPE-funded Congo Basin Forest Partnership will address this shortfall.

The Monts de Cristal is purportedly one of the most botanically diverse areas of Gabon (Wilks, 1990) and with its proximity to Libreville is one of the most floristically well-known regions of Gabon, currently with 545 taxa listed for Mbé National Park (extracted from database from Herbier National du Gabon). The Monts de Cristal is purported to be a significant Pleistocene Forest Refuge (Hamilton, 1982; Sosef 1994) and is considered one of the two[1] distinct "Centres of Plant Diversity" in the Atlantic Coastal Forest Ecoregion (CBFP Annex 2, 2002). The borders of the two National Parks in the Monts de Cristal are currently not delimited nor is there a management system yet in place.

[1] The other being the Mayombe region.

This report is the result of a multi-national and multi-institutional effort undertaken as part of the partially CARPE-funded Congo Basin Forest Partnership (CBFP) initiative. With members from the Herbier National, Libreville, Limbe Botanic Garden, Cameroon, Smithsonian Institution, and the Missouri Botanical Garden, a combination of field training and standardized vegetation assessment techniques were implemented in the Mbé National Park, the southern park of the pair in the Monts de Cristal. The information presented in this report can be used as a basis for comparison with other vegetation studies in Gabon (Minkébé, Monts Doudou, Foret des Abeilles, etc) and the wider Congo Basin. In addition, the establishment of permanent biodiversity plots (BDP's) to provide critical baseline data for future monitoring within the Monts de Cristal is a powerful tool to understand the dynamic forest processes in the region and how such forest can be best managed. Finally, linking national institutions to form regional partnerships will only strengthen the ability of the CBFP partners to monitor, assess, and protect its resources across all landscapes.

## SITE DESCRIPTION

The Mbé National Park is located in the Estuaire and Woleu Ntem Provinces of Gabon (0º36'-1º00' N; 10º13'-10º 58' E). The Park includes contains the watershed of the Mbé River and reaches almost to the Komo River. The Mbé River is the source of Libreville's hydroelectricity and two hydroelectric dams are located in the area, the northern Tchimbélé Dam at 900m and the Kinguélé Dam at 500m.

In common with southern Cameroon and Rio Muni, the geology of the Monts de Cristal is comprised of Precambrian African basement consisting of granite and gneiss (St. Aubin, 1963). Elevations reach over 900m with the highest point being Mont Mbilan, just north of Kinguélé, at 925m. Rainfall in the mountains is reported as having a marked dry season from June to September and a small dry season in January or February (Davis *et al*. 1994), but some consider the Monts de Cristal to be aseasonal (Wilks, pers. comm.). The highest rainfall in Gabon occurs in adjacent Mont Seni National Park, in the northern portion of the Monts de Cristal at 3,500mm per year (St. Aubin, 1963), decreasing on the eastern slopes to 2000mm per year (Rietsma, 1988). The mean annual temperature is 26ºC (*ibid*.).

The vegetation of the Monts de Cristal has been described as a component of "la forêt des montagnes Gabonaises", characterised by an abundance of *Aucoumea klaineana, Desbordesia glaucescens, Dacryodes buettneri* and *Erismadelphus exul*, but particularly by the genus *Bikinia* (syn. *Monopetalanthus*) (Christy *et al*., 2003). The Monts de Cristal are thought to contain as many as 3,000 taxa, with ca.100 endemic species (de Wilde cited in Davis *et al*., 1993). Inselbergs, or rock outcrops, are also a common feature of the Monts de Cristal, possessing unique vegetation communities and many narrow endemics (Ngok Banak, 2002). In terms of wider diversity, the Monts de Cristal are reported to support substantial populations of large mammals, notably the western lowland gorilla (*Gorilla gorilla gorilla*), mandrill (*Mandrillus sphinx*), chimpanzee (*Pan troglodytes troglodytes*), elephant (*Loxodonta africana cyclotis*), buffalo (*Syncerus caffer*) and

leopard (*Panthera pardus*). Very few studies have been made of any other biota in the region.

The human population is low, with only a few scattered villages in the area. Environmental threats to this area include local gold mining, its resultant mercury pollution, and hunting (Wilks, 1990), both of which were very much in evidence during our field work.

## MATERIALS AND METHODS

### Introduction

Five permanent 1ha biodiversity plots were established within the Mbé National Park. The location of the plots were not only dictated by logistical constraints but reflected the need to site them in "representative" forest. Three were located in the vicinity of the Tchimbélé Dam and two, close to the Kinguélé Dam. In order to ensure the plots captured the representative forest types, site selection of the plots was based on "reccé walks" (White and Edwards, 2000). These were undertaken to assess the dominant vegetation types within the area. A team of foresters and botanists (two of whom were familiar with the vegetation of the Monts de Cristal) prospected the area using existing trails and identified the dominant tree species every 200m or so. Within a relatively short distance from the commencement of the recce walks, it was clear that the forest exhibited significant heterogeneity and vegetation composition changed dramatically between closely situated sites. Plots were then laid out in the major forest variations encountered. It was clear from these walks that the heterogeneity of the forest was tremendous and would need numerous plots in order to effectively describe its beta diversity.

**Figure 1**. Census of a large *moabi* (Baillonella toxisperma) during a reccé walk on Mont Mbilan.

**Table 1.** Locations of BDP's within the Mbé National Park.

| Plot # | Location | Gazeteer | Altitude (m) |
|---|---|---|---|
| GAB 01 | Tchimbélé | 00º37'02"N: 010º24'49"E | 400 |
| GAB 02 | Tchimbélé | 00º37'08"N: 010º24'35"E | 300 |
| GAB 03 | Tchimbélé | 00º37'02"N: 010º23'57"E | 300 |
| GAB 04 | Kinguélé | 00º28'00"N: 010º16'41"E | 200 |
| GAB 05 | Kinguélé | 00º28'50"N: 010º17'56"E | 250 |

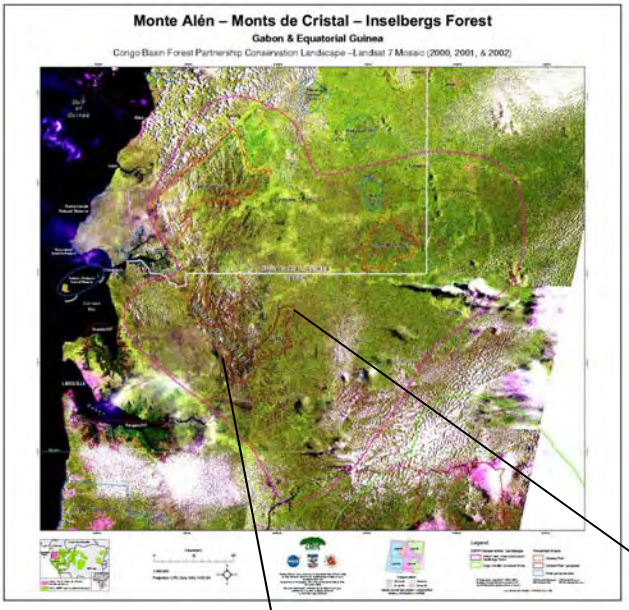
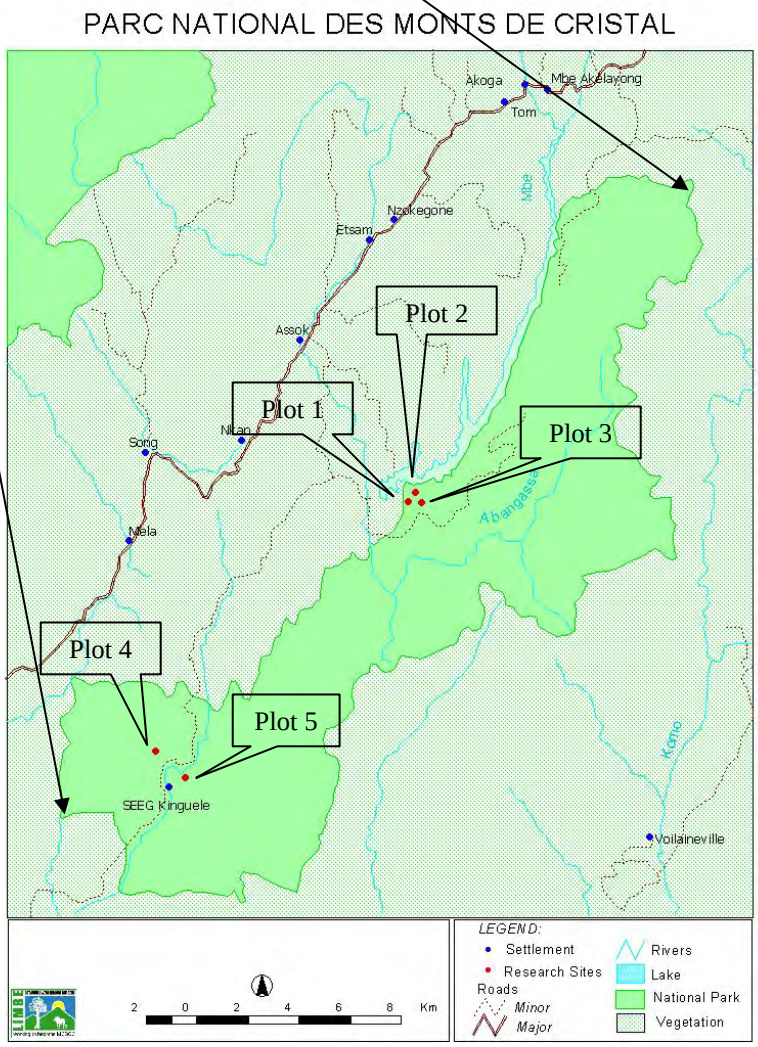



**Figure 2**: Location of the Mbé National Park within the Monts de Cristal-Monts Alèn Landscape. Note field study sites within the Park (below).



## Plot establishment

In the one-hectare configuration used for SI/MAB 1ha BDP's, the area is first geo-referenced using a GPS and is then surveyed in a horizontal plane using a compass, tape and clinometer. The one-hectare plot is divided into 25 quadrats, each 20 x 20 meters in size (Fig. 1). It should be noted that, generally, 20 meters is the longest distance that can be accurately surveyed in dense forest.

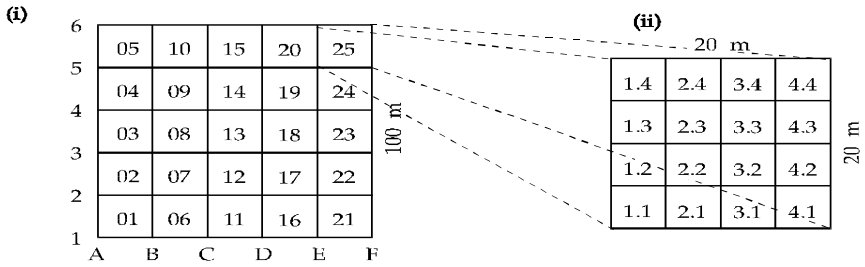



**Figure 3: One hectare Biodiversity Plot (BDP) layout**

**Figure 4**: Line sighting using a compass

**Figure 5**. Measuring horizontal distance

Surveying to establish quadrat corners proceeds from the bottom left-hand corner of the plot outward to eliminate errors. Corrections for slope are made, ensuring that each of the quadrats contains 400 square meters regardless of topography. The calculations used for slope correction are fully described in Dallmeier *et al.* (1992) and White and Edwards (2000). A row of quadrats is built north to south along the left line from the baseline; new

quadrats are then added westward until rows two to five are completed. All the quadrat corners are marked with stakes topped with flagging tape marked with the distance from the baseline.

**Tree enumeration**

Tree tagging and identification begins as soon as the corner stakes of the quadrats are set. The process includes locating all trees with a diameter 10 centimetres in diameter at breast height (dbh), then measuring, marking and identifying the species; these specific activities are elaborated upon below. During the enumeration process, a team of three to five individuals walks the quadrat, starting at the left corner baseline and moving in concentric clockwise circles of decreasing size, ending in the centre of the quadrat in order to systematically encounter and record all trees of appropriate size.

*Tree measurement and marking*

All trees >10cm diameter at breast height (dbh) are measured. The dbh is measured with a diametric tape at approximately 1.3m, avoiding any protrusions or lianas growing on the trunk. Trees with stilt roots and buttresses are measured at the lowest point at which the diameter of the bole can be accurately measured without the influence of these additional protuberances. Measuring above buttress and stilt roots often requires the use of a skilled tree climber. The measurement of trees above the dbh point is known as the diameter at reference height (drh). The point of measurement is marked with an "X" with the sharp point of the dbh tape. At this exact point, a ring is then painted around the tree. This marking ensures that future measurements of the same tree are taken at exactly the same point.

**Figures 6 & 7**: Measuring tree diameter at breast height and at reference height.

*Numbering and tagging*

Each individual tree is tagged with a different number consisting of a sequence of three double digits. Using (01-24-09) as an example, the first two numbers (01) corresponds to the one-hectare plot within the zone, second pair (24) identifies the number of the quadrat and the last two numbers (09) represent an individual tree within the quadrat. No other tree receives this unique number. The tree numbers start at 1 in each quadrat and continue until the last tree is labelled. Prior to all trees being permanently tagged with aluminium labels a temporary ribbon is tied to each tree with the number written in indelible ink. Once aluminium labels are produced with the correct numbers, they are nailed to the tree 10cm above the point of measurement, and as marked by the ring of paint on the trunk. The aluminium label faces outwards and is oriented toward the baseline of the plot. The nail is driven to angle down and just far enough in so that it will not fall out when pulled or when bark falls off, leaving enough room for the tree to grow before "eating" the tag.

**Figure 8.** Tagged and painted tree

*Tree identification and voucher collection*

As far as possible, individual trees within a BDP are identified in the field often using bark and slash characters. However, to verify the field determinations, voucher specimens are collected for each taxon encountered, whether the species has been identified with confidence or not. For problematic genera such as *Drypetes, Diospyros*, *Memecylon* and *Bielschmeidia*, all individuals encountered were vouchered. Unidentified species were sorted into "morphospecies" and at least one voucher was collected for each. The use of a tree climber greatly facilitated access to the forest canopy and ensured that very few, if any, individual species were not represented in the voucher collections. The specimens are preserved in the field using a portable aluminium field dryer with kerosene stoves providing the heat source.

