

Geographic and ecological distribution of the endemic montane chameleons along the Cameroon mountain range

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Abstract. We report on observations of chameleons endemic to the Cameroon highlands between May 2003 and December 2005. Six species already known from this range were observed in the course of fieldwork. Our records extend the known range of *Chamaeleo montium*, *C. pfefferi*, and *C. w. wiedersheimi* to Koano and the Mbulu Hills. The later was also recorded on Mount Mbam. The species exhibit varied and overlapping altitudinal ranges and prefer primary montane forest (*C. pfefferi*, *C. q. quadricornis*, *C. q. gracilior*), submontane primary/secondary forest and farm bush (*C. montium*) and montane savanna grassland (*C. w. wiedersheimi*, *C. wiedersheimi perreti*). The most common subspecies was *C. w. wiedersheimi* while the rarest species was *C. pfefferi*. The night time perching habits of the species varied between the surveyed sites. On Mount Oku, individuals of *C. w. wiedersheimi* were observed at a mean perch height of 0.9 m while on Tchabal Mbabo individuals were observed at a mean perch height of 2.1 m resulting from disturbances of grazing cattle. The main threats are habitat destruction through wood cutting, savanna burning for cattle grazing and collection for trade.

Key words. Reptilia, Squamata, Chamaeleonidae, *C. montium*, *C. pfefferi*, *C. q. quadricornis*, *C. q. gracilior*, *C. w. wiedersheimi*, *C. w. perreti*, Cameroon, montane habitats, distribution, ecology, conservation.

Introduction

The Biafran mountain range that extends from Bioko Island in Equatorial Guinea to the Cameroon highlands, over to the Obudu and Mambila Plateaus in eastern Nigeria is a fertile environment for speciation and endemism in many floral and faunal groups (KINGDOM 1990, POOK & WILD 1997, BOWDEN 2001, WILD 2004). Within these mountain highlands, chameleons of the genus *Chamaeleo* have undergone a remarkable adaptative divergence in montane habitats of the central and western part of these mountains in Cameroon (BÖHME & KLAVER 1981, BÖHME 1985, KLAVER & BÖHME 1992, LAWSON 1993, WILD 1993, 1994b). There are 13 species of chameleons (Appendix 1) confirmed from Cameroon, in the genus *Chamaeleo* there are 12 species of which five are montane endemics with restricted ranges. Two of these are

divided into two subspecies. In Cameroon, the highest chameleon diversity occurs on Mount Manengouba with 7 species (WILD et al. 2004). Endemic chameleons from the genus *Chamaeleo* include: the Cameroon mountain chameleon (*C. montium*), Pfeffer's chameleon (*C. pfefferi*), Wiedersheim's chameleon (*C. w. wiedersheimi*), Perret's chameleon (*C. wiedersheimi perreti*), Eisen-traut's chameleon (*C. eisentrauti*) and the four-horned chameleon (*C. q. quadricornis*, *C. quadricornis gracilior*) (MERTENS 1968, KLAVER & BÖHME 1992, WILD 1993, 1994b, WILD et al. 2004). Although there is high diversity of chameleons found along the altitudinal zones, human impact on natural vegetation is rampant and is likely to have a negative effect on chameleon populations. Species endemic or near endemic to the region are potentially threatened directly or indirectly by habitat fragmentation (WILD

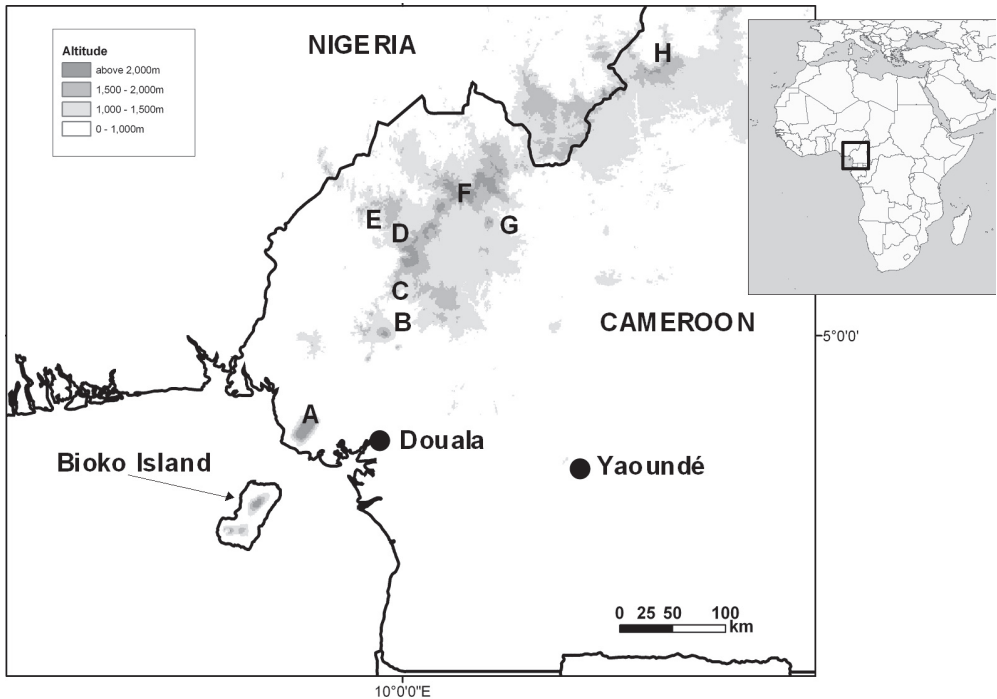


Fig. 1. Map of highlands of western Cameroon showing the eight localities surveyed.

