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Korup Forest Dynamics Plot, Cameroon

George B. Chuyong, Richard Condit, David Kenfack, Elizabeth C. Losos, Sainge Nsanyi Moses, Nicholas C. Songwe, and Duncan W. Thomas

Site Location, Administration, and Scientific Infrastructure

Korup National Park was created in 1986 and covers 125,900 hectares, most of which is evergreen forest. The park includes the former Korup Forest Reserve, established under British mandate in the 1930s. It is now under the administration of the Department of Wildlife and Protected Areas in the Ministry of Environment and Forests (MINEF). The 50-ha Korup Forest Dynamics Plot (KFDP) is located near the southern end of the park (fig. 29.1). The plot is approximately 60 km inland from the open Atlantic Ocean in the Bight of Biafra, and about 30 km from the edge of the mangrove swamps of the Rio Del Rey estuary. It is also 10 km from the Cameroon–Nigeria border at its closest point.

Both the Korup National Park and the KFDP are administered from the isolated town of Mundemba, which can be reached from Yaoundé (the capital of Cameroon) or Douala by four-wheel-drive vehicle or by light aircraft. The KFDP program maintains an office, residence, and limited visitor accommodations in Mundemba, supervised by a few permanent field staff. The park headquarters has two small, unequipped laboratories. Travel from Mundemba to the 50-ha plot requires a 10-km drive on plantation roads along the edge of the park and a 10-km hike through the park. The research camp, "Chimpanzee Camp," is less than 1 km from the KFDP and has simple visitor accommodations.

The KFDP program is run by the Center for Tropical Forest Science of the Smithsonian Tropical Research Institute with the Bioresources Development and Conservation Programme–Cameroon (BDCPC). The KFDP program also has a research agreement with the Herbarium at the Limbe Botanical Garden, a 4–5 hour drive from Mundemba in the dry season. Limbe is a coastal town, about 2 hours drive west of Douala International Airport, and is a good place to start an expedition to Korup. Travel during the latter part of the wet season (July–November) is very difficult.

In addition to the KFDP, the Smithsonian Institution/Monitoring and Assessing Biodiversity Program has established a series of 1-ha forest monitoring plots elsewhere in Cameroon, in the forest reserves of Ejagham and Takamanda and in the Campo National Park.