**Figure 9**. Identifying species using slash characters

In addition to the voucher specimens collected during the enumeration of the plots, DNA silica collections were made for the following taxa: *Carapa, Garcinia*, *Memecylon,* and *Warneckia*. These groups have active researchers at MBG who will potentially be

performing molecular systematics and population genetics analyses on the material. Furthermore, as fertile specimens were found outside the plots, these were collected as well. At the time of setting the plots, the forest was not prolifically flowering and so botanical support focused primarily on the plots themselves. Several interesting taxa were collected in and around the plots, including one Triuridaceae which is awaiting determination by a specialist, and may potentially be a new species.

**Figure 10**. Field dryer using kerosene stoves as a heat source.

*Voucher specimen management*

During the plot enumeration, more than 300 vouchers, the majority of which were sterile, were collected. The first set of these vouchers have been deposited at the Herbier National du Gabon in Libreville and are still in the process of being determined, and will be subsequently curated and databased using BRAHMS. As with all CARPE-supported activities in the Congo Basin implemented by SI and MBG, duplicates of these vouchers will be kept in a sterile voucher collection at MBG and will be entered onto the TROPICOS database. This database provides taxonomic, ecological and geographical information on each accession and can be accessed via the internet (http://mobot.mobot.org/W3T/Search/vast.html). Undetermined plants will be sent to family specialists to complete the identification process and identify potential new species.

**Figure 11.** Pressing voucher specimens in the field

*Tree mapping*

In addition to measuring and identifying trees in the quadrats, SI/MAB researchers map each tree to the nearest centimetre. A mapping team of seven people uses automatic range finders to accomplish this task. The tree is located by one of two people person known as the "tree locators." The distance of the tree from one of the lines of the quadrat (1,2,3 or 4) where the corners are visible, is then taken using the range finders.

These are recorded as "line A" and "line B". These lines denote the diagonal distance from a left quadrat corner (line A) to the tree being measured and from a right corner (line B) to the same tree. The lines also allow measurements from any of the four sides of the quadrat. The coordinate corners are denoted by their intersecting boundary lines (quadrat boundary lines are numbered in clockwise sequence from one to four, starting at the baseline). BIOMON (see below) automatically calculates the *x* and *y* coordinates of the distances mapped and maps each individual tree on the quadrats.

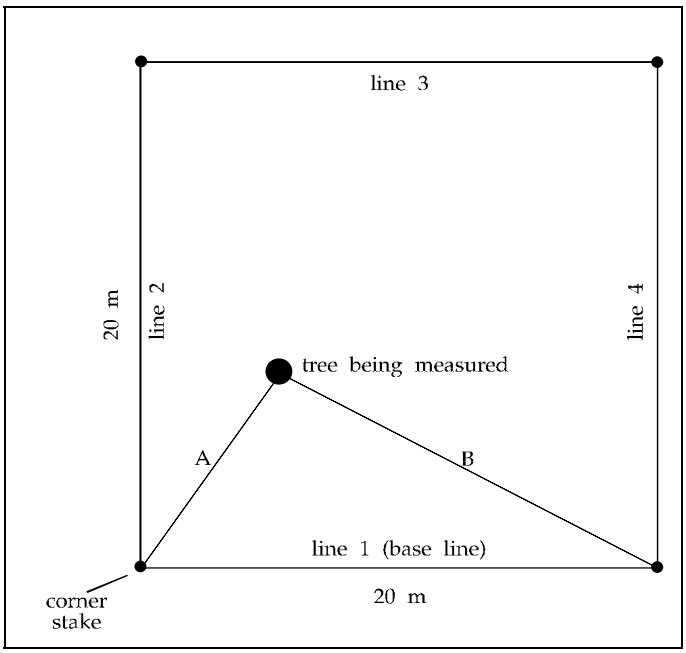



**Figure 12.** Tree mapping

**Figures 13 & 14**. Using electronic range finders to measure distance during the mapping process.

*On-site training and capacity building*

One of the main objectives of this field work was to bring together a wide range of local technicians (tree climbers, herbarium technicians, botanists, foresters) from a number of recognised regional institutions to share professional experience and technical expertise and jointly evaluate the forest using their combined knowledge. By working on a standardized plot protocol, implementing it in the field, and undertaking preliminary data analysis, the local capacity for both monitoring the existing plots and perhaps extending the plot network to other new national parks in Gabon to allow further comparison between sites, has been considerably supported. In this regard the staff of the National Herbarium in Libreville are currently working on a proposal to develop a national strategy for the establishment of such a permanent sample plot network. Some basic field equipment to support this initiative was donated to LBV by the SI/MBG team.

*Data analysis*

The Smithsonian Institution's Monitoring and Assessment of Biodiversity Programme (SI/MAB) has developed a Windows driven computer programme that manages and analyses data collected on the 1ha BDP's. BIOMON[2] undertakes basic assessments based calculations of species numbers, frequencies, basal areas and mean dbh as well as on species "importance value index" (IVI) i.e. species with the highest IVI are referred to as the most "important" at that site. The IVI is calculated as follows:

$$\text{Relative density} = \frac{\text{Number of individuals of a species} \times 100}{\text{Total number of individuals of all species}}$$

$$\text{Relative dominance} = \frac{\text{Total basal area of the species} \times 100}{\text{Total basal area of all species}}$$

$$\text{Relative frequency} = \frac{\text{Frequency of species} \times 100}{\text{Sum of all frequencies}}$$

Frequency = Number of quadrats in which a species is found.

Cover value index (CVI) = Relative density + Relative dominance.

Important value index (IVI) = CVI + Relative frequency.

[2] BIOMON can be downloaded at www.si.edu/simab

**Summary of results**

A total of 2,697 individual trees representing 39 families, 114 genera and 152 species[3] were enumerated on the Monts de Cristal BDP's. The detailed breakdown of species composition, density, dominance and frequency within each BDP are presented in the field guide accompanying this report. A brief summary of results is presented below.

**Table 2.** A summary of the preliminary data gathered from each BDP.

| Site | Plot No. | No. of species | No. of trees | No. of stems | Mean dbh (cm) | Total BA ($m^2$/ha) |
|---|---|---|---|---|---|---|
| Tchimbélé | GAB 01 | 91 | 533 | 542 | 25.97 | 28.7 |
| Tchimbélé | GAB 02 | 92 | 554 | 560 | 30.78 | 41.68 |
| Tchimbélé | GAB 03 | 102 | 533 | 533 | 29.83 | 37.42 |
| Kinguélé | GAB 04 | 90 | 523 | 526 | 29.22 | 35.27 |
| Kinguélé | GAB 05 | 110 | 554 | 557 | 31.59 | 43.65 |

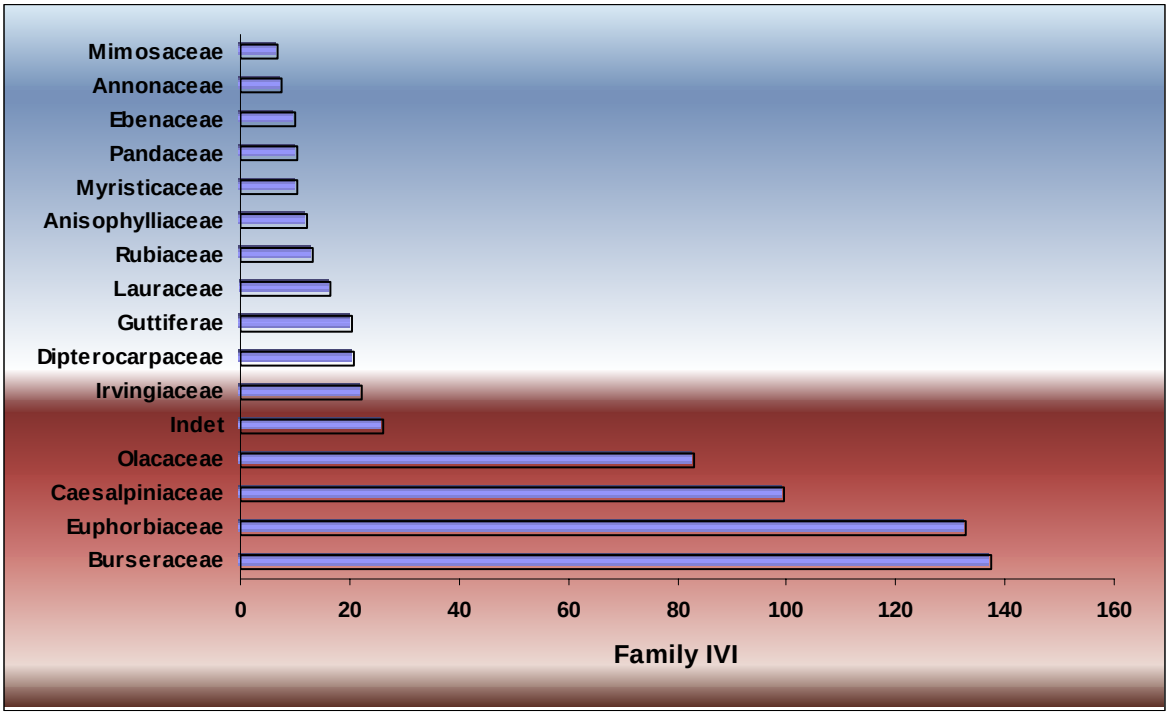
In terms of family importance, the Caesalpiniaceae has the most number of species, followed by the Euphorbiaceae and the Rubiaceae (see Table 3). However when the family importance is calculated in terms of cumulative IVI, the Burseraceae, Euphorbiaceae, Caesalpiniaceae and Olacaceae are by far the dominant families within the Monts de Cristal (see Figure 3).

**Table 3. Summary of number of species per family**

| Family | Number of species |
|---|---|
| Caesalpiniaceae | 25 |
| Euphorbiaceae | 14 |
| Rubiaceae | 10 |
| Olacaceae | 7 |
| Annonaceae | 7 |
| Burseraceae | 6 |
| Mimosaceae | 6 |
| Anacardiaceae | 4 |
| Apocynaceae | 4 |
| Meliaceae | 4 |
| Irvingiaceae | 4 |
| Myristicaceae | 4 |
| Sapindaceae | 4 |
| Sapotaceae | 4 |

[3] Although this figure will undoubtedly rise as the voucher specimens are determined.

**Figure 15. Dominant families (IVI) of Mbé National Park (all trees >10cm dbh)**




The most important species by plot are presented in the following graphs.