2004). Whilst the conservation of pristine tropical habitats is among the priorities for conservation biologists, the consideration of altered habitats in forest management is becoming increasingly important (Bawa & Seidler 1998). Forest habitat preservation is among the primary objectives in chameleon conservation (Tilbury 1997, Euskirchen et al. 2000). Of particular concern is the increasing agricultural development, forest clearance and human settlement and grazing by livestock which is reducing forest cover along this mountain chain. It is recognised that severe disturbance reduces diversity (Holloway et al. 1992) and can render habitat unsuitable for species that are dependant on primary vegetation (Stephenson 1995). Cameroon's chameleons should be the focus of increasing conservation attention as many species have localised distributions in primary montane forests and grasslands and as such could be disproportionately affected by habitat degradation. A lack of information

on the ecology and distribution of chameleons in the Cameroon mountain range is a major impediment to effective chameleon conservation in Cameroon. While there have been a number of papers dealing with the distribution of chameleons in Cameroon (e.g. Böhme 1985, Klover & Böhme 1992, 1997, Wild 1993, 1994a, Hofer et al. 2003), many regions in the Cameroon mountain range remain unsurveyed.

This study provides an up-to-date review of the distribution and ecology of endemic chameleons in this ecoregion and additional data from recent fieldwork. The status of various species and prospects for conservation are also discussed.

Materials and methods

Study sites

This study was carried out along the Cameroon highlands which form an extensive

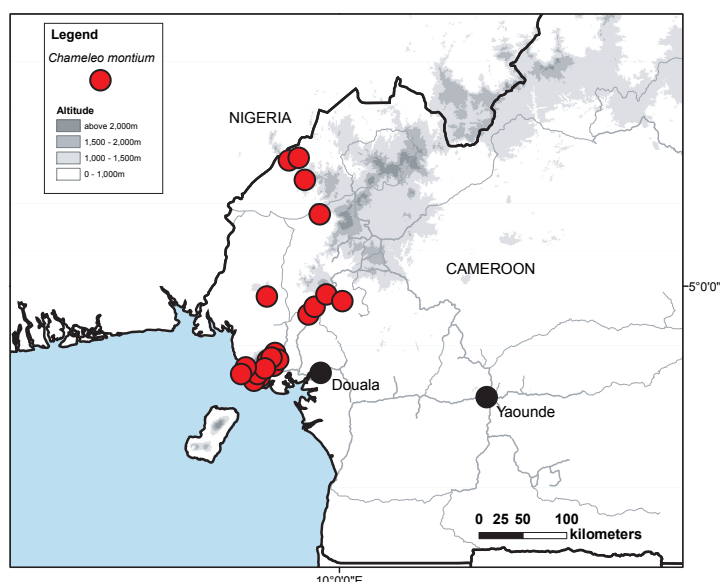


Fig. 2. Distribution of *C. montium* in Cameroon.

mountain chain aligned along a N-E to S-W axis of a major fault in the earth's crust separating West Africa from the Congo basin (WILD 2004). This mountain range runs from Bioko Island through Mts Cameroon, Kupe, Manengouba into the Bamenda and Adamawa Highlands, extending into the Mambila and Obudu Plateaus in eastern Nigeria. The data presented here is based on our survey of the Cameroonian part of the mountain chain (Fig. 1) carried out between May 2003 and December 2005. Surveyed localities are:

(A) Mount Cameroon (04.14° N, 09.12° E) is on the coast in the Southwest Province of Cameroon. With the summit at 4,095 m above sea level (a.s.l.) it is the highest mountain in west and central Africa. The slopes are steep and rugged and are marked by recent lava flows and volcanic cones (TAME 1999). Mt Cameroon has a relatively unbroken sequence of natural vegetation from lowland evergreen forest at sea level, through montane forest, to sub-alpine grassland near its summit (ACWORTH et al. 1996). The slopes are intensively cultivated by large agro-in-

dustrial companies (e.g. CDC, SOCAPALM) that grow mainly export crops (rubber, oil palm, tea, banana, etc). Small-holder farmers in the region extensively cultivate crops for subsistence and sale around the villages on the slopes of the mountain.

(B) Mount Manengouba has well-developed tropical montane cloud forest that extends to the Eboga Caldera at 1,800 m a.s.l. with forest becoming very unstable at this altitude. Primary forest extends down the slopes to the altitude of 1,500 m above the village of Nsong south of the mountain. The mid-altitude forest in the south-east of the mountain is drier and of more recent origin than the primary forest higher up the slopes. The peak is at 2,411 m a.s.l. and there are two volcanic lakes in the caldera at 1,950 m a.s.l. (05.04° N, 09.83° E) with the larger being 600 m across. There is some forest on the edge of the two lakes, mainly on the eastern rim of the crater. Fulani herdsmen inhabit the crater and use the area as a grazing ground for cattle, sheep, goats, horses all year round. During the late dry season burning of the grassland is practised. The forest

on the slopes is intact except near the village of Nsoung where agricultural encroachment has extended to an altitude of 1,700 m a.s.l. The southern slopes of the mountain are still well forested down to around 1,200 m at Manengouba village.

(C) The Ediango area (05.17° N, 09.78° E, 1,416 m a.s.l.) is in the south-eastern part of the Banyang-Mbo Wildlife Sanctuary. There is sub-montane forest vegetation on the rough and rocky slopes in this area and the forest has retained its pristine nature except in small patches around settlements where forest has been transformed into coffee plantations and farms. The forest here is drained by many small streams from the hill tops and people in this area are principally involved in cultivating and hunting.

(D) The Koano area (05.76° N, 09.80° E, 1,145 m a.s.l.) south of the Mamfe-Bamenda road is part of the Bamenda Highlands. It is at the north-eastern boundary of the Southwest Province, and at the limit of a forest concession (UFA 11-02). This area extends to 1,000 m a.s.l. and is characterised by savannah, woodland, primary forest, and widely distributed secondary forest which is very rich in species. Around villages are plantations, farm bushes and regenerating secondary forest due to the shifting cultivation practiced here.

(E) The Mbulu region is found in the northern part of the Southwest Province of Cameroon and extends to the Bamenda Highlands. Altitude in this region extends to 2,200 m a.s.l. at the Wildlife Conservation Society's Cross River Gorilla Research Station (06.11° N, 09.73° E). This area consists of extensive unbroken lowland tropical rainforest from the Takamanda Forest Reserve border to sub-montane /montane forest and grassland on the western edge of the Bamenda Highlands. Above 1,000 m a.s.l. vegetation consists of a mosaic of sub-montane forest and grassland. In higher valleys, there is thick gallery forest along watercourses. The main occupation of people in this region is farming and hunting. Crops range from cocoa and palm oil in the lowlands to coffee and peanuts in the hilly

grassland regions.