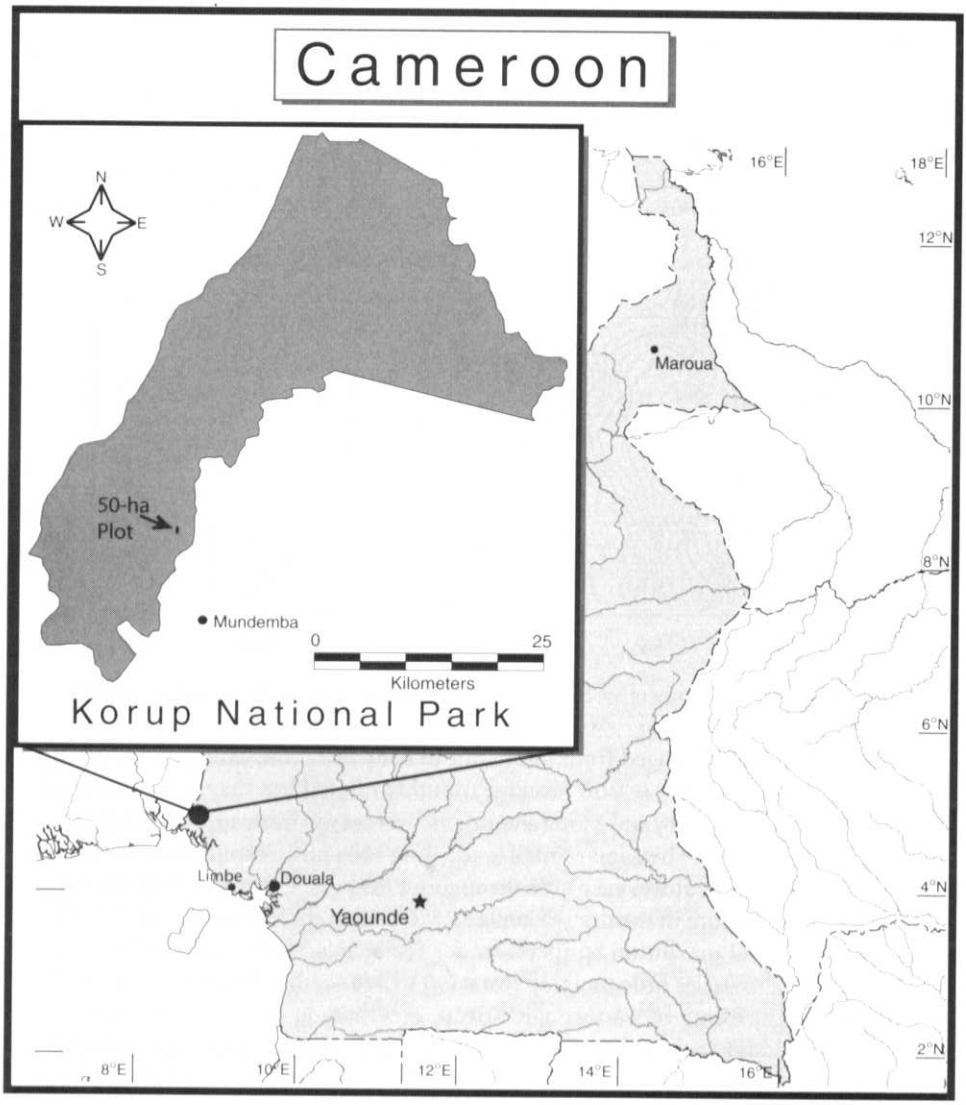

Fig. 29.1. Location of the 50-ha Korup Forest Dynamics Plot.

Climate

Although it is only 5 degrees north of the equator, Korup has a pseudoequatorial climate, with two seasons instead of four. Over a 22-year period, from 1973 to 1994, annual rainfall near the southern (coastal) end of the park, about 15 km

Table 29.1. Korup Climate Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total/ Averages
Rain (mm)	38	58	221	329	459	564	913	914	691	668	341	76	5272
ADTMx	31.6	32.8	32.6	32.0	31.5	30.4	28.7	27.8	28.8	29.7	30.7	31.1	30.6
ADTMn	21.9	23.0	23.1	23.0	22.8	22.8	22.2	22.4	22.3	22.5	22.8	23.1	22.7

Notes: Mean monthly rainfall and average daily temperature based on data collected about 20 km from the plot from 1973 to 1994.

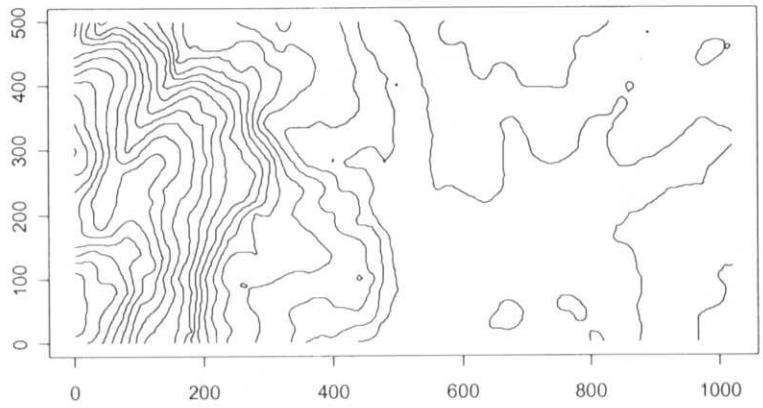

Fig. 29.2. Topographic map of the 50-ha Korup Forest Dynamics Plot with 5-m contour intervals.

south of the plot, ranged from 4027 mm to 6368 mm, and averaged 5272 mm. There is a distinct dry season (average monthly rainfall less than 100 mm) from December to February and a long and intense wet season from approximately May to October, with the heaviest rainfall (exceeding 1000 mm a month in some years) in August. Temperatures vary little throughout the year. The mean monthly maximum temperature in the dry season is 31.8°C and in the wet season 30.2°C. The average annual maximum temperature for the area is 30.6°C (table 29.1). Solar radiation also varies little, ranging from 199 to 248 W/m^2 (Newbery et al. 1998). Many storm fronts move through Korup, especially at the beginning (March, April) and end (September, October) of the rainy season, when the intertropical convergence zone passes. Treefalls in the forest mostly occur during this period.

