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Small mammals from forest islands of eastern Nigeria and adjacent Cameroon, with systematical and biogeographical notes

R. Hutterer, F. Dieterlen & G. Nikolaus

Abstract. 26 species of insectivores, bats and rodents are recorded from the Gotel Mts and the Mambilla Plateau in eastern Nigeria and adjacent Cameroon. These mountain ranges carry relict forests representing distribution islands for many vertebrate species. 8 species of mammals are recorded for the first time from Nigeria, one bat from Cameroon, and a new subspecies of *Praomys hartwigi* is described. The taxonomic status of several forms is discussed and full species rank is proposed for *Sylvisorex camerunensis*, *Hylomyscus grandis* and *Lophuromys eisentrauti*. The insectivore and rodent faunas of nine mountain areas within the Cameroon Mountains system are analyzed and the result is presented in the form of an area cladogram.

Key words. Mammalia, Insectivora, Chiroptera, Rodentia, fauna, systematics, biogeography, forest islands.

Introduction

The forested mountains of south-eastern Nigeria and adjacent Cameroon are little-known geographical areas, particularly with respect to the mammal fauna. As the north-western extension of the Cameroon Mountains chain they form a unique geographical zone within Nigeria; the only other part of this system are the Obudu Mountains further south. During a 1988 Nigerian Conservation Foundation survey of the bird faunas (see Dowsett 1989) of some of these forested mountains, one of us (G. Nikolaus) also collected and observed small mammals in the Gotel Mountains. Although the collection is small in number it contains valuable new information and adds a number of species to the current list of mammals known to occur in Nigeria (Happold 1987).

In a hasty report R. J. Dowsett (1989) published our preliminary determinations of the new material, under authorship of "Nikolaus & Dowsett". We regret this action because almost half of the species names given by us in correspondence were tentative and not considered for publication before the identification work had been properly completed. To us now remains the unpleasant duty of correcting these misidentifications, for the publication of which we refuse any responsability.

The aim of this paper is (1) to present a more solid list of small mammal species obtained in eastern Nigeria, (2) to discuss some systematical problems and conclusions to which the first two authors came during their studies of Cameroon mammals, and (3) to give a zoogeographical comparison of the insectivores and rodents of the Cameroon Mountains Arc.

Description of the study site

The aims of the 1988 bird survey have been outlined by Ash & Dowsett-Lemaire (1989), and the geographical setting was fully described by Dowsett-Lemaire (1989). The expedition visited two principal areas, the Gotel Mountains and the Mambilla Plateau. Both are close to the border in south-eastern Nigeria and partially extend into Cameroon.

The Gotel Mts are mainly covered by montane grassland, with some narrow strips of montane scrub along streams and a few patches of forest up to 2300 m. There is a peak at 2420 m and a forest of c. 46 sq. km on the north-east side of Gangirwal spur, at 1400 to 2250 m. Other forested slopes, often inaccessible, occur in some places at lower altitudes. Localities where mammals have been obtained are Gangirwal (14—20 March 1988), and Chappal Waddi (20—24 March).

The Mambilla Plateau rises from 500 to 1500 m in the north over a distance of 5 km. On its eastern side it is flanked by the Gotel Mts. Much of the plateau consists of overgrazed rolling montane grassland. Small patches of forest have survived here and there (Njawai, Yelwa: 28—30 March). At the edge of the western escarpment is the Ngel Nyaki Forest Reserve at c. 1650 m with 4.5 sq. km of good forest. Another small forest (c. 3 sq. km) exists at the eastern edge of the escarpment at Leinde Fadali (25—27 March), and some riverine forest at Jauro Masali, in Cameroon (12—13 March).

The principal localities are listed below; all are in Nigeria except for Jauro Masali, which is in Cameroon.

Gotel Mts	
Chappal Waddi, 1600—1900 m	[07° 01' N, 11° 41' E]
Gangirwal, 1950—2419 m	[07° 01' N, 11° 42' E]
Mambilla Plateau	
Leinde Fadali, 1250—1700 m	[06° 58' N, 11° 36' E]
Njawai, 1500—1650 m	[06° 55' N, 11° 34' E]
Yelwa, 1500—1650 m	[07° 04' N, 11° 05' E]
Jauro Masali, 1300—1400 m, Cameroon	[06° 20' N, 03° 25' E]

Material and Methods

During the ornithological survey a limited amount of collecting was carried out by Nikolaus using 30—40 snap-traps per night. The traps were usually set five meters apart in forest, open grassland, and bushy thickets with ferns or other attractive sites. The traps were baited with roasted peanuts and checked early in the morning and late in the evening. Most mammals were skinned in the field, some were preserved in liquid. Weight (g) and external measurements (mm) were taken in the field; they include head and body length, tail length, hindfoot length including ungues, and ear length. Skull measurements were taken with calipers with an accuracy of 0.05 mm. All specimens mentioned are stored either in the Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn (ZFMK), or in the Staatliches Museum für Naturkunde, Stuttgart (SMNS). For the purpose of comparison and identification we also made intensive use of the collections of Cameroon mammals stored in these two institutions. We analyzed our distributional data (presence or absence based on a voucher specimen) with the PAUP program of Swofford (1990) and compared the small mammal faunas of one real island (Bioko) and eight continental "forest islands", all belonging to the Cameroon Mountains chain. For the analysis we selected only faunas for which (1) a reasonable set of information was available, and (2) which we studied ourselves. We compared only

two groups, Insectivora and Rodentia; we are familiar with them and are confident that our systematic treatment is chiefly correct.

Species records and systematic notes

Insectivora: Soricidae

Sylvisorex megalura (Jentink, 1888)
1 ♂ (ZFMK 88.90) from Chappal Waddi, 1900 m, on clearing in forest. The specimen represents the second locality record from Nigeria, the first being Afon in the south-western part of the country (Hutterer & Happold 1983). However, this long-tailed shrew is common even further north of the Gotel Mts on the Adamaoua Plateau (Hutterer & Joger 1982).

Measurements: Weight 4.8; head and body 60; tail 68; hindfoot 15; ear 7. Condylo-incisive length 17.6; maxillary breadth 5.4; greatest width 7.8; upper toothrow length 7.4.

Sylvisorex camerunensis Heim de Balsac, 1968, new rank
3 ♂, 2 ♀ (ZFMK 88.85–89) from Gangirwal at 2300 m. This is a new record for Nigeria of a species previously known only from two localities in Cameroon, Mt Oku and Lake Manenguba (Heim de Balsac 1968). Its has been suggested earlier (Hutterer et al. 1987) that *Sylvisorex granti camerunensis*, as it was originally described, differs from the East African *granti* on the species level, and the new material from Nigeria supports this view. *S. camerunensis* averages larger in skull measurements, has a slenderer rostrum and a larger upper M3. All these differences were already included in the figures and descriptions of Heim de Balsac (1968). We now formally propose full species rank for the populations of the Cameroon Mountains. They are isolated from true *S. granti* by some 2100 km of lowland forest and savanna.

Measurements of ZFMK 88.85–86, ♂ & ♀: Weight 5.5, 4.9; head and body 60, 60; tail 61, 61; hindfoot 14, 13; ear 10, 9. Condylo-incisive length 17.6, 17.9; maxillary breadth 5.4, 5.6; greatest width 8.2, 8.5; upper toothrow length 7.5, 7.7.

Sylvisorex ollula Thomas, 1913
1 ♂ (ZFMK 88.91) from Chappal Waddi, 1900 m. A rather unexpected new record for Nigeria. This relatively large shrew has its main distribution in the lowland forest of southern Cameroon, Gaboon and Zaire. Previously, the northernmost record from Cameroon was from the foot of Mt Cameroon (Heim de Balsac 1959). The new specimen from the Gotel Mts therefore leaves a large distributional gap which eventually may be filled in by future collecting in the forests of the Bamenda Plateau.

