

A faunal survey in Kingu Pira (south Tanzania), with new karyotypes of several small mammals and the description of a new Murid species (Mammalia, Rodentia)

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ABSTRACT

A multidisciplinary approach combining morphology, classical morphometry and cytogenetics allowed to establish an updated taxonomic inventory of small mammals from Kingu Pira in the Selous region (south Tanzania). Among the 229 rodents and 21 shrews that were captured during the fieldwork in Ngarembé village in July 2003, 45 specimens were karyotyped. Concerning rodents, this allowed the description of a new karyotype of *Acomys* and *Grammomys*, while the cytotypes of *Paraxerus flavovittis* and *Pelomys fallax* are here figured for the first time. Taxonomic revisions of the literature allowed to clarify the status of *Lemniscomys rosalia* and *Aethomys chrysophilus* in Tanzania. Using a combination of morphological and cytogenetical characters, a new species of *Grammomys* is described. For shrews, we provide here the first description of *C. hirta* karyotype. Comparisons with voucher of genetically typed specimens of different east African collections confirmed the important biodiversity of this region for conservation and the necessity to preserve the coastal forest of south Tanzania.

KEYWORDS

Mammalia,
Rodentia,
Muridae,
Soricomorpha,
Africa,
Tanzania,
cytogenetics,
taxonomy,
new species.

RÉSUMÉ

Inventaire faunique dans la région de Kingu Pira (sud Tanzanie) et description de nouveaux caryotypes de petits mammifères et d'une nouvelle espèce de rongeur Muridae (Mammalia, Rodentia).

Une approche multidisciplinaire combinant morphologie, morphométrie classique et cytogénétique nous permet d'établir un inventaire taxonomique actualisé des petits mammifères dans la région de Kingu Pira dans le Selous (Sud de la Tanzanie). Parmi les 229 rongeurs et 21 musaraignes capturés au cours d'une mission de terrain dans le village de Ngarembé en juillet 2003, 45 spécimens ont fait l'objet de caryotypes standard. Pour les rongeurs, nous avons pu décrire un nouveau caryotype d'*Acomys* et de *Grammomys*, tandis que les cytotypes de *Paraxerus flavovittis* et *Pelomys fallax* sont déterminés pour la première fois. Une révision des données de la littérature a permis de faire une mise au point sur le statut de *Lemniscomys rosalia* et *Aethomys chrysophilus* en Tanzanie. La combinaison des caractères morphologiques et cytogénétiques nous permet de décrire une nouvelle espèce de *Grammomys*. Pour les musaraignes, nous fournissons la première description du caryotype de *C. hirta*. La comparaison avec des spécimens de collections d'Afrique de l'Est ayant fait l'objet de typages génétiques confirme l'importante biodiversité de cette région pour la conservation et la nécessité de préserver la forêt côtière du Sud de la Tanzanie.

MOTS CLÉS

Mammalia,
Rodentia,
Muridae,
Soricomorpha,
Afrique,
Tanzanie,
cytogénétique,
taxonomie,
espèce nouvelle.

INTRODUCTION

Systematics has recently benefited from new biological techniques and concepts such as those developed in molecular phylogenetics, molecular cytogenetics

or geometric morphometric analyses. The integration of all these techniques provides a powerful tool to more accurately identify small mammal taxa, which constitute about 80% of the mammalian biodiversity in Africa (Denys *et al.* 2003). Indeed,

recent works have emphasized that the level of small mammal biodiversity is underestimated, especially in rodents, due to taxa being lumped because of similar morphology, whereas genetic divergence among these taxa is significant (Taylor 2000; Dobigny *et al.* 2003; Corti *et al.* 2004; Lecompte *et al.* 2005).

Due to the diversity of its habitats and environments, created, in part, by the major fault line of the Rift Valley extending from Ethiopian and Kenyan high plateaux to north Tanzania famous grasslands of the Serengeti, East Africa represents one "hot-spot" of biodiversity (Myers *et al.* 2000). In this region, many high reliefs have also created islands of diversity, which have promoted speciation of all taxa (Kindgon 1974; Demeter & Hutterer 1986; Goodman *et al.* 1995; Stanley *et al.* 1996, 1998; Clausnitzer & Kityo 2001; Kasangaki *et al.* 2003; Carleton & Stanley 2005; Huhndorf *et al.* 2007, Mulungu *et al.* 2008). Especially, new rodents and other small mammal species have recently been described in the eastern Arc Mountains of East and central Tanzania (Stanley & Hutterer 2000; Carleton & Stanley 2005; Stanley *et al.* 2005). Also, some isolated forests have preserved relict taxa of central Africa which considerably extend their geographical distribution (Stanley & Foley 2008).

The southeastern region of Tanzania has received less attention until now; the relief is low and a coastal forest has developed in the plain of the Pwani and Lindi districts. The landscape is also fragmented by a succession of west-east flowing rivers which cross the landscape till the Mozambique border and are associated with permanent swamp regions. These rivers include the Wami, Rufiji and great Ruhaha, the Luwego, Mbenkuru, Lukuledi, the Rio Rovuma. The Rufiji river, which constitutes the northern border of the Selous Game Reserve, has the largest water catchment in east Africa, and massive amounts of silt flow into the Indian Ocean annually during the wet season. Surrounded by these rivers and limited to the east by some mountains and rift escarpment, the Selous Game Reserve is a 55000 square kilometres protected area and one of the largest game reserves in the world, established in 1922 (Fig. 1). The Selous has long been recognized as an important area for conservation of the large

mammals. According to the definition of terrestrial ecoregions of the world by Olson *et al.* (2001), the Selous Game Reserve belongs to the eastern Miombo woodlands ecoregion and the northern and southern Zanzibar-Inhambane coastal forest mosaics, whose transition is not clear and has been situated at the Lukuledi River in south Tanzania, surround it in the east. The terrestrial small mammal biodiversity of the Selous Game Reserve is poorly known. The reserve is surrounded by geographic barriers such as rivers and mountains and has peculiar mosaic vegetation, which may hide underestimated cryptic small-mammal diversity.

Although previous small-mammal systematic surveys have been conducted either on the highlands zones of central Tanzania as cited above or in the Serengeti (north Tanzania) (Swynnerton 1958; Kingdon 1974; Lavrenchenko *et al.* 1998; Fadda *et al.* 2001; Corti *et al.* 2004, 2005) and from Zambia to South Africa (Burda 2001; Mullin *et al.* 2004), the small mammals from the Coastal region of southeastern Tanzania remain poorly known.