(F) Mount Oku (06.12° N, 10.28° E, 3,011 m a.s.l.) is situated in the northern section of the Bamenda Highlands close to the montane forest and savannah transition zone. The northern slope holds one of the best preserved fragments of montane forest in the region. The vegetation association includes moist montane forest very common around the Crater Lake at 2,300 m a.s.l. (Fig. 6). Farming is practised all around the mountain up to the reserved mountain forest zone. This forest plays an important role in the local economy and culture as it provides a wide range of forest products for the local people including firewood, honey and medicinal plants. Signs of human activity are common in the forest reserve with many footpaths. Several of these paths were used for our transect samples.

(G) Mount Mbam (05.11° N, 10.16° E, 2,335 m a.s.l.) as on Mount Oku, is characterised by a varied landscape of montane forest and grassland savannah. Montane gallery forest is abundant in higher valleys. Fulani herders inhabit the mountain and regularly set fire to promote new pasture growth for cattle grazing. The forests are experiencing increasing pressure from the expansion of grazing lands and the collection of fire wood for domestic use.

(H) Tchabal Mbabo is found in the western part of the Adamawa Province (07.23° N, 12.05° E, 2,997 m a.s.l.). The area includes grassland savannah and gallery forest along the streams on the plateau. The dry sub-montane forest is well developed on the northern escarpment with a few patches of variable size on the plateau. This forest gradually transitions into savannah forest on the lower slopes to the north. Large numbers of nomadic Fulani pastoralists migrate with their cattle in the area and there are a number of resident Fulani herding families also. There is intensive and unsustainable collection of *Prunus africanus* bark in the region for pharmaceutical companies. For more details concerning vegetation and characteristics of the Cameroon highlands see LETOUZEY 1985.

Survey methods

Visual encounter was the detection technique used in all habitat types (BRANCH & RÖDEL 2003, RÖDEL & ERNST 2004). Surveys consisted of establishing random forest line transects in the surveyed sites following an altitudinal gradient and involves searching of individuals in homogenous habitats. Boundaries are not usually specific except that observations remain inside specific habitats and replicates assume standard time limits. To generate encounter rates of species in their habitats, a time constrained rate count (TCC) was used. This method generates an index of individuals per time of searching (BURY & CORN 1991, HAYER et al. 1994). It can also be used to determine the species richness of an area and the species composition of a local assemblage, and to estimate relative abundances of species. The standard time used during this survey was 1 hour. Each transect was followed in the evening between 19.00 and 22.00 h to detect chameleons. Night walks were carried out at a constant slow rate to maximize chameleon observation (0.35-0.40 m/s). A team of two experienced persons moved slowly along each transect searching opposite flanks for roosting chameleons with the help of head lamps. Chameleons are readily found when roosting at night (e.g. PARCHER 1974, RAXWORTHY 1988, 1991, JENKINS et al. 1999) where they become pale and immobile. Information recorded during each encounter included altitude, number of individuals of each species, substrate and perch height. Most specimens were immediately released back into the sites after sampling and some voucher specimens were collected where they represented extralimital records. Sampling efforts were calculated by evaluating the time of searching at each locality in person hours (RÖDEL & BRANCH 2002) to come up with the species relative abundance at each sites. The average data collected using this method was also used to determine species richness of each habitat. The number of individuals of each species observed per hour at each site was used as the measure

of relative abundance classified as: Abundant; > 20 records, Common; 10-20 records, Uncommon; 4-9 records, Rare; 1-3 records. Species threat status is determined by the extent of a species range and the response of that species to variations in habitat quality (ALLPORT 1991). As such, threatened species tend to have limited distribution in primary forest and will be very sensitive to human activities such as habitat alteration and collection for the pet trade. The threatened species categorization given in this study has been considered in the light of modern information in literature and observations made in the field. All the distribution records both from literature sources and those collected in the field were plotted on a map of the mountain range at the western part of Cameroon.

Results and discussion

Species records

A total of 56 person-hours were spent searching 28 random line transects at the eight surveyed localities. Assuming that sampling efforts were the same at each of the localities, there was substantial variation in observed species composition among sites. The most species rich site was Mount Manengouba and Mbulu Hills - four species each (Table 1). Sites with new records include the Ediango area with *C. montium* and *C. wiedersheimi perreti*, Koano with *C. montium*, *C. pfefferi*, and *C. w. wiedersheimi*, and the Mbulu Hills with *C. montium*, *C. pfefferi*, *C. w. wiedersheimi* and *C. quadricornis gracilior*. In Mbulu Hills four range extensions were recorded. Two species were recorded at Mount Oku (*C. w. wiedersheimi* and *C. quadricornis gracilior*) whereas there was only one species on Mount Cameroon, *C. montium*, and on Mt Mbam and Tchabal Mbabo (*C. w. wiedersheimi*). A range extension was also recorded for *C. w. wiedersheimi* on Mount Mbam. The occurrence of great diversity of endemic chameleons on Mount Manengouba and Mbulu hills (4 species each) compared to other sites, highlights the high conservation

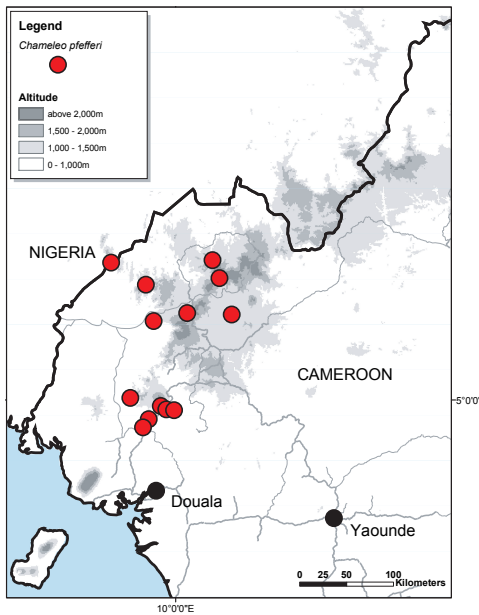


Fig. 3. Distribution of *C. pfefferi* in Cameroon.

