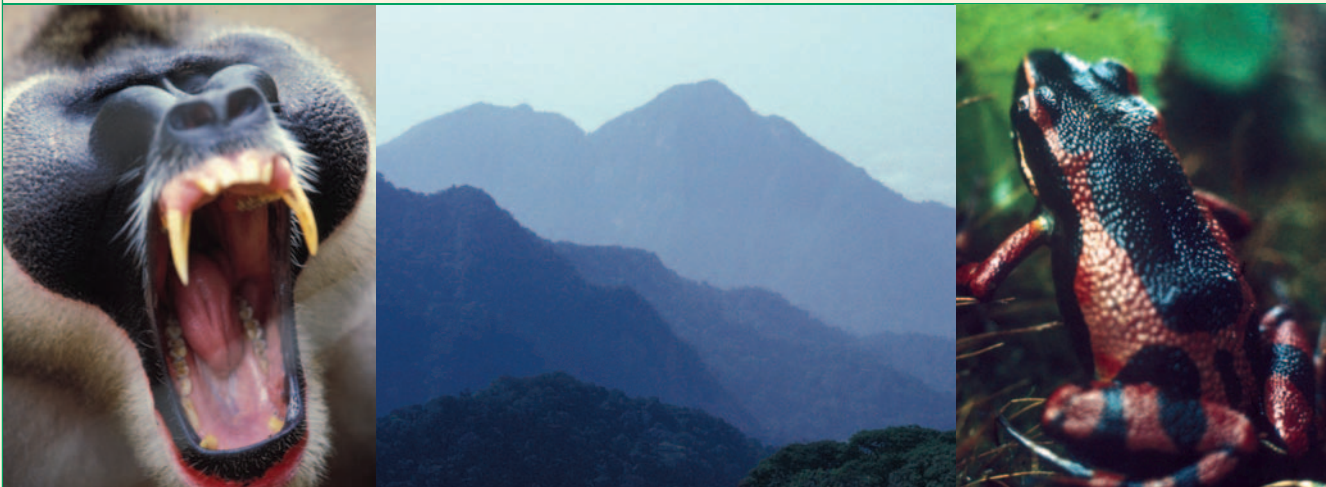


Africa's Gulf of Guinea Forests: Biodiversity Patterns and Conservation Priorities

John F. Oates, Richard A. Bergl, and Joshua M. Linder



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Front cover: [left] Drill, *Mandrillus leucophaeus*. Photo by Daniel Louk. [center] The hills in the north of the Okwangwo Division of Cross River National Park, viewed from the edge of the Obudu Plateau. Photo by John Oates. [right] *Cardioglossa* frog from Moka, Bioko Island. Photo by John Reckless. **Inside:** Chapter 5 photo by Joshua Linder. All other inside photos by John Oates.

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To the Reader

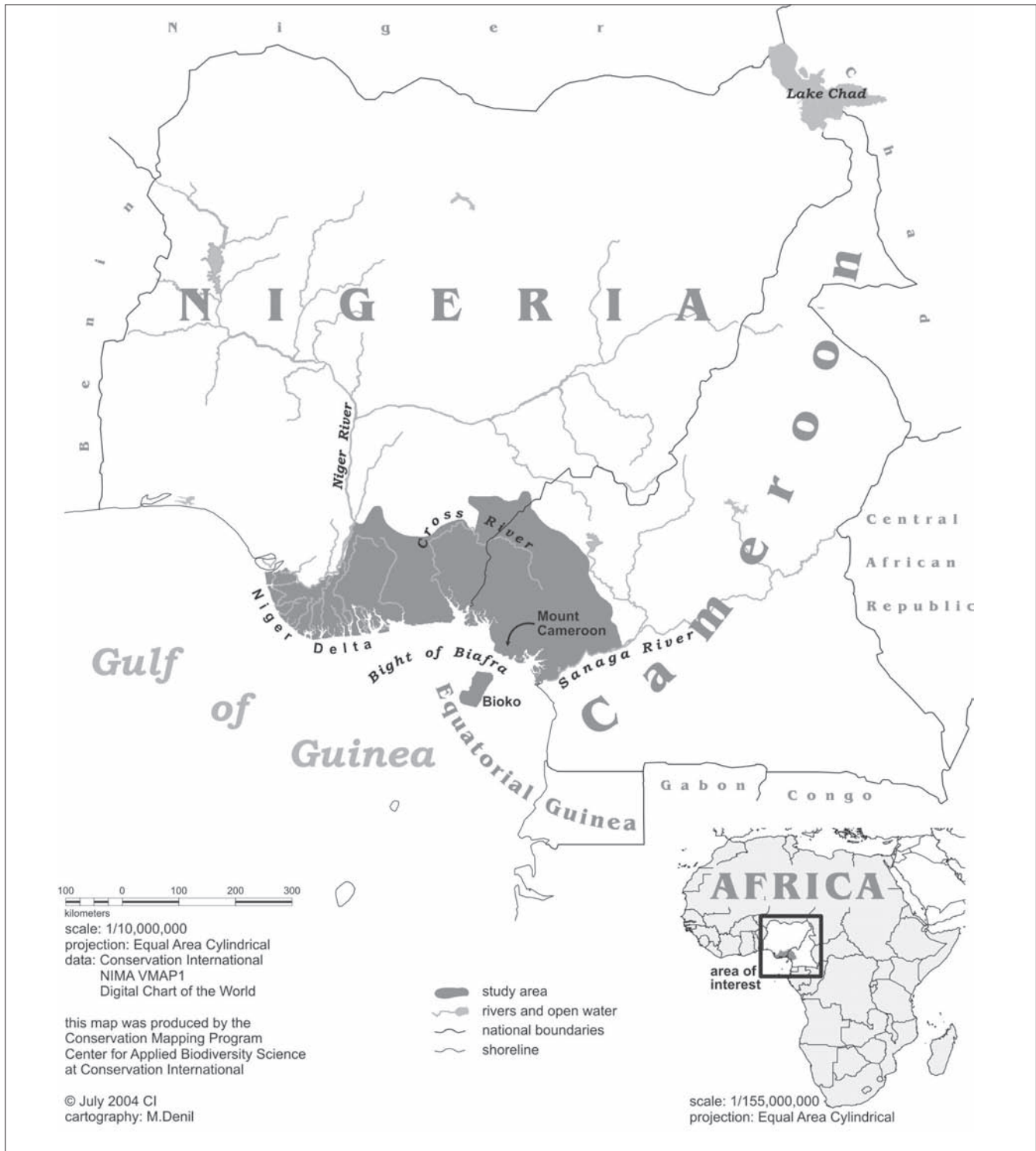
The purpose of this volume is to draw attention to the special biological diversity found in the forests of the Bight of Biafra region in the Gulf of Guinea, West Africa, and to consider how well existing protected areas conserve this biodiversity. Despite the great biological richness of this region, and the high level of endemism it contains, it has been relatively neglected in international conservation planning. The region is located between two areas that have recently attracted more attention: the forests of Upper Guinea to the west, and those of the Congo Basin to the east and south. One factor contributing to the relative neglect of the Gulf of Guinea forests has been the absence of a unified account of their biodiversity, leading to a lack of appreciation of their importance. A major objective of this report is to remedy this lack. We map patterns of species richness and endemism in this region in relation to other parts of Africa, we collate information from published sources on the total number of species present in different taxonomic groups, and we plot the geographical distributions of many individual endemic species. Using a Geographic Information System (GIS), we relate species distributions to land elevation and to the location of protected areas; through this analysis we identify gaps both in knowledge of the geographical distribution of species, and in the extent to which protected areas conserve the region's special biodiversity. Combining information gathered from fieldwork with our GIS analysis, we also draw attention to the problems posed by a dense human population and a rampant trade in bushmeat. We hope that this publication will nurture a better appreciation of the Gulf of Guinea forest region as a biodiversity hotspot of global importance, and thus lead to further research and better conservation. We stress the need for new inventory surveys and more ecological monitoring, and we make recommendations for increasing the coverage of protected areas—especially in montane forests—and for improving the effectiveness of the protected areas that already exist.

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AFRICA'S GULF OF GUINEA FORESTS: BIODIVERSITY PATTERNS AND CONSERVATION PRIORITIES

by John F. Oates, Richard A. Bergl, and Joshua M. Linder

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The rain forest region of the Gulf of Guinea considered in this volume extends along the coast of the Bight of Biafra from the Niger River in Nigeria to the Sanaga River in Cameroon, and includes the continental shelf island of Bioko, part of the nation of Equatorial Guinea. The Gulf of Guinea forests have very high levels of endemism and are rich in species. This high biodiversity is partly a consequence of the special and complex geography of the region, which contains the Niger Delta (the largest river delta in tropical Africa), the basin of the Cross River, and the highlands of Cameroon, including the volcano of Mount Cameroon, the highest mountain in West Africa. But the region also includes some of the densest human populations in all of Africa. As a consequence, much of the original forest cover has been removed or greatly modified, and populations of the larger animals reduced to perilously low levels by rampant hunting for the bushmeat trade.

CHAPTER 1

Defining the Gulf of Guinea Forests



Iladyi valley, southern highlands, Bioko Island.

The area within the West African rain forest zone between the Niger and Sanaga rivers, including the continental-shelf island of Bioko (see map, p. 7), has been long recognized for high species richness and high endemism in many taxa. At the same time, parts of this region also have some of the highest human population densities in tropical Africa, and throughout the area human numbers continue to grow rapidly. Consequently, the region's remaining forests are becoming increasingly degraded and fragmented, and its large-animal populations are under intense pressure from hunting, particularly for the bushmeat trade.

The volcano Mount Cameroon, the highest mountain in West Africa at 4,095 m, sits within the region, part of a chain of highlands along a tectonic fault that extends northwest-southeast into the Gulf of Guinea through Bioko, Príncipe, São Tomé, Annobón, and on to St. Helena. The Cross River runs through the mainland portion of the region, while the delta of the River Niger—the largest river delta in tropical Africa—occupies the region's western edge. Important coastal swamplands lie east of the Niger Delta. From the southern shore of Bioko to the Nigerian town of Obudu, 380 km to the north, annual rainfall ranges from more than 10,000 mm (the highest in Africa) to around 1,800 mm, with a four-month dry season. The resultant ecological diversity, combined with high species richness, high endemism, and high threat, make this region a classic “biodiversity hotspot,” and therefore a high global priority for conservation. Indeed, the European Commission's Joint Research Centre TREES project classified a major section of this area (labeled “Korup-Cross River”) as one of 19 tropical humid forest deforestation hotspots in West and Central Africa (Achard *et al.* 1998).

Despite its exceptional characteristics, this region remains without a generally accepted name. It has been referred to as “Cameroon” (Oates 1986), “West-Cameroon” (Grubb 1990), and “Cameroon Highlands” (Sayer *et al.* 1992), but none of these names is entirely appropriate because a significant part of the region is in Nigeria, another part on the island of Bioko (a component of the Republic of Equatorial Guinea), and much of the area is lowland forest.

The geography of the area includes the coastal areas and islands of the Bight of Biafra, a name that appears in many atlases. Letouzey (1968) refers to the coastal forest area from southeastern Nigeria to the south of Cameroon as *la forêt biafrière* (Biafran forest), and in an analysis of African centers of endemism, Kingdon (1990) uses the term Bight of Biafra for one of his centers. Kingdon does not precisely define this center's boundaries, but his reference map covers the area from the Bénin-Nigeria border in the west to the mouth of the Ogooué River in Gabon in the south. He notes that this area contains “one of the greatest concentrations of plant and animal life on the entire continent.” However, by treating the entire area under one broad rubric, Kingdon disregards the distinct zoogeographical communities within it, especially the major faunal disjunction which occurs in the region of the Sanaga River in Cameroon. The name “Biafra” also has unfortunate political connotations in Nigeria as it is associated with the secession of the Eastern Region in 1967 and the subsequent civil war.

Given the problems associated with the various alternative names described above and the lack of any other familiar term, in this report we use “Gulf of Guinea Forests” for this region. We recognize that this term is not ideal, for the geographical limits of the Gulf are usually considered to extend well to the west of this region as it is defined here. We use this term only on a provisional basis, in the absence of any obviously satisfactory alternative.

AN UNDERSTUDIED AREA

Although Eisentraut's classic study (1973) compares the vertebrate fauna of Bioko with that of West Cameroon, and although a recent quantitative analysis confirms the pattern of high species richness and high endemism for the primates of this region (Eeley & Lawes 1999), no unified investigation has yet been done of biodiversity patterns in the Gulf of Guinea forests as a whole. To be sure, the region's birds have been quite well studied, and its montane forests are recognized as an important area of bird species endemism (Jensen & Stuart 1984, Collar & Stuart 1988, Stattersfield *et al.* 1998). Lists of butterfly, amphibian, reptile, and plant species have also been compiled for several sites in the region, but in most cases these have not been accompanied by analyses of the number and proportion of species that are narrowly or broadly endemic, or by an examination of how patterns of endemism compare with areas to the west and east.

This region has also been relatively neglected in international conservation planning. It was not given special attention in a continent-wide “ecoregional” assessment conducted by WWF-US in Cape Town in August 1998, nor was it included in Conservation International's Upper Guinea Rain Forest Priority-setting Workshop, held in Ghana in December 1999. The region has also been excluded from a variety of special conservation activities targeted at the Congo Basin.

For a variety of reasons, the Gulf of Guinea forest region lacks an integrated approach to its conservation problems. Creating an integrated plan is difficult not only because of problems posed by the long border between Nigeria and Cameroon (a border which passes directly through some of the largest remaining areas of natural forest), but also by the political isolation of Nigeria under its recent military regimes (and associated lack of foreign aid funds), and the Equatorial Guinean government's apparent wariness of foreign scientists and organizations. Although Nigeria, Cameroon, and Equatorial Guinea have each designated or proposed protected areas within the Gulf of Guinea forest region, the extent to which these areas provide adequate protection for the region's biodiversity has not been carefully examined.

In this volume, we give particular attention to the primates of the Gulf of Guinea forests because they are relatively well known and of special interest to the authors, and because this region is clearly a world hotspot for this group. Between the Niger and Sanaga Rivers, including Bioko Island, 22 primate species have been recorded, with some forests in the region supporting up to 14 sympatric species. At least six of the region's primate species are endemics, as are most of the region's primate subspecies, particularly those on Bioko. Furthermore, because these primates occur in a relatively small area, and because the pressures from hunting and habitat destruction are great, the region contains a high concentration of endangered and critically endangered taxa. Chapter 4 provides more extended discussion of these primates and their distribution.

This study was carried out to address the need for more information regarding the Gulf of Guinea forests, to more fully document their biological importance, and to promote a unified treatment of the forests' biodiversity and conservation needs. To accomplish these goals, we

- documented and mapped existing information on biogeographic patterns in the Gulf of Guinea forests,
- compared these patterns to those of neighboring regions, paying particular attention to the status of several rare and endemic primates,
- investigated the extent to which existing conservation activities provide adequate protection to the region's biodiversity, and
- identified gaps in existing knowledge and conservation activities and developed recommendations for actions needed to be taken to fill these gaps.

CHAPTER 2

Approaches and Methods



Biological survey team heading into the Oban Hills, Cross River National Park, Nigeria.

To meet our goals of mapping aspects of biodiversity in the Gulf of Guinea forests and analyzing the area's conservation needs, we created a single Geographic Information System (GIS) database with integrated information on animal and plant distribution, elevation and land cover, and the location of existing protected areas. We drew data from published literature and museum and herbarium specimens, as well as from existing databases, which are described in the following section. Distribution data were first examined for patterns of species richness and endemism, and then were combined with information on forest cover, and compared to existing and proposed protected area boundaries, and to patterns of human activity. We also evaluated the effectiveness of current protected areas at preserving patterns of biodiversity and gathered information on conservation challenges and options, drawing on fieldwork, local experts, and published literature.

During the initial research, conducted between September 2000 and August 2001, we were able to collate and map only a small part of the information on biodiversity patterns in the region between the Niger and Sanaga Rivers, and could only evaluate a portion of the region's existing and proposed protected areas. Therefore, after writing and circulating a draft report, we resumed data collection between February and August 2002, adding to our database for several taxonomic groups and analyzing Landsat imagery. Final data analysis and writing took place from September through November 2002.

LABORATORY-BASED BIODIVERSITY ANALYSIS

General approach

Geographic and distributional data were analyzed in the Department of Anthropology at Hunter College using ArcView™ GIS 3.2a, Spatial Analyst software (Environmental Systems Research Institute, Redlands, California), and WORLDMAP software (Williams 2000). Paul Williams (Natural History Museum, London) provided us with training in the use of WORLDMAP and created customized versions of the program for this project. Carsten Rahbek of the Zoological Museum, University of Copenhagen (ZMUC) allowed us access to ZMUC's African vertebrate database, and particularly to digital data on mammal, bird, snake, and amphibian distributions in our region of interest.

WORLDMAP software and the ZMUC database allowed us to view the importance of our project region in relation to other parts of Africa, in terms of patterns of species richness and endemism (a similar approach has been taken in a recent parallel study by Brooks *et al.* 2001, which also uses the ZMUC database). This "first cut" was one device we employed in deciding which taxa to focus on in a more fine-grained analysis; some selection was essential, given our limited time and resources. For instance, we used WORLDMAP, the ZMUC database, and the literature to identify taxa endemic to the Gulf of Guinea project area in selected groups. Only taxa entirely restricted to the project area (i.e., the forest zone between the Niger and Sanaga Rivers north to the Mambilla Plateau, and Bioko Island) were considered.

Base maps, protected area, and land cover mapping

Base maps for the GIS were constructed using published maps of the project region, collected during many years of research on West African primates and biogeography (see Oates 1988). Newer maps, especially of Cameroon and Bioko, were acquired during project fieldwork, and boundaries of protected area manually added to electronic files, with details clarified by experts in the region. Land cover data from several sources were examined, but many proved to be either highly inaccurate or incomplete for the Nigeria-Cameroon border area; sources included the United States Geological Survey Global Land Cover Classification (USGS GLCC), the Digital Chart of the World (DCW), the Tropical Ecosystem Environment Observations by Satellites (TREES) project, and the World Conservation Monitoring Centre (WCMC). We used the WCMC data

for this study because our field surveys ("ground truthing") suggested that it offered the most accurate and complete coverage for our project area.

Remote sensing analysis

Satellite images of the project area were generated using public-domain data from the Landsat 4 and 5 satellites (TM sensor). The selected scenes cover a range of dates between 1986 and 1988, together with one scene of the core of our study region from 2000. High prevalence of cloud cover in this region mitigates against the acquisition of cloud-free images for the entire area.

Landsat scenes were processed using standard image software (ERDAS), and then imported into the existing GIS in Arcview™ and mosaiced together. Landsat bands 3, 4, and 7 were assigned to the blue, green, and red wavelengths, resulting in maps where intact forest appears as dark green, degraded forest and farmland appear light green, and bare earth and urban areas are pink. Constraints of time and budget prevented us from conducting a formal land-cover classification from this imagery. However, familiarity with the area suggests that the simple classification we have used produces a quite accurate land-cover map.

Point locality mapping

The ZMUC database is relatively comprehensive, although it does not include Bioko data. However, it only provides distribution data in one-degree grid cells, and many of the maps used in the database are expected distributions based on interpretations from known occurrences. Because of the relatively small area considered by our project (relative to the large cells of the ZMUC maps), and the need to relate distributions to protected area boundaries, we moved to the acquisition of point-locality data for certain focal taxa identified in our initial research. Considering the availability of data, our own interests, and conservation concerns, we decided to focus on anthropoid primates, birds, amphibians, and trees, as each of these groups has distributions affected by different sets of environmental and historical factors. Locality data for these taxa were gathered from many sources (see below) and imported into the GIS along with data on protected area boundaries and land cover.

Monkey distribution data, drawn from a large existing hand-written database (1,782 individual records) assembled since 1980 (Oates, personal data) include point locality information for all West African forest monkeys collected from the literature, museum collections, and field observations. In this project, we updated and added ape distribution to these data records.

A list of endemic birds (along with primates, probably the best studied taxonomic group in the region) was compiled using both WORLDMAP (Williams 2000) and published literature (e.g., Jensen & Stuart 1984, Stattersfield *et al.* 1998). Locality data were acquired from the collections of the American Museum of Natural History, New York, and the Ornithology group, Natural History Museum, Tring, UK, and from a broad set of literature, including valuable compilations from Louette (1981) and Pérez del Val (1996).

After identifying species endemic to the project region from WORLDMAP-ZMUC data and the literature, locality data on anuran amphibians (frogs and toads) were gathered from museum collections and the literature. We consulted Amiet (1971, 1972a, 1972b, 1977, 1978, 1981, 1983), Gartshore (1986), Hofer *et al.* (1999), Lawson (1993), Parker (1936), Perret (1966, 1977), and Schiøtz (1963, 1966, 1999). Data were also compiled from collections at the Natural History Museum, London, as well as from the electronic databases of the Field Museum of Natural History, Chicago, the Museum of Natural History at the University of Kansas, and from the Natural History Museum of Geneva, Switzerland. At the time of our study, this list was likely the most complete compilation of data yet assembled for the amphibians of this region.

For plants, we examined the limited dataset already established for WORLDMAP by Jon Lovett at University of York in the UK. Because this dataset has an East African emphasis, we found that we needed to consult other sources to produce a list of endemics for our study region. As a first step in this process we consulted Cable and Cheek (1998); this publication on the plants of Mount Cameroon summarizes distribution records of plants not only collected on the mountain, but also growing in the lowlands in the mountain's vicinity. From Cable and Cheek it was possible to identify a list of 353 species known from the Mount Cameroon area that apparently had been recorded only in the Nigeria-Cameroon-Bioko area. This list was narrowed down to a set of 55 trees listed as reaching a height of at least 10 m, on which additional locality data were acquired from Keay *et al.* (1964), Hutchinson *et al.* (1954, 1958), and Sunderland *et al.* (2002), and from the herbaria of the Missouri Botanical Garden (MOBOT database provided to us electronically by R. Gereau), the New York Botanical Garden, and the Royal Botanic Gardens, Kew.

FIELD STUDIES

General approach

Following a planning trip to Nigeria in July 2000, field work took place at intervals between September 2000 and September 2002. The main aim of the field surveys was to visit existing or potential protected areas in southeastern Nigeria, southwestern Cameroon, and Bioko, to get first-hand impressions of the state of their fauna and flora and of human pressures on the areas. Most of this fieldwork was conducted by Oates, but Bergl visited two sites in Nigeria in January of 2001, and Bergl and Linder visited two sites in Cameroon in October and November of 2001.

Where possible field trips were made with other researchers, so that field work also provided an opportunity to learn about current research in the region. Discussions were also held with protected-area managers, representatives of non-governmental organizations (NGOs) devoted to conservation, and local residents. These discussions, and visits to the offices of a variety of government departments and NGOs, provided

important information on the challenges of protected-area management in the region. They also led to many useful resources including maps, publications, and databases.

In Nigeria, field work in 2000 was conducted in association with Edem Eniang and Ernest Nwufoh, in liaison with the management of Cross River National Park and the Cross River State Forestry Commission. In Cameroon, field work was conducted with the help of Jacqueline Sunderland-Groves, and staff of the Ministry of the Environment and Forests, the Wildlife Conservation Society, and the World Wide Fund for Nature. On Bioko, Oates joined expeditions organized by Gail Hearn and Wayne Morra of Arcadia University's Bioko Biodiversity Protection Program (BBPP) in association with the National University of Equatorial Guinea.

Most field excursions lasted between 3 and 10 days, although a few single-day or overnight trips were made. Extended excursions involved trekking into the forest with research associates and assistants and establishing base camps for further explorations. Formal line-transect censuses were used only on Bioko. More typically, surveys involved walking slowly for several kilometers along existing paths, making notes of vegetation, animals, and signs of human activity. Global Positioning System (GPS) receivers (specifically Garmin GPS-II Plus and GPS 12 units) were used to record position in the forest, and a barometric altimeter was used to estimate height above sea level because GPS readings of altitude were often not accurate.

Allocation of effort

Nigeria was a particular focus of this study in part because the authors were involved in several ongoing research and conservation efforts there, including a gorilla research project at Afi Mountain, Cross River State, and an associated program developing a wildlife sanctuary at Afi (in conjunction with the Cross River State Forestry Commission, Fauna and Flora International and the Pandrillus NGO). Other projects in Nigeria included the planning of a Cross River gorilla workshop (Calabar, April 2001), and supporting the development of an education center at Obudu Cattle Ranch. These involvements provided useful insights into conservation and research challenges, and so contributed to the larger project. Table 1 provides a schedule of field activities for the authors.

Organizing field research in southeastern Nigeria was hampered by the lack of a well-developed research infrastructure in the area. Much time was spent developing systems that could facilitate future field research in Cross River State. This work led to the launching of a new research program in September 2001, the Biodiversity Research Program, managed jointly by the Wildlife Conservation Society and the Nigerian Conservation Foundation, which includes a training component based at the University of Calabar.

Studying the bushmeat trade

Researchers recorded evidence of bushmeat trade as they came upon it, noting evidence of hunting at the field sites,

carcasses being sold at the roadside or in markets, and loads being carried on forest trails. We also gathered further information from our extensive discussions.

More comprehensive sampling was carried out at the bushmeat market in the Bioko capital of Malabo, the best-sampled bushmeat market in West Africa due to the studies of John Fa (Fa *et al.* 1995, Fa *et al.* 2000). Since the observations at this bushmeat market by Butynski in 1986 and by Fa and associates at intervals between 1988 and 1997, the market has shifted from its own location to become part of the Malabo central market.

Much of the wild game hunted on Bioko Island passes through the Malabo market, and market vendors are not especially obstructive to studies of their activities since they are rarely prosecuted. Quick surveys (10–15 minutes) of the bushmeat available were made by Oates on five days in January 2001 and on two days in January 2002, with one extended observation (of one hour). In 2001, additional data were gathered by students from a BBPP expedition, who visited the market at other times of day, or on other days. Particularly important were visits by Eric Lombardini, who was carrying out a study of parasites in market carcasses.

Table 1. Schedule of visits to sites outside state, provincial, or national capitals (all by Oates unless otherwise indicated).

Nigeria	
July 20–23, 2000	Obudu Plateau and headquarters of Okwangwo Division, CRNP
July 26–28, 2000	Ekonganaku area, Oban Division, CRNP
Sept 7–8, 2000	Obudu Plateau
Sept 11–14, 2000	Nkuesah Hills, Oban Division, CRNP
Sept 18–22, 2000	Ekonganaku area, Oban Division, CRNP
Dec 5–6, 2000	Okomu National Park, Edo State
Dec 11, 2000	Akamkpa headquarters, CRNP; visit to tourist circuit in south of Oban Division
Dec 14–17, 2000	Kyang Field Station, Mbe Mountains, and Obudu Plateau
Jan 6–19, 2001	Mbe Mountains (Bergl)
Jan 24–27, 2001	Ekonganaku area, Oban Division, CRNP (Bergl)
Oct 11–13, Nov 16–19, 2001	Obudu Plateau
Dec 10–11, 2001	Ikom and Bunyia (Afi)
Jan 18–20, 2002	Obudu Plateau and Afi Mountain
June 10–14, 2002	Obudu Plateau
Sept 20–23, 2002	Boje (Afi) and Obudu Plateau
Cameroon	
Oct 24–26, 2000	Limbe, including Wildlife Centre and Botanical Garden
Oct 27–Nov 3, 2000	Mamfe and Takamanda Forest Reserve
Nov 3–6, 2000	Nguti and Banyang-Mbo Community Wildlife Sanctuary
Nov 7–8, 2000	Mount Kupé
Nov 8–13, 2000	Mundemba and Korup National Park
Nov 14–16, 2000	Limbe
Oct 19–31, 2001	Mundemba and Korup National Park (Bergl & Linder)
Nov 5–13, 2001	Bamenda Highlands, particularly Kenshi (Bergl & Linder)
Bioko	
Jan 6–18, 2001	Luba, Moraka Beach, and the Gran Caldera de Luba
Jan 2–10, 2002	Moeri, Moka, Riaba, and Pico Basile

CHAPTER 3

Description of Study Region



Farming near Aking-Osomba on the edge of the Oban Hills, near boundary of Cross River National Park, Nigeria.

PHYSICAL GEOGRAPHY

Our study region covers approximately 109,000 km². Its western boundary, at 5°16'E, is where the western major branch of the Niger—the Forcados River—reaches the Gulf of Guinea, and its eastern boundary lies where the Sanaga River leaves the moist lowland forest zone, at about 12°E. The most northerly extension of the moist lowland forest zone in this region is just south of the towns of Obudu and Ogoja in Nigeria, at about 6°40'N (White 1983), and the southern limit of the region is the southeastern corner of Bioko Island (Punta Santiago) at 3°12'N. Parts of the montane flora and fauna of the region extend at least as far north as 7°00'N in the northern extensions of the Cameroon Highlands along the Cameroon-Nigeria border.

Topography and drainage

Figure 1 displays relief in the project region. This map is taken from the GTOPO30 global digital elevation model (completed in late 1996 through a collaborative effort led by the USGS EROS Data Center). Like much of the information we located in widely-used databases, many details in the data used for this model were inaccurate for our study region. For example, these data do not portray the fact that much of the Obudu Plateau is above 1,500 m elevation; and they show the region around Port Harcourt in Nigeria, just east of the Niger Delta, rising to over 400 m, when in fact this area lies close to sea level. However, the GTOPO30 data were the best we could locate in readily-available digital form for entry into our GIS.

The western part of the study region, between the Niger and Cross Rivers in Nigeria, is generally low-lying (<600 m above sea level) with little relief other than the range of hills between Okigwi and Nsukka. The southwestern portion of this segment includes the Niger Delta, with its maze of coastal creeks and meandering distributaries of the Niger. East of the valley of the lower Cross River the land starts to rise into the Oban Hills, the most westerly outlier of the Cameroon Highlands system. The Oban Hills remain poorly mapped, but they are rugged, and in several places their peaks reach elevations of 900–1,000 m. Northeast of the Oban Hills and north of

the Cross, but still within Nigeria, are further western outliers of the highland system, with parts of the Obudu Plateau and Sankwala Mountains rising to 1,800 m.

Much of western Cameroon is hilly, with several major peaks along a chain extending northeast from Mt. Cameroon (4,095 m), including Mt. Kupé (2,064 m), Mt. Manengouba (2,411 m), and Mt. Oku (3,011 m). Due north of Mt. Cameroon are the Rumpi Hills, which rise to 1,768 m (Mt. Rata). Mt. Oku is part of an extensive highland area around Bamenda, known as the Bamenda Highlands, which also contain the Bamboutos Mountains (2,000–2,600 m). From these highlands the Cross River drains to the west, the Benue River to the north, and the Sanaga River to the south. Although large areas of western Cameroon are above 500 m, not all of western Cameroon is upland. There are extensive lowland areas towards the coast, including the swamplands bordering the Rio del Rey, the low-lying southern sections of the Korup National Park, and the region of Douala and the lower Sanaga.

Bioko is separated from the Cameroon coast by a 37-km sea channel (many publications give an apparently erroneous figure of 32 km), a channel which reaches maximum depths of between 50 and 100 m. The island has an area of 2,017 km² and rugged topography, with Basilé peak (3,011 m, formerly Santa Isabel peak) dominating the northern half of the island, and the southern highlands reaching 2,261 m on the rim of

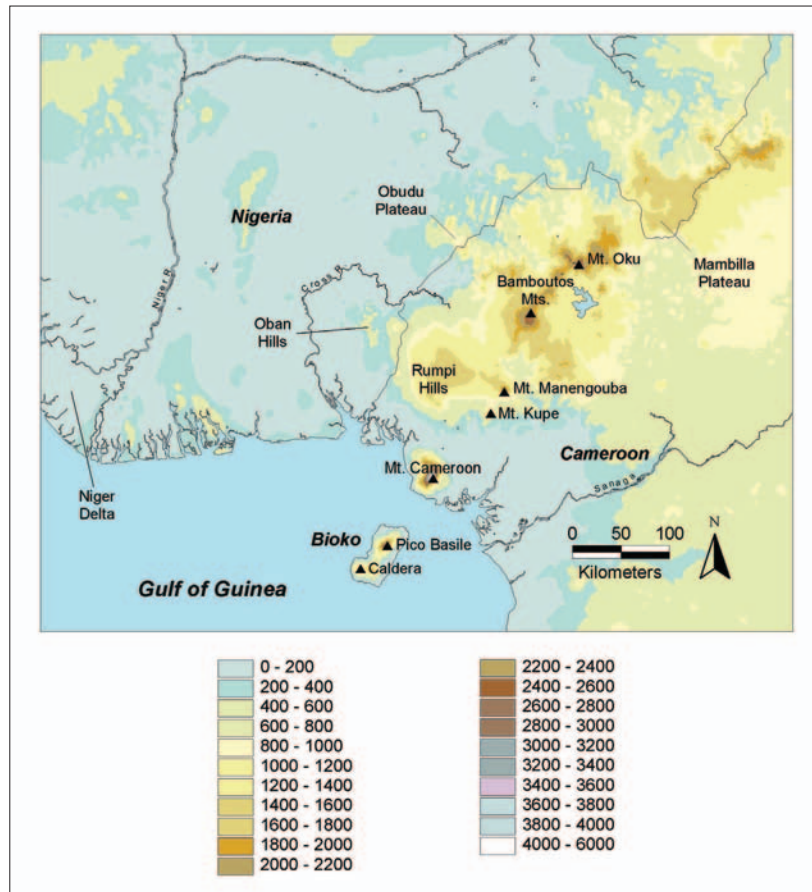


Figure 1. Elevations in the projected region in meters (data from United States Geological Survey GTOPO30 data set).

the Gran Caldera de Luba (formerly San Carlos) in the southwest and 2,009 m on the rim of the more central crater lake of Biao. Major rivers draining the southern highlands include the Ole, Osa, Moaba, and Iladyi.

Climate

Precipitation maps show that this region has the highest mean annual rainfall on the African continent. In general, total annual rainfall in the region is between 2,000 and 3,500 mm, but there is great intraregional variation related to proximity to the coast and elevation, and compounded by rain-shadow effects. For instance, annual rainfall exceeds 10,000 mm on the southern coast of Bioko, and Debundscha at the southwestern foot of Mt. Cameroon has an annual rainfall of 9,086 mm. However, Mokoko in the lowlands immediately northeast of Mt. Cameroon receives 2,844 mm of rain and Mpundu, to the east, only 2,085 mm (Fraser *et al.* 1998). Similar striking variation is shown between the annual mean rainfall of 5,460 mm at Ndian, close to the southern end of Korup National Park, and the annual mean of 3,424 mm at Mamfe, 100 km to the northeast of Korup (Gartlan *et al.* 1986, Sarmiento & Oates 2000).

Most of this region has a distinctly seasonal pattern of rainfall, related to the north-south movement of the Intertropical Convergence Zone (ITCZ). The northward movement of the ITCZ brings warm, moist air from the St. Helena Anticyclone, and between May and October there is typically heavy rainfall, with a peak between July and September (Tye 1984b, Fraser *et al.* 1998). When the ITCZ is to the south, between November and February, dry air tends to sweep down from the Sahara (the dust-laden Harmattan). Although northern locations in the region can have 4–5 months with <50 mm of monthly rainfall (e.g., Obudu town at 6°40'N, 9°09'E), the southern coasts of Bioko and Mt. Cameroon get rain in every month, and the monthly mean rainfall at Debundscha is always in excess of 100 mm (Fraser *et al.* 1998, Sarmiento & Oates 2000).

Given the proximity of the region to the equator, monthly mean temperatures in the lowlands are high and show relatively little seasonal variation. Monthly mean minimum temperatures typically vary between 22° and 24° C, and monthly maxima between 24° and 32° C. Temperatures decline with altitude, so that monthly means are 18–20° at Tole on Mt. Cameroon (elevation 700 m) and 14–16° at Dschang (elevation 1,200 m) (Tye 1984b, Fraser *et al.* 1998).

POLITICAL DIVISIONS

The region is divided politically between the Federal Republic of Nigeria, the Federal Republic of Cameroon, and the Republic of Equatorial Guinea.

The Nigerian part of the region was once part of the Eastern Region of the British-administered Federation of Nigeria, which became independent in 1960. Following political tensions in 1966–67, the Eastern Region seceded from the Nigerian federation, its military government declaring itself the

Republic of Biafra. After the ensuing civil war and the reestablishment of federal rule, the east was divided into several states, which have subsequently been further subdivided. As of 2001 there were eight states between the Niger and Cross Rivers that had some of their territory in the rain forest zone: Bayelsa, Rivers, Anambra, Imo, Enugu, Abia, Ebonyi, Akwa-Ibom, and Cross River. Several of these states now have very little remaining forest cover. The largest and most easterly state, Cross River (26,590 km²), borders Cameroon and contains by far the largest surviving area of rain forest.

The Cameroon part of the region was once divided into the United Nations trusteeship territories of Southern Cameroons (administered by Britain as part of Nigeria), and Cameroun (administered by France). Both areas had been under German administration (as Kamerun) prior to World War I. French-administered Cameroun became independent in 1960 and was joined in 1961 by the Southern Cameroons (following a plebiscite) to form the Federal Republic of Cameroon in 1961. The area of Cameroon between the Nigerian border and the Sanaga River within the rain forest zone falls within the administrative provinces of South-West (adjacent to the Nigerian border in the forest zone), North-West, l'Ouest, and Littoral.

The island of Bioko (or Bioco) is part of the Republic of Equatorial Guinea, along with the mainland territory of Río Muni (south of our study region), and the small volcanic island of Annobón, which lies along the same fault line as the Cameroon Highlands and Bioko, but is not on the continental shelf and is outside our study region. Equatorial Guinea was a Spanish colony before independence in 1968, and in colonial times Bioko was known as Fernando Poo. Although mainland Río Muni is considerably larger (at 26,003 km²) than Bioko, the nation's capital is still at Malabo (formerly Santa Isabel) on the northern coast of Bioko.

HUMAN POPULATION, VEGETATION, AND LAND USE

Human population

In July 2003, the human populations in this region were estimated at 133.9 million for Nigeria, 15.7 million for Cameroon, and 510,000 for Equatorial Guinea (CIA, The World Factbook 2003).

With an estimated 134 million people, Nigeria is Africa's most populous country, with twice as many inhabitants as any other sub-Saharan nation. Despite its size, Nigeria is also the second most densely populated country in Africa, with an average of 140 people per square kilometer. Southeastern Nigeria is the most densely populated area of the country (where many areas support >500 people per km²), and most of this population is concentrated between the Niger and Cross Rivers (Figure 2). Although Cameroon is less densely populated than Nigeria, some of the most densely populated areas of Cameroon (especially the Bamenda Highlands) lie within our study region. Bioko is today relatively sparsely populated, with the majority of its inhabitants located in the northern portion of the island near the capital city of Malabo.

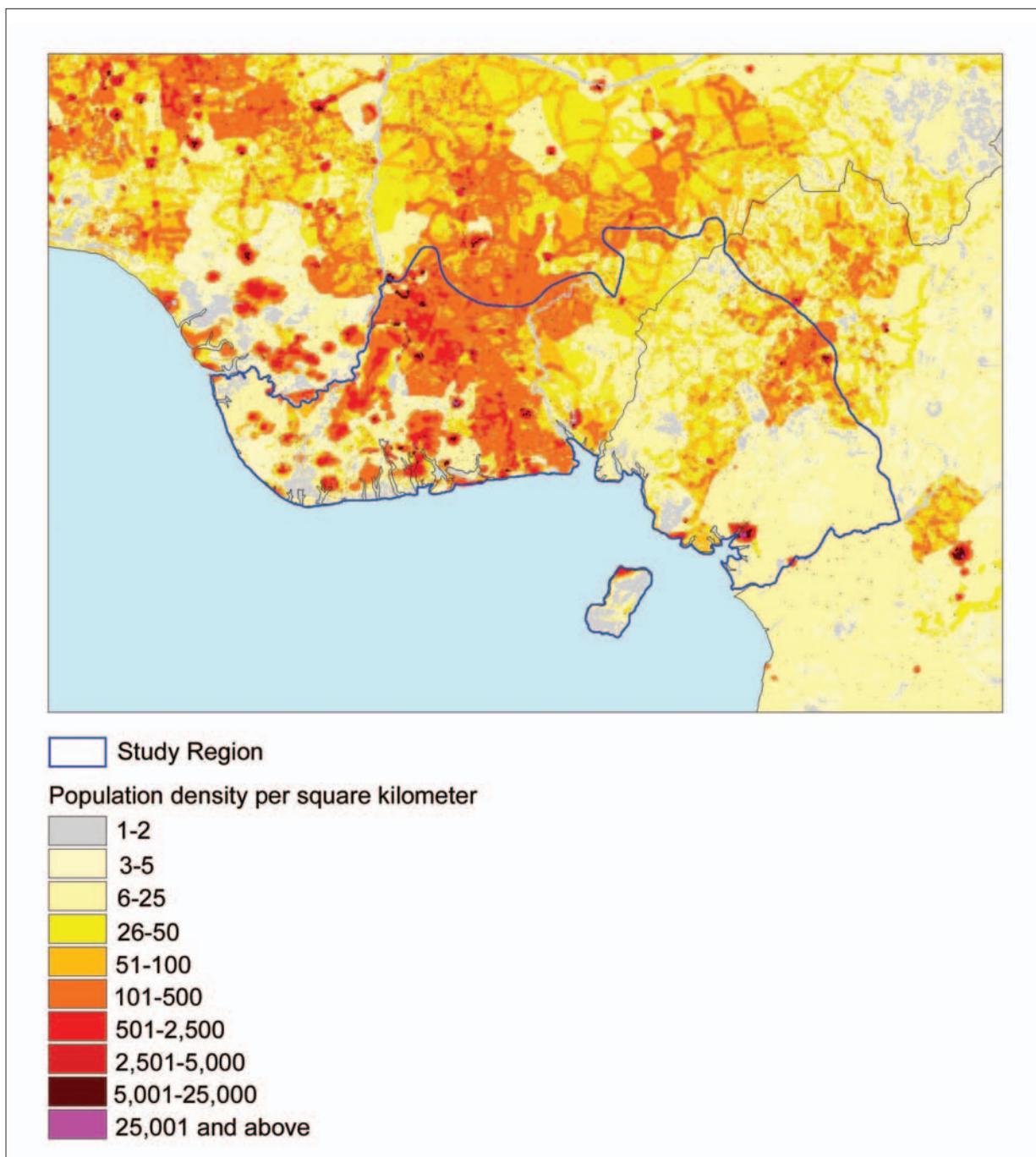


Figure 2. Estimated human population density in Nigeria and Cameroon, compared with neighboring countries (data from LandScan Global Population 1998 Database).

Forest cover

While large tracts of relatively undisturbed tropical forest are still common in Central Africa, forest cover in West Africa has become increasingly reduced and fragmented. There is considerable current debate, however, regarding the precise extent and rate of deforestation in tropical Africa. Widely available data sets for vegetation cover on a pan-African scale differ considerably in the patterns they portray. Some data sets, while generally accurate at a large scale, were highly inaccurate for our study region. For instance, the US Geological

Survey Global Land Cover Classification (GLCC) misclassifies much of the southern Nigeria-Cameroon border region—an area containing the largest remaining forest block in West Africa—as cropland, grassland, and pasture. After inspecting a number of available data sets and comparing their patterns with our field observations, we decided to use the data generated by the World Conservation Monitoring Centre (WCMC) (Iremonger *et al.* 1997) as being most consistent with our observations (Figure 3).

The WCMC maps indicate that our Gulf of Guinea study region contains almost 50,000 km² of evergreen tropical for-

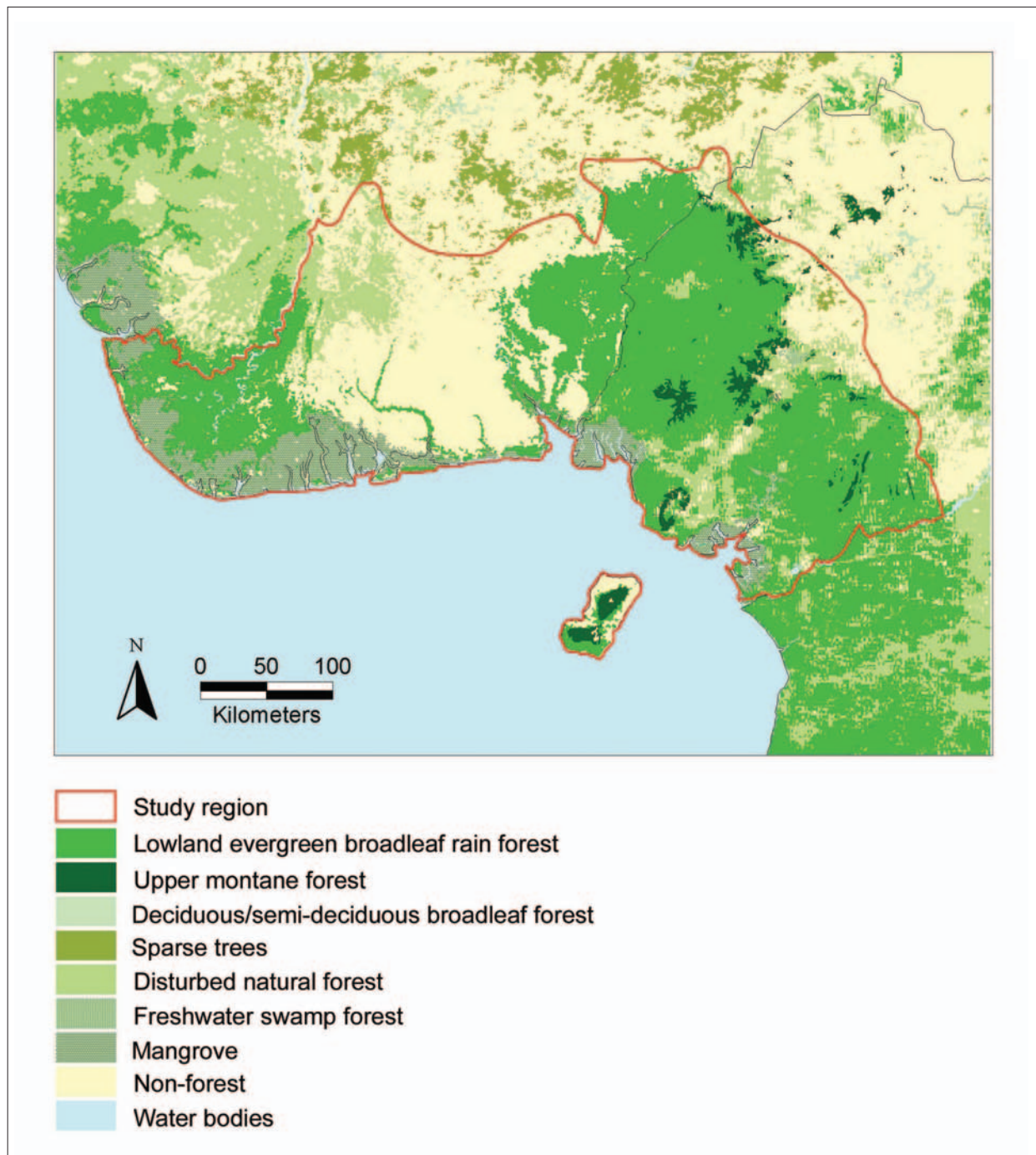


Figure 3. Land cover in the study region based on data from the World Conservation Monitoring Centre (Iremonger *et al.* 1997).

est, including approximately 3,000 km² of montane forest. This 50,000 km² represents over one third of the remaining evergreen tropical forest in West Africa. The project region also includes one of the largest—possibly the largest—remaining relatively intact blocks of contiguous forest in West Africa (approximately 26,000 km²). This block straddles the southern portion of the Nigeria–Cameroon border and contains most of the existing protected areas in the study region.

The remaining near 50 percent of the project region consists of disturbed forest, mangrove, and non-forest, including

savanna and cropland. Although the forest area still standing along the Nigeria–Cameroon border is substantial, areas around it on all sides are heavily modified by human activity. The remaining forest is being encroached upon by farmland and logging, both at its borders and from within, by enclaves of human settlements.

Landsat imagery (Figure 4) shows both substantial blocks of forest remaining and high levels of forest loss in some areas of the study region. Though more pronounced in Nigeria, the encroachment of human settlement and cultivation on forest land can be clearly seen throughout the area. The high resolution (30 m) of

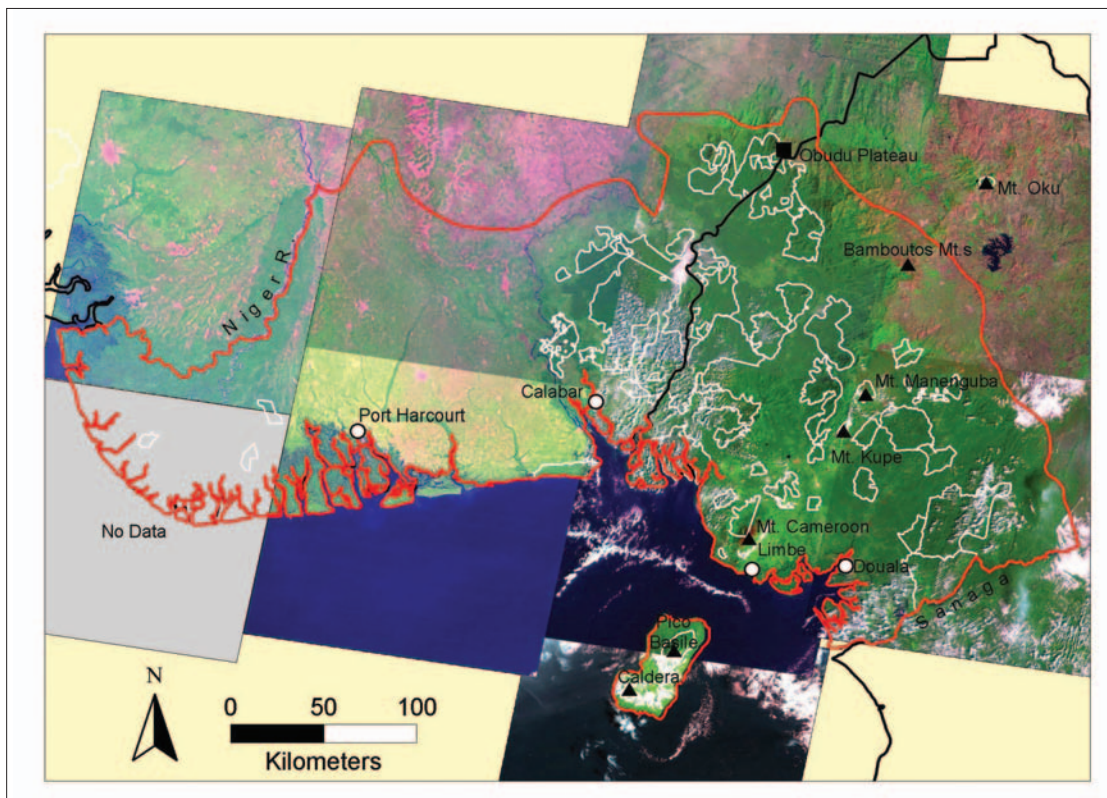


Figure 4. Satellite imagery of the project area collected by the Landsat 4 and 5 satellites (1985–87). Forested areas appear as dark green, disturbed forest and farm land as light green, and bare earth/urban areas as pink. Existing and proposed protected areas and reserves are outlined in white.

the Landsat data allows a finer-scale examination of land-cover characteristics than is possible with coarser sensors like AVHRR (1 km), upon which datasets such as the WCMC classification are based. The Landsat imagery therefore shows considerable loss of forest in areas designated as intact by the WCMC classification (even though the Landsat imagery used for Figure 4 is from 1985–87). Therefore, the WCMC dataset probably considerably overestimates the extent of continuous forest remaining in this region.

Lowland versus montane forest

The WCMC classification we have used in our land-cover mapping puts the boundary between lowland and montane forest at 1,200 m above sea level. This is, of course, a somewhat arbitrary division. Vegetation changes everywhere with elevation, but there are rarely abrupt transitions from one set of plants to another. The local climate that influences vegetation varies from place to place depending on such features as latitude, proximity to the ocean, average cloud cover, and rain-shadow effects. In general, though, as one ascends tropical mountains in the rain forest zone, tall forest gives way to forest that is lower in stature, simpler in structure, and less rich in tree species (Richards 1996).

A widely-used classification divides tropical montane forest into lower and upper montane forest (Richards 1996, Whitmore 1975). The upper montane forest is of lower stature than the lower montane forest, sometimes called “submontane” forest.

The trees of the upper montane forest typically have small leaves, and epiphytes and especially bryophytes are abundant. Although the WCMC classification places the transition between lower and upper montane forest at 1,800 m, other classifications differ. Richards (1996) notes that the transition from lowland to montane forest may occur as low as 700 m, and that the transition to upper montane forest can occur at 1,100 m. For Mt. Cameroon, Richards describes lower montane forest as occurring between 1,200 and 1,800 m, but Thomas (1984), who is very familiar with the area, describes montane forest as beginning at only 800 m, with the upper montane forest commencing at 1,600 m. Cable and Cheek (1998) also set the upper limit of lowland forest at 800 m on Mount Cameroon, but refer to upper montane forest occurring between 1,800 and 2,500 m. Because of the prevalence of clouds, tropical montane forests have often been referred to as “tropical cloud forests” or “tropical montane cloud forests” (e.g., Walter 1973, Aldrich *et al.* 2000). The recent international Tropical Mountain Cloud Forest Initiative describes these forests as “frequently covered in cloud or mist” and notes that they typically occur between 1,500 and 3,000 m (Aldrich *et al.* 2000).

Despite the confusion of terms and inevitable lack of precise boundaries between them, the differences between lowland forest and the two types of montane forest are of considerable significance within our study region, for the three forest types harbor different plant and animal communities. Each is home to its

own set of endemic species, and the montane forests in particular have a limited and patchy distribution and are almost everywhere under intense human pressure.

LONG-TERM HISTORY

In a review of the geology of the western Cameroon highlands, Tye (1984a) notes that many of the mountains in this area date to the Cretaceous. However, the region's orogeny appears to date to a much older tectonic feature, the junction between ancient crustal material of the West African and Congo cratons (Tye 1984a). It is apparently faulting at this junction that has led to the volcanic activity and uplifting that has produced the region's mountains.

Superimposed on this long-term tectonic activity and, along with it, influencing the history of the vegetation and fauna, has been climatic change. The historical pattern of climate change in Africa and its consequences have been matters of considerable debate. Moreau (1966) emphasized the likely effects of the Pleistocene glacial cycle on the evolution of the African fauna, and especially the montane bird fauna. Moreau envisaged the African tropical forest spreading during glaciations, whereas more recent analyses (e.g., Hamilton 1982) suggested the opposite, that at glacial maxima the climate of Africa was cooler and drier than today, and that forest was restricted to small "refuge" areas. Maley (1996) has proposed that although general forest cover was fragmented during glacial maxima, montane vegetation spread more widely at these times, allowing montane fauna and flora to migrate more readily between mountain ranges. However, West African sea cores show such wide and frequent swings in eolian dust levels over the last 2.8 million years (deMenocal 1995) that it seems unlikely that the pattern of climate change has been simple. Certainly between extremely cool, dry episodes and warm, wet episodes there must have been a range of intermediate conditions, with resultant complex impacts on vegetation and fauna.

Many deductions on the history of vegetation have been made based on animal distributions. However, a few independent data sets are available giving insights on past vegetation patterns. For instance, a recent study of geomorphological evidence on the existence of "fossil" dunes (using AVHRR radar images) suggests the advance of Saharan dunes far south in West Africa (e.g., to around Ibadan, Nigeria) earlier than the last glacial maximum at 18,000 years BP (Nichol 1999); this advance was probably at some point between 90,000 and 250,000 years BP. Nichol suggests that most of the West African rain forest would have been eliminated during such an extremely arid period. During the last glaciation there is evidence for forest growing under cool, wet conditions around Lake Barombi-Mbo in southwest Cameroon. From ca. 24,000–20,000 years BP, pollen typical of montane forest trees accumulated in this lake, which is at 350 m a.s.l. (Maley *et al.* 1990). From 20,000–14,000 years BP, there is less tree pollen and an increase in grass pollen in lake sediments, suggesting a drier climate, and after 14,000 years BP evidence appears of a more humid forest environment. However, tree pollen

is present throughout. This suggests that this region contained a forest refuge at the time of the last glacial maximum, but such a refuge appears to have had forest similar to that of present-day cloud forest (Maley *et al.* 1990).

New pollen data indicate that the vegetation of the Nigeria-Cameroon border region has been even more dynamic than was suspected. Between 2,500 and 2,000 years BP, the pollen record from Barombi-Mbo indicates that primary forest trees almost completely disappeared from the area and that there was a major expansion of savanna (Maley 2002). Such a retreat of forest appears to have been widespread across Central Africa. Maley relates this event to evidence of a warming of sea surface temperature in the Gulf of Guinea at this time, which appears to have produced extended dry seasons in the forest zone. The dramatic changes in vegetation that resulted must have had major impacts on the distribution of plant and animal species that are probably reflected in present-day distribution patterns.

BIOGEOGRAPHY

The evolution of our study region's fauna and flora will have been strongly influenced by this long-term history of climate change, with its impact on the relative distribution of "lowland" and "montane" forest, and of grassland. On present evidence, it seems likely that only occasionally has vegetation similar to current montane forest spread very widely across tropical Africa. In addition to vegetation change, global fluctuations in sea level resulting from the glacial cycle will have periodically opened and closed the connection between the continental shelf island of Bioko and the mainland. The larger rivers in the region (particularly the Niger, the Cross, and the Sanaga) will also have impeded gene flow, at least for certain taxa.

Constantly changing climate and vegetation, combined with the presence of water barriers, has produced the complex array of biodiversity in our project region, and it is probably the persistence of some forest during the most arid periods of the Quaternary, and the existence of both montane and lowland forest, that has produced the high species richness and the high endemism typical of the area.

Our own special interest is in primates. A majority of the forest primates in the study region are endemic species or subspecies, restricted to some part of this area (Booth 1958, Oates 1988). Several of the monkeys are endemic to the forests between the Cross and Sanaga Rivers, and most (if not all) of the Bioko primates are subspecies endemic to the island but closely related to mainland forms (see Table 2 in Chapter 4, p. 34). Each of the primates has a slightly different distribution pattern, however, and while some are largely restricted to lowland forests, one (Preuss's guenon) is found mainly at higher elevations (see Chapter 4). Such patterns are found, with variations, across all the taxonomic groups we have studied.

CHAPTER 4

Results of Biodiversity Assessment and Mapping



Sclater's guenons (*Cercopithecus sclateri*) in Bombax tree, Agpugoeze, Nigeria. This monkey species is endemic to the Gulf of Guinea forests.

As mentioned in Chapter 2, we collected background and distribution information on the species of our study region using the ZMUC database (processed using WORLDMAP) and museum and herbarium records, which we either collated directly from original specimens or acquired from existing databases. We also conducted a broad literature search. This background research yielded no comprehensive datasets on the region's fauna and flora that included the point-locality data needed for accurate species mapping. Consequently, we narrowed our mapping efforts to include only sets of endemic species within certain taxonomic groups, as described in the previous section. Here, we present the results of our mapping efforts and discuss how the species we mapped are connected to broader patterns of diversity within larger taxonomic groups.

MAMMALS

Mammals in general

ZMUC-WORLDMAP data (Figure 5, p. 33) show that this region of Africa is a hotspot for mammalian endemism and has relatively high mammalian species richness, though it is not as species-rich as parts of eastern Africa with more mosaic habitats that include open woodland (also noted by Brooks *et al.* 2001). Patterns evident in the ZMUC-WORLDMAP data, however, are probably biased because, in all likelihood, collection and systematic study have focused on the vertebrates of eastern and southern Africa more than west and central Africa.

Of the world's 4,763 mammal species (IUCN compilation as cited by Hilton-Taylor 2000), Mittermeier *et al.* (1999) estimate that 551 occur in the "Guinean forests of West Africa" biodiversity hotspot, which includes our study region and extends much further west, to Sierra Leone. Mittermeier *et al.* cite the Kingdon field guide (1997) as the source for this estimate, but that publication does not give distributions for many species of small mammal.

In his careful analysis of the vertebrate fauna of Bioko Island and the immediately adjacent section of western Cameroon, Eisentraut (1973) lists 136 mammal species. Eisentraut lists a total of 64 mammal species for the island of Bioko (2,017 km²), of which 18 are represented on the island by endemic subspecies. This total is surprisingly small given the island's forest habitat, its combination of lowland and montane environments, and the likelihood that it was connected to the mainland relatively recently. Bioko is particularly poor in large mammals; no apes, antelopes larger than duikers, or elephants have ever been recorded on the island, and the largest mammal species known from Bioko, the forest buffalo (*Syncerus caffer nanus*), is now extinct (Eisentraut 1973).

For the Oban Hills area of Nigeria, Reid (1989) lists 127 mammal species as recorded or almost certain to occur. Usongo (1997) lists 103 mammals known from Korup.

In the last decade a number of new species of small mammal have been named from this region, including several endemics (see, e.g., Dieterlin & van der Straeten 1992, Hutterer & Schlitter 1996, Verheyen *et al.* 1997). At least six endemic mammal species are found on Mt. Oku alone (Maisels *et al.* 2001).

Primates

Our own analysis of mammal distribution has focused on primates. In terms of primate species richness and, especially, endemism (Table 2, p. 34, and Figure 6, p. 35), the study region stands out as a hotspot within Africa. The region also contains a large number of threatened primate taxa. For instance, the Cross River gorilla (*Gorilla gorilla diehli*), the local subspecies of chimpanzee (*Pan troglodytes vellerosus*), the drill (*Mandrillus leucophaeus*), Sclater's guenon (*Cercopithecus sclateri*), Preuss's guenon (*C. preussi*), and three subspecies of red colobus monkey (*Procolobus pennantii pennantii*, *P. p. epieni*, and *P. p. preussi*) are all restricted to this region and are among Africa's most endangered primates (IUCN 2000).

Using point locality data, we produced distribution maps for all the monkey and ape species that inhabit the forests of our area (Figure 7, pp. 36–38), revealing several distinct patterns. First, three species that are present on the immediately adjacent mainland are not found on Bioko, including *Cercopithecus mona*, *Cercocebus torquatus*, and *Pan troglodytes*. It is not clear if these species never reached Bioko or were once present but have gone extinct, although the absence of *C. mona*, a highly adaptable species that has thrived on the islands of Principe and São Tomé after being introduced by humans, suggests that it may never have reached the island. Among Bioko's monkey species, all but one (*Cercopithecus pogonias*) are represented on the island by endemic subspecies. *C. p. pogonias* occurs on both Bioko and the mainland, but the pelage differences between mainland and island populations may justify their subspecific separation (Gautier-Hion *et al.* 1999).

Second, major rivers appear to act as boundaries between several taxa (as noted in earlier analyses, e.g., Oates 1988). *Cercopithecus sclateri* occurs only between the Niger and the Cross. *C. erythrotis* and *Mandrillus leucophaeus* occur only between the Cross and the Sanaga (with the exception of a small area inhabited by *C. erythrotis* immediately south of the Sanaga). *C. satanas* occurs only south of the Sanaga and on Bioko, and different subspecies of chimpanzee (*Pan troglodytes*) occur north and south of the Sanaga.

Third, in general, the species occurring between the Cross and Sanaga Rivers show no clear preferences for lowland or montane areas, except for *Cercopithecus preussi*, which is more associated with uplands.

Finally, several taxa in the area have very localized distributions. These include the Cross River gorilla (*Gorilla gorilla diehli*), found only in a limited area west of the Bamenda Highlands, the three subspecies of red colobus (*Procolobus pennantii*), and the olive colobus (*P. verus*), which is apparently restricted to the upper Niger Delta and the Niger valley. In addition, the gray-cheeked mangabey (*Lophocebus albigena*) has only been recorded near Takamanda Forest Reserve in the center of the range of Cross River gorillas. However, no recent surveys in Takamanda have encountered *L. albigena*, indicating that it may have become locally extinct.

Other mammals

Figure 8 (p. 39) presents ZMUC-WORLDMAP data on the species richness and endemism of duikers of the genus *Cephalophus*. Along with parts of Upper Guinea, Central Africa, and the Albertine Rift, our study region is one of only a few areas containing at least eight duiker species. Duiker endemism in the region is also high, but not as pronounced as in Upper Guinea.

Figures 9 and 10 (pp. 40–41) present ZMUC-WORLDMAP data on rodents as a whole, and squirrels in particular. Our area is not especially rich in rodent species, which is not surprising, given the ecology of many rodent species. (The woodland zone of East Africa is the area richest in rodent species on the continent.) Our area does have significant rodent endemism, however, because of the presence of several endemic montane species. Among rats and mice, these endemics include *Hybomys*

eisentrauti, *Hylomyscus grandis*, *Lamottemys okouensis*, *Lemniscomyx mittendorfi*, *Lophuromys dieterlini*, *L. eisentrauti*, *L. roseveari*, *Otomys occidentalis*, and *Praomys bartwigi* (Hutterer et al. 1992, Verheyen et al. 1997, Maisels et al. 2001). In contrast to the area's relative sparseness of rodents in general, squirrels of the family Sciuridae show pronounced species richness and endemism in our study region and in the forests immediately south. Species of this particular family of squirrels show more richness and endemism here than in the central Congo basin.

BIRDS

ZMUC-WORLDMAP data (Figure 11, p. 42) show that, in relation to other parts of west and central Africa, this region has the highest bird-species richness and endemism, due in part to the overlap of Upper and Lower Guinea species here. However, throughout the continent, eastern Africa and especially the Rift Valley are the regions where bird species are richest. These regions also contain many concentrations of restricted-range bird species.

The IUCN Red List records a worldwide total of 9,946 bird species (Hilton-Taylor 2000), and Mittermeier et al. (1999) estimate that 514 birds species occur in the Guinean forests of West Africa, including our area. Given that more than 400 bird species are known to occur in Korup alone (see below), 514 is probably an underestimate of the total bird species in the Guinean forests.

Eisentraut (1973) lists 293 bird species occurring on Bioko Island and in the immediately adjacent section of western Cameroon. Reid (1989) lists 296 species in the area of the Oban Division of Cross River National Park (CRNP) in Nigeria. However, these lists must represent only part of the avifauna, for careful studies in the adjacent Korup National Park (1,240 km²) and its surrounding Korup "project area" (which includes the forest reserves of Ejagham, Nta Ali, and Rumpi Hills) have revealed a total of 407 species, including waterbirds (Rodewald et al. 1994, Green & Rodewald 1996). Of this total, at least 233 are "true lowland rainforest birds," compared with 250 and 242, respectively, from the better-known sites of Makokou and Taï (Rodewald et al. 1994). Obot (2000) reports more than 300 bird species from the Okwangwo Division of CRNP.

As with mammals, the bird fauna of Bioko is relatively depauperate. Eisentraut (1973) lists only 138 resident land birds on Bioko, including one endemic species (the white-eye, *Speirops brunneus*) and 44 endemic subspecies. Excluding seabirds and a cormorant, the recent compilation by Pérez del Val (1996) lists 178 Bioko species, of which 143 are apparently resident (Pérez del Val et al. 1994). Surprisingly, only one species of hornbill, the black-casqued (*Ceratogymna atrata*), is known from the island, compared with nine species from the Korup area. In updating Eisentraut's list, Pérez del Val et al. (1994) recognize two bird species endemic to Bioko (*S. brunneus* and the flycatcher *Batis poensis*) and 43 endemic subspecies. Some other ornithologists regard *Batis poensis* as a species with relatively wide distribution, occurring both on the West Africa mainland and on Bioko (e.g., Elgood et al. 1994); in this case, the Bioko form is an endemic

subspecies, *B.p. poensis*. All the region's restricted-range birds are montane forest and grassland species, a feature no doubt related to the dispersal abilities of birds which allow them to readily traverse barriers that limit other vertebrates (e.g., the rivers which form barriers for many lowland forest primates).

The 26 endemic species we have mapped are listed in Table 3 (p. 43), and their ranges based on point-locality data are shown in Figure 12 (pp. 44–48). Among these endemics *Poliolais* (Sylviidae) and *Urolais* (Sylviidae) are monotypic endemic genera. Our maps indicate that only a few of the endemic montane birds are restricted to a single mountain. This may be a consequence of the distribution of uplands in our region. North of Mount Manengouba there is more or less continuous terrain above 1,200 m, and to the south of Manengouba the highlands of Kupé, Mount Cameroon, and Pico Basilé are all relatively proximate for birds. However, there are few consistent distribution patterns among the montane birds. Some are found in many montane forests in our region (e.g., *Columba sjostedti*, *Nectarinia oritis*, *Phyllastrephus poensis*, *Andropadus montanus* and *A. tephrolaemus*, and *Urolais epichlora*). Others have a broad but patchy distribution (e.g., *Cisticola discolor* and *Malaconotus gladiator*), while several occur at just a few sites (e.g., *Telophorus kupeensis* and the Bamenda Highland endemics *Tauraco bannermani*, *Platysteira laticincta*, and *Apalis bamendae*). The only species recorded from a single mountain are the Mount Cameroon francolin, *Francolinus camerunensis*, found only on that mountain, and the white-eyes *Speirops* spp. (one endemic species on Pico Basilé and one on Mount Cameroon). The genus *Speirops* is restricted to Mount Cameroon, Bioko, and other Gulf of Guinea islands.

Five of the restricted-range birds in this region are rated as endangered by IUCN (2002): *Kupeornis gilberti*, *Telophorus kupeensis*, *Tauraco bannermani*, *Francolinus camerunensis*, and *Platysteira laticincta*. The Mount Kupé bush-shrike (*Kupeornis gilberti*), once considered restricted to Mt. Kupé, has in recent years also been observed in the Bakossi Mountains and in the highlands in the south of Banyang-Mbo Sanctuary. A sixth endangered bird species in this region, Monteiro's bush-shrike (*Malaconotus monteiri*), also occurs in montane forest in Angola.

REPTILES AND AMPHIBIANS

ZMUC-WORLDMAP data show that this area has high snake-species richness compared to most other parts of West Africa (though it is not as rich as the western rift of East Africa or parts of southeastern Africa), and high snake-species endemism (Figure 13, p. 49). Data on lizards were not available to us (the ZMUC database we used included only snakes and chelonians). With regard to amphibians (Figure 14, p. 50), this region is a hotspot of both species richness and endemism. Of the world's 7,970 reptile and 4,950 amphibian species (IUCN Red List cited in Hilton-Taylor 2000), 139 reptiles and 116 amphibians are estimated to occur in the Guinean forests of West Africa, including our area (Bakarr et al. in Mittermeier et al. 1999). Eisentraut (1973) lists 52 reptile and 32 amphibian species from Bioko island, and Reid (1989) lists 64 reptile and 61 amphibian species

from the Oban Division area of Cross River National Park in Nigeria.

Lawson's (1993) evaluation of herpetofauna in the Korup area is probably the most comprehensive ever conducted of any one part of this region. Lawson collected samples in the Korup National Park and Korup project area in 1991, and then augmented his records with data from the literature and from collections made in 1990 by the WCI (now the Wildlife Conservation Society) research team in Korup. His final assessment lists 83 reptiles and 90 amphibians, numbers which strongly suggest that Reid's list for the immediately adjacent Oban area is only a partial account of the herpetofauna in that part of Nigeria. Bakarr *et al.* (in Mittermeier *et al.* 1999) acknowledge that their estimate of 116 amphibians occurring in the Guinean forests is preliminary. Indeed, Lawson's numbers suggest that if at least 90 amphibians occur in the Korup area alone, many more than 116 must occur in the Guinean forests as a whole.

Drawing on data from the literature as well as the ZMUC database and WORLDMAP, we produced a list of 52 anuran amphibian species (frogs and toads) that appear to be restricted to our project region. These are listed in Table 4 (p. 51). Noteworthy among these amphibians are the toad genera *Didynamipus*, *Werneria*, and *Wolterstorffina* (Bufonidae). With the exception of *Werneria preussi*, which occurs in both southwest Cameroon and Togo, these genera are restricted to this region and appear to be members of an archaic radiation dating to before the separation of Africa and South America (Gartshore 1984). The genus *Cardioglossa* (Arthroleptidae) is particularly speciose in our study region and includes several species with highly restricted distributions. The frog genera *Petropedetes* and *Phrynobatrachus* (Ranidae) also have relatively large numbers of endemic species in this region. Interestingly, the region contains rather few endemic treefrogs (Hyperolidae), although treefrog species are notably rich.

The results of amphibian locality mapping are shown in Figure 15 (pp. 52–56). This mapping revealed that eight species (*Astylosternus diadematus*, *A. schioetzi*, *Cardioglossa elegans*, *C. nigromaculata*, *Petropedetes parkeri*, *Phrynobatrachus steindachneri*, *Werneria mertensi*, and *Wolterstorffina parvipalmata*) have been found in Cameroon south of the Sanaga River. Although, like *Werneria preussi*, they are not absolutely restricted to our study region, we nonetheless mapped them because their limited distributions are concentrated in this region.

The frogs and toads of this region show a highly diverse set of distributions. Although many are limited to upland areas, others (such as *Astylosternus diadematus*, *Cardioglossa nigromaculata*, and *Petropedetes cameronensis*) are predominantly lowland forms. The species in our study that cross the Sanaga tend to be lowland species, for which the Sanaga is presumably not a serious barrier to dispersal. Some species are known from many localities (e.g., *Petropedetes parkeri* and *Wolterstorffina parvipalmata*) and others have been recorded at only one site (e.g., *Cardioglossa trifasciata* and *Phrynobatrachus manengoubensis* from Mount Manengouba).

This diversity of amphibian distribution patterns in this region was recognized by Gartshore (1984) in her analysis of the Cameroon montane herpetofauna. Gartshore recognized seven distributional categories, including a group in "submontane"

vegetation (defined as 1,000–1,800 m), two montane groups, and the Manengouba endemics. However, these are clearly not exclusive categories: the categories themselves have considerable overlap, and members of different distributional categories often occur in the same habitat. For instance, species from three different categories occur together on the Obudu Plateau. Hofer *et al.* (1999) draw the same conclusion from their study of the herpetofauna of Mt. Kupé, namely, that Cameroon amphibians occur in groupings of species that are not exclusive. Gartshore notes the particular species richness (16 forms) of the submontane group of endemics, a phenomenon that she attributes to the persistence of submontane vegetation in this area during a glacial maximum. Hofer *et al.* (1999) also recognize a characteristic amphibian fauna at intermediate altitudes on Mt. Kupé (1,100–1,500 m), a fauna that includes not only species centered at this elevation, but also lowland and montane species.

Probably at least in part due to relatively low levels of collecting, only four of the region's endemic anurans have so far been recorded from Bioko, and many of the Nigerian species have not yet been recorded. For instance, the University College London 1964 expedition to Bioko collected a red and black *Cardioglossa* (pictured on the front cover of this volume) in Moka that has yet to be identified, and may be a new species (R. Drewes, personal communication). Similarly, Fa (1992) notes an endemic skink (*Scelotes poensis*) and a caecilian (*Schistometopum garzonbeydti*) from the island. Most of the Nigerian records for the endemic amphibians we mapped are from the Obudu Plateau, which herpetologists have visited much more frequently than other localities in southeastern Nigeria.

FISH

Because the environmental features limiting fish distributions are different from those that limit the distributions of terrestrial vertebrates, the biogeographical patterning of fish species is different from the other groups we have analyzed. While the Niger, Cross, and Sanaga Rivers form distributional barriers to many terrestrial vertebrates, they and their drainages contain different fish faunas, and the distributional barriers for the fish are typically the watersheds between the drainages.

Our study area includes parts of the drainages of three major or medium-sized river systems—the Niger-Benue, the Cross, and the Sanaga—as well as several smaller rivers. Southwestern Cameroon also contains a series of intriguing volcanic crater lakes that are home to some unique fish.

G.M. Reid's study of the hydrobiology and fish fauna of the Korup area in Cameroon, based on a 1989 survey (Reid 1989), is, to our knowledge, the only detailed evaluation of fish taxonomy, ecology, and zoogeography in the forest rivers and streams within our study region. Reid lists a total of about 140 species of fish from the Korup area, distributed among the Upper Cross, the Akpa-Yafe/Upper Nnian, and the Lower Nnian river systems, each with a different fish fauna. About 90 species were found in the Upper Cross drainage, about

27 in the Akpa-Yafe/Upper Ndian system, and about 40 in the Lower Ndian. Interestingly, although the Upper Ndian and Upper Cross drainages draw quite near to one another in northern Korup (the Cross draining east and north, the Ndian south), they share only ten species. Reid notes that the fish fauna of Korup is extremely diverse when compared to some principal African rivers, which have fewer total species. The Niger, for instance, has 134, the Nile has 115, and the Sanaga and other coastal rivers of southeastern Cameroon have 110. Moreover, many of the fish found by Reid in Korup rivers were not readily identifiable and probably new to science.

Within Korup, the fish of the Lower and Upper Ndian show intriguing differences that Reid attributes to the presence of a shear waterfall and historical (perhaps catastrophic) events. The Lower Ndian is dominated by species from marine families, while the most common fish families in the Upper Ndian and Akpa-Yafe drainages were the Cyprinidae (7 species), Cyprinodontidae, and Cichlidae (each with 5 species). Of the 27 fish found in these river systems, 13 could not be identified with certainty to species and, in several instances, may be new to science (Reid 1989). The Akpa-Yafe drainage also includes a large section of the eastern part of the Oban Division of Cross River National Park in Nigeria. With so many potential new species found in Korup, it appears that Oban would repay further ichthyological research—so far, only preliminary surveys have been conducted, by J.C. Reid.

In addition to Reid's report on the fishes of parts of the Upper Cross drainage, the Teugels *et al.* treatise (1992) on the fishes of the Cross River Basin as a whole summarizes the special features of this community. Teugels *et al.* note that the Cross River Basin contains a minimum of 166 fish species. Even after excluding species with marine affinities, this represents 36–47 percent more freshwater species than have been recorded from other hydrographically comparable West African river basins (such as the Comoé and Sassandra). Teugels *et al.* speculate that this relatively large total number of species may relate to the former persistence of a forest refuge in the basin. They note that at least 11 of the Cross Basin species are probably endemic, but if we consider fish included in their analysis that occur both in the Cross and in other river systems or water bodies in the region (including the Niger Delta), then the number of endemics increases to at least 19. In a correspondence analysis, Hugueny and Lévêque (1994) found the Cross River Basin fish fauna to be most closely related to that of the Niger Delta. Their analysis places these two faunas in a cluster that includes major West African rivers such as the Senegal, Volta, and Niger. This cluster is distant from that of Lower Guinea river systems, including the Sanaga.

The crater lakes in southwestern Cameroon include Barombi-Mbo (also known as Kumba Lake and Elefanten-see), Soden, Kotto (or Barombi Kotto), Mbwandong (or Mboandong), and Bermin. Two of these are rich in endemic cichlids: L. Barombi Mbo and its inflowing stream, which contains 17 fish species, 12 of them endemic (11 of them cichlids) (Trewavas *et al.* 1972); and L. Bermin, which has 11 species, including a “flock” of nine endemic cichlids (Stiassny *et al.*

1992). Lake Soden has only four species, including an endemic cyprinodont (*Procatopus lacustris*), and Lake Kotto has fish endemism only at the subspecific level (Trewavas 1974). Trewavas (1974) also describes a number of new species from the Meme and Mungo river systems, which drain some of these lakes as well as the Mount Cameroon area.

As with other groups, the freshwater fish fauna of Bioko is depauperate compared with the mainland. Castelo (1994) lists 43 species from the island, three of which occur only on Bioko and around Mount Cameroon. An analysis by Thys van den Audenaerde (1967) found only 12 Bioko species to be true freshwater fishes with little or no salt tolerance, and all of these also occur around Mount Cameroon. The crater lakes of Bioko do not contain fish.

INVERTEBRATES

The invertebrate fauna of our study region is inevitably less well-known than the vertebrate fauna. Although some groups of insects (including Lepidoptera and Odonata) have been moderately well studied at a few localities, most of the invertebrates remain very superficially investigated.

Butterflies

Among the Lepidoptera, butterflies are especially well known in our region through the work of Torben Larsen, who has drawn many important biogeographical, taxonomic, and conservation conclusions from his studies. Larsen has collected in both the Oban (3 visits) and Okwangwo (2 visits) divisions of Cross River National Park; on the Obudu Plateau (2 visits); and in the Korup area (1 visit). In his first visit to Oban in 1995, he collected almost 600 species (1995a); he also estimated that this section of the park probably supports around 950 species, and the park as a whole more than 1,000 species, which would be the highest number reported from any one locality in Africa. Table 5 (p. 57) summarizes Larsen's collections.

Through his subsequent research, Larsen concluded that the butterfly fauna of Oban, together with Korup (where he collected 400 species in 1997), is indeed the richest in all of Africa (Larsen 1997c). This area contains well over 1,000 lowland rainforest species, equivalent to six percent of all butterflies described worldwide and almost one third of all species known from continental afrotropical Africa. These numbers represent more species than are found in either peninsular Malaysia or in New Guinea, and only parts of upper Amazonia show higher local species richness.

Larsen (1997c) notes that Oban and Korup are very similar, and may be treated as a single biogeographical unit. Although similar to the western equatorial forests, the Oban-Korup unit contains a distinctive set of species that are endemic to the area between the Cross and Sanaga Rivers. Larsen ascribes this endemism (and the area's species richness) to a long-existing series of forest refuges in the area.

Extrapolating from butterfly richness to total species richness, Larsen estimates that the Oban-Korup area may contain

500,000 to 1 million invertebrate species, and perhaps many more.

For the Okwangwo and Obudu area in Nigeria, Larsen (1997a) estimates a butterfly fauna of about 950 species, more than 100 of which are not present in the Oban Hills. Half of these are essentially submontane species (from the Obudu Plateau and environs), and the remainder are specialists of the drier forests and savannah characteristic of the margins of the Okwangwo Division of CRNP.

The Obudu Plateau is probably the best-studied site for butterflies in this region. Larsen's collections from the plateau supplement those of several previous visitors, such as R. St. Leger (Larsen 1995b, 1997b). Larsen lists 203 species from the plateau, including four that have been collected nowhere else: *Pseudathyma legeri*, *Liptena priscilla*, a *Ceratrachia* sp., and a *Gorgyra* sp. The *Ceratrachia* has since been named *C. lewisi* (Collins & Larsen 2000). What Larsen calls the "submontane element" from Obudu consists of a group with affinities to the highland fauna of East African mountains such as the Ruwenzoris, Kivu, Burundi (Larsen 1997b). Larsen compares the Obudu butterflies with other areas in the Cameroon-Nigeria highlands in our region and identifies a total of 14 endemic species and 21 endemic subspecies (Table 6, p. 57).

Larsen (1997b) notes that the number of butterfly species recorded from the Obudu Plateau is much higher than for any of the single Cameroon montane localities studied by Libert (who recorded 74 species from Mt. Tabenken and from Mt. Manengouba).

Larsen (1997b) comments also on the montane butterfly fauna of the Mambilla Plateau. This is very similar to that of the Obudu Plateau, but because Mambilla is higher than Obudu, several montane species are known from there that are absent (or have not been collected) from Obudu. Finally, Larsen (1997c) has reported on collections by associates in the Rumpi Hills; he notes that this collection suggests that above 1,100 m these hills are a very important submontane refuge that will repay further study.

Dragonflies

Odonata have been surveyed in southwest Cameroon by Vick (1999), who has carried out field work at several sites over three years, and examined literature and museum records. Vick lists 179 known species and estimates that the fauna probably contains at least 200 species. He speculates that "few parts of Africa of equivalent area can match" the dragonfly species richness of S.W. Cameroon—he notes that Belize (similar in area to southwest Cameroon) has 170 recorded species and that Kenya (which is 24 times larger) has 194 species. He also observes that the area is rich in ancient relicts and endemics, although he does not list them specifically.

PLANTS

As with other groups of organisms, the montane flora in our region has many differences from that in the lowlands. The

flora of Mount Cameroon has been especially well documented by Cable and Cheek in *The Plants of Mount Cameroon* (1998), where they provide a checklist of the vascular plants of Mount Cameroon together with its foothills and surrounding lowlands, a total area of about 2,700 km². Their study recorded 2,435 species (both indigenous and naturalized) in this area, which they compare with 1,693 species from the Korup project area and 842 from Bioko. Cable and Cheek note that the Korup project area lacks the habitat diversity and altitudinal range of Mount Cameroon, and that Bioko lost much of its lower altitude forest before it could be properly enumerated. Schmitt (1996) lists approximately 1,570 plant species as occurring in the Oban area of Nigeria. Brennan (cited in Richards 1996) has estimated a total of 30,000 vascular plant species for the whole of tropical Africa.

Cable and Cheek (1998) list 49 plant taxa (species, subspecies, and varieties) endemic to Mount Cameroon. Eleven of these species occur in lower montane (also referred to as "submontane" or "cloud") forest between 800 and 1,800 m, and 29 in lowland forest. Of the lowland species, 17 are newly discovered, and Cable and Cheek guess that the number of lowland forest endemics will rise with further study. Although Bioko clearly has fewer species than the mainland (a pattern we see in all taxonomic groups), Cable and Cheek's species number appears to be an understatement—Figueiredo (1994) says that the island has 1,105 species of angiosperms alone, 40 of which are endemic.

As described in Chapter 2, we studied the distribution patterns of a small sample of the region's plants. Of the 353 Mount Cameroon species that Cable and Cheek list as only occurring in Bioko, Nigeria, or Cameroon, we selected the 55 tree species that reach at least 10 m in height. Seven of these are caesalpinoid legumes (family Leguminosae, subfamily Caesalpinioideae). After further analysis we removed the following eight species from this list: *Vitex* "sp. A" and "sp. B" (Verbenaceae), *Isolona* sp. nov., *Polyceratocarpus* sp. nov., and *Piptostigma* sp. aff. *glabrescens* (Annonaceae), which were regarded as insufficiently known to have useful locality records available; *Monopetalanthus letestui* (Caesalpinioideae), which has been subsumed under the species *Bikinia letestui* that ranges to Congo-Brazzaville (Wieringa 1999); *Uapaca staudtii* (Euphorbiaceae), which was found to occur as far south as Gabon (and far west in Nigeria); and *Oxyanthus speciosus* (Rubiaceae), which extends to central Africa. We also added to our database a new genus and species, *Korupodendron songweanum* (Vochysiaceae), so far known only from Korup National Park and described during the preparation of this volume (Litt & Cheek 2002). In addition, we would have added *Tetraberlinia korupensis* (Caesalpinioideae), apparently also known only from Korup (Wieringa 2000), had we learned of its existence before we completed our analysis. Our final set of 48 large trees is listed in Table 7 (p. 58), and their distributions are shown in Figure 16 (pp. 59–63).

If we had followed the same selection procedure we applied to birds, we would have had to exclude many of the plant species included in our final mapping because we found records of their occurrence south of the Sanaga River or west

of the Niger. We included these species, however, because their distributions appear to be centered on our study region, and some of their more distant records may eventually prove to represent members of different species.

We examined distribution in relation to elevation of the 25 larger tree species strictly endemic to our region and found that five species span a wide altitude range, 11 appear to be largely restricted to lowland forest, six to lower montane forest, and three to upper montane forest. Of these 25 endemics, three are caesalpinoid legumes restricted to lowland forest: *Crudia bibundina*, *Daniellia oblonga*, and *Microberlinia bisulcata*. Thus, the distribution pattern we found in relation to elevation is that lowland forest contains the largest number of endemics, followed by the lower montane forest. Caesalpinoid legumes are also a characteristic feature of the forests in this region. This pattern, albeit based on a limited sample, is consistent with the observations of Letouzey (1968) and Cable and Cheek (1998). Letouzey characterized the lowland forest in this area (his “Biafran forest”) as having a high species richness of Caesalpinioideae.

This pattern strongly suggests (as do our analyses of the primate, amphibian, and butterfly faunas) that both lowland and montane forest refuges have existed in this region in the past, as have refuges for forest types similar both to today’s lower montane (or submontane) forest and to today’s upper montane forest. The long generation times of large trees, together with the low-dispersal abilities of large-seeded caesalpinoid legumes (Hart *et al.* 1989), hint at a possibly very ancient lowland forest refuge in the area. Indeed, Maley and Brenac (1998) found peaks of caesalpinoid pollen in Lake Barombi Mbo sediments corresponding to the wetter climate phases of the last 28,000 years.

Cheek *et al.* (2000) consider whether the Cross-Sanaga “interval” should be classified as a special phytogeographic unit. They recognize its especially high plant species richness and considerable endemism (although much of the endemism is restricted to the Cameroon Highlands). While a few plants appear to be limited by the Sanaga River, more have their southern boundary at the Nyong River, just south of the Sanaga. Cheek *et al.* note that the Sanaga may once have had its mouth at the Nyong.

In addition to their checklist, Cable and Cheek (1998) provide a “red data list” for Mount Cameroon plants. Among the species in the tree sample we have analyzed, they classify *Anthonothea leptorrhachis*, *Crudia bibundina*, and *Microberlinia bisulcata* as Critically Endangered, noting that *C. bibundina* was last collected in 1928. However, Cable and Cheek are incorrect in stating that *M. bisulcata* is restricted to southwest Cameroon and that “records of it occurring elsewhere are spurious.” The Missouri Botanical Garden collection contains a specimen from Oban; Schmitt (1996) also recorded it in the Oban Division of Cross River National Park. In addition, we have observed it as an upper-canopy dominant near Ekongnaku in the Oban Division in 2000, we encountered it at Afi Mountain in 2002, Sunderland *et al.* (2002) observed it in Takamanda Forest Reserve, and we have encountered it in Korup National Park, where it is said to be associated with sandy

soils that have low available phosphorus concentrations (Newbery & Gartlan 1996). Among other red-list species, Cable and Cheek include five species of shrubs and small trees in the genus *Cola*, including three undescribed species. We observed a high diversity of *Cola* species in the Oban Hills, and we suspect that many Nigerian range extensions of plants considered restricted to Cameroon would probably be revealed by more botanical explorations of the Oban Hills.

The trees of the lowland and montane forests in our region are not the only ones that show special features. Mount Cameroon, for instance, has some montane grassland endemic tree species (Cable & Cheek 1998), and important high-altitude *Sphagnum* bogs are found in the Bakossi Mountains and on Mount Oku summit (Maisels *et al.* 2000).

CONCLUSIONS FROM BIODIVERSITY ASSESSMENT

Our analysis makes clear that this region is indeed a “hotspot” of global importance, in terms of the species richness and endemism apparent in many taxonomic groups. Using a similar analysis to our own, Brooks *et al.* (2001) have also recently shown the importance of the Cameroon Highlands.

Several key features of the hotspot emerged from our analysis. First, compared to the rest of Africa, the Niger-Sanaga region (and especially the Nigeria-Cameroon border area) has high mammalian endemism, especially high primate richness and endemism, high snake endemism, and very high amphibian richness and endemism. Relative to comparable areas of west and central Africa, this region also has high bird richness and endemism, and the Cross River Basin is very rich in fish species relative to comparable West African river basins. Southwestern Cameroon also has a unique fauna of crater-lake fish. For butterflies, the Oban-Korup forest may be the richest locality in Africa, and the Obudu Plateau is particularly rich in endemic butterflies. Dragonflies also show high species richness in the region.

Second, the island of Bioko, although separated from the mainland by a sea channel of less than 40 km, has a depauperate fauna in all taxonomic groups examined. On the other hand, many of the Bioko taxa are endemic to the island, although most of this endemism is at the subspecies rather than species level.

Third, given the different habits and dispersal abilities of different taxonomic groups, patterns of endemism vary taxonomically in this region. For instance, among the groups we have examined carefully, four patterns are apparent:

- Most anthropoid primates do not show a restriction to lowland or montane forest, with the exception of Preuss’s guenon (*Cercopithecus preussi*), which is particularly associated with (though not restricted to) lower montane forests. On the other hand, some primates are not found at the highest elevations in the region, notably the red colobus (*Procolobus pennantii*). More than the other taxa we have studied, the primates tend to be limited by major rivers, presumably because many forest primates do not readily take to water.

- No doubt because they readily fly over rivers, lowland birds do not show any notable endemism in our region. However, montane birds do, probably because the mountains in our study region are so far from any other similar region in Africa. Only a small number of the montane bird species are restricted to just one or a few mountains, probably because the mountains in our region are relatively close to each other. Notable exceptions to the generally broad montane distributions are the white-eyes (*Speirops* spp.), found only on Bioko and Mount Cameroon; the Mount Cameroon francolin (*Francolinus camerunensis*); the Mount Kupé bush-shrike (*Telophorus kupeensis*); and the Bamenda Highland endemics *Tauraco bannermani* and *Apalis bamendae*.
- Endemic amphibians in our region show a very diverse range of distributions. Authorities who have studied this region's amphibians have noted that there are groups of lowland, lower montane, and upper montane endemics, with the lower montane group being especially rich. Amphibians probably speciated in this way because many are habitat specialists, and they can maintain viable populations in an area that is very small relative to the area needed, say, for a viable monkey population. Amphibians are expected to have many mountain-living endemics in this region, given the relative isolation of the mountains and the inability of these organisms to fly.
- Endemic large trees show a similar pattern to the primates and an opposite pattern to the birds. As with other plant groups in the region, a majority of endemics are lowland species, with somewhat fewer lower montane endemics and even fewer upper montane species. Lowland plant species are most likely to show local speciation if they have low dispersal abilities; this seems to be particularly true of the caesalpinoid legumes that predominate among the endemic large trees of our region.

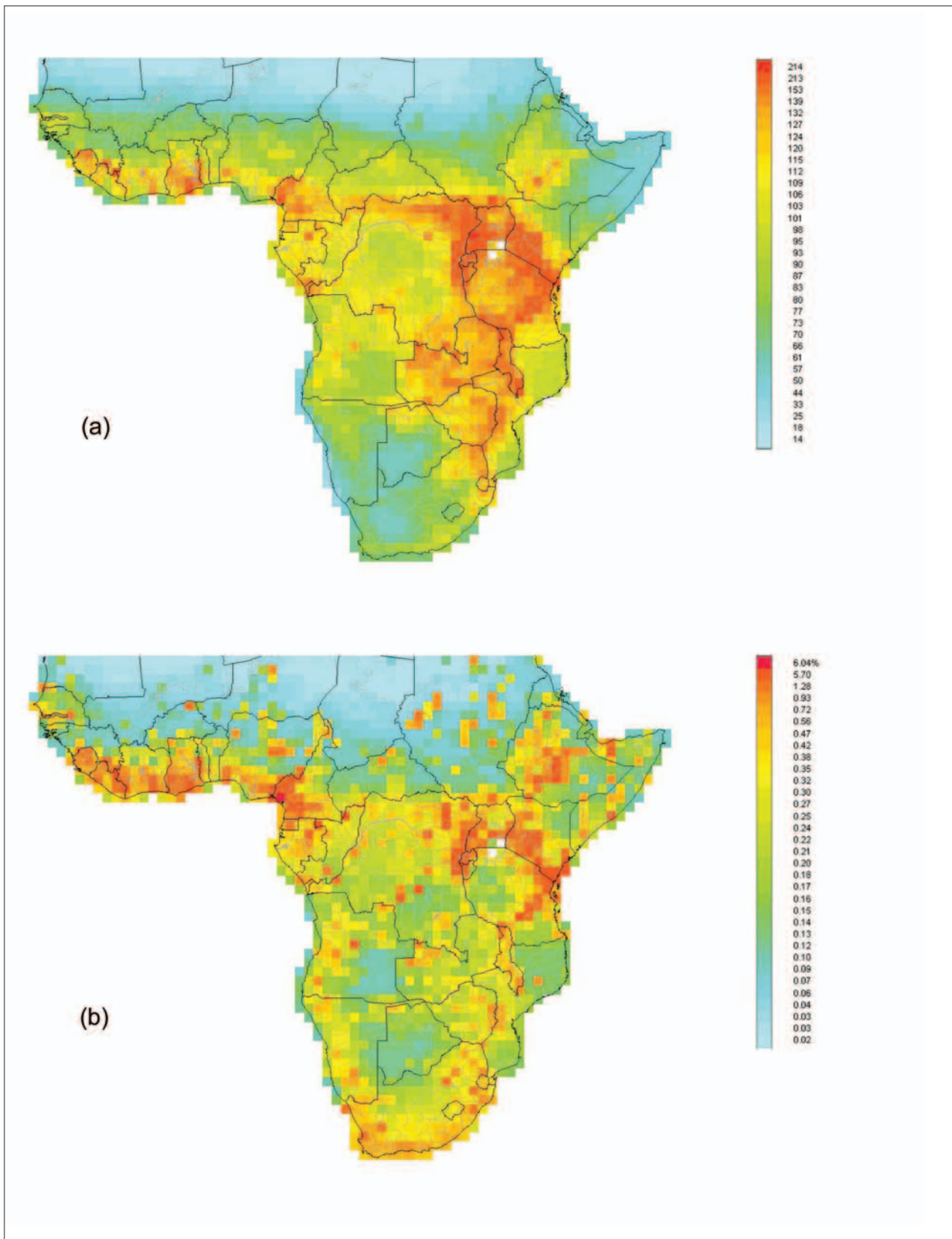


Figure 5. Mammal species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Rarity is measured as the inverse of number of grid cells occupied by a species within the map area. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

Table 2. Forest primates of the study region and their conservation status.

Taxon	Distribution	IUCN Category (IUCN 2002)
** <i>Arctocebus calabarensis</i>	Niger-Sanaga	LR
<i>Perodicticus potto edwardsi</i>	Niger-Congo	NT
** <i>Euoticus pallidus pallidus</i>	Bioko	EN
** <i>Euoticus pallidus talboti</i>	Niger-Sanaga	NT
** <i>Galago alleni alleni</i>	Bioko	EN
** <i>Galago alleni camerounensis</i>	Niger-Sanaga	LR
<i>Galago demidoff murinus</i>	Niger-Congo	NT
** <i>Galago demidoff poensis</i>	Bioko	NT
<i>Galago thomasi</i>	W.-E. Africa	NT
<i>Cercocebus torquatus</i>	W. Nigeria-Gabon	LR
** <i>Mandrillus leucophaeus leucophaeus</i>	Cross-Sanaga	EN
** <i>Mandrillus leucophaeus poensis</i>	Bioko	EN
<i>Lophocebus albigena</i>	S.E. Nigeria-Uganda	NT
** <i>Cercopithecus preussi preussi</i>	Cross-Sanaga	EN
** <i>Cercopithecus preussi insularis</i>	Bioko	EN
* <i>Cercopithecus erythrogaster pococki</i>	S.W. Nigeria & Niger Delta	EN
** <i>Cercopithecus sclateri</i>	Niger-Cross	EN
** <i>Cercopithecus erythrotis erythrotis</i>	Bioko	EN
** <i>Cercopithecus erythrotis camerounensis</i>	Cross-Sanaga	VU
* <i>Cercopithecus mona</i>	E. Ghana-Sanaga	NT
** <i>Cercopithecus pogonias pogonias</i>	Bioko + Cross-Sanaga	EN
** <i>Cercopithecus nictitans ludio</i>	Cross-Sanaga?	NT
** <i>Cercopithecus nictitans martini</i>	Bioko?	EN
<i>Procolobus verus</i>	Sierra Leone-E. Nigeria	LR
** <i>Procolobus pennantii pennantii</i>	Bioko	EN
** <i>Procolobus pennantii preussi</i>	Cross-Sanaga	EN
** <i>Procolobus pennantii epieni</i>	Niger Delta	EN
** <i>Colobus satanas satanas</i>	Bioko	EN
<i>Colobus guereza occidentalis</i>	E. Nigeria-Uganda	NT
** <i>Gorilla gorilla diehli</i>	S.E. Nigeria-S.W. Cameroon	CR
** <i>Pan troglodytes vellerosus</i>	Niger-Sanaga?	EN

(** endemic to study region)

(* endemic to study region plus restricted neighboring area)

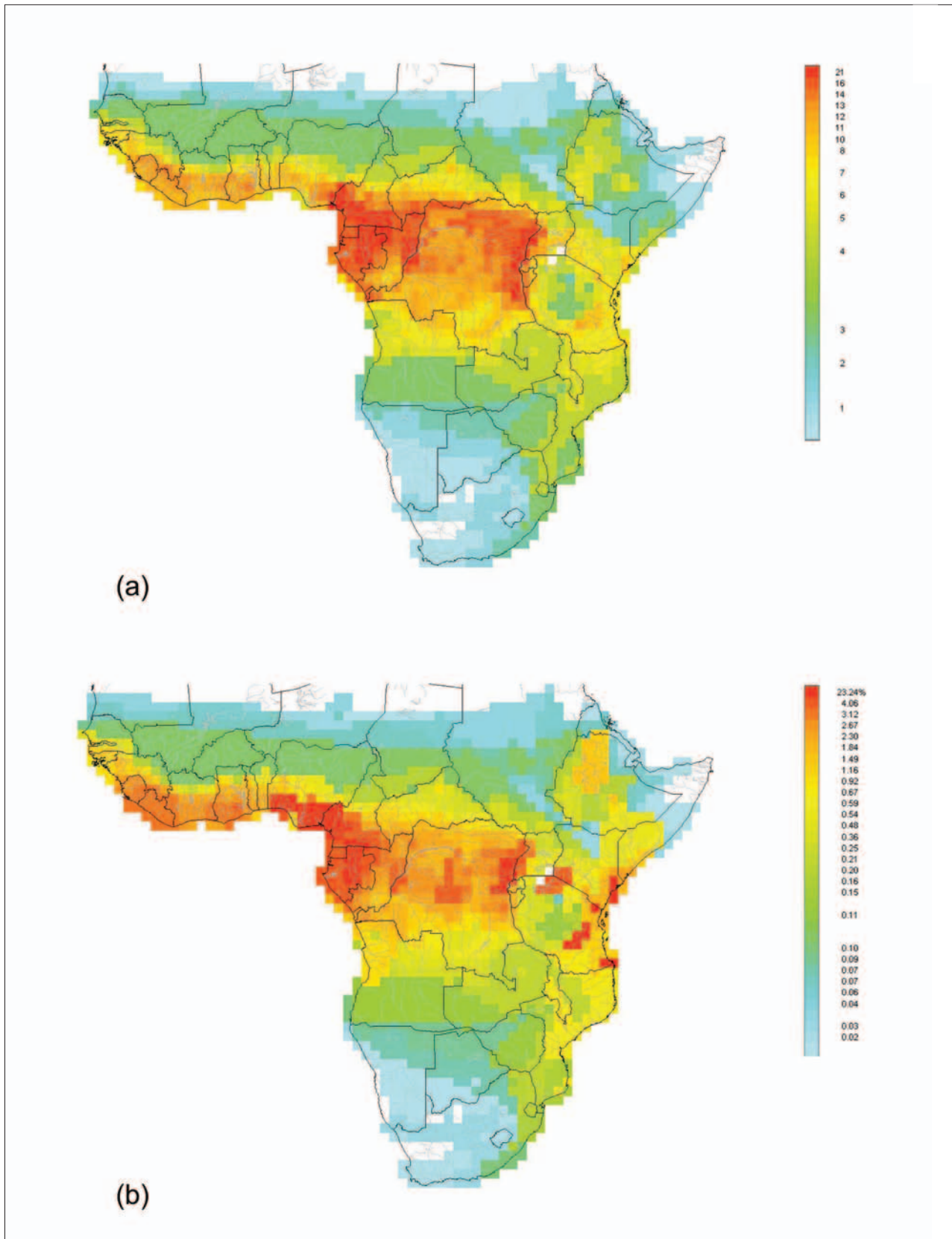


Figure 6. Primate species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

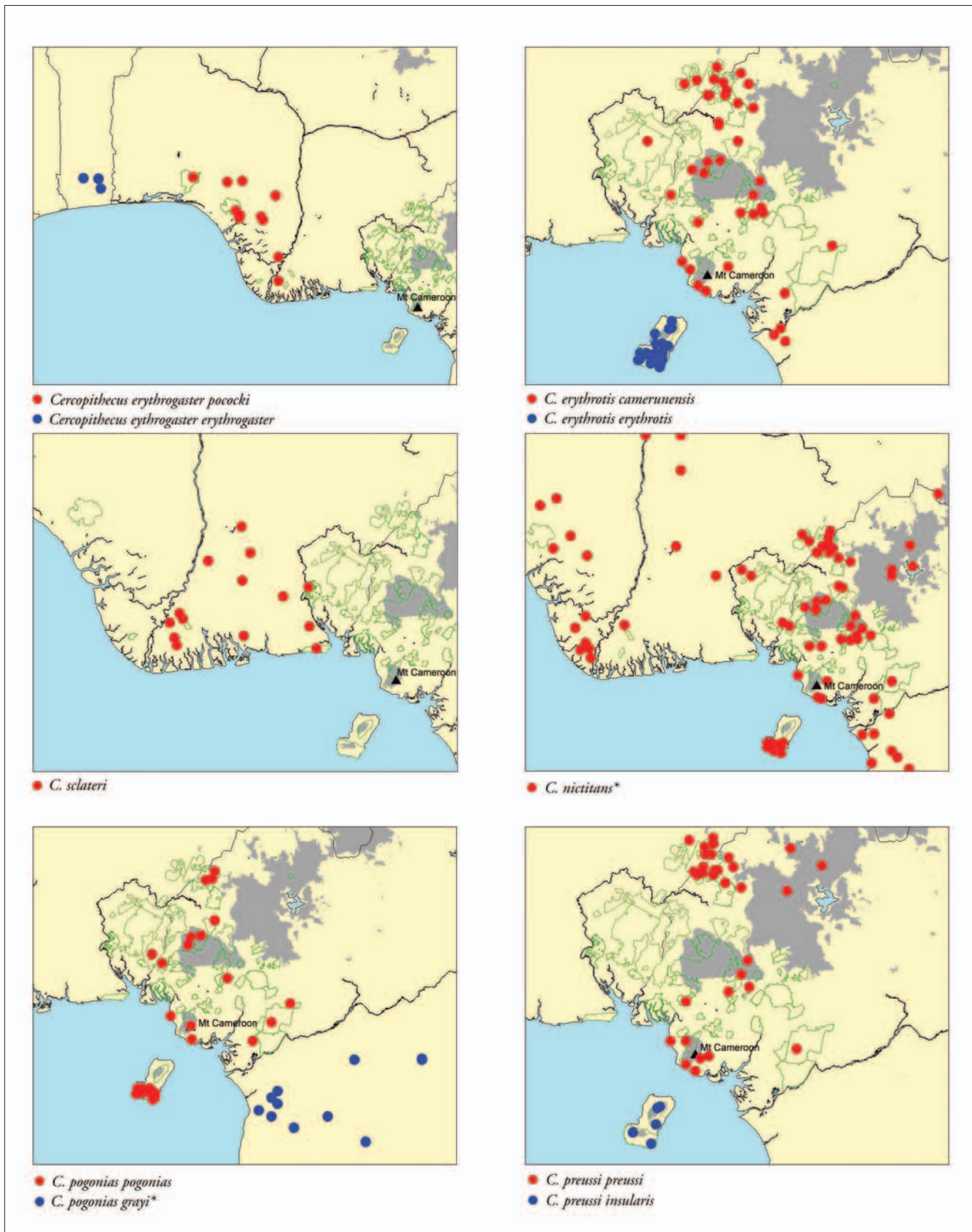


Figure 7. Point locality maps of all forest dwelling anthropoid primate species occurring in the study region. Taxa marked with an asterisk also occur outside the map area. Existing and proposed protected areas and reserves shown in green. Land above 1,200 m shown in gray. See text for sources of data. Figure continues on pp. 37–38.

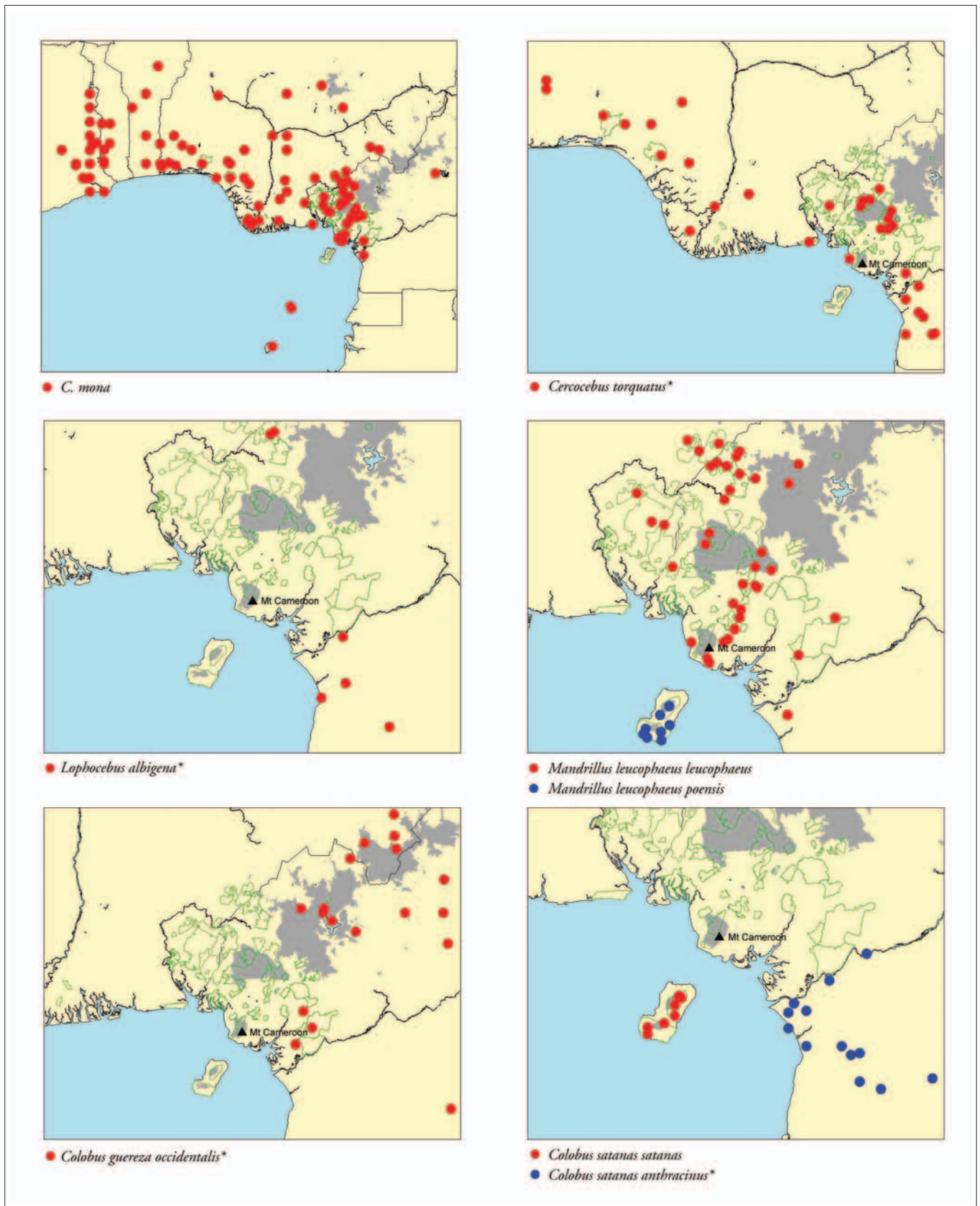


Figure 7 continued.

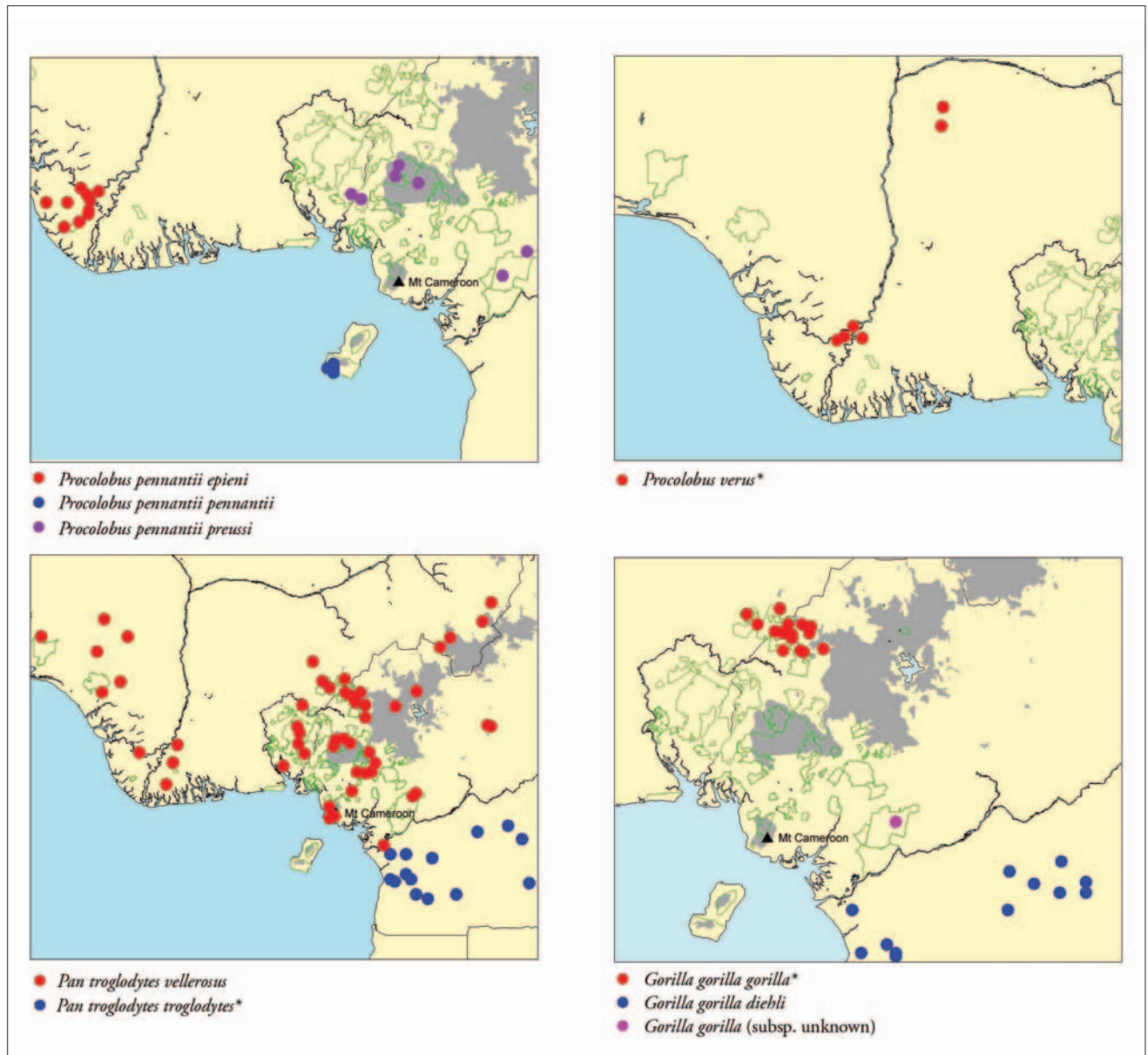


Figure 7 continued.

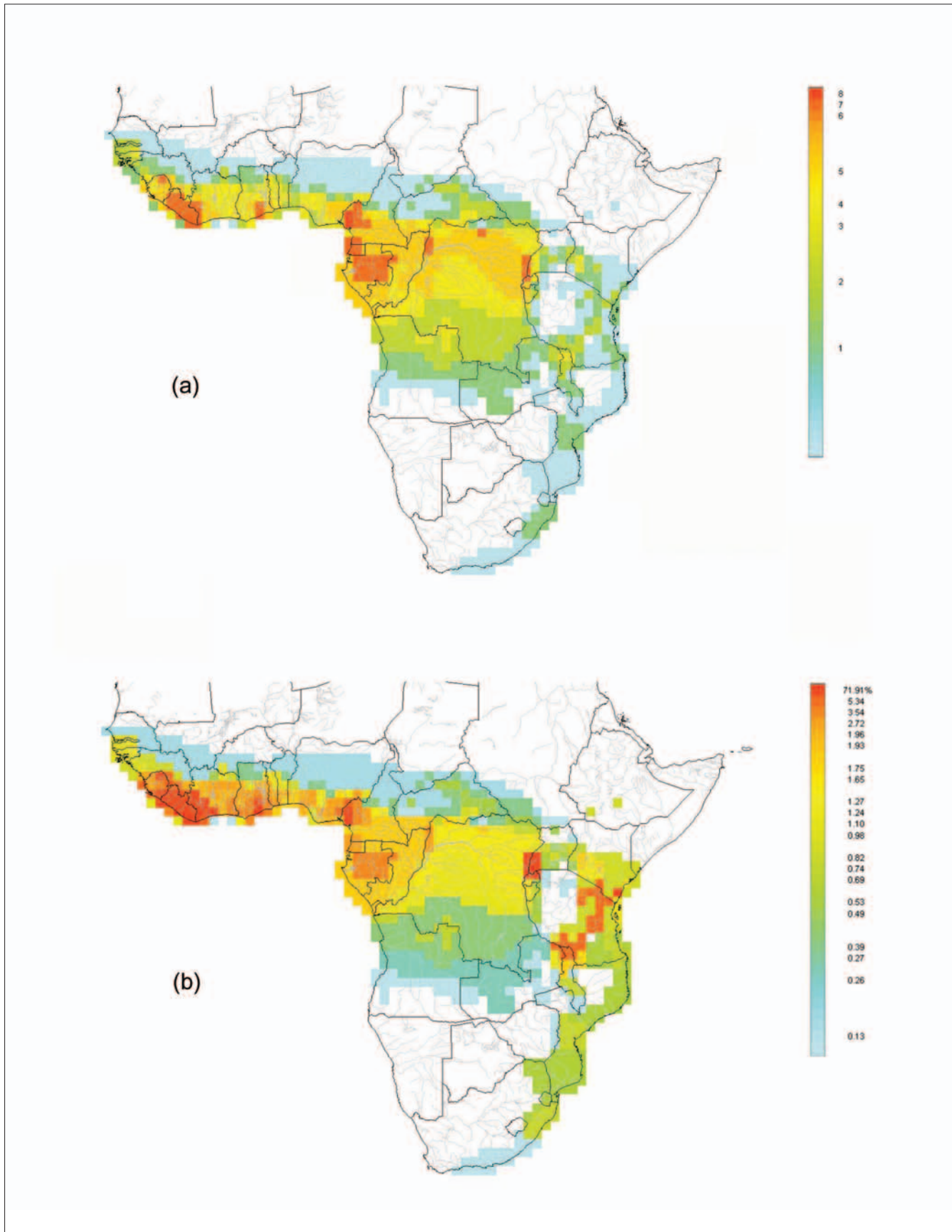


Figure 8. Duiker (*Cephalophus*) species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

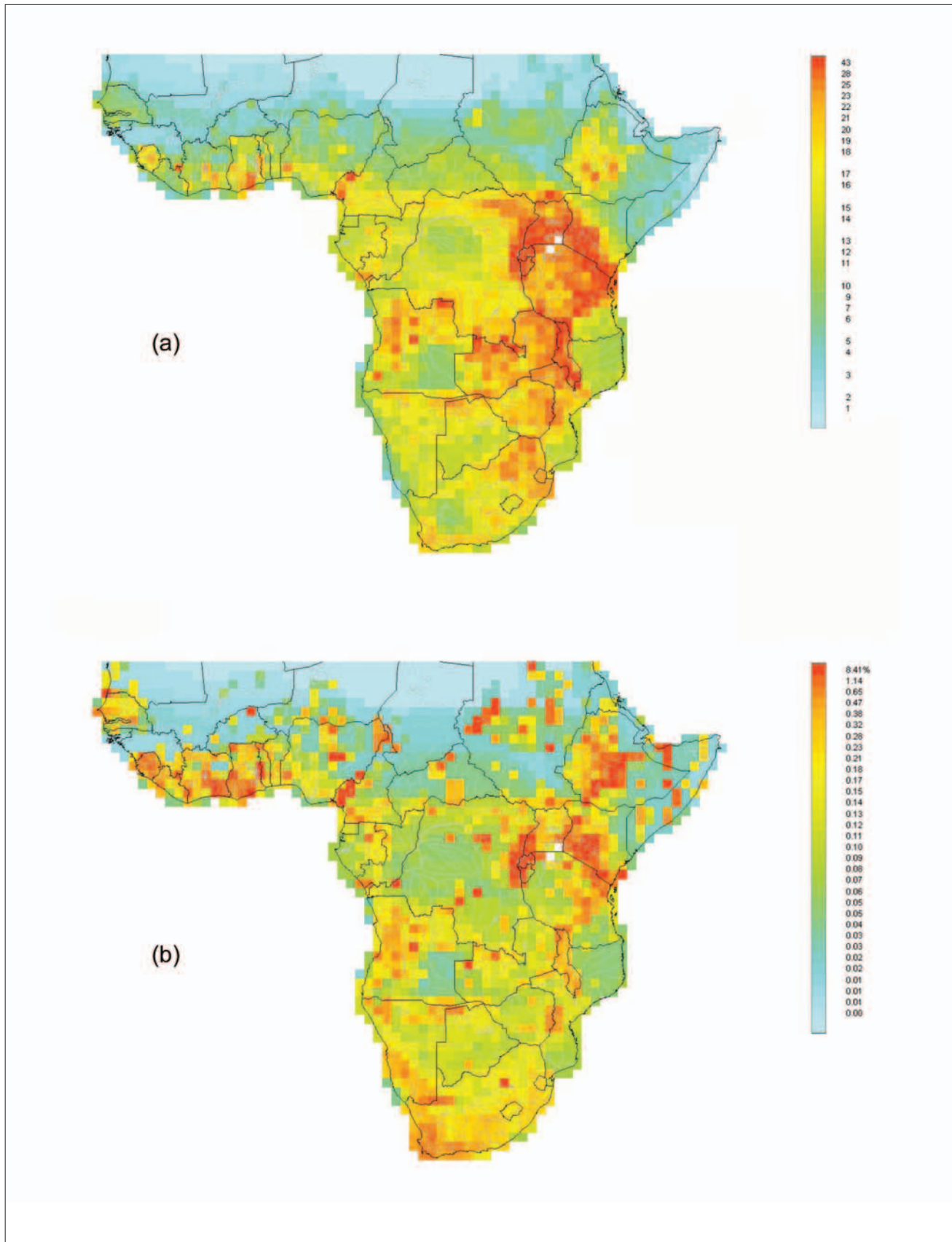


Figure 9. Rodent species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

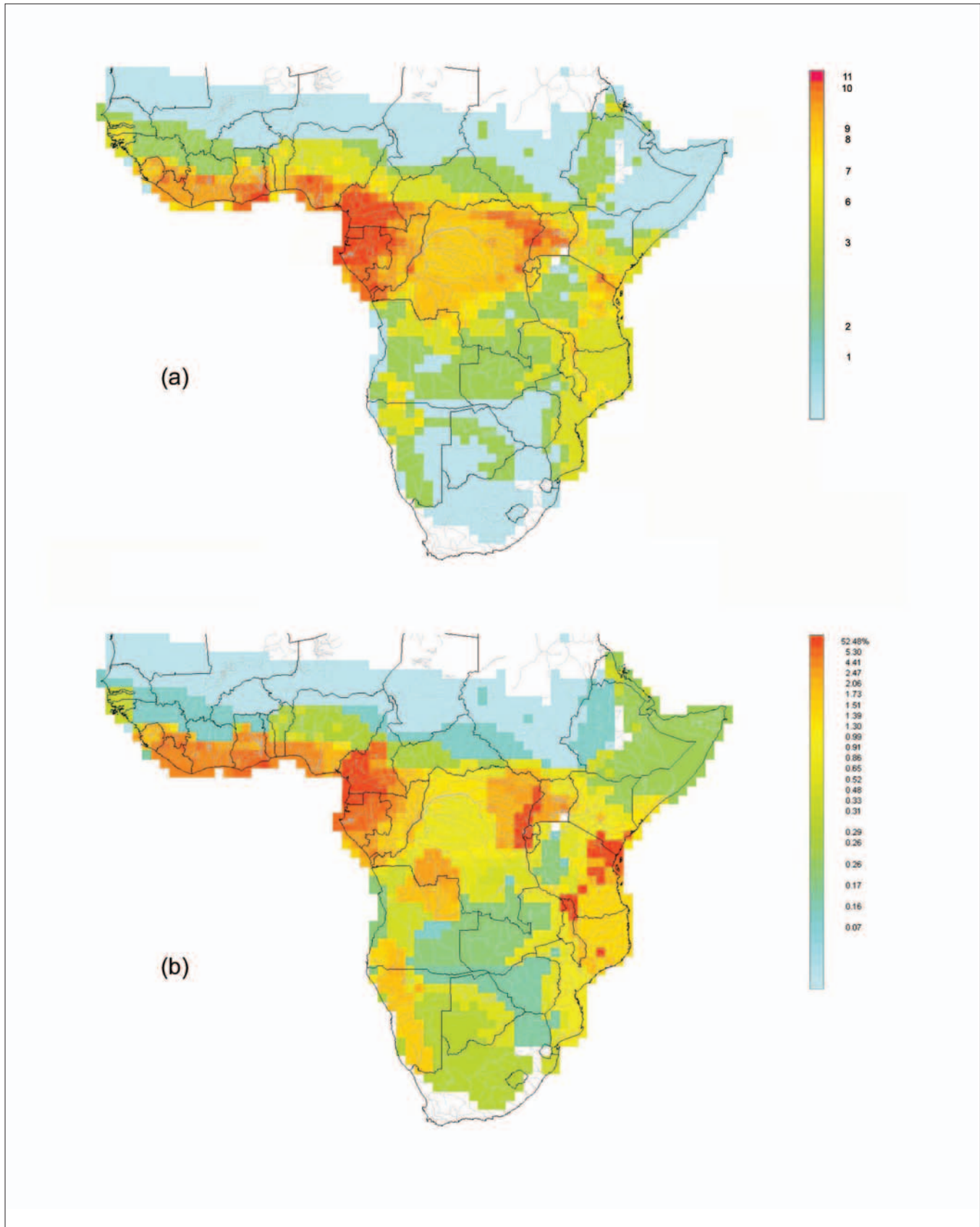


Figure 10. Squirrel (Sciuridae) species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

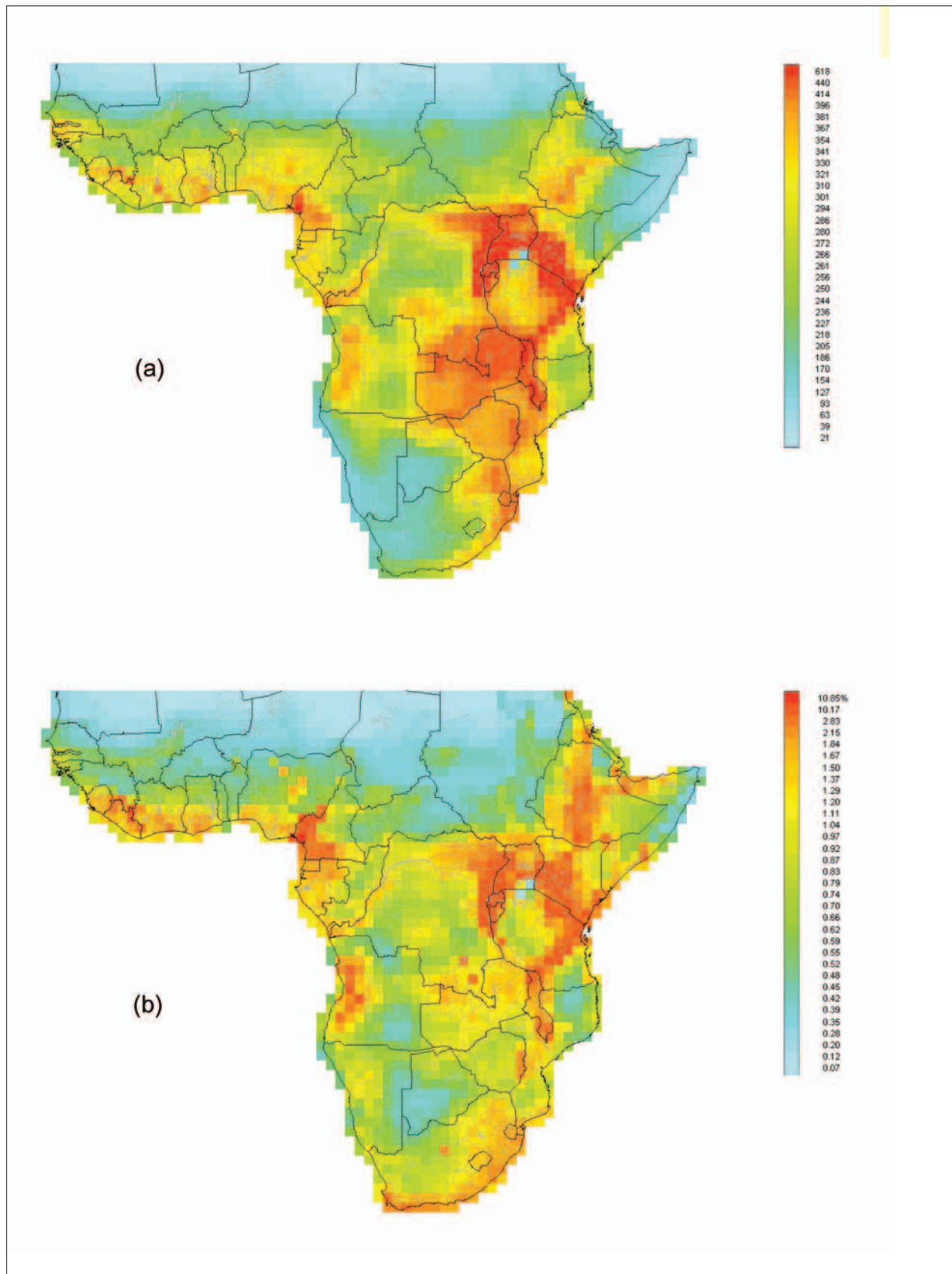


Figure 11. Bird species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

Table 3. Restricted-range bird species of the study region and their conservation status. Taxonomy follows Dowsett and Forbes-Watson (1993).

Family	Scientific Name	Common Name	IUCN Category (IUCN 2002)
Columbidae	<i>Columba sjostedti</i>	Cameroon olive pigeon	NT
Estrildidae	<i>Nesocharis shellyi</i>	Fernando Po oliveback	NT
Hirundinidae	<i>Psalidoprocne fuliginosa</i>	Cameroon mountain roughwing	NT
Malaconotidae	<i>Laniarius atroflavus</i>	Yellow breasted boubou	NT
Malaconotidae	<i>Malaconotus gladiator</i>	Green breasted bushshrike	VU
Malaconotidae	<i>Telophorus kupeensis</i>	Mt. Kupé bushshrike	EN
Musophagidae	<i>Tauraco bannermani</i>	Bannerman's turaco	EN
Nectariniidae	<i>Nectarinia oritis</i>	Cameroon sunbird	NT
Nectariniidae	<i>Nectarinia ursulae</i>	Ursula's mouse colored sunbird	LR
Phasianidae	<i>Francolinus camerunensis</i>	Cameroon francolin	EN
Platysteiridae	<i>Platysteira laticincta</i>	Banded wattle-eye	EN
Ploceidae	<i>Ploceus bannermani</i>	Bannerman's weaver	VU
Pycnonotidae	<i>Andropadus montanus</i>	Cameroon greenbul	LR
Pycnonotidae	<i>Andropadus tephrolaemus</i>	Gray throated greenbul	NT
Pycnonotidae	<i>Phyllastrephus poensis</i>	Cameroon olive greenbul	NT
Pycnonotidae	<i>Phyllastrephus poliocephalus</i>	Gray headed greenbul	LR
Sylviidae	<i>Apalis bamendae</i>	Bamenda apalis	NT
Sylviidae	<i>Bradypterus bangwaensis</i>	Bangwa forest warbler	LR
Sylviidae	<i>Cisticola discolor</i>	Brown backed cisticola	NT
Sylviidae	<i>Phylloscopus herberti</i>	Black capped woodland warbler	NT
Sylviidae	<i>Poliolais lopezi</i>	White tailed warbler	LR/NT
Sylviidae	<i>Urolais epichlora</i>	Green longtail	NT
Turdidae	<i>Cossypha isabellae</i>	Mountain robin-chat	NT
Timaliidae	<i>Kupeornis gilberti</i>	White throated mountain babbler	EN
Zosteropidae	<i>Speirops brunneus</i>	Fernando Po speirops [white-eye]	VU
Zosteropidae	<i>Speirops melanocephalus</i>	Mt. Cameroon speirops [white-eye]	VU



Figure 12. Point locality maps bird species endemic to the study region. Existing and proposed protected areas and reserves shown in green. Land above 1,200 m shown in gray. See text for sources of data. Figure continues on pp. 45–48.



Figure 12 continued.

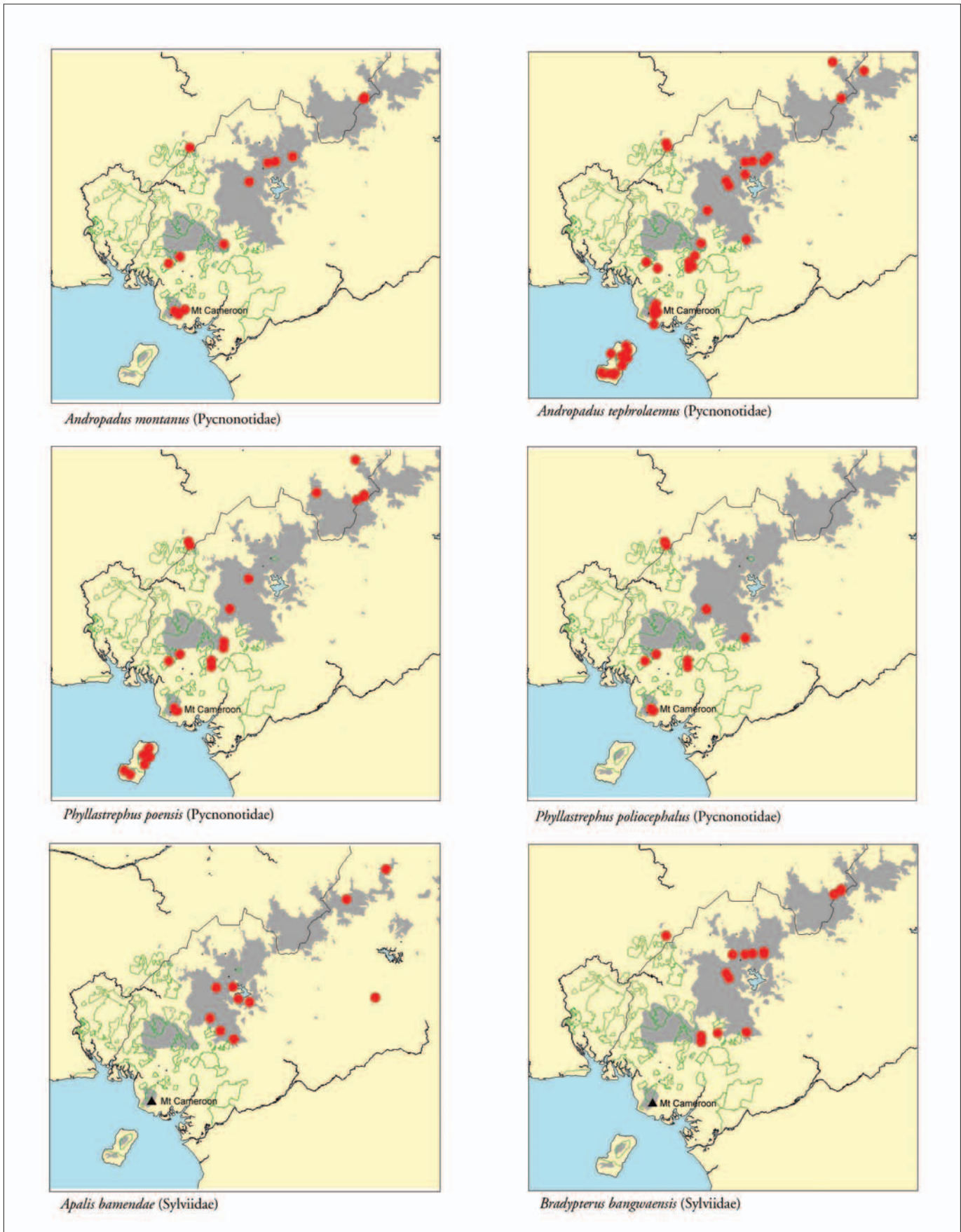


Figure 12 continued.



Figure 12 continued.

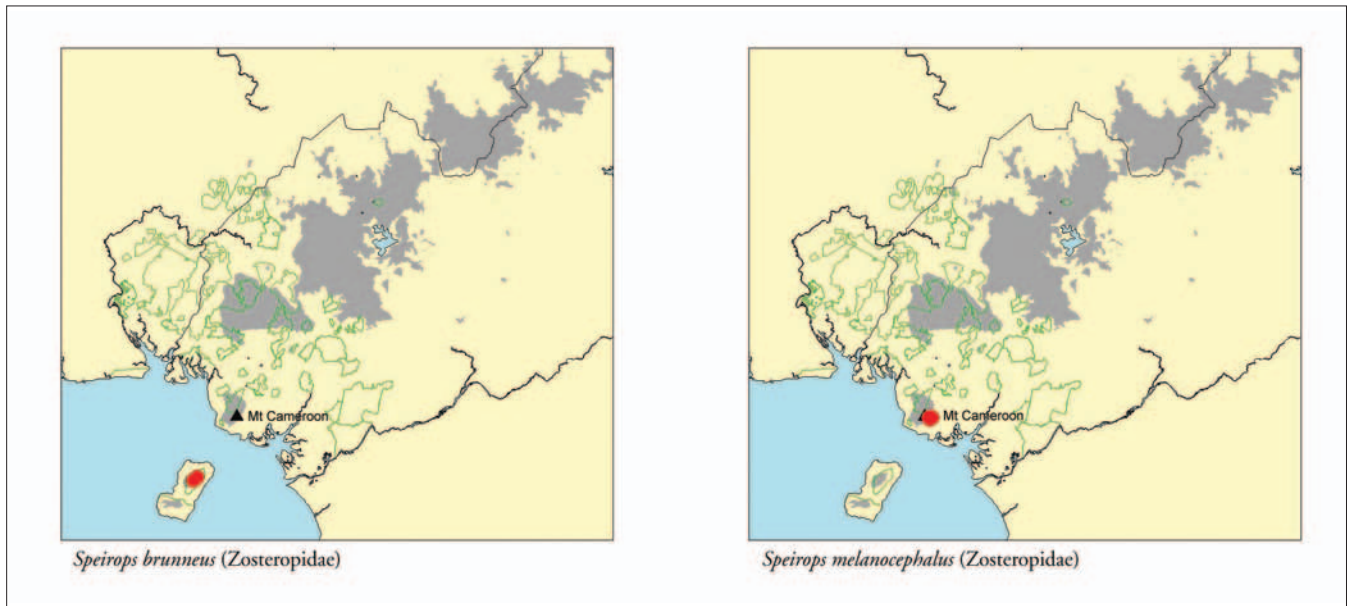


Figure 12 continued.

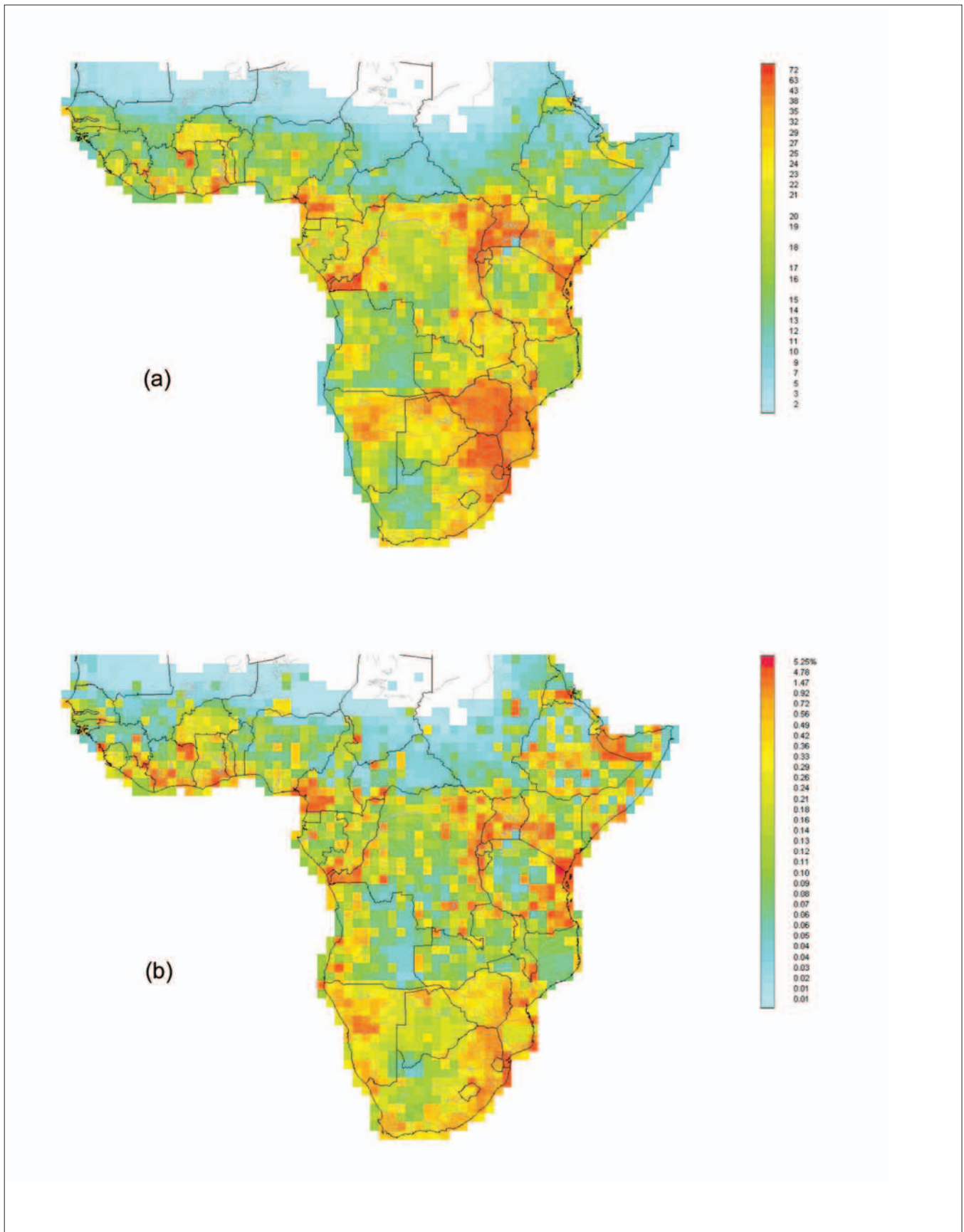


Figure 13. Snake species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

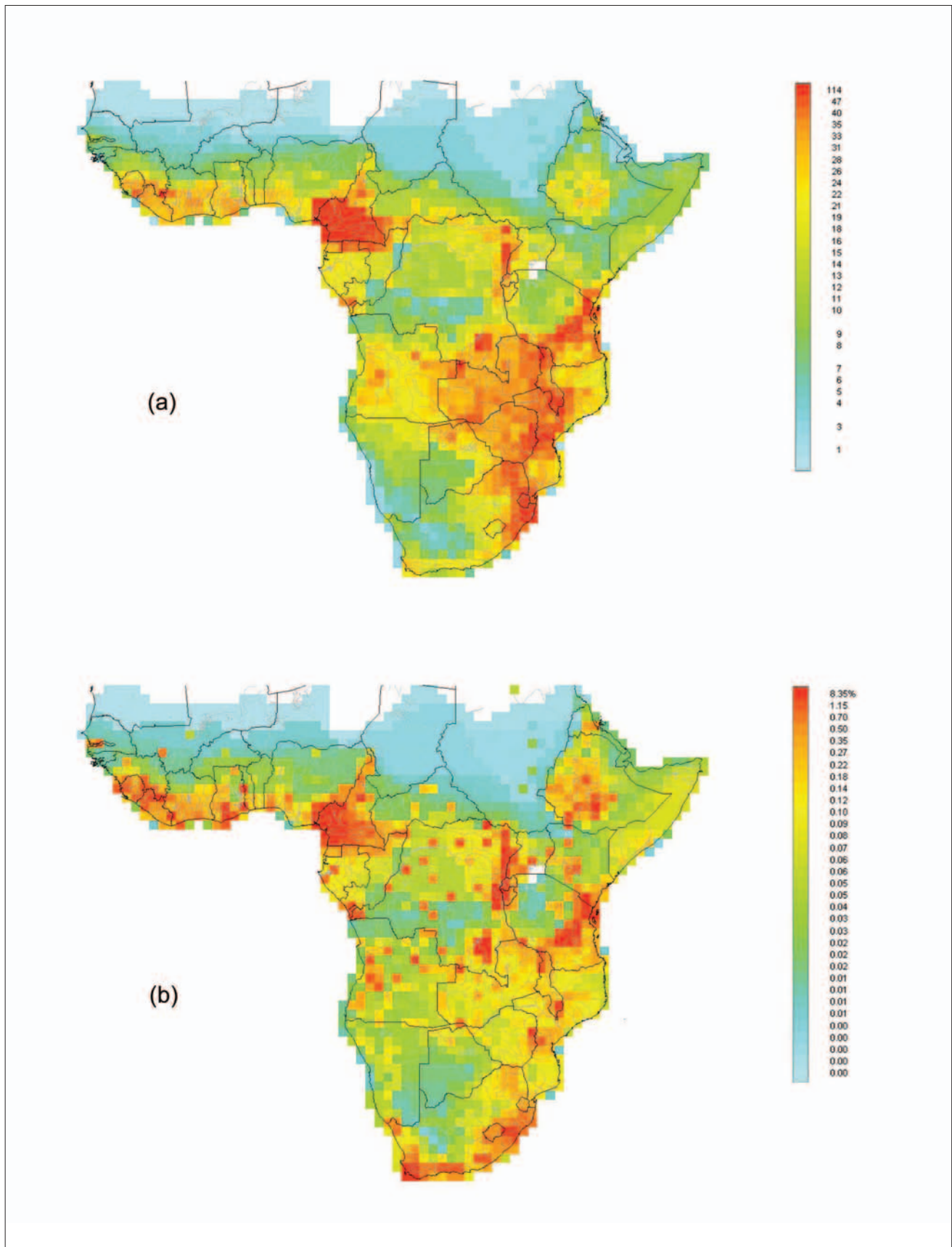


Figure 14. Amphibian species (a) richness and (b) inverse range size rarity (endemism) in sub-Saharan Africa. Data from the Zoological Museum, University of Copenhagen (ZMUC) database. Maps generated using WORLDMAP (Williams 2001).

Table 4. Anuran amphibian species either completely or mostly restricted to the Nigeria-Cameroon border region, based on ZMUC/WORLD-MAP data and our own research (list may be partial). Species known to occur in a few sites outside the region are indicated with an asterisk.

Family	Species
Arthroleptidae	* <i>Cardioglossa elegans</i>
	<i>C. melanogaster</i>
	<i>C. nigromaculata</i>
	<i>C. oreas</i>
	<i>C. pulchra</i>
	<i>C. schioetzei</i>
	<i>C. trifasciata</i>
	<i>C. venusta</i>
	<i>Astylosternus diadematus</i>
	<i>A. fallax</i>
	<i>A. laurenti</i>
	<i>A. montanus</i>
	<i>A. nganbanus</i>
	<i>A. perreti</i>
	<i>A. nanoides</i>
	<i>A. rheophilus</i>
	<i>A. schioetzi</i>
	<i>Leptodactylon axillaris</i>
	<i>L. bicolor</i>
	<i>L. boulengeri</i>
<i>L. erythrogaster</i>	
<i>L. mertensi</i>	
<i>L. ornatus</i>	
<i>L. perreti</i>	
<i>L. polyacanthus</i>	
Bufonidae	<i>B. villiersi</i>
	<i>Didynamipus sjostedti</i>
	<i>Werneria bambutensis</i>
	* <i>W. mertensi</i>
	* <i>W. preussi</i>
	<i>W. tandyi</i>
	<i>Wolterstorffina mirei</i>
	* <i>W. parvipalmata</i>
Hyperoliidae	<i>Afrixalus lacteus</i>
	<i>A. schneideri</i>
	<i>Arlequinus krebsi</i>
	<i>Hyperolius adametzi</i>
	<i>H. bopeleti</i>
<i>H. koelheri</i>	
<i>H. riggenbachi</i>	
Pipidae	<i>Xenopus amieti</i>
	<i>X. longipes</i>
Ranidae	<i>Conraua robusta</i>
	<i>Petropedetes cameronensis</i>
	* <i>P. parkeri</i>
	<i>P. perreti</i>
	<i>Phrynobatrachus cricogaster</i>
	<i>P. manengoubensis</i>
	* <i>P. steindachneri</i>
	<i>P. wernerii</i>
<i>Hylarana asperrima</i>	

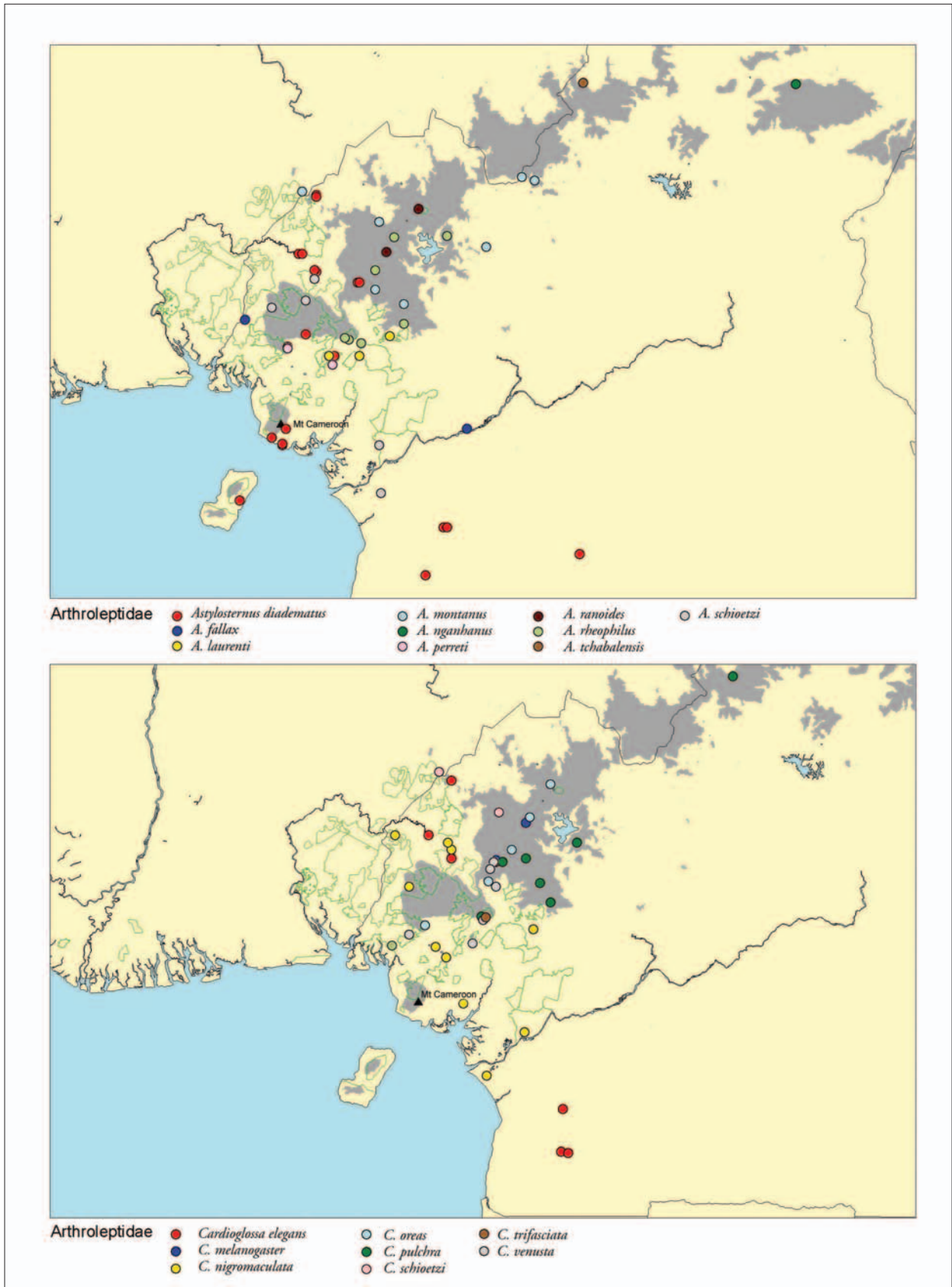


Figure 15. Point locality maps for anuran amphibian species endemic to the study region. Existing and proposed protected areas and reserves shown in green. Land above 1,200 m shown in gray. See text for sources of data. Figure continues on pp. 53–56.

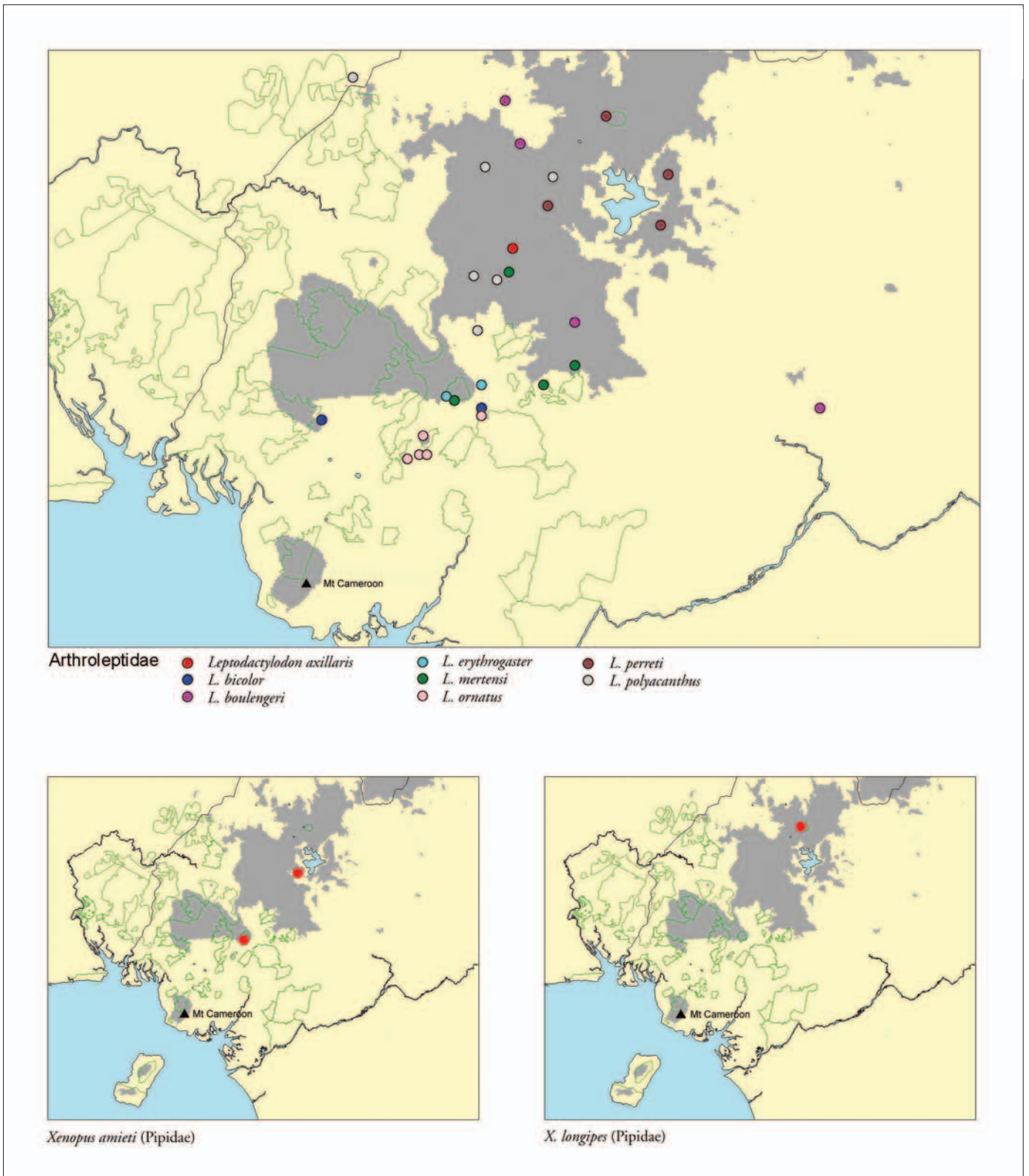


Figure 15 continued.

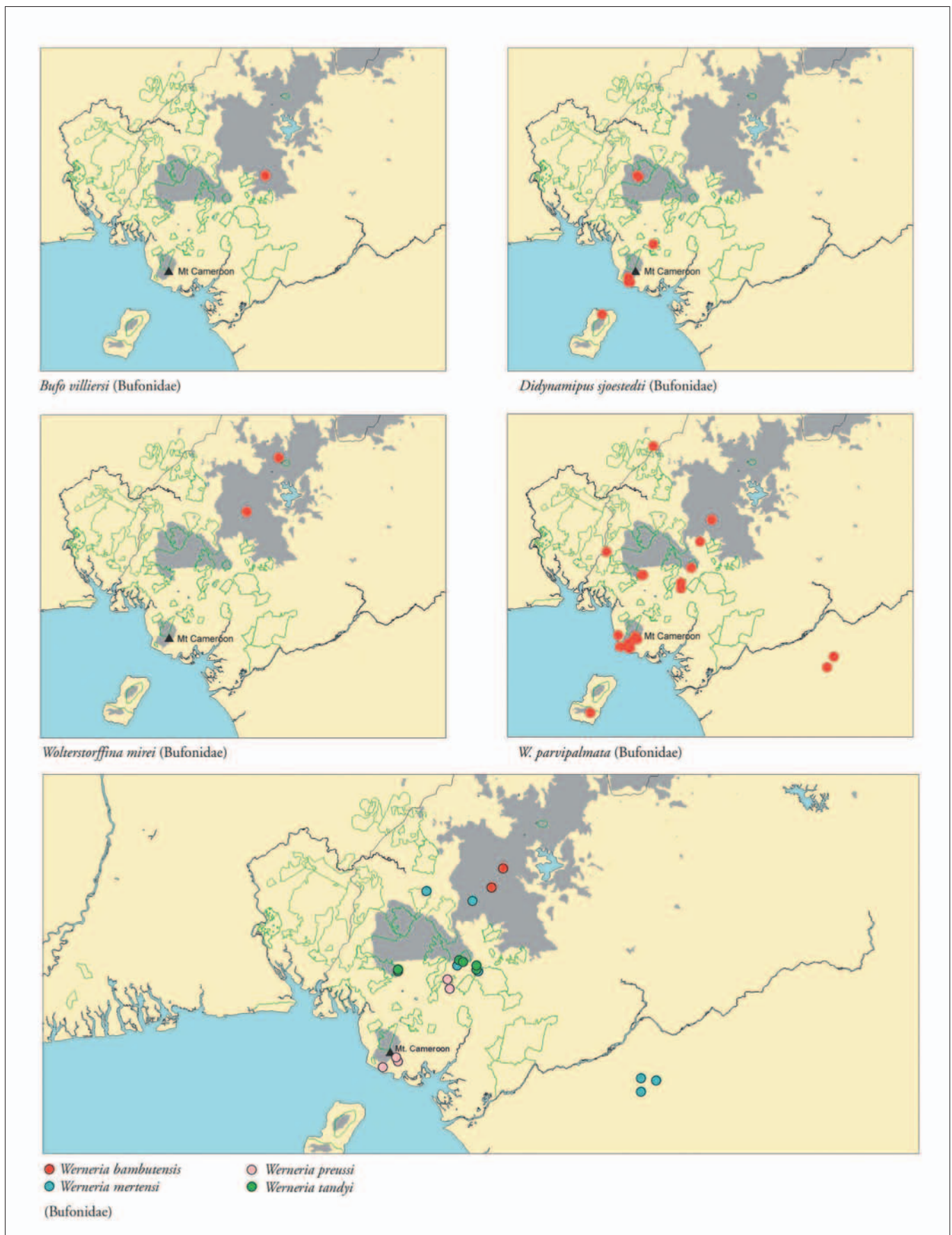


Figure 15 continued.

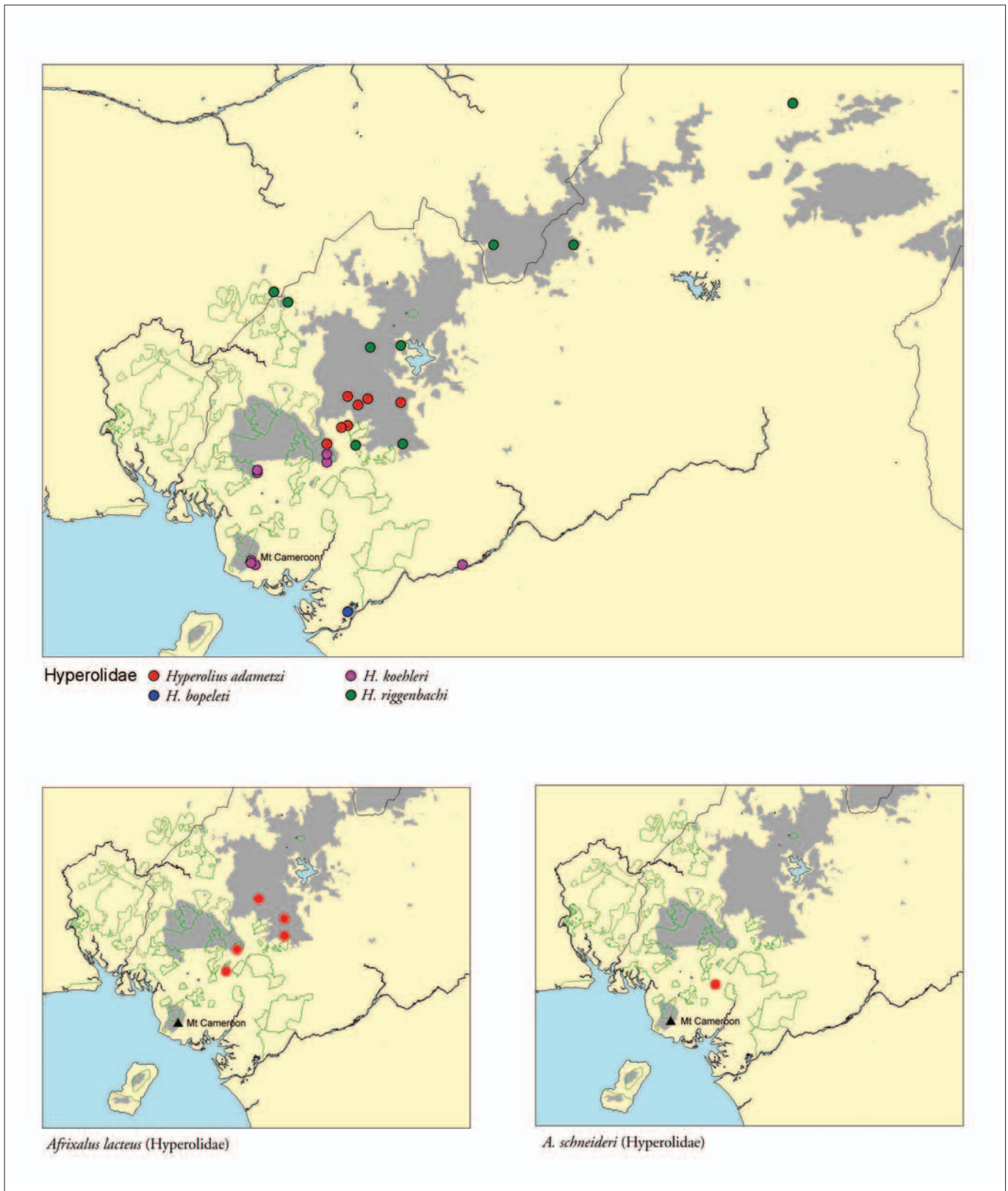
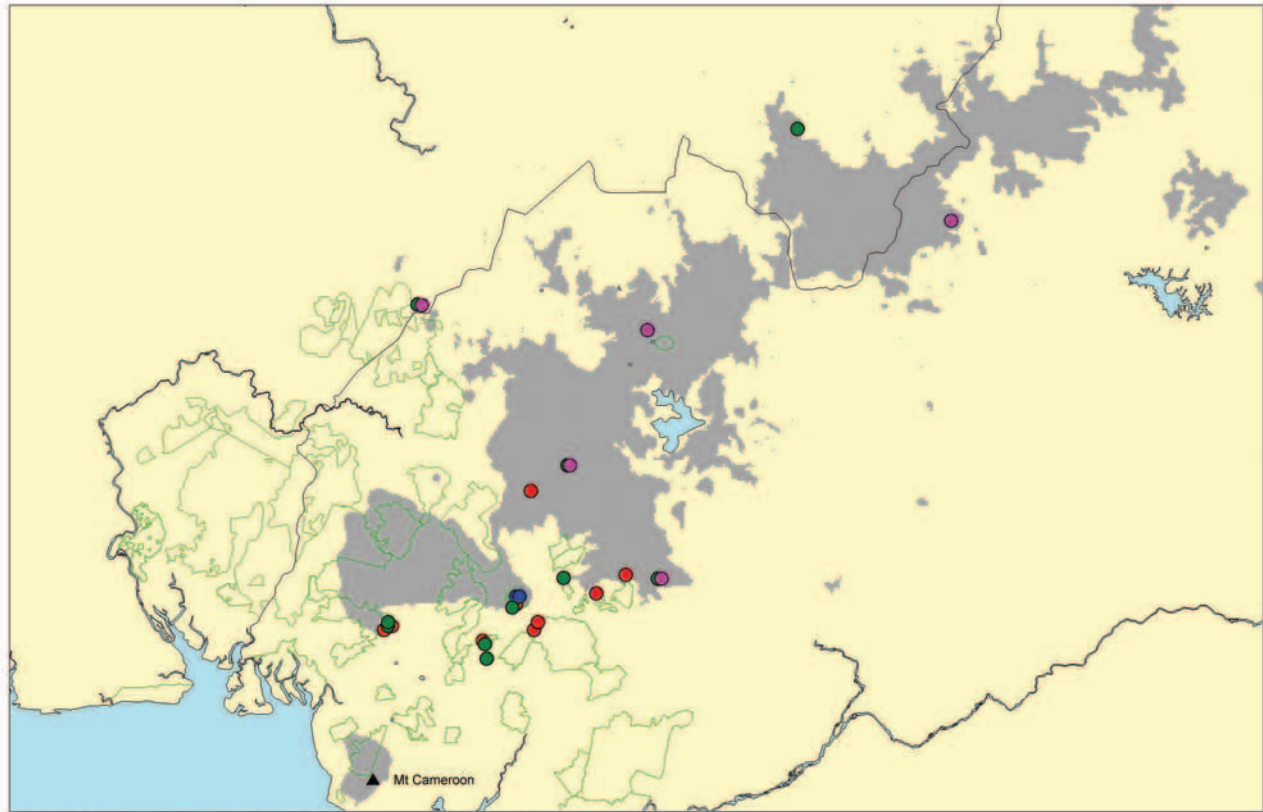


Figure 15 continued.



Ranidae
 ● *Phrynobatrachus cricogaster* ● *P. steindachneri*
 ● *P. manengoubensis* ● *P. werneri*



Hylarana asperrima (Ranidae)



Conraua robusta (Ranidae)

Figure 15 continued.

Table 5. Butterflies of the Korup and Cross River National Parks (Okwangwo and Oban), not including the Rumpi Hills (from Larsen 1997c).

	Korup	Oban Hills	Okwangwo*
Larsen expeditions 1995/97	400	650	600
Ever recorded from area	477	775**	620
Estimated total for area	990	1,000	950

*Including about 60 submontane species from the Obudu Plateau.

**Museum studies would probably add another 25–50 confirmed species.

NOTE: The joint total known from CRNP (Oban and Okwangwo) is 920, with an estimated total of 1,100.

Table 6. Butterfly species and subspecies endemic to the Cameroon-Nigeria highlands including the Obudu Plateau (from Larsen 1997b).

Taxon	Known distribution
Endemic species	
<i>Liptena boei</i>	Mt. Tabenken only
<i>Liptena priscilla</i>	Obudu only
<i>Capys bamendanus</i>	Bamenda, but perhaps widespread
<i>Uranothauma frederikkae</i>	Obudu, many mountains
<i>Bicyclus anisops</i>	Obudu, many mountains
<i>Charaxes obudoensis</i>	Obudu, many mountains
<i>Charaxes tectonis</i>	Obudu, many mountains
<i>Charaxes musakensis</i>	Mt. Cameroon only
<i>Euriphene bernaudi</i>	Obudu and Rumpi Hills
<i>Pseudathyma legeri</i>	Obudu only
<i>Pseudacraea annakae</i>	Obudu, Mambilla, and Mbam
<i>Gorgyra</i> sp.	Obudu only
<i>Ceratrachia</i> sp.	Obudu only
<i>Chondrolepis nero</i>	Obudu, many mountains
Endemic subspecies	
<i>Papilio rex schultzei</i>	Obudu/Atlantika
<i>Papilio charopus charopus</i>	Many mountains
<i>Papilio zoroastres zoroastres</i>	Not in Nigeria
<i>Colias electo manengoubensis</i>	Many mountains
<i>Colotis elgonensis glauningi</i>	Many mountains
<i>Belenois zochalia connexiva</i>	Many mountains
<i>Mylothris jacksoni knutsoni</i>	Many mountains
<i>Mylothris yulei bansoana</i>	Many mountains
<i>Iolaus bansana bansana</i>	Not in Nigeria
<i>Eicochrysops ?unigemmata sangba</i>	Obudu/Sangba
<i>Abisara neavei latifasciata</i>	Many mountains
<i>Tirumala formosa morgeni</i>	Many mountains
<i>Amauris echeria occidentalis</i>	Many mountains
<i>Aphysanota scapulifascia occidentalis</i>	Mambilla/Cameroon
<i>Bicyclus saussurei camerunia</i>	Mambilla/Cameroon
<i>Ypthima albida occidentalis</i>	Many mountains
<i>Neptis occidentaliu batesi</i>	Not yet in Nigeria
<i>Neptis ochracea milbraedi</i>	Many mountains
<i>Antanartia dimorphica mortoni</i>	Many mountains
<i>Acraea wigginsii occidentaliu</i>	Not yet in Nigeria
<i>Acraea obliqua obliqua</i>	Many mountains

Table 7. Species of large trees restricted to the Nigeria-Cameroon border region, or with their range centered within this region, and mapped in this project. List compiled from Cable and Cheek (1998) and our own research.

Family	Species
Anacardiaceae	<i>Sorindeia mildbraedii</i>
	<i>S. nitidula</i>
	<i>Trichoscypha abut</i>
	<i>T. mannii</i>
	<i>T. preussii</i>
Annonaceae	<i>Uvariastrum zenkeri</i>
	<i>Uvariadendron connivens</i>
	<i>U. fuscum</i>
Apocynaceae	<i>Tabernaemontana contorta</i>
Caricaceae	<i>Cylicomorpha solmsii</i>
Ericaceae	<i>Aguaria salicifolia</i>
Euphorbiaceae	<i>Drypetes preussii</i>
	<i>D. staudtii</i>
	<i>Hamilcoa zenkeri</i>
	<i>Macaranga occidentalis</i>
Flacourtiaceae	<i>Oncoba lophocarpa</i>
	<i>O. ovalis</i>
Guttiferae	<i>Garcinia contrauna</i>
	<i>G. densivenia</i>
	<i>G. staudtii</i>
Huaceae	<i>Afrostryrax kamerunensis</i>
Leguminosae, Caesalpinioideae	<i>Anthothona leptorrhachis</i>
	<i>Brachystegia cynometroides</i>
	<i>Crudia bibundina</i>
	<i>Daniellia oblonga</i>
	<i>Loesenera talbotii</i>
	<i>Microberlinia bisulcata</i>
Leguminosae, Mimosoideae	<i>Calpocalyx winkleri</i>
Leguminosae, Papilionoideae	<i>Andira inermis</i> (subsp. <i>inermis</i>)
	<i>Baphia leptostemma</i> (var. <i>gracilipes</i>)
Loganiaceae	<i>Strychnos elaeocarpa</i>
	<i>S. gnetifolia</i>
Moraceae	<i>Ficus chlamydocarpa</i> (subsp. <i>chlamydocarpa</i>)
Myricaceae	<i>Myrica arborea</i>
Podocarpaceae	<i>Podocarpus mannii</i>
Rubiaceae	<i>Aidia rhacodosepala</i>
	<i>Cuviera wernhamii</i>
	<i>Ixora foliosa</i>
	<i>Pausinystalia talbotii</i>
	<i>S. gnetifolia</i>
	<i>Pavetta hookeriana</i>
	<i>Psydrax dunlapii</i>
	<i>Oricia trifoliata</i>
Sapindaceae	<i>S. gnetifolia</i>
	<i>Allophylus bullatus</i>
	<i>Lychnodiscus grandifolius</i>
Sterculiaceae	<i>Leptonychia pallida</i>
	<i>Mansonia altissima</i> (var. <i>kamerunica</i>)
	<i>Scaphopetalum</i> cf. <i>zenkeri</i>
Vochysiaceae	<i>Korupodendron songweanum</i>

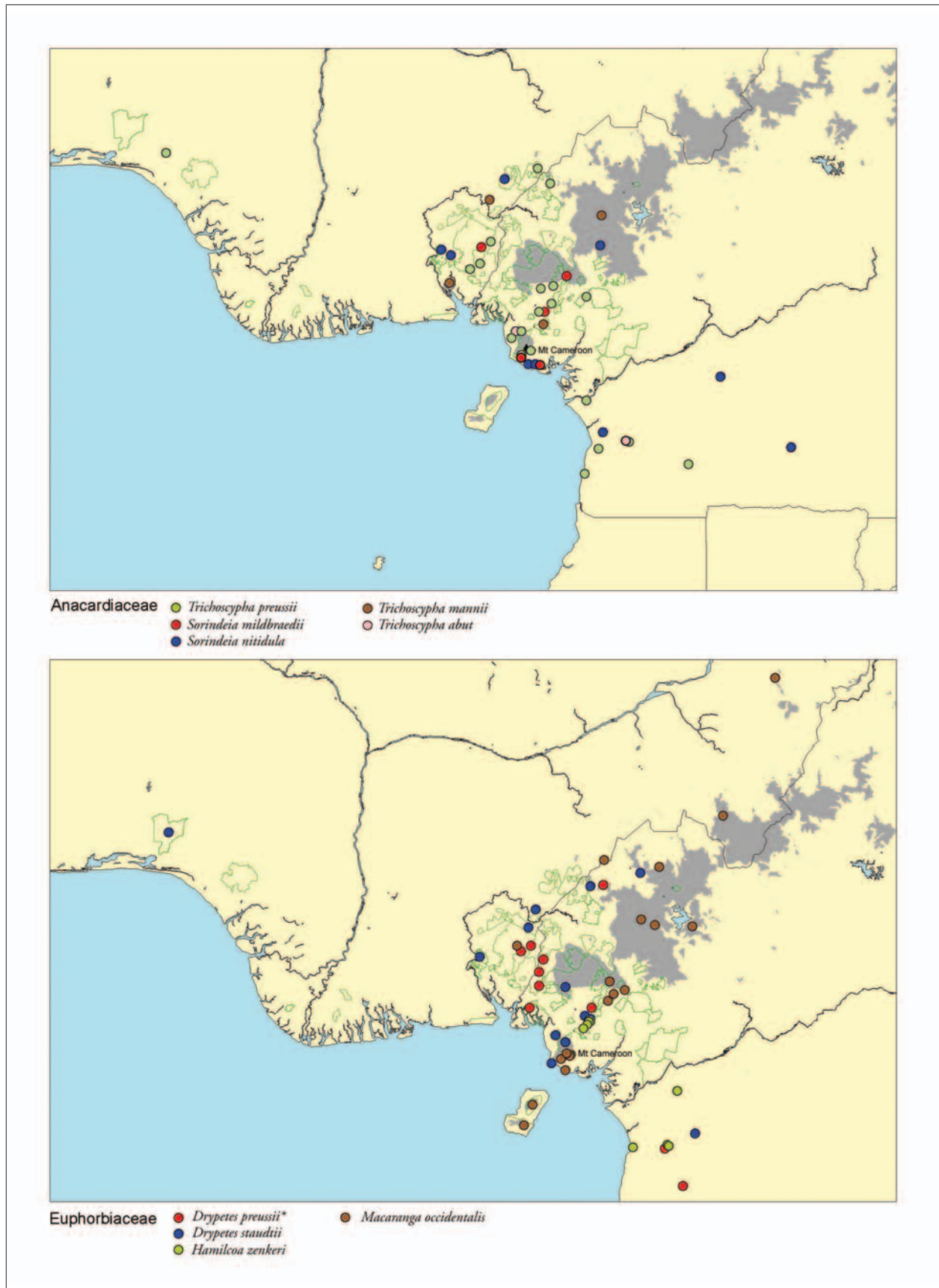


Figure 16. Point locality maps for tree species endemic in the study region. Taxa marked with an asterisk have unverified localities outside the map area. Existing and proposed protected areas and reserves shown in green. Land above 1,200 m shown in gray. See text for sources of data. Figure continues on pp. 60–63.

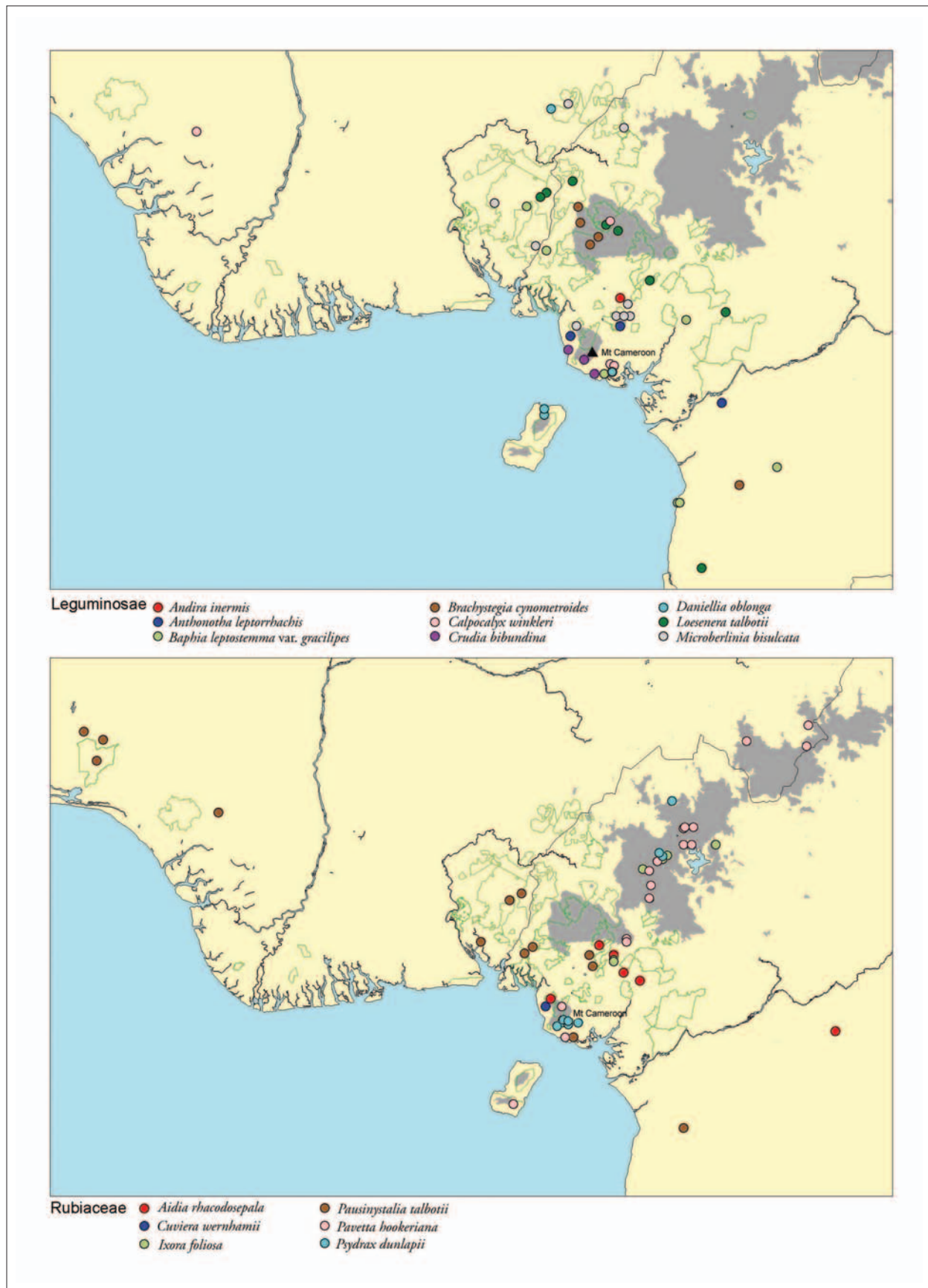


Figure 16 continued.

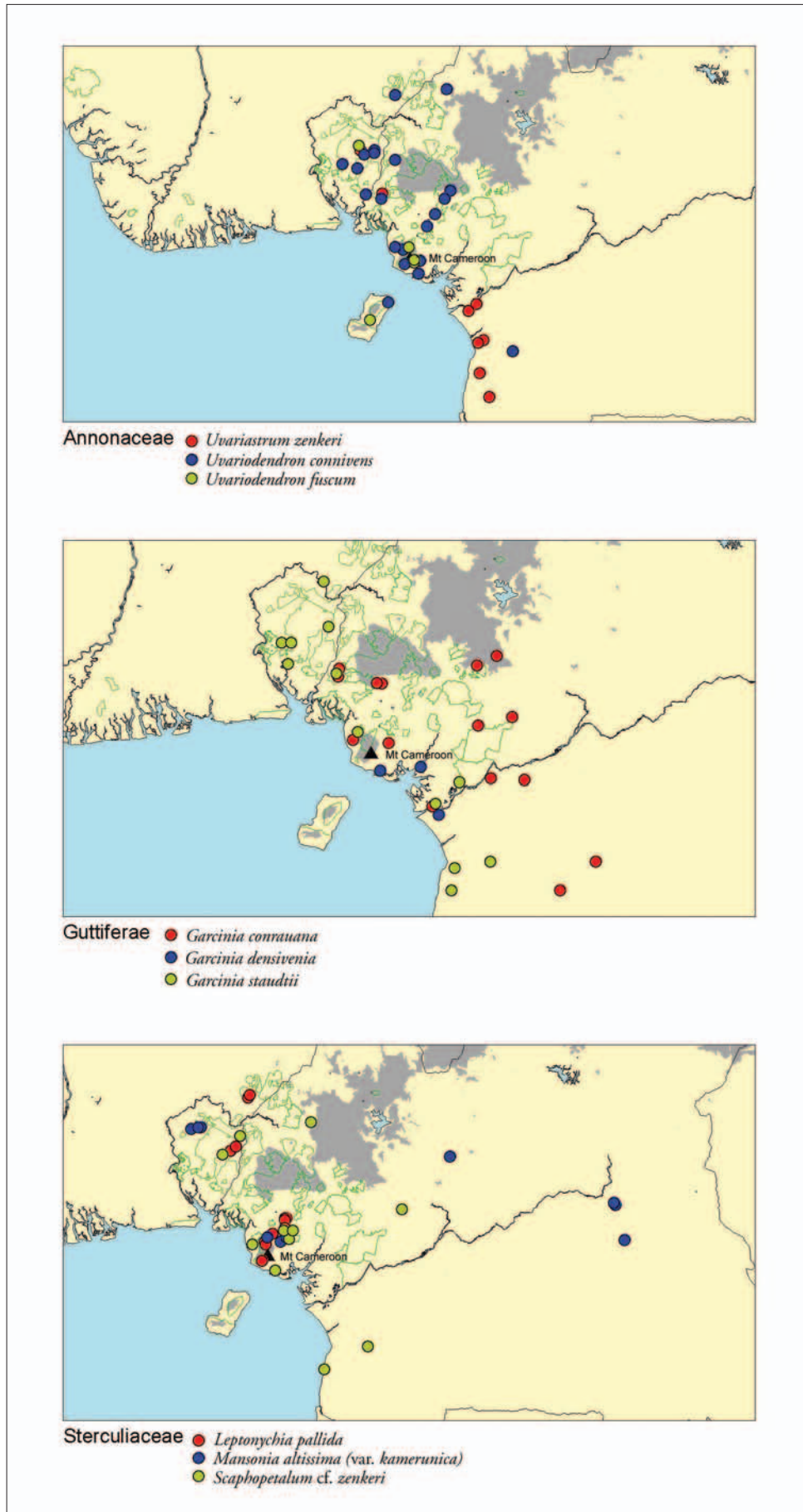
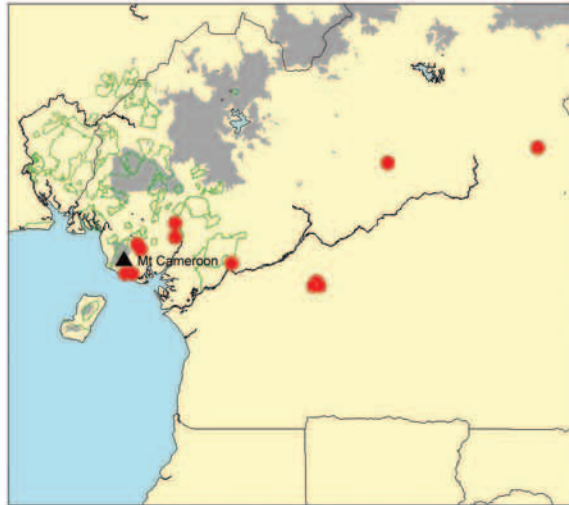


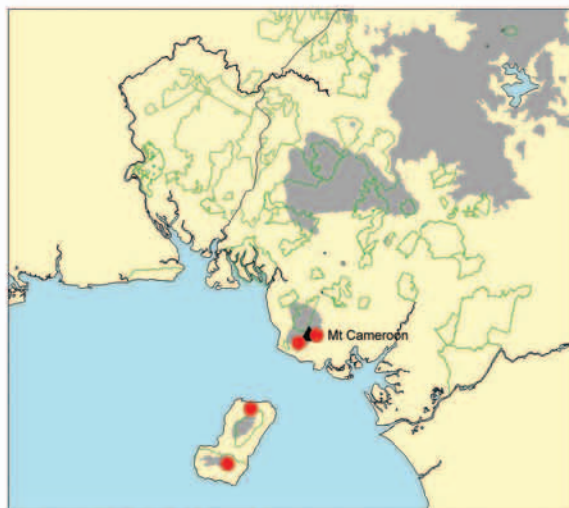
Figure 16 continued.



Tabernaemontana contorta (Apocynaceae)



*Cylicomorpha solmsii** (Caricaceae)



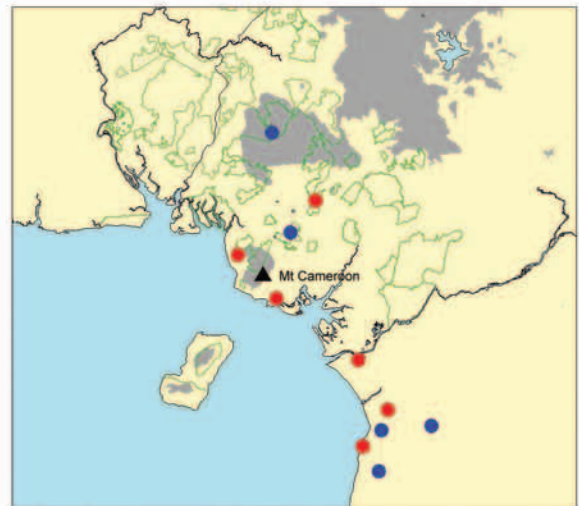
Aguaria salicifolia (Ericaceae)



● *Oncoba lophocarpa* (Flacourtiaceae)
● *Oncoba ovalis*



Afrostyrax kamerunensis (Huaceae)



● *Strychnos elaeocarpa* (Loganiaceae)
● *Strychnos gnetifolia*

Figure 16 continued.

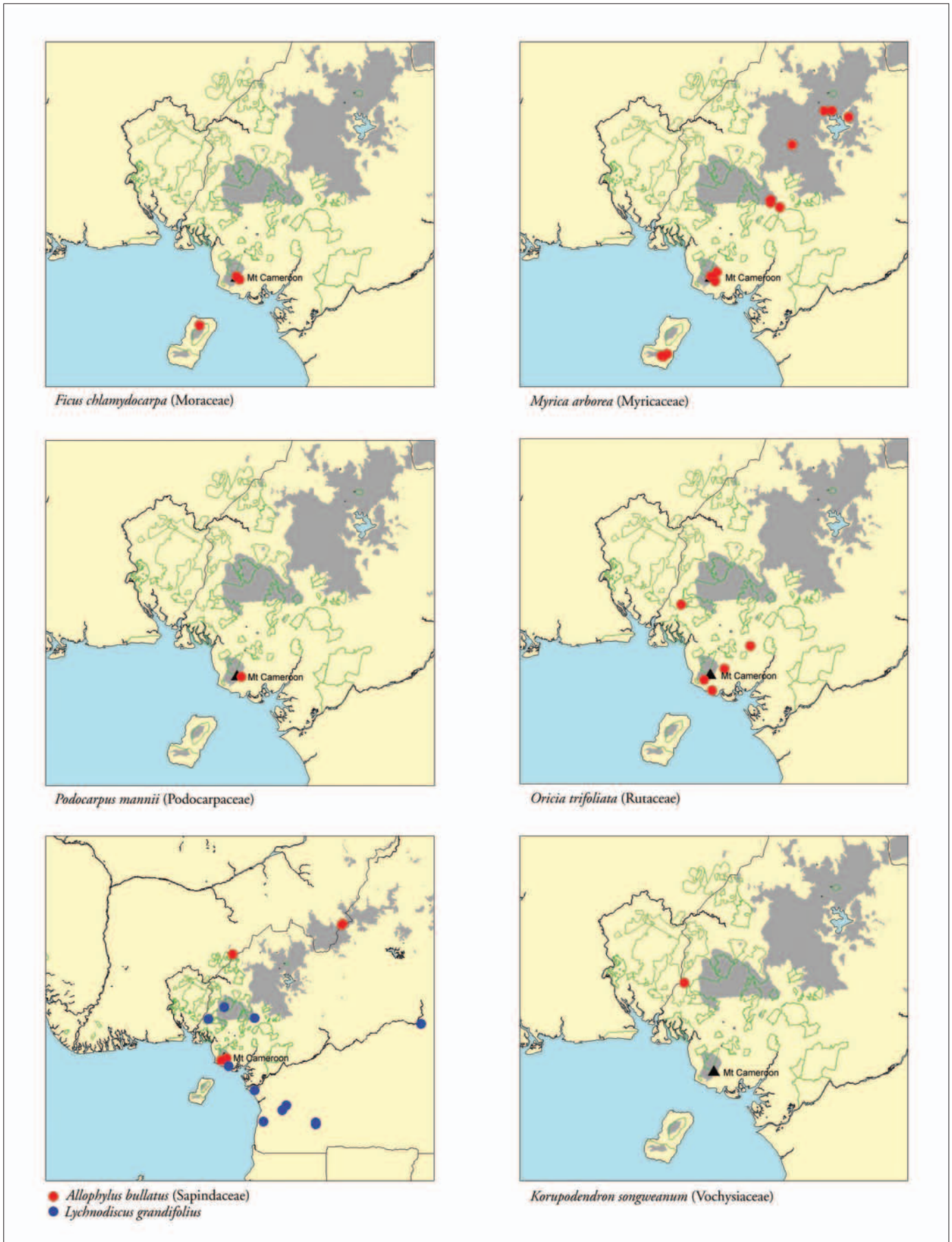


Figure 16 continued.

CHAPTER 5

Review of Existing Conservation Areas



Korup National Park entrance,
Cameroon.

In this chapter we describe the designated protected areas in the Gulf of Guinea forests and discuss the extent to which they protect the region's biodiversity, especially its endemic and threatened animals and plants.

THE DISTRIBUTION OF PROTECTED AREAS AND OTHER RESERVES

Figures 17 and 18 map the distribution, in Nigeria and Cameroon respectively, of existing and proposed protected areas and reserves in the Gulf of Guinea forests. Figure 19 shows these areas in relation to vegetation.

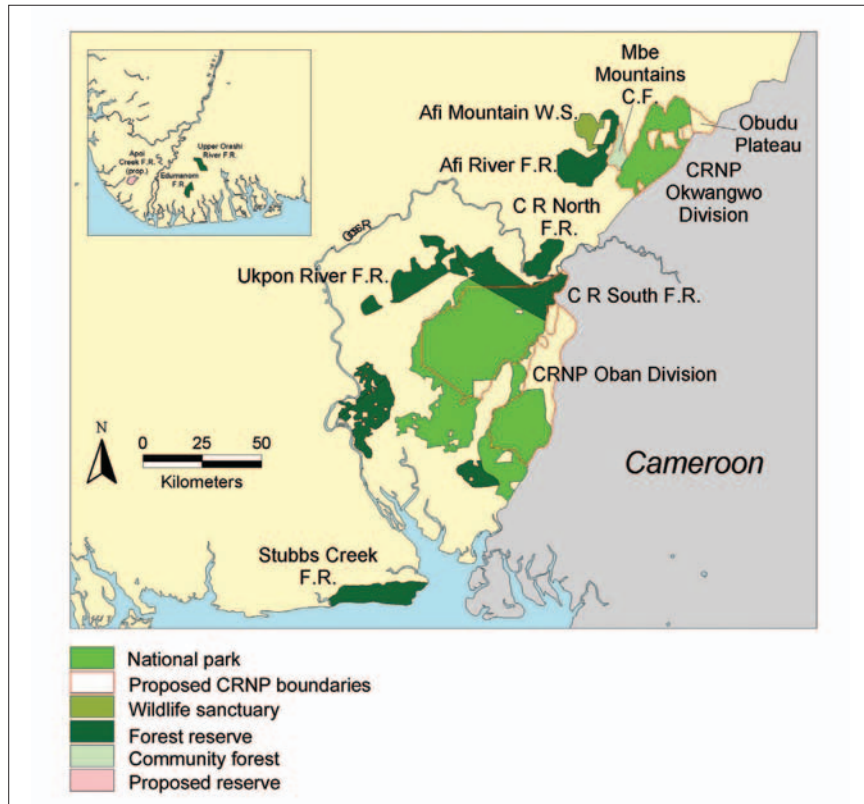


Figure 17. Existing and proposed protected areas and other reserves in southeastern Nigeria and the Niger Delta (inset). Both the current legal boundaries of Cross River National Park (as decreed in 1991) and the boundaries recommended by the park management plan (Caldecott *et al.* 1990) are shown.

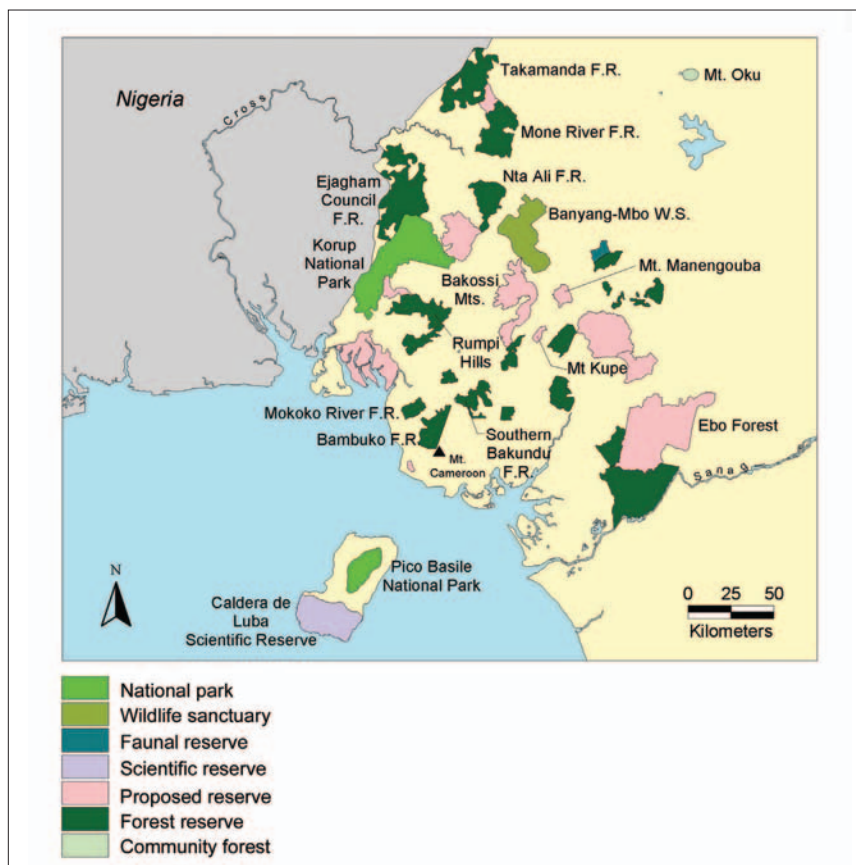


Figure 18. Existing and proposed protected areas and other reserves in southwestern Cameroon and Bioko (information on proposed reserves from a MINEF zoning plan supplied to WCS Cameroon).

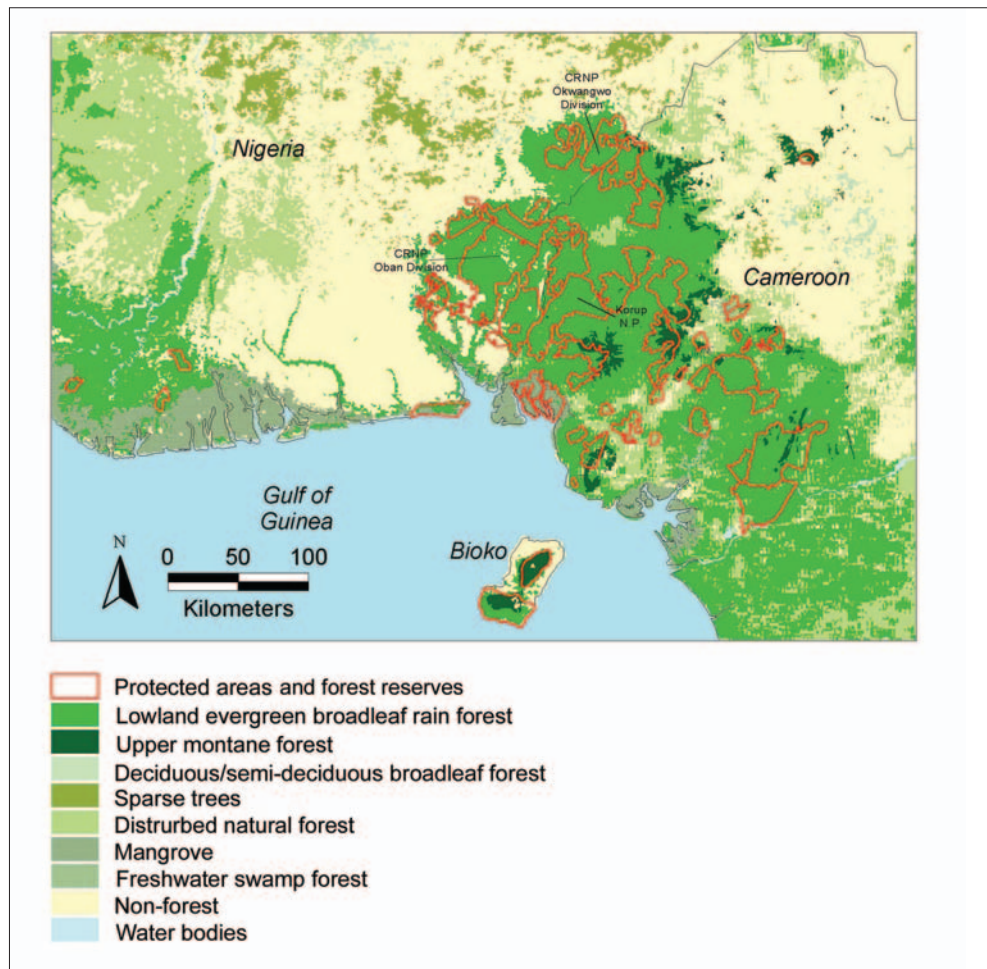


Figure 19. Protected areas and forest reserves in the study region in relation to land cover (for details of protected areas see Figs. 17 and 18; land cover data from WCMC, see Fig. 3).

Protected areas

Within the region, legally designated protected areas in which biological conservation is a priority presently include three national parks (Cross River in Nigeria, Korup in Cameroon, and Pico Basilé on Bioko), two wildlife sanctuaries (Afi Mountain in Nigeria and Banyang-Mbo in Cameroon), and one scientific reserve (Caldera de Luba on Bioko Island) (Table 8). Ngandjui and Blanc (2000) claim that three small areas in Cameroon—Kimbi, Mbi and Oku—have been designated as “faunal reserves” (Réerves de faune). However, R. Fotso (personal communication) informs us that these areas have no such designation, although Mt. Oku is currently a proposed community forest.

In November 2000, Cameroon’s Ministry of the Environment and Forests (MINEF) introduced a “Plan de Zonage” that includes proposals for several new protected areas. Of the areas proposed for our study region, two are ecological reserves (Mount Kupé and the Etinde section of Mt. Cameroon or “small Mount Cameroon”), three are faunal reserves (Rio Del Rey, the area between the Takamanda and Mone River Forest Reserves, and an area east and south of Nkongsamba that includes Mt. Nlonako), and one is a large wildlife sanctuary (the Ebo Forest, south of Yingui between the Dibamba and Ouem Rivers) (Source: MINEF map provided to us by R. Fotso). In addition, under this plan the Bakossi Mountains, the Nkwende Hills, Mt.

Manengouba, and a corridor between the Rumpi Hills and Korup National Park would be designated “Protected Forests.”

Forest reserves

Forest reserves in Anglophone West Africa are areas designated by government for forest protection and management, typically to protect water supplies and provide a supply of timber and other forest products. They are supposed to be harvested according to plans drawn up by the responsible government management authority (a state Forestry Department or Commission in Nigeria, the Ministry of Environment and Forests in Cameroon), the agency that typically provides logging licenses to private contractors. These forest reserves provide no special protection to wildlife, and biodiversity conservation has not, traditionally, been one of their main aims. They are therefore not usually regarded as protected areas, although they appear to qualify for IUCN’s designation as Multiple Use Management/Managed Resource Areas.

In Nigeria, Cross River State contains 12 forest reserves. The former Oban Block forest reserve is now the Oban Division of Cross River National Park, while the Okwangwo, Boshi, and Boshi Extension reserves have become Cross River National Park’s Okwangwo Division. The largest forest reserves remaining outside the Park are Afi River, Cross River South, and Ukpon

Table 8. Legally designated protected areas within the Gulf of Guinea forests region, excluding forest reserves.

Name	Country	Status	Area (km ²)
Cross River	Nigeria	National Park	ca. 3,650
Korup	Cameroon	National Park	1,260
Pico Basilé	Equatorial Guinea	National Park	350
Banyang-Mbo	Cameroon	Wildlife Sanctuary	650
Afi Mountain	Nigeria	Wildlife Sanctuary	100
Caldera de Luba	Equatorial Guinea	Scientific Reserve	600
TOTAL area			6,610

River. Numerous small forest reserves and proposed forest reserves are also located in the other Nigerian states between the Niger and Cross Rivers, though many are now largely deforested. Those with the most potential importance for biodiversity conservation may be the Edumanon and Upper Orashi forest reserve in Bayelsa State (on the eastern edge of the Niger Delta), the proposed Apoi Creek forest reserve in Bayelsa State (in the central delta), and the Stubbs Creek forest reserve in Akwa Ibom State (on the western side of the Cross River mouth).

The Cameroon sector of the region also contains numerous forest reserves (see Figure 18). Among the most important are the Ejagham, Rumpi Hills, and Nta Ali forest reserves in the Korup project area; the Mokoko River and Southern Bakundu forest reserves in the foothills of Mount Cameroon; and the Takamanda and Mone River forest reserves north of Mamfe and the Cross River.

DESCRIPTION AND EVALUATION OF PARTICULAR AREAS

In this section we describe the legally designated protected areas in the Gulf of Guinea forests region, together with those forest reserves and proposed protected areas that have particular conservation significance from the perspective of our analysis. We also discuss some of the management challenges facing these areas.

Cross River National Park, Nigeria

Cross River National Park (CRNP) was established by presidential decree in 1991, following feasibility studies managed by the World Wide Fund for Nature-UK (WWF) and funded by the UK Overseas Development Administration (now DfID) and the European Commission, working in conjunction with the Cross River state government and the federal government of Nigeria. Previously, a long-standing government proposal for one or more national parks in the area had been hampered by a lack of resources. WWF stepped in at the encouragement of the Nigerian Conservation Foundation (NCF), who had carried out biological surveys in the area. WWF was also deeply involved in developing Cameroon's Korup National Park, which is adjacent to CRNP.

The two divisions of CRNP are the Oban Division (approximately 3,000 km², south of the Cross River), created from the former Oban Group forest reserve; and the Okwangwo

Division (640 km², north of the Cross), created from the former Okwangwo, Boshi, and Boshi Extension forest reserves. The divisions are separated by 63 km. Some of this intervening area, which is partially forested, is included in other forest reserves. The forest of Oban is contiguous with that of Korup.

The area encompassed by CRNP was chosen because it has relatively intact forests (Oban is the largest remaining continuous area of closed-canopy rain forest in Nigeria), its biological richness is internationally recognized, it forms an important watershed, and it is highly threatened by farming, hunting, logging, and fire. At the same time, the area also has considerable potential for tourism (Caldecott *et al.* 1989, Caldecott *et al.* 1990).

Cross River National Park contains large areas of lowland rain forest (covering all of Oban Division and part of Okwangwo Division) as well as an unbroken elevational gradient of lowland to submontane forest in the Okwangwo Division. This gradient rises from 150 m above sea level in the valleys of Cross River tributaries to 1,700 m on the edge of the Obudu Plateau. Parts of the central Oban Hills rise above 500 m, with one peak reaching approximately 1,000 m. Although the Obudu Plateau itself has high rainfall, the Okwangwo Division in general has lower annual rainfall than Oban, with a longer dry season and therefore a different forest structure. Among the many biologically significant features of CRNP are its small population of Cross River gorillas (below the Obudu Plateau in the former Boshi Extension forest reserve, which was created as a gorilla sanctuary in 1958), and its population of Preuss's red colobus monkeys (in the Oban Division, northeast of Ekonganaku towards Korup).

Following the policy WWF pursued at Korup, a "support zone" was established around CRNP for the human communities located near the park, though support zone programs were later canceled due to funding shortfalls (see below). Communities within this zone were to be assisted with agricultural and economic development as compensation for lost access to park resources. They were also to be involved in park activities so that they might have a vested interest in defending it (Holland *et al.* 1989).

CRNP is managed by Nigeria National Parks, an agency of the federal government under the Ministry of the Environment. Park headquarters are located in Akamkpa, about 10 km from the southwestern edge of the Oban Division, with a divisional office at Butatong, 4 km west of the Okwangwo Division boundary.

In 2000, CRNP had a staff of approximately 250 people, 100 of whom were employed directly in the park protection

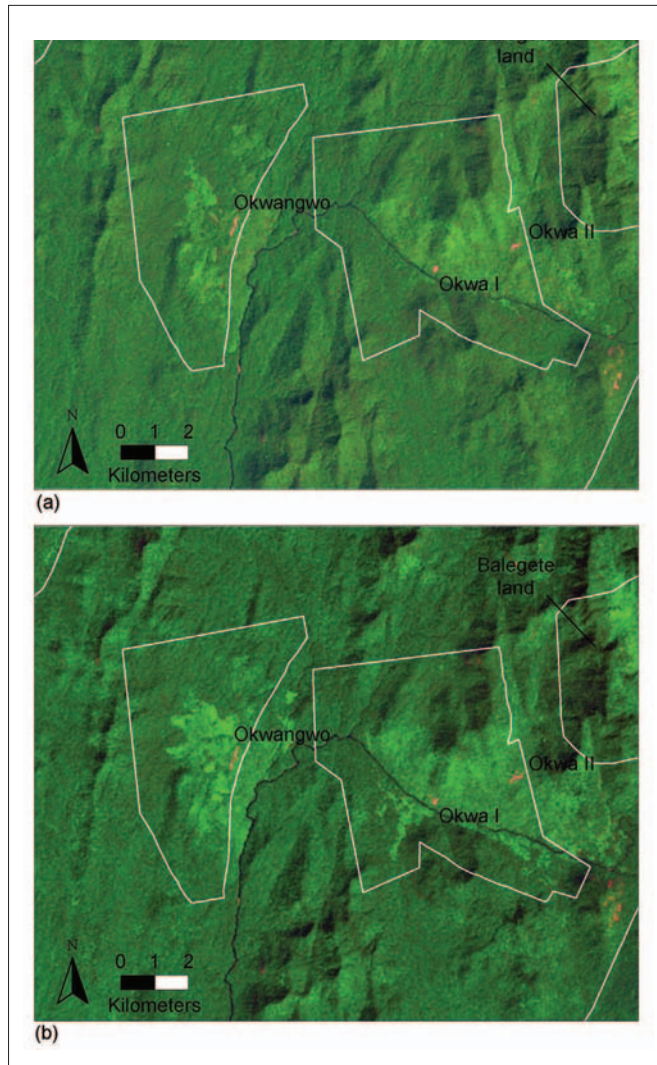


Figure 20. Landsat satellite images from 1986 (a) and 2000 (b) showing increase in the extent and intensity of forest loss around three villages enclaved within Cross River National Park. Undisturbed forest appears dark green, disturbed forest/farm land appears light green, and human settlement/bare earth appears pink.

force as guards and rangers (two thirds at Oban, one third at Okwangwo). A bonus system for park staff (for instance, rewarding staff who arrest poachers who are prosecuted) is not in place, though management would like to institute such a system if funds become available.

Since CRNP was established, the threat of commercial logging in the Oban and Okwangwo forests has diminished significantly. When the park was first mapped, existing logging concessions in the Oban Division were revoked in exchange for concessions in other state reserves. Some illegal logging has occurred in CRNP since its creation, but most of this has been on a small scale. A greater threat to the park's integrity is hunting, which is mostly driven by the commercial bushmeat market. Despite the efforts of park authorities, high levels of hunting still occur in most sectors of the park and have particularly impacted anthropoid primates and other larger mammals, which are now at low densities almost everywhere. Oates and Bergl encountered

no monkeys during three days in the Boshi Extension area of Okwangwo Division in 1999, Oates saw none during seven days in the Ekonganaku area of Oban in 2000 (though *Cercopithecus* calls were heard on four occasions), and Bergl saw no monkeys (but heard one set of calls) during three days near Ekonganaku in 2001.

In 1995 the effort to control hunting in the park became more difficult after the European Union (EU) withdrew support for a management program in Oban, ostensibly in response to the military government's execution of Ogoni activist Ken Saro-Wiwa. In addition, a WWF park advisory program at Okwangwo, also supported with EU funding, came to an end in 1998. This substantial loss of support has not only limited the funds available for hiring protection staff and for equipment purchases, it has brought an end to the support zone programs, leading to antagonism from local communities whose hopes of development assistance had been raised (Oates 1999).

Another unresolved problem in CRNP is the presence of village enclaves within the park's boundaries, notably Mkpot I and Ekonganaku in the Oban Division, and Okwangwo, Okwa I, and Okwa II in the Okwangwo Division. These villages existed before the formation of the original forest reserves, so reserve boundaries were drawn around them and they were left with their own farmland. Over time, village populations have grown, causing demands for more farmland and increased pressure on forest resources. Furthermore, now that the EU has withdrawn its support, progress has not been made on proposals to resettle Mkpot and the Okwangwo villages, creating an especially serious problem for the Okwangwo and Okwa villages. Figure 20 shows Landsat imagery for the Okwangwo villages from 1986 and 2000. During this period forest clearance increased quite dramatically within and beyond the Okwa and Okwangwo enclaves, so that by 2000 Okwa farmlands were beginning to merge with those of Balegete to the northeast and Cameroon to the east. As a result, only a tenuous forest connection now remains between the Boshi Extension forests in the north of the Okwangwo Division and the hill forest south of Okwa. Communities have responded to the lack of development assistance and resettlement opportunities by showing considerable hostility to park management and interfering with protection efforts in the Okwangwo Division.

Park management is also hindered by the government's failure to formally gazette the boundaries recommended by park planning consultants in 1989–90. The official decree from 1991 (Decree 36) established the park's boundaries as those of the original Oban and Boshi-Okwangwo forest reserves. But in Oban, consultants recommended boundaries that include a section of community forest linking the main Oban Hills forest to Korup through the area north of Ekonganaku, while excluding Ekonganaku itself in order to keep the community from becoming a park enclave. In Okwangwo, the recommended boundaries include the Mbe Mountains (home to one of the Cross River gorilla subpopulations) and the Obudu Plateau (see sections below). Although park managers often work on the basis of the recommended boundaries, these do not yet have the force of law. The actual and recommended boundaries are shown in Figure 17.

Apart from the limited research Oates has recently done on the primates of CRNP, in association with Nwufoh and Eniang

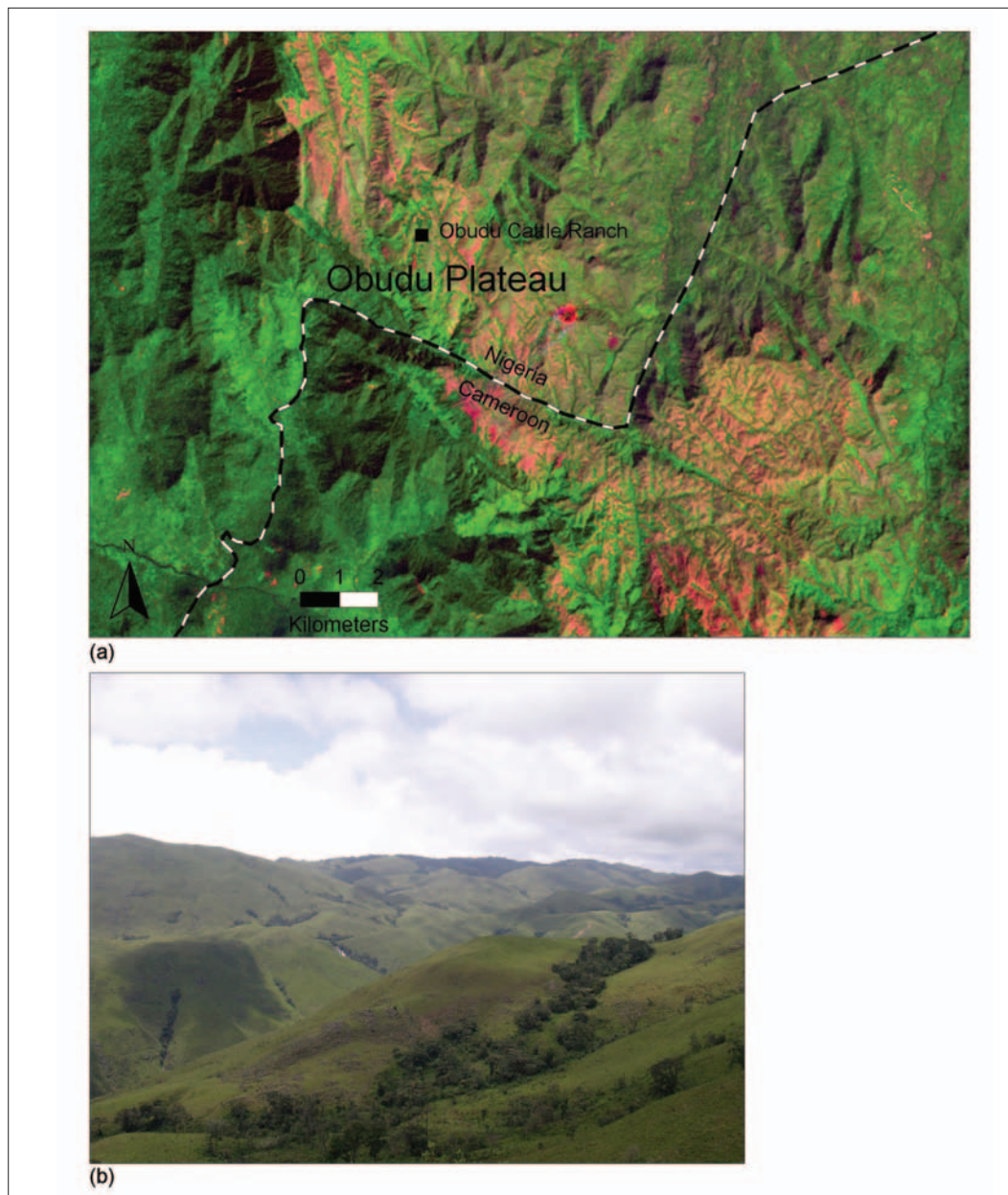


Figure 21. (a) Satellite image (Landsat 7; December 2000) of the highland area along the Nigerian-Cameroon border showing the dissected nature of the area. Pink areas are probably recently burned grassland and human settlements (for instance, the Balegete villages in the southwestern corner of this scene). (b) A view of the Obudu Plateau looking WNW from near the Obudu Cattle Ranch, September 2002.

of the NGO Biodiversity Preservation Group, the biology of the park remains quite poorly known. During the 1980s, J. Reid carried out one of the few biological studies of CRNP, an inventory project in the Oban section, especially near Calabar (Reid 1989). A WWF project from 1994 to 1996 continued Reid's inventory (Schmitt 1996). NCF and WWF also conducted a biological inventory in Okwangwo from 1995 to 1998 (Obot 2000).

Finally, some tourist infrastructure is being developed near Akamkpa in the Oban Division (motorable tracks and simple accommodations) and at Kanyang near the Okwangwo Division (a visitor's center), but at this point the level of tourism in the park is very low.

Obudu Plateau, Nigeria

The Obudu Plateau is a dissected upland area covering about 90 km² between elevations of 1,200 and 1,800 m adjacent to similar upland areas across the border in Cameroon. Most of the plateau is covered by annually-burned grassland, but patches of submontane and montane forest survive, particularly along some of the stream and river valleys. Until the 1950s the plateau was used only by Fulani cattle herders and, seasonally, by hunters from the lowlands. An influx of people began in 1951 when the government of what was then the Eastern Region of Nigeria established a cattle-ranching operation on the plateau. The influx increased after a hotel was opened on the ranch in 1959. By the 1980s the new residents were heavily exploiting the plateau

forests for firewood and were farming forest land because it had the best soil. By 1990 the state-managed ranch was in serious decline, and the approximately 1,400 people living on the plateau were surviving by subsistence farming; most of the plateau forest had been disturbed, and many sites near the ranch had been completely deforested (Oates *et al.* 1990; Figure 21).

Our analysis demonstrated the special biological importance of the plateau. In particular, the region is abundant in montane endemic birds, amphibians, and butterflies. Indeed, the region's biological importance has long been recognized. After a 1962 survey, George Petrides recommended national park status for the plateau (Petrides 1965), a recommendation that was repeated by J.B. Hall in 1981 (Hall 1981). The WWF-CRNP Okwangwo Division planning exercise in 1990 stressed the need for immediate action to halt the destruction of the plateau ecosystem, and proposed that the plateau be annexed to CRNP as a protected landscape and recuperation zone (Caldecott *et al.* 1990). However, as mentioned above, CRNP is officially designated only to include the former Boshi-Okwangwo forest reserves, so the plateau has yet to be annexed.

Although the Obudu Plateau as a whole still has no special conservation status, it has received some conservation attention since the inception of Cross River National Park. A park ranger post has been established at the ranch, and the WWF-CRNP Okwangwo Programme collaborated with the local Becheve community and the NCF to establish a nature reserve protecting the forest near the ranch hotel that provides the hotel's water supply (the 25 ha Becheve Nature Reserve). In addition, the NGO Development in Nigeria has based itself at the ranch and is engaged in efforts both to prevent dry-season fire damage to plateau forests and encourage the ranch village communities to adopt new vegetable farming techniques (including potato farming) to take pressure off the plateau forests. These measures appear to have slowed the destruction of the forest and, in some places, to have reversed it.

The results of a five-hour observation session near the ranch hotel in April 2001 by Roger Fotso of WCS-Cameroon indicate that the Obudu Plateau still retains some of its biologically special features. Fotso observed nine species of restricted-range birds (including Bannerman's weaver, *Ploceus bannermani*), as well as a group of Preuss's guenons (*Cercopithecus preussi*). Moreover, studies by Daniel Louk (Hunter College Dept. of Anthropology) in early 2002 show that at least three groups of Preuss's guenons continue to use the plateau forests.

The cool climate and fine scenery of the plateau, combined with its interesting fauna and flora, give it considerable tourism potential. Until recently the Obudu Cattle Ranch hotel on the plateau received modest numbers of visitors, especially from within Nigeria. However, recognizing the area's potential as a tourist destination, the Cross River state government launched an ambitious renovation of the ranch hotel in 2000, including construction of a new conference center and golf course. In late 2002 the hotel was officially reopened under the management of a South African-based company. Nevertheless, environmental groups have raised some concerns about the ecological impacts of the construction work that accompanied the renovation and

the expansion of the hotel's facilities. These concerns have grown since 2002 with the announcement of plans to build a presidential lodge near the hotel and to install a cable-car system from the lowlands to the plateau. In addition, the original cattle ranching system is being revived.

Mbe Mountains, Nigeria

The Mbe Mountains lie in an area of community land sandwiched between the Okwangwo Division of CRNP and the Afi River Forest Reserve. In 1990 unfarmed forested land in the mountains was estimated to cover 100 km², mostly on hilly terrain on elevations up to around 900 m. Conservation groups became interested in the mountains after gorillas were discovered there in 1983 (Ebin 1983). Several teams sponsored by the NCF subsequently surveyed the mountains and made recommendations for a community-based conservation program (e.g., Harcourt *et al.* 1989). Such a program began in 1988, sponsored by the NCF and based near the villages of Kanyang at the western foot of the hills. Local hunters were hired as a protection force, local people were encouraged to limit their hunting, and efforts were made to establish a small-scale ecotourism program.

As discussed above, park planning consultants have recommended that CRNP be expanded to include the Mbe Mountains as a conservation and tourism zone (Caldecott *et al.* 1990), but, as with the Obudu Plateau, this annexation has yet to occur. However, the park authorities have developed the NCF Kanyang field station and added ranger accommodation and other facilities. Until recently, about ten rangers were assigned to Kanyang and were tasked with patrolling Mbe in cooperation with the landlord communities. In addition, local communities report that they are patrolling and managing Mbe on their own, although the extent and effectiveness of their efforts are unclear.

The mountains are surrounded on three sides by 10 villages that lay claim to parts of the forest, and in some cases these claims are competing. These communities have resisted inclusion of their land in the park and appear to be holding out for significant compensation.

Visitors to the Mbe Mountains usually see more wildlife than in other nearby forests. The gorilla population has been estimated at about 30 individuals, and drills and chimpanzees are also present. The mountains are also a nesting site for bare-headed rock fowl (*Picathartes oreas*). As for research, the Kanyang facilities could be a significant aid, but at present the local communities are somewhat resistant to research that they do not perceive as bringing direct benefits to them. However, the local NGO Biodiversity Preservation Group has managed to gain some local respect and, with support from the Wildlife Conservation Society and the Margot Marsh Biodiversity Foundation, has been able to continue low-level monitoring of the gorillas.

Afi Mountain Wildlife Sanctuary and Afi River Forest Reserve, Nigeria

Afi River Forest Reserve covers approximately 380 km² at the headwaters of the Afi River in the northern part of Cross River state, to the west of the Okwangwo Division of CRNP. The forest reserve includes part of one of the state's largest re-

maining blocks of forest outside CRNP. The northwestern corner of the forest reserve was gazetted as a wildlife sanctuary in 2000. The sanctuary and the forest reserve are managed by the Cross River State Forestry Commission. The approximately 100 km² sanctuary contains a mountainous area—Afi Mountain—that rises to elevations of around 1,300 m and is home to a subpopulation of Cross River gorillas, estimated at 25–30. Other endangered species at Afi are drills, chimpanzees, and *Picathartes*. On the western flank of the mountain, at Ebbaken-Boje, is a large grassland roost site for migratory European barn swallows; it has been suggested that this is the largest wintering roost site of barn swallows in Africa, occupied at times by 20 million birds.

Afi Mountain is relatively accessible by road, and is scenic, containing spectacular bare rock faces and pinnacles. Considerable logging has occurred under concessions in low-lying eastern and southern sections of the forest reserve, but the ruggedness of the mountain has protected the gorilla habitat from logging, although it is often damaged by dry-season fires that are started in nearby farmlands.

In a 1987 survey on behalf of NCF, John Ash discovered the swallow roost and the presence of *Picathartes* at Afi, and received reports of the existence of gorillas. Harcourt *et al.* (1989) subsequently surveyed gorilla populations in Nigeria (December 1987–January 1988) and recommended that core areas of gorilla habitat (including Afi Mountain) be gazetted as sanctuaries. The feasibility study for the Okwangwo Division of CRNP (Caldcott *et al.* 1990) contains the same recommendation for Afi Mountain, based on the need to stop hunting and protect the forest against fire. These reports also recommend that opportunities for gorilla-based tourism be explored.

In 1992, the NGO Pandrillus and the Cross River State Forestry Department (now Forestry Commission) began work on plans for the sanctuary. They have since developed an upcountry captive drill and chimpanzee rehabilitation facility on community land to the south of Buanchor, at the foot of the mountain. In 1993, Kelley McFarland of CUNY conducted a pilot study of the mountain's gorillas, and in 1996 began a long-term study, supported in part by WCS. WCS has continued to monitor these gorillas using the field assistants trained by McFarland. This monitoring builds on an earlier community-based patrol system sponsored by Pandrillus, and complements Pandrillus's community awareness program.

Fauna and Flora International (FFI) began supporting conservation efforts at Afi Mountain in 1999, and in April 2001 they joined with the Forestry Commission, Pandrillus, WCS, and NCF in a partnership to further conservation and research in the sanctuary.

In 2002 the government of Cross River State released funds to the Forestry Commission for the recruitment of a small protection force for Afi Mountain Wildlife Sanctuary. FFI has funded the appointment of a conservation coordinator for the sanctuary, and one of the coordinator's first tasks will be the training of the new sanctuary rangers, some of whom have been recruited from the gorilla research team. In addition to hunting, other management problems to be addressed are farming (mostly in low-lying areas near the edge of the sanctuary) and dry-season fires.

The feasibility of protecting a corridor of forest connecting Afi Mountain to the Mbe Mountains through the eastern part of the Afi River Forest Reserve is being studied. The Ikom-Obudu highway could be a serious impediment to animal movement, however, especially as there are plans to improve the road.

FOREST RESERVES BETWEEN THE NIGER AND CROSS RIVERS, NIGERIA

In the rain forest zone between the Niger and Cross Rivers, most of the forest reserves on dry land sites have been converted to farmland or plantations. However, large areas of swamp forest still survive in the Niger Delta itself (see Figure 3, p. 21), and further sections of such forest exist near the coast between the delta and mouth of the Cross River. Hardly any of these forests are pristine. Human settlements are scattered throughout the delta, especially on high ground near the banks of the Niger distributaries and the creek network; oil industry installations and operations are widespread; and individual artisans have harvested trees across the delta and in the other coastal forests. Although the tree harvest is conducted on a small scale, the cumulative effect has been serious. The logs are collected into large rafts that are delivered as far away as Lagos to be sold or processed; the cumulative result is that large trees (especially the most commercially valuable species) have been lost over much of the delta. In addition, animals are hunted everywhere for food, and a trade in meat has emerged with the rise of the oil industry.

In the Niger Delta, the status of forest reserves has been ambiguous. Many that appear on maps are apparently reserves that were proposed long ago but in many cases were never fully gazetted. The Delta was once largely confined to Rivers State, but it is now divided between Rivers and Bayelsa States. The forestry departments of both states have inadequate resources (Powell 1997).

Given our time limitations, we have focused our study on the immediate Nigeria-Cameroon border area, and have not devoted as much attention as we would have liked to the Niger Delta and the Niger-Cross area. However, we will briefly consider the three forest reserves of Edumanon (Bayelsa State), Upper Orashi (Bayelsa), and Stubbs Creek (Akwa Ibom) because of their importance for primate conservation. Another important area is near the town of Gbanraun in the Niger Delta, on the edge of the proposed Apoi Creek Forest Reserve (also Bayelsa State).

Edumanon Forest Reserve (approximately 90 km²) was surveyed by C. Bocian in 1998–99, and was found to have patches of forest (thinned by tree felling) surrounded by cultivation and fallow bush. Chimpanzees were observed in the forests, with a total population estimated at not more than 50 individuals (C. Bocian, personal communication).

The Upper Orashi Forest Reserve (approximately 90 km²) falls within a zone designated by Powell as the delta's "Eastern Flank" (1997). This zone contains populations of mammals typical of more eastern forests, such as the duiker *Cephalophus ogilbyi* and the squirrels *Paraxerus poensis* and *Funisciurus pyrhopus talboti*; it also contains Sclater's guenon, *Cercopithecus sclateri*.

The zoological surveys by Powell led him to conclude that the ranges of *C. sclateri* and *C. erythrogaster* may overlap in the Upper Orashi Forest Reserve, with some hybridization occurring between the two species (C.B. Powell, personal communication). Powell (1997) was also informed by a reliable hunter that pygmy hippopotamuses survived in Upper Orashi at least until 1990.

Stubbs Creek Forest Reserve (311 km²) occupies a series of parallel depressions and ridges (probably old beach lines) between the mouths of the Kwa Ibo and Cross Rivers. Explorations by E. Gadsby and P. Jenkins in 1989 found that a good deal of forest survived in the reserve and that four species of monkey were still present: *Cercocebus torquatus*, *Cercopithecus mona*, *C. nictitans*, and *C. sclateri* (Gadsby 1989). Although much of the reserve has been converted to farmland or plantation, as of 1990 an estimated 80 km² of relatively undisturbed swamp forest survived in the center of the reserve. Proposals have been developed for a wildlife sanctuary, but these have not yet come to fruition.

The wildlife of Edumanon, Upper Orashi, and Stubbs Creek Forest Reserves currently receives no special protection.

From 1996 to 1998, Lodewijk Werre of CUNY studied the ecology of Niger Delta red colobus monkeys (*Procolobus pennantii epieni*) in an area of marsh forest between the Pennington and Apoi Creeks and about 5 km southwest of the town of Gbanraun (4°48'N, 5°54'E), in the central Niger Delta. This area, on the edge of the proposed Apoi Creek Forest Reserve, has a relatively undisturbed forest habitat (although there has been a low level of tree cutting) and the highest density of red colobus monkeys found by Werre in a survey of the delta (Werre 2000). No hunting took place at the site during Werre's study. Other monkeys present are *Cercocebus torquatus*, *Cercopithecus mona*, and *C. nictitans*. Werre has recommended expanding his 1.5 km² study area into a 5–6 km² nature reserve and field station, managed by the University of Science and Technology, Port Harcourt, and supported by the Nigerian Agip Oil Company, in whose concession area the forest is located. The local community has expressed interest in this plan and would participate in managing the reserve.

Korup National Park and Korup Project Area, Cameroon

Korup National Park, created in 1986 from the former Korup Forest Reserve and some adjacent areas of forest, was intended to protect 1,260 km² of relatively undisturbed and high-diversity lowland rain forest, including a population of Preuss's red colobus monkey (*Procolobus pennantii preussi*), known from few other places. As with Cross River National Park, the plan for Korup was developed for the Government of Cameroon by WWF-UK with support from the UK Overseas Development Administration (now DFID), GTZ (the German technical assistance agency), and the European Commission.

The planning for Korup served as a model for the later development of Cross River National Park (CRNP). As with CRNP, a buffer or "support" zone was created adjacent to Korup, within which villages were to be given development assistance. This 5,360 km² support zone lies to the north, east, and south of the park and includes three major forest reserves (Ejagham, Nta Ali, and Rumpi Hills). To the west of the park lies the Oban Division of CRNP. The park and its support zone comprise the

Korup Project Area (KPA). The Cameroon Ministry of Environment and Forests (MINEF) is responsible for managing the park and the forest reserves, and development activities and research in the KPA were until recently supported by WWF-Cameroon, the EU, and GTZ, with five percent of the protected area's funding coming from the Government of Cameroon and 95 percent from outside donors. However, the support zone component of the Korup project apparently came to an end in mid-2003 (A. Dunn & M. Waltert, personal communications), and WWF-Cameroon's support has been reduced.

Park headquarters is located 12 km from the park's south-eastern boundary at Mundemba, with a sub-headquarters at Nguti, 45 km east of the northern part of the park. The Mundemba headquarters has many useful facilities, including a library and herbarium. At the time of Oates's visit in late 2000 the park had a total staff of about 65, including 14 game guards, 3 resettlement officers, several technical staff, and 40 administrators who worked both for the park and the support zone. The support zone project also employed 19 technical staff. Four patrols were posted on the park boundary, but the protection staff lacked adequate equipment for communication and long-range patrols. Support zone staff (paid with EU money) received higher salaries than park staff, although game guards were eligible for bonuses for overnight stays in the park and the seizure of guns and traps. Since Oates's visit at least one extra patrol post was established, new protection staff were added, and the rate at which patrols confiscated hunting materials increased (A. Dunn, personal communication). However, protection appears to have diminished since the beginning of 2004 as external support for the park has been reduced.

Similar to what occurred in CRNP, the immediate threat of commercial logging in Korup dissipated when it was declared a national park, although the threat may have already been low because the area previously had no road access and a low apparent density of commercially-valuable tree species. However, hunting is still a serious threat within the park. In addition, as in CRNP, enclaved villages within Korup pose a problem. When the park was established, management plans called for the resettlement of the six villages that existed in the park. But by late 2000, only one of the six villages (Ikondo-Kondo, with about 200 people) had been resettled, to a location east of the park. The Ikondo-Kondo resettlement site near Mundemba (visited by Oates) has well-built housing, a piped water supply, a community hall, and primary school. The cost of resettlement (funded by the EU and the US Dept. of Defense) was CFA 360,000,000 (almost \$500,000 in 2000). It is not clear how the other resettlements will be funded, and Ikondo-Kondo people still return to their original village site to harvest crops. However, work has begun on resettling the small village of Bareka II. The largest village enclaved in the park is Erat (or Ekon II), with over 400 people, located in the southwestern corner of the park, close to the Nigerian border. Cross-border trade from Erat to Ekonganaku in Nigeria is flourishing, much of it in smuggled goods. Park authorities allow Erat people (and many Nigerian traders) to use a major path through the south of the park, where the visitor and research infrastructure is located.

WCS had a biological research program in northern Korup (the Ikenge research station) from 1989 through 1993, when research shifted to Banyang-Mbo. Permanent tree plots have been established under a Smithsonian program in two locations in the park, and these are monitored at intervals. Recently, a park biologist began conducting regular large-mammal transect surveys in the southeast section of the park, near Mundemba. This area, which has been developed for tourism, has easily-traversed and well-marked trails, bridges over streams, and camp sites with well-constructed wooden buildings, proper latrines, and accessible bathing sites. A map is provided to visitors, who pay set fees to enter the park and to hire guides and porters. However, visitation is currently at low levels.

When Oates visited the southeastern part of Korup in November 2000, signs of mammals were relatively common and included tracks and feeding signs of elephants. We had at least 16 encounters with monkeys, all of which (where identification was possible) were identified as *Cercopithecus* spp., commonly in mixed-species associations. Twice, foraging signs of drills were observed. Preuss's red colobus monkey was not seen or heard, suggesting that the population of this monkey may have been affected by hunting. However, very little direct evidence of hunting was found in the area surveyed. Bergl and Linder, in their visit in October 2001, encountered many monkey associations in seven days of surveying park trails in this same general area, and encountered Preuss's red colobus twice (with one clear sighting).

Biological monitoring teams, organized under the auspices of the GTZ support-zone program, have conducted censuses of primates and drills in the northern part of the support zone, including Nta Ali Forest Reserve (Waltert *et al.* 2002). In the course of walking 596 km of transects in the northern support zone forest in 1999–2001, these census teams reported 188 visual encounters with primates (0.315 encounters/km). Waltert *et al.* estimated that they encountered 712 different groups of monkeys and apes, many of which were in multi-species associations; they encountered only two groups of drills, and three of red colobus. Noting an apparent major decline in numbers of the latter two species since 1990, probably due to hunting, Waltert *et al.* call for more effective conservation management of the support zone, integrated with management of the national park and of the neighboring Oban area; they suggest that this management should be combined with an environmental education program.

The Ejagham Council Forest Reserve is a potentially key area, lying between the northwestern part of Korup and the community forest area in the northeast of the Oban Division of CRNP in Nigeria (proposed for inclusion in CRNP, but not yet annexed). Ejagham remains little studied. The Rumpi Hills Forest Reserve southeast of Korup has land rising to 1,768 m (Mount Rata) and therefore supports areas of montane forest and some of the endemic montane species of our region; it also remains relatively little explored biologically, and the forest is apparently not highly disturbed.

Banyang-Mbo Wildlife Sanctuary, Cameroon

In 1994, WCS moved its research effort in southwest Cameroon from the Ikenge area of Korup to the Banyang-Mbo Council Forest Reserve. Working with local communities and the

government of Cameroon, WCS helped create the Banyang-Mbo Wildlife Sanctuary (662 km²), which was gazetted in March 1996 and covers much of the original council forest, together with extensive hill areas to the southeast. The hills, which rise to over 1,700 m and lie close to the northeastern part of the Bakossi Mountains, support some montane forest. The endangered Mount Kupé bush-shrike (*Telophorus kupeensis*) has recently been found to occur in the montane forest of Banyang-Mbo and Bakossi, as well as at Mount Kupé.

With significant support from a Dutch government (DGIS) grant, the WCS project has focused on establishing a community-based sustainable-use management program for the sanctuary. The plan is for the 54 villages located within 10 km of the sanctuary boundary to undertake management under the authorization of MINEF, on terms negotiated with the communities. Management agreements are to be drawn up between villages, MINEF, and the project, under which the communities will be asked to manage their portion of the forest wisely. As part of this management plan, the government will authorize villagers to patrol the forest.

From 1999, WCS staff have been engaged in a biological inventory of the sanctuary, socioeconomic studies of the communities, and conservation education and awareness-raising projects. WCS has also overseen the construction of a research station near the forest, within a short distance of the town of Nguti (7 km from the sanctuary), where WCS has its office and staff accommodation at this station. Biological surveys have been conducted on the basis of a stratified random sample of 50 points throughout the forest. These points were plotted using GPS. No regularly-monitored fixed transects have been established. When visiting Banyang-Mbo in November 2000, Oates was told that few monkeys have been seen on surveys, which is consistent with observations made by Oates at Banyang-Mbo in 1997, as well as subsequent reports obtained from Katherine Gonder and Lee White. However, the WCS sampling technique (in which several people are active in a small area for a short period) is unlikely to readily detect monkeys that are already shy as a result of hunting.

Under present sanctuary management, villagers can hunt many animal species anywhere in the wildlife sanctuary, although certain threatened species (leopard—which may be extinct—elephant, buffalo, giant pangolin, drill, chimpanzee, water chevrotain, and tortoises) are supposed to be off limits. However, this protection system is monitored by hunters themselves; we were told that if any of the protected animals are killed for local consumption the event will probably not be reported. Some MINEF staff are present at Banyang-Mbo, but are said to do little patrolling. Local youth have taken action against hunters from communities outside the project area, evicting them from the forest. Non-timber forest products are freely harvested, some of which (such as bush mangos and eru leaf) are traded to Nigerians, but the creation of the sanctuary appears to have spared the forest from the commercial logging to which parts of it might otherwise have been exposed.

Takamanda Forest Reserve, Cameroon

Takamanda Forest Reserve (676 km²) is located in the northwestern corner of South-West Province, adjacent to the Ni-

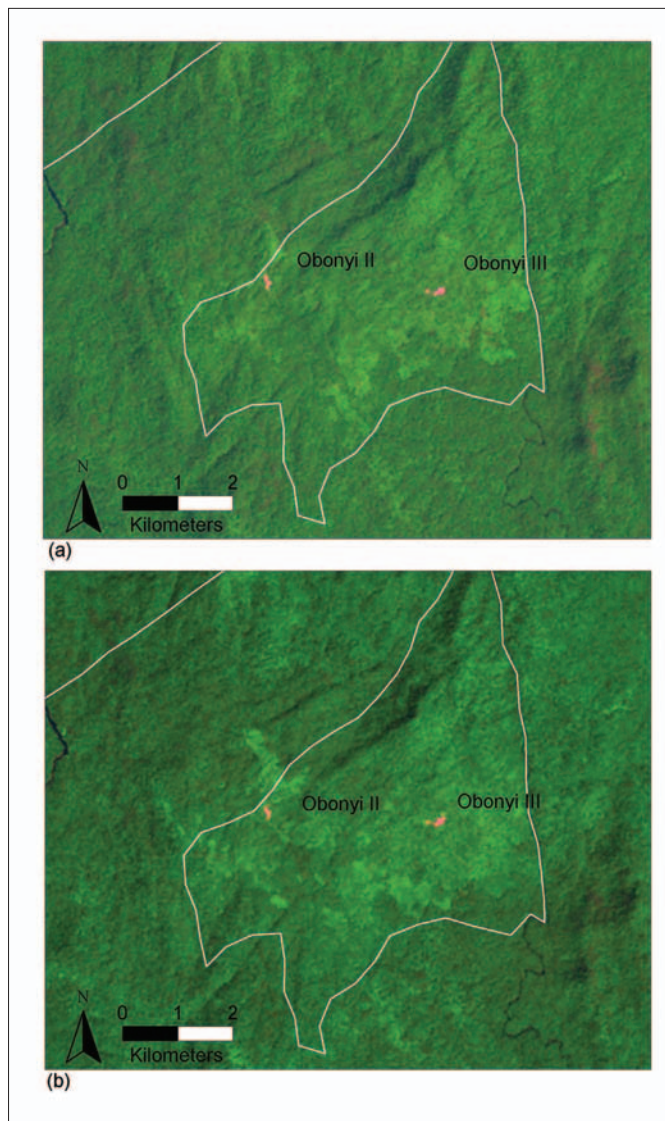


Figure 22. Landsat satellite images from 1986 (a) and 2000 (b) showing increase in the extent and intensity of forest loss around two villages enclaved within Takamanda Forest Reserve. Undisturbed forest appears dark green, disturbed forest/farm land appears light green, and human settlement/bare earth appears pink. White lines are reserve/enclave boundaries.

gerian border, across which lies the Okwangwo Division of Cross River National Park. This is one of the most inaccessible forests in Cameroon, with no motorable road yet running close to the forest. The type specimens of *Gorilla gorilla diehli* were collected in 1904 from the vicinity of the present forest reserve. During surveys in 1996–98, Jacqueline Groves confirmed the continued existence of gorillas in Takamanda.

Elevations in Takamanda rise from about 100 m in the south to over 1,600 m in the north, where the reserve adjoins the Obudu Plateau. As in Okwangwo, the reserve has a vegetational gradient that runs from lowland rain forest through lower montane forest to upper montane forest mixed with grassland.

Although Takamanda Forest Reserve officially comes under the jurisdiction of MINEF, the ministry had no staff based at the reserve at the time of our visit. In 2000, GTZ began its “Project for the protection of forests around Akwaya” (PROFA),

in collaboration with MINEF; two of the project’s focal areas are Takamanda and Mone River Forest Reserves. The project is headquartered in Mamfe, and, working in collaboration with MINEF, GTZ sends consultants and staff members to the field on surveys. The first three years of the GTZ project were an orientation phase devoted to gathering information and planning for a subsequent implementation phase (Ayeni & Mdaihli 2001).

Groves began a more intensive census of gorillas and other large mammals in Takamanda in September 2000, working in conjunction with GTZ and a Smithsonian Institution/Man and the Biosphere (SI/MAB) program entitled “Biodiversity Assessment and Monitoring of Takamanda and Okwangwo” (overseen by T. Sunderland). Groves’s field surveys and interviews have revealed evidence of Cross River gorilla subpopulations in several parts of Takamanda, all restricted to hill areas. However, this research has also shown that possibilities still exist for migration between most of the gorilla subpopulations.

Under the SI/MAB program, whose initial phase is now complete, individual experts conducted inventories of the forest’s fauna and flora. Sunderland led a survey that revealed the forest’s vegetation to be very diverse. Among trees, caesalpinoid legumes were found to be relatively rare, but otherwise tree-species richness was very high, higher than in Korup or Ejagham to the south (Sunderland *et al.* 2002).

Oates joined Groves and Sunderland on a visit to Takamanda in October–November 2000 and found that, despite being remote from roads, the area has much evidence of human presence. Takamanda supports many stands of large trees, especially on hill ridges, and, although almost no commercial logging has taken place in the reserve, much of the forest is of secondary nature, probably due to generations of shifting cultivation. In addition, farmland is spread widely around the villages within the forest, and many demarcated enclave boundaries are apparently being neglected. Figure 22 shows Landsat images of the Obonyi village enclave within Takamanda in 1986 and 2000; there has been a significant increase in forest clearance in these few years, and an expansion of clearance north of the Obonyi II village beyond the reserve boundary.

Populations of larger mammals are now low in Takamanda. In 2000, Oates encountered monkeys only twice, and these (*Cercocebus erythrotis* and *C. nictitans*) may have been part of one association. A specialist elephant hunter reported that elephants are now rare, and that the few encountered are entering Takamanda from Nigeria. The hunters have relatively strict hunting territories, and we were informed that Nigerians are not hunting in the Cameroonian part of the forest. Given the absence of MINEF field staff, hunters killing endangered species are not prosecuted.

The GTZ project has recommended that local communities participate in the future management of Takamanda. In a draft management proposal presented to a Cross River gorilla conservation workshop in Limbe, Cameroon, in August 2003 (J. Ayeni, personal communication), the project also recommended zoning Takamanda for multiple use, with a core “protected zone” established to protect gorilla populations and other key species, along with a “timber production zone” and a “future timber production zone.” This proposal conflicts with MINEF’s 2000

“Plan de Zonage” for protected areas and forest reserves, which suggested upgrading the protection status for all of Takamanda, a suggestion endorsed by the Limbe gorilla workshop. Discussions in Cameroon in early 2004 seem to have produced a consensus in favor of an upgraded protection status for Takamanda that could be linked to Okwangwo in Nigeria as a transboundary protected area, or “Peace Park” (T.C.H. Sunderland, personal communication).

Mone River Forest Reserve, Cameroon

Mone (or Mawne) River Forest Reserve covers 538 km² just north of the Manyu River (a major branch of the upper Cross), northeast of the town of Mamfe. The reserve appears to be mostly lowland forest on hilly terrain between 100 and 1,000 m elevation. The hilliest area is in the east. The reserve is poorly known biologically even though its southwest corner is only 10 km from Mamfe. In January 2001, J. Groves found gorilla nests in the reserve, in hills about 8 km east of the village of Mbu.

Mount Cameroon, Cameroon

Rising to 4,095 m, Mount Cameroon (or Fako) is the highest mountain and only active volcano in West Africa. Lowland forest at the mountain's base (much of it now lost to cultivation and plantations) changes to lower montane forest at around 800 m. The transition to upper montane forest occurs at around 1,800 m, with grassland beginning at about 2,200 m.

Despite the international significance of Mount Cameroon, none of it is strictly protected, although some have urged that it be designated a national park (e.g., Collar & Stuart 1988) and a World Heritage Site. The flanks and foothills of the mountain contain several forest reserves, including Bambuko, Mokoko River, and Southern Bakundu. Several new forest reserves have also been proposed, including Etinde, Mabeta-Moliwe, and Onge. Mokoko and Onge in the western foothills constitute the most intact and extensive lowland forest area, according to Cable and Cheek (1998), and contain plant species (e.g., of *Cola*) not found anywhere else.

A Mount Cameroon Project (MCP) began in 1994, funded by the UK ODA (now DfID). The project's stated aim is to involve local communities in biodiversity conservation. Although the management structure is difficult to comprehend, it appears to be divided into three units, each covering a different zone and/or set of management issues. One component is based in Limbe at the Botanic Garden and is funded by DfID; another component focusing on land use by northern communities is funded by GTZ and is based in Buea; the project also has a GEF-funded component. Various collaborative research programs are associated with MCP, including one funded by CARPE on utilization of non-timber forest products.

We have not had an opportunity to visit forests around Mount Cameroon or to study MCP activities first hand. However, information on file at the Limbe Botanic Garden Visitor Centre library (visited by Oates in November 2000) indicates that the main wildlife research and conservation component of MCP is in the Mokoko River Forest Reserve, where the project has helped establish the Mokoko Wildlife Management Association. This association apparently consists mostly of local hunt-

ers who have been trained in carrying out censuses of animal species and their habitats, and who are supposed to monitor their own exploitation of wildlife. Project reports show that the only evident constraints on hunting are laws against hunting with poison and with fence traps, together with the exclusion of hunters from outside villages. Plans have apparently been made to establish hunting quotas, but how the quotas would be enforced is unclear.

Mount Kupé and the Bakossi Mountains, Cameroon

Mount Kupé (2,084 m) lies to the northeast of Mount Cameroon and is granitic rather than volcanic. Kupé supports approximately 30 km² of forest, including an important area of montane forest with associated fauna (such as Preuss's guenon, *Cercopithecus preussi*, and the Mount Kupé bush-shrike, *Telophorus kupeensis*). Mt. Kupé is not at this time formally protected, but has been proposed as an Ecological Reserve in MINEF's 2000 “Plan de Zonage.”

Between 1991 and 1995, Birdlife International ran a project at Mount Kupé, financed by the EU, which focused on the conservation of montane forest birds, including the Mount Kupé bush-shrike, once believed to be restricted to Kupé but now reported at other sites including southern Banyang-Mbo. Starting in 1996, the Mount Kupé project was managed by WWF with funding from WWF-UK, DfID, and GEF. The project has suffered from management problems, and when we visited Kupé in November 2000 we were informed that funding was due to run out in mid-2001. At that time the project was aiming to register Mount Kupé as a “community forest” and help 16 local villages establish their own management system for it. A boundary was being demarcated at 1,000 m, above which farming would not be allowed, although some farms still existed above that altitude. We were told that, while local chiefs had issued a hunting ban for certain large animals, they were still being hunted.

Mount Kupé receives a modest level of ecotourism. A guide who led us on a mountain climb reported that he escorts tourist groups about 20 times each year. He noted that he has not seen drills or chimpanzees in the previous two years, nor had he seen bare-headed rock-fowls in the last 6 years. In 2000 the mountain had no regular patrol system, and the local MINEF office was said to be short-staffed.

The WWF project manager at Mount Kupé informed us that a proposal had been prepared to extend project activities into the nearby Bakossi Mountains, an area suggested for Protected Forest status in MINEF's Plan de Zonage. These rugged and poorly-known mountains rise to elevations of more than 1,700 m and are therefore an important area for montane species. Drills and Preuss's guenons are reported to occur there (King 1994). Work suggested in the proposal to extend the WWF Mount Kupé project includes a study of bushmeat offtake (some records are already being collected), transect censuses of primates, and village-based wildlife monitoring. Recently, the Center for the Reproduction of Endangered Species of the Zoological Society of San Diego launched a research and conservation program in the Bakossi Mountains, with a focus on the endangered drill.

Mount Manengouba, Cameroon

Mount Manengouba is an extinct volcano rising to 2,411 m with a caldera 4 km in diameter that contains two crater lakes. It is a key biological site, home to many regional endemics, some known at only one or a few other sites, and some known nowhere else (e.g., the amphibians *Cardioglossa trifasciata* and *Phrynobatrachus manengoubensis*). According to Collar and Stuart (1988) the montane forest of Manengouba is dry and stunted in character (possibly because it is in the rain shadow of Mt. Kupé) and patchy and disturbed from farming, tree-cutting, burning, and grazing.

Mount Manengouba currently has no formal protection, but in the new MINEF zoning plan for the region it is proposed as a Protected Forest.

Mount Oku, Cameroon

At 3,011 m, Mount Oku is the third highest mountain in West Africa (after Mount Cameroon and Pico Basilé on Bioko). Located in the northern part of the Bamenda Highlands, in the North-West Province of Cameroon, Mount Oku was produced by a combination of uplift and volcanism (Collar & Stuart 1988). On its western flank is Lake Oku, a crater lake. Mount Oku lies within the Kilum-Ijim forest area, which covers some 200 km². Human population density is very high in this part of Cameroon, and all lowland forest on the flanks of Mount Oku has been cleared for agriculture and grazing. The remaining forest between 2,000 and 3,000 m (about 100 km²) is said to be the largest remaining area of upper montane forest in West Africa (Maisels *et al.* 2000). However, we estimate that more upper montane forest (though with a different species-composition) occurs on Bioko. The upper elevations of Mount Oku have sub-Afroalpine grassland otherwise found in this region only on Mount Cameroon and Bioko.

Mount Oku and its surroundings are extremely important as a site for endemic plants and animals. For instance, it is home to seven endemic small mammal species (one of which is an endemic genus), several endemic plant species, Bamenda Highland endemic birds (such as Bannerman's turaco, *Tauraco bannermani*), and several rare amphibians (Collar & Stuart 1988, Maisels *et al.* 2000, 2001, Verheyen *et al.* 1997). Preuss's guenons are also present.

BirdLife International (with MINEF) has had a conservation project (the Kilum-Ijim Forest project) at Mount Oku since 1987. The project has taken a community-based management approach, and has been funded by GEF, DfID, and the Dutch Ministry of Agriculture. The forest is still under great pressure, however. Because of deforestation and many years of hunting, the largest mammals (e.g., elephant, buffalo, leopard) have been extirpated while other large mammals have been reduced to small numbers (Maisels *et al.* 2001).

According to Ngandjui and Blanc (2000), Mount Oku is designated as a *Réserve de faune*, along with two small nearby sites, Kimbi and Mbi, but R. Fotso (personal communication) informs us that this information is erroneous.

Pico Basilé and Caldera de Luba, Bioko

The volcanic mass of Pico Basilé (at 3,011 m the second highest mountain in West Africa) dominates the landscape of northern Bioko. During Spanish colonial times, when the peak was called Santa Isabel and the island Fernando Poo, most of the lowland rain forest around the mountain was converted to cacao and coffee plantations, but natural vegetation survived on the peak's upper slopes. As on neighboring Mount Cameroon, lower montane forest begins at about 800 m. A transition to upper montane, cloud, or "moss" forest occurs at 1,500 m (although some accounts say 1,800 m), with another transition to montane heathland at 2,500 m, which gives way to grassland at the summit (Juste & Fa 1994, Pérez del Val 1996). Pico Basilé above 2,000 m is the only known habitat of the endemic Bioko white-eye (*Speirops brunneus*). The other regionally endemic bird species and subspecies generally occur both in the forests of Pico Basilé and in the forests of Bioko's southern highlands (Pérez del Val *et al.* 1994).

According to Castroviejo *et al.* (1994), a Pico de Santa Isabel park was decreed by the colonial government of Spanish Equatorial Guinea in the 1960s, but does not appear to have become effective before independence in 1968. No conservation progress occurred during the oppressive regime of Macias Nguema, which lasted until 1979. Under the auspices of the Spanish technical cooperation agency, a Research and Nature Conservation Programme was launched in Equatorial Guinea in 1985, managed by the Asociación Amigos del Coto de Doñana research and conservation program. This program recommended a network of protected areas, which led to the declaration of nine protected zones in 1988, two of them on Bioko: Pico Basilé and Sur de Bioko. The Amigos del Coto de Doñana program has not been active on Bioko since 1998, but the role it played in stimulating research and conservation has been taken over by the Bioko Biodiversity Protection Program (BBPP) of Beaver College, Pennsylvania (now renamed Arcadia University), directed by Gail Hearn.

For many years after the two Bioko protected zones were declared, no practical measures were taken to conserve them. But in May 2000, probably in part because of growing international concern about conservation on Bioko, Pico Basilé was officially declared a national park, and the southern highlands declared a scientific reserve (known as the Caldera de Luba reserve). In July–September 2002, 81 km of the protected areas' boundaries in critical access zones were said to have been demarcated and park signboards posted (report from Conservation International, November 2002).

As originally proposed, the Pico Basilé park covered 350 km² of the upper slopes of the mountain, above the 800 m contour. The upper parts of the Pico contain very few human settlements, but a meteorological station is located on the summit, accessible by a guarded road. The guard post only controls unauthorized access by vehicles, however, and largely uncontrolled hunting has occurred on the mountain until very recently, with many hunters traveling the road on foot to reach a network of hunting trails. Hearn and Morra (2000) claim that over-hunting caused a decline in the number of primate carcasses from the Pico area entering the Malabo market in 1997–2000. Money entering the Equatorial Guinea and Bioko economy from the newly-de-

veloped offshore oil industry is probably increasing consumer demand for bushmeat.

The Luba protected area on Bioko covers approximately 600 km² of the southern portion of the island, including the Gran Caldera de Luba (the impressive remains of a large volcano, whose walls reach to 2,261 m), the crater lake of Biao (2,009 m), and areas of lowland “monsoon” forest on the very wet southern coast of the island. This area is largely uninhabited, with the exception of the small town of Ureca near the center of the southern coast, and pressures on it have therefore not been as great as on Pico Basilé.

In recent years the southern highlands are the only part of Bioko where researchers have confirmed the presence of all the island’s monkeys, including Pennant’s red colobus, the drill, and Preuss’s guenon (Butynski & Koster 1994). Similarly, several of the island’s birds, including *Ceratogymna atrata* and *Picathartes oreas*, have recently been recorded only in the southern highlands (Pérez del Val 1996). The beaches of the southern coast of Bioko are also an important nesting site for four species of marine turtle, including the leatherback *Dermochelys coriacea* (Butynski & Koster 1989).

Hearn of the BBPP began surveys of the primates and other mammals in the Gran Caldera de Luba in 1997. These surveys, which take place during several weeks of the dry season each year, have relied particularly on the help of students from American colleges, but they have also come to involve students and faculty from Equatorial Guinea’s National University. The BBPP has established two camps in the Gran Caldera, as well as a network of trails extending from these camps, along which censuses of mammals are conducted. This project has also now expanded to include surveys of turtle nesting on the southern beaches, a project originally run by the Doñana group.

The Caldera forest has an unusual appearance, showing signs of frequent major disturbance, probably from wet-season storms. Especially in the northern part of the Caldera, dense undergrowth (reaching to around 5 m) covers large areas, and through this undergrowth emerge scattered trees. The Caldera forest at around 1,000 m is similar in appearance to mainland forests at around 1,500 m. Rain and clouds are frequent even in dry season months.

Oates visited the Caldera in January 2001 with a BBPP team and observed *Mandrillus leucophaeus*, *Cercopithecus pogonias*, *C. erythrotis*, *C. preussi*, *Procolobus pennantii*, and *Colobus satanas*, and heard *Cercopithecus nictitans*. Although monkeys were much less shy of people in the Caldera forest than in adjacent mainland forests, almost all Caldera monkeys showed clear flight reactions to people. Hearn informed us that there was hunting in the Caldera between 1990 and 1996, but since then hunting appears to have declined. BBPP-employed assistants from Ureca currently visit the Caldera at monthly intervals, creating an informal protection system that Hearn speculates has limited the number of hunters entering the Caldera each year to three or four.

The combined factors of the BBPP program and the inaccessibility of the Gran Caldera de Luba (it can be reached only by hiking up the valley of the Rio Ole from the southern coast) have made this the best protected site on Bioko, but hunting is probably increasing in other parts of the southern highlands, particularly near Moka. In a visit to other areas of the southern

highlands in January 2002, a BBPP team (including Oates) observed large numbers of *C. erythrotis* and moderate numbers of *C. pogonias* as well as several groups of *M. leucophaeus*. Hunters were also encountered, as well as traps and the casings of shotgun cartridges. No evidence of red colobus was found.

BBPP envisages a management system for the Caldera de Luba reserve that would give a significant role to the widely respected national university rather than the government’s forestry division, whose main focus is the logging of mainland forests.

CONCLUSIONS FROM PROTECTED AREA REVIEW

Our review of the protected areas of the Gulf of Guinea forests yields several clear observations:

First, legally protected areas cover only a small portion of the study region, despite its tremendous biological importance. Only 6,610 km² (6.1%) of the region’s 109,000 km² are included within legally protected areas (excluding forest reserves). However, existing and proposed protected areas do cover a relatively large proportion of the remaining forest in the Nigeria-Cameroon border region (Figure 19, p. 67).

Second, even inside the legally protected areas, conservation is rarely fully effective. The few parks and sanctuaries that have been established do a relatively good job of habitat protection, but hunting of the larger animals (such as anthropoid primates and ungulates) is usually a serious problem.

Third, lack of adequate protection is, in part, a consequence of a lack of resources. The protected areas receive inadequate support from national or state governments. Instead, they have tended to depend heavily on foreign funding, but this funding has been unreliable and never guaranteed in the long term. Foreign funding has gone much more heavily into conservation-and-development projects than into basic protection mechanisms.

Fourth, in Cameroon, almost all the conservation projects we visited were working on, or towards, a community-based management model, with the sole exception of Korup National Park itself. We have not seen convincing evidence that such community conservation will effectively protect habitat or wildlife in the long run, especially in the absence of major foreign funding, outside technical assistance, and independent evaluations.

Fifth, the only areas where larger mammals, and especially primates, currently have some measure of protection from hunting (or did until recently) are sites which combine a constant (or frequent) research presence with relative inaccessibility. In Nigeria, such sites include Afi Mountain, Gbanraun in the Niger Delta, and the Mbe Mountains; in Cameroon, the southern part of Korup National Park; and on Bioko, the Gran Caldera de Luba.

Sixth, several important areas which currently have little or no legal protection, but which are important sites for endemic taxa, are threatened by serious habitat destruction and conversion (particular examples are small isolated montane areas such as Obudu Plateau and Mount Manengouba).

Finally, the status of several existing protected areas is ambiguous. For instance, the boundaries recommended for Cross River National Park in management studies are different from the legally decreed boundaries, and many potential protected areas in Cameroon are presently only “paper parks.”

CHAPTER 6

Observations on the Bushmeat Trade



Red-eared guenons (*Cercopithecus erythrotis*) (red tails) and Preuss's guenons (*Cercopithecus preussi*) (gray tails) displayed for sale in the bushmeat section of Malabo market, Bioko Island.

During field work we carried out in the course of this study, and during our previous visits to the Gulf of Guinea forests, it was apparent that larger animals, especially large rodents, ungulates, and anthropoid primates, are hunted almost everywhere, both with guns (typically 12-gauge shotguns) and wire-snare traps. Gun hunting occurs both during the day and at night, with the aid of acetylene or battery-powered headlamps. Although we did not collect quantitative data during this study, the amount of evidence we observed of hunting activity (e.g., spent shotgun cartridges, active snares) appeared to correlate roughly with the number of animals we observed in the forest. We ultimately concluded that hunting was mostly to blame for the low number of animals we encountered in most forests. A striking example of the impact of hunting is that we observed primates and ungulates most frequently in the Gran Caldera de Luba on Bioko, which has the lowest number of hunters. Animals in this area are also less afraid of people than elsewhere in the Gulf of Guinea forests.

At most sites it is unclear how much hunting is devoted to providing meat for local consumption, and how much is driven by trade. Trade is probably the main driver of hunting in southern Bioko, since human population density is very low there. Because most Bioko inhabitants live on the northern part of the island, and especially in and around the capital of Malabo, much of the game hunted on the island ends up in the Malabo market. Similarly, the area immediately surrounding Korup National Park has a relatively sparse human population, whereas eastern Nigeria to the west of the Cross River is very densely populated. Most of the hunting taking place in and around Korup is therefore probably done for trade. Indeed, we found evidence of a major one-way trade route for bushmeat running through Cross River National Park. The route appears to originate at the Korup enclave of Erat in Cameroon and runs to Ekonganaku on the edge of the Oban Division of Cross River National Park in Nigeria. For instance, over a three-day period in January 2001 Bergl observed the following mammal carcasses being carried on forest trails towards Ekonganaku: 10 *Cephalophus* spp., 6 *Mandrillus leucophaeus*, 4 *Atherurus africanus*, 3 *Hyemoschus aquaticus*, 1 *Cercocebus torquatus*, 1 *Cercopithecus erythrotis*, and 1 *Manis* sp. Much of this meat is apparently sold in a weekly market at Anigeje, on the Oban road about 30 km north of Calabar. From there it is probably widely distributed in the east of the country. More than 100 monkey carcasses, many of them drills, are reported to be sold at this market each week (Eniang, E. & Louk, D., pers. comm.).

Oates visited the Malabo bushmeat market several times in January 2001 and January 2002 and found it to be highly dynamic. Fresh carcasses arrived frequently, at least during the early part of the day, and purchases were also frequent. As a result, a spot check of the carcasses available at a particular moment could provide a significantly different view of the market than a full sampling of the carcasses available throughout an entire day.

In 2001 and 2003, Oates conducted a total of six spot-check samples of the Malabo market. Eric Lombardini of the University

of Pennsylvania and his student associates also conducted 10 spot samples of the Malabo market on different days in 2001. The total carcasses observed during these 16 spot samples are as follows: 143 *Cephalophus monticola*, 104 *Cricetomys emini*, 38 *Cercopithecus erythrotis*, 25 *Atherurus africanus*, 10 *Cephalophus ogilbyi*, 7 *Colobus satanas*, 6 *Manis tricuspis*, 6 *Varanus niloticus*, 4 *Cercopithecus preussi*, 4 *C. pogonias*, 3 *Mandrillus leucophaeus*, 2 *Python sebae*, 2 squirrels, 1 *Procolobus pennantii*, 1 *Dendrohyrax dorsalis*, and 1 *Galago alleni*. The number of carcasses observed per day of *C. monticola*, *C. ogilbyi*, *P. pennantii*, and *M. leucophaeus* is smaller than Fa *et al.* (2000) reported in 1991 and 1996. On the other hand, despite the small size of our sample, we recorded more *C. erythrotis* than did Fa *et al.* in 1996. At first glance, these numbers seem to confirm Fa *et al.*'s speculation that larger primates and Ogilby's duiker are becoming scarcer in the market and thus perhaps are disappearing from Bioko's forests as well.

However, our figures are probably not directly comparable to those reported by Fa *et al.* (2000), who sampled the market between 06:30 and 12:00 hours, six days each week, for eight months in 1991 and 1996, and who claim to have recorded all meat reaching the market on each day of their sample. Our observations strongly suggest that spot samples such as ours represent only part of a day's total number of marketed carcasses. One would thus expect the results of our samples to include significantly fewer carcasses than Fa recorded in his surveys. Yet, for some species, our results are similar to the figures reported by Fa for 1991, and for several species (e.g., *Cercopithecus erythrotis* and *Cephalophus monticola*) our results considerably exceed the results of spot checks by Butynski in 1986 and Fa in 1988 (Butynski & Koster 1990) (see Table 9).

As part of a new bushmeat study, John Fa of the Durrell Wildlife Trust recently finished surveying markets and human nutritional status on both sides of the Nigeria-Cameroon border that extends into our study region. The data from that study were being prepared for publication as this volume was finalized.

Table 9. Number of carcasses seen per visit during spot checks of the Malabo bushmeat market in 1986, 1988, and 2001–2.

Species	Butynski & Koster 1986*	Fa 1988**	Oates & Lombardini 2001–2***
<i>Mandrillus leucophaeus</i>	0.22	0.13	0.19
<i>Cercopithecus erythrotis</i>	0.44	1.33	2.38
<i>C. nictitans</i>	0.22	0.13	0
<i>C. pogonias</i>	0	0	0.25
<i>C. preussi</i>	0	0	0.25
<i>Colobus satanas</i>	0.22	0.20	0.44
<i>Procolobus pennantii</i>	0	0	0.06
<i>Cephalophus monticola</i>	2.56	5.40	8.94
<i>C. ogilbyi</i>	0.22	0.27	0.63
<i>Cricetomys eminii</i>	3.11	3.67	6.50
<i>Atherurus africanus</i>	1.44	0	1.56
<i>Manis tricuspis</i>	0.22	0	0.38

*9 market visits (reported in Butynski & Koster 1990)

**15 market visits (report to IUCN, from Butynski & Koster 1990)

***16 market visits (this volume)

CHAPTER 7

Conclusions and Recommendations



Logs of felled swamp forest trees awaiting transport to Lagos in a creek in the Niger Delta, Nigeria.

Our findings underscore the global significance of this biodiversity hotspot and provide solid evidence of the extreme threat it is under. Nonetheless, additional basic inventory surveys are needed to assess relatively neglected areas in Nigeria (e.g., the Niger Delta, the Oban Hills, and the Sankwala Mountains) and in Cameroon (e.g., the Rumpi Hills, the Bakossi Mountains, the Mone River Forest Reserve, and the Ebo forest to the southeast of Yabassi). Small mammals, lizards, freshwater fish, and most invertebrates (other than butterflies) are among the most neglected taxonomic groups. In addition, long-term ecological monitoring programs are needed in the region, efforts that could be launched by establishing a series of modest field stations, which could be used in the training of local scientists.

Among the many threatened taxa in the region, the status of Preuss's red colobus is particularly poorly known. Hunting is believed to be the cause of the significant decline of these animals as well as the decline of populations of most of the region's larger mammals. However, little quantitative data are available on the scope and scale of this hunting and its associated bushmeat trade, nor on the precise impact of hunting on wildlife populations. The threatened status of smaller vertebrates and plants in this region also needs to be more thoroughly analyzed and better understood. Many amphibians, for instance, have highly restricted ranges in montane areas that are poorly protected, yet these species appear to have been neglected in IUCN listings.

The coverage and functionality of protected areas in the region need to be improved. The existing protected areas, although relatively small, provide relatively good coverage of the major lowland forest block on the Nigeria-Cameroon border (particularly in Oban-Korup). However, the recommended boundaries of the Oban Division of Cross River National Park are not yet gazetted, and the parks have not yet gained control of bushmeat hunting, other than in localized areas. In addition, other lowland forest areas need to be brought under protection, especially in places such as the Niger Delta, which have a different fauna and flora from the Nigeria-Cameroon border area. Montane forest in the region, home to a very large number of endemic taxa, is very poorly protected and under great threat. Among montane areas that need to be given greater legal protection are the Obudu Plateau, Mount Cameroon, Mount Kupé, and Mount Manengouba.

Simply adding new protected areas to the existing system in the region will not solve all its conservation problems, however. For example, a set of protected forest patches will not conserve the largest mammals in the region. These mammals are particularly threatened not only because they are targeted by hunters, but also because they live at low densities and use large areas of habitat. For large forest mammals such as elephants, gorillas, and chimpanzees, we need to investigate the possibility of establishing conservation corridors that connect core protected areas. This is particularly critical in the case of the Cross River gorilla, unique to this region and now reduced to a fragmented population of less than 300 individuals. One way to facilitate such comprehensive conservation planning would be to hold a conservation planning workshop for this region. Such a workshop should bring together experts on different taxonomic groups, ecologists familiar with these systems, non-governmental conservationists, and conservation managers from government, to set priorities for conservation action.

Finally, expanding the scope of research in the area would help to more fully realize the value of quite large datasets combined in a GIS. For instance, much could be learned by more carefully examining the extent to which there is congruence in the distribution of endemic and/or endangered species belonging to different taxonomic groups. In turn, knowing of such congruence could aid in the selection of priority areas for conservation attention, and might allow the use of a few species as indicators for biodiversity more generally. Better knowledge of the patterns of biological communities in the region would be similarly useful. For example, a lowland-montane forest dichotomy oversimplifies the complexity of the real patterns in this area, which appears to

have some unique middle-altitude (submontane) communities with their own endemic species, as well as south-north variation on a rainfall gradient, and west-east variation influenced by river barriers. These patterns need to be clarified if a fully representative set of protected areas is to be established.

Further analyses and planning would be aided by the acquisition of better-quality data on the relief and vegetation of this region. In the course of our research we found that some widely-used digital global databases (for instance, for land cover and relief) are quite inaccurate, at least at the scale of our analysis.

RESEARCH RECOMMENDATIONS

Our analysis shows that a number of specific lines of research are needed to improve conservation in the Gulf of Guinea forests:

Recommendation 1: Focus new field inventories at poorly-known sites.

Additional field inventories of biodiversity are needed throughout the Gulf of Guinea forests, followed by taxonomic study of the material collected. Among the many poorly known sites are the Niger Delta (where initial survey work on just a few taxonomic groups [Powell 1995, 1997] has turned up many species and subspecies that are either entirely new to science or not previously known from this area) and the Oban Division of Cross River National Park. Our maps show few records of regional endemics from the central Oban Hills. Yet large segments of the Hills have elevations above 500 m, with some areas reaching 1,000 m, which leads us to suspect that the low number of recorded regional endemics is due to a lack of biological exploration. Indeed, Torben Larsen's research on the extremely rich butterfly fauna of the Oban Hills (at least 775 species have been recorded and 1,000 are predicted to be present) suggests that the flora and fauna as a whole are much richer than has been estimated, and that much remains to be discovered. Elsewhere in Nigeria, the biologically unexplored Sankwala Mountains that lie southeast of the town of Obudu, north of the Okwangwo section of Cross River National Park and northwest of the Obudu Plateau, are a potentially rich research site because the mountains rise to elevations of 1,800 m. Little-studied sites in Cameroon include the Rumpi Hills and Bakossi Mountains, which each have elevations of 1,700 m in places, and the Mone River Forest Reserve. The Ebo Forest on the hills southeast of Yabassi also need a more thorough survey, particularly to check on a recent report that Preuss's red colobus monkey may survive there.

Recommendation 2: Give priority to surveys of neglected animal groups in certain areas.

Small mammals are particularly poorly known in the Gulf of Guinea forests—several new species have recently been discovered based on collecting at just a few sites (Dieterlin & Van der Straeten 1992, Hutterer & Schlitter 1996, Verheyen *et al.* 1997), suggesting that much remains to be learned about this group in the region. Most bird observations carried out on the Nigerian side of the border have focused on the Obudu Plateau. Conse-

quently, more careful surveys are needed in the Oban Hills. The same is true for amphibians. Lizards appear to be yet another poorly sampled group in the region, although we have still not carefully researched their diversity and distribution. Similarly, while one study of freshwater fish from Korup has been published, virtually nothing appears to have been published on the fish fauna of Oban.

Recommendation 3: Launch ecological investigations and monitoring on a broad scale in the Gulf of Guinea forests.

The Wildlife Conservation Society operated a research station in Korup from 1989 to 1993 and then shifted its research operations to Banyang-Mbo. However, the Society's research in Banyang-Mbo has focused mostly on species inventories rather than monitoring. An ongoing ecological study of gorillas, begun in 1986, is taking place at Afi Mountain. The study has a monitoring component that includes tree phenology. In 2003 a similar gorilla monitoring project began at Kagwene in Cameroon. The Smithsonian Institution has established tree-monitoring plots in Korup, although it is not clear how carefully these are being studied. Within the Mount Cameroon project, hunters' associations are primarily the ones charged with monitoring primate populations. More independent, scientific monitoring is therefore needed on Mount Cameroon. On Bioko, censuses of primates and other larger mammals in the Gran Caldera de Luba are conducted once a year, but long-term ecological research on other organisms, including plants, is needed. Several small field stations should be established throughout the Gulf of Guinea forests to act as bases for long-term ecological research and monitoring.

Recommendation 4: Conduct more extensive research on the population status and numerical trends of threatened primates in the region.

Despite the attention some researchers have devoted to threatened primates in the Gulf of Guinea forests, the population status and numerical trends of most primate species in the region are still very poorly known. Our own observations in Cross River and Korup National Parks suggest that Preuss's red colobus may have been reduced to perilously low numbers. These observations have been corroborated by other researchers who recorded this species only three times in a recent extended survey of the Korup project area outside the park (Waltert *et al.* 2002). The drill appears to have been heavily impacted by bushmeat hunting, although no reliable population figures are available for this species. As for the Cross River gorilla, surveys in 2000–2002 revealed new locality records for this subspecies in Cameroon, although these studies also highlighted the extremely fragmented distribution of this critically endangered primate (Oates *et al.* 2003). A population viability analysis is thus a priority for the Cross River gorilla, with an examination of options for maintaining or encouraging connections between isolated populations; such an analysis was initiated by Bergl in 2003.

Recommendation 5: Expand knowledge of the impact of the bushmeat trade on wild animal populations in the Gulf of Guinea forests.

Until recently, the only available studies on the bushmeat trade in the Gulf of Guinea forests were those by J. Fa and colleagues in the Malabo market (Fa *et al.* 1995, 2000) and by M. Infield in and around Korup (Infield 1988). New market data are now being analyzed from a project directed by Fa focusing on bushmeat in both Cameroon and Nigeria. However, better information is still badly needed on the locations, methods, and extent of bushmeat hunting as well as its impact on different species.

CONSERVATION RECOMMENDATIONS

With regard to the conservation needs of the Gulf of Guinea forests, we recommend specific improvements to the region's existing network of protected areas as well as actions to address several gaps in the network of protected areas that were revealed by our analysis.

Recommendation 6: Improve law enforcement within existing protected areas.

While protected areas in the Gulf of Guinea forests currently do a reasonably good job of conserving certain habitats, they have generally not been successful in protecting larger animals from hunting. A broad analysis of African rain forest park management by Struhsaker (2001) concluded that the most important short-term measure needed to improve the conservation status of wildlife in these parks is better law enforcement. Struhsaker's recommendation definitely applies to the two key protected areas discussed in this report: Cross River National Park and Korup National Park.

Recommendation 7: Increase investments in existing protected areas.

Put simply, more funding is needed for protected area management in the Gulf of Guinea forests. In large part, increased investments in both the short and long terms will probably need to come from overseas. Trust funds and similar mechanisms should be explored as sources of secure funding. However, while local people need to be involved in management, it is not advisable to pursue this through development projects because such projects tend to increase pressure on park resources and draw attention away from conservation. Moreover, devolving most of the responsibility for protected area management to local communities, as is being suggested in many instances in Cameroon, would likely prove to be ineffective. Local communities in developing countries rarely have the capacity to manage protected areas and, compared to national governments, they tend to give more weight to maximizing short-term material gains than to protecting nature for the benefit of future generations (Oates 1999, Terborgh 1999).

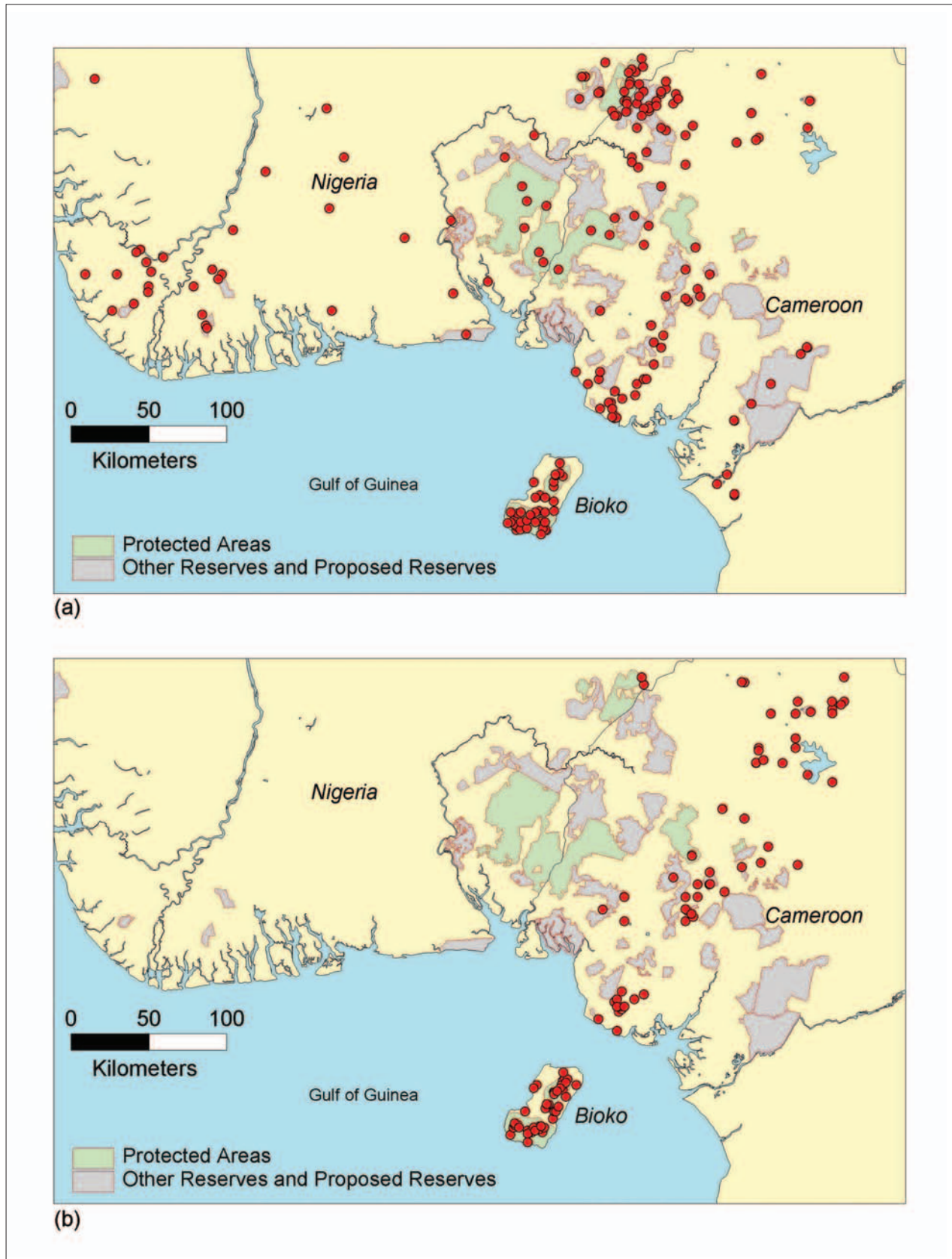


Figure 23. Distributions of endemic (a) primates, (b) birds, and (c) anuran amphibians relative to existing protected areas and other reserves or proposed reserves in the study region. Figure continues on p. 85.

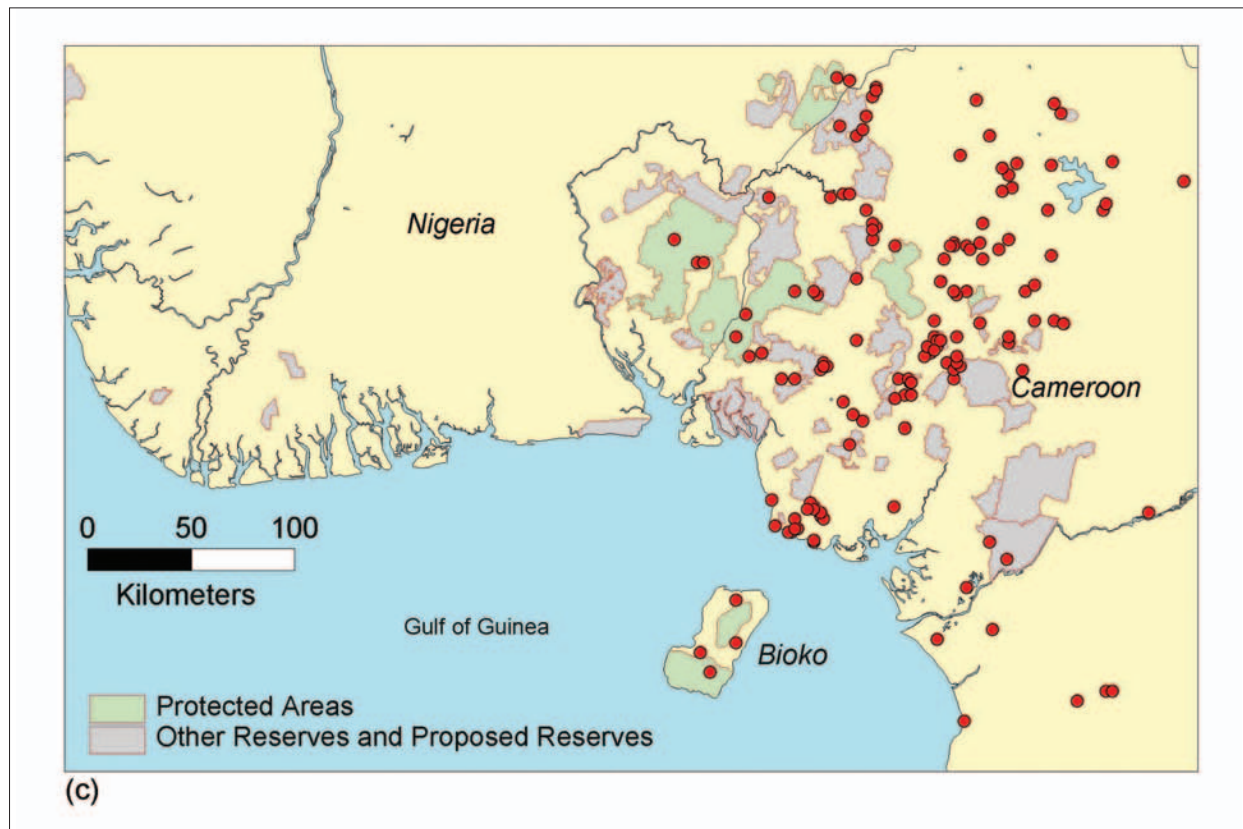


Figure 23 continued.

Recommendation 8: Increase currently inadequate protection of endemic birds and amphibians.

A major aim of our study was to identify gaps in the existing protected area system, especially in relation to the distribution of endemic and threatened plants and animals. Figure 23 shows the distribution of endemic primates, birds, and anuran amphibians in relation to protected areas in the Gulf of Guinea forests. This map series indicates that endemic primates are relatively well covered (except between the Cross and the Niger), but birds and amphibians are not. The main reason for this is that many of the region's endemic birds and amphibians are associated with montane forest, which is poorly represented in the region's system of protected areas.

Recommendation 9: Increase representation of montane forests in protected areas.

Presently the only montane forests legally designated for conservation are the higher elevations of the southern Banyang-Mbo Wildlife Sanctuary in Cameroon, a small northern area in the Okwangwo Division of Cross River National Park in Nigeria, and the Pico Basilé National Park on Bioko, and even the protection available within these few areas is limited and often ineffective. For instance, Banyang-Mbo is a community-based management area where hunting occurs, and Pico Basilé still has no organized protection system. Because montane endemic species tend to have highly localized distributions—many occur at just

one or, at most, only a handful of sites—many more montane protected areas are needed in the Gulf of Guinea forests. Important sites for montane endemics that currently lack full legal protection include the Obudu Plateau, Mount Cameroon, Mount Kupé, Mount Manengouba, Mount Oku, and the Bamenda Highlands. We strongly endorse MINEF's plan to upgrade the conservation status of Mounts Kupé and Manengouba, and the Bakossi Mountains. In Nigeria, the importance of the Sankwala Mountains requires investigation.

Recommendation 10: Put high priority on conservation in several lowland forest reserves.

Although lowland forest endemics in the Gulf of Guinea forests (including many primates and several large tree and amphibian species) are relatively well covered by existing protected areas, including the Korup and Cross River National Parks, the full suite of lowland endemics would be more secure if the management plans of several important lowland forest reserves were more focused on conservation. In particular, upgraded conservation status is needed for the lowland forest reserves of Apoi Creek and Stubbs Creek in Nigeria, which contain endemic taxa not found in Korup or Cross River National Parks. More attention should also be given to conservation in several forest reserves bordering existing protected areas. These include, in Nigeria, Cross River South and Ukpon River, together with lowland sections of Afi River, and, in Cameroon, Ejagham. A greater emphasis on

conservation is also needed in the lowland forest reserves of the Mount Cameroon foothills in Cameroon.

Recommendation 11: Improve the conservation of endangered primates.

Cross River gorilla (*Gorilla gorilla diehli*)

Most of the known populations of Cross River gorilla (*Gorilla gorilla diehli*) occur outside legally protected areas. The only exceptions are the subpopulations in Afi Mountain Wildlife Sanctuary and in the Boshi Extension section of Cross River National Park, Okwangwo Division. The conservation status of gorilla habitat in other areas, especially the Mbe Mountains and the Takamanda and Mone River Forest Reserves, needs to be improved.

Nigeria chimpanzee (*Pan troglodytes vellerosus*)

If this subspecies is recognized as distinct from the western chimpanzee (*P. t. verus*), it occurs only in Nigeria and western Cameroon. Within our study area, chimpanzees occur in all the mainland protected areas, but not on Bioko. Like other primates, chimpanzees suffer from bushmeat hunting and are nowhere abundant. *P. t. vellerosus* ranges north of the limits of our study region into the forest-savanna mosaic zone. In this zone it is found in Nigeria's largest national park, Gashaka-Gumti, in Adamawa and Taraba States. Gashaka-Gumti has an area of 6,402 km² and an estimated chimpanzee population of 1,500 individuals. Within the Gulf of Guinea forests, chimpanzees suffer from bushmeat hunting and are not abundant anywhere. Like gorillas, chimpanzee populations are especially vulnerable to hunting because of their slow rate of reproduction. They need strong protection wherever they occur.

Subspecies of Pennant's red colobus monkey (*Procolobus pennantii*)

Each of the three subspecies of red colobus monkey (*Procolobus pennantii*) occurring in the Gulf of Guinea forests has a highly localized distribution. Red colobus monkeys are also very susceptible to hunting. Currently the Niger Delta red colobus (*P. p. epieni*) is not protected at all because no protected areas exist in the Niger Delta. Preuss's red colobus (*P. p. preussi*) may still be scattered across a handful of sites in Nigeria and Cameroon—a population survives in Korup National Park and adjacent parts of the Oban Division of Cross River National Park in Nigeria, and another population may occur in or near the Ebo Forest, Cameroon. All of these remaining populations need better protection. Pennant's red colobus (*P. p. pennantii*) may now occur only in a small southern area of Bioko, where the terrain and low hunting pressure give it some protection. Nevertheless, its prospects for survival will improve if an effective reserve is established in the area.

The drill (*Mandrillus leucophaeus*)

The drill (*Mandrillus leucophaeus*) occurs in all the protected areas, but is hunted everywhere except, perhaps, parts of southern Bioko. More drill habitat thus needs to be protected,

and hunting laws must be more rigorously enforced. The drill is particularly vulnerable to hunting with dogs. In addition, the future of the Bioko drill (*M. l. poensis*) would be more secure if the island's protected zones were made fully effective.

Sclater's guenon (*Cercopithecus sclateri*)

Sclater's guenon occurs only between the Niger and Cross Rivers in Nigeria, and is not found in any formally protected area. New surveys suggest that this species is more widespread than was recently suspected, but populations are mostly small and fragmented. The status of some of the forest reserves where Sclater's guenon occurs (especially Stubbs Creek) should be upgraded, and efforts should be made to protect this monkey from hunting wherever it occurs.

Preuss's guenon (*Cercopithecus preussi*)

Our study indicates that Preuss's guenon (*Cercopithecus preussi*) occurs over a relatively wide area, but is largely restricted to hill areas. Although it is semi-terrestrial like the drill, Preuss's guenon is a quieter, more secretive animal, and thus less easily hunted. However, it has still been reduced by hunting in many parts of its range, and much of its remaining montane forest habitat, such as the Obudu Plateau, is threatened. Preuss's guenon would benefit from a network of effective montane-forest protected areas.

The crowned guenon (*Cercopithecus pogonias pogonias*)

The crowned guenon (*Cercopithecus pogonias pogonias*) occurs in protected areas on the mainland and Bioko (Southern Highlands). Any measures aimed at reducing hunting in protected areas would benefit this species. Differences between the island and mainland populations should be clarified, as the Bioko form may be a distinct subspecies (Gautier-Hion *et al.* 1999).

The white-throated guenon (*Cercopithecus erythrogaster pococki*)

Most of the range of the white-throated guenon (*Cercopithecus erythrogaster*) is to the west of our study region, but small populations occur in the western and central parts of the Niger Delta. *C. erythrogaster* is found in one protected area, the Okomu National Park in Edo State, southwestern Nigeria. Protected areas are needed in the Niger Delta, and it would be advisable for one of these to include *C. erythrogaster*.

REFERENCES CITED

- Achard, F., Eva, H., Glinni A., Mayaux P., Richards, T., & Stibig, H.J. 1998. *Identification of Deforestation Hot Spot Areas in the Humid Tropics*. Ispra, Italy: Joint Research Centre, European Commission.
- Aldrich, M., Bubbs, P., Hostettler, S., & van de Wiel, H. 2000. *Tropical Montane Cloud Forests: Time for Action*. Gland and Cambridge: WWF-IUCN-UNEP.
- Amiet, J.-L. 1971. *Leptodactylon* nouveaux du Cameroun (Amphibiens Anoures). *Ann. de la Fac. des Sciences du Cameroun* 7–8: 141–172.
- Amiet, J.-L. 1972a. Description de cinq nouvelles espèces camerounaises de *Cardioglossa* (Amphibiens Anoures). *Biologica Gabonica* 8: 201–231.
- Amiet, J.-L. 1972b. Description de trois Bufonidés orophiles du Cameroun appartenant au groupe de *Bufo preussi* Matschie (Amphibiens Anoures). *Ann. de la Fac. des Sciences du Cameroun* 11: 21–140.
- Amiet, J.-L. 1977. Les *Astylosternus* du Cameroun (Amphibia, Anura, Astylosterninae). *Ann. de la Fac. des Sciences du Cameroun* 23–24: 99–227.
- Amiet, J.-L. 1978. Les amphibiens anoures de la région de Mamfé (Cameroun). *Ann. de la Fac. des Sciences du Cameroun* 25: 189–219.
- Amiet, J.-L. 1981. Une nouvelle *Cardioglossa* orophile de la dorsale camerounaise: *C. schioetzi* nov. sp. (Amphibia, Anura, Arthroleptinae). *Ann. de la Fac. des Sciences du Cameroun* 28: 117–131.
- Amiet, J.-L. 1983. Une espèce méconnue de *Petroedetes* du Cameroun: *Petroedetes parkeri* n. sp. (Amphibia Anura: Ranidae, Phrynobatrachinae). *Revue suisse de Zoologie* 90: 457–468.
- Ayeni, J.S.O. & Mdaihlhi, M. 2001. The Cameroonian-German (MINEF-GTZ) project for protection of forests around Akwaya (PROFA), South West Province, Cameroon. In A.E. Bassey & J.F. Oates (eds.), *Proceedings of the International Workshop and Conference on the Conservation of the Cross River Gorillas*. Calabar, Nigeria: NCF and WCS.
- Booth, A.H. 1958. The zoogeography of West African primates: A review. *Bulletin de l'I.F.A.N.* 20, sér. A: 587–622.
- Brooks, T., Balmford, A., Burgess, N., Fjeldsa, J., Hansen, L.A., Moore, J., Rahbek, C., & Williams, P. 2001. Toward a blueprint for conservation in Africa. *BioScience* 51: 613–624.
- Butynski, T.M. & Koster, S.H. 1989. Marine turtles on Bioko Island (Fernando Poo), Equatorial Guinea: A call for research and conservation. Washington, DC: WWF.
- Butynski, T.M. & Koster, S.H. 1990. The status and conservation of forests and primates on Bioko Island (Fernando Poo), Equatorial Guinea. Washington, DC: WWF.
- Butynski, T.M. & Koster, S.H. 1994. Distribution and conservation status of primates in Bioko island, Equatorial Guinea. *Biodiversity and Conservation* 3: 893–909.
- Cable, S. & Cheek, M. 1998. *The Plants of Mount Cameroon: A Conservation Checklist*. Kew: Royal Botanic Gardens.
- Caldecott, J.O., Bennett, J.G., & Ruitenbeek, H.J. 1989. *Cross River National Park (Oban Division): Plan for Developing the Park and Its Support Zone*. Godalming, Surrey: WWF-UK.
- Caldecott, J.O., Oates, J.F., & Ruitenbeek, H.J. 1990. *Cross River National Park (Okwangwo Division): Plan for Developing the Park and Its Support Zone*. Godalming, Surrey: WWF-UK.
- Castelo, R. 1994. Biogeographical considerations of fish diversity in Bioko. *Biodiversity and Conservation* 3: 808–827.
- Castroviejo, J., Javier Juste, B., Castelo, R., & Pérez del Val, J. 1994. The Spanish co-operation programme in Equatorial Guinea: A ten-year review of research and nature conservation in Bioko. *Biodiversity and Conservation* 3: 951–961.
- Central Intelligence Agency. 2003. *The World Factbook 2003*. Online. Available: <http://www.cia.gov/cia/publications/factbook>.
- Cheek, M., Mackinder, B., Gosline, G., Onana, J.-M., & Achoundong, G. 2000. The phytogeography and flora of western Cameroon and the Cross River-Sanaga River interval. In E. Robbrecht, J. Degreef, & I. Friis (eds.), *Plant Systematics and Phytogeography for the Understanding of African Biodiversity*. Proceedings of the XVIth AEFTAT Congress, National Botanic Garden of Belgium.
- Collar, N.J. & Stuart, S.N. 1988. *Key Forests for Threatened Birds in Africa*. Cambridge: ICBP.
- Collins, S.C. & Larsen, T.B. 2000. Eight new species and five new subspecies of African butterflies (Rhopalocera) – an ABRI research paper. *Metamorphosis* 11: 57–70.
- deMenocal, P.B. 1995. Plio-Pleistocene African climate. *Science* 270: 53–59.
- Dieterlen, F. & Van der Straeten, E. 1992. Species of the genus *Otomys* from Cameroon and Nigeria and their relationship to East African forms. *Bonn. Zool. Beitr.* 43: 383–392.
- Dowsett, R. J. & Forbes-Watson, A.D. 1993. *Checklist of birds of the Afrotropical and Malagasy regions. Volume 1: Species limits and distribution*. Liege, Belgium: Tauraco Press.
- Ebin, C.O. 1983. An appraisal of the biotic and material resources of some game reserves and wildlife management in Nigeria. Lagos: Report to the Nigerian Conservation Foundation.
- Eeley, H.A.C. & Lawes, M.J. 1999. Large-scale patterns of species richness and species range size in anthropoid primates. In J.G. Fleagle, C. Janson, & K.E. Reed (eds.), *Primate Communities*. pp. 191–219. Cambridge: Cambridge University Press.
- Eisentraut, M. 1973. Die Wirbeltierfauna von Fernando Poo und Westkamerun. *Bonner Zoologische Monographien*, No. 3: 1–428.
- Elgood, J.H., Heigham, J.B., Moore, A.M., Nason, A.M., Sharland, R.E., & Skinner, N.J. 1994. *The Birds of Nigeria: An Annotated Check-List*. 2nd Ed. Tring, UK: British Ornithologists' Union.

- Fa, J.E. & Castroviejo, J. 1992. Equatorial Guinea. In J.A. Sayer, C.S. Harcourt, & N.M. Collins (eds.), *The Conservation Atlas of Tropical Forests: Africa*. pp. 161–167. London: Macmillan.
- Fa, J.E., Juste, J., Pérez del Val, J., & Castroviejo, J. 1995. Impact of market hunting on mammal species in Equatorial Guinea. *Conservation Biology* 9: 1107–1115.
- Fa, J.E., Yuste, J.E.C., & Castelo, R. 2000. Bushmeat markets on Bioko Island as a measure of hunting pressure. *Conservation Biology* 14: 1602–1613.
- Figueiredo, E. 1994. Diversity and endemism of angiosperms in the Gulf of Guinea islands. *Biodiversity and Conservation* 3: 785–793.
- Fraser, P.J., Hall, J.B., & Healey, J.R. 1998. *Climate of the Mount Cameroon Region; Long and Medium Term Rainfall, Temperature and Sunshine Data*. University of Wales, Bangor, School of Agricultural and Forest Sciences Publication No. 16. 56 pp.
- Gadsby, E.L. 1989. *Cross River Basin Primate Survey: Stubbs Creek Forest Reserve*. Calabar: Unpublished report, 10 pp.
- Gartlan, J.S., Newbery, D.McC., Thomas, D.W., & Waterman, P.G. 1986. The influence of topography and soil phosphorus on the vegetation of Korup Forest Reserve, Cameroon. *Vegetatio* 65: 131–148.
- Gartshore, M.E. 1984. The status of the montane herpetofauna of the Cameroon highlands. In S.N. Stuart (ed.), *Conservation of Cameroon Montane Forests*. pp. 204–240. Cambridge: International Council for Bird Preservation.
- Gautier-Hion, A., Colyn, M., & Gautier J.-P. 1999. *Histoire naturelle des Primates d'Afrique Centrale*. Libreville, Gabon: ECOFAC.
- Green, A.A. & Rodewald, P.G. 1996. New bird records from Korup National Park and environs, Cameroon. *Malimbus* 18: 122–133.
- Grubb, P. 1990. Primate geography in the Afro-tropical forest biome. In G. Peters & R. Hutterer (eds.), *Vertebrates in the Tropics*. pp. 187–214. Bonn: Museum Alexander Koenig.
- Hall, J.B. 1981. Ecological islands in south-eastern Nigeria. *African Journal of Ecology* 19: 55–72.
- Hamilton, A.C. 1982. *Environmental History of East Africa: A Study of the Quaternary*. London: Academic Press.
- Harcourt, A.H., Stewart, K.J., & Inaharo, I.M. 1989. Gorilla quest in Nigeria. *Oryx* 23: 7–13.
- Hart, T.B., Hart, J.A., & Murphy, P.G. 1989. Monodominant and species-rich forests of the humid tropics: Causes for their co-occurrence. *American Naturalist* 133: 613–633.
- Hearn, G.W. & Morra, W. 2000. *Annual report (July 1999–June 2000) on Beaver College's Bioko Biodiversity Protection Program*. Glenside, PA: Beaver College Biology Department.
- Hilton-Taylor, C. 2000. *2000 IUCN Red List of Threatened Species*. Gland: IUCN.
- Hofer, U., Bersier, L.-F., & Borcard, D. 1999. Spatial organization of a herpetofauna on an elevational gradient revealed by null model tests. *Ecology* 80: 976–988.
- Holland, M.D., Allen, R.K.G., Barton, D., & Murphy, S.T. 1989. *Cross River National Park, Oban Division: Land Evaluation and Agricultural Recommendations*. Chatham, Kent: ODNRI.
- Hugueny, B. & Lévêque, C. 1994. Freshwater fish zoogeography in west Africa: Faunal similarities between river basins. *Environmental Biology of Fishes* 39: 365–380.
- Hutchinson, J., Dalziel, J.M., & Keay, R.W.J. 1954. *Flora of West Tropical Africa*. Vol. 1, Part 1. London: Crown Agents.
- Hutchinson, J., Dalziel, J.M., & Keay, R.W.J. 1958. *Flora of West Tropical Africa*. Vol. 1, Part 2. London: Crown Agents.
- Hutterer, R., Dieterlen, F., & Nikolaus, G. 1992. Small mammals from forest islands of eastern Nigeria and adjacent Cameroon, with systematical and biogeographical notes. *Bonn. Zool. Beitr.* 43: 393–414.
- Hutterer, R. & Schlitter, D.A. 1996. Shrews of Korup National Park, Cameroon, with the description of a new *Sylvisorex* (Mammalia: Soricidae). In *Contributions in Mammalogy: A Memorial Volume Honoring Dr. J. Knox Jones, Jr.* pp. 57–66. Museum of Texas Tech University.
- Iremonger, S., Ravilious, C., & Quinton, T. (eds.). 1997. *A Global Overview of Forest Conservation*. CD-ROM. Cambridge: WCMC & CIFOR.
- IUCN. 2002. *2002 IUCN Red List of Threatened Species*. Online. Available: <http://www.redlist.org>. 14 August 2002.
- Jensen, F.P. & Stuart, S.N. 1984. The origin and evolution of the Cameroon montane forest avifauna. In S.N. Stuart (ed.), *Conservation of Cameroon Montane Forests*. pp. 28–37. Cambridge: International Council for Bird Preservation.
- Juste, J.B. & Fa, J.E. 1994. Biodiversity conservation in the Gulf of Guinea islands: Taking stock and preparing action. *Biodiversity and Conservation* 3: 759–771.
- Keay, R.W.J., Onochie, C.F.A., & Stanfield, D.P. 1964. *Nigerian Trees*, 2 vols. Ibadan, Nigeria: Federal Department of Forest Research.
- King, S. 1994. Utilisation of wildlife in Bakossiland, West Cameroon. *Traffic Bulletin* 14: 63–73.
- Kingdon, J. 1990. *Island Africa: The Evolution of Africa's Rare Animals and Plants*. London: Collins.
- Larsen, T.B. 1995a. *Butterfly Research in the Oban Hills, Cross River National Park*. Calabar: Oban Hills Programme, Second Interim Report.
- Larsen, T.B. 1995b. *A Provisional Annotated List of the Butterflies of the Obudu Plateau*. Obudu: WWF-CRNP Okwangwo Programme.
- Larsen, T.B. 1997a. Butterflies of the Cross River National Park – diversity writ large. Proceedings of workshop on *Essential Partnership – The Forest and the People*, Cross River National Park, Calabar, Nigeria. pp. 229–235.
- Larsen, T.B. 1997b. An annotated list of the butterflies known from the Obudu Plateau (eastern Nigeria). Proceedings of workshop on *Essential Partnership – The Forest and the People*, Cross River National Park, Calabar, Nigeria. pp. 213–228.
- Larsen, T.B. 1997c. *Korup Butterflies – Diversity Writ Large*. Report on a butterfly study mission to Korup National Park in Cameroon during January and February of 1997. Report to WWF-UK and Korup National Park.
- Lawson, D.P. 1993. The reptiles and amphibians of the Korup National Park Project, Cameroon. *Herpetological Natural History* 1: 27–90.
- Letouzey, R. 1968. Notes phytogéographique du Cameroun. *Encyclopédie Biologique* 49, 508. Paris: P. Lechevalier.
- Litt, A. & Cheek, M. 2002. *Korupodendron songweanum*, a new genus and species of Vochysiaceae from West-Central Africa. *Brittonia* 54: 13–17.

- Louette, M. 1981. The birds of Cameroon: An annotated check-list. *Verhandl. Kon. Acad. Wetensch. Lett. Schone Kunst. Belg.* 43: 1–218.
- Maisels, F.G., Cheek, M., & Wild, C. 2000. Rare plants on Mount Oku summit, Cameroon. *Oryx* 34: 136–140.
- Maisels, F.G., Keming, E., Kemei, M., & Toh, C. 2001. The extirpation of large mammals and implications for montane forest conservation: The case of the Kilum-Ijim Forest, North-west Province, Cameroon. *Oryx* 35: 322–331.
- Maley, J. 1996. The African rain forest – main characteristics of changes in vegetation and climate from the Upper Cretaceous to the Quaternary. *Proceedings of the Royal Society of Edinburgh* 104B: 31–73.
- Maley, J. 2002. A catastrophic destruction of African forests about 2,500 years ago still exerts a major influence on present vegetation formations. In M. Leach, J. Fairhead, & K. Amanor (eds.), *Science and the Policy Process: Perspectives from the Forest*. pp. 13–30. IDS Bulletin, Vol. 33, No. 1.
- Maley, J. & Brenac, P. 1998. Vegetation dynamics, palaeoenvironments and climatic changes in the forests of western Cameroon during the last 28,000 years. *Review of Palaeobotany and Palynology* 99: 157–187.
- Maley, J., Livingstone, D.A., Giresse, P., Thouveny, N., Brenac, P., Kelts, K., Kling, G., Stager, C., Haag, M., Fournier, M., Bandet, Y., Williamson, D., & Zogning, A. 1990. Lithostratigraphy, volcanism, paleomagnetism and palynology of Quaternary lacustrine deposits from Barombi Mbo (West Cameroon): Preliminary results. *Journal of Volcanology and Geothermal Research* 42: 319–335.
- Moreau, R.E. 1966. *The Bird Faunas of Africa and Its Islands*. London: Academic Press.
- Newbery, D.McC. & Gartlan, J.S. 1996. A structural analysis of rain forest at Korup and Douala-Edea, Cameroon. *Proceedings of the Royal Society of Edinburgh* 104B: 177–224.
- Ngandjui, G. & Blanc, P.C. 2000. Biogeographie et biodiversité: Aires protégées et conservation des mammifères au Cameroun. *Biogeographica* 76: 63–77.
- Nichol, J.E. 1999. Geomorphological evidence and Pleistocene refugia in Africa. *Geographical Journal* 165: 79–89.
- Oates, J.F. 1986. *Action Plan for African Primate Conservation: 1986–90*. Stony Brook, NY: IUCN/SSC Primate Specialist Group.
- Oates, J.F. 1988. The distribution of *Cercopithecus* monkeys in West African forests. In A. Gautier-Hion, F. Bourlière, J.-P. Gautier, & J. Kingdon (eds.), *A Primate Radiation: Evolutionary Biology of the African Guenons*. pp. 79–103. Cambridge: Cambridge University Press.
- Oates, J.F. 1996. *African Primates: Status Survey and Conservation Action Plan*. Revised edition. Gland: IUCN.
- Oates, J.F. 1999. *Myth and Reality in the Rain Forest: How Conservation Strategies are Failing in West Africa*. Berkeley: University of California Press.
- Oates, J.F., McFarland, K.L., Groves, J.L., Bergl, R.A., Linder, J.M., & Disotell, T.R. 2003. The Cross River gorilla: Natural history and status of a neglected and critically endangered subspecies. In A.B. Taylor & M.L. Goldsmith (eds.), *Gorilla Biology: A Multi-disciplinary Perspective*. pp. 472–497. Cambridge: Cambridge University Press.
- Oates, J.F., White, D., Gadsby, E.L., & Bisong, P.O. 1990. Conservation of gorillas and other species. Appendix 1 to *Cross River National Park (Okwangwo Division): Plan for Developing the Park and Its Support Zone*. Godalming, Surrey: World Wide Fund for Nature, United Kingdom.
- Obot, E. 2000. Saving the green gold: Nigerian Conservation Foundation in Cross River National Park, Okwangwo Division. *Naturewatch* (NCF, Lagos) January 2000: 28–29.
- Parker, H.W. 1936. The amphibians of the Mamfe Division, Cameroons – I. Zoogeography and systematics. *Proceedings of the Zoological Society of London* (1936): 135–163.
- Pérez del Val, J. 1996. *Las Aves de Bioko, Guinea Ecuatorial: Guía de Campo*. León, Spain: Edilsa.
- Pérez del Val, J., Fa, J., Castroviejo, J., & Purroy, F.J. 1994. Species richness and endemism of birds in Bioko. *Biodiversity and Conservation* 3: 868–892.
- Perret, J.-L. 1966. Les amphibiens du Cameroun. *Zool. Jarhb., Abt. Syst.* 93: 289–464.
- Perret, J.-L. 1977. Les *Hylarana* (Amphibiens, Ranidés) du Cameroun. *Revue suisse Zool.* 84: 841–868.
- Petrides, G.A. 1965. *Advisory Report on Wildlife and National Parks in Nigeria, 1962*. Bronx, NY: American Committee for International Wildlife Protection.
- Powell, C.B. 1995. Wildlife Study I, Contract E-00019, Final Report. Submitted to Environmental Affairs Department, Shell Petroleum Development Company of Nigeria, Port Harcourt.
- Powell, C.B. 1997. Discoveries and priorities for mammals in the freshwater forests of the Niger Delta. *Oryx* 31: 83–85.
- Reid, G.McG. 1989. *The Living Waters of Korup Rainforest: A Hydrobiological Survey Report and Recommendations, with Emphasis on Fish and Fisheries*. WWF Report No. 3206/A8:1.
- Reid, J.C. 1989. Floral and faunal richness of Oban Division of Cross River National Park and list of flora and fauna of the Calabar Oban Area. Appendix 7 to *Cross River National Park (Oban Division): Plan for Developing the Park and its Support Zone*. Godalming, Surrey: WWF-UK.
- Richards, P.W. 1996. *The Tropical Rain Forest: An Ecological Study*. 2nd Ed. Cambridge: Cambridge University Press.
- Rodewald, P.G., Dejaive, P.-A., & Green, A.A. 1994. The birds of Korup National Park and Korup Project Area, Southwest Province, Cameroon. *Bird Conservation International* 4: 1–68.
- Sarmiento, E.J. & Oates, J.F. 2000. Cross River gorillas: A neglected subspecies. *American Museum Novitates* no. 3304, 55 pp.
- Sayer, J.A., Harcourt, C.S., & Collins, N.M. (eds.). 1992. *The Conservation Atlas of Tropical Forests: Africa*. IUCN/Macmillan.
- Schiøtz, A. 1963. The amphibians of Nigeria. *Vidensk. Medd. Fra Dansk naturh. Foren.* 125: 1–92.
- Schiøtz, A. 1966. On a collection of Amphibia from Nigeria. *Vidensk. Medd. fra Dansk naturh. Foren.* 129: 43–48.
- Schiøtz, A. 1999. *Treefrogs of Africa*. Frankfurt am Main: Edition Chimaira.

- Schmitt, K. 1996. Botanical survey in the Oban Division, Cross River National Park. Calabar: Oban Hills Programme, Cross River National Park-WWF.
- Stattersfield, A.J., Crosby, M.J., Long, A.J., & Wege, D.C. 1998. *Endemic Bird Areas of the World: Priorities for Biodiversity Conservation*. Cambridge: BirdLife International.
- Stiassny, M.L.J., Schliewen, U.K., & Dominey, W.J. 1992. A new species flock of cichlid fishes from Lake Bermin, Cameroon with a description of eight new species of *Tilapia* (Labroidei: Cichlidae). *Ichthyol. Explor. Freshwaters* 3: 311–346.
- Struhsaker, T.T. 2001. Africa's rain forest parks: Problems and possible solutions. Report to Center for Applied Biodiversity Science, Conservation International, Washington, DC.
- Sunderland, T.C.H., Mboh, H., Comiskey, J.A., Besong, S., Fonwebon, J., & Dione, M.A. 2002. *The Vegetation of the Takamanda Forest Reserve, Cameroon*. Unpublished draft report to the Smithsonian Institution, Washington, DC.
- Terborgh, J. 1999. *Requiem for Nature*. Washington, DC: Island Press.
- Teugels, G.G., Reid, G.M., & King, R.P. 1992. Fishes of the Cross River Basin (Cameroon-Nigeria): Taxonomy, zoogeography, ecology and conservation. *Annales de le Musée Royal de l'Afrique Centrale. Sciences Zoologique* 266. 132 pp.
- Thomas, D.W. 1984. Vegetation in the montane forest of Cameroon. In S.N. Stuart (ed.), *Conservation of Cameroon Montane Forests*. pp. 20–27. Cambridge: International Council for Bird Preservation.
- Thys van den Audenaerde, D.F.E. 1967. The freshwater fishes of Fernando Poo. *Verh. K. vlaamse Acad. Wet. Lett. Sch. Kunst. Belgie (Wet.)*, Jg. 29, no. 100. 167 pp.
- Trewavas, E. 1974. The freshwater fishes of Rivers Mungo and Meme and Lakes Kotto, Mboandong and Soden, West Cameroon. *Bulletin of the British Museum (Natural History), Zoology* 26: 331–419.
- Trewavas, E., Green, J., & Corbet, S.A. 1972. Ecological studies on crater lakes in West Cameroon: Fishes of Barombi Mbo. *Journal of Zoology, London* 167: 41–95.
- Tye, H. 1984a. Geology and landforms in the highlands of western Cameroon. In S.N. Stuart (ed.), *Conservation of Cameroon Montane Forests*. pp. 15–17. Cambridge: International Council for Bird Preservation.
- Tye, H. 1984b. The climate of the highlands of western Cameroon. In S.N. Stuart (ed.), *Conservation of Cameroon Montane Forests*. pp. 18–19. Cambridge: International Council for Bird Preservation.
- Usongo, L. 1997. Annotated list of known mammals of Korup National Park. Unpublished report in library of Korup National Park, Mundemba, Cameroon.
- Verheyen, W.N., Hulselmans, J., Colyn, M., & Hutterer, R. 1997. Systematics and zoogeography of the small mammal fauna of Cameroun: Description of two new *Lophuromys* (Rodentia: Muridae) endemic to Mount Cameroun and Mount Oku. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique. Biologie* 67: 163–186.
- Vick, G.S. 1999. A checklist of the Odonata of the South-west Province of Cameroon, with the description of *Phyllogomphus corbetiae* spec. nov. (Anisoptera: Gomphidae). *Odontologica* 28: 219–256.
- Walter, H. 1973. *Vegetation of the Earth in Relation to Climate and Eco-Physiological Conditions*. New York: Springer-Verlag.
- Waltert, M., Lien, Faber, K., & Mühlenberg, M. 2002. Further declines of threatened primates in the Korup Project Area, south-west Cameroon. *Oryx* 36: 257–265.
- Werre, J.L.R. 2000. Ecology and behavior of the Niger Delta Red Colobus monkey (*Procolobus badius epieni*). Unpublished Ph.D. thesis. NY: City University of New York.
- White, F. 1983. *The Vegetation of Africa*. Paris: Unesco.
- Whitmore, T.C. 1975. *Tropical Rain Forests of the Far East*. Oxford: Oxford University Press.
- Wieringa, J.J. 1999. *Monopetalanthus* exit. A systematic study of *Aphanocalyx*, *Bikinia*, *Icuria*, *Michelsonia* and *Tetraberlinia* (Leguminosae, Caecalpinioideae). *Wageningen Agricultural University Papers* 99–4. 320 pp.
- Williams, P.H. 2000. *WORLDMAP*. Vers. 4.20.12. London: Natural History Museum.

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