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CHECKLIST

Phytogeographical analysis and checklist of the vascular plants of Loango National Park, Gabon

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Background and aims – Floristic inventories are the primary means by which the plant diversity of an area can be understood and are important in underpinning management plans for conservation. One of the priorities set out for Loango National Park (LNP) in an IUCN assessment of Gabon's protected areas was to produce a vascular plant checklist. Therefore, the primary goal of this research was to significantly increase the number of specimens for the park and make a concentrated effort to increase knowledge of plant diversity in the area. The secondary goal of this study was to analyse the flora of LNP in terms of phytogeography and endemism.
Methods – A specimen-based botanical inventory was carried out in LNP (1005 herbarium specimens collected for this study were added to 752 existing records) and vegetation observations were made. Phytogeographical analyses were also performed using two different methods and datasets for comparison.
Key results – A preliminary checklist of 686 species of vascular plants of LNP is presented, making a significant contribution to our knowledge of the flora of Gabon with more than twenty new country records.
Conclusions –There is a surprisingly high proportion (15%) of the overall Gabonese flora recorded from within the park in this preliminary checklist. Further inventory within the park will undoubtedly produce a much higher percentage of the flora of the whole country. This high proportion is explained in part by the combination of restricted coastal endemics, diversity of habitats, and dynamic biological and physical processes. Phytogeographical analyses reveal different floristic relationships between the forest and savanna components of the flora suggesting different origins of these two biomes in coastal Gabon. The forest species are typically Guineo-Congolian in distribution and the savanna species are Sudano-Zambezian or widespread in distribution. Together, the faunal elements and the high diversity of the flora of Loango National Park make it a globally important site for conservation.

Key words – Gabon, Loango National Park, Guineo-Congolia, Lower Guinea, checklist, phytogeography, coastal endemics, forest, savanna.

This paper is dedicated to the memory of our dear friend and colleague Chris Wilks (13 Jul. 1947–2 Nov. 2008), whose depth and breadth of knowledge of the trees of Gabon was unparalleled. Without his years of experience walking the forests of Gabon, our understanding of the vegetation of Loango would not have been as rich.

INTRODUCTION

Coastal Gabon contains mangroves, lowland forest and savannas in a complex of beach, *terra firma*, riverine, and lagoon systems. This zone is partially covered by a series of protected areas including Loango National Park (LNP) and Pongara National Park. LNP was first given protected area status in 1966 and declared a national park in 2002. Initial scientific and conservation interest in the area was due to the presence of animal species that are rare or threatened in Gabon such as manatees, crocodiles and leatherback turtles, the high populations of buffalo and elephant and the variety of vegetation habitats found in the area (Wilks 1990).

Floristic inventories are the primary means by which the plant diversity of an area can be understood and are important in underpinning management plans for conservation. One of the priorities set out for the Loango area in an IUCN assessment of Gabon's protected areas was a vascular plant checklist (Wilks 1990). Previous vegetation studies in the park have focused on habitats and food plants for target species such as primates (Yamagiwa et al. 1995) or transect-based vegetation description (Campbell et al. 2007, Morgan 2005).

For an area to be considered botanically well-known at a global scale, the minimum requirement for collection density has been defined as 100 herbarium specimens per 100 km^2 (Campbell & Hammond 1989). In the 1980s, Gabon was one of the most under-collected countries in the world. Collection effort has increased in recent decades, however, many areas remain under-collected. LNP was one such area. Prior to the work presented in this paper, LNP was represented by less than 400 specimens. In a national analysis of well collected areas by Sosef et al. (2005), Loango with approximately 0.25 specimens per km^2 did not meet the minimum criterion of one specimen per km^2 and it was not included in the list of nine well known or fairly well known regions. Therefore, the primary goal of this research was to significantly increase the number of specimens for LNP and as a consequence to increase knowledge of plant diversity in the area. This fundamental data is necessary to inform conservation decisions in the wider area and for management of the national park.

The secondary goal of this study was to analyse the plant diversity of LNP in terms of phytogeography and endemism. The park lies within what White (1983) called the "hygrophilous coastal evergreen Guineo-Congolian rain forest" stretching along the Atlantic coast between Sierra Leone and western Gabon. Analyses were designed to investigate how the coastal vegetation (in the first 20 km inland from the sea) in this part of Lower Guinea compares with other centres of plant endemism and in particular whether the elements of the forest and savanna vegetation might have different affinities.

Site

LNP is located on the coast of Gabon south of the equator between 1°50'S 9°20' E and 2°30'S 9°40'E (see figs 1 & 2). It is 1550 km^2 in extent and the elevation ranges from sea level to 100 m.

Climate

Precipitation is estimated for the Gamba-Rabi areas, to the south of LNP, to range between 2093 and 2363 mm per year as measured between the years of 1985 and 2002 (Morgan 2005, Lee et al. 2007). Precipitation is greatest between October and March but includes a small dry season in January. The main dry season is from April to August. During the period from 1984 to 2002, less than 100 mm per month fell during the long dry season (Campbell et al. 2007). Temperatures in the Gamba complex range from 24 to 28°C, remaining relatively constant over the year (Campbell et al. 2007).

Geology

LNP is part of a sedimentary basin formed of sandstone, sand, clay, and limestone deposited during the Cretaceous. Soils are ferralitic to sandy (Wilks 1990). The coastal sands are marine deposits and are more recent, dating from the Quaternary (UNESCO 1987).

METHODS

The methods and results are divided into four parts: checklist, phytogeographical analysis using published species maps, floristic analysis using herbarium records per grid cell, and vegetation types.

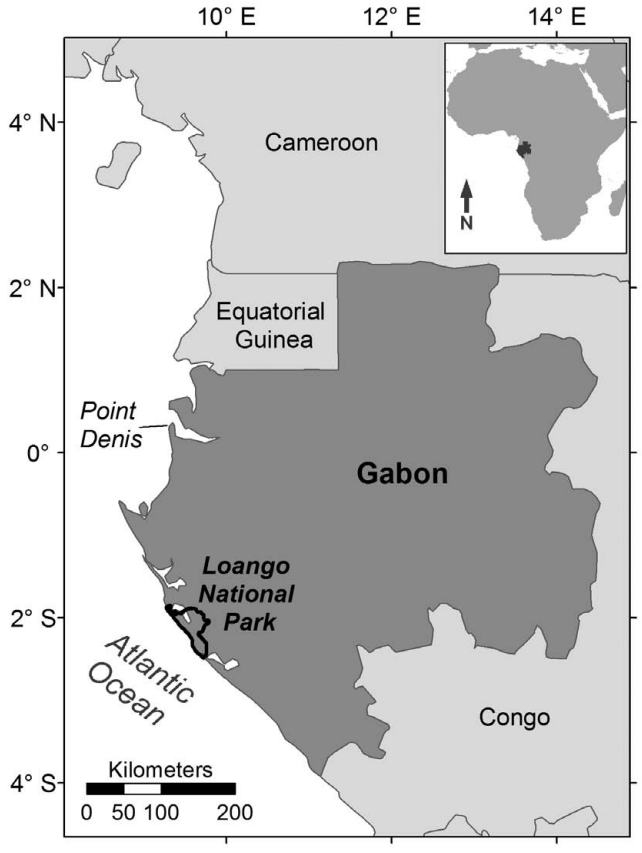

Figure 1 – The position of Loango National Park in Gabon.

Checklist

The fieldwork portion of this research consisted of two strategies, firstly collection by Mouandza who was resident in LNP from 2004 to 2006 and secondly a four-week field trip in April and May 2005 by Harris, Armstrong, Walters, Mouandza, Niangadouma and Wilks. During this time the sampling was stratified by broad habitat type, geography across the national park and taxonomic group. Each day one of the habitats was selected and sampled. The main sites visited were predominately in the northern part of the national park. They were: south of Iguela Lodge, Lauri Lagoon, Rembo Rabi, Akaka, the site of Nioungou Village, Rembo Nioungou, Tassi and Tassi Sud. The location of the collecting sites is shown in fig. 2. The objective was to collect specimens of all species of vascular plants occurring in the National Park. The inventory team made general collections and, due to taxonomic interest, also paid particular attention to the following groups: Caesalpinioideae (especially *Berlinia*), *Diospyros*, Irvingiaceae, rattans, Cyperaceae, Gramineae, Eriocaulaceae, *Utricularia*, *Xyris*, *Thomandersia*, Costaceae, Marantaceae and Zingiberaceae.

Herbarium specimens were made of all vascular plants encountered for which it was thought species level identification could be made. This meant that, as usual in general collection, there was a concentration on fertile material, but sterile material was also collected. Each herbarium specimen consisted of several duplicates (in most cases five), a piece of leaf dried in silica gel for DNA studies and digital photographs. Herbarium specimens were air-dried using heat each evening. The majority of the specimens were in the following ranges of collector number series: *Harris* (8210–8784), *Mouandza* (2–362), and *Walters* (1536–1607) and represent 1005 specimens. Standard collection data were recorded, including latitude and longitude using a GPS unit for all specimens. Vegetation observations and descriptions were also made at all sites visited.