Topography and Soil

Elevation in Korup National Park ranges from near sea level along the Atlantic coast to 1079 m above sea level (asl) on Mount Yuhan in the hilly center of the park. The KFDP is located on the southern edge of the hills around Yuhan, where

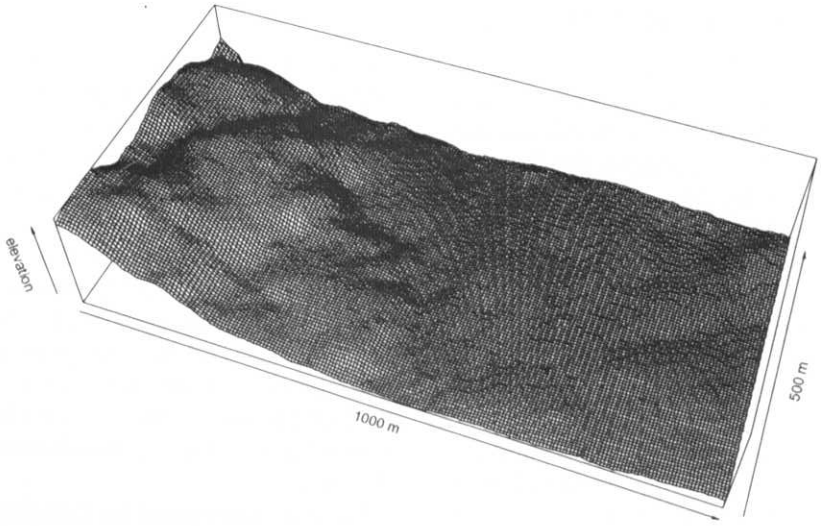

Fig. 29.3. Perspective map of the 50-ha Korup Forest Dynamics Plot.

the terrain starts to slope gently down toward the mangrove swamps of the Rio Del Rey, 30 km to the south. The lowest point in the KFDP is about 150 m asl, with a range of about 90 m between the highest and the lowest points (figs. 29.2 and 29.3).

The plot occupies part of a narrow, flat-bottomed valley surrounded by steep hillsides. It is fairly flat at the low-lying south end and rises steeply within the northern third of the plot. Habitat types include swamp, low-lying gentle slopes, and moderate to steep hillsides with boulders and small rock outcrops. A valley runs east-west through the central portion of the plot with a permanent stream. There are several other permanent and seasonal streams in the plot.

Soils in the southern part of Korup are generally skeletal, sandy (up to 70% sand in some areas), and very nutrient poor through the leaching action of the very high rainfall, which removes nutrients and clay particles. Most of the organic material is in the top few centimeters of the soil profile. As soil depth increases, there are small, but increasing, amounts of clay (Newbery et al. 1997). Soils on the steeper slopes tend to be thin and stony but still very nutrient poor. The soils are mostly derived in situ through the weathering of the metamorphic bedrock. Exposed rocks in the plot have been identified as syenite porphyry, a base-rich form of granite. Along the valley bottom there are swamps on alluvium, with sandy and silty soils, the latter hydric and gleyed.

Forest Type and Characteristics

In the Pleistocene era, the forests of the Korup area formed part of the Cross River–Mayombe Refugium (Maley 1987) that extended, probably discontinuously, along the West African coast from southeastern Nigeria to the Congo Republic. At present, the Korup forests appear very ancient and rich in paleoendemics, though with some puzzling indicators of old disturbance. The forest in the vicinity of the KFDP has been classified as Biafran coastal forest by Letouzey (1968, 1985). Thomas (1996) modified Letouzey's classification and described the coastal forests of south Korup and the southwest part of Mount Cameroon as *Oubanguia alata* (Scytopetalaceae) forests, a vegetation type dominated by this species where the annual rainfall exceeds 4000 mm. This lowland evergreen forest is locally dominated by Leguminosae-Caesalpinioideae that sometimes occur in groves of codominant species: *Didelotia letouzeyi* Pellegr., the rare *Microberlinia bisulcata* A.Chev., *Tetraberlinia bifoliolata* (Harms) Hauman, and the newly described narrow endemic, *T. korupensis* Wieringa.