Measurements: Weight 30; head and body 100; tail 64; hindfoot 19; ear 10. Condylo-incisive length 26.6; maxillary breadth 7.6; greatest width 11.9; upper toothrow length 11.8.

Crocidura attila Dollman, 1915
1 ♀ (ZFMK 88.92) from Chappal Waddi, 1900 m. Another new species record for Nigeria. This small shrew is common throughout Cameroon and was therefore likely to occur.

Measurements (very young female): Weight 5; head and body 62; tail 45; hindfoot 13; ear 8. Condylo-incisive length 18.6; maxillary breadth 5.8; upper toothrow length 8.5.

Crocidura olivieri (Lesson, 1827)
1 ♂ (ZFMK 88.93) from Gangirwal, 2300 m. The animal was collected in forest near a rocky stream. It represents the subspecies *bueae* which has small body dimensions and a blackish colour. It is common all along the Cameroon Mountains chain.

Measurements: Weight 33; head and body 118; tail 75; hindfoot 22; ear 8. Condylo-incisive length 29.6; maxillary breadth 9.3; greatest width 12.3; upper toothrow length 13.1.

Chiroptera: Pteropodidae

Rousettus angolensis (Bocage, 1898)
1 ♂ (ZFMK 88.94) was caught along the forest edge at Leinde Fadali, 1700 m. The species is uncommon but widely distributed in Nigeria, where it occurs in rocky habitats in the rainforest zone and in relict forest in the savanna zone (Happold 1987).

Measurements: Weight 85; head and body 125; tail 10; tibia 34; ear 23; forearm 81.

Epomops franqueti (Tomes, 1860)
1 ♀ (SMNS 41337) was netted along with *Rousettus angolensis* at a forest edge near Leinde Fadali. The species has a wide distribution and is probably not uncommon in Nigerian forests.

Measurements: Weight 74; head and body 126; tibia 30; ear 24; forearm 82.

Micropteropus pusillus (Peters, 1867)
2 ♂ (ZFMK 88.95; SMNS 41338), Jauro Masali (Cameroon), 1300 m. A group of eleven bats was netted at dusk in a gallery forest, perhaps as they were leaving a roosting site. Some females carried juveniles. This is a common species throughout the Guinea and derived savanna.

Measurements of two males: Weight 31, 35; head and body 83, 91; tibia 24, 24; ear 16, 16; forearm 51, 54.

Chiroptera: Rhinolophidae

Rhinolophus simulator K. Anderson, 1904
1 ♂ (ZFMK 88.99), Chappal Waddi, 1900 m, 1 ♀ (ZFMK 88.100), Gangirwal, 2300 m. Caught along small forest streams. In Nigeria, this highland species in only known from the Jos Plateau (Happold 1987), while it is rather common in the Cameroon highlands.

External measurements of male and female: Weight 12.5, 10.5; head and body 56, 55; tail 26, 22; tibia 20, 20; ear 21, 21; forearm 49, 49.

Chiroptera: Hipposideridae

Hipposideros ruber (Noack, 1893)
2 ♀ (ZFMK 88.96—97), Jauro Masali, 1300 m, 1 ♀ (ZFMK 88.98), Gangirwal, 2300 m, 2 ♀ (SMNS 41339—40), Chappal Waddi, 1900 m. Five specimens were collected in highland and gallery forest near small streams. All were pregnant females. In Nigeria this species is not common but widely distributed in the forest and Guinea savanna zone.

Measurements of 5 ♀ (means and variation): Weight 11.7 (11.5—12.0); head and body 56.6 (52—60); tail 33.8 (33—35); tibia 21.8 (21—22); ear 16.2 (15—17); forearm 53 (52—54).

Chiroptera: Vespertilionidae

Eptesicus capensis (A. Smith, 1829)
1 ♀ (SMNS 41342) of this species was collected over a small forest stream at Chappal Waddi, 1900 m. Bergmans (1977) recorded it from Pandam, Nigeria, and Happold (1987) added two further localities in the southern rainforest zone of the country. There are also two records from Cameroon (Hutterer & Joger 1982).

Measurements: Weight 6.0; head and body 35; tail 30; tibia 11; ear 13; forearm 28. Greatest length of skull 13.2.

Pipistrellus kuhlii (Natterer, 1817)
2 ♂ (SMNS 41343, 41344), Gangirwal, 15 March 1988. These are the first specimens from Nigeria and another record from this geographical region since Eisentraut collected two of these bats at Lake Oku in the Banso Highlands, Cameroon (Hill 1968). The specimens from Nigeria were compared with the ones reported by Hill and, like these, are dark brown in colour with no traces of a white wing margin and in this respect are rather similar to *Pipistrellus eisentrauti*. However, in their smaller external and skull measurements as well as in details of the dentition they fully agree with West African *kuhlii* described by Hill (1968, 1982) from Cameroon and Liberia. From the smaller *P. eisentrauti bellieri* (De Vree 1972), the West African *kuhlii* differs by larger forearm measurements and by bicoloured ventral hairs.

Measurements: Weight 7, 7.2 g; length of forearm 35, 34; head and body length 49, 49; tail 31, 32; hindfoot 14, 14; ear 14, 14. Skull of SMNS 41343: Greatest length 13.4; condylocanine length 12.2; zygomatic width 8.7; least interorbital width 4.0; width of braincase 6.9; mastoid width 7.6; c1—c1 4.15; m3—m3 5.8; c—m3 4.6; length complete mandible from condyle 9.4.

Miniopterus schreibersii (Kuhl, 1819)
1 ♀ (SMNS 41341) carrying 1 embryo, from Jauro Masali (Cameroon). This bat has been recorded previously from the Cameroon Mountains by Eisentraut (1956, 1963, as *inflatus villiersi*), Hill (1968, as *schreibersii villiersi*), Hutterer & Joger (1982) and Fedden & Macleod (1986). Jauro Masali is close to the border with Nigeria and the species certainly occurs there as well, although it has not yet been listed for that country. The new specimen is small and light brown, and the hairs on the belly are

tipped with white. Specimens from Mt Oku, Mt Kupe, and particularly from Mt Cameroon (the material studied by Eisentraut and Hill) tend to be more blackish brown and uniformly coloured, although some specimens from Mt Oku and Mt Kupe show a slightly paler belly. In size of the forearm and the skull, however, they all are indistinguishable, and we therefore concur with Hill (1968) that they all represent *schreibersii*. (Happold 1987) listed only *Miniopterus inflatus* Thomas, 1903, for Nigeria as occurring "very localized at higher altitudes near the Cameroon border and on the Jos plateau." We assume that all Nigerian records represent *M. schreibersii* as well, and particularly a specimen quoted from Gembu (06° 42' N, 11° 16' E), a town which lies little north of the Mambilla Plateau.

Measurements of SMNS 41341: Weight 10; head and body 57; tail 45; ear 11; forearm 44. Greatest length of skull 14.6.

Chiroptera: Molossidae

Chaerephon ansorgei (Thomas, 1913)

1 ♂, 1 ♀ (SMNS 41351—52), Jauro Masali (Cameroon), 1300 m, and Leinde Fadali. This beautiful bat with a strongly contrasted dark throat is first recorded from Nigeria (Leinde Fadali) and the Mambilla Plateau now marks the westernmost corner of its range which is centered in East Africa (see map in Eger & Peterson 1979). Records from Cameroon include Mt Oku (Hill 1968), Waza, Mokolo (Eger & Peterson 1979), and Garoua (Smith et al. 1986), all but Mt Oku in the northern part of the country. This species was formerly listed under *Tadarida* (e. g. Koopman 1975) but Freeman (1981) subdivided the genus into three genera and included *ansorgei* in *Chaerephon*. Our first allocation of the specimens to *nigeriae*, followed by Dowsett (1989), was evidently wrong, as they do not show the characters of genus *Mops* in which *nigeriae* is currently included. The measurements of the new specimens are slightly larger than those of a specimen from Mt Oku, Cameroon (Hill 1968) but fit well within the range of measurements given by Eger & Peterson (1979).