As a contribution to the knowledge of biodiversity of this region, we present here the results of a taxonomic inventory of terrestrial small mammals in the Kingu Pira zone at the eastern entrance of the Selous Game Reserve using a combined morphological, morphometric, cytogenetical and molecular approach. We aim to provide better discrimination between sibling species and bring new identification characters for future studies.

MATERIAL AND METHODS

Trapping took place from 5 to 10 July 2003. Rodents were captured using Sherman traps and by hand. Eight trap lines (A to H) were run during three nights each (except line G and H which were maintained for 2 nights only) both in anthropogenic and natural environments. Lines A, B and C were put in the vicinity of Ngarembé village in the residential area (Table 1, Fig. 2), lines D and E were situated in the logging area, lines F and H in the Kichi coastal forest and finally line G in the resident hunting area (Acacia woodland zone). Each trap line usually comprised 100 traps, placed 10 m apart. The baits used were

peanut butter and maize flour with oil. The traps were checked every morning for night captures and re-baited each evening. About 10 additional traps were set with no standardized protocol and were distributed to people to be placed in houses.

All the animals captured were sacrificed using cervical dislocation, and autopsied by one of us (É. L.). Classical measurements (weight, head and body length, tail length, ear length and hind foot length with claws apart) were only taken by one of us in the field (É. L.); the reproductive condition was noted (testes position-scrotal or abdominal and size for males; opening of the vagina, presence of placental scars or embryos, and nipples appearance for females), as well as any other potentially informative detail. Organs (liver, kidney, spleen) were preserved in 90% ethanol for future molecular studies, and the carcasses were fixed in formalin for later preparation as skin and skull specimens. Except when stated, the nomenclature follows Wilson & Reeder (2005).

Forty five specimens were kept for standard karyotypic analyses directly in the field by one of us (V. A.). Metaphase chromosome preparations were obtained by standard colchicine method according to protocols in Lee & Elder (1980) and Seabright (1971). Few specimens were sequenced by one of us (É. L.) for fast molecular taxonomy identification (cyt B, BLAST).

Standard skull measurements were taken by one of us (C. D.) for each specimen by using a Mitutoyo calliper with a 0.01 mm resolution. Comparisons were made either with the use of measurements made on type specimens or voucher specimens or using data from the literature. The relative age of the specimens is examined through the weight and dental rows wear (Lalis *et al.* 2006). Drawings were made through a camera lucida on a binocular at 25 magnification. Standard descriptive and classical multivariate statistical analyses like principal component and canonical analyses were performed either on external measurements or skull distances using XLSTAT software version 7.1 (Addinsoft).

The whole series of voucher specimens is deposited in the collections of Muséum national d'Histoire naturelle, Paris under General catalogue numbers from CG2007-996 to CG2007-1261.

ABBREVIATIONS

Countries and localities

BEA	British East Africa;
CAR	Central African Republic;
DRC	Democratic Republic of the Congo;
E	Ethiopia;
EG	Equatorial Guinea;
K	Kenya;
KP	Kingu Pira (Tanzania);
MA	Malawi;
MZ	Mozambique;
RSA	Republic of South Africa;
S	Sudan;
SO	Somalia;
TZ	Tanzania;
Z	Zimbabwe.

Institutions

BMNH	Natural History Museum, London;
DM	Durban Natural Science Museum;
FMNH	Field Museum of Natural History, Chicago;
MNHN	Muséum national d'Histoire naturelle, Paris;
NMH	Natural History Museum, London;
SMMN	National Museum of Namibia, Windhoek;
TM	Transvaal Museum, Pretoria;
ZFMK	Museum Alexander Koenig, Bonn;
ZMB	Berlin Museum für Naturkunde.

Karyotype

2n	diploid number of chromosomes;
AC	acrocentric chromosome;
FN	fundamental number of chromosomal arms;
FNa	number of autosomal arms;
MC	metacentric chromosome;
SM	submetacentric chromosome;
ST	subtelomeric chromosome.

External measurements

E	ear length;
HB	head and body length;
HF	hindfoot length;
TL	tail length;
W	body weight.

Skull measurements

CIO	width of the interorbital constriction;
HMDB	height of the mandible;
LI13	length of the lower molar row;
LBT	length of the tympanic bulla;
LGT	greatest length of the skull;
LFOINC	length of the incisor foramen;
LMDB	length of the mandible;
LNAS	length of the nasal bone;
LS13	length of the upper molar row;
WBR	width of the braincase;
WNAS	width of the nasal bone;

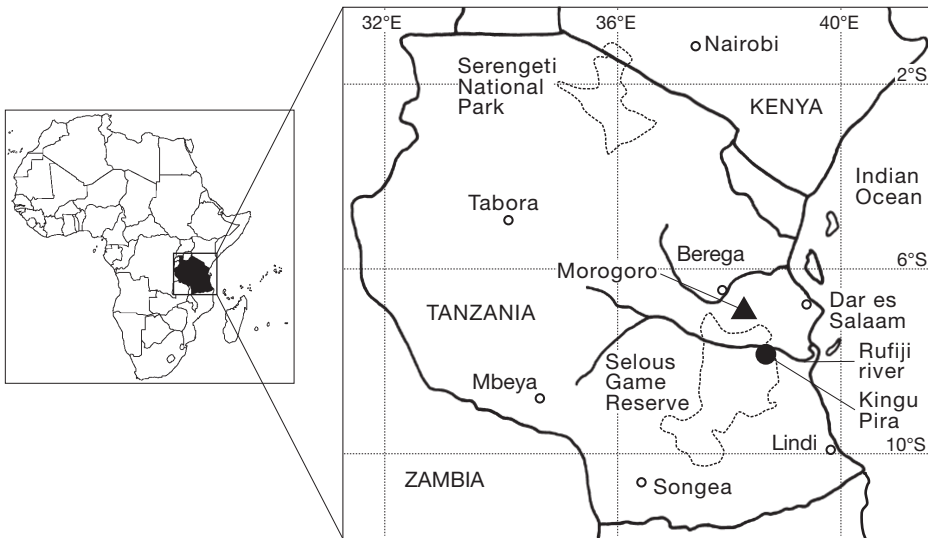


FIG. 1. — The study area in the vicinity of Kingu Pira, Tanzania, is located just south of Rufiji river at the entrance of the Selous Game reserve. Symbols: (▲) Morogoro; (●) KP (Kingu Pira).