Floristically, the KFDP is very rich and has many rare species for Cameroon, including some of the most abundant species in the plot. *Oubanguia alata* Bak.f., the species with the highest basal area, is a near-endemic, mostly limited to the wet forests of the Korup–Mount Cameroon area. The plot's most common large tree and the species with second-highest basal area, *Lecomtedoxa klaineana* (Pierre ex Engl.) Dubard (Sapotaceae) is rare in Cameroon and limited to the coastal forest of Cameroon and Gabon. It occurs gregariously in nutrient-poor lowland forest, but lacks ectomycorrhizae. The two most abundant species, *Phyllobotryon spathulatum* Müll. Arg. (Flacourtiaceae) and *Cola semecarpophylla* K. Schum. (Sterculiaceae) are also Lower Guinea endemics with rather limited distribution. *Phyllobotryon* is especially unusual since the flowers are borne on the leaves. By contrast, *Dichostemma glaucescens* Pierre (Euphorbiaceae), third in both abundance and basal area, is widespread and often dominates the wetter forests throughout Lower Guinea. New species are continuously being described from the Korup area (Thomas 1986; Thomas and Gereau 1993; Thomas and Harris 1999; Gereau and Kenfack 2000; Sonké et al. 2002). For census data and rankings, see tables 29.2–29.6.

A more or less continuous canopy layer reaches about 15 to 25 m, with scattered emergents up to 50 m tall. The woody understory is fairly dense with both lianas

Table 29.2. Korup Plot Census History

Year	Dates	Number Trees (≥1 cm dbh)	Number Species (≥1 cm dbh)	Number Trees (≥10 cm dbh)	Number Species (≥10 cm dbh)
First	January 1997–July 1999	329,026	494	24,591	307

Notes: One census has been completed, the second census is scheduled to start in November 2004.

Table 29.3. Korup Summary Tally

Size Class (cm dbh)	Average per Hectare							50-ha Plot				
	BA	*N*	*S*	*G*	*F*	*H'*	α	*S*	*G*	*F*	*H'*	α
≥1	32.0	6581	236	143	45	1.75	48.0	494	235	62	1.93	57.0
≥10	26.1	492	87	66	30	1.48	30.8	307	179	53	1.73	49.4
≥30	16.1	84	35	32	20	1.29	24.0	192	129	43	1.69	41.5
≥60	6.8	11	8	8	7	0.79	21.6*	85	74	32	1.58	28.6

*Fisher's alpha based on 42 hectares, sample size for remaining 8 ha was too low to calculate alpha.

Notes: *BA* represents basal area in m^2, *N* is the number of individual trees, *S* is number of species, *G* is number of genera, *F* is number of families, *H'* is Shannon–Wiener diversity index using $\log_{10}$, and α is Fisher's α. Basal area includes all multiple stems for each individual. 640 individuals were not identified to species or morphospecies. Data are from the first census.

Table 29.4. Korup Rankings by Family

Rank	Family	Basal Area (m^2)	% BA	% Trees	Family	Trees	% Trees	Family	Species
1	Euphorbiaceae	256.6	16.1	13.8	Sterculiaceae	72,262	22.0	Rubiaceae	86
2	Scytopetalaceae	227.1	14.3	4.7	Euphorbiaceae	45,296	13.8	Leguminosae	38
3	Leguminosae	143.6	9.0	5.9	Violaceae	31,386	9.6	Euphorbiaceae	37
4	Sterculiaceae	139.3	8.7	22.0	Flacourtiaceae	31,077	9.5	Sterculiaceae	28
5	Sapotaceae	106.9	6.7	0.4	Rubiaceae	22,945	7.0	Annonaceae	22
6	Olacaceae	104.9	6.6	4.5	Leguminosae	19,378	5.9	Sapindaceae	18
7	Ebenaceae	57.2	3.6	5.8	Ebenaceae	19,139	5.8	Guttiferae	16
8	Flacourtiaceae	53.4	3.4	9.5	Scytopetalaceae	15,551	4.7	Anacardiaceae	15
9	Apocynaceae	45.4	2.9	1.9	Olacaceae	14,657	4.5	Ebenaceae	14
10	Irvingiaceae	41.9	2.6	0.1	Annonaceae	10,705	3.3	Violaceae	14