Measurements: Weight 17.5, 18.5; head and body 68, 71; tail 33, 34; tibia 15, 16; ear 19, 20; forearm 47, 48. Greatest length of skull 19.1, 19.6.

Chaerephon major (Trouessart, 1897)

2 ♂, 6 ♀ (SMNS 41347—350, ZFMK 88.103—106), Yelwa, 1500 m; collected over a swamp in rocky grassland. These are probably the first vouchers for the occurrence of this bat in Nigeria. Nigeria was included in the distribution by Honacki et al. (1982) but Happold (1987), who referred to a paper by Bergmans (1977), stated that the Nigerian vouchers of "*major*" had been re-identified as *Mops condylura*. The new specimens are clearly *Chaerephon major* by the character "distinct separate lobe or lappet projecting between inner bases of ears" (Hayman & Hill 1971). Other features mentioned by Rosevear (1965) are also typical, such as pale spots on belly and throat, a forearm length of 42 to 44 mm, and the pattern of the upper M3 ("3rd leg at least half as long as the 2nd"). The range of the greatest length of the skull is slightly lower than that given by Rosevear (18.5—19.0). A character which does not fit very well is the palatal emargination. Compared to the type of *major*, as figured by Rosevear (1965: 324), the Nigerian specimens show a deeper anterior palatal gap

or notch which in some specimens reaches behind the posterior margin of the upper incisors.

It is noteworthy that the specimens were collected in rocky grassland; Rosevear (1965) also noted "rock crevices" as roosting sites, and Koch-Weser (1984) found colonies of this bat in flat rock crevices in the Sahel of Burkina Faso.

Measurements (n = 8): Weight 24.8 (23.5—28); head and body 67 (65—70); tail 31.5 (26—36); tibia 13.6 (13—14); ear 15.8 (14—17); forearm 42.6 (42—44). Greatest length of skull (n = 3) 17.9 (17.6—18.3).

Tadarida aegyptiaca (E. Geoffroy, 1818)

4 ♂ (ZFMK 88.101—102, SMNS 41345—46), Jauro Masali (Cameroon), 1300 m; collected while drinking at a river. This bats has a wide but spotty distribution, with few records from West Africa. In Nigeria it is known only from the Jos Plateau (Rosevear 1965, Happold 1987). The present specimens seem to be the first ones from Cameroon. They were initially misidentified as *Mops congica* (see Dowsett 1989) but external and cranial characters including the shape of the upper M3 point to *Tadarida aegyptiaca*. In measurements they agree well with a typical series from Egypt (Qumsiyeh 1985) but range near the upper limit of specimens reported from Sudan (Koopman 1975) and Nigeria (Happold 1987).

Measurements (n = 4): Weight 23.5 (22—25); head and body 77 (76—78); tail 41 (40—43); tibia 17 (16—18); ear 20.3 (20—21); forearm 53.8 (53—55). Greatest length of skull (n = 1) 21.3.

Rodentia: Muridae

Grammomys rutilans (Peters, 1876)

1 ♀ (SMNS 41324), Chappal Waddi. According to Happold (1987) the thicket-rat is fairly common in suitable habitats in southern Nigeria. However, it has not been found before in the geographical area studied by us. The Mambilla Plateau may be the northernmost occurrence of this forest rat within the Cameroon Mountains system. The next known locality further south is Mt Oku where Eisentraut procured a specimen (ZFMK 69.206) with which the young female from Chappal Waddi concurs in size and shape. *Grammomys rutilans* is often referred to genus *Thamnomys* and we (Hutterer & Dieterlen 1984) tentatively did so as well, but work in progress shows that it definitively does not belong to *Thamnomys* and is therefore shifted, albeit provisionally, to *Grammomys*.

Measurements: Weight 36 g; head and body length 117; tail 137; hindfoot 25; ear 17. Greatest length of skull 30.4; zygomatic width 15.7; least interorbital width 5.3; width of braincase 14.6; upper toothrow length 5.6.

Hylomyscus stella (Thomas, 1911)

1 ♂ (SMNS 41325), Gangirwal. This arboreal mouse is known from forest and secondary bush in southern Nigeria (Happold 1987), where it reaches its western distributional limit (Robbins et al. 1980). The single record from the Gotel Mts may represent one of the northernmost populations within Nigeria and Cameroon. In its measurements and skull morphology it agrees with specimens from further south in

the collections of the Bonn Museum. From the similar *Hylomyscus aeta* (Thomas, 1911) it is distinguished by a narrower and more slender skull, and by less pronounced supraorbital ridges. The specimen was compared with all forms of *Hylomyscus* kept in the Bonn Museum, including the subspecies *Hylomyscus aeta grandis* which Eisentraut (1969a) collected at Mt Oku, Cameroon. This study revealed that the type series of this taxon differs so much from typical *aeta* from southern Cameroon that we now conclude that *grandis* does not form part of *aeta* but instead represents a species of its own. In external measurements both are quite similar, but *grandis* has a larger and broader skull and considerably larger molars (crown length of upper molars 4.4—4.7 mm versus 4.0—4.3 in *aeta* from Cameroon).

Measurements of SMNS 41325: Weight 26 g; head and body length 97; tail 143; hindfoot 20; ear 16. Greatest length of skull 26.2; zygomatic width 12.8; least interorbital width 4.4; width of braincase 11.6; upper toothrow length 3.9.

Lemniscomys striatus (Linnaeus, 1758)

2 ♂ (SMNS 41333—34), Gangirwal, 1 ♀ (ZFMK 88.138), Jauro Masali (Cameroon), 1300 m; one caught in fern bush and one in gallery forest. A rather common species in Nigeria and Cameroon; known from nearby Mt Oku and the Adamaoua Plateau. These populations belong to the typical subspecies (Van der Straeten & Verheyen 1980).

Measurements (n = 3): Weight 36.8 (29.5—41); head and body length 107 (98—118); tail 124 (117—128); hindfoot 26.3 (26—27); ear 16.3 (16—17).

Lophuromys sikapusi (Temminck, 1853)

1 ♀ (SMNS 41328), Gangirwal. Only one specimen was caught in fern bush. It represents the typical *sikapusi* known from southern Nigeria and Cameroon (Dieterlen 1979, Happold 1987). It has also been found in owl pellet remains from the Adamaoua Plateau, north-east of the Gotel Mts (Hutterer & Joger 1982). Both localities are close to the northern border of the range in West Africa (see map in Dieterlen 1976: 10). The species does not vary much over large geographical distances; an exception is a dwarf form of Mt Lefo (Eisentraut 1975) which was named *Lophuromys sikapusi eisentrauti* by Dieterlen (1979). We have restudied the type material and compared it with specimens from Mt Cameroon, Rumpi Hills, Mt Kupe, Mt Oku, Gotel Mts, and the Adamaoua Plateau. The size differences between all these and the dwarfs of Mt Lefo are so pronounced (Figs 4, 5) that we now think that two species are involved. We therefore suggest to recognize the Mt Lefo population as a full species, *Lophuromys eisentrauti* Dieterlen, 1979.

Measurements of SMNS 41328: Weight 53.5; head and body length 119; tail 69; hindfoot 24; ear 17.

Mastomys sp.