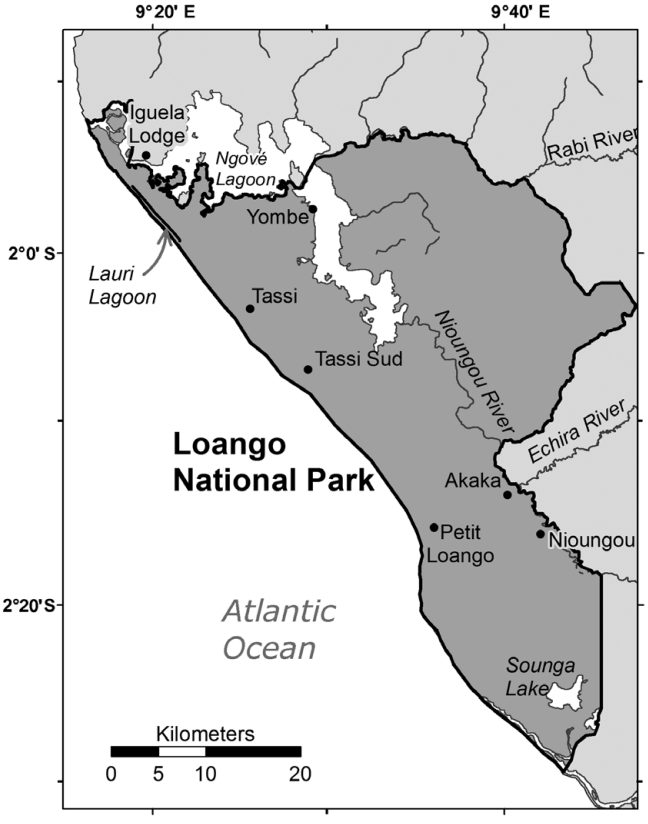

Figure 2 – Loango National Park and the main collecting sites.

The herbarium specimens were identified at the National Herbarium of the Netherlands Wageningen branch, Missouri Botanical Garden and the Royal Botanic Gardens, Kew. During identification particular attention was paid to the level of confidence placed on a determination. All identifications were recorded by identifier and date. Duplicates have been distributed to the following herbaria: BR, COI, E, G, K, LBV, MO, P and WAG.

In addition to the specimens collected specifically for this inventory, data was also extracted from the herbarium database at the National Herbarium of the Netherlands ('NHN'; L, U and WAG) for all collections made within the limits of the National Park and a 10 km buffer zone. A single representative specimen was chosen for each species. In the choice of specimens, priority was given to specimens collected during this inventory and to specimens named by taxonomic specialists. Substantial work has been completed by botanists from Wageningen in the nearby Rabi-Toucan area of the Shell Concession, but except for the most southern specimens these are not included in this paper as they were collected outside the buffer zone. The cut off date for collections cited in the checklist is December 2006, which marks the time period when herbarium identifications were completed. The total number of specimens, including those made during the fieldwork portion of this study was 1757.

This initial list of specimens was edited critically. Specimens that did not have a named identifier were not included in the checklist. Those which could not be matched at the herbarium in WAG were labelled as 'sp. 1'. If the abbreviation 'cf' had been used for species in a genus that had certain (not cf) names the 'cf' names were usually removed. These 'cf' determinations were only left in for names of rather distinct species which are unlikely to be confused with other species in the genus already on the list. These determinations might be due to lack of sufficient material for a confirmed identification or due to taxonomic uncertainty, particularly for genera needing revision. Finally one specimen was chosen for each species. All the names used in the checklist have a voucher specimen.

To estimate the total number of species of vascular plants in Loango National Park, including the species not yet collected, a Chao2 estimation (Chao 1987) was run on all fully identified collections from within the park and the 10 km buffer zone.

Phytogeographical analysis using individual species maps from DPA and TAFP

In order to determine the phytogeographical affinities of the LNP flora, in relation to the Vegetation of Africa (White 1983), a subset of the checklist was analysed. This subset of 272 species (40%) included all the species in the checklist

Table 1 – Top families and genera in the checklist.
The number of species are listed for each family (including the three sub-families of Leguminosae) and genus.

Taxon	Number of species
Legumisosae	97
[Leguminosae Caesalpiniaceae]	[51]
[Leguminosae Papilionaceae]	[37]
[Leguminosae Mimosaceae]	[9]
Rubiaceae	88
Cyperaceae	29
Euphorbiaceae	22
Gramineae	17
Annonaceae	16
Acanthaceae	15
Apocynaceae	15
Melastomataceae	15
Diospyros	14
Psychotria	13
Cyperus	9
Ficus	9
Utricularia	9
Dichapetalum	8
Combretum	7
Rinorea	7
Strychnos	7
Berlinia	6
Campylospermum	6

covered by either *Distributiones Plantarum Africanarum* (DPA) (Jardin Botanique National de Belgique 1969–1999) or *Tropical African Flowering Plants* (TAFP) (Lebrun & Stork 2003, 2006, 2008a, 2008b). An attempt was made to score the distribution of the remaining species in the checklist using floras, revisions and monographs but it was found that the data available was of extremely variable quality. This was particularly the case when trying to find the limits of plants occurring in Lower Guinea and Congolia. Many works only cite full countries for presence of a species whereas phytogeographic classification requires maps and localities. The subset to be analysed was therefore, restricted to those species with the standardised and comparable data in these two published sources. Introduced species were not included in the subset. Distributions outside Africa were checked using the Royal Botanic Garden Edinburgh Herbarium Catalogue, TROPICOS (Missouri Botanical Garden), and Global Biodiversity Facility (GBIF) online databases. These online databases were not populated enough to provide the level of data in the two published sources (DPA and TAFP) but they had sufficient data to tell us whether a species was present at the continental level, for example, in South America. The distribution of the species in the subset was put into the categories listed in electronic appendix 5. African categories were defined based on White's description of the Guineo-Congolia phytochorion (White 1979) and his vegetation map of Africa (White 1983).

The species were also separated into two habitat categories: forest vegetation and non-forest vegetation. Forest vegetation includes forest species, coastal scrub, woody pioneer species (including *Chrysobalanus icaco* and *Thomandersia butayei*), forest herbs, and forest edge species. Non-forest vegetation comprises savanna, beach herbs and aquatics. They are referred to as "savanna species" for the remainder of this paper.

To present the results, several of the smallest categories in electronic appendix 5 are presented together in fig. 4. Electronic appendix 5 has 22 categories and fig. 4 has eleven categories.

Grid cell floristic analysis using NHN specimen database

A second type of analysis comparing the flora of LNP with the rest of the world was carried out using the NHN herbarium database. This database also includes specimens from Gabon in the National Herbarium in Libreville (LBV), Missouri Botanical Garden (MO) and Paris (P) and represents 90% of all plant collections ever made in Gabon (Sosef et al. 2005). For this analysis only geo-referenced records identified to the species level were used. Any subspecific classification was ignored. Using grid cells of one degree square, for all cells around the world, the number of species present in each grid cell was calculated. Grid cells with less than eleven species were excluded as being insufficiently known to compare with the Loango list. Alternative cut-offs of fifteen and twenty species per grid cell were used in preliminary analyses but the number of cells available for comparison dropped greatly. Next, the number of species present in Loango National Park was calculated for each of the sampled grid cells around the world. Finally, for each grid cell, the ratio of species known from Loango against all the species in the cell was calculated as a percentage. To obtain a higher resolution for the better represented areas of west central Africa, the same calculations, with the same lower limit of eleven species per grid cell were performed using quarter degree squares. For more detail regarding this method see Wieringa & Sosef (2011).

Both analyses of one degree square and a quarter degree were performed using three different species lists. The first list was that of all species recorded in Loango and a 10 km buffer area around the park. To investigate whether different vegetation types, forest and savanna, have different relationships with other parts of Africa the comparisons were also made with a list of forest species and a list of non-forest species from Loango, using the same criteria as in the phytogeographical analysis.

Vegetation classification

The vegetation types were described by Wilks over several visits to Loango National Park. They were defined by walking the forest and noting dominant species. The forest types are based on more than thirty years of experience by Wilks with tree identification in Central Africa. Some vegetation

types are based on species which are not in the checklist because they were not vouchered for this paper. Unvouchered names of vascular plants from tropical forests are sometimes misidentifications or based on taxon concepts that change over time. Since the absence of a voucher means that the names cannot be revisited in the future they are not included in the checklist.

RESULTS

Checklist

The checklist of LNP presented in electronic appendix 1 represents 686 species in 115 families. In the checklist each species is listed with a voucher specimen, as well as the name of the person who identified it, a note if the specimen is one of the first four recorded for that species compared to the Checklist of Gabon (Sosef et al. 2005), a note on endemic status, whether the species was introduced and the broad habitat categories of 'forest' or 'savanna' as defined in the methods above. Specimen collections were made in all months of the year and the dates of collection are represented in fig. 3. The top nine families are listed in table 1. Leguminosae is the most species-rich family with 97 species followed by Rubiaceae with 88 species. The top genera are also presented in table 1, with the top three being: *Diospyros* (fourteen species) *Psychotria* (thirteen species), and *Cyperus*, *Ficus* and *Utricularia* (nine species each). For Gabon, 24 of the species are additional country records which were not included in the Gabon Checklist (Sosef et al. 2005); they are listed in table 2. Another seventeen species are represented by new second collections and nineteen species are new third collections when compared against the Gabon Checklist (Sosef et al. 2005). Two species *Berlinia razzifera* and *Campylospermum paucinervatum* are endemic or sub-endemic to LNP and 41 species in our checklist from Loango are endemic or sub-endemic to Gabon (electronic appendix 2). Twelve species are introduced.