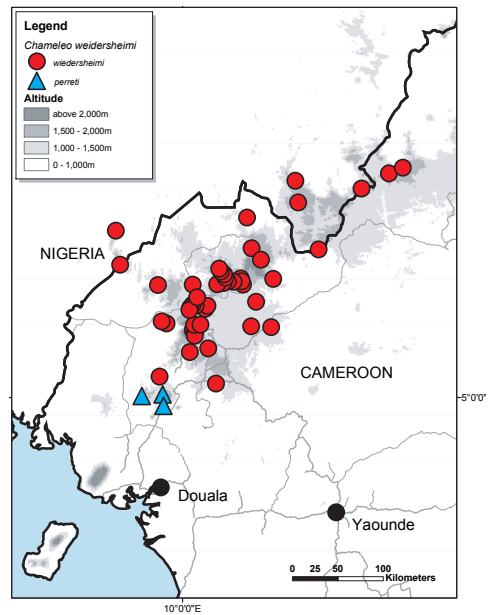


Fig. 4. Distribution of *C. wiedersheimi wiedersheimi* and *C. w. perreti* in Cameroon.

value of these sites. Variation in species at hill tops is certainly due to the varying complex habitats and varied environmental conditions found on each of the peaks, especially to the north.

Species abundance

The overall abundance varied with vegetation between the sites (Table 1). *Chamaeleo montium* was uncommon in mature secondary forests around Mount Cameroon (mean of 9.60 specimens per transect hour) and the Mbulu Hills (5.33). At other sites (Mount Manengouba, Ediango hill, and Koano) this species was rare. *Chamaeleo pfefferi* was the most rare species (mean scores <1 at all sites) and was restricted to primary forest. *Chamaeleo wiedersheimi perreti* was recorded as uncommon at Mount Manengouba (4.25) and rare at Ediango (0.50). The most abundant species was found at Mount Oku, *C. w. wiedersheimi* (35.67). This same sub-

species was uncommon in the Mbulu Hills (8.67) and rare at Koano, Mount Mbam and Tchabal Mbabo (2.00, 2.30, and 2.25 respectively). Both subspecies of the four-horned chameleon were rare: *Chamaeleo q. quadricornis* at Mount Manengouba (1.00) and *C. quadricornis gracilior* at Mbulu Hills (0.33) and Mount Oku (1.67). These findings support the hypothesis that chameleon populations decline in rainforest habitats where rapid changes in the environment are occurring (AKANI et al. 2001).

Distribution

Many of the localities for the seven endemic chameleons have been documented in the past. Literature records together with field observations during recent years are presented in Figures (2, 3, 4, 5 & 6). The chameleons occurring in the mountains of western Cameroon can be classified based

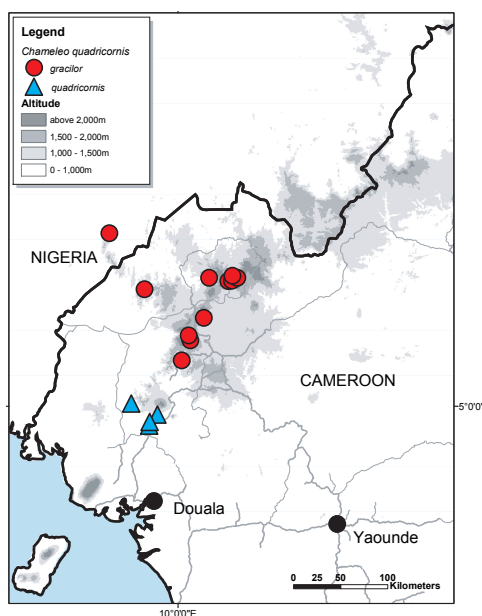


Fig. 5. Distribution of *C. quadricornis quadricornis* and *C. q. gracilior* in Cameroon.

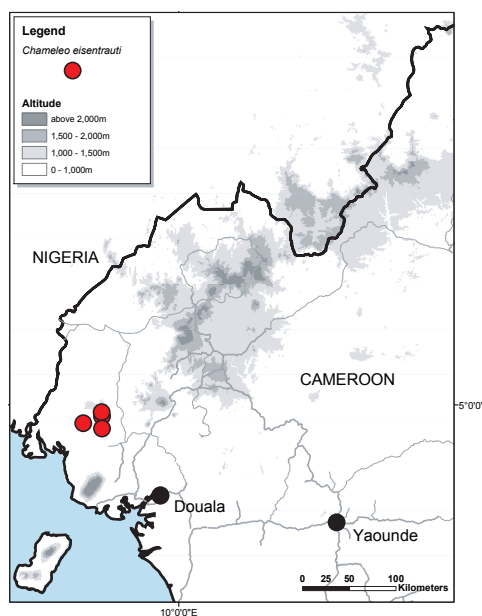


Fig. 6. Distribution of *C. eisentrauti* in Cameroon.

on their altitudinal range. This includes the submontane distribution characterised by submontane vegetation around 800 to 1,800 m .a.s.l. These regions are known to be characterised by cool temperatures, low isolation due to regular cloud cover, high precipitation and mist around the southern portion of the mountain chain. It appears to be dryer in the northern section of the chain particularly around Mount Tchabal Mbabo. Factors that account for the distributional patterns of assemblages observed on elevation gradients are well recognised (e.g. CADLE & PATTON 1988, HOFER et al. 2000).