1 ♂ 1 ♀ (ZFMK 88.131—132), Jauro Masali, 1300 m; 2 (SMNS 41326—27), Yelwa. All were collected in houses or within villages. A specific identification is not possible, as karyotypes have not been obtained. Morphologically, they are identical with specimens from Adamaoua Plateau reported as *Mastomys huberti* (Wroughton, 1908) by Hutterer & Joger (1982), and also with specimens from Mt Oku in the Bonn

Museum. Robbins & Van der Straeten (1989) described the rather distinctive *Mastomys verheyeni* from northern Cameroon and Nigeria; they also stated that two or three further occur in Cameroon. Our specimens belong to this yet unsolved species group.

Measurements: Weight 58.3 (54—66); head and body length 132.5 (124—140); tail 119 (110—132); hindfoot 26.8 (26—28); ear 19.3 (19—20).

Mus musculoides (Temminck, 1853)
1 ♂ 1 ♀, 1 indet. (ZFMK 88.134—135, SMNS 41332), Chappal Waddi, 1900 m. This pygmy mouse is common in grassland in the savanna zones but uncommon in the forest zone. Happold (1987) listed a large number of records from Nigeria under the name *minutoides*. We prefer to use *Mus musculoides*, the type locality of which is the Guinea Coast, West Africa. The type locality of *minutoides* is the Cape of Good Hope, South Africa, and we know of no convincing evidence that both forms are conspecific.

Measurements: Weight 5.2—6.9; head and body length 58—60; tail 50—54; hindfoot 15; ear 10—11. Greatest length of skull (n = 1) 18.5; upper toothrow length 3.2.

Mus setulosus Peters, 1876
2 indet. (ZFMK 88.133, SMNS 41329), Gangirwal, 2300 m, 2 ♂, 1 ♀ (ZFMK 88.136, SMNS 41330—31), Chappal Waddi, 1900 m, 1 ♂ (ZFMK 88.137), Yelwa, 1500 m. This slightly larger mouse has not been recorded from Nigeria before although it is common in the Cameroon Mountains, particularly in the southern ones (Eisentraut 1973). However, Hutterer & Joger (1982) reported it also from the Adamaoua Plateau where it probably lives in relict gallery forest. Three skins from Gangirwal are paler than specimens we have seen from southern Cameroon but concur well in external and cranial measurements. The two species of mice were not distinguished by Dowsett (1989) and the measurements given therein are composite.

Measurements: Weight 6.3—9; head and body length 62—73; tail 54—58; hindfoot 15—17; ear 10—12. Skull (n = 3): Greatest length 19.5—21.1; upper toothrow length 3.1—3.7.

Otomys occidentalis Dieterlen & Van der Straeten, 1992
Three specimens were caught in bushy grassland at Gangirwal (ZFMK 88.139—140; SMNS 41336) and one in a grassy clearing at Chappal Waddi (SMNS 41335). The genus *Otomys* is new to Nigeria. From the territory of Cameroon it was only known from Mount Cameroon and Mount Oku (Eisentraut 1973, Petter 1982), under the name *O. irroratus burtoni* Thomas, 1918. The Nigerian *Otomys* and the specimens from Mt Oku, Cameroon, represent a new species which is fully described by Dieterlen & Van der Straeten (1992).

Measurements: Weight 68.3 (55—78); head and body length 139 (127—160); tail 78 (69—88); hindfoot 27.8 (26—29); ear 19.8 (18—22).

Praomys cf. *jacksoni* (De Winton, 1897)
Chappal Waddi, 1900 m, 2 ♂, 2 ♀ (ZFMK 88.107—108, SMNS 41318—19); Jauro Masali (Cameroon), 1300 m, 1 ♂, 2 ♀ (ZFMK 88.109—110, SMNS 41323); Fadare

Forest, Leinde Fadali, 1 ♂ 2 ♀, 1 indet. (ZFMK 88.111–113, SMNS 41322); Yelwa, 1 ♀ (SMNS 41321); Njawai, 1 ♂ (SMNS 41317). This is a rare species in Nigeria; Happold (1987) plotted three localities close to the Jos Plateau. In Cameroon it is known from a few more places including Mamfe, Tinta, Genderu (Rosevear 1969), Mt Kupe, Rumpi Hills, Wum (Eisentraut 1973, 1975), and Adamaoua Plateau (Hutterer & Joger 1982). The identification of the Nigerian as well as Cameroon specimens must remain provisional. There are obvious differences between our West African sample and typical *jacksoni* from eastern Zaire (see measurements in Van der Straeten & Dieterlen 1991); the latter generally have smaller molars. But also within West Africa differences exist. The skulls of our sample from the Gotel Mts are smaller, although their molars are big, than examples from Adamaoua in the Bonn Museum. It is well possible that *Praomys viator* Thomas, 1911 (type locality: Panyam, Nigeria) represents a good species or subspecies; the holotype has an upper molar row length of 5.1 mm (Thomas 1911), which fits well with our sample. It belongs in the *jacksoni* group as is secured by the presence of a t3 in the first upper molar (Van der Straeten & Dieterlen 1987), and by the presence of seven palatal ridges, as is typical for that group (Eisentraut 1969). The West African species is capable of surviving in small strips of gallery forests, as has been also observed by Nikolaus near Njawai on Mambilla Plateau. This ability can easily lead to isolated populations and may explain the strange size variation observed in Cameroon and Nigeria.

Measurements (n = 9–10): Weight 39 (31–46); head and body length 113 (105–118); tail 134 (125–142); hindfoot 24.9 (24–26); ear 18.1 (17–19). Skull (n = 5–7): greatest length of skull 30.0 (29.2–31.0); zygomatic width 12.8; least interorbital width 4.8 (4.7–5.0); width of braincase 12.8 (12.4–13.1); upper toothrow length, alveolar 5.2 (4.7–5.6), crown length 4.9 (4.6–5.0); M1–M1 6.0 (5.8–6.4).

Praomys hartwigi obscurus Hutterer & Dieterlen, ssp. n.

Holotype: ZFMK 88.115, flat skin and skull of adult female, both in good condition, collected 16 March 1988 by G. Nikolaus (GN5) at 2300 m at Gangirwal, Gotel Mts, south-eastern Nigeria.

Paratypes: 24 ex. (ZFMK 88.114, 88.116–124, SMNS 41296–308, 41313), same locality as holotype, 15–20 March 1988; 14 ex. (ZFMK 88.125–130, SMNS 41309–316), Chappal Waddi, 1900 m, 21–23 March 1988.

Diagnosis: A large and long-furred *Praomys* with 9 palatal ridges; similar to *P. hartwigi* Eisentraut, 1968, but with the dorsal pelage dusky in adults and slate grey in juveniles, lighter in weight and with smaller external and cranial dimensions. About 30 % of first upper molars with traces of a t3, molar pattern on average less stephanodont than in *hartwigi*.

Etymology: The specific epithet points out the dark (Latin: *obscurus*) colour of this forest rat.