The Chao2 estimation run on all the fully identified specimens from within the park and the 10 km buffer zone gave a result of 1361 species. This is the number of species expected to occur in the checklist area based on the analysis of the existing species names and the number of specimens for each species.

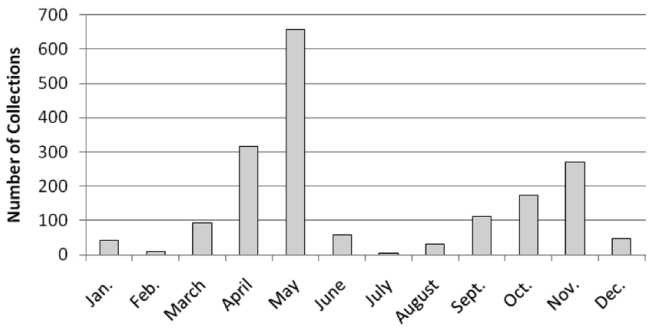

Figure 3 –The distribution by month of herbarium specimens made in Loango National Park and 10 km buffer zone.

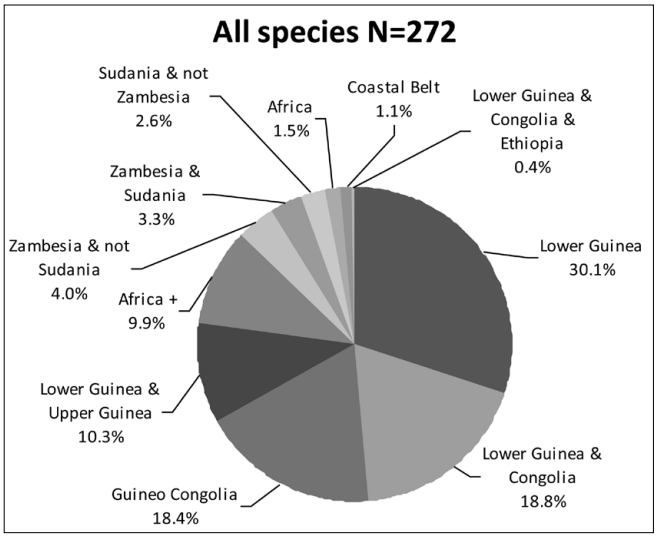

Figure 4 – Categories of continental and phytochorion distribution patterns for all 272 non-introduced vascular plant species recorded in Loango National Park for which species level distribution maps were available in the two references: *Distributiones Plantarum Africanarum* (DPA) (Jardin Botanique National de Belgique 1969–1998) or *Tropical African Flowering Plants* (TAFP) (Lebrun & Stork 2003, 2006, 2008a, 2008b).

Sixty-seven percent of the names in the checklist represent fieldwork in LNP by Mouandza Mbembo (2004–2006) and the four-week collecting trip carried out by six of the co-authors in 2006. The remaining 33% of the names were added by including specimens previously collected by others within the park as well as a 10 km buffer zone from the NHN database of specimens.

The checklist follows the families of APG III (2009) and Smith et al. (2006) and the genus and species nomenclature of the Gabon Checklist (Sosef et al. 2005). The exceptions to this are the use of the following genera or species: *Caloncoba* and *Lindackeria* (Chase et al. 2002), *Bobgunnia* (Kirkbridge & Wiersema 1997), *Manilkara lacera* (pers. comm. V. Plana, Royal Botanic Garden Edinburgh, UK 2009), all of which are treated as synonyms of other names in the Gabon Checklist.

Despite careful searching, no specimens of rattans were seen in the LNP during the four-weeks visit. Similarly giant forest herbs in the families Marantaceae, Zingiberaceae, Costaceae and Commelinaceae were actively sought but very few species appeared to be present.

Phytogeographical analysis using individual species maps from DPA and TAFP

Based on an analysis of 272 species, forest and non-forest species, the flora is best represented by Lower Guinea with 30.1% of the species being limited in distribution to this phytochorion. The next most important category was Lower Guinea & Congolia (18.8%), followed closely by Guineo-Congolia (18.4%). Species with a Lower Guinea & Upper Guinea distribution (10.3%) were less represented than those showing a distribution across Guineo-Congolia (18.4%). All the categories which are more widespread than Guineo-Con-

Table 2 – New country records to the Gabon checklist (Sosef et al. 2005).
New names with "cf" determinations are not included here but remain in the checklist.

Family	Species	Notes
Cyperaceae	*Websteria confervoides* (Poir.) S.S.Hooper	Wide-spread in West Africa, Zambia, and DRC
Eriocaulaceae	*Eriocaulon nadjae* S.M.Phillips	Littoral endemic previously known only from savanna in Equatorial Guinea
Eriocaulaceae	*Eriocaulon setaceum* L.	From South America, India, in Africa from the CAR
Eriocaulaceae	*Syngonanthus ngoweensis* Lecomte	Previously only known from the type collection in 1894 from coastal Gabon
Euphorbiaceae	*Euphorbia pulcherrima* Willd. ex Klotzsch	Introduced
Gentianaceae	*Sebaea lineariformis* Sileshi	Known from East Africa
Gramineae	*Panicum heterostachyum* Hack.	Known from tropical Africa
Leguminosae-Caes.	*Anthonotha mouandzae* Breteler	Known from lowland primary forest in Gabon (Breteler 2010)
Leguminosae-Caes.	*Berlinia razzifera* Mackinder & Wieringa	Littoral endemic only known from Loango NP (Mackinder & Wieringa 2007)
Leguminosae-Pap.	*Baphia laurentii* De Wild.	Known from DRC and Republic of Congo. Genus in need of revision
Leguminosae-Pap.	*Desmodium salicifolium* (Poir.) DC.	Widespread in Africa and Madagascar
Leguminosae-Pap.	*Eriosema terniflorum* Hiern ex Baker f. var. *katangense* Hauman	Known from Angola and DRC
Leguminosae-Pap.	*Mucuna sloanei* Fawc. & Rendle	Known from Senegal to DRC
Leguminosae-Pap.	*Pseudarthria fagifolia* Baker	Known from Senegal to CAR
Lentibulariaceae	*Utricularia simulans* Pilg.	Known from South America, Senegal to DRC, Angola, and Zambia
Linderniaceae	*Artanema longifolium* (L.) Vatke	Widespread in tropical Africa and in Asia
Ochnaceae	*Campylospermum paucinervatum* Sosef	Littoral endemic Loango to Mayumba, Gabon (Sosef et al. 2007)
Olacaceae	*Strombosia gossweileri* S.Moore	Known from Angola (Cabinda), Gabon and Cameroon (Breteler 2007)
Onagraceae	*Ludwigia abyssinica* A.Rich.	South America; in Africa, CAR to East Africa and Zambia
Onagraceae	*Ludwigia adscendens* (L.) Hara	Known from Asia, Australia and Cameroon
Rhizophoraceae	*Cassipourea carringtoniana* Mendes	Previously known from Angola (Cabinda), Congo Brazzaville (Breteler 2008)
Rubiaceae	*Psychotria avakubiensis* De Wild.	Known from DRC
Rubiaceae	*Psychotria guineensis* E.M.A.Petit	Petit (1964) reported this species from Gabon but it is not listed by Sosef et al. (2005)
Xyridaceae	*Xyris imitatrix* Malme	Known from wet, sandy environments in Congo, DRC, Angola, and Zambia

golia each had less than 10% of species and a combined total of 22.8%. All categories follow definitions in White (1983) with the exception of 'Africa +' which represents species that occur outside of Africa (fig. 4).

The analysis for forest species alone (N = 242) follows the same trends (fig. 5). The categories that are more widepread than Guineo-Congolia, however, are less well represented than in the results of the 272 forest and non-forest species.

For non-forest species (N = 30) the proportions are quite different from those of the forest species (fig. 6). Of the non-forest species 40% of these had distributions extending outside of Africa. This category was next followed by Zambesia & Sudania. Species distributions that included Sudania but not Zambesia (three species) or Zambesia but not Sudania (four species) were only 3.3% apart which, with this limited sample size, is not significant. Very few non-forest species were limited to Lower Guinea & Congolia (one species) or Lower & Upper Guinea (one species).

Grid cell floristic analysis using NHN specimen database

For many areas in the world the NHN database did not contain enough data to reach the minimum of eleven species per grid cell. Of those grid cells which did have enough species hardly any had more than 10% of species in common with

the entire Loango list, therefore the focus for the rest of the paper will be on Africa.