Species accounts

Chamaeleo montium BUCHHOLZ, 1874 (Mountain chameleon, Fig. 7)

Distribution: This species has a wide range in Cameroon. It is known to occur in Dikome Balue in the Rumpi Hills, Nyassoso on

Mount Kupe, Buea on Mount Cameroon, Nsoug on Mount Manengouba, Bafut in the Bamenda Highlands (MERTENS 1938, 1968, ANGEL 1940, MONARD, 1951, EISENTRAUT 1963, BÖHME 1975a, 1975b, JOGER 1982, GARTSHORE 1986, KLAVER & BÖHME 1992, WILD 1993, 1994a, HOFER et al. 2003) and Mamfe / Takamanda Forest Reserve (KLAVER & BÖHME 1992, LeBRETON et al. 2003). We collected individuals from Ediango (05.18° N, 09.78° E, 1,400 m a.s.l.) in the Banyang-Mbo Wildlife Sanctuary, Koano (05.76° N, 09.80° E, 1,145 m a.s.l.), in the Mbulu Hills at Kenshi (06.11° N, 09.71° E, 1,080 m a.s.l.) and Alumfa (06.15° N, 09.73° E, 1,175 m a.s.l.). The Mbulu Hills also contains a population of the Cross River Gorilla (*Gorilla gorilla diehli*) and chameleons here will benefit from any forest conservation undertaken for this species. These Mbulu Hills records are also new range records for this species and narrow the gap between known sites in Takamanda Forest Reserve and Mount Manengouba.

| | Mount Cameroon (A) | Mount Manengouba (B) | Ediango hill (C) | Koano hill (D) | Mbulu hills (E) | Mount Oku (F) | Mount Mbam (G) | Mount Tchabal Mbabo (H) |
|------------------------------------|--------------------------|----------------------------|------------------------|----------------------|-----------------------|---------------------|----------------------|-------------------------------|
| <i>Chamaeleo montium</i> | 9.60 | 0.50 | 1.00 | 1.75 | 5.33 | | | |
| <i>C. pfefferi</i> | | 0.50 | | 0.75 | 0.33 | | | |
| <i>C. wiedersheimi perreti</i> | | 4.25 | 0.50 | | | | | |
| <i>C. w. wiedersheimi</i> | | | | 2.00 | 8.67 | 35.67 | 2.30 | 2.25 |
| <i>C. q. quadricornis</i> | | 1.00 | | | | | | |
| <i>C. q. gracilior</i> | | | | | 0.33 | 1.67 | | |

Tab. 1. Relative abundance of chameleons for the various surveyed sites calculated from transect Time Constrained Counts (TCCs).

Ecology: This species occurs in submontane and montane areas from 700 to 1,900 m a.s.l. in the southwestern highlands of the Cameroon mountain chain. Its northernmost locality is Atolo and Tinta in the Takamanda Forest Reserve (KLAVER & BÖHME 1992, LEBRETON et al. 2003) and Kenshi and Alumfa in the Mbulu Hills. At these sites, there is montane forest on the southern slopes which gradually changes to gallery forest and savannah on the northern slopes. The species is reported from secondary forest, gallery forest and farm bush in the Cameroonian highlands (KLAVER & BÖHME 1986, LAWSON 1993, HOFER et al. 2003). We observed 48 individuals on secondary forest margins in Mount Cameroon (mean perch height 1.8 m), two individuals on Mount Manengouba and seven near Koano (mean perch heights 1.7 and 2.3 m respectively; Table 2). Sixteen individuals were observed during night surveys around the Mbulu Hills (mean perch height 1.9 m).

Status: Given its preference for degraded forest habitats and its relatively wide distribution, the species is unlikely to be threatened by habitat alteration. It was found in mature secondary forest, disturbed farm bushes and plantations and seems to adapt well to disturbance. However, it is also highly collected around Mount Cameroon and Mount Manengouba for the international pet trade. Local collectors for the pet trade in these

regions already signal the populations have reduced as they have to spend more time searching than before. The species is vulnerable to over-exploitation and trade should be monitored.

Chamaeleo pfefferi TORNIER, 1900 (Pfeffer's chameleon, Fig. 8)

Distribution: Formerly known only from its type locality Nyassosso on Mount Kupe (KLAVER & BÖHME 1986, 1992, WILD 1993, HOFER et al. 2003) and very recently Mount Nlonako adjacent to Mount Manengouba (HERRMANN et al. 2005), this species appears to be uncommon throughout its range. We recorded three individuals near Koano, two on Mount Manengouba, one in the Mbulu Hills. All these records are new localities for this species except for Mount Manengouba. This range extension of *C. pfefferi* narrows the previously known distribution gap between Mount Manengouba and the Takamanda highlands (KLAVER & BÖHME 1992, LEBRETON et al. 2003).

Ecology: The species is found in submontane areas between 1,100 to 1,800 m a.s.l. mostly in undisturbed habitats. Around Koano and Mbulu Hills, the species is found in submontane/montane gallery forest. Individuals were recorded at mean perch heights of 1.8 m and 2.1 m respectively. It is found in closed canopy forest on Mount Manengouba

Geographic and ecological distribution of montane chameleons

| Localities/ Habitats Taxa (Altitude) | Mount Cameroon (A) | Mount Manengouba (B) | Ediango (C) | Koano (D) | Mbulu Hills (E) | Mount Oku (F) | Mount Mbam (G) | Tchabal Mbabo (H) | PF | SF | FB/ PL | SV |
|--|--------------------------|----------------------------|----------------|--------------|-----------------------|---------------------|----------------------|-------------------------|----|----|-----------|----|
| <i>Chamaeleo montium</i> (700-1900 m) | 1.8 | 1.7 | 2.1 | 2.3 | 1.9 | / | / | / | | X | X | |
| <i>C. pfefferi</i> (1100-1800 m) | / | 1.6 | / | 1.8 | 2.1 | / | / | / | X | | | |
| <i>C. wiedersheimi perreti</i> (1400-2400 m) | / | 1.5 | 1.4 | / | / | / | / | / | | X | X | X |
| <i>C. w. wiedersheimi</i> (1400-2450 m) | / | / | / | 1.1 | 1.2 | 0.9 | 2.6 | 2.1 | | X | X | X |
| <i>C. quadricornis quadricornis</i> (1500-2250 m) | / | 1.6 | / | / | / | / | / | / | X | | | |
| <i>C. quadricornis gracilior</i> (1800-2400 m) | / | / | / | / | / | 1.9 | / | / | X | X | | |

Tab. 2. Mean perch height (m) altitudinal range and habitat of Chameleons at various surveyed sites. Habitat: PF, Primary Forest; SF, Secondary Forest; FB/PL, Farm Bush/Plantations; SV, Savannah.