Description: This is a large forest rat (head and body length 121 mm) with a long tail (133 % of HBL). All external measurements are very similar to *Praomys hartwigi* from Cameroon (Table 1, and Eisentraut 1968). However, the body weight of *obscurus* averages 10 grams lower than in *hartwigi*, meaning that the Nigerian rats

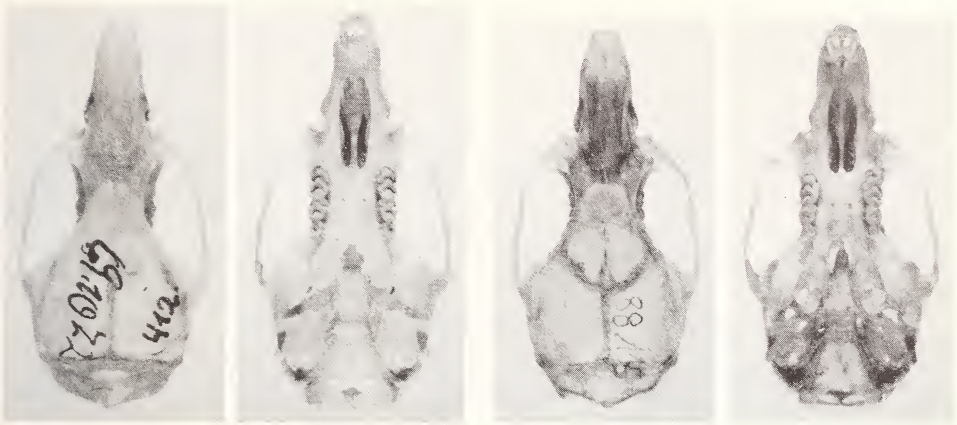

Fig. 1: Dorsal and ventral aspect of an adult cranium of *Praomys hartwigi* (ZFMK 69.1072; greatest length 33.0 mm) and of the holotype of *Praomys h. obscurus* n. ssp. (ZFMK 88.115; greatest length 31.7 mm).

are less heavily built. The fur is long and soft, about 13—14 mm at dorsum. In colouration the series from Nigeria is very uniform. The dorsal pelage is dusky brown in adults and slate grey in young animals; reddish-brown components are almost absent. Towards the flanks the dark tone becomes a little lighter. The venter is sharply set apart by grey hairs with short creamy tips. The dorsal surfaces of hands and feet are covered by short creamy hairs, a strip of dark colour runs down to the interdigit area. The tail is scaly, very short-haired and as dark as the dorsum. The ears have a similar colour and are also short-haired; in the juveniles a narrow white margin runs along the outer edge of the ear conch. Numerous whiskers of a length up to 42 mm are black at base and white at tip. The skull of *obscurus* (Fig. 1) is long but

Table 1: External measurements of *Praomys h. hartwigi* and *P. h. obscurus* n. ssp. (young adults to old adults only).

Weigth (g) and Measurements (mm)	*hartwigi* n = 11	*obscurus* n = 22
Weight	57.2 (44—69.5)	47.2 (34—60)
Head and body length	125.0 (115—134)	121.0 (108—137)
Tail length	162.1 (152—173)	161.0 (149—174)
Hindfoot length (c. u.)	26.5 (24—28)	27.1 (26—28)
Ear length	19.2 (17—20.5)	20.1 (19—21)

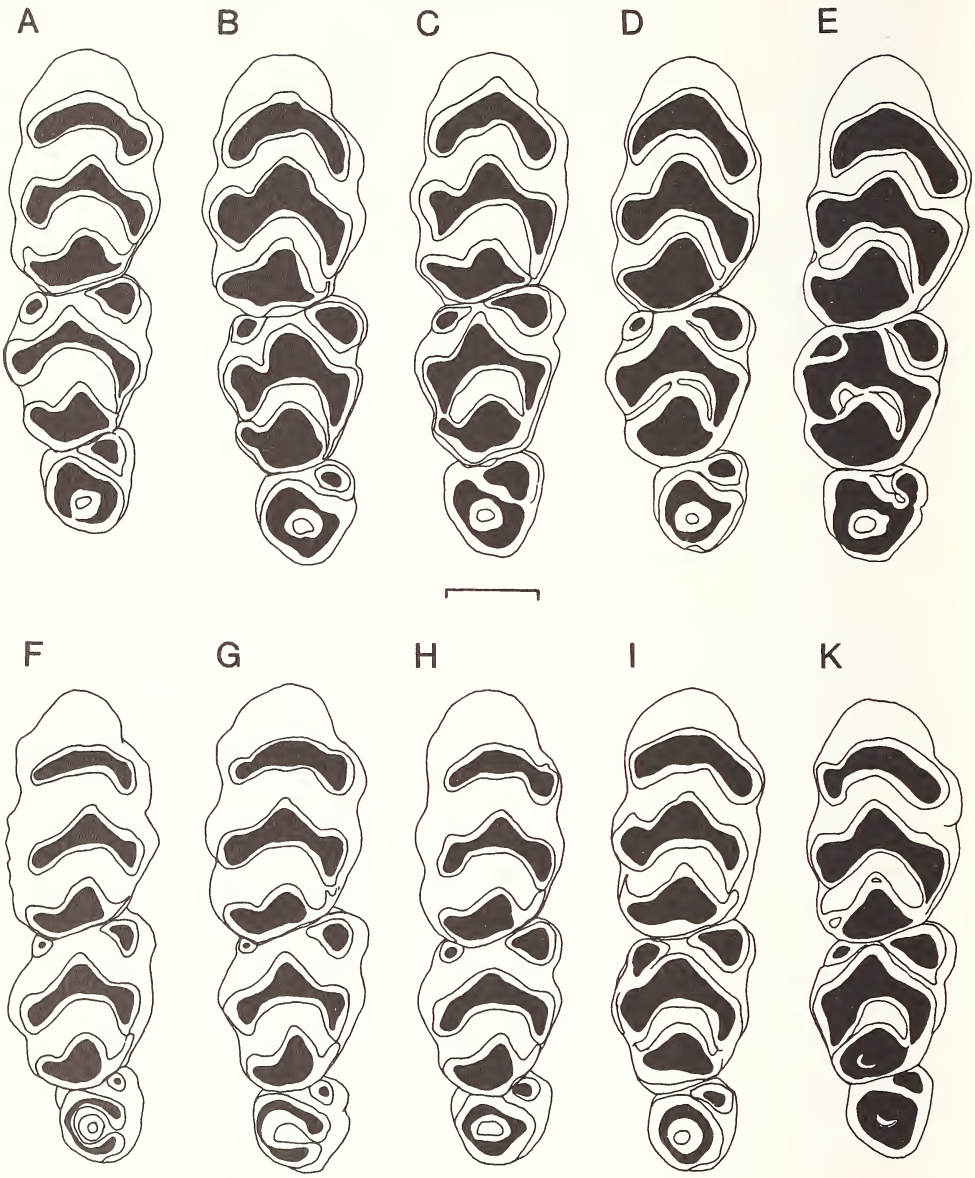

Fig. 2: Occlusal surfaces of right upper molars of *Praomys h. hartwigi* (A—E) and *P. h. obscurus* n. ssp. (F—K). A: ZFMK 69.1081, B: ZFMK 69.1075, C: ZFMK 69.1072, D: ZFMK 69.1078, E: ZFMK 68.7, holotype of *hartwigi*, F: ZFMK 88.122, G: ZFMK 88.130, H: ZFMK 88.121, I: ZFMK 88.126, K: ZFMK 88.115, holotype of *obscurus*. Scale = 1 mm.

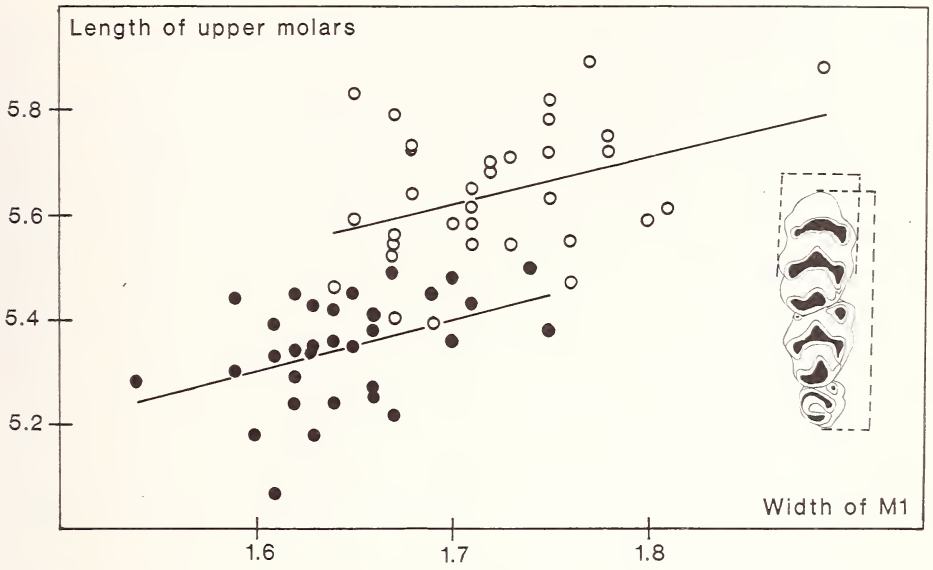

Fig. 3: Bivariate plot of "Width of M1" versus "Length of upper molars" for *Praomys h. hartwigi* (n = 33) and *P. h. obscurus* n. ssp. (n = 32); all ages and both sexes combined.