WT4	width of the palate between the two upper molars at the t4 level;	sel	<i>Grammomys selousi</i> n. sp.;
WZYG	bizygomatic width.	spo	<i>Grammomys spoliomops</i> Osgood, 1910;
		sur	<i>Grammomys surdaster</i> Thomas & Wroughton, 1908;
<i>Species</i>		usa	<i>Grammomys usambara</i> (Matschie, 1915).
ari	<i>Grammomys aridulus</i> Thomas & Hinton, 1923;	<i>Specimen</i>	
bal	<i>Grammomys baliolus</i> (Osgood, 1910);	HT	holotype;
bre	<i>Grammomys brevirostris</i> Kryštufek, 2008;	PT	paratype;
but	<i>Grammomys butingi</i> Thomas, 1911;	T	type;
can	<i>Grammomys caniceps</i> Hutterer & Dieterlen, 1984;	TS	types species.
com	<i>Grammomys cometes</i> Thomas & Wroughton, 1908;	<i>Statistics</i>	
dis	<i>Grammomys discolor</i> (Thomas, 1910);	CVA	canonical variance analysis;
dol	<i>Grammomys dolichurus</i> Smuts, 1832;	N	number of individuals;
dry	<i>Grammomys dryas</i> Thomas, 1907;	PCA	principal component analysis;
elg	<i>Grammomys s. elgonis</i> (Thomas, 1910);	SD	standard deviation.
gaz	<i>Grammomys gazellae</i> Thomas, 1910;		
gig	<i>Grammomys gigas</i> Dollman, 1911;		
ibe	<i>Grammomys ibeanus</i> Osgood, 1910;		
ins	<i>Grammomys insignis</i> (Thomas, 1911);		
kem	<i>Grammomys kempi</i> Dollman, 1911;		
lut	<i>Grammomys s. lutosus</i> Dollman, 1911;		
mac	<i>Grammomys macmillani</i> (Wroughton, 1907);		
min	<i>Grammomys minnae</i> Hutterer & Dieterlen, 1984;		
nat	<i>Grammomys natalensis</i> Smith, 1834;		
po	<i>Grammomys poensis</i> (Eisenraut, 1965);		
rut	<i>Grammomys rutilans</i> Peters, 1876;		
sil	<i>Grammomys silidensis</i> Roberts, 1938;		

RESULTS

TRAPPINGS

Details of vegetation and captures of each line are provided in Table 1. A total of 250 rodents and shrews was obtained in 1967 night-traps which represents a trapping success of 12.7%. Trapping success and species composition varied considerably between lines (Table 1). In fields and fallow zones (lines A, B, C, and E) *Mastomys* was dominant and constitutes 80%

TABLE 1. — Kingu Pira line trapping success per species, trap line and habitat description and GPS coordinates. Abbreviations: **N**, individual occurrence in each line; **%**, percentage of captured individuals of each taxa per line compared to the whole number of captures; **Night traps**, number of traps per line × number of nights; **Trapping success**, number of captures / number of night traps × 100; **Mean TS**, average trapping success for the whole lines.

Trapping line and species	N	%	Trap line and habitat description
Line A			Maize field close to village
<i>Crocidura hirta</i> Peters, 1852	3	1.2	08°26'53"S, 38°36'48"E
<i>Mastomys natalensis</i> Smith, 1834	63	25.2	Night traps: 200
<i>Rattus rattus</i> Linnaeus, 1758	1	0.4	Trapping success: 32.5%
Total captures	67		
Line B			River bed close to fields
<i>Crocidura hirta</i>	3	1.2	08°26'52"S, 38°36'46"E
<i>Mastomys natalensis</i>	67	26.8	Night traps: 300
Total captures	70		Trapping success: 23.33%
Line C			Bush-fallow close to the village
<i>Gerbilliscus leucogaster</i> (Peters, 1852)	1	0.4	08°26'52"S, 38°36'46"E
<i>Lemniscomys rosalia</i> Thomas, 1904	1	0.4	Night traps: 267
<i>Mastomys natalensis</i>	54	21.6	Trapping success: 21.35%
<i>Mus minutoides</i> Smith, 1834	1	0.4	
Total captures	57		
Line D			Swamp close to cultivated fields and bush
<i>Acomys</i> sp.	2	0.8	08°26'10"S, 38°38'11"E
<i>Aethomys chrysophilus</i> de Winton, 1897	1	0.4	Night traps: 300
<i>Crocidura hirta</i>	14	5.6	Trapping success: 14.67%
<i>Mastomys natalensis</i>	25	10	
<i>Mus minutoides</i>	1	0.4	
<i>Pelomys fallax</i> Peters, 1852	1	0.4	
Total captures	44		
Line E			Degraded woodland with recent fires
<i>Lemniscomys rosalia</i>	1	0.4	08°26'13"S, 38°38'09"E
<i>Mastomys natalensis</i>	4	1.6	Night traps: 200
Total captures	5		Trapping success: 2.5%
Line F			Kichi coastal lowland forest
<i>Beamys</i> cf. <i>hindei</i> Thomas, 1909	3	1.2	08°17'30"S, 38°39'10"E
<i>Grammomys selousi</i> n. sp.	2	0.8	Night traps: 300
<i>Hystrix</i> sp.			Trapping success: 1.67%
Total captures	5		
Line G			Open woodland
<i>Crocidura hirta</i>	1	0.4	08°27'14"S, 38°35'18"E
<i>Paraxerus flavovittis</i> (Peters, 1852)	1	0.4	Night traps: 200
Total captures	2		Trapping success: 1%
Line H			Degraded coastal forest
			08°17'20"S, 38°39'11"E
			Night traps: 200
Total captures	0		Trapping success: 0%
Total	250	100	Total night traps: 1967, Mean TS: 12.7

to 96% of the captures. In line D, *Mastomys* was still dominant with 56.8% and it was absent from the more protected zones of lines F and G.

Thirteen species were found to occur in the Kingu Pira area and there were more species of rodent than of *Soricomorpha*. Most of the rodents belong

to the family Muridae with *Mastomys natalensis* Smith, 1834, being highly dominant (83.52%), followed by other Murinae and Deomyinae, in very low proportions (between 0.38% to 1.15% each) but representing high diversity including *Aethomys*, *Acomys*, *Pelomys*, *Grammomys*, *Lemniscomys*, *Mus* (*Nannomys*), and *Rattus*. The subfamilies Nesomyinae and Gerbillinae are represented by *Beamys* (1.15%) and *Gerbilliscus* (0.77%), respectively. Other families of rodents documented include Sciuridae, represented by *Paraxerus* (0.38%), and Hystricidae, represented by *Hystrix* sp. (this taxon was not trapped but its quills were collected). In addition to trapped specimens, *Paraxerus* were also observed twice.

The second most abundant taxon was *Crocidura*, representing 8.4% of the captures (Table 1).