(mean perch height 1.6 m). Mount Kupe seems to be the site with a high concentration of its population with 49 individuals of this species recorded over a nine month period (HOFER et al. 2003).

Status: *Chamaeleo pfefferi* is likely to be particularly vulnerable to forest disturbance. Activities such as selective logging, forest exploitation for firewood and building materials, forest degradation from farming and collection for the pet trade are serious threats to the species. It was the rarest chameleon species encountered during this study. The low number recorded at Mount Manengouba may be a result of capture for commercial pet trade over the past years as revealed by locals of the region. The village community has presently stopped further collection for the pet trade due to its impact on the local population. HOFER et al. (2003) suggested that continuous degradation of the habitat over its entire range will severely endanger the species. It is likely to benefit from the conservation activities around Mount Kupe but will certainly be threatened at other range sites. Continuous survival of this species is heavily dependent upon protection from log-

ging, encroachment and collection for the international pet trade.

Chamaeleo wiedersheimi wiedersheimi NIEDEN, 1910 (Wiedersheim's chameleon, Fig. 9)

Distribution: This subspecies of montane chameleon is confined to the highlands of western Cameroon and eastern Nigeria. It has been documented from Mount Oku, Mount Lefo, Dschang, Bafut, Tchabal Mbabo, Djuttista, the Bamboutos mountains (NIEDEN 1910, ANGEL 1940, MERTENS 1968, BÖHME 1975b, WILD 1994b) and recently around Koano, Mbulu Hills and Mount Mbam.

Ecology: *Chamaeleo w. wiedersheimi* is a high elevation montane savannah/grassland subspecies commonly encountered between 1,500 to 2,450 m a.s.l. This herb-layer chameleon is sympatric with the large Slender Four-Horned Chameleon *Chamaeleo quadricornis gracilior* on Mount Bamboutos, Foto, Dschang, Mount Lefo, Mount Oku, and the Obudo Plateau (Nigeria) (KLAVAR & BÖHME 1992, WILD 1994a). One hundred and seven (107) individuals of this subspecies were re-



Fig. 7. *C. montium* male from Mbulu hills (top), female from Mount Cameroon (bottom).

corded on Mount Oku (mean perch height 0.9 m). This subspecies prefers low perch heights: Koano and Mbulu Hills (mean perch heights 1.1 and 1.2 m respectively). However, on Tchabal Mbabo and Mount Mbam, individuals perch above 2 m (2.1 and 2.6 m respectively, Table 2). This could be a behavioural adaptation to avoid contact with cattle that roam the vegetation daily or a product of differences in local vegetation or climate.

Status: This species tolerates some degree of habitat alteration and has a large range, as such there is probably no immediate threat to its survival. However, localised effects such as burning and forest clearing could cause local extinctions. It is very common in the international pet trade market and regulation of collection would certainly benefit the subspecies.

Chamaeleo wiedersheimi perreti KLAVER & BÖHME, 1992 (Perret's chameleon, Fig. 10)



Fig. 8. *C. pfefferi* male from Takamanda Forest Reserve (top), female from Mbulu hills (bottom).

Distribution: This near endemic subspecies of chameleon is known only from Mount Manengouba and the Bakossi Highlands (WILD 1994b, WILD et al. 2004) and very recently in the Banyang-Mbo Wildlife Sanctuary around Ediangou where one individual was collected at the forest-edge on grass (05.17° N, 09.78° E, 1416 m a.s.l.). Seventeen individuals were observed during night surveys on Mount Manengouba with six from Nsoug village at 1400 m a.s.l. and 11 at the Fulani camp on the south eastern flank of the mountain at 2,050 m a.s.l.

Ecology: This chameleon is common from 1,400 to 2,400 m a.s.l. It was seen in the night on plant stems used as fences around farms and on bracken fern around the Fulani camp (mean perch heights 1.5 m, Table 2). It seems to tolerate human disturbances as some individuals were observed in farm lands.

Status: This subspecies has a very restricted distribution. Forest clearance and annual burning of grasses by Fulani herders for cattle within its distribution area is a serious threat if not controlled. In the current situ-

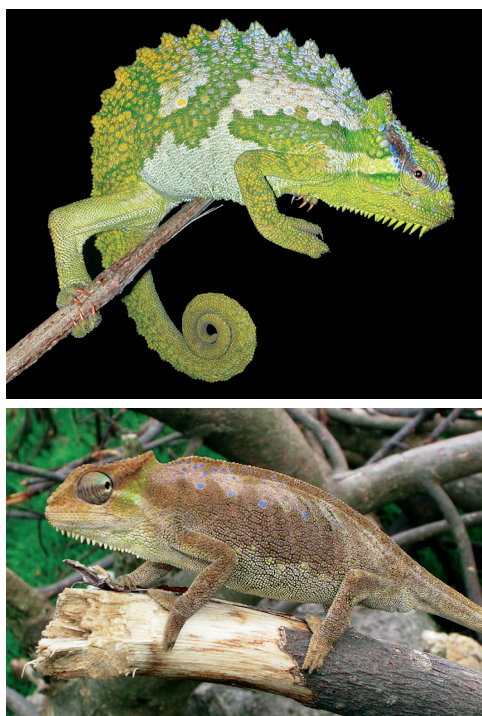


Fig. 9. *C. w. wiedersheimi* male (top), female (bottom) from Mount Mbam.



Fig. 10. *C. w. perreti* male (top), female (bottom) from Mount Manengouba.

ation, the future of this subspecies is very uncertain. It is also intensively collected for the international pet trade around Nsoug.

Chamaeleo quadricornis quadricornis TORNIER, 1899 (Southern four-horned chameleon, Fig.11)

Distribution: The southern four-horned chameleon is only known from Mount Kupe (JÖGER 1982) and Mount Manengouba (MERTENS 1968, KLAVER 1981, BÖHME & KLAVER 1981, KLAVER & BÖHME 1986, 1992, HOFER et al. 2003). Four individuals were observed during night searches at Mount Manengouba. A sub-adult female collected in forest near Nsoug village and three males in undisturbed mountain forest 2,250 m a.s.l. on the south-eastern slope of the mountain.

Ecology: This subspecies occurs strictly in montane habitat between 1,800 and 2,250

m a.s.l. It was observed in pristine mountain forest on Mount Manengouba (mean perch height 1.6 m). It seems to prefer mountain forest where there is reduced human activity.

Status: This subspecies may be threatened as a result of habitat degradation through forest clearance. It is highly collected for the international pet trade and this activity seems to be unsustainable. Its population appears to have very much dropped around Mount Manengouba due to this activity and it was reported as the most traded chameleon from Cameroon in 1996 (UNEP-WCMC 2003).

Chamaeleo quadricornis gracilior BÖHME & KLAVER, 1981 (Northern four-horned chameleon)

Distribution: The subspecies is known from Mount Lefo, Bamboutos Mountains,

and Mount Oku in the Bamenda highlands (BÖHME 1975, BÖHME & KLAVER 1981, WILD 1994) and very recently the Mbulu Hills west of the above sites.

Ecology: This subspecies lives in the montane gallery forest strips between forest and grassland at 1,800 to 2,400 m a.s.l. Five individuals (two females and three males) were observed during a night transect search in the montane forest (Fig.12) around Lake Oku (mean perch height 1.9 m, Table 2). An adult male was found dead in an advanced state of decomposition along a forest path in the Mbulu Hills during the day. It was probably killed by a hunter of the region as revealed by our local guide. This is the first record of this species for the site and appears here as a range extension.

Status: This species is threatened by environmental degradation such as forest clearing for cultivation and burning to encourage fresh grass growth for cattle grazing. However, it is able to persist in isolated shrub patches distant from forest. WILD (1994b) revealed that extensive impact to the habitat of this subspecies is likely to result in population fragmentation and isolation. Conservation of the remaining mountain forest on Mount Oku has been unsuccessful due to increasing deforestation from the growing human population.

Chamaeleo eisentrauti MERTENS, 1968 (Eisentraut's chameleon)

Distribution: This species is endemic to western Cameroon and only known from around the type locality: Dikume Balue in the Rumpi Hills, at 1150 m a.s.l. (MERTENS 1968, BÖHME 1975b, KLAVER 1981, BÖHME & KLAVER 1981, KLAVER & BÖHME 1992). No field work was conducted in this region but the species is known to be confined to relatively pristine montane forest (GARTSHORE 1986, LAWSON 1993). It is probably not currently threatened by the pet trade (GARTSHORE 1986) but it is sought for the international pet trade.

Conclusions and conservation implications

Broad species surveys can clarify geographical distribution of poorly known species. This study provides data on the distribution and altitudinal range of six endemic chameleons from Cameroon.

Mount Cameroon and Mount Manengouba have no protection status and the forest on the south eastern slope of Mount Manengouba is fast disappearing. This site harbours four of the chameleons endemic to the mountain range and as such needs special attention. An effort to gazette Mount Manengouba as a protected area has been initiated by the Conservation and Research of Endangered Species, Zoological Society of San Diego (CRES) and WWF Coastal Forest Programme in collaboration with the Ministry of Forestry and Wildlife (MINFOF) but this initiative has slowed. Sites in the region which are recognised as protected areas include the Banyang-Mbo Wildlife Sanctuary (near Ediangou) and Mount Oku in the Bamenda Highlands which holds one of the best preserved fragments of montane forest in the region. There are a number of villages within the Banyang-Mbo Wildlife Sanctuary and the inhabitants are principally involved in cultivation and hunting. However, the vegetation on the sub-montane forest on the rough and rocky slopes northwest of the village of Ediangou is still intact and is likely to be important for long term protection of chameleon species. Although there is still some forest around the lake on Mount Oku in which two species of chameleon occur, human impact on the environment has been severe during the last 50 years. Now it is managed by the village community forest group but trespassing and use of the forest for grazing by sheep and goats is very common. Both Koano and the Mbulu Hills have only very small areas of native sub-montane forest and no formal protection. Current land uses includes local subsistence farming, tree fell-

ing for fire wood and slash and burn agriculture. The Mbulu Hills, in which four endemic chameleons were recorded, also harbour one of the last populations of the endangered Cross River Gorilla and are likely to benefit from some kind of protection status from the government in the near future. The Tchabal Mbabo forest at the northern end of the Cameroonian mountain chain still possesses some important sub-montane/montane forest but this area has no management plan. A preliminary survey conducted in this region by Birdlife International in 2004 identified Mount Tchabal Mbabo as a site of high biodiversity importance. This mountain forest extends across the Cameroonian border into Nigeria and the Gashaka Gumti National Park. The extensive mountainous area of the region prevents vehicular access and limits access by foot. Several sites were not surveyed due to access difficulties and it is possible that an undiscovered chameleon remains to be discovered in this area (BÖHME & KLAVER 1981, BÖHME & SCHNEIDER, 1987). Any efforts to protect the high altitude ecosystems and the biological diversity in the Tchabal Mbabo area should be supported.

Some of the endemic montane chameleons of Cameroon are seriously threatened, although others are locally common in parts of their ranges. Habitat is being severely degraded and we highlight the high levels of destruction and the precarious conservation status of some habitats in the mountain chain. The main threats are forest clearance for agriculture, grazing, and timber extraction for commercial and local use. There has been notable degradation of the natural vegetation of this ecoregion over the past century. The major threat is the conversion of highland forest to cattle pasture, a situation already evident on the savannah plateau of the Manengouba caldera and Tchabal Mbabo. An associated problem is the regular burning to stimulate grass growth. In both Manengouba and Tchabal Mbabo, frequent burning has degraded significant areas of the montane habitat.

A conservation strategy is urgently required for the species and the many other endangered taxa found in the area but even more important is the need to protect representative tracts of forested biomes in the montane range. We suggest that protection of gallery forests in the region requires legal enforcement and should be considered an essential part of land management in the various areas. This could be achieved through local community based management forestry groups. Although all chameleons of the genus *Chamaeleo* are protected under CITES Appendix II, we also proposed a reclassification of the chameleons at the national level. Based on the restricted range and collection for the pet trade, *C. q. quadricornis* (southern four-horned chameleon), *C. wiedersheimi perreti* (southern wiedersheim's chameleon) and *C. eisentrauti* (Eisentraut's chameleon) should be placed at the highest levels of protection.

Given the current uncontrolled collection for the pet trade at some sites, environmental awareness and education campaigns directed at schools in the region should be planned. Furthermore, we strongly recommend studies on the natural life history of the six endemic species. These studies should focus on demographic and ecological requirements which will facilitate the preservation of these species.

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Fig. 11. *C. quadricornis quadricornis* (male) from Mount Manengouba.



Fig. 12. Mountain forest around Lake Oku habitat for *C. w. widersheimi* and *C. quadricornis gracilior*.

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Appendix

Key to the chameleons of Cameroon

- 1a:** Toes with single claws; tail prehensile, scales of soles of feet smooth 2
- 1b:** Toes with bicuspid claws; tail feebly prehensile; spines present on soles of feet *Rhampholeon spectrum*
- 2a:** Gular crest consisting of scaly broad flattened lobes *Chamaeleo eisentrauti*
- 2b:** Gular crest absent or if present not consisting of flattened lobes 3
- 3a:** Three annulated (ringed) horns *Chamaeleo oweni* (male)
- 3b:** Not as above; with or without annulated horns 4
- 4a:** Canthi rostrales meet above the tip of the snout to form a prominent ridge and a groove above the upper lip; gular crest present, largest anteriorly (*C. wiedersheimi*) 5
- 4b:** Not as above (sometimes a shallow groove); gular crest absent or present 6
- 5a:** Dorsal surface of the casque flat; parietal crest consisting of keeled scales on the posterior part of the casque; gular crest prominent, consisting of large conical scales; tops of the dorsal crenulation with 2-4 enlarged scales (Fig. 8) *Chamaeleo w. wiedersheimi*

| | |
|---|---|
| 5b: Dorsal surface of the casque convex; parietal crest indicated on posterior part of the casque; gular crest consisting of blunt conical scales; tops of the dorsal crenulation with 7-11 enlarged scales (Fig. 9) | <i>Chamaeleo w. perreti</i> |
| 6a: Dorsal and caudal crest present, continuous or consisting of a serrated ridge | 7 |
| 6b: Dorsal and caudal crest absent or indistinct | 11 |
| 7a: High continuous crest from body to tail | <i>Chamaeleo cristatus</i> |
| 7b: Discrete or notched dorsal crest | 8 |
| 8a: Usually four horns, sometimes two present with up to four adjacent reduced horns; gular and ventral crest present (consisting of a row of enlarged scales) | 9 |
| 8b: Two horns on the snout (no adjacent reduced horns); ventral crest absent | 10 |
| 9a: Dorsal surface of the casque covered by irregular scales of comparable sizes, surrounding two large flattened scales (Fig. 10) | <i>Chamaeleo q. quadricornis</i> |
| 9b: Dorsal surface the casque covered by irregular scales of comparable sizes, without large distinct scales | <i>Chamaeleo quadricornis gracilior</i> |
| 10a: Two annulated horns; gular crest merely indicated (Fig. 6) | <i>Chamaeleo montium</i> |
| 10b: Two horns on saddle-shaped protuberance on snout, gular crest present (Fig. 7) | <i>Chamaeleo pfefferi</i> |
| 11a: Ventral crest present (consisting of a row of enlarged scales) | 12 |
| 11b: No ventral crest | 18 |
| 12a: Cutaneous lobes present at the back of the casque | 13 |
| 12b: No cutaneous lobes at the back of the casque | 15 |
| 13a: Lobes extending beyond posterior point of casque | 14 |
| 13b: Lobes reduced, adpressed to sides of casque, not extending beyond posterior point of casque | <i>Chamaeleo gracilis</i> |
| 14a: Lobes big, in contact along the median line; length of the lobe greater than its distance from corner of the mouth | <i>Chamaeleo dilepis</i> |
| 14b: Lobes little, well separate on the median line; length of the lobe usually less than (or subequal to) its distance from corner of mouth | <i>Chamaeleo quilensis</i> |
| 15a: Posterior edge of the casque well rounded or continuous with back | <i>Chamaeleo senegalensis</i> |
| 15b: Posterior edge of the casque angular in profile | 16 |
| 16a: Gular crest consisting of 15-20 irregular, elongated, conical scales, 3-4 times as long as high (<i>C. quadricornis</i>) | 9 |
| 16b: Gular crest consisting of 25 or more subequal spines, at most twice as long as high | 7 |
| 17a: Posterior portion of the casque flat or almost so, perhaps slightly depressed or raised along the median line | <i>Chamaeleo gracilis</i> |
| 17b: Posterior portion of the casque strongly elevated along medial line, higher than long | <i>Chamaeleo africanus</i> |
| 18a: Gular crest present | <i>Chamaeleo pfefferi</i> |
| 18b: Gular crest absent or merely indicated | 19 |

- 19a:** Gular crest indicated or absent, prominent conical tubercules on the rostrum, pointed scales behind the nostrils (Fig. 6) *Chamaeleo montium*
- 19b:** Gular crest absent, no prominent conical tubercules on the rostrum, nor pointed scales behind the nostrils 20
- 20a:** Flattened cutaneous lobes present at the rear of the casque (female) *Chamaeleo oweni*
- 20b:** No flattened lobes present behind casque *Chamaeleo camerunensis*

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