slightly smaller than in *hartwigi* (Table 2). Differences exist in the greatest length of skull, mastoid width, crown length of upper toothrow, and width of first upper molar (Figs 2, 3). The molars not only differ in size but also in the crown pattern (Fig. 2). While some show the "typical" *hartwigi* pattern with only t1 and t2 present at the first upper molar, 13 out of 33 specimens have at least traces of a t3 (Fig. 2 G), in some cases more than that (Fig. 2 K). Also, the arrangement of the first transverse laminae is strongly angular in *hartwigi* (Fig. 2 A—E) and less so in *obscurus* (Fig. 2 F—K). This also counts for the second lamina of the first and second molar, giving *obscurus* a less "stephanodont" aspect.

Discussion: With the present material at hand we cannot make a clear decision whether *obscurus* represents a subspecies of *hartwigi* (a view favoured by Dieterlen) or a different species (the view favoured by Hutterer). Both populations are separated by a distance of about 100 km and have not been found to occur in sympatry yet, which seems unlikely as both live in isolated forests on different plateaus. The morphological differences are obvious. However, within the genus *Praomys* both *hartwigi* and *obscurus* share a similarly long pelage, large body size, large molars, and similar skull proportions. Erik Van der Straeten (Antwerp), whom we consulted during our study, kindly performed a principal compound analysis with measurements he had taken from our specimens. His results are equally difficult to interpret: they show clear, statistically significant differences in skull measurements and proportions but also a slight overlap in all measurements, as can be seen in our bivariate diagram of molar dimensions (Fig. 3). We therefore describe the new rat as a subspecies of

Table 2: Cranial measurements of *Praomys h. hartwigi* and *P. h. obscurus* n. ssp. (young adults to old adults only).

Measurements (mm)	*hartwigi* n = 8–9	*obscurus* n = 15–22
Greatest length	32.6 (31.6–33.6)	31.4 (29.7–33.1)
Zygomatic width	15.6 (15.0–16.2)	15.4 (14.4–16.3)
Mastoid width	13.8 (13.3–14.1)	13.1 (12.7–13.9)
Interorbital width	4.8 (4.6–5.2)	4.9 (4.8–5.2)
Upper toothrow length (crown length)	5.6 (5.4–5.8)	5.3 (5.2–5.4)
M1–M1	7.0 (6.8–7.3)	6.8 (6.3–7.1)
Width of upper M1	1.71 (1.67–1.80)	1.65 (1.59–1.75)

hartwigi, leaving a final decision to future studies. The discovery of a high proportion of animals with traces of a t3 weakens the concept of a *tullbergi* (no t3) and *jacksoni* (t3 present) species group within *Praomys* (Petter 1965, Eisentraut 1970a, Van der Straeten & Dieterlen 1987). At least this character is no longer distinctive. One character, however, which supports the two species groups is the number of the palatal folds. As Eisentraut (1969b, 1970a) and Van der Straeten & Dieterlen (1987) pointed out, members of the so-called *tullbergi* group (*morio*, *tullbergi*, *rostratus*, *hartwigi*, *misonnei*) always have 2 + 7 = 9 palatal ridges, while members of the *jacksoni* group (*jacksoni*, *montis*, *mutoni*, *viator*, e. t. c.) have only 2 + 5 = 7. We have not yet found exceptions from this rule, and for the moment it remains the only constant character for the species groups.

Habitat: Of a total of 38 specimens, 36.8 % were collected in fern-grassland, 28.9 % in forest, 21.1 % along streams in forest, 7.9 % in gallery forest, and 5.3 % in forest swamp.

Reproduction: If a body weight of 40 g is considered as minimum for the reproductive activity of females, then four out of eleven adult females were reproductive in the second half of March; one was lactating, and three were pregnant with 4, 4 and 3 embryos respectively. One pair of pectoral and two pairs of inguineal teats are present. The maturation of males seems to happen at a body weight of 30–35 g, because the testis size increases abruptly at that weight and almost reaches its final size. Testis size was 5–6 mm in the size group 18–25 g (n = 3), 4–15 mm in size group 26–35 g (n = 7), 14–18 mm in size group 36–45 g (n = 3), and 16–18 mm in size group 46–58 g (n = 5).

Discussion: systematics and zoogeography

The present collection of 26 mammal species adds one genus and eight species (*Sylvisorex camerunensis*, *S. ollula*, *Crocidura attila*, *Pipistrellus kuhlii*, *Chaerephon*

ansorgei, *Chaerephon major*, *Mus setulosus*, *Otomys occidentalis*, *Praomys hartwigi obscurus*) to the fauna of Nigeria and one bat (*Tadarida aegyptiaca*) to the fauna of Cameroon. In contrast with the preliminary report of Dowsett (1989) 58 % of the identifications had to be corrected; a synopsis is provided in Table 3. It may be surprising for the non-specialist to recognize how difficult it seems to properly identify small mammals from these tropical regions. However, Africa is a huge continent, and only few geographical areas have been thoroughly studied; many more, including the Mambilla Plateau and the Gotel Mts, have never been surveyed for mammals before. Another aspect, perhaps more relevant, is the fact that tropical regions with a high topographic diversity like the Cameroon Mountains are "workshops of nature" (Bates 1926, Eisentraut 1970b) where palaeoclimatical changes and subsequent fragmentation of habitats and species' distributions may have resulted in a higher rate of speciation and extinction (see Vrba 1992 for a discussion of her "habitat theory").

Our study of the sample from south-eastern Nigeria not only leaves a number of problems like the correct identification of *Praomys* cf. *jacksoni* (?*viator*) and the unsolved species/subspecies status of *obscurus*, but also uncovered further systematic problems with already known and named taxa of Cameroon mammals. As a result we conclude that *Hylomyscus grandis* is a good species, not a subspecies of *aeta* as previously believed, and we propose also species status for *Lophuromys eisentrauti*

Table 3: Identifications of the mammals from the Gotel Mts and the Mambilla Plateau. Left, as published by Dowsett (1989), right, as given in the present paper.

Dowsett 1989	Present paper
Crocidura cf. *attila*	*Crocidura attila*
Crocidura (*flavescens*) *manni*	*Crocidura olivieri*
Sylvisorex (*granti*) *camerunensis*	*Sylvisorex camerunensis*
Sylvisorex megalura	*Sylvisorex megalura*
Sylvisorex ollula	*Sylvisorex ollula*
Rousettus angolensis	*Rousettus angolensis*
Epomops franqueti	*Epomops franqueti*
Micropteropus pusillus	*Micropteropus pusillus*
Rhinolophus alticolus	*Rhinolophus simulator*
Hipposideros ruber	*Hipposideros ruber*
Pipistrellus (?*eisentrauti*)	*Pipistrellus kuhlii*
Eptesicus capensis	*Eptesicus capensis*
Miniopterus schreibersii	*Miniopterus schreibersii*
Tadarida congica	*Tadarida aegyptiaca*
Tadarida major	*Chaerephon major*
Tadarida sp. (?*nigeriae*)	*Chaerephon ansorgei*
Otomys (*irroratus*) *burtoni*	*Otomys occidentalis*
Lemniscomys striatus	*Lemniscomys striatus*
Thamnomys rutilans	*Grammomys rutilans*
Mus minutoides	*Mus musculoides*
	Mus setulosus
Lophuromys sikapusi	*Lophuromys sikapusi*
Hylomyscus (*carillus*) *aeta*	*Hylomyscus stella*
Praomys morio	*Praomys* cf. *jacksoni*
Praomys hartwigi	*Praomys hartwigi obscurus*
Mastomys sp.	*Mastomys* sp.

and the shrew *Sylvisorex camerunensis*. We figure here the skin and skull of the holotype of *Lophuromys eisentrauti* to show the differences to the more common *L. sikapusi* (Figs 4, 5). Many other genera of mammals, among them *Hylomyscus*, *Hybomys*, *Otomys*, and *Cricetomys* are problematical in this geographical region and are in need of revision.