Notes: The top 10 families for trees ≥1 cm dbh are ranked in terms of basal area, number of individual trees, and number of species, with the percentage of trees in the plot. Data are from the first census.

and small trees. The herbaceous layer, however, is sparse outside of light gaps. One unusual characteristic of the wet forests of Korup is an abundance of small, unbranched trees with terminal rosettes of large leaves (litter-trap treelets), from at least five dicotyledon families.

Small litterfall is estimated at 8.7 Mg/ha/year, of which close to 60% is leaf litter (Chuyong et al. 2000). Leaf litter production is continuous but peaks during the dry season. Litter breakdown and mineralization are very rapid, particularly during the first 3 months of the rainy season.

In terms of phenology, the flowering and fruiting of Korup trees is strongly seasonal. Most species flower from January to July, with a flowering peak at the beginning of the wet season, around March–May, followed by the peak fruiting season. Most species flower and set fruits to varying degrees in most years but there is a marked tendency toward mast fruiting at greater than 1-year intervals. The gregarious Caesalpiniodeae of Korup have been shown to have a 2–3 year mast fruiting pattern (Newbery et al. 1998).

Table 29.5. Korup Rankings by Genus

Rank	Genus	Basal Area (m^2)	% BA	% Trees	Genus	Trees	% Trees	Genus	Species
1	*Oubanguia* (Scytopetalaceae)	218.9	13.8	4.6	*Cola* (Sterculiaceae)	70,254	21.7	*Cola* (Sterculiaceae)	23
2	*Cola* (Sterculiaceae)	137.8	8.7	21.7	*Rinorea* (Violaceae)	30,504	9.4	*Diospyros* (Ebenaceae)	14
3	*Lecomtedoxa* (Sapotaceae)	99.3	6.3	0.1	*Phyllobotryon* (Flacourtiaceae)	26,736	8.3	*Rinorea* (Violaceae)	13
4	*Dichostemma* (Euphorbiaceae)	78.8	5.0	5.3	*Diospyros* (Ebenaceae)	19,139	5.9	*Psychotria* (Rubiaceae)	12
5	*Protomegabaria* (Euphorbiaceae)	73.2	4.6	1.0	*Dichostemma* (Euphorbiaceae)	17,251	5.3	*Garcinia* (Guttiferae)	10
6	*Strombosia* (Olacaceae)	64.9	4.1	2.4	*Oubanguia* (Scytopetalaceae)	15,011	4.6	*Trichoscypha* (Anacardiaceae)	10
7	*Diospyros* (Ebenaceae)	57.2	3.6	5.9	*Strombosia* (Olacaceae)	7,876	2.4	*Beilschmiedia* (Lauraceae)	7
8	*Hymenostegia* (Leguminosae)	34.1	2.2	1.3	*Drypetes* (Euphorbiaceae)	7,576	2.3	*Drypetes* (Euphorbiaceae)	6
9	*Vitex* (Labiatae)	31.5	2.0	0.1	*Angylocalyx* (Leguminosae)	5,853	1.8	*Ouratea* (Ochnaceae)	6
10	*Klaineanthus* (Euphorbiaceae)	30.9	2.0	0.6	*Tabernaemontana* (Apocynaceae)	4,256	1.3	*Vitex* (Labiatae)	6

Notes: The top 10 tree genera for trees ≥1 cm dbh are ranked by basal area, number of individual trees, and number of species with the percentage of trees in the plot. Data are from the first census.

Fauna

The forest around the plot is an important habitat for medium- and large-sized mammals. At least 326 species of birds are found in and around the Korup National Park (Thomas 1992, Rodewald 1993), along with over 40 species of terrestrial mammals—including eight diurnal primate species—and more than 200 species of macrofungi. A recent survey conducted by Larsen (1997) indicates that the Korup–Oban Hills area harbors more than 1000 of tropical Africa's 3700 butterfly species. The short rivers, characteristic of the Korup area, support endemic species of fish (Reid 1989; Forbin 1996).