In Africa the number of one degree grid cells with more than ten species per grid cell can be seen in figs 7, 9 & 10. Most of West and Central Africa as well as Malawi, Tanzania and Ethiopia are represented by more than ten species per one degree square in this sample. Notable exceptions in tropical Africa are Chad, Sudan, Zambia, Angola and the savannas of Central African Republic. Figure 8 and electronic appendices 3 & 4 show the quarter degree squares with sufficient data for this detailed analysis: most of Gabon is covered, but many grid cells in both DRC and Republic of Congo and eastern Cameroon have insufficient data at this level in the NHN database.

Figure 7 illustrates the percentage of species in each one degree grid cell that is shared with our species list for Loango. This map shows clearly that the species from Loango are a part of the Guineo-Congolian region, and in particular, that the coastal zone of Gabon has a flora that is comparable to Loango. The entire coast from Point Denis southwards has a percentage above 39% but moving inland the percentage immediately drops below 30%. Even a few one degree cells in the Congo Basin share a higher percentage of species with Loango than the interior of Gabon. Looking more closely using data from quarter degree squares in fig. 8, one can see that the narrow coastal strip shares over 50% of its species with Loango, this zone continues with a level of c. 40% along the coast into Equatorial Guinea and southwards to the Republic of Congo. This map also shows that the grid cells of the sedimentary basin of the Ogooué still share 40–65% of their species with Loango, but moving further inland this percentage drops below 40%. In summary: except for the coast and the sedimentary basin of the Ogooué, most of the forest block of Lower Guinea and Congolia only shares 16–30% of its species with Loango.

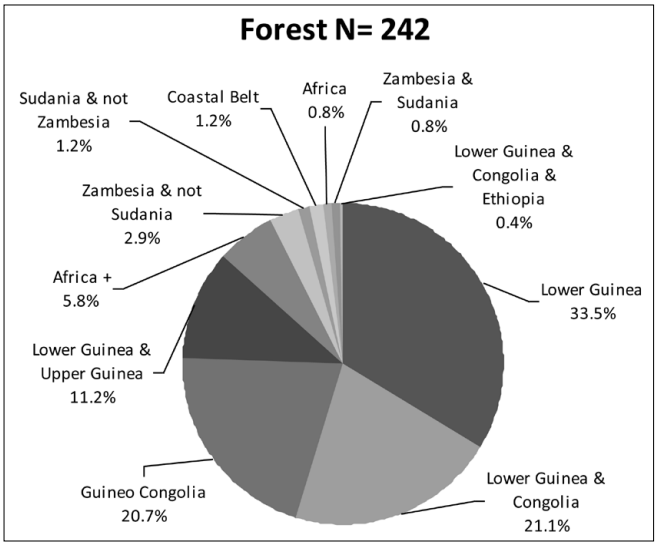

Figure 5 – Categories of continental and phytochorion distribution patterns for 242 forest vascular plant species recorded in Loango National Park for which species level distribution maps were available in the two references: *Distributiones Plantarum Africanarum* (DPA) or*Tropical African Flowering Plants* (TAFP).

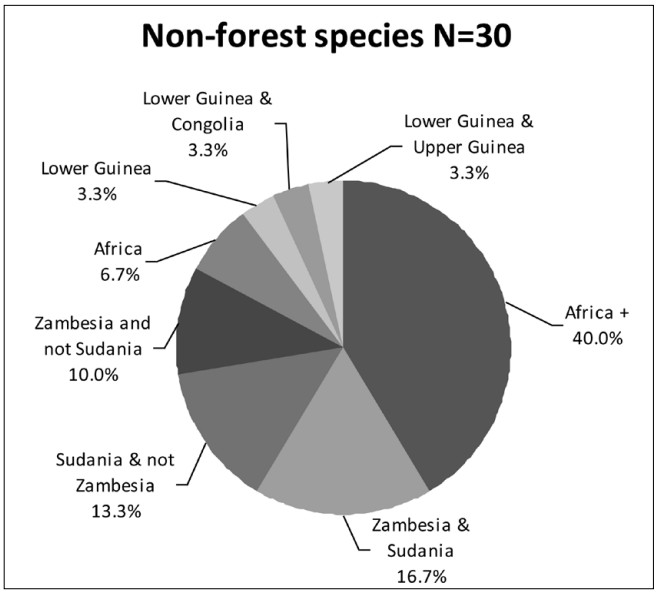

Figure 6 – Categories of continental and phytochorion distribution patterns for thirty non-forest vascular plant species recorded in Loango National Park for which species level distribution maps were available in the two references: *Distributiones Plantarum Africanarum* (DPA) or *Tropical African Flowering Plants* (TAFP).

In fig. 9 the non-forest component of the Loango list is compared with 1-degree squares across Africa. It is clear from this map that this non-forest element of the flora of Loango National Park is not responsible for the similarity with the central Congo Basin as seen in fig. 7. It is also clear that the non-forest element from Loango contains weak links to both the Sudanian or Zambezian savannas of Africa. Instead, the non-forest part of Loango has much more in common with the coastal savannas of Gabon than any other area. This appears, at first glance to be in contradiction with the results in fig. 6, however, it is the assemblage of species in each grid square that are shown to be similar to the other coastal savannas of Gabon, whereas the distribution shown in fig. 6 reflects individual species. Figure 9 also shows the close relationship between the non-forest flora of Loango and the coastal areas of Lower Guinea. This analysis shows that the general floristic resemblance, presented above, between Loango and the coast of Gabon is mostly caused by the non-forest elements. In addition there are two quarter degree squares away from the coast in Gabon, which share 29–32% of species with Loango savannas. One of these cells, west of Fougamou, contains the included savanna of Ezanga and the other, south of Makokou, contains mostly records collected on an inselberg. The inland savannas around Tchibanga and those of Batéké Plateau yield a slightly higher percentage than the surrounding forest areas, but still much lower than those from the coast. The savanna area in Lopé has the same value as the surrounding forested area.

The forest component of Loango is compared with one degree and quarter degree grid cells in fig. 10 and electronic appendix 4 respectively. In fig. 10 it can be seen quite clearly that the forest species in Loango are responsible for the similarity with the Congo Basin. This resemblance is most likely caused by the lower number of restricted endemic forest spe-

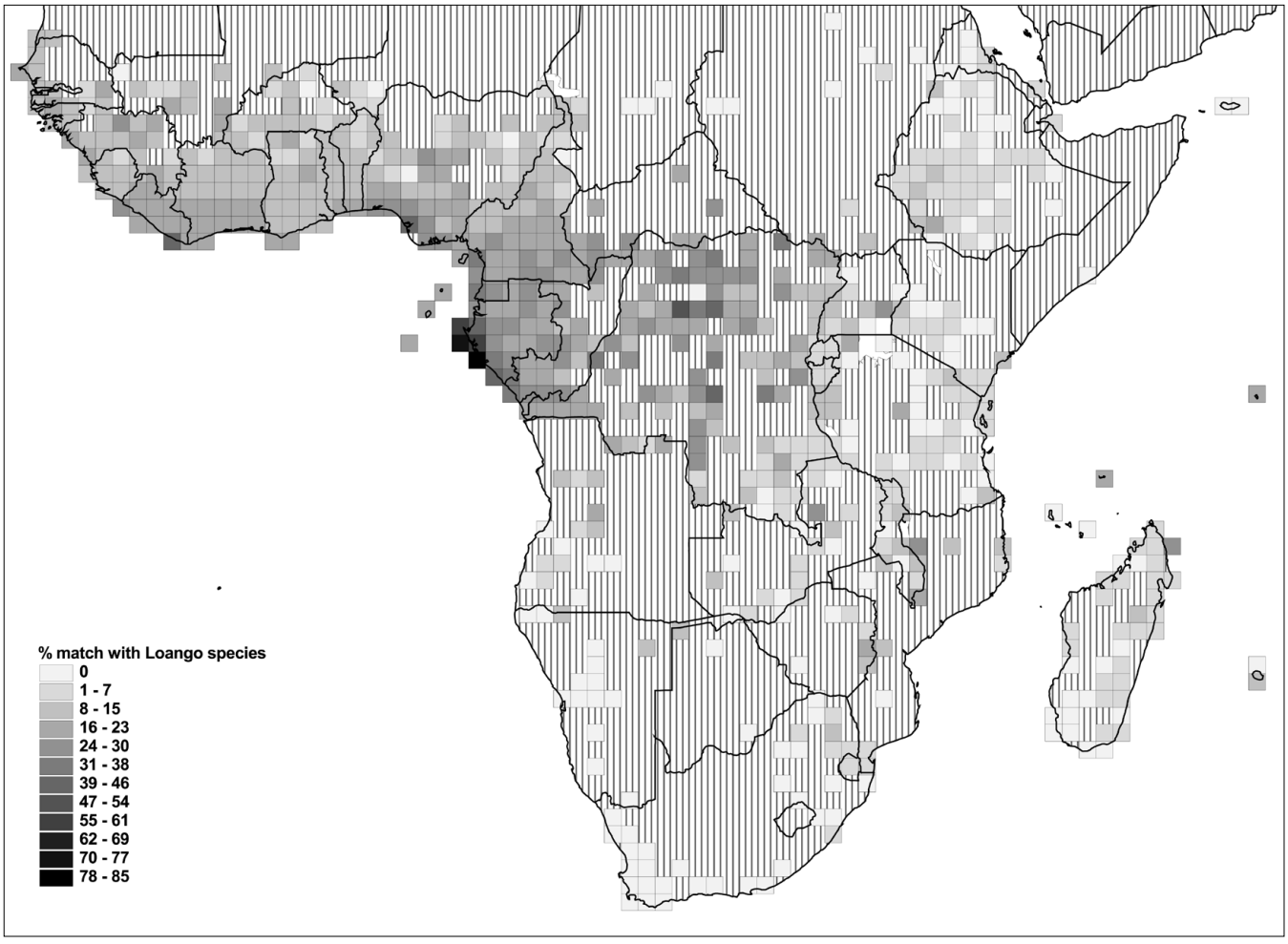

Figure 7 – Percentage of species of each 1° × 1° grid cell that is shared with Loango National Park (including a 10 km buffer zone).