**Figure 16. Dominant species by IVI in Plot 1 (all trees >10cm dbh)**

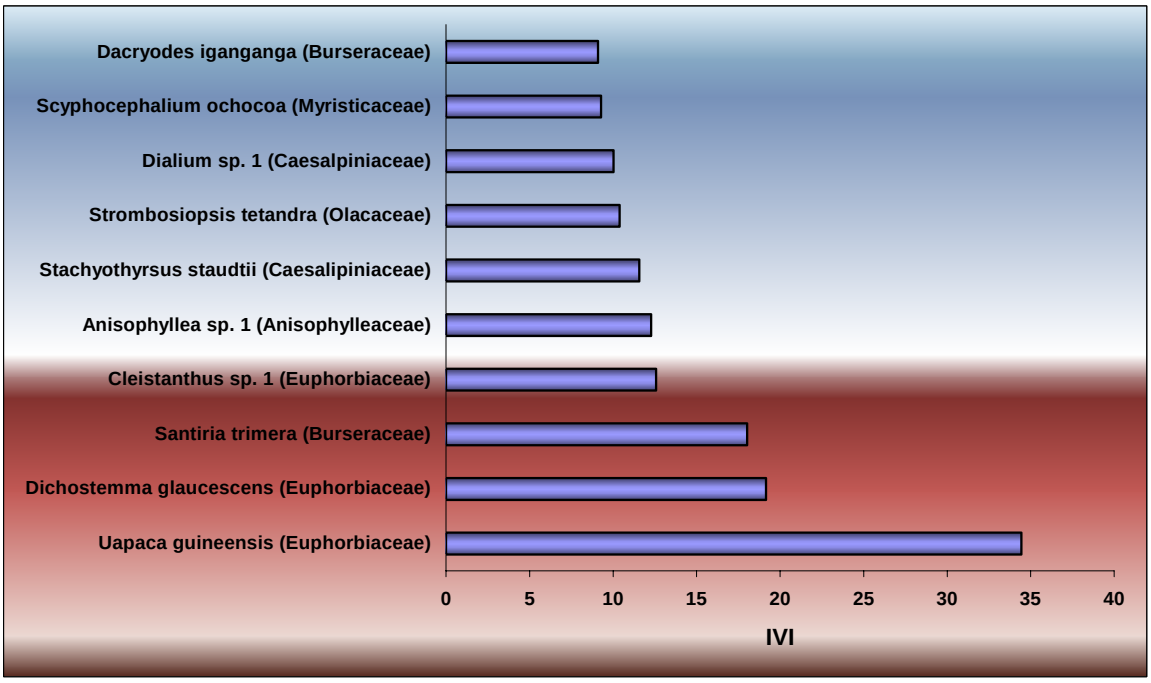


**Figure 17. Dominant species by IVI in Plot 2 (all trees >10cm dbh)**

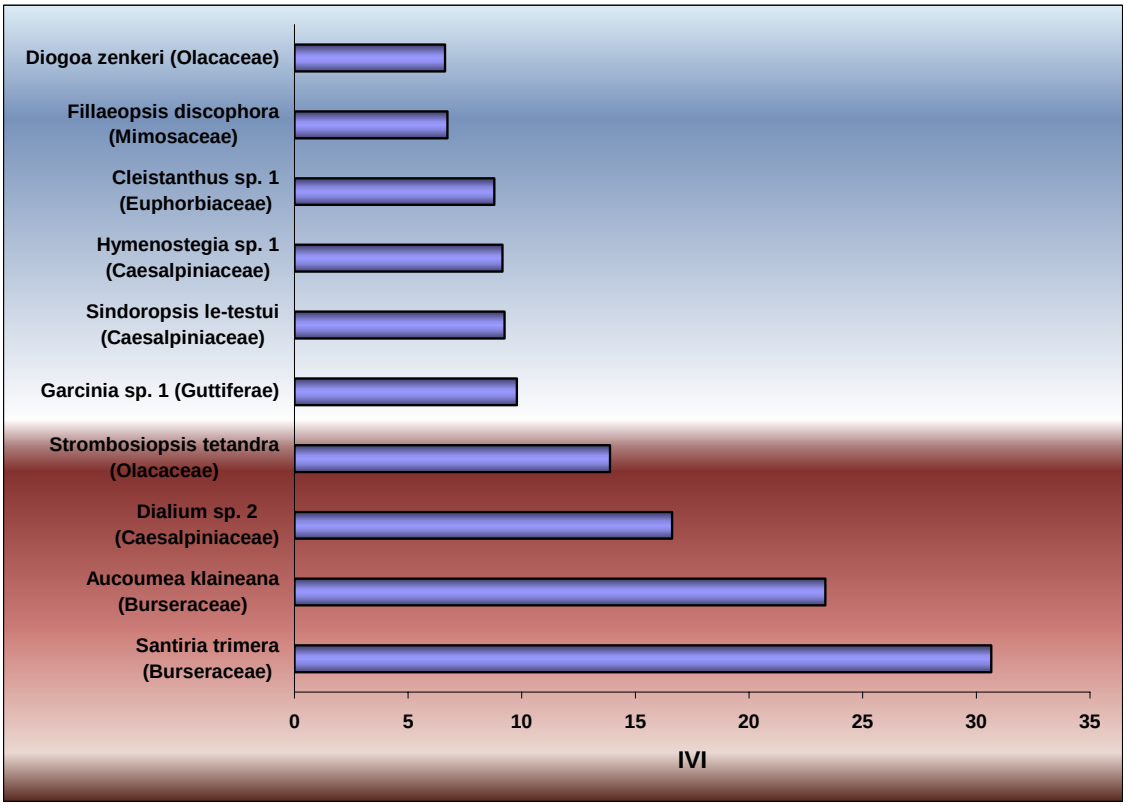



**Figure 18. Dominant species by IVI in Plot 3 (all trees >10cm dbh)**

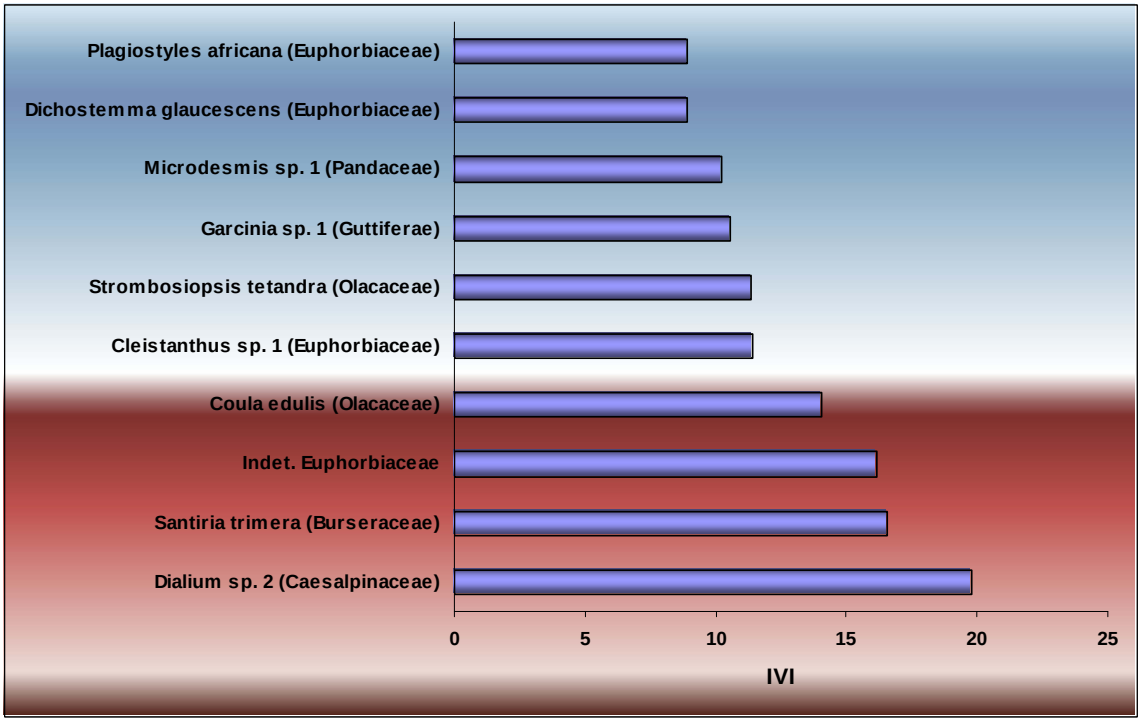


**Figure 19. Dominant species by IVI in Plot 4 (all trees >10cm dbh)**

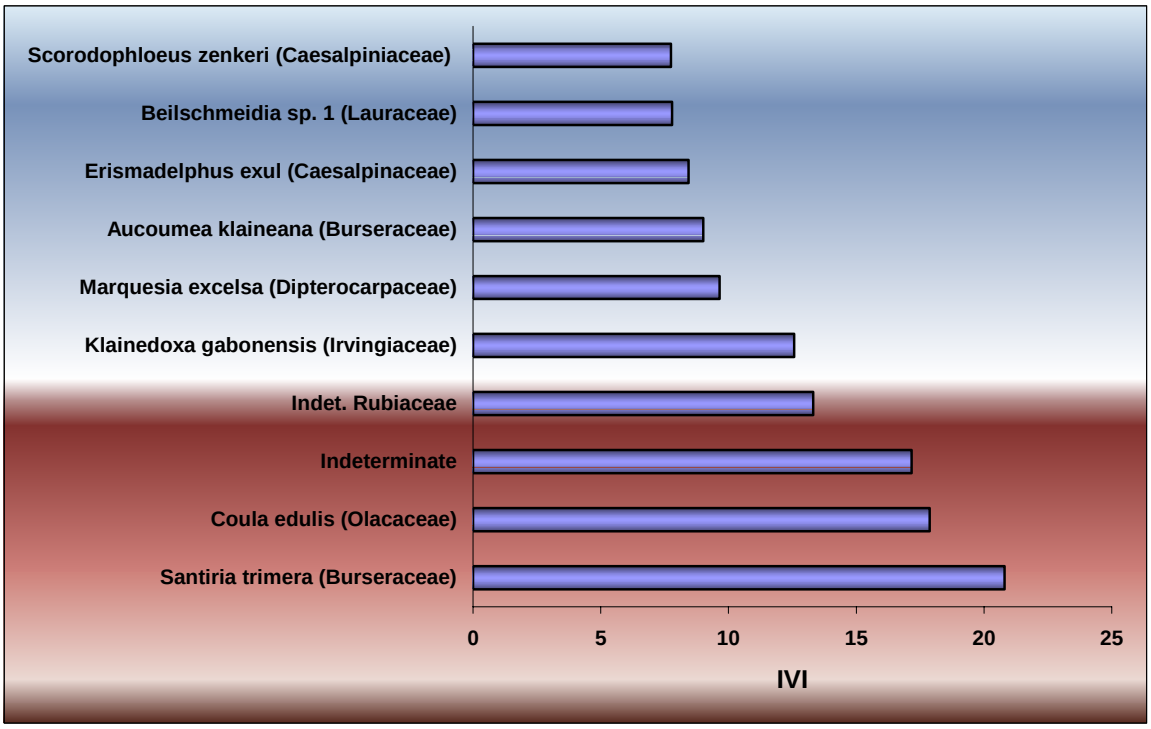
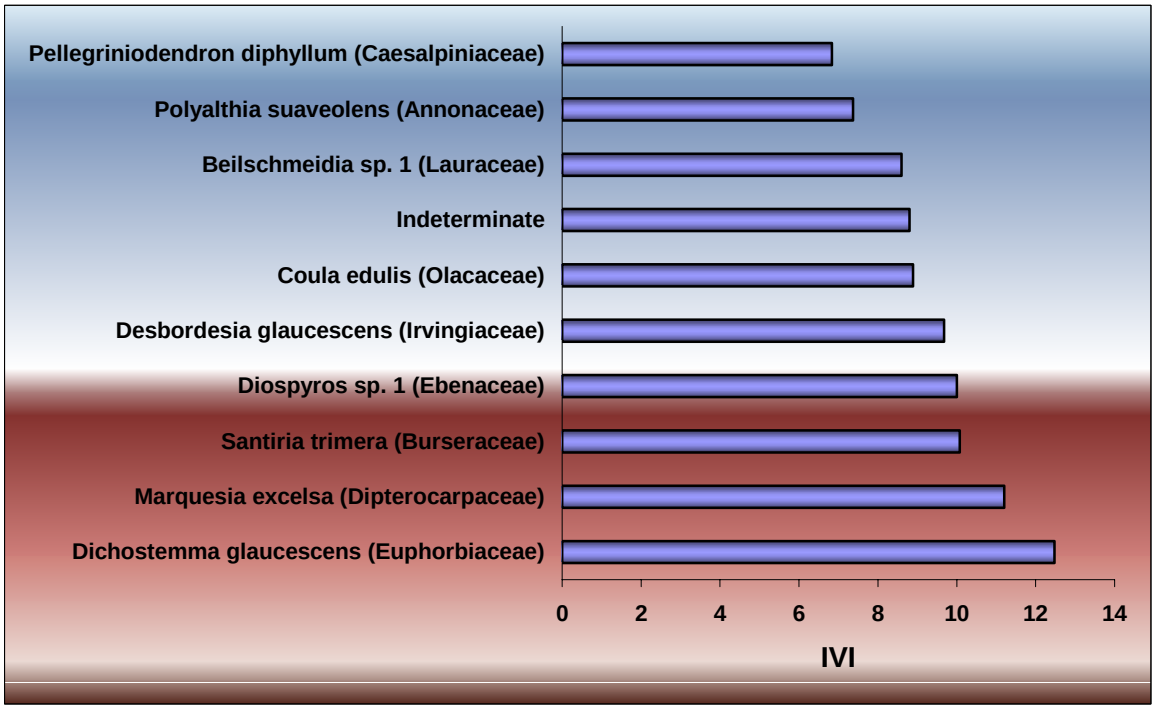



**Figure 20. Dominant species by IVI in Plot 5 (all trees >10cm dbh)**



*Species richness*

Monts de Cristal exhibits a remarkably high level of alpha diversity (in terms of number of species per hectare, of individuals >10cm dbh) when compared with other SI/MAB vegetation assessment sites in Africa.

**Table 4**. Summary of SI/MAB BDP's in Central Africa.

| | **Campo, Cameroon** | **Ejagham, Cameroon** | **Takamanda Cameroon** | **Monts de Cristal Gabon** |
|---|---|---|---|---|
| **No. of plots** | 3 | 2 | 10 | 5 |
| **Mean no. of trees (min. dbh)** | 397 (>10cm) | 525 (>10cm) | 463 (>10cm) | 539 (10cm) |
| **Mean total BA ($m^2$/ha)** | 31.9 | 33.6 | 30.8 | 37.23 |
| **Mean no. of species/ha (standard deviation)** | 76 (4.04) | 75 (6.36) | 93 (16.54) | 97 (8.71) |

*Species distribution*

It can be seen from the graphs above, Appendix 1, and the data presented in the accompanying field guide to this report, there are significant differences in species composition both within and between the two main sites suggesting that the Mbé National Park exhibits a remarkably high level of beta diversity. For example, of particular note is the dominance of *Uapaca guineensis* on Plot 1 and its virtual absence, aside from a few scattered individuals on Plots 2 and 3, from the other plots. Similarly the high frequency of two (unidentified) species of *Anisophyllea* on Plot 1, and their relative absence elsewhere is also of noticeable interest. Likewise, a species that is seemingly ubiquitous to the Mont de Cristal, *Dichostemma glaucescens*, is present in high densities in Plots 1, 2, 3 and 5 but is completely absent from Plot 4, where the sub-canopy is dominated by *Klainianthus gaboniae* and an indeterminate Rubiaceae, both of which are rare or absent from the other BDP's. *Oubangia* sp. is particularly well represented on Plot 5 but rare or absent elsewhere. These examples indicate that the species composition of the forests of the Monts de Cristal changes considerably within a relatively small spatial area and the forest is highly heterogeneous.

Summary of species restricted to a particular site:

Tchimbélé: *Afrostyrax lepidophyllus, Anisophyllea sp. 2, Anthonotha sp., Bikinia letestui, Dacryodes edulis, Dialium sp. 1, Gilbertiodendron ogoouense, Hymenostegia afzelii, H. klainii, Parinari excelsa, Pentaclethra macrophylla, Protomegabaria stapfiana, Psychotria gabonica, Pterocarpus soyauxii, Stachyorthyrsus staudtii, Swartzia fistuloides, Uapaca guineensis, Vitex doniana, Xylopia macrophyllum* and *X. quintasii*.

Kinguélé: *Angylocalyx sp.,Baillonella toxisperma, Bikinia durandii, Carapa sp., Chrysophyllum pruniforme, Craterispermum sp., Desbordesia glaucescens, Dialium tessmannii, Drypetes gossweileri, Hunteria sp, Irvingia robur, Lecomtedoxa heitziana, Lophira alata, Pellegriniodendron diphyllum, Paraberlinia bifoliolata, Scottelia zenkeri, Symphonia globulifera, Synsepalum sp.* and *Zenkerella* sp.

Some taxa are well represented in both sites and in all plots; these include *Aucoumea klaineana, Beilschmeidia sp., Coula edulis, Dacryodes igaganga, D. klaineana, Microdesmis sp., Polyalthia suaveolens, Santiria trimera, Strombosia grandifolia, S. scheffleri, Tetraberlinia bifoliolata* and *Trichoscypha acuminata*.