The most common large mammals in the plot are several species of duiker (forest antelope), especially *Cephalophus monticola* and *C. dorsalis*, and various primates, including four species of guenon (*Cercopithecus spp.*), mangabeys (*Cercocebus torquatus*), red colobus (*Colobus badius*), and at least five species of nocturnal primates. Frequent visitors are drills (*Mandrillus leucophaeus*) and bush pigs (*Potamochoerus porcus*). Forest elephants (*Loxodonta africana cyclotis*) and chimpanzees (*Pan troglodytes*) are seen occasionally. Squirrels, flying squirrels, porcupines, hyraxes, and pangolins are all common. The many bat species include large fruit bats, which are important seed dispersers, and small nectar-eating bats.

Table 29.6. Korup Rankings by Species

Rank	Species	Number Trees	% Trees	Species	Basal Area (m^2)	% BA	% Trees
1	*Phyllobotryon spathulatum* (Flacourtiaceae)	26,728	8.1	*Oubanguia alata* (Scytopetalaceae)	218.6	13.7	4.5
2	*Cola semecarpophylla* (Sterculiaceae)	24,518	7.5	*Lecomtedoxa klaineana* (Sapotaceae)	99.3	6.2	0.1
3	*Dichostemma glaucescens* (Euphorbiaceae)	17,251	5.3	*Dichostemma glaucescens* (Euphorbiaceae)	78.8	5.0	5.3
4	*Cola praeacuta* (Sterculiaceae)	15,471	4.7	*Protomegabaria stapfiana* (Euphorbiaceae)	73.2	4.6	1.0
5	*Oubanguia alata* (Scytopetalaceae)	14,918	4.5	*Cola praeacuta* (Sterculiaceae)	34.9	2.2	4.7
6	*Cola sp.nov.* (Steculiaceae)	12,366	3.8	*Strombosia pustulata* (Olacaceae)	34.4	2.2	1.3
7	*Cola flavo-velutina* (Sterculiaceae)	8,234	2.5	*Cola semecarpophylla* (Sterculiaceae)	33.3	2.1	7.5
8	*Diospyros preussii* (Ebenaceae)	7,356	2.2	*Klaineanthus gaboniae* (Euphorbiaceae)	30.9	1.9	0.6
9	*Angylocalyx oligophyllus.* (Leguminosae)	5,796	1.8	*Hymenostegia afzelii* (Leguminosae)	27.7	1.7	1.2
10	*Rinorea lepidobotrys* (Violaceae)	5,492	1.7	*Diospyros gabunensis* (Ebenaceae)	27.6	1.7	1.2

Notes: The top 10 tree species for trees ≥1 cm dbh are ranked by number of trees and basal area. The percentage of the total population is also shown. Data are from the first census.

The large boulders and caves in the plot area are important bat roosting habitat, and also serve as nest sites for the rare bird, *Picathartes oreas.* Forest hingeback turtles (*Kinyxis*) are common. Large snakes include Gabon and rhinoceros vipers (*Bitis gabonica* and *B. nasicornis*) and black cobras (*Naja melanoleuca*). The dwarf crocodile (*Ostreolaenus tetraspis*), listed by IUCN as vulnerable, is common in the creeks of Korup and may be present in the plot.

According to Thomas (1992), the most common birds in the understory include species that follow army ant swarms such as the fire-crest alethe (*Alethe diademata*) and the brown-chested alethe (*A. poliocephala*), also sunbirds, greenbuls, forest robins (*Stiphrornis erthrothorax*), and paradise flycatchers (*Terpsiphone rufiventer*). Hornbills of several species are common in the canopy and are important dispersers of canopy fruits. Rare rainforest birds in the plot area include the white-crested tiger bittern (*Tigriornis leucolophus*) found along forest creeks, the crowned hawk-eagle (*Staphanoaetus coronatus*) that hunts monkeys, Sjostedt's barred owlet (*Glaucidium sjoestedti*) that hunts during the day, the white-crested hornbill (*Tockus albocristatus*) that follows monkey troops, the rarely seen black-eared groundthrush (*Turdus cameronensis*), and the IUCN-listed red-headed rockfowl (*Picathartes oreas*). Nine species of kingfisher occur in the forest.