cies in the Congo Basin and the higher number in the interior forests of Gabon that lower the percentage of species shared with Loango. The forest block of Upper Guinea shares some species with Loango but less so than Lower Guinea and Congolia. The more detailed fig. 8 shows that these Loango forest species are especially present in the sedimentary basin of the Ogooué: whereas the mountainous areas of the Crystal Mountains and Chaillu Massif, and the areas to the East only reach about half the levels of similarity compared to the sedimentary basin.

Vegetation descriptions

Northern Loango comprises several forest and savanna types. Starting from the ocean and moving inland, one encounters beach, mangroves, coastal scrub, lagoon, forest and savanna vegetation. The main unbroken forest block accounts for over 90% of the North Loango *terra firma* forests and includes *Calpocalyx heitzii* dominant forest, *Sacoglottis gabonensis* dominant forest, and mixed forests. Other forests, which are less extensive and non-continuous, include *Fegimanra africana* dominant forest, forest fringing savanna, and post-agricultural forest. Wetland forests include *Lecomtedoxa*-dominated forests. Wetland marshes are also present near Akaka.

Lagoon vegetation – The coast of Loango is characterised by several lagoons. These areas have two species of mangrove, *Rhizophora racemosa* and *Avicennia germinans*. Within the lagoon itself, at the water's edge, several sedge species are found including *Cyperus articulatus*, *C. cyperoides*, *Pycreus polystachyos*, and *Fimbristylis cymosa*. Adjacent to these is a scrubby vegetation dominated by *Dalbergia ecastaphyllum*, *Hibiscus tiliaceus* and *Acrostichum aureum*. Occasionally floating populations of *Nymphaea lotus* are present.

Beach vegetation – Along the beach, the first habitat encountered is a narrow band 2–20 m wide, which begins at the high tide line and comprises only a few dominant species such as *Sporobolus virginicus* and *Remirea maritima*. These dominants are interspersed with other herbs such as *Ipomoea stolonifera*.

Open marsh – Along open rivers, marshes dominated by Cyperaceae occur. These are typically found downstream from Akaka on the Rembo Ngowe.

Wet and dry savannas – The savanna vegetation of coastal Gabon is one of four types described by Koechlin (1962). The coastal formation stretches along the country's entire coastline, being primarily on white sands and forming discontinuous patches of savanna vegetation (Koechlin 1962). Here, savanna is defined as a grass formation with a few

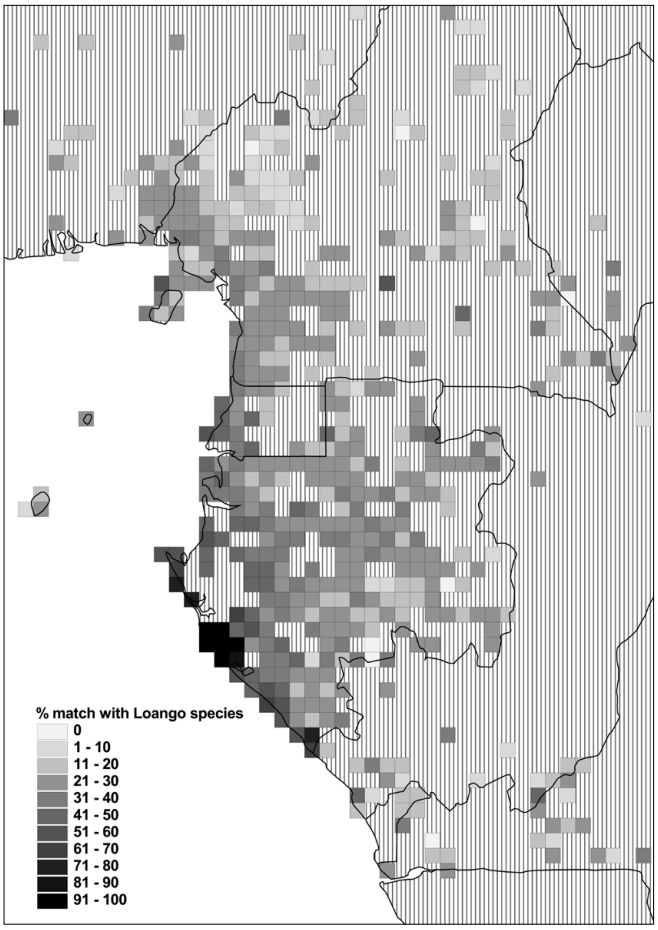

Figure 8 – Percentage of species of each 15' × 15' grid cell that is shared with Loango National Park (including a 10 km buffer zone).

trees and where occasional fires occur (Bourlière & Hadley 1983). The savanna vegetation of Loango is comprised of two types: dry savannas and seasonally wet savannas.

Seasonally wet savannas are found within the dry savanna matrix and consist mainly of shallow ponds. Within the ponds themselves, mats of floating vegetation contain *Websteria confervoides*, *Nymphoides forbesiana*, *Nymphaea heudelotii*, *Eriocaulon nadjae* and *Utricularia benjaminiana*. At the edge of these ponds, populations of *Xyris* species, terrestrial *Utricularia* species, *Syngonanthus ngoweensis*, and *Mesanthemum radicans* can be found.

The dry savannas are dominated by *Ctenium newtonii*, but *Schizachyrium pulchellum*, *Anadelphia leptocoma*, *Andropogon gayanus* and other herbs are present throughout. These savannas sometimes contain islands of trees containing forest edge species such as *Chrysobalanus icaco*, *Barteria nigritana* and *Thomandersia butayei* (Mouandza-Mbembo & Walters 2007).

Three *terra firma* forest blocks – The large dry land (or *terra firma*) forest blocks cover over 90% of the total forest area of north Loango. We use the term 'block' to indicate size and continuity, not shape. These forests seem to be large unbroken tracts from the ground but from the air, there are large finger-like incursions of different types of wetland forest, and also 'islands' of wetland forest, enclosed savanna and colonizing forests. The three vegetation types are *Sacoglottis gabonensis* dominated forest; *Calpocalyx heitzii* dominated forest; and mixed species *terra firma* forest.

***Sacoglottis gabonensis* dominated forest (old *Ozouga* forest)** – This forest type is dominated by large *S. gabonensis* individuals, which are sometimes in almost monospecific stands. More often it contains scattered large canopy trees of other species such as *Klainedoxa gabonensis*, *Pterocarpus soyauxii*, *Aucoumea klaineana*, *Hexalobus salicifolius*, *Duguetia confinis* and *Symphonia globulifera*. There is visibly less diversity in trees of all sizes than in the other large blocks of dry-land forests to the northwest of LNP, both in terms of species richness and in terms of the degree of dominance of the principal species. The understory space is remarkably clear. *Sacoglottis gabonensis* dominated forest is found behind the strip of coastal vegetation and on the elephant paths between Akaka and Petit Loango and between Petit Loango and Yatanga. The north-western extent of this block of forest is not well known but it is likely to reach the young *S. gabonensis-A. klaineana* forests bordering the Iguela savannas. The south-eastern border is unknown and extends into the South Loango area. It is the smallest of our three main blocks of forest.

***Calpocalyx heitzii* dominated forest (*Miama* forest)** – This forest type is rich in *Calpocalyx heitzii* but exhibits a greater diversity in trees (of all sizes) than *Sacoglottis gabonensis* forest towards the coast. *C. heitzii* is generally dominant, occasionally in almost pure stands, but there are also some local patches of forest where it does not occur. *S. gabonensis* is rarer here and never dominant. Other canopy species which we observed include *Klainedoxa gabonensis*, *Pterocarpus soyauxii*, *Aucoumea klaineana*, *Hexalobus salicifolius*, *Symphonia globulifera*, *Piptadeniastrum africanum*, *Irvingia gabonensis*, *Erismadelphus exsul*, *Mammea africana*, *Scottellia klaineana* and *Tieghemella africana.* Smaller, usually understory species include species of *Strombosia*, *Caloncoba* and *Rinorea*.

A major difference between *Calpocalyx heitzii* and *Sacoglottis gabonensis* forest is that in *C. heitzii* forest, seedlings and small saplings of the dominant species are noticeable on the forest floor and appear to be very shade tolerant, whereas in *S. gabonensis* forest, seedlings of this species are not evident and its regeneration does not seem to be very tolerant of shade. *C. heitzii* forest is found on the elephant boulevards between Akaka and Petit Loango, and between Petit Loango and the Yatanga area (on the upper Iguela lagoon). It is delimited by *S. gabonensis* forest on the seaward side and the Iguela lagoon, Rembo Ngowe and associated marshes to the inland side.

Mixed *terra firma* forest – This seems to be the richest forest block of North Loango in terms of diversity of large canopy trees and more resembles dry-land forests of the sedimentary plains further inland from the Loango National Park. *Calpocalyx heitzii* is not common and no single species is markedly dominant. It is also the richest in commercial timbers such as *Aucoumea klaineana*, *Teighemella africana*, and various species of *Entandrophragma*, *Khaya* and *Lovoa*. Other canopy trees occasionally include *Nauclea diderichii* and *Staudtia kamerunensis* var. *gabonensis*, *Klainedoxa gabonensis*, *Ma-*

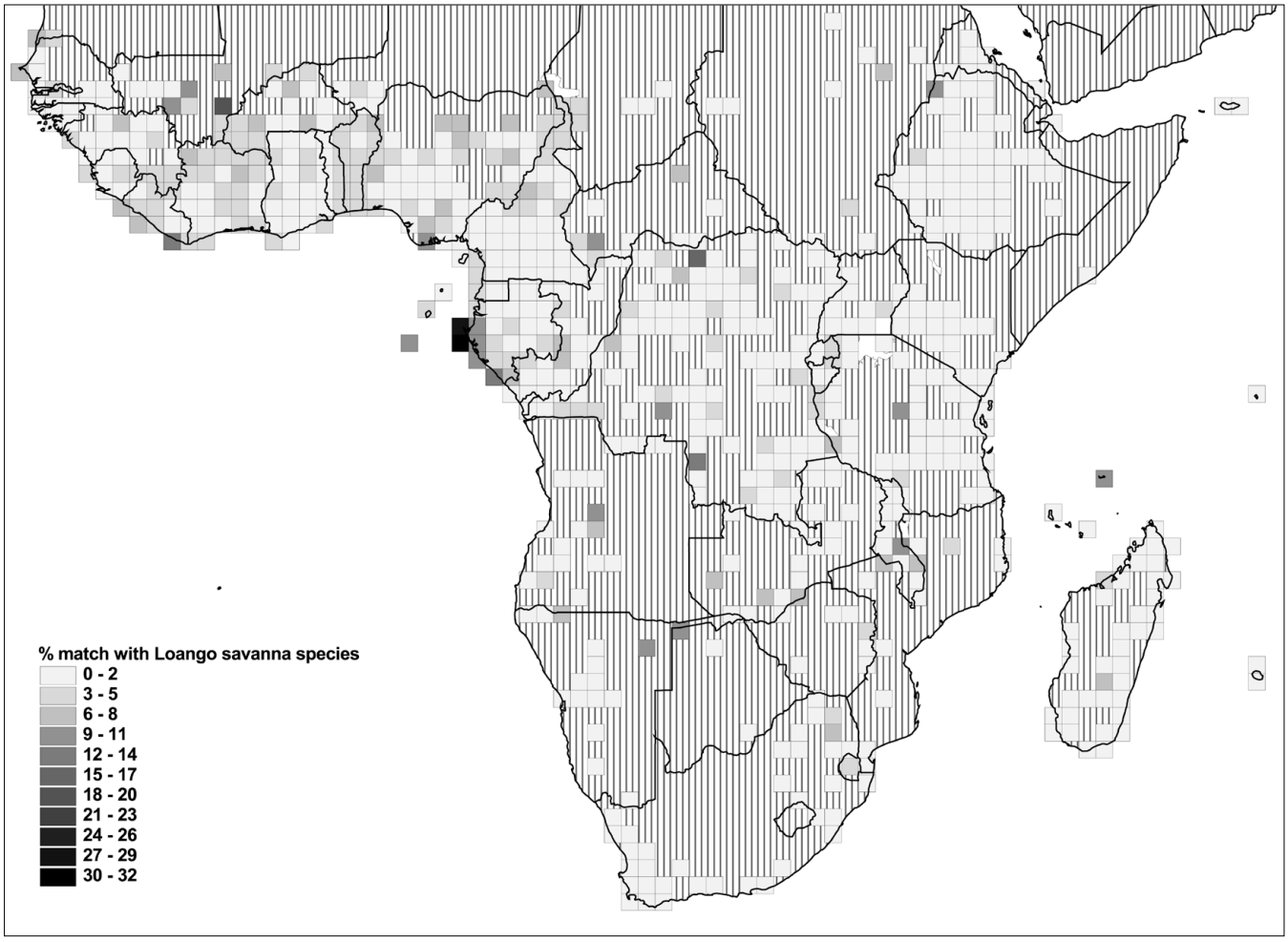

Figure 9 – Percentage of species of each 1° × 1° grid cell that is shared with the non-forest species list of Loango National Park.

ranthes glabra and *Coelocaryon preussii*. The presence of *Sapium ellipticum*, *Pycnanthus angolensis*, *Nauclea diderrichii* and high density areas of *Aucoumea klaineana* indicate patches of younger forest. There seems to be a high diversity of understory trees including various species of *Strombosia*, *Caloncoba* and *Diospyros*. This forest extends inland from the Rembo Ngowe marshes.

***Manilkara lacera* scrub forest** – This narrow strip of forest is usually dominated by *Manilkara lacera*, often with *Phoenix reclinata*, *Chyrsobalanus icaco* and occasional *Fegimanra africana*. Sometimes the canopy is quite closed, but often, these trees have a windswept appearance and are in open formation in various types of scrub with species such *Dalbergia ecastaphyllum*. This forest type occurs in non-continuous strips of 5–100 m wide along the Lauri Lagoon and Petit Loango along the coast behind the beach.

Forest fringing the savanna – This forest type surrounds the savanna. The canopy is often low, especially towards the savanna side. The commonest trees are *Sacoglottis gabonensis* and *Aucoumea klaineana* but these two species are not evenly distributed. *Vitex doniana*, *Guibourtia pellegriniana*, *Maranthes glabra*, *Odyendyea gabonensis* and *Dracaena arborea* are more common here than in the other forest types. *Newtonia duparquetiana* is typical of these forests. Other trees include the *Duguetia confinis*, *Symphonia globulifera*, *Chrysobalanyus icaco*, and *Klainadoxa gabonensis*. Smaller trees and shrubs, *Xylopia aethiopica*, *Cassipourea barteri*, *Barteria nigritana* and other light-loving species grow at the interface of this forest and the savanna, mixed with saplings and small trees of the species mentioned above. *Barteria nigritana* is a typical forest edge species, but also found in small clumps in the savannas. *Barteria nigritana*, *Fegimanra africana* and *Cola flavo-velutina* are more common to the seaward side. This type of forest is found surrounding the savannas of the Iguela and Lauri lagoons and also to a limited extent around some thin strips of savanna at Petit Loango.

Post-agricultural forest – Within Loango, there are small areas of recent post-agricultural forest, which fall into two distinct types. The first type is young forest full of light-loving canopy trees at different stages of development with quite dense undergrowth. The second type is Marantaceae-Zingiberaceae forest. Here various Marantaceae and *Aframomum* species dominate the ground layer, and the space between this and the canopy is often quite clear. This can be described as 'the empty sandwich effect'. The canopy here can be continuous or not, and it also contains many light-loving species. These forests are found at disconnected spots

along the Iguela lagoon and its major rivers, including the islands but they are rarer on the park mainland.

Wetland forests – This category is composed of permanently and temporarily flooded forests, including mangroves. Unlike the dry-land forests and most open wetland marshes, these wetland forests are scattered and generally cover only small areas. Other wetland forest types include small mono-dominant patches of trees including *Alstonia congensis*, *Haplormosia monophylla*, *Sacoglottis gabonensis* and *Raphia* sp. Also, at times, the 'mixed *terra firma*' and *S. gabonenis* dominated forests can be flooded.

***Lecomtedoxa* forest (*Adzacon*)** – In this forest type *Lecomtedoxa* sp. is found in small mono-dominant patches in areas that are seasonally flooded. This forest type is found in the north-western coastal part of the park.

DISCUSSION

Checklist

The checklist of LNP presented in this paper contains 686 species. This is a very conservative list of species known to occur in the park and a 10 km buffer zone, based on herbarium specimen vouchers and compiled with a very strict policy on reducing the accumulation of species numbers from unidentified 'morphospecies'.

The present Loango list, when compared with the checklist of Gabon (Sosef et al. 2005) (4710 species), represents 15% of the national flora. Using the result of the Chao2 estimation of 1361 species one can predict that when the botanical inventory for LNP is completed between a quarter and a third of all plants at present known from Gabon will be recorded from this national park. The 25 new species to add to the checklist of Gabon listed in table 2 reflect the large amount of basic inventory work which remains to be done in this botanically diverse country. We suggest from this study that such inventory work is not very time consuming or expensive if it is targeted and carried out in an efficient manner by a team with complementary expertise. One important part of budgeting for an inventory such as this is to include the time spent identifying the specimens in an appropriate herbarium.

The publication of this paper on the LNP follows on from a recent checklist of Pongara National Park (Dauby et al. 2008). Together, both these studies have contributed substantially to the knowledge of the coastal flora of Gabon and its associated littoral endemics. One notable difference between the Pongara list and the Loango list is the greater number of species in LNP. This probably reflects greater species diversity per vegetation type as well as the great diversity of habitats at Loango. Another difference is the high number of Orchidaceae species on the Pongara list, a result of one of the authors being a specialist in the family.

Comparing the results from LNP with Monts Doudou (Sosef et al. 2004), the collecting effort appears to be similar but more species (991) are recorded from the later. This difference is probably due to the higher number of species occurring along a greater altitudinal range.

The relatively high number of species in LNP is likely due to the diversity of habitats. We recorded thirteen vegetation types with 686 species between 0 and 100 m above sea level. This compares with six vegetation types recorded from Monts Doudou from sea level to 700 m. The list of species per vegetation type would be much smaller in LNP but the accumulation of different species in very diverse habitats gives rise to the surprisingly high percentage of the national flora.

The absence of rattans and the low number of species of giant herbs in LNP is puzzling. To put this in context, Harris collected and identified these taxonomic groups in Dzanga-Sangha in the Central African Republic (Harris 2002) and found the following numbers of species: Rattans 6 (none in LNP but one in the buffer zone), Zingiberaceae 15 (2 in LNP), Costaceae 4 (none in LNP but three species are in the buffer zone), *Palisota* 6 (three species in LNP), and Marantaceae 17 (six species in LNP). Biases in collecting can easily influence the reported number of species in an area. When the bias is conscious and reported, as in this case, it can point towards real absence, something which is very hard to study when using only herbarium records to examine species distributions.

When comparing our checklist with the short Loango checklist of trees and lianas complied by Morgan (2005), we found some overlap. Of Morgan's 82 fully determined species, our list had 47 of them in common (57%). This is not very high and the discrepancy is probably due to a combination of factors. The first is that both inventories are incomplete and that Morgan simply collected species which others have not yet collected in the park. Secondly, Morgan's study site was in the south of the park, which may have a different species composition. Thirdly, inconsistencies may be due to differences in taxonomy, for example: *Avicennia nitida* Jacq., recorded by Morgan (2005), is not listed in the Gabon Checklist (Sosef et al. 2005) and is often treated as a synonym of *Avicennia germinans* (L.) L., which is in both our list and the Gabon Checklist. Morgan's vouchers are lodged in the Herbier National du Gabon and future work should attempt to reconcile the differences and integrate these data.

Most of the specimens in this checklist were collected in the northern part of LNP. The southern portion is very undercollected. The northern part of the park is still much less well known than the adjacent Rabi site which has been visited by WAG botanists for decades and is consequently one of the best collected in Gabon (see Sosef et al. 2005). It is, however, interesting to note that several new records for Gabon were collected during this study in northern LNP close to Rabi. This may reflect a steep species gradient from Rabi west to the Atlantic Ocean although preliminary comparisons using the NHN database suggest that the composition of forest species (but not the savanna species) from Loango is similar to that of Rabi.

Normally 100 specimens per 100 km^2 is considered to be the minimum acceptable collection density for describing an area as well-known (Campbell & Hammond 1989). In an area such as LNP, in a very species-rich country with restricted endemics, very diverse vegetation types and rather steep species distribution gradients, the figure of 100 speci-

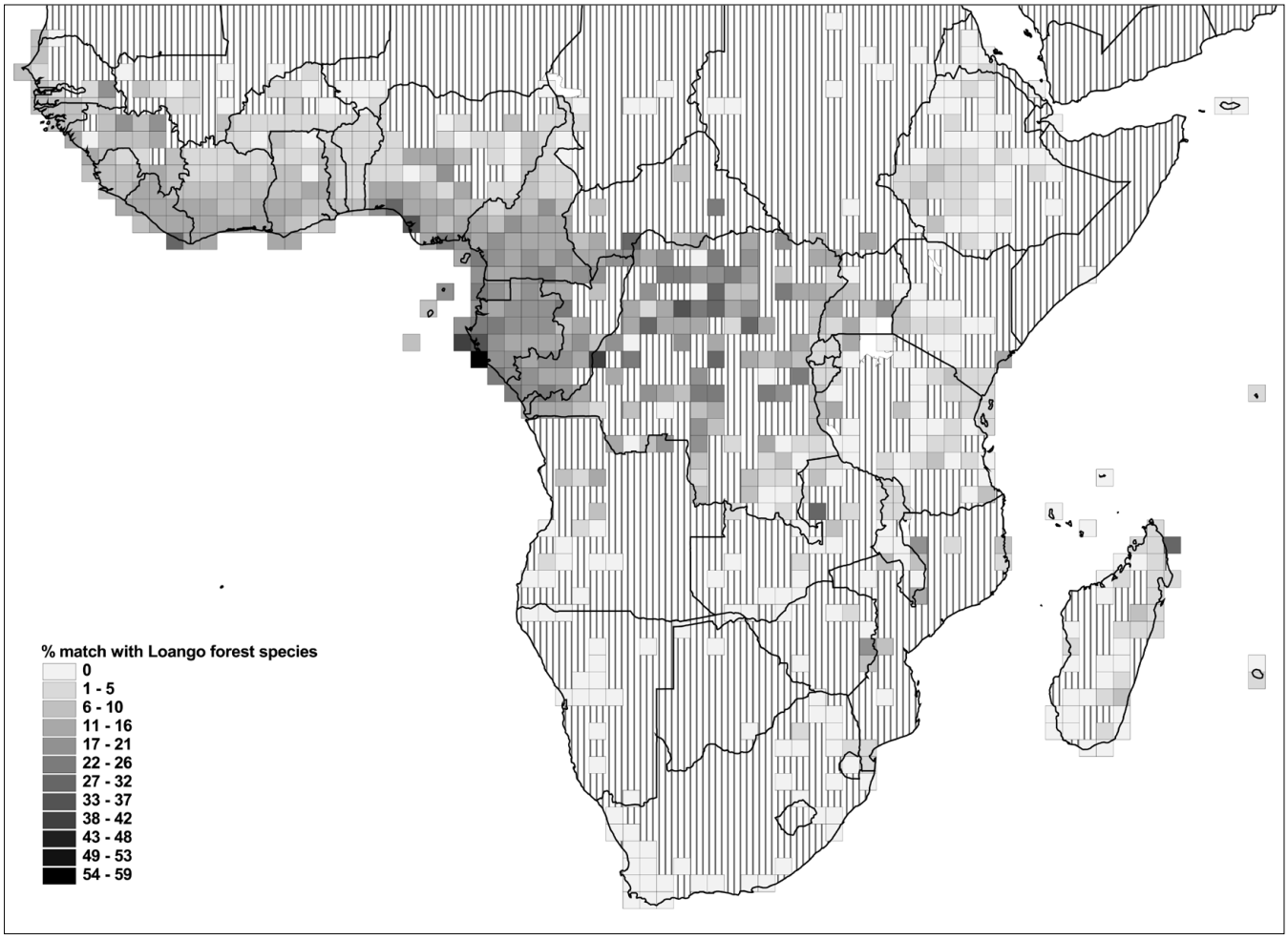

Figure 10 – Percentage of species of each 1° × 1° grid cell that is shared with the forest species list of Loango National Park.

mens per km^2 is too low and 200 specimens per km^2 might be more appropriate.

It is probable that the mixed species *terra firma* forest in LNP is the habitat with the most vascular plant species not yet collected. Further studies should concentrate on carrying out an inventory of the trees of this habitat.

There is a definite seasonal bias when considering collections. The well-collected months are April and May (when the extended field trip took place) and September to November. Other less well-collected months should be the focus of future collecting trips.

Phytogeographical analysis using individual species maps from DPA and TAFP

Our analyses, using a subset of species from the checklist, were shown to be valuable in understanding the general phytogeographic affinities of the flora of Loango. Forest species are of a more limited distribution than non-forest species in LNP. More of the forest species are restricted to Lower Guinea than shared with any other area. The affinities are more with Congolia than Upper Guinea by a factor of two. Slightly more species were associated with Zambesia than Sudania; however, a larger sample would be required to see if this is a significant difference. A very small portion of species are shared with East Africa's coastal belt. These results confirm White's view that the Lower Guinea centre of endemism shares most species with Congolia and that together with Upper Guinea these make up a very clear Guineo Congolia centre of endemism.

Non-forest species, by contrast, are generally widespread. Very few were restricted to Lower Guinea or even Lower Guinea and Congolia. Despite many being associated with both Sudania and Zambesia, only 13.3% were strictly associated with Sudania and 10% with Zambesia. Given that the subset was very small, in this case thirty species, no firm conclusions can be made. It would be interesting to analyse the affinities of the savanna flora using the whole non-forest species list, and by dividing this list into aquatics, ruderals, seasonally flooded savanna and dry savanna. This could be compared with other such lists from savannas (such as Lopé, Pongara, and Batéké Plateau) in Gabon to understand similarities and differences in species composition and phytogeographic affinities.