Such problems are critical for zoogeographical analyses, as a wrong taxonomy may spoil the entire analysis. Before we started to think about the relation of the newly studied fauna to other faunas of forest islands on different plateaus of the

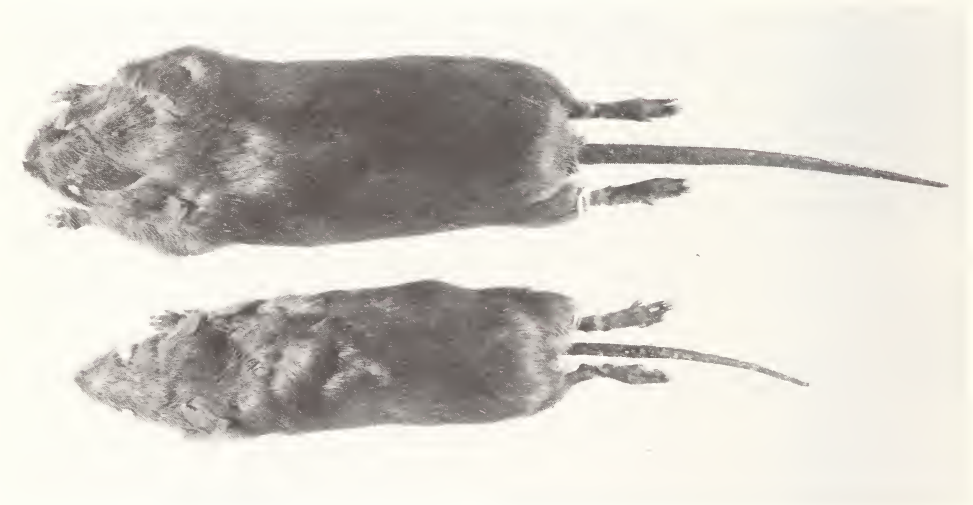

Fig. 4: Study skins in dorsal view of a *Lophuromys sikapusi* (ZFMK 69.289) from Mt Oku, and the holotype of *Lophuromys eisentrauti*, new rank (ZFMK 74.436), from Mt Lefo. Total length of *sikapusi* is 198 mm, and of *eisentrauti* 156 mm.

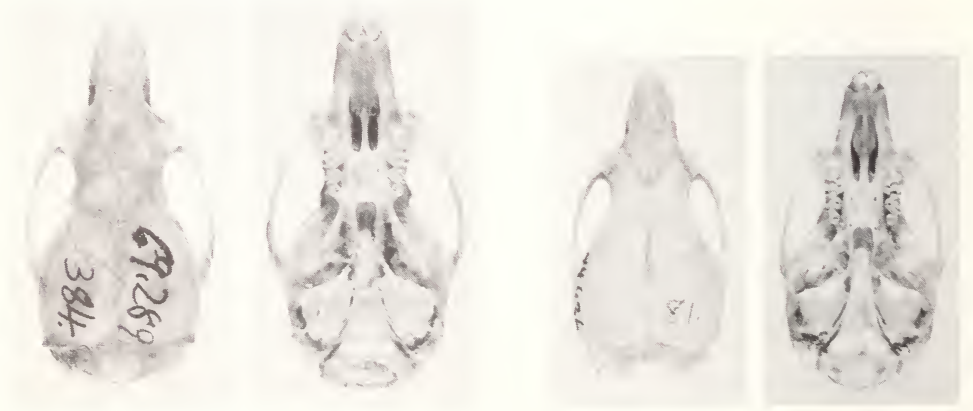

Fig. 5: Dorsal and ventral aspect of a cranium of *Lophuromys sikapusi* (greatest length 31.0 mm) confronted with the holotype of *Lophuromys eisentrauti*, new rank (greatest length 26.7 mm). Same specimens as in Fig. 4.

Cameroon Mountains system, we tried to solve as many systematic problems as possible. Some of them have been mentioned above, others will be dealt with in future reports.

Biogeographical analyses of mammals in the Cameroon area were previously done for some islands and mountains (Eisentraut 1968, Feiler 1988) on a merely descriptive basis but never in a quantitative and systematic manner. To biogeographically analyze the new Nigerian fauna we compared it with eight other mammal faunas (Fig. 6) which we have personally studied. They range from the island of Bioko (formerly Fernando Poo) in the south to the Adamaoua Plateau in the north. We selected 60 species (or subspecies, if distinct) of Insectivora and Rodentia and recorded the presence or absence of the 60 species for 9 mountain areas plus one outgroup. As outgroup we used the fauna of the Virunga Mts, based on the reports of Verschuren et al. (1983), Hutterer et al. (1987), and our own knowledge.

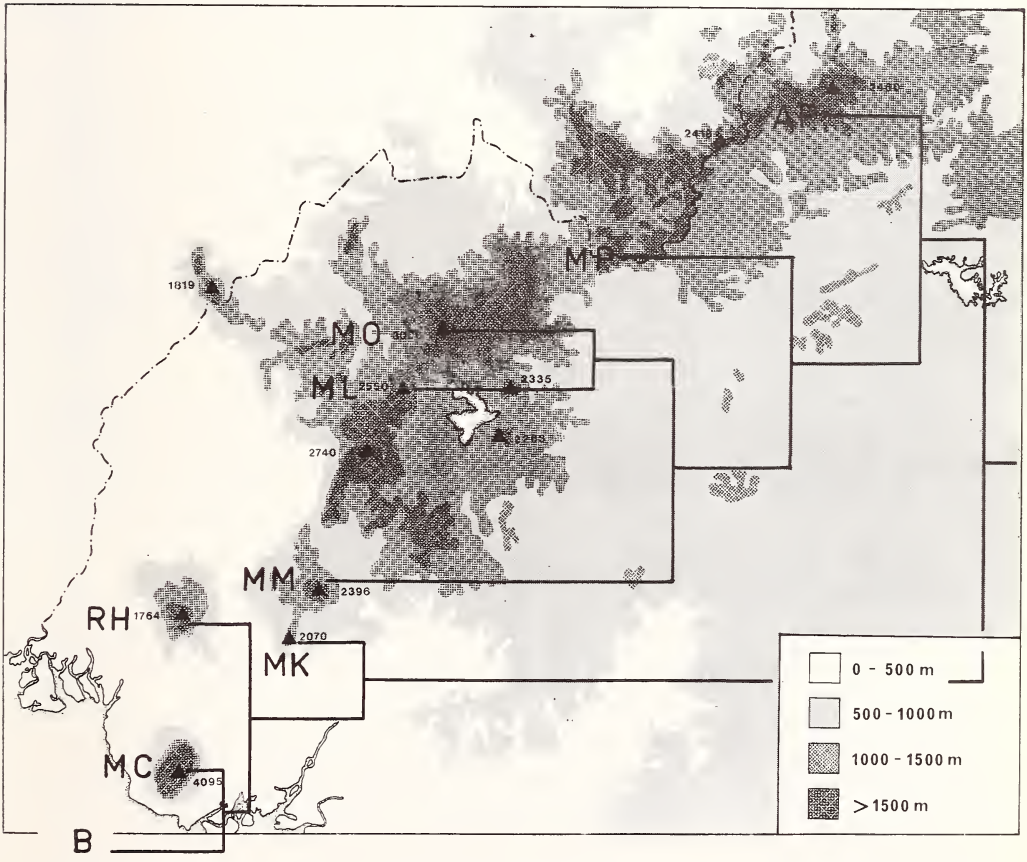

Fig. 6: Area cladogram of the insectivore and rodent faunas of eight forested mountain ranges and the island of Bioko (only indicated). Order from south to north: Bioko (B), Mt Cameroon (MC), Rumpi Hills (RH), Mt Kupe (MK), Mt Manenguba (MM), Mt Lefo (ML), Mt Oku (MO), Mambilla Plateau (MP), Adamaoua Plateau (AP); the fauna of the Virunga Mts was taken as the outgroup.