Natural Disturbance

Although the Korup forest is slow-growing with a slow turnover rate of trees, small-scale natural disturbances such as branchfalls and treefalls are frequent. More rarely, windthrows flatten larger areas, up to 1 ha. The origin of these strong winds is something of a mystery since hurricanes do not occur in the area; the events appear to be linked to thunderstorms. There is also evidence of a long-term change in the climate of the area, as demonstrated by the scattered presence of large old trees of species normally found in drier forest. These species have little or no regeneration in the evergreen forest. According to Maley (1987), there is evidence in the pollen record of a drier period about 2000 years ago, so these species may be left over from that event. The forest does not burn naturally, except on rocky areas with very thin soils.

Human Disturbance

Small widely separated villages, with their shifting agricultural fields and small plantations, occur within and around the Korup forest. There has been no commercial logging in the park, only logging for local use and the harvesting of natural plant products. Some plants, notably the Yoruba chewing stick, *Massularia acuminata* (Rubiaceae), and the Hausa stick, *Carpolobia* spp. (Polygalaceae), are overharvested to the north of Korup, but not in the Forest Dynamics Plot where they are less protected and abundant. Use of the plants of the Korup area has been studied by the Korup Project (Thomas et al. 1989). Patches of secondary forest on long-abandoned fields are encountered sporadically, though not in the plot. Apparently, the human population in the area was historically at low density except along the coast, probably because of the very dense vegetation and the very low soil fertility. In the recent past, hunting of large mammals by shotgun was intense. Hunters with shotguns came from the nearby oil palm plantations, and there were a few elephant hunters with heavier caliber weapons. During this period, mammal populations declined drastically, and elephants were more or less extirpated. Since the creation of the national park, hunting has declined to moderate levels as a result of law enforcement, and animal populations are recovering. Elephants have started to visit the Korup Forest Dynamics Plot again in the last few years. However, because of the exceptionally low productivity of the forest, it is likely that mammal biomass is naturally relatively low compared to drier forests.

Plot Dimensions

Korup is a 50-ha, 1000 × 500 m plot; its long axis lies north-south (magnetic north). Post 1800 (plot coordinate: 560, 0), which is located 560 m to the south

of the plot's northwest corner (plot coordinate: 0, 0), is at 05°03′86″N and 08°51′17″E.

Funding Sources

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References

Chuyong, G. B., D. M. Newbery, and N. C. Songwe. 2000. Litter nutrients and retranslocation in a central African rain forest dominated by ectomycorrhizal trees. *New Phytologist* 148:493–510.

———. 2002. Litter breakdown and mineralization in a central African rain forest dominated by ectomycorrhizal trees. *Biogeochemistry* 61:73–94.

Courade, G. 1974. *Cameroon Regional Atlas, West 1.* ORSTOM, Paris.

Forbin, I. 1996. Fish biodiversity of lower Korup Basin with emphasis on the development of ornamental fish trade, aquaculture and capture fishery. Consultancy report to the Korup Project, Mundemba, Ndian South West Province, Cameroon.

Gartlan, J. S., D. M. Newbery, D. W. Thomas, and P. G. Waterman. 1986. Studies on the rain forest vegetation of Cameroon. 1: The role of phosphorus in species distribution in Korup Forest Reserve. *Vegetatio* 65:131–48.

Gereau, R. E., and D. Kenfack. 2000. Le genre *Uvariopsis* (Annonaceae) en Afrique tropicale, avec la description d'une espèce nouvelle du Cameroun. *Adansonia* 22(1):39–43

Hawkins, P., and M. Brunt. 1965. Soils and ecology of west Cameroon. A report to the government of West Cameroon. Project Ca/TE/LA, Food and Agriculture Organization, Rome, Italy.

Kingdon, J. 1997. *The Kingdon Field Guide to African Mammals.* Academic Press, London.

Larsen, T. 1997. Butterfly inventory in Korup National Park, Rumpi Hills Forest Reserve and surrounding areas. Interim report to the Korup Project, Mundemba, Cameroon.