A full analysis of the species richness using diversity indices such as the Shannon-Weaver index and a comparison between assessment sites using ordinations will be undertaken once the final voucher determinations are completed.

*Forest structure*

In terms of forest structure, the Monts de Cristal BDP's exhibit high tree densities, with a mean number of 539 individuals / ha. Correspondingly, the area also possesses a very high basal area $m^2$/ha with many large merchantable tree species being represented. Canopy emergents up to 50m tall were recorded, however, most canopy trees are between 25-35m in height.

*Endemism*

Gabon is denoted as having a high rate of endemism, and the Monts de Cristal are considered to contain a significant proportion of endemic species. As a direct result of this study, a new population of *Korupodendron songweanum* was noted for the first time outside of Korup National Park, Cameroon (Litt and Cheek, 2003). Previously thought to be of conservation concern due to its limited distribution, botanists from the CTFS Korup Forest Dynamcis Plot who were collaborating on this project recorded *Korupodendron* from plot 3. This exciting new discovery was made possible by the rare field collaboration between Cameroonian and Gabonese botanists. Similar collaboration in the future will undoubtedly result in other additions to the knowledge of Central African plants and a better understanding of their IUCN conservation status and hence their overall conservation needs.

**Discussion**

Without question, particularly when compared with other humid tropical forests in Africa the Monts de Cristal exhibit high levels of species richness. In terms of numbers of species per hectare (trees >10cm dbh) it is the richest site in Africa assessed to date. The high levels of both alpha and beta diversity are remarkable. In terms of species richness, Africa has been referred to as the "odd man out" (Richards, 1973) when compared with high diversity forests of Latin America and SE Asia. However, when comparing the SI/MAB Central African sites with other SI/MAB assessment sites elsewhere in the tropics it is evident that they exhibit comparatively high levels of species richness. Similarly, with the MBG Gentry global dataset of 0.10 ha plots measuring stems greater than 2.5cm in diameter, within tropical continental Africa (Phillips and Miller 2002), the Monts de Cristal are the second most diverse site, even though only trees >10cm dbh were measured. It must be noted that when smaller stems are measured, a greater diversity of liana and subcanopy species are captured (Tchouto, 2004), thus if the Monts de Cristal plots had been enumerated below 10cm dbh, this site would surely exceed the Banyang Mbo 0.10 ha study site.

**Figure 21**. A comparison of SI/MAB assessment sites in the humid tropics in terms of species richness (calculated as the mean number of species per hectare).

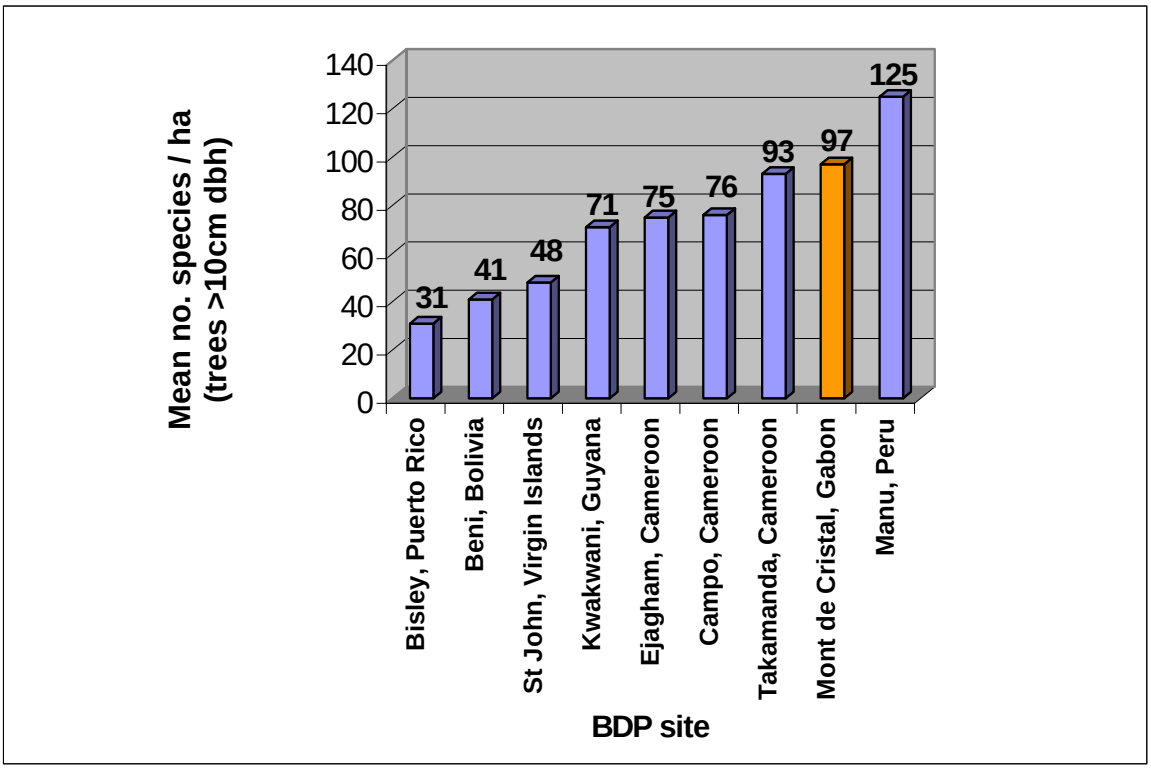
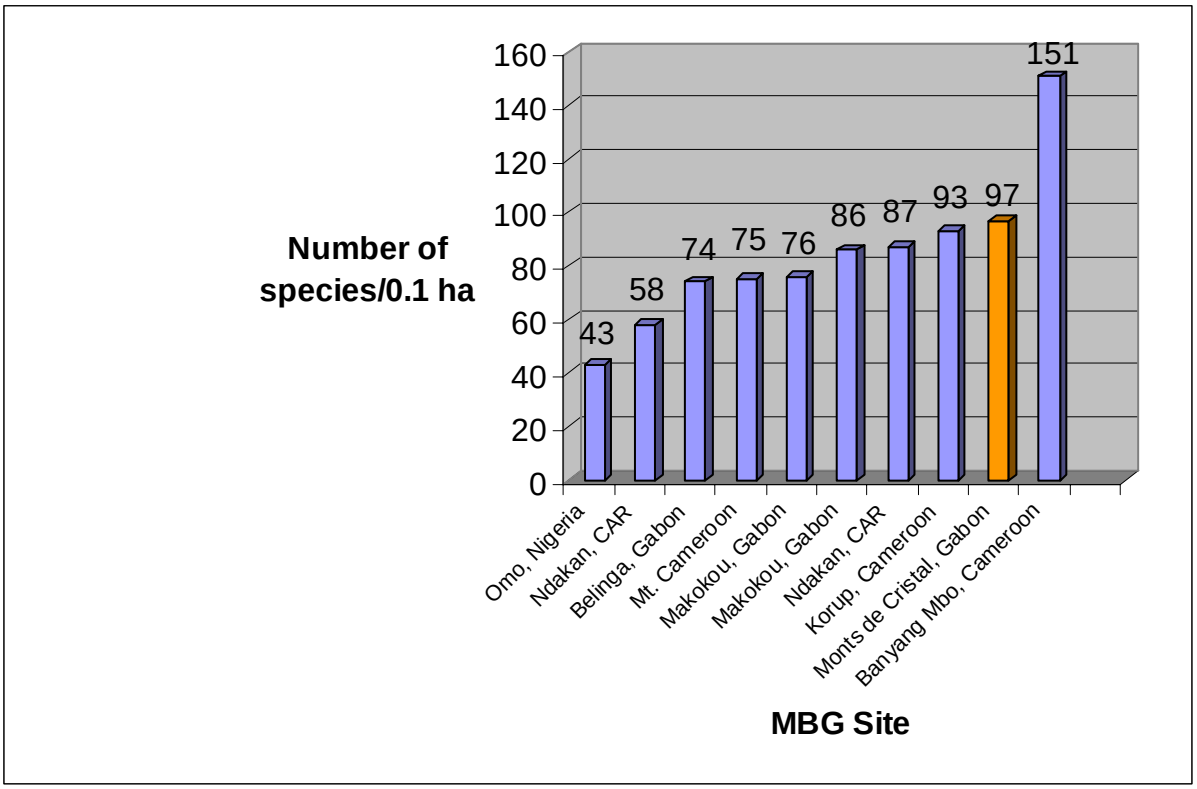


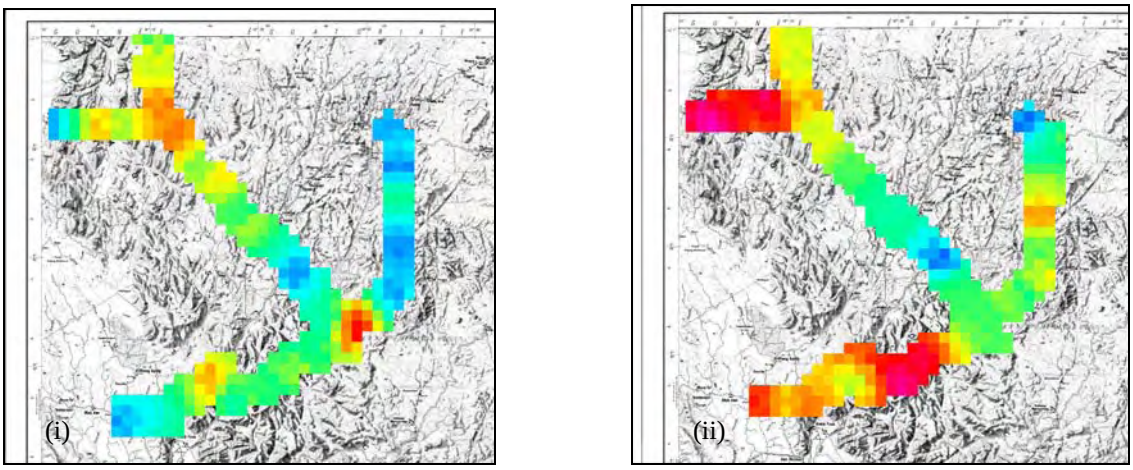
**Figure 22**. MBG 0.1 ha sites from Central Africa in comparison with the Monts de Cristal 1.0 ha plot.




As has been found to be the case with the CTFS plot network, lower diversity sites are more commonly situated in the drier tropics (Thomas, 2004). In these sites, it is clear that species richness is not as high as at sites with consistently high rainfall that falls for much of the year and without a pronounced dry season, such as Manu in Peru. The reputedly aseasonal nature of the climate of the Monts de Cristal (Wilks, pers. comm.) may certainly be one of the main reasons that this site exhibits such high species diversity.

The high heterogeneity of the area also contributes to the overall diversity of the Monts de Cristal. For example, it is interesting to note that diversity "hot spots" vary for different taxa, suggesting that high levels of diversity are encountered throughout the entire Monts de Cristal region. This is clear from the examples below where high levels of diversity recorded for the genus *Begonia*, do not necessarily correspond to those recorded for Caesalpinioid legumes.

**Figure 23**. Species richness for (i) Begonia and (ii) Caesalpinioid legumes. High levels of diversity are indicated by pink-red pixels, low diversity by yellow pixels (reproduced with permission of Lee White, WCS Gabon).




In common with Reitsma's Oveng study site, on the eastern and drier slopes of the mountains, the Monts de Cristal vegetation is dominated by Burseraceae, Euphorbiaceae and Caesalpiniaceae. However, although a common representative of the Burseraceae, *Santiria trimera* is found on all BDP's, the other two families exhibit remarkable changes in species composition, particularly between sites, but also, as has been discussed above, between individual BDP's. The presence of narrowly distributed taxa such as *Bikinia durandii*, and other members of that genus, and the only representative of the Dipterocarpaceae in Africa, and seemingly endemic to Gabon, *Marquesia excelsa*, suggests the vegetation composition of the Monts de Cristal is unique to the region, despite obvious affinities with the Monts Doudou (Sosef *et al*., 2004) and the Massif du Chaillu (Christy *et al*., 2003). Subsequent identification of the remaining voucher specimens and further analysis of the data collected will provide more insights into the vegetation types, and their relative "importance" of the area.

As part of a larger Gabon plant database project with Missouri Botanical Garden, Wageningen University, and the Musée National d'Histoire Naturel in Paris, the Herbier National du Gabon provided a list of the plants collected from the National Park with a 2 km buffer zone (Appendix 2) including collections made by MBG botanists. This list includes 545 taxa, which is drastically different from the 3,000 plant species estimated to occur in the Monts de Cristal by (de Wilde, cited in Davis *et. al*., 1994). However, it must be stressed that most of this collecting is centred in the immediate vicinity of the hydroelectric dams and thus large portions of the Monts de Cristal remain botanically unknown (Sosef, 2001). In comparing the species list of 152 taxa generated by our BDP's (Appendix 3) identified to date, it appears that almost 100 of these vouchers serve as new species records for the Monts de Cristal area. This may in part be due to the presence full time tree climber who collected many of the canopy trees normally overlooked by botanists undertaking random collections of fertile material. However, this disparity underlines how even the most well collected locality in Gabon is still in need of more exploration. The depositing of the voucher material collected during this assessment into

the permanent collections in LBV and MO and adding it to the joint database will also increase our capacity for future biodiversity analyses in the region and will better document the distribution of plant diversity in Gabon CARPE landscapes. Efforts such as this add to the knowledge of biodiversity in each protected area. While some parks such as Lopé have had a concentrated floristic project for some years, enabling effective conservation initiatives, other areas, such as the Monts de Cristal parks, have none. Future efforts such as this one will undoubtedly add to the biodiversity knowledge of what is protected in each landscape in the Congo Basin.

## Conclusion

The findings of our assessment of the vegetation of the Monts de Cristal certainly support the theory that the Pleistocene refugia of the Atlantic Equatorial Coastal forests that range from the Cross River basin to the Mayombe region are the greatest reservoirs of Africa's plant diversity. In this regard, the Monts de Cristal are undoubtedly one of the most important sites for plant diversity in Central Africa. Additionally, the documented diversity of Mbé National Park was increased by 18% with the addition of numerous canopy species as well as a significant range extension of *Korupodendron* originally noted uniquely from Korup National Park, Cameroun. The beta diversity argues favourably for the preservation of the Monts de Cristal as, in terms of diversity and endemism it ranks extremely high when compared to other areas in the region. Furthermore, this baseline data will be essential for understanding management implications in Mbé. With the proximity to Libreville and the subsequent pressures of bushmeat hunting, the existence of the forest as it stands now is at risk. Many trees are dependent upon animals for dispersal and sometimes are critical for triggering germination. Without decreasing the hunting in the Monts de Cristal, eventually the composition of the forest will change and diversity diminish. The monitoring system put in place by this project will help detect these potential and arguably deleterious changes.

The training and capacity building component of this field work will hopefully lead to a more standardised and comparable approach to vegetation assessments throughout the Congo Basin and the data generated will provide the biological baseline data required for the monitoring of forests for both natural and anthropogenic processes, within the CARPE Landscapes. Furthermore, the collaboration of a Cameroonian-Gabonese team strengthened the regional capacity to evaluate vegetation across the Congo Basin CARPE landscapes. With similar collaboration in the future, a region wide picture of landscape plant diversity will emerge along with a strong regional network of botanists able to undertaken and analysis the data from such field assessments.

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**Appendix 1: Occurrence of species by Plot (Figures represent number of individuals in each plot)**

| Species | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 |
|---|---|---|---|---|---|
| AFROSTYRAX LEPIDOPHYLLUS | 1 | 2 | 0 | 0 | 0 |
| AIDIA MICRANTHA | 0 | 0 | 0 | 0 | 1 |
| AIDIA SP. | 0 | 0 | 0 | 0 | 1 |
| ANGYLOCALYX SP. | 0 | 0 | 0 | 1 | 1 |
| ANISOPHYLLEA SP. 1 | 32 | 9 | 3 | 8 | 2 |
| ANISOPHYLLEA SP. 2 | 14 | 3 | 2 | 0 | 0 |
| ANNICKIA CHLORANTHA | 1 | 0 | 1 | 0 | 4 |
| ANNONACEAE | 0 | 2 | 0 | 0 | 1 |
| ANOPYXIS KLAINIANA | 1 | 0 | 0 | 1 | 0 |
| ANTHONOTHA SP | 0 | 0 | 1 | 2 | 1 |
| ANTHOCLEISTA SP | 3 | 0 | 0 | 0 | 0 |
| APHANOCALYX MICROPHYLLUS | 0 | 0 | 1 | 0 | 0 |
| APOCYNACEAE | 0 | 0 | 0 | 0 | 1 |
| AUCOUMEA KLAINEANA | 7 | 17 | 5 | 13 | 4 |
| BAILLONELLA TOXISPERMA | 0 | 0 | 0 | 0 | 1 |
| BAPHIA SP. | 0 | 1 | 0 | 0 | 1 |
| BARTERIA FISTULOSA | 0 | 0 | 2 | 0 | 0 |
| BEILSCHMEIDIA SP. | 3 | 13 | 8 | 15 | 21 |
| BERLINIA SP. | 2 | 0 | 2 | 1 | 1 |
| BIKINIA DURANDII | 0 | 0 | 0 | 7 | 10 |
| BIKINIA LETESTUI | 0 | 3 | 0 | 0 | 0 |
| BIKINIA PELLEGRINII | 0 | 3 | 1 | 5 | 0 |
| BLIGHIA SP. | 0 | 0 | 0 | 0 | 1 |
| CAESALPINIACEAE | 2 | 1 | 3 | 1 | 0 |
| CALPOCALYX SP. | 1 | 0 | 0 | 0 | 0 |
| CANTHIUM SP. | 19 | 0 | 0 | 1 | 0 |
| CARAPA PROCERA | 3 | 3 | 0 | 0 | 1 |
| CARAPA SP. | 0 | 0 | 0 | 0 | 7 |
| CENTROPLACUS GLAUCINUS | 0 | 7 | 7 | 10 | 3 |
| CHRYSOPHYLLUM PRUNIFORME | 0 | 0 | 0 | 0 | 2 |
| CHRYSOPHYLLUM SP. | 4 | 1 | 1 | 1 | 0 |
| CLEISTANTHUS SP. 1 | 27 | 17 | 23 | 5 | 7 |
| CLEISTANTHUS SP. 2 | 1 | 0 | 2 | 2 | 1 |
| CLEISTANTHUS SP. 3 | 0 | 9 | 2 | 6 | 0 |
| CLEISTANTHUS TETANDRA | 0 | 1 | 0 | 0 | 0 |
| COELOCARYON PREUSII | 2 | 3 | 3 | 1 | 0 |
| COELOCARYON SP. | 0 | 1 | 0 | 0 | 0 |
| COLA SP. | 0 | 5 | 0 | 0 | 2 |
| COPAIFERA RELIGIOSA | 0 | 0 | 1 | 0 | 1 |
| CORYNANTHE MAYUMBENSIS | 0 | 0 | 0 | 1 | 0 |
| COULA EDULIS | 9 | 5 | 14 | 23 | 12 |
| CRATERISPERMUM SP. | 0 | 0 | 0 | 2 | 2 |
| CROTON SILVATICUS | 1 | 0 | 0 | 0 | 0 |
| CROTON SP. 1 | 0 | 1 | 0 | 0 | 0 |
| CRYPTOSEPALUM SP. | 0 | 0 | 0 | 1 | 1 |
| DACRYODES BUETTNERI | 1 | 1 | 2 | 5 | 9 |
| DACRYODES EDULIS | 6 | 14 | 2 | 0 | 0 |
| DACRYODES IGAGANGA | 20 | 13 | 12 | 9 | 11 |
| DACRYODES KLAINEANA | 4 | 5 | 6 | 1 | 7 |
| DACRYODES SP. | 0 | 2 | 0 | 1 | 2 |
| DANIELLIA SP. | 0 | 0 | 1 | 0 | 0 |
| DESBORDESIA GLAUCESCENS | 0 | 0 | 0 | 3 | 10 |
| DIALIUM SP. 1 | 24 | 6 | 6 | 0 | 0 |
| DAILIUM SP. 2 | 18 | 27 | 24 | 5 | 8 |
| DIALIUM SP. 3 | 2 | 1 | 2 | 1 | 1 |
| DIALIUM TESSMANNII | 0 | 0 | 0 | 2 | 1 |

| Species | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 |
|---|---|---|---|---|---|
| DICHOSTEMMA GLAUCESCENS | 55 | 15 | 23 | 0 | 35 |
| DIOSPYROS SP. | 10 | 5 | 8 | 12 | 24 |
| DIOGOA ZENKERI | 0 | 12 | 14 | 1 | 2 |
| DISCOGLYPREMNA CALONEURA | 2 | 0 | 0 | 0 | 0 |
| DISCOGLYPREMNA SP. | 0 | 1 | 0 | 0 | 0 |
| DRYPETES GOSSWEILERI | 0 | 0 | 0 | 0 | 1 |
| DRYPETES SP. | 1 | 4 | 8 | 11 | 9 |
| DUVIGNEAUDIA INOPINATA | 0 | 0 | 1 | 0 | 0 |
| ENTANDROPHRAGMA SP. | 1 | 0 | 1 | 0 | 0 |
| ERISMADELPHUS EXUL | 0 | 1 | 3 | 5 | 0 |
| ERISMADELPHUS SP. 1 | 4 | 0 | 1 | 2 | 1 |
| ERISMADELPHUS SP. 2 | 1 | 0 | 0 | 0 | 0 |
| EUPHORBIACEAE | 2 | 0 | 45 | 4 | 1 |
| FILLAEOPSIS DISCOPHORA | 0 | 2 | 0 | 1 | 0 |
| FUNTUMIA AFRICANA | 1 | 0 | 0 | 0 | 0 |
| GANOPHYLLUM GIGANTEUM | 0 | 0 | 1 | 0 | 0 |
| GARCINIA CONRAUANA | 0 | 0 | 6 | 0 | 0 |
| GARCINIA SMEATHMANNII | 0 | 3 | 1 | 2 | 11 |
| GARCINIA SP. 1 | 0 | 2 | 6 | 8 | 4 |
| GARCINIA SP. 2 | 7 | 26 | 24 | 3 | 14 |
| GILBERTIODENDRON BRACHYSTEGIOIDES | 0 | 0 | 1 | 0 | 6 |
| GILBERTIODENDRON OGOOUENSE | 0 | 0 | 1 | 0 | 0 |
| GILBERTIODENDRON SP. | 0 | 8 | 0 | 1 | 7 |
| GREWIA CORIACEA | 9 | 0 | 0 | 0 | 0 |
| GROSSERA SP. | 1 | 0 | 0 | 0 | 0 |
| GUAREA SP. | 0 | 0 | 0 | 0 | 1 |
| GUAREA THOMPSONII | 0 | 0 | 0 | 1 | 0 |
| GUIBOURTIA EHIE | 0 | 3 | 4 | 3 | 3 |
| HEISTERIA PARVIFOLIA | 0 | 6 | 4 | 1 | 0 |
| HUNTERIA SP. | 0 | 0 | 0 | 0 | 1 |
| HYMENOSTEGIA AFZELII | 0 | 0 | 1 | 0 | 0 |
| HYMENOSTEGIA KLAINII | 3 | 0 | 2 | 0 | 0 |
| HYMENOSTEGIA SP. | 0 | 20 | 2 | 0 | 0 |
| INDETERMINATE | 0 | 9 | 1 | 48 | 23 |
| IRVINGIA GABONENSIS | 1 | 6 | 1 | 4 | 3 |
| IRVINGIA ROBUR | 0 | 0 | 0 | 1 | 0 |
| ISOMACROLOBIUM SP. | 0 | 2 | 0 | 0 | 0 |
| ISOLONA SP. | 1 | 0 | 0 | 0 | 0 |
| KLAINEDOXA GABONENSIS | 3 | 3 | 3 | 2 | 0 |
| KLAINIATHUS GABONIAE | 3 | 0 | 6 | 26 | 12 |
| LAURACEAE | 1 | 0 | 0 | 0 | 0 |
| LECOMTEDOXA HEITZIANA | 0 | 0 | 0 | 0 | 4 |
| LECOMTEDOXA SP. | 0 | 0 | 0 | 0 | 3 |
| LOPHIRA ALATA | 0 | 0 | 0 | 4 | 3 |
| MACARANGA SP. | 0 | 1 | 0 | 1 | 0 |
| MAESOBOTRYA SP. | 2 | 0 | 2 | 1 | 0 |
| MAGNISTIPULA SP. | 0 | 0 | 0 | 0 | 3 |
| MANILKARA SP. | 0 | 0 | 1 | 0 | 1 |
| MAPANEA MEMBRANACEA | 4 | 0 | 2 | 1 | 0 |
| MARQUESIA EXCELSA | 0 | 0 | 5 | 7 | 10 |
| MARANTHES SP. | 1 | 0 | 0 | 0 | 1 |
| MELASTOMATACEAE | 0 | 0 | 1 | 0 | 0 |
| MEMECYLON SP. | 0 | 2 | 1 | 6 | 15 |
| MICRODESMIS SP. | 6 | 16 | 28 | 14 | 5 |
| MYRIANTHUS SERRATUS | 0 | 1 | 2 | 0 | 0 |
| NEOCHEVALIODENDRON STEPHANII | 0 | 2 | 0 | 0 | 0 |
| NEWTONIA DUPARQUETIANA | 0 | 0 | 2 | 0 | 0 |
| NEWTONIA GRIFFONIANA | 0 | 1 | 0 | 0 | 0 |
| NEWTONIA LEUCOCARPA | 2 | 0 | 0 | 1 | 0 |