We restricted this analysis to the Insectivora and Rodentia, (1) because these groups are best represented in all collections studied, (2) because terrestrial, subterranean or scansorial animals are often tied to the forest and provide better area-specific information than other groups, and (3) because we know them best. We left the Chiroptera aside because even forest bats can fly over large distances and therefore do not provide much area-specific information. For example, *Pipistrellus eisentrauti* Hill, 1968 was first believed to be endemic to Cameroon but is now known to occur from Liberia (Koopman 1989) to Somalia (Varty 1986). Similarly, *Hipposideros camerunensis* Eisentraut, 1956, for long known from Cameroon only, has recently been found in Zaire and Kenya (Schlitter et al. 1986). On the other hand, *Myotis morrisi* Hill, 1971, formerly "endemic" to Ethiopia, was recently netted in Adamaoua Province, Nigeria (Hill et al. 1988).

Our data matrix was analyzed with the parsimony program PAUP (Swofford 1990) which shows the degree of similarity between samples. From the given data set only one tree resulted which is shown in Fig. 6. We are well aware that this is a preliminary analysis which has a number of limitations, such as the different degrees of completeness of the data sets, and which may be changed in the future by the input of new information. Nevertheless it offers some interesting information. The area cladogram shows a dichotomy between four areas in the south and five other areas further north. It is common knowledge that the fauna of Bioko is similar to that of Mt Cameroon, and the inclusion of the Rumpi Hills makes also sense. More unexspected is the clustering of Mt Kupe with Mt Cameroon and the Rumpi Hills. Mt Kupe is situated on a different plateau, but with its foothills still in the same rainforest zone as the two other mountains. However, the faunas of both Mt Kupe and the Rumpi Hills are not completely known and this clustering is still unsettled. Three other areas, Mt Manenguba, Mt Lefo and Mt Oku, group also together. They represent mountain forests on top of the Bamenda Plateau and share a number of species endemic to that plateau. These include *Praomys hartwigi*, *Hybomys eisentrauti* Van der Straeten & Hutterer, 1984, *Sylvisorex* cf. *isabellae* Heim de Balsac, 1968, and others. The forests of Mt Oku house also species which occur only there and nowhere else such as *Lamottemys okuensis* Petter, 1986, and an undescribed new species of tree rat. The fauna of the Mambilla Plateau groups next with the Bamenda Plateau, common taxa are *Otomys occidentalis* and *Praomys hartwigi*, although present in a distinct subspecies, *obscurus*. Next to the Mambilla Plateau branches the Adamaoua Plateau. However, the resolution of the last two branches is weak and may be modified by further species records. Particularly the relict forest fauna of the Adamaoua Plateau is still poorly known.

The preliminary biogeographical analysis offers two main results. First, forest relict faunas of the same plateau are more similar than between different plateaus, and second, the faunas of the southern mountains which stand within the lowland forest zone and Bioko island are more closely related to each other than to the faunas of the more northern plateaus. This result suggests the speculation that the present mammal fauna of the Cameroon Mountains chain is the result of different invasions from different parts of Africa. One faunal invasion clearly came from Central Africa via southern Cameroon, and most of Bioko's fauna originated from there. Other invasions may have populated the Cameroon Mountains from north-east, perhaps via

the Central African Republic. Also, faunal invasions from the west, particularly from northern Nigeria, must be considered. This is suggested by the recent finding of *Cryptomys foxi* Thomas, 1911 (type locality: Jos Plateau, Nigeria) near Ngaoundere east of the Adamaoua Plateau (Williams et al. 1984), and possibly *Praomys viator* will turn out to be another example of faunal relations with Nigeria. Much more sampling in these mountains and subsequent rigid systematic analyses have to be done before we can fill the empty space in the puzzle we have before us. However the information we have is already based on a lifetime's work of many dedicated experts, among them Martin Eisentraut, and therefore offers a unique basis for the understanding of species diversity and faunal turnover in tropical Africa.

Summary of systematic changes

Sylvisorex camerunensis stat. nov.
Sylvisorex granti camerunensis Heim de Balsac, 1968. Bonn. zool. Beitr. 19: 35. Lake Manenguba, 1800 m, Cameroon. Holotype ZFMK 69.358.

Hylomyscus grandis stat. nov.
Hylomyscus aeta grandis Eisentraut, 1969. Z. Säugetierkunde 34: 300. Lake Oku, 2100 m, Cameroon. Holotype ZFMK 69.731.

Lophuromys eisentrauti stat. nov.
Lophuromys sikapusi eisentrauti Dieterlen, 1979. Bonn. zool. Beitr. 29: 296. Mt Lefo, Cameroon. Holotype ZFMK 74.436.

Praomys hartwigi obscurus ssp. nov.
Praomys hartwigi obscurus Hutterer & Dieterlen, 1992. Bonn. zool. Beitr. 43: 402. Gangirwal, 2300 m, Gotel Mts, Nigeria. Holotype ZFMK 88.115.

Acknowledgements

Drs Erik Van der Straeten and Guy G. Musser examined critical specimens and Dr Dieter Kock informed us about molossid bats; we thank them for freely sharing their experience with us. Dr Renate van den Elzen run the PAUP analysis, Horst Meurer photographed the skins and skulls figured in this paper, and Dr Gustav Peters checked our language and style. Thanks to all for their courtesy.

Zusammenfassung

Eine Kleinsäugerfauna aus einem Bergmassiv im südöstlichen Nigeria und angrenzendem Kamerun wurde untersucht. Diese Berge tragen reliktäre Wälder, die Verbreitungsinseln für viele kleine Wirbeltiere darstellen. 26 Arten von Insektivoren, Fledermäusen und Nagern werden aus den Gotel-Bergen und dem Mambilla Plateau gemeldet. Davon sind 8 Arten neu für Nigeria und eine Fledermausart (*Tadarida aegyptiaca*) neu für Kamerun. An neuen Taxa enthält die Aufsammlung eine neue Grasratte, *Otomys occidentalis*, die separat beschrieben wird, und eine neue Subspezies von *Praomys hartwigi*, deren formale Beschreibung in diesem Bericht enthalten ist. Der systematische Status einiger problematischer Säuger wird diskutiert und Artrang vorgeschlagen für *Sylvisorex camerunensis*, *Hylomyscus grandis* und *Lophuromys eisentrauti*. Die Insektivoren- und Nagerfauna von neun verschiedenen Gebieten innerhalb des Kameruner Bergsystems wird analysiert und in Form eines Areal-Kladogramms präsentiert.

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Dr. Rainer Hutterer, Zoologisches Forschungsinstitut und Museum Alexander Koenig, Adenauerallee 162, 5300 Bonn 1. — Dr. Fritz Dieterlen, Staatliches Museum für Naturkunde, Schloß Rosenstein, 7000 Stuttgart 1. — Gerhard Nikolaus, Bosenbüttel 4, 2859 Spieka.

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