Letouzey, R. 1968. *Étude Phytogéographique du Cameroun.* Lechevalier, Paris.

———. 1985. *Carte Phytogéographique du Cameroun, 1:500 000.* Institut de la Recherche Agronomique. Toulouse, France.

Mabberley, D. J. 1997. *The Plant-Book: A Portable Dictionary of the Vascular Plants.* Cambridge University Press, Cambridge, U.K.

Maley, J. 1987. Fragmentation de la forêt dense humide ouest-africaine et extension des biotopes montagnards au quaternaire récent: nouvelles données polliniques et chronologiques: implications paléoclimatiques et biogéographiques. *Palaeoecology of Africa* 18:307–34.

Moyersoen, B., A. H. Fitter, and I. J. Alexander. 1998. Spatial distribution of ectomycorrhizas and arbuscular mycorrhizas in Korup National Park rain forest, Cameroon, in relation to edaphic parameters. *New Phytologist* 139:311–20.

Newbery, D. M., and J. S. Gartlan. 1996. The structural analysis of the rainforest of Korup and Douala-Edea. *Proceedings of the Royal Society of Edinburgh* 1048:177–224.

Newbery, D. M., I. J. Alexander, and J. A. Rother. 1997. Phosphorous dynamics in a lowland African rainforest: the influence of ecto-mycorrhizal trees. *Ecological Monographs* 67:367–409.

Newbery, D. M., N. C. Songwe, and G. B. Chuyong. 1998. Phenology and dynamics of an African rain forest at Korup, Cameroon. Pages 267–308 in D. M. Newbery, H. H. T. Prins, N. D. Brown, editors. *Dynamics of Ecological Communities.* Blackwell Science, Oxford, U.K.

Newbery, D. M., G. B. Chuyong, J. J. Green, N. C. Songwe, F. Tchuenteu, and L. Zimmermann. 2002. Does low phosphorus supply limit seedling establishment and tree growth in groves of ectomycorrhizal trees in a central African rainforest? *New Phytologist* 156:297–311.

Reid, G. M. 1989. *Living Waters of Korup Rainforest: A Hydrobiological Survey Report and Recommendations with Emphasis on Fish and Fisheries.* WWF Report No. 2306/A8:1. Korup Project, Mundemba, Cameroon.

Rodewald, P. G. 1993. *An Annotated Checklist of Birds of Korup National Park and the Project Area.* Korup Research Project No. 3. Wildlife Conservation Society, New York.

Sonké, B., D. Kenfack, and E. Robbrecht. 2002. A new species of the *Tricalysia atherura* group (Rubiaceae) from southwestern Cameroon. *Adansonia* 24:173–77.

Thomas, J. 1992. Birds of the Korup National Park, Cameroon. *Malimbus* 13:11–23.

Thomas, D. W. 1986. Notes on *Deinbollia* from Cameroon. *Annals of the Missouri Botanical Garden* 73:219–21.

Thomas, D. W. 1996. Botanical Survey of the Rumpi Hills and Nta Ali. Report to the GTZ, Germany, and to the Korup Project, Mundemba, Cameroon.

Thomas, D. W., and R. E. Gereau. 1993. *Ancistrocladus korupensis* (Ancistrocladaceae): A new liana form Cameroon. *Novon* 3:494–98.

Thomas, D. W., and D. J. Harris. 1999. New Sapindaceae from Cameroon and Nigeria. *Kew Bulletin* 54:951–57.

Thomas, D. W., D. Kenfack, G. B. Chuyong, S. N. Moses, E. C. Losos, R. S. Condit, and N. C. Songwe. 2003. Tree Species of Southwestern Cameroon: Tree Distribution Maps, Diamter Tables, and Species Documentation of the 50-Hecatre Korup Forest Dynamics Plot. Center for Tropical Forest Science of the Smithsonian Tropical Research Institute and Bioresources Development and Conservation Programme-Cameroon, Washington, D.C.

Thomas, D. W., J. M. Thomas, W. A. Bromley, and Mbenkum Fonki Tobias. 1989. *Korup Ethnobotany Survey.* World Wide Fund for Nature, Godalming, U.K.