| Species | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 |
|---|---|---|---|---|---|
| NEWTONIA SP. | 0 | 2 | 0 | 0 | 0 |
| ODYENDYEA GABONENSIS | 2 | 0 | 2 | 3 | 0 |
| OLACACEAE | 0 | 0 | 0 | 4 | 1 |
| ONCOBA GLAUCA | 3 | 0 | 0 | 0 | 0 |
| OUBANGIA SP. | 0 | 1 | 0 | 1 | 13 |
| OURATEA SP. | 0 | 0 | 0 | 0 | 1 |
| PARKIA BICOLOR | 2 | 3 | 0 | 0 | 1 |
| PARABERLINA BIFOLIOLATA | 0 | 0 | 0 | 0 | 6 |
| PARINARI EXCELSA | 1 | 1 | 0 | 0 | 0 |
| PAUSINYSTALIA JOHIMBE | 0 | 0 | 1 | 6 | 0 |
| PAUSINYSTALIA MACROCERAS | 0 | 4 | 5 | 1 | 1 |
| PAUSINYSTALIA SP. | 0 | 1 | 1 | 1 | 0 |
| PELLEGRINIODENDRON DIPHYLLUM | 0 | 0 | 0 | 4 | 21 |
| PENTACLETHRA MACROPHYLLA | 0 | 7 | 0 | 0 | 0 |
| PENTACLETHRA SP. | 0 | 0 | 0 | 0 | 1 |
| PICRALIMA NITIDA | 0 | 0 | 0 | 0 | 2 |
| PLAGIOSTYLES AFRICANA | 11 | 9 | 13 | 8 | 4 |
| PLACODISCUS SP. | 0 | 0 | 0 | 1 | 0 |
| POLYALTHIA SUAVEOLENS | 4 | 11 | 16 | 13 | 18 |
| PORTERANDIA CLADANTHA | 1 | 0 | 0 | 0 | 0 |
| PROTOMEGABARIA STAFPIANA | 1 | 1 | 9 | 0 | 0 |
| PSYCHOTRIA GABONICA | 2 | 0 | 0 | 0 | 0 |
| PSYCHOTRIA SP. | 0 | 0 | 0 | 1 | 0 |
| PTEROCARPUS SOYAUXII | 1 | 0 | 0 | 0 | 0 |
| PYCNANTHUS ANGOLENSIS | 0 | 1 | 0 | 1 | 1 |
| RHABDOPHYLLUM SP. | 2 | 0 | 0 | 0 | 1 |
| RUBIACEAE | 2 | 2 | 4 | 36 | 4 |
| SANTIRIA TRIMERA | 37 | 70 | 33 | 48 | 21 |
| SAPIUM ELLIPTICUM | 0 | 0 | 1 | 0 | 0 |
| SAPINDACEAE | 0 | 0 | 2 | 0 | 2 |
| SAPOTACEAE | 0 | 0 | 2 | 0 | 3 |
| SCAPHOPETALUM BLACKII | 0 | 5 | 3 | 0 | 2 |
| SCHEFFLERA SP | 0 | 0 | 0 | 0 | 1 |
| SCOTTELIA CORIACEA | 2 | 0 | 1 | 0 | 2 |
| SCOTTELIA KLAINIANA | 1 | 0 | 0 | 0 | 0 |
| SCOTTELIA ZENKERI | 0 | 0 | 0 | 11 | 2 |
| SCYTOPETALUM KLAINIANUM | 0 | 2 | 1 | 6 | 5 |
| SCYTOPETALUM SP. | 0 | 1 | 0 | 0 | 0 |
| SCYPHOCEPHALIUM OCHOCOA | 3 | 0 | 1 | 1 | 1 |
| SCYPHOCEPHALIUM SP. | 0 | 0 | 1 | 0 | 1 |
| SINDEROPSIS LETESTUI | 0 | 12 | 7 | 3 | 2 |
| SORINDEIA SP. | 1 | 3 | 2 | 4 | 6 |
| STACHYORTHYRSUS STAUDTII | 20 | 6 | 7 | 0 | 0 |
| STAUDTIA GABONENSIS | 0 | 0 | 1 | 0 | 0 |
| STAUDTIA STIPITATA | 0 | 0 | 2 | 1 | 4 |
| STREPHONEMA MANNII | 0 | 1 | 0 | 0 | 0 |
| STREPHONEMA SP. | 0 | 2 | 3 | 0 | 0 |
| STROMBOSIA GRANDIFOLIA | 1 | 2 | 1 | 4 | 7 |
| STROMBOSIA PUSTULATA | 1 | 2 | 2 | 3 | 0 |
| STROMBOSIA SCHEFFLERI | 5 | 4 | 1 | 2 | 1 |
| STROMBOSIOPSIS SERENII | 5 | 0 | 3 | 0 | 1 |
| STROMBOSIOPSIS TETANDRA | 21 | 34 | 23 | 9 | 4 |
| STRYCHNOS SP. | 3 | 0 | 0 | 0 | 0 |
| SWARTZIA FISTULOIDES | 0 | 1 | 0 | 0 | 0 |
| SYMPHONIA GLOBULIFERA | 0 | 0 | 0 | 6 | 5 |
| SYNSEPALUM SP. | 0 | 0 | 0 | 1 | 7 |
| SYZYGIUM SP. | 0 | 0 | 2 | 0 | 1 |
| TABERNASMONTANA CRASSA | 2 | 0 | 0 | 0 | 0 |
| TAPURA SP. | 0 | 7 | 0 | 0 | 1 |

| Species | Plot 1 | Plot 2 | Plot 3 | Plot 4 | Plot 5 |
|---|---|---|---|---|---|
| TETRABERLINA BIFOLIOLATA | 8 | 9 | 6 | 0 | 11 |
| TRICHILIA SP. | 2 | 0 | 0 | 1 | 0 |
| TRECULIA AFRICANA | 0 | 0 | 0 | 0 | 1 |
| TRECULIA OBOVOIDEA | 1 | 0 | 0 | 0 | 0 |
| TRICHOSCYPHA ABUT | 0 | 0 | 2 | 0 | 1 |
| TRICHOSCYPHA ACUMINATA | 4 | 1 | 2 | 4 | 5 |
| TRICHOSCYPHA ARBOREA | 1 | 0 | 0 | 0 | 0 |
| TRICHOSCYPHA SP. | 1 | 3 | 0 | 0 | 6 |
| TRICALYSIA SP. | 2 | 1 | 0 | 0 | 1 |
| UAPACA GUINEENSIS | 36 | 4 | 2 | 0 | 0 |
| UNKNOWN (DEAD) | 2 | 8 | 6 | 1 | 6 |
| VITEX DONIANA | 1 | 2 | 0 | 0 | 0 |
| VITEX SP. | 0 | 0 | 0 | 0 | 1 |
| WARNECKIA SP. | 0 | 1 | 5 | 19 | 15 |
| XANTHOXYLUM HEITZII | 1 | 0 | 0 | 0 | 0 |
| XANTHOXYLUM MACROPHYLLUM | 1 | 0 | 0 | 0 | 0 |
| XYLOPIA AETHIOPICA | 2 | 0 | 0 | 2 | 0 |
| XYLOPIA MACROPHYLLUM | 1 | 0 | 0 | 0 | 0 |
| XYLOPIA PHLLOIOLONE | 0 | 0 | 3 | 0 | 1 |
| XYLOPIA QUINTASII | 0 | 1 | 1 | 0 | 0 |
| XYLOPIA SP. | 1 | 1 | 1 | 8 | 3 |
| XYLOPIA STAUDTII | 6 | 0 | 2 | 4 | 4 |
| ZENKERELLA SP. | 0 | 0 | 0 | 0 | 2 |

## APPENDIX 2: CHECKLIST NATIONAL PARK MTS DE CRISTAL EASTERN PART

*Based on NHN WAG database info February 2003*

(Based on an initial number of 963 records, 545 'taxa'; if for a family the specimens are only identified up to family level still the family name is mentioned)

(No verification of taxonomical status of names or doubtful species records)

Johan L.C.H. van Valkenburg, CENAREST/Herbier National du Gabon

**ACANTHACEAE**
*Acanthus latisepalus* C.B.Clarke
*Brillantaisia lancifolia* Lindau
*Dischistocalyx* T.Anders. ex Benth.
*Dischistocalyx grandifolius* C.B.Clarke
*Dischistocalyx hirsutus* C.B.Clarke
*Dischistocalyx strobilinus* C.B.Clarke
*Mendoncia phytocrenoides* (Gilg) Benoist
*Phaulopsis angolana* S.Moore
*Physacanthus* Benth.
*Physacanthus batanganus* (G.Braun & K.Schum.) Lindau
*Physacanthus nematosiphon* (Lindau) Rendle & Britten
*Pseuderanthemum tunicatum* (Afzel.) Milne-Redh.
*Stenandrium guineense* (Nees) K.Vollesen

**ADIANTACEAE**
*Adiantum* L.

**AMARYLLIDACEAE**
*Crinum* L.

**ANACARDIACEAE**
*Sorindeia* Thouars
*Sorindeia winkleri* Engl.
*Trichoscypha acuminata* Engl.
*Trichoscypha bijuga* Engl.
*Trichoscypha ealaensis* Van der Veken
*Trichoscypha laxiflora* Engl.

A**NNONACEAE**
*Anonidium mannii* (Oliv.) Engl. & Diels
*Anonidium mannii* (Oliv.) Engl. & Diels var. *brieyi* (De Wild.) R.E.Fr.
*Cleistopholis glauca* Pierre ex Engl. & Diels
*Cleistopholis patens* (Benth.) Engl. & Diels
*Piptostigma macranthum* Mildbr. & Diels
*Uvaria klaineana* Engl. & Diels
*Xylopia* L.

**APOCYNACEAE**
*Baissea leonensis* Benth.
*Hunteria macrosiphon* Omino
*Landolphia* P.Beauv.
*Landolphia buchananii* (Hallier f.) Stapf
*Landolphia dewevrei* Stapf
*Landolphia glabra* (Pierre ex Stapf) Pichon
*Landolphia glandulosa* (Pellegr.) Pichon
*Pleiocarpa mutica* Benth.
*Rauvolfia mannii* Stapf
*Strophanthus thollonii* Franch.
*Tabernaemontana* L.
*Tabernaemontana divaricata* (Jacq.) Willd.
*Tabernaemontana letestui* (Pellegr.) Pichon
*Tabernanthe iboga* Baill.
*Vahadenia laurentii* (De Wild.) Stapf
*Voacanga psilocalyx* Pierre ex Stapf

**ARACEAE**
*Anubias* Schott.
*Anubias barteri* Schott
*Anubias barteri* Schott var. *glabra* N.E.Br.
*Anubias gilletii* De Wild. & T.Durand
*Cercestis* Schott.
*Colocasia*
*Culcasia panduriformis* Engl. & K.Krause
*Culcasia parviflora* N.E.Brown
*Culcasia rotundifolia* Bogner
*Culcasia striolata* Engl.

**ARISTOLOCHIACEAE**
*Pararistolochia macrocarpa* (Duch.) Poncy

**ASPLENIACEAE**
*Asplenium* L.
*Asplenium africanum* Desv.
*Asplenium barteri* Hook.
*Asplenium dregeanum* Kunze
*Asplenium mannii* Hook.

**BALSAMINACEAE**
*Impatiens* L.
*Impatiens hians* Hook.f.
*Impatiens hians* Hook.f. var. *hians*
*Impatiens macroptera* Hook.f.
*Impatiens pseudomacroptera* Grey-Wilson

**BEGONIACEAE**
*Begonia* L.
*Begonia (filicibegonia)* Hook.f.

*Begonia ampla* Hook.f.
*Begonia auriculata* Hook.f.
*Begonia clypeifolia* Hook.f.
*Begonia elaeagnifolia* Hook.f.
*Begonia elatostemmoides* Hook.f.
*Begonia erectocaulis* Sosef
*Begonia erectotricha* Sosef
*Begonia heterochroma* Sosef
*Begonia hirsutula* Hook.f.
*Begonia komoensis* Irmsch.
*Begonia letouzeyi* Sosef
*Begonia longipetiolata* Gilg
*Begonia macrocarpa* Warb.
*Begonia minutifolia* N.Hallé
*Begonia poculifera* Hook.f. var. *poculifera*
*Begonia sciaphila* Gilg ex Engl. var. *longipedunculata* R.Wilczek
*Begonia scutulum* Hook.f.
*Begonia sessilifolia* Hook.f.
*Begonia squamulosa* Hook.f.
*Begonia subscutata* De Wild.
*Begonia susaniae* Sosef

**BURMANNIACEAE**
*Burmannia congesta* (Wright) Jonker
*Gymnosiphon* Blume
*Gymnosiphon longistylus* (Benth.) Hutch.

**BURSERACEAE**
*Dacryodes le-testui* (Pellegr.) Lam
*Santiria trimera* (Oliv.) Aubrév.

**CACTACEAE**
*Rhipsalis baccifera* (J.S.Muell.) Stearn

**CAPPARACEAE**
*Ritchiea macrantha* Gilg

**CELASTRACEAE**
*Apodostigma pallens* (Planch. ex Oliv.) Wilcz.
*Salacia* L.
*Salacia regeliana* J.Braun & K.Schum.

**CHRYSOBALANACEAE**
*Dactyladenia staudtii* (Engl.) Prance & F.White
*Parinari* Aubl.

**COMBRETACEAE**
*Combretum* Loefl.
*Combretum bracteatum* (Laws.) Engl. & Diels
*Combretum exellii* Jongkind

*Combretum mannii* Engl. & Diels

**COMMELINACEAE**
*Aneilema* R.Br.
*Commelina longicapsa* C.B.Clarke
*Palisota bogneri* Brenan
*Palisota hirsuta* (Thunb.) K.Schum.
*Palisota lagopus* Mildbr.
*Palisota mannii* C.B.Clarke
*Stanfieldiella* Brenan
*Stanfieldiella oligantha* (Mildbr.) Brenan

**COMPOSITAE**
*Eclipta prostrata* (L.) L.
*Elephantopus* L.
*Erlangea misera* (Oliv. & Hiern) S.Moore
*Gutenbergia*
*Spilanthes uliginosa* Sw.

**CONNARACEAE**
*Agelaea pentagyna* (Lam.) Baill.
*Agelaea poggeana* Gilg
*Connarus* L.
*Manotes expansa* Sol. ex Planch.
*Rourea calophylla* (Gilg ex Schellenb.) Jongkind

**CUCURBITACEAE**
*Cogniauxia podolaena* Baill.
*Momordica* L.
*Momordica parvifolia* Cogn.

**CYATHEACEAE**
*Cyathea camerooniana* Hook.

**CYPERACEAE**
*Cyperus difformis* L.
*Cyperus halpan* L.
*Fimbristylis dichotoma* (L.) Vahl
*Fuirena umbellata* Rottb.
*Hypolytrum scaberrimum* Boeck.
*Mapania africana* Boeck. ssp. *africana*
*Mapania amplivaginata* K.Schum.
*Mapania mannii* C.B.Clarke
*Mapania mannii* C.B.Clarke ssp. *mannii*
*Mapania pubisquama* Cherm.
*Mapania purpuriceps* (C.B.Clarke) J.Raynal
*Pycreus cataractarum* C.B.Clarke
*Rhynchospora corymbosa* (L.) Britt.

**DENNSTAEDTIACEAE**
*Lonchitis currorii* (Hook.) Mett. ex Kuhn

**DICHAPETALACEAE**
*Dichapetalum heudelotii* (Planch. ex Oliv.) Baill.
*Dichapetalum heudelotii* (Planch. ex Oliv.) Baill. var. *hispidum* (Oliv.) Breteler
*Dichapetalum madagascariense* Poir.
*Dichapetalum staudtii* Engl.
*Dichapetalum tetrastachyum* Breteler

**DILLENIACEAE**
*Tetracera alnifolia* Willd.

**DIOSCOREACEAE**
*Dioscorea minutiflora* Engl.
*Dioscorea smilacifolia* De Wild.

**DRACAENACEAE**
*Dracaena* Vand. ex L.
*Dracaena acaulis* Baker
*Dracaena phanerophlebia* Baker

**DRYOPTERIDACEAE**
*Lastreopsis davalliaeformis* (Tardieu) Tardieu
*Triplophyllum dimidiatum* (Mett. ex Kuhn) Holttum
*Triplophyllum varians* (Moore) Holttum

**EBENACEAE**
*Diospyros* L.
*Diospyros hoyleana* F.White
*Diospyros physocalycina* Gürke
*Diospyros zenkeri* (Gürke) F.White

**ERYTHROXYLACEAE**
*Aneulophus africanus* Benth.

**EUPHORBIACEAE**
*Alchornea floribunda* Müll.Arg.
*Alchornea hirtella* Benth.
*Argomuellera macrophylla* Pax
*Crotonogyne* Müll.Arg.
*Drypetes* Vahl
*Drypetes magnistipula* (Pax) Hutch.
*Duvigneaudia inopinata* (Prain) J.Léonard
*Grossera paniculata* Pax
*Maesobotrya* Benth.
*Maesobotrya klaineana* Pierre ex Pax
*Maesobotrya longipes* (Pax) Hutch.
*Maesobotrya staudtii* (Pax) Hutch.
*Manniophyton fulvum* Müll.Arg.

*Microdesmis afrodecandra* Floret, A.M.Louis & J.M.Reitsma
*Pentabrachion reticulatum* Müll.Arg.
*Pogonophora letouzeyi* Feuillet
*Protomegabaria stapfiana* (Beille) Hutch.
*Tetrorchidium didymostemon* (Baill.) Pax & K.Hoffm.
*Tetrorchidium gabonense* Breteler
*Uapaca* Baill.

**FLACOURTIACEAE**
*Homalium africanum* (Hook.f.) Benth.
*Oncoba flagelliflora* (Mildbr.) Hul
*Oncoba glauca* (P.Beauv.) Planch.
*Phyllobotryon spathulatum* Müll.Arg.

**GENTIANACEAE**
*Neurotheca loeselioides* (Spruce ex Prog.) Baill.

**GLEICHENIACEAE**
*Dicranopteris linearis* (Burm.) C.B.Clarke

**GNETACEAE**
*Gnetum africanum* Welw.

**GRAMINEAE**
*Centotheca lappacea* (L.) Desv.
*Eragrostis squamata* (Lam.) Steud.
*Guaduella marantifolia* Franch.
*Isachne buettneri* Hack.
*Olyra* L.
*Panicum brevifolium* L.
*Paspalum paniculatum* L.
*Puelia ciliata* Franchet
*Sorghum arundinaceum* (Desv.) Stapf

**GRAMMITIDACEAE**
*Grammitis serrulata* (Sw.) Sw.

**GUTTIFERAE**
*Garcinia kola* Heckel
*Garcinia lucida* Vesque
*Garcinia mannii* Oliv.
*Harungana madagascariensis* Lam. ex Poir.
*Mammea africana* Sabine
*Vismia rubescens* Oliv.

**HERNANDIACEAE**
*Illigera vespertilio* (Benth.) Baker f.

**HYMENOPHYLLACEAE**
*Trichomanes* L.

**ICACINACEAE**
*Alsodeiopsis rubra* Engl.
*Desmostachys brevipes* (Engl.) Sleumer
*Lasianthera africana* P.Beauv.
*Leptaulus holstii* (Engl.) Engl.
*Rhaphiostylis fusca* (Pierre) Pierre

**IRVINGIACEAE**
*Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill.

**LAURACEAE**
*Beilschmiedia* Nees

**LECYTHIDACEAE**
*Napoleonaea talbotii* Baker f.

**LEGUMINOSAE-CAES.**
*Anthonotha macrophylla* P.Beauv.
*Aphanocalyx cynometroides* Oliv.
*Aphanocalyx heitzii* (Pellegr.) Wieringa
*Aphanocalyx microphyllus* (Harms) Wieringa ssp. *microphyllus*
*Berlinia bracteosa* Benth.
*Bikinia coriacea* (J.Morel ex Aubrév.) Wieringa
*Bikinia durandii* (F.Hallé & Normand) Wieringa
*Bikinia grisea* Wieringa
*Bikinia le-testui* (Pellegr.) Wieringa
*Bikinia le-testui* (Pellegr.) Wieringa ssp. *le-testui*
*Bikinia pellegrinii* (A.Chev.) Wieringa
*Brachystegia mildbraedii* Harms
*Dialium* L.
*Dialium angolense* Welw. ex Oliv.
*Dialium bipindense* Harms
*Gilbertiodendron unijugum* (Pellegr.) J.Léonard
*Guibourtia ehie* (A.Chev.) J.Léonard
*Hymenostegia klainei* Pierre ex Pellegr.
*Hymenostegia talbotii* Baker f.
*Julbernardia pellegriniana* Troupin
*Pellegriniodendron diphyllum* (Harms) J.Léonard
*Tetraberlinia bifoliolata* (Harms) Hauman

**LEGUMINOSAE-MIM.**
*Acacia pentagona* (Schum.) Hook.f.
*Entada gigas* (L.) Fawcett & Rendle
*Pentaclethra macrophylla* Benth.
*Tetrapleura tetraptera* (Schum. & Thonn.) Taub.

**LEGUMINOSAE-PAP.**
*Baphia* Afzel. ex Lodd.
*Dalbergiella gossweileri* Baker f.
*Dalhousiea africana* S.Moore

*Desmodium ramosissimum* G.Don
*Millettia harmsiana* De Wild.
*Zornia durumuensis* De Wild.
*Zornia latifolia* Sm.

**LILIACEAE**
*Chlorophytum comosum* (Thunb.) Jacq. var. *petiolatum* (Baker) A.D.Poulsen & Nordal
*Chlorophytum comosum* (Thunb.) Jacq. var. *sparsiflorum* (Baker) A.D.Poulsen & Nordal
*Chlorophytum occultum* A.D. Poulsen & Nordal

**LINACEAE**
*Hugonia* L.

**LOGANIACEAE**
*Anthocleista laxiflora* Baker
*Mostuea neurocarpa* Gilg
*Strychnos aculeata* Solered.

**LOMARIOPSIDACEAE**
*Bolbitis fluviatilis* (Hook.) Ching
*Lomariopsis* Fée
*Lomariopsis hederacea* Alston
*Lomariopsis rossii* Holttum

**LORANTHACEAE**
*Globimetula cornutibracteata* Balle ex Polhill & Wiens
*Globimetula dinklagei* (Engl.) Tiegh.

**LYCOPODIACEAE**
*Huperzia staudtii* (Nessel) Pic.Serm.

**MALPIGHIACEAE**
*Acridocarpus longifolius* (G.Don) Hook.f.

**MARANTACEAE**
*Halopegia azurea* (K.Schum.) K.Schum.
*Haumania danckelmaniana* (J.Braun & K.Schum.) Milne-Redh.
*Hypselodelphys violacea* (Ridl.) Milne-Redh.
*Marantochloa mannii* (Benth.) Milne-Redh.
*Megaphrynium* Milne-Redh.
*Sarcophrynium brachystachyum* (Benth.) K.Schum.
*Sarcophrynium schweinfurthianum* (Kuntze) Milne-Redh.

**MEDUSANDRACEAE**
*Soyauxia* Oliv.

**MELASTOMATACEAE**
*Amphiblemma molle* Hook.f.
*Amphiblemma setosum* Hook.f.
*Amphiblemma soyauxii* Cogn.

*Calvoa hirsuta* Hook.f.
*Dicellandra barteri* Hook.f.
*Dicellandra barteri* Hook.f. var. *escherichii* (Gilg) Jacq.-Fél.
*Dicellandra barteri* Hook.f. var. *magnifica* (Mildbr.) Jacq.-Fél.
*Dicellandra descoingsii* Jacq.-Fél.
*Dinophora spenneroides* Benth.
*Heterotis decumbens* (P.Beauv.) Jacq.-Fél.
*Medinilla mannii* Hook.f.
*Memecylon* L.
*Memecylon sitanum* Jacq.-Fél.
*Spathandra blakeoides* (G.Don) Jacq.-Fél.
*Tristemma mauritianum* J.F.Gmel.

**MELIACEAE**
*Guarea glomerulata* Harms
*Guarea leonensis* Hutch. & Dalziel
*Heckeldora staudtii* (Harms) Staner

**MENISPERMACEAE**
*Kolobopetalum auriculatum* Engl.
*Penianthus* Miers
*Sarcolophium suberosum* (Diels) Troupin

**MORACEAE**
*Dorstenia* L.
*Dorstenia dinklagei* Engl.
*Dorstenia mannii* Hook.f.
*Dorstenia poinsettiifolia* Engl.
*Dorstenia poinsettiifolia* Engl. var. *angusta* (Engl.) Hijman & C.C.Berg
*Dorstenia poinsettiifolia* Engl. var. *librevillensis* (De Wild.) Hijman & C.C.Berg
*Ficus* L.
*Ficus conraui* Warb.
*Ficus lutea* Vahl
*Ficus ottoniifolia* (Miq.) Miq.
*Ficus ovata* Vahl
*Scyphosyce manniana* Baill.

**MYRISTICACEAE**
*Scyphocephalium mannii* (Benth.) Warb.
*Staudtia*

**MYRSINACEAE**
*Ardisia* Sw.

**OCHNACEAE**
*Ouratea* Aubl.
*Ouratea calantha* Gilg
*Ouratea congesta* (Oliv.) Engl. ex Gilg
*Ouratea mannii* (Oliv.) Engl.
*Ouratea turnerae* (Hook.f.) Hutch. & Dalziel

*Sauvagesia erecta* L.

**OLACACEAE**
*Coula edulis* Baill.
*Heisteria zimmereri* Engl.
*Olax* L.
*Olax latifolia* Engl.
*Ptychopetalum petiolatum* Oliv.

**OLEACEAE**
*Jasminum* L.

**OLEANDRACEAE**
*Nephrolepis biserrata* (Sw.) Schott
*Nephrolepis undulata* (Afzel. ex Sw.) J.Sm.
*Oleandra distenta* Kunze

**ONAGRACEAE**
*Ludwigia* L.

**ORCHIDACEAE**
*Ancistrochilus thomsonianus* (Rchb.f.) Rolfe
*Ancistrorhynchus* Finet
*Ancistrorhynchus capitatus* (Lindl.) Summerh.
*Ancistrorhynchus clandestinum* (Lindl.) Schltr.
*Ancistrorhynchus crystalensis* Cribb & Laan
*Angraecum* Bory
*Angraecum bancoense* Burg
*Angraecum gabonensis* Summerh.
*Angraecum multinominatum* Rendle
*Angraecum pungens* Schltr.
*Angraecum subulatum* Lindl.
*Bulbophyllum* Thouars
*Bulbophyllum acutebracteatum* De Wild.
*Bulbophyllum acutebracteatum* De Wild. var. *rubrobrunneopapillosum* (De Wild.) J.J.Verm.
*Bulbophyllum becquaertii* De Wild.
*Bulbophyllum calyptratum* Kraenzl. var. *calyptratum*
*Bulbophyllum cochleatum* Lindl.
*Bulbophyllum distans* Lindl.
*Bulbophyllum falcatum* (Lindl.) Rchb.f.
*Bulbophyllum falcatum* (Lindl.) Rchb.f. var. *velutinum* (Lindl.) Vermeulen
*Bulbophyllum saltatorium* Lindl.
*Bulbophyllum sandersonii* (Hook.f.) Rchb.f. ssp. *sandersonii*
*Bulbophyllum schinzianum* Kraenzl. ex De Wild. & T.Durand
*Chamaeangis*
*Cyrtorchis* Schltr.
*Eulophia horsfallii* (Batem.) Summerh.
*Graphorkis lurida* (Sw.) Kuntze
*Habenaria* Willd.
*Habenaria procera* (Sw.) Lindl.

*Habenaria weileriana* Schltr.
*Listrostachys pertusa* (Lindl.) Rchb.f.
*Plectrelminthus caudatus* (Lindl.) Summerh.
*Polystachya* Hook.
*Polystachya carnosa* P.J.Cribb & Podz.
*Polystachya fractiflexa* Summerh.
*Polystachya pobeguinii* (Finet) Rolfe
*Polystachya rhodoptera* Rchb.f.
*Polystachya seticaulis* Rendle
*Polystachya tessellata* Lindl.
*Rangaeris trilobata* Summerh.
*Tridactyle tridactylites* (Rolfe) Schltr.

**OXALIDACEAE**
*Biophytum zenkeri* Guill.

**PALMAE**
*Oncocalamus macrospathus* Burret
*Podococcus barteri* G.Mann & H.Wendl.

**PANDANACEAE**
*Pandanus* Parkinson

**PASSIFLORACEAE**
*Adenia reticulata* (De Wild. & T.Durand) Engl. var. *reticulata*
*Efulensia clematoides* C.H.Wright
*Passiflora* L.

**PINACEAE**
*Pinus jeffreyi* Balf.

**PIPERACEAE**
*Peperomia rotundifolia* (L.) H.B.& K.

**POLYGALACEAE**
*Atroxima liberica* Stapf

**POLYGONACEAE**
*Afrobrunnichia erecta* (Asch.) Hutch. & Dalziel

**POLYPODIACEAE**
*Microgramma lycopodioides* (L.) Copel.
*Microsorum punctatum* (L.) Copel.

**PTERIDACEAE**
*Afropteris repens* (C.Chr.) Alston
*Pteris* L.
*Pteris linearis* Poir.

**RUBIACEAE**
*Aidia* Lour.
*Aidia micrantha* (K.Schum.) F.White
*Aidia rubens* (Hiern) Taylor
*Argostemma africanum* K.Schum.
*Bertiera* Aubl.
*Bertiera arctistipula* N.Hallé
*Bertiera batesii* Wernham
*Bertiera bicarpellata* (K.Schum.) N.Hallé
*Bertiera breviflora* Hiern.
*Bertiera racemosa* (G.Don) K.Schum.
*Chassalia* Comm. ex Poiret
*Chazaliella*
*Chazaliella letouzeyi* Robbr.
*Commitheca* Bremek.
*Craterispermum caudatum* Hutch.
*Cuviera* DC.
*Ecpoma*
*Ecpoma hiernianum* (Wernham) N.Hallé & F.Hallé
*Gaertnera* Lam.
*Gaertnera dinklagei* K.Schum.
*Gardenia imperialis* K.Schum.
*Geophila obvallata* (Schumach.) F.Didr.
*Heinsia crinita* (Afzel.) G.Taylor
*Hymenocoleus* Robbr.
*Ixora* L.
*Ixora aneimenodesma* K.Schum. ssp. *aneimenodesma*
*Ixora hippoperifera* K.Schum.
*Ixora inundata* Hiern
*Ixora minutiflora* Hiern ssp. *chasalliensis* De Block
*Ixora minutiflora* Hiern ssp. *minutiflora*
*Lasianthus* Jack
*Lasianthus batangensis* K.Schum.
*Leptactina arnoldiana* De Wild.
*Massularia acuminata* (G.Don) Bullock ex Hoyle
*Morinda* L.
*Mussaenda arcuata* Lam. ex Poir.
*Mussaenda tenuiflora* Benth.
*Oxyanthus formosus* Hook.f. ex Planch.
*Oxyanthus gracilis* Hiern
*Oxyanthus setosus* Keay
*Pauridiantha* Hook.f.
*Pauridiantha hirtella* (Benth.) Bremek.
*Pauridiantha mayumbensis* (R.Good) Bremek.
*Pauridiantha micrantha* (Hiern) Bremek.
*Pavetta* L.
*Pavetta microthamnus* K.Schum.
*Pentalonchia humilis* Hook.f.
*Pouchetia* A.Rich. ex DC.
*Pseudosabicea* N.Hallé

*Pseudosabicea aurifodinae* N.Hallé
*Pseudosabicea batesii* (Wernham) N.Hallé
*Pseudosabicea floribunda* (K.Schum.) N.Hallé
*Pseudosabicea proselyta* N.Hallé
*Pseudosabicea segregata* (Hiern) N.Hallé
*Psychotria* L.
*Rothmannia talbotii* (Wernham) Keay
*Rutidea* DC.
*Sabicea* Aubl.
*Sabicea carbunica* N.Hallé
*Sabicea duparquetiana* Baill. ex Wernh.
*Sabicea duparquetiana* Baill. ex Wernh. var. *duparquetiana*
*Sabicea najatrix* N.Hallé
*Stelecantha cauliflora* (Good) Bremek.
*Tarenna* Gaertner
*Tarenna pallidula* Hiern
*Temnopteryx sericea* Hook.f.
*Tricalysia* A.Rich. ex DC.
*Trichostachys* Hook.f.
*Trichostachys aurea* Hiern
*Uragoga le-testui* De Wild.
*Virectaria* Bremek.
*Virectaria angustifolia* (Hiern) Bremek.

**SAPINDACEAE**
*Allophylus* L.
*Allophylus cobbe* (L.) Räusch.
*Chytranthus* Hook.f.
*Deinbollia maxima* Gilg
*Eriocoelum* Hook.f.

**SAPOTACEAE**
*Delpydora macrophylla* Pierre
*Lecomtedoxa heitziana* (A.Chev.) Aubrév.
*Neolemonniera batesii* (Engl.) Heine
*Synsepalum seretii* (De Wild.) Pennington
*Zeyherella le-testui* Aubrév. & Pellegr.

**SCYTOPETALACEAE**
*Brazzeia* Baill.
*Brazzeia soyauxii* (Oliv.) Tiegh.

**SOLANACEAE**
*Solanum* L.
*Solanum torvum* Sw.

**STERCULIACEAE**
*Cola duparquetiana* Baill.
*Cola ficifolia* Mast.
*Cola marsupium* K.Schum.

*Leptonychia* Turcz.
*Scaphopetalum thonneri* De Wild. & T.Durand
*Sterculiaceae* Bartl.

**THYMELAEACEAE**
*Dicranolepis baertsiana* De Wild. & T.Durand
*Octolepis casearia* Oliv.

**TILIACEAE**
*Ancistrocarpus densispinosus* Oliv.

**ULMACEAE**
*Trema* Lour.

**UMBELLIFERAE**
*Centella asiatica* (L.) Urb.
*Hydrocotyle* L.

**URTICACEAE**
*Boehmeria macrophylla* Hornem.

**VERBENACEAE**
*Clerodendrum fuscum* Gürke
*Clerodendrum splendens* G.Don
*Clerodendrum volubile* P.Beauv.
*Vitex* L.

**VIOLACEAE**
*Hybanthus* Jacq.
*Rinorea* Aubl.
*Rinorea kamerunensis* Engl.
*Rinorea talbotii* (Baker f.) De Wild.

**VITACEAE**
*Cissus* L.
*Cissus barteri* (Baker) Planch.
*Cissus diffusiflora* (Baker) Planch.
*Cissus dinklagei* Gilg & Brandt
*Cissus leonardii* Dewit
*Cissus petiolata* Hook.f.
*Cissus planchoniana* Gilg
*Leea guineensis* G.Don

**VITTARIACEAE**
*Vittaria owariensis* Fée

**ZINGIBERACEAE**
*Aframomum* Schumann
*Costus dubius* (Afzel.) K.Schum.
*Costus englerianus* K.Schum.

*Costus letestui* Pellegr.
*Costus ligularis* Baker
*Costus phaeotrichus* Loes.
*Renealmia* L.f.
*Renealmia congoensis* Gagnep.

## Appendix 3: Synonymized species list for the Monts de Cristal 1 ha plots

**Anacardiaceae**
*Sorindeia* Thou.
*Trichoscypha abut* Engl. & Brehmer
*Trichoscypha acuminata* Engl.
*Trichoscypha arborea* A.Chevalier

**Anisophyllaceae**
*Anisophyllea* R.Br. ex Sabine
*Anopyxis klaineana* Pierre

**Annonaceae**
*Annickia chlorantha* ( Oliver ) A.K.van Setten & P.J.M.Maas
*Isolona* Engl.
*Polyalthia suaveolens* Engl. & Diels
*Xylopia aethiopica* A.Rich.
*Xylopia phloiodora* Mildbr.
*Xylopia quintasii* Pierre ex Engl. & Diels
*Xylopia staudtii* Engl. & Diels

**Apocynaceae**
*Funtumia africana* Stapf
*Hunteria* Roxb.
*Picralima nitida* Th. & H.Dur.
*Tabernaemontana crassa* Benth.

**Burseraceae**
*Aucoumea klaineana* Pierre
*Dacryodes buettneri* ( Engl. ) H.J.Lam
*Dacryodes edulis* ( G.Don ) H.J.Lam
*Dacryodes igaganga* Aubrev. & Pellegr.
*Dacryodes klaineana* ( Pierre ) H.J.Lam
*Santiria trimera* ( Oliver ) Aubrev.

**Caesalpineaceae**
*Anthonotha* P. Beauv.
*Aphanocalyx microphyllus* ( Harms ) J.J.Wieringa
*Berlinia* Sol. ex Hook f. & Benth.
*Bikinia durandii* ( F.Hallé & Normand ) J.J.Wieringa
*Bikinia le-testui* ( Pellegr. ) J.J.Wieringa
*Bikinia pellegrinii* ( A.Chev. ) J.J.Wieringa
*Copaifera religiosa* J.Leonard
*Cryptosepalum* Benth.
*Dialium tessmannii* Harms
*Fillaeopsis discophora* Harms
*Gilbertiodendron brachystegioides* ( Harms ) J.Leonard
*Gilbertiodendron ogoouense* ( Pellegr. ) J.Leonard
*Guibourtia ehie* ( A.Chev. ) J.Leonard
*Hymenostegia afzelii* Harms
*Hymenostegia klainei* Pierre ex Pellegr.
*Isomacrolobium* Aubrev. & Pellegr
*Neochevalierodendron stephanii* (A. Chev.) J. Léonard
*Paraberlinia pellegriniana* Troupin = *Paraberlinia bifoliolata* Pellegr.
*Pellegriniodendron diphyllum* ( Harms ) J.Leonard
*Scorodophloeus zenkeri* Harms

*Sindoropsis le-testui* ( Pellegr. ) J.Leonard
*Stachyothyrsus staudtii* Harms
*Swartzia fistuloides* Harms
*Tetraberlinia bifoliolata* ( Harms ) Hauman
*Zenkerella Taub.*

**Chrysobalanaceae**
*Magnistipula* Engl.
*Maranthes* Blume
*Parinari excelsa* Sabine

**Combretaceae**
*Strephonema mannii* Hook f.

**Dichapetalaceae**
*Tapura* Aubl.

**Dipterocarpaceae**
*Marquesia excelsa* R.E.Fr.

**Ebenaceae**
*Diospyros* L.

**Euphorbiaceae**
*Croton sylvaticus* Hochst. Ex Krauss
*Dichostemma glaucescens* Pierre
*Discoglypremna caloneura* Prain
*Drypetes gossweileri* S.Moore
*Duvigneaudia inopinata* ( Prain ) J.Leonard
*Grossera* Pax
*Klaineanthus gaboniae* Pierre ex Prain
*Macaranga* Thou.
*Maesobotrya* Benth.
*Maprounea membranacea* Pax & K.Hoffm.
*Plagiostyles africana* Prain ex De Wild.
*Protomegabaria stapfiana* Hutchinson
*Sapium ellipticum* Pax
*Uapaca guineensis* Müll.Arg.

**Flacourtiaceae**
*Oncoba glauca* Planch.
*Scottellia coriacea* A.Chevalier
*Scottellia klaineana* Pierre

**Guttiferae**
*Garcinia conrauana* Engl. Note: Lebrun and Stork note as a poorly known taxon from FWTA
*Garcinia smeathmannii* ( Planch. & Triana ) N.Robson ex Spirl
*Symphonia globulifera* L.f.

**Irvingiaceae**
*Desbordesia glaucescens* Tiegh.
*Irvingia robur* Mildbr.
*I. gabonensis* Baill. ex Lanen.
*Klainedoxa gabonensis* Pierre

**Lauraceae**
*Bielschmeidia* Pancher & Sebert

**Loganiaceae**
*Anthocleista* Afzel. ex R.Br.
*Strychnos* L.

**Melastomataceae**
*Memecylon* L.
*Warneckea* Gilg

**Meliaceae**
*Carapa procera* DC.
*Entandrophragma* C.DC.
*Guarea* Allem. ex L.
*Trichilia* P.Browne

**Mimosaceae**
*Calpocalyx* Harms
*Newtonia duparquetiana* ( Baill. ) Keay
*Newtonia griffoniana* Baker f.
*Newtonia leucocarpa* ( Harms ) Gilbert & Boutique
*Parkia bicolor* A.Chevalier
*Pentaclethra macrophylla* Benth.

**Moraceae**
*Myrianthus serratus* ( Trecul ) Benth.
*Treculia africana* Decne.
*Treculia obovoidea* N.E. Br.

**Myristicaceae**
*Coelocaryon preussii* Warb.
*Pycnanthus angolensis* ( Welw. ) Exell
*Scyphocephalium chrysothrix* Warb. = S. ochocoa Warb.
*Staudtia kamerunensis* var. *gabonensis* (Warb) Fouilloy = *S. gabonensis* Warb. = *S. stipitata* Warb.

**Myrtaceae**
*Syzygium* Gaertn.

**Ochnaceae**
*Lophira alata* Banks ex Gaertn f.
*Ouratea* Aubl.
*Rhabdophyllum* Tiegh.

**Olacaceae**
*Diogoa zenkeri* ( Engl. ) Exell & Mendonca
*Heisteria parvifolia* Sm.
*Strombosia grandifolia* Hook f. ex Benth.
*Strombosia pustulata* Oliver
*Strombosia scheffleri* Engl.
*Strombosiopsis sereinii* Breteler
*Strombosiopsis tetrandra* Engl.

**Pandaceae**
*Centroplacus glaucinus* Pierre
*Microdesmis* Hook.f.

**Papillionaceae**
*Angylocalyx* Taub.
*Baphia* Afrel. ex Lodd.
*Pterocarpus soyauxii* Taub.

**Passifloraceae**
*Barteria fistulosa* Mast.

**Rubiaceae**
*Aidia micrantha* ( K.Schum. ) Bullock ex F.White
*Aoranthe cladantha* (K. Schum.) Somers = *P. cladantha* ( K.Schum. ) Keay
*Canthium* Lam.
*Corynanthe mayumbensis* ( Good ) N.Halle
*Craterispermum* Benth.
*Pauridiantha* Hook.f.
*Pausinystalia johimbe* (K. Schum.) Pierre ex Beille
*Pausinystalia macroceras* J.D. Kenn.
*Psychotria gabonica* Hiern
*Tricalysia* A.Rich. ex DC.

**Rutaceae**
*Zanthoxylum macrophyllum* Nutt.
*Zanthoxylum holtzianum* (Engl.) P.G. Waterman

**Sapindaceae**
*Blighia* Kon.
*Eriocoelum* Hook.f.
*Ganophyllum giganteum* ( A.Chev. ) Hauman
*Placodiscus* Radlk.

**Sapotaceae**
*Baillonella toxisperma* Pierre
*Lecomtedoxa nogo* (A. Chev.) Aubrev. = *Lecomtedoxa heitzana* ( A.Chev. ) Aubrev.
*Manilkara* Adans.
*Synsepalum* ( A.DC. ) Daniell

**Scytopetalaceae**
*Oubanguia* Baill.
*Scytopetalum klaineanum* Pierre

**Simaroubaceae**
*Odyendyea gabonensis* (Pierre) Engl.

**Sterculiaceae**
*Cola* Schott & Endl.
*Scaphopetalum blackii* Mast.

**Styracaceae**
*Afrostyrax lepidophyllus* Mildbr.

**Tiliaceae**
*Grewia coriacea* Mast.

**Verbenaceae**
*Vitex doniana* Sweet

**Vochysiaceae**
*Erismadelphus exsul* Mildbr.