The differences in phytogeographic affinities between the forest and non-forest species at Loango suggest that these two vegetation types have had different origins and are possibly of quite different ages.

Dauby et al. (2008) in a phytogeographic analysis from Pongara used eleven total categories and lumped these into six for their graphical presentation as opposed to our nineteen categories lumped into eleven for presentation in the graphs. However, some comparisons between the analyses are possible. We lumped our finer categories to compare with the coarser ones for Pongara. When considering forest species, the results from Loango are very similar to those of Pongara. Most species are of Guineo-Congolian or more restricted distributions and very few (10% or less) species are of multi-regional distribution within Africa. However, the non-forest comparison is different between the two sites. For Pongara, 28% of their species were Guineo-Congolian while Loango was 9.9%. Furthermore, 23% of theirs were multi-regional, while Loango species were 46%. Similar percentages were achieved for species with distributions outside Africa from both national parks. The Loango result, however, should be interpreted with caution as it only contains a subset of 30 of a total of 134 non-forest species in the checklist.

Grid cell floristic analysis using NHN specimen database

The analysis of the grid cell data acted as a second comparison of a different data set. It is interesting to note that several of the same results were found between the two phytogeographical analyses, for example: the different signal from the forest and non-forest species in Loango, the lack of strong correlation for non-forest species with either Sudania or Zambesia and the closer relationship of forest species with the flora of Congolia compared to Upper Guinea. It is also interesting to note that analyses of quite small sets of species, when using high quality datasets based on accurate species identification and mapped points, give consistent results. This is similar to White's (1979) observation when analysing the patterns of endemism on which he built his vegetation map of Africa (White 1983).

The new and surprising result which this analysis showed was the lack of similarity between the largest areas of savanna in Gabon (Lopé and Batéké) and the non-forest species at Loango. In addition the similarity with the savanna of Ezanga and inselberg floras indicate some interesting new lines of enquiry into the history of the vegetation of Gabon. If, as it is widely assumed, there was non-forest vegetation at the height of the last glacial maximum (c. 18,000 BP) surrounding islands of forest refugia (Sosef 1994, Leal 2004), then one would expect that these savannas would be floristically rather similar. Floristic dissimilarity may be attributed to substrate dissimilarity and differing times of savanna formation.

A weakness of this analysis is that it shows only the percentage of species in the other grid squares which also occur in Loango. With low absolute numbers and random variation this could lead to artificially high percentages. For this reason the lower limit of eleven species per cell was used in the analysis. When a higher limit (for example twenty) was used, a few somewhat extreme cells disappeared but so did many cells which show quite normal results when compared with their neighbours. Areas with a lot of unique species will result in a low relative similarity. In contrast areas with many widespread species will result in a higher similarity. Another weakness is that any endemics in Loango, for example *Berlinia razzifera*, are not highlighted in this analysis. However, this kind of data can simply be presented as a list of species endemic to Loango.

One of the strengths of this kind of analysis is that it can demonstrate how much of a wider flora a protected area represents which can provide evidence for conservation decisions. From these results it appears that Loango is a good representative of the coastal flora in Gabon but it does not include all the species of any of the quarter degree squares in the analysis.

Lower Guinea Littoral endemics

The endemic element of the flora of the Lower Guinea littoral zone has been recently evaluated as being as high as 18.5% for the coastal area stretching between the Dahomey Gap and Cabinda (Senterre 2005). Recent work from coastal Equatorial Guinea and Gabon has demonstrated the importance of coastal vegetation types (Dauby 2007, Senterre 2005). The recent new species descriptions from the coast may indicate that this area has been under-collected (see comments in Phillips 2000, Sosef et al. 2007). In this checklist, species presented together for the first time in Gabon include coastal endemics *Campylospermum paucinervatum* (Sosef et al. 2007), *Cassipourea carringtoniana* (Breteler 2008), *Berlinia raziffera* (Mackinder & Wieringa 2007), and *Eriocaulon nadjae* (Phillips 2000). A list of 25 littoral endemics was presented in Pongara (Dauby et al. 2008). However, a further analysis of coastal endemics in Gabon needs to be carried out as the coastal endemics found in the LNP appear to be more restricted than those reported in previous studies.

According to Senterre's synthesis (2005), the Lower Guinea and Upper Guinea littoral areas are different. This is also clearly shown in our own analysis.

Vegetation types

The basis for most vegetation classifications in Gabon is that of Caballé & Fontès (1977) which has been built upon by other maps such as Mayaux et al. (1999). These studies, however, are at a country or region scale. In contrast, the site based studies such as that in Minkebe (van Valkenberg et al. 1998) and this one in Loango are finer in scale and result in more vegetation units being delimited. It is interesting to note that Wilks' vegetation descriptions which were based on observations match closely the results of vegetation transects in Campbell et al. (2007). This indicates that such breadth of knowledge can be appropriate for making quantitative vegetation assessments. However, individuals with this experience are rare.

Thirteen vegetation types were found in this study, supporting the proposal made by Wilks (1990) that Loango is special because of the great variation in habitats. Part of this variation in vegetation types is due to the diversity of geomorphological environments, such as coast, lagoons, rivers, *terra firma* and swamps, which give rise to different edaphic and hydrological parameters; but also due to the dynamic nature of shifting coastlines, the sudden change in water level

in lagoons when sand barriers become eroded, and movement of river courses across broad, flat flood plains.

In their study of lowland forest types of the Monts Doudou, Sosef et al. (2004) only described three types: *terra firma* forest, swamp forest, and gallery forest. These appear to be quite different vegetation types from those at Loango, and this difference is probably due to its inland location.

One vegetation type which appears to be unique to Loango National Park and the immediately surrounding area is the seasonally flooded forest dominated by a species of *Lecomtedoxa*. De Saint Aubin (1963) reported pure stands of a *Lecomtecoxa nogo* which occurs in seasonally flooded forests in the Loango area and this may be the same species.

The forest-savanna mosaic vegetation on the coast of Gabon and Congo has been fluctuating throughout much of the Holocene with forest dominating in earlier phases, following a dry period, and recovering during a wetter period (Vincens et al. 1999). Savannas enclosed in the coastal forest are thought to be remnants of this drier phase (Delègue et al. 2001). Related enclosed coastal savannas in Republic of Congo are estimated to experience forest encroachment at a rate of 20–50 m per century, suggesting many will disappear in the next few hundred years (Schwartz et al. 1996).

Chrysobalanus icaco and *Barteria nigritana* form islands of woody vegetation in the savanna which most likely aid the succession of savanna to forest, as in coastal Congolese savannas (Favier et al. 2004). It has been suggested that *C. icaco* has been introduced and has become naturalised along the Central African coast (Raponda-Walker 1953). There is no indication of how long this species has been in Africa, however, and it is perhaps more likely to have arrived naturally, as the fruit float and have a thick wall.

According to Loango National Park's management plan (Anonymous 2009), one aim is to manage the variety of habitats including savanna as well as protect species particular to the coastal zone. Burning has occurred in coastal Central African savannas since at least the Miocene (Morley & Richards 1993) and is largely ascribed to a drying climate and an increase in oxygen (Keeley & Rundel 2005, Osborne 2008). Today, these fires are sometimes lit for a variety of reasons including habitat management and for local subsistence (Walters 2010a). In LNP prescribed fire may be required to maintain the savannas and also create forage (Molloy 1997, Walters 2010b). The savannas of Loango support a set of plant and animal species dependent on the open environment and these areas are important for tourism. However, a study of fire's impacts on the ecosystem is needed in order to understand how and when it should be used to maintain this habitat and create forage.

CONCLUSIONS

The results from this paper show convincingly that a considerable proportion (15–30%) of the vascular plant flora of Gabon is represented by the plants of Loango National Park. This high proportion is probably due to the great diversity of habitats. The Loango flora is composed of two main elements: savanna and forest. Although low in endemics, the savanna element is unique in its species composition. It is restricted to a narrow coastal strip of central Africa and is markedly different from the inland savannas of Gabon. The forest element is phytogeographically distinct from the savanna. Although with some restricted area endemics of its own, it is clearly part of the forest covering the sedimentary basin of the Ogooué. Together these elements make Loango a botanically unique place of high conservation value.

SUPPLEMENTARY DATA

Supplementary data are available at *Plant Ecology and Evolution*, Supplementary Data Site (http://www.ingentaconnect.com/content/botbel/plecevo/supp-data), and consist of the following: (1) preliminary checklist to the vascular plants of Loango National Park and 10 km-wide buffer zone (Excel file); (2) a list of vascular plants, endemic and subendemic to Gabon that are present in Loango National Park (Excel file); (3) percentage of species of each 15' × 15' grid cell that is shared with the non-forest species list of Loango National Park (pdf format); (4) percentage of species of each 15' × 15' grid cell that is shared with the forest species list of Loango National Park (pdf format); (5) groupings of phytochoria and continental distributions used in the phytogeographic analysis (pdf format).

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