SPECIFIC TAXONOMIC ACCOUNT

The following accounts summarize specific morphological and karyological characteristics of each species trapped.

Order RODENTIA Bowdich, 1821

Family MURIDAE Illiger, 1811

Subfamily DEOMYINAE Thomas, 1888

Genus *Acomys* I. Geoffroy, 1838

Acomys sp. indet.

Tanzania hosts at least four species of spiny mice: *Acomys ignitus* Dollman, 1910, *A. kempi* Dollman, 1911, *A. wilsoni* Thomas, 1892, *A. spinosissimus* Peters, 1852 (Barôme *et al.* 2001). The *A. spinosissimus* complex may comprise at least 4 species according to Walter Verheyen (pers. comm.) and the separation of *A. selousi* de Winton, 1896 from *A. spinosissimus* was claimed by Barôme *et al.* (2001). Only one individual of spiny mouse was found in line D in herbs of a swamp zone which is an unusual habitat for the genus which prefers rocky areas. The belly is white and the dorsal pelage is orange-light brown. Its general size is medium and the tail rather long but slightly shorter than the HB. This last character eliminates *A. wilsoni*, which has a shorter tail (between 42

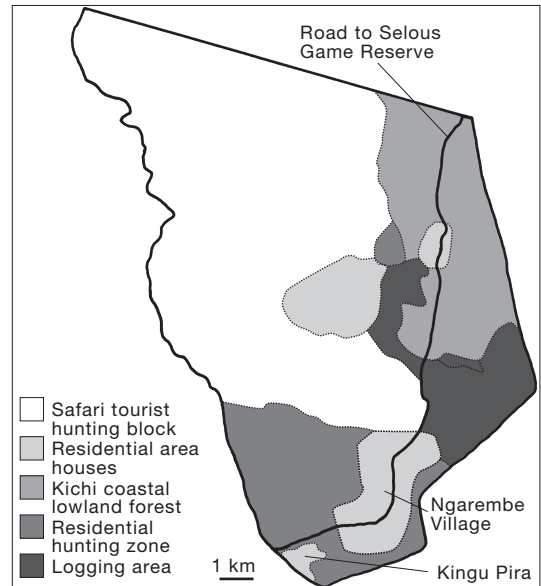


FIG. 2. — Map of the Ngarembé region with the resource zoning Plan. The road runs from north to south across the Kichi forest, a small residential area, the logging area, Ngarembé village, the residential hunting area and enters the Selous Game reserve at Kingu Pira barrier.

to 48 mm according to Kingdon (1974) and a smaller external size (Table 2). The Kingu Pira specimen is smaller than the *A. spinosissimus* holotype from Mozambique and has a similar HB but a smaller TL compared to the *A. selousi* holotype (Table 2).

The karyotype of the only female of Kingu Pira studied here is characterized by $2n = 62$ and $FN_a = 78$ (Fig. 3), which is close to that published by Fadda *et al.* (2001) and Corti *et al.* (2005) attributed to *A. wilsoni*. The slight differences in the FN_a values, 78 vs. 76, result from difficulty to distinguish between one small pair, which may be considered as subtelocentric or acrocentric. However both are different from the first description of chromosomes of *A. wilsoni* by Matthey (1968) who established $2n = 60$ and $FN_a = 70$ (Table 3). The karyotype of MNHN-CG2007-1230 is also different from that of *A. cf. selousi* from Berega (Tanzania) (Barôme *et al.* 2001), which may represent a new species (W. Verheyen pers. comm.), and from that of *A. spinosissimus* described by

TABLE 2. — External measurements (in millimetres) of *Acomys* spp. Holotypes come from BMNH and ZMB; karyotyped or molecularly typed specimens from MNHN Paris collections are noted with an asterisk and some are listed from Barôme *et al.* (2001) and Matthey (1965). The 8 specimens of *A. wilsoni* are numbered CG1974-23, CG1974-25, CG1974-26, CG1974-28, CG1974-29, CG1974-31, CG1974-32 and CG1978-219. Abbreviations: see Material and methods.

Species	Specimen	Country	HB	TL	E	HF
<i>Acomys</i> sp.	MNHN-CG2007-1230	Tanzania, KP	80	61	14	15.5
<i>A. spinosissimus</i> Peters, 1852	MNHN-CG1998-1611*	Tanzania	91	73	14.7	15.1
<i>A. spinosissimus</i>	MNHN-CG1999-74*	Malawi	94.5	87	16	16.5
<i>A. spinosissimus</i>	MNHN-CG99-36*	Malawi	84.5	89	14	16
<i>A. spinosissimus</i>	Lectotype	Mozambique	100	85	18	13.5
<i>A. selousi</i> de Winton, 1896	MNHN-CG1964-53	Tanzania	80	53+	15	17
<i>A. selousi</i>	BMNH 74.814	Zambia	82	72	15	18
<i>A. selousi</i>	Holotype	Zimbabwe	83	92.5	16.5	14
<i>A. selousi</i>	BMNH 74.813	Zambia	84	67	15	16
<i>A. selousi</i>	BMNH 7.6.2.82	Mozambique	91	78	12	16
<i>A. selousi</i>	BMNH 7.6.2.81	Mozambique	93	87	15	17
<i>A. selousi</i>	BMNH 7.6.293	Mozambique	78	60	12	17
<i>A. brockmani</i> Dollman, 1911	Holotype	Somalia	105	105	18	17
<i>A. wilsoni</i> Thomas, 1892	MNHN (N = 8)	Ethiopia	81.5	48.6	12.3	13.5
<i>A. w. wilsoni</i>	Holotype	Kenya	80	48	8.5	12
<i>A. w. argillaceus</i> Hinton & Kershaw, 1920	Holotype	Sudan	76	51	12	10
<i>A. ablutus</i> Dollman, 1911	Holotype	Kenya	77	55	12.5	13
<i>A. ignitus</i> Dollman, 1910	Holotype	Kenya	109	89	16.5	17
<i>A. kempfi</i> Dollman, 1911	Holotype	Kenya	103	106	16	17

TABLE 3. — Cytogenetical data for *Acomys* spp. from Kingu Pira compared with other literature data and to Dakawa (Morogoro region in Tanzania). We have kept the original names given by previous authors in the literature, pending a further revision of all the specimens to clarify the taxonomic situation. Abbreviations: see Material and methods.

Taxon/specimen	2n	FNa	Origin	Authors
<i>Acomys</i> sp. MNHN-CG2007-1230	62	78	Tanzania, KP	this work
<i>Acomys</i> sp.	60-61	68-69	Tanzania	Barôme <i>et al.</i> 2001
	60	68	Tanzania	Verheyen <i>et al.</i> unpubl. data
<i>A. spinosissimus</i> Peters, 1852	56-62	68-75	Mozambique	Matthey 1965, 1968
<i>A. spinosissimus</i>	60	68	South Africa	Dippenaar & Rautenbach 1986
<i>A. cf. selousi</i> de Winton, 1896	60	70	Tanzania	Fadda <i>et al.</i> 2001; Corti <i>et al.</i> 2005
	36	66	Ethiopia	Matthey 1968
	59	68	Tanzania, Dakawa	Corti <i>et al.</i> 2005
<i>A. wilsoni</i> Thomas, 1892	60	76? (FN)	Ethiopia	Matthey 1968
	62	76	Tanzania	Fadda <i>et al.</i> 2001; Corti <i>et al.</i> 2005
<i>Acomys</i> sp. 1	59-60	68	Tanzania	Verheyen <i>et al.</i> unpubl. data
	58-62	68-76	Tanzania	Verheyen <i>et al.</i> unpubl. data
<i>A. ignitus</i> Dollman, 1910	50	66-70 (FN)	Kenya	Matthey 1956, 1968
<i>A. cf. ? ignitus</i>	36	68	Tanzania	Fadda <i>et al.</i> 2001; Corti <i>et al.</i> 2005
MNHN-CG2007-1258	61	68	Tanzania, Dakawa	this work
MNHN-CG2007-1259	59	68	Tanzania, Dakawa	this work
MNHN-CG2007-1261	59	68	Tanzania, Dakawa	this work

Dippenaar & Rautenbach (1986). It is also different from the karyotype of the so-called *A. spinosissimus* of south Tanzania and Masai steppe

described by Fadda *et al.* (2001) and Corti *et al.* (2005) ($2n = 60$, FNa = 70). A thorough banding analysis is needed to elucidate the nature of

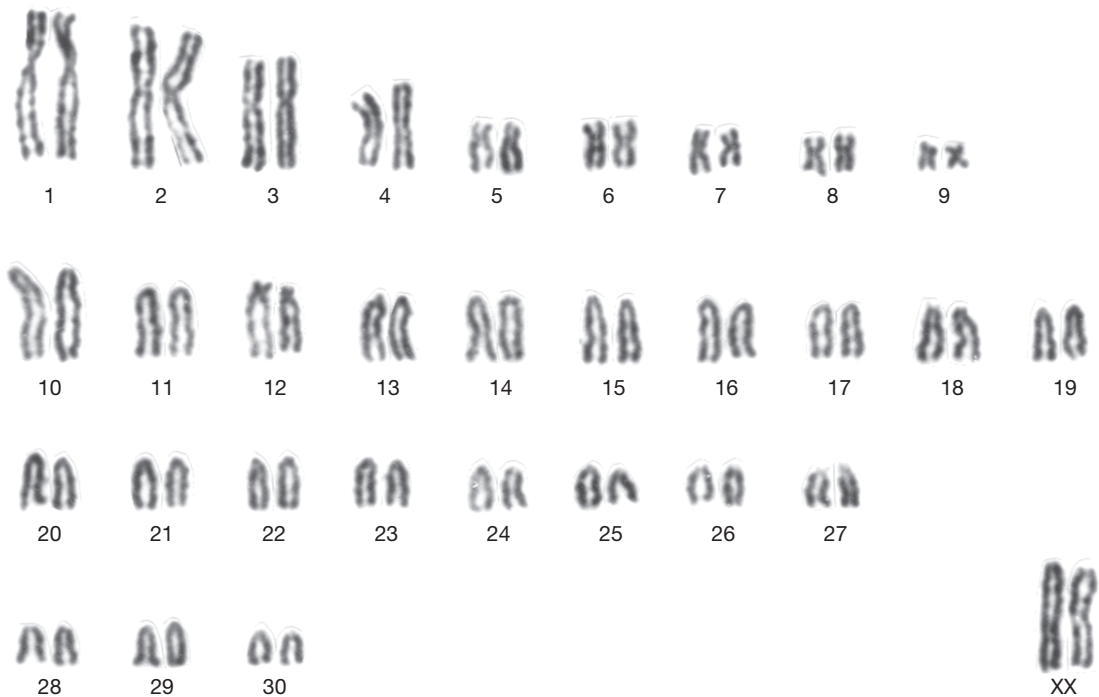


FIG. 3. — Standard karyotype of female *Acomys* sp. specimen (MNHN-CG2007-1230).

this mismatch. However, the type specimen of *A. wilsoni* comes from Mombasa (Kenya) and has different characters from the so-called *A. wilsoni* from Ethiopia karyotyped by Matthey (1968). We also found in Dakawa another karyotype which does not correspond to previous published ones (Table 3). The type specimens of *A. selousi* come from Zambia and that of *A. spinosissimus* from Mozambique.

By referring only to the type specimens of *A. spinosissimus* and *A. wilsoni*, as well as to specimens karyotyped by Matthey, from a morphological point of view, and according to preliminary cytB results, we assume that the specimens from Kingu Pira (and probably those of Fadda *et al.* [2001]) may belong to a new yet undescribed species. Further molecular and morphometric analyses are requested to definitively conclude on this identification problem (Verheyen *et al.* unpubl. data).

Subfamily MURINAE Illiger, 1811
Genus *Aethomys* Thomas, 1915

Aethomys chrysophilus (de Winton, 1852)

Mus chrysophilus de Winton, 1852: 801.

In Kingu Pira, line D provided one large *Aethomys*. In Tanzania *A. hindei* Thomas, 1902, *A. kaiseri* Noack, 1887 and *A. chrysophilus* de Winton, 1897 are coexisting (Kingdon 1974). In their revision of the *A. hindei* complex, Denys & Tranier (1992) provided some criteria to separate between those species based on dental, skull and external morphology. The Kingu Pira specimen is attributed to *A. chrysophilus* due to the very long tail (Table 4), the characteristic skull and dental morphology (cf. Denys & Tranier 1992). A CVA analysis performed upon the four external measurements including topotypes specimens of *A. hindei* (type locality of Machakos, Kenya) and *A. chrysophilus* from

TABLE 4. — Measurements (in millimetres) for the external standard biometric characters of *Aethomys chrysophilus* de Winton, 1897 and *A. hindei* Thomas, 1902 populations. For *A. hindei*, specimens from Machakos (type locality, south Kenya) and Dakawa localities have been pooled. For *A. chrysophilus*, the southern specimens belong to the Tanzanian localities of Morogoro, Ruaha, Sangasanga, Songea, Mkundi and Dakawa, while the northern specimens all come from Kanyelele locality (Verheyen pers. comm.). Largest and smallest mean values are indicated in bold and italics respectively. Abbreviations: see Material and methods. Note: *, see legend for a list of localities.

Taxon/specimen	Origin	Parameter	W	HB	TL	HF	E
<i>A. chrysophilus</i> MNHN-CG2007-1248	KP		60	124	166.5	27.5	21
<i>A. chrysophilus</i>	south localities *	N	22	22	22	22	22
		Minimum	27.0	108.0	130.0	24.6	17.2
		Maximum	100.0	152.0	191.0	29.5	21.5
		Mean	64.718	135.4	162.0	27.2	19.2
		SD	0.253	0.081	0.110	0.047	0.048
<i>A. chrysophilus</i>	north locality (Kanyelele)	N	11	11	11	11	11
		Minimum	26.0	101.0	124.0	24.8	16.8
		Maximum	72.0	145.0	170.0	28.0	19.8
		Mean	44.0	121.6	145.7	26.7	18.4
		SD	0.340	0.115	0.093	0.042	0.061
<i>A. hindei</i>	Machakos and Dakawa	N	26	26	25	26	26
		Minimum	25.0	98.0	91.0	20.0	16.0
		Maximum	130.0	168.0	149.0	31.0	23.0
		Mean	79.9	137.1	127.6	26.4	20.1
		SD	0.321	0.141	0.123	0.099	0.075

northern and southern Tanzania displays a good distinction between the three groups (Fig. 4) with an overall rate of classification error of 13.56%. All *A. hindei* were 100% well classified, against 99.76% of the *A. chrysophilus* for which one individual was classified as *A. hindei*. The most confusion occurred between north and south *A. chrysophilus* which have some overlap on the graph. On Figure 4, the Kingu Pira specimen is morphologically close to specimens of the Morogoro and southern Tanzanian localities attributed to *A. chrysophilus*. At Dakawa, the two species occur in sympatry. The chromosome formula of our Kingu Pira specimen is $2n = 50$, $FN_a = 58$, which corresponds unambiguously to the true *A. chrysophilus* from Zimbabwe and RSA according to Gordon & Rautenbach (1980) and to *A. cf. chrysophilus* of north Tanzania found by Castiglia *et al.* (2003) and Fadda *et al.* (2001) (Table 5, Fig. 5). It is different from *A. ineptus* Thomas & Wroughton, 1908 ($2n = 44$, $FN_a = 58$) from Zimbabwe and South Africa and from *A. kaiseri*

of Zambia ($2n = 50$, $FN_a = 60$), which has very large sex chromosomes and 45 acrocentric chromosomes (Corti *et al.* 2005; Linzey & Chimimba 2008).

Genus *Pelomys* Peters, 1852

Pelomys fallax (Peters, 1852)

Mus (Pelomys) fallax Peters, 1852: 275.

One relatively young individual was trapped in line D in herbs close to a waterhole. The skull displays grooved upper incisors, short nasal bones and a wide interorbital constriction, upper molars with large round cusps, which are relatively well aligned, and a large third upper molar, with one narrow posterior lobe that characterizes the genus. The only species recorded in Tanzania is *Pelomys fallax*. Comparisons with BMNH specimens of *P. fallax* from Uluguru Mountains (Tanzania) showed a larger size of external parts and skulls (Table 6). Comparison with the

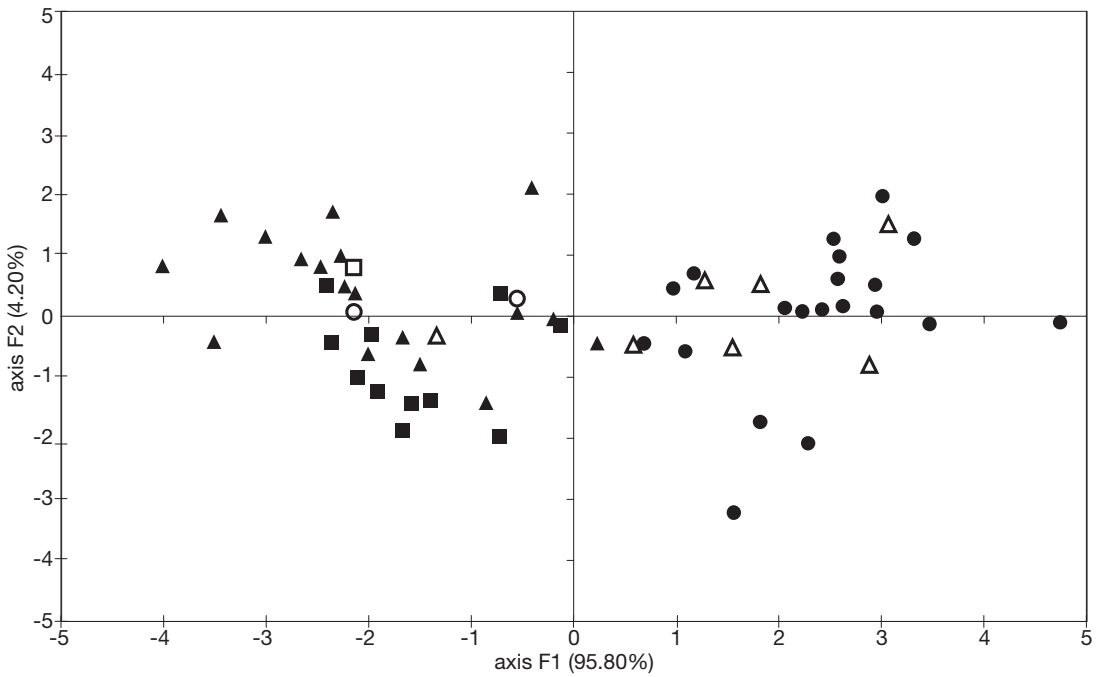


Fig. 4. — CVA performed on external measurements of Tanzanian *Aethomys hindei* Thomas, 1902 from Machakos (type locality) and Dakawa (●), *A. chrysophilus* de Winton, 1897 from Kanyelele (north Tanzania) (■) and *A. chrysophilus* from various localities further south (▲), Morogoro (○), Kingu Pira (□) and Dakawa (△). The Dakawa locality has yielded both *A. chrysophilus* and *A. hindei* specimens.

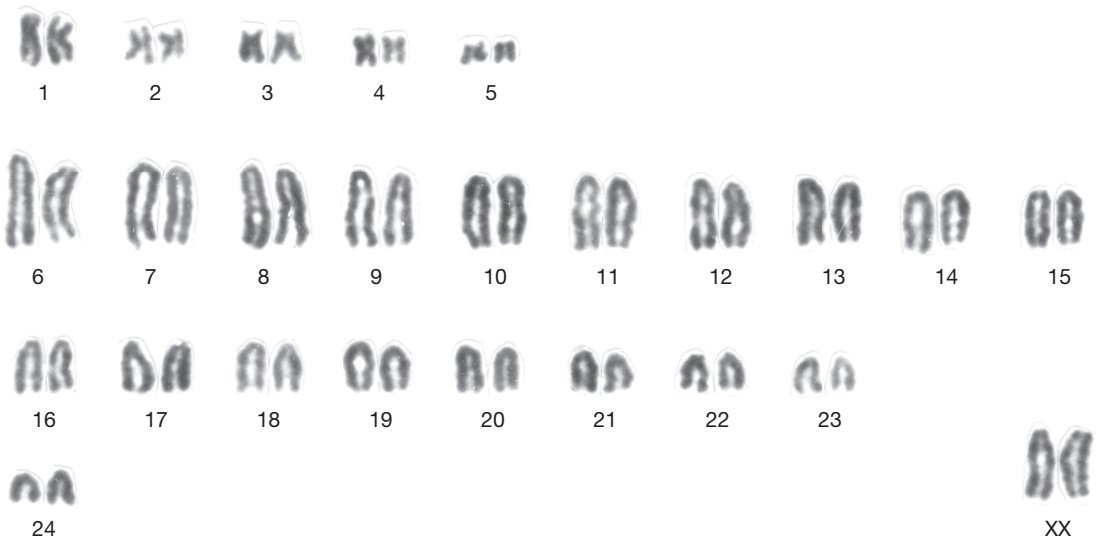


Fig. 5. — Standard karyotype of KP female *Aethomys chrysophilus* de Winton, 1897 specimen (MNHN-CG2007-1248).

TABLE 5. — Cytogenetic data for *Aethomys* Thomas, 1915 of the *A. chrysophilus* de Winton, 1897 complex. Abbreviations: see Material and methods.

Taxon/Specimen	2n	FNa	Origin	Authors
<i>A. chrysophilus</i> MNHN-CG2007-1248	50	58	KP	this work
<i>A. ineptus</i> Thomas & Wroughton, 1908	44	50-58	west Africa, South Africa, Zimbabwe	Matthey 1958, 1964; Visser & Robinson 1986; Gordon & Watson 1986; Gordon & Rautenbach 1980; Chimimba & Linzey 2008
<i>A. chrysophilus</i>	50	58	South Africa, Zimbabwe, north Tanzania,	Gordon & Watson 1986; Gordon & Rautenbach 1980; Fadda et al. 2001; Castiglia et al. 2003
<i>A. bocagei</i> Thomas, 1904	50	38-46	west Africa, Zambia, South Africa	Matthey 1963, 1964; Visser & Robinson 1986; Castiglia et al. 2003
<i>A. kaiseri</i> Noack, 1887	50	60	Zambia	Castiglia et al. 2003; Corti et al. 2005

type specimen of *P. fallax* from near the Zambezi River, Caya District, Mozambique, shows some similarities in size and morphology with the KP specimen in that it has the tail equal in length to head and body. However, the KP specimen is smaller than all other measured specimens but it has larger molars compared to the Angolan specimen and fits better with the Tanzanian specimens and the holotype (Table 7). All these results support the conclusions of Musser & Carleton (2005) that *P. fallax* may represent a species complex.

The karyotype of the studied male has $2n = 42$ and $FNa = 56$ (Fig. 6). As far as we know, the chromosome data are available for only one taxon of the genus, namely *P. campanae* Huet, 1888 (Matthey 1963) which displays $2n = 48$ and $FNa = 52$ and is very distinct from that of the KP specimen.

Genus *Lemniscomys* Trouessart, 1881

Lemniscomys rosalia Thomas, 1904

Lemniscomys griselda rosalia Thomas, 1904: 414.

The single-striped mouse of the genus *Lemniscomys* found in fallow bush and degraded woodlands in KP displays only one dark median band on a yellow bright pelage which identifies it as a member of the species complex including *L. zebra* Heuglin, 1864, *L. griselda* Thomas, 1904 and *L. rosalia* Thomas, 1904. Van der Straeten (1980) has separated several species within this complex on a morphometric basis, and *L. griselda* is only

known from Angola, Zambia, and DRC (Wilson & Reeder 2005). Cytogenetic studies have shown that three species coexist in Tanzania: *L. zebra*, *L. rosalia* and *L. striatus* Linnaeus, 1758 (Fadda et al. 2001; Castiglia et al. 2002a; Corti et al. 2005). On a cytogenetic basis, Castiglia et al. (2002a) proposed without justification to rename the South African representatives of *L. rosalia* into *L. calidior* Thomas & Wroughton, 1908, a decision that was not validated by Wilson & Reeder (2005).

By their general size and morphology the KP specimens are closer to the other Tanzanian specimens of *L. rosalia* from Berega (Tanzania) than to the South African specimens of Tembe Elephant Park, especially in the ear size and both populations may belong to distinct taxonomic units (Table 8).

Karyological data provide a $2n = 54$, $FNa = 62$ for the two specimens of KP (Fig. 7) and these values do not correspond to *L. rosalia* from Tembe (South Africa) ($2n = 48$, $FNa = 62$) described by Ducroz et al. (1999) or *L. zebra* (Fadda et al. 2001; Castiglia et al. 2002a; Corti et al. 2005) from Tanzania ($2n = 54$, $FNa = 58$). But this karyotype corresponds to *L. rosalia* from Tanzania described by Castiglia et al. (2002a), Corti et al. (2005) and by Fadda et al. (2001) in northern Tanzania (Table 9).

Because the type locality of *L. rosalia* is Nguru Mts, Monda (Tanzania), we agree with Castiglia et al. (2002a) that the South African specimens called *L. rosalia* may represent a different species,

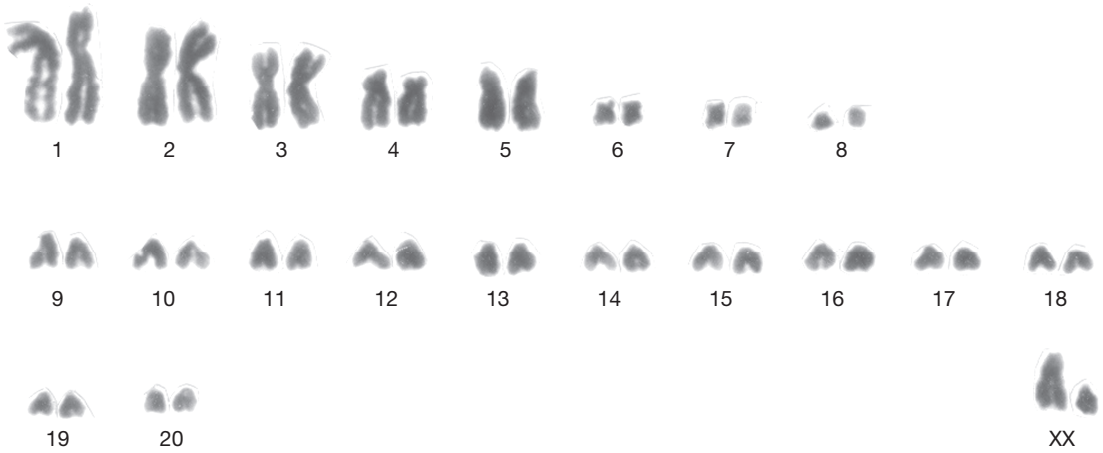


FIG. 6. — Standard karyotype of KP *Pelomys fallax* Peters, 1852 specimen (MNHN-CG2007-1247).



FIG. 7. — Standard karyotype of KP *Lemniscomys rosalia* Thomas, 1904 specimen (MNHN-CG2007-1206).

but without a careful examination of the type specimens of the various synonyms of *L. griselda* or of *L. roseveari* Van der Straeten, 1980 from

Zambia, we cannot here name the Kwazulu Natal karyotypic form described by Ducroz *et al.* (1999). We cannot follow the nomenclatural proposal of

TABLE 6. — Measurements (in millimetres) of the standard external characters of *Pelomys fallax* Peters, 1852 specimens. Abbreviations: see Material and methods.

Specimen	Country	HB	TL	HF	E
ZMB 1675 Holotype	Mozambique			24+	
MNHN-CG2007-1247	Tanzania	123.5	128.5	29	17
BMNH 84.1794	Tanzania	158	151+	31	21
SMM4256	Tanzania	165	140	35	15
SMM5498	Angola	152	152	29	19
SMM5453	Angola	129	142	28	17
SMM5458	Angola	131	136	28	16
SMM5468	Angola	130	154	30	17
SMM5469	Angola	141	150	30	18
SMM5470	Angola	144	141	29	18
SMM5471	Angola	136	146	30	18
SMM5457	Angola	133	142	29	21

TABLE 7. — Skull measurements (in millimetres) of *Pelomys fallax* Peters, 1852 specimens from different museums. Abbreviations: see Material and methods.

Specimen	Country, District	LGT	WZYG	CIO	WNAS	LNAS	WBR	LS13	LBT	LMDB	HMD	LI13
ZMB 1675												
Holotype	S Mozambique		15.30	4.80				6.60				6.38
MNHN-CG2007-1247	TZ, KP	31.68	15.90	5.41	4.62	12.06	13.98	6.56	6.14	20.92	10.21	6.48
BMNH 34.8.26.6	TZ	33.43	15.68	4.43		13.68	13.80	6.63	6.25	20.99	10.71	6.49
BMNH 84.1794	TZ, Morogoro	36.05	16.73	5.70	4.77	13.44	13.17	6.76	6.11	22.2	11.87	6.52
BMNH												
33.10.1.190	TZ, Uluguru Mtns	34.82	17.25	5.55	5.73	14.05	13.76	6.54	6.31	22.36	11.61	6.21
ZMBA48.09	TZ, Rugege wald	37.65	17.16	14.15	5.18	4.96	14.24	7.78	5.45	24.41	12.58	7.65
SMM5472	Angola	34.40	15.29	13.00	5.04	5.09	13.62	6.30	6.27	21.68	11.46	6.07
SMM5469	Angola	34.54	16.23	13.20	5.39	5.44	14.45	6.14	6.03	21.79	11.50	5.71
SMM5468	Angola	33.73	16.41	12.68	5.48	5.35	14.30	6.00	5.80	21.29	10.75	5.70
SMM5415	Angola	34.44	16.62	12.70	5.67	5.31	14.73	6.03	6.16	22.58	11.38	5.90
TM8632	Zimbabwe	36.33	17.68	14.19	4.69	5.61	13.30	6.68	6.03	22.92	11.79	6.66
TM180	Zambia	36.42	17.45	14.04	4.63	5.66	13.67	6.81	6.43			6.67

TABLE 8. — External standard measurements (in millimetres) of KP *Lemniscomys rosalia* Thomas, 1904, compared with other karyotyped Tanzanian and South African specimens. Abbreviations: see Material and methods.

Specimen	HB	TL	HF	E	Locality/Country
MNHN-CG2007-1206	131	140	27.5	16.5	TZ, KP
MNHN-CG2007-1254	117	68+	26	17	TZ, KP
MNHN-CG1998-1610	120	125	24.9	15.5	TZ, Berega
MNHN-CG1998-1609	130	152	24.3	15.8	TZ, Berega
MNHN-CG1996-569	138	126	28	19	RSA, Tembe
MNHN-CG1999-19	135	80+	25.2	19	RSA, Tembe

Castiglia *et al.* (2002a) and Corti *et al.* (2005) because the type specimen of *L. calidior* (Thomas & Wroughton, 1908) came from Mozambique and not from South Africa. Similarly, these authors

propose to give the name *L. zebra* for a given Tanzanian karyotype without any morphological or geographical justification (the oldest described?). *Lemniscomys zebra* was described from the Bahr

el Ghazal (Sudan), which corresponds to a very different region and a distant one from Tanzania. Moreover, there are other available names from old descriptions of the *L. griselda* complex and pending their revision we will not propose synonymies for the South African and north Tanzanian forms.

Consequently, here we attribute the Selous specimen to *L. rosalia* s.s. due to its geographical proximity with the holotype, pending a further revision of this taxon.

Genus *Mastomys* Thomas, 1915

Mastomys natalensis (Smith, 1834)

Mus coucha natalensis Smith, 1834: 156.

In Tanzania, *Mastomys* is very abundant, especially in cultivated areas (Leirs *et al.* 1990; Lima *et al.* 2003). Different studies have shown that only *M. natalensis* is present in Tanzania.

This very common species was represented in our sample from KP by 217 individuals, of which 108 females and 109 males. *Mastomys* was found in all the trapping lines except the Kichi forest (F) and the open woodland (G). Some specimens were also trapped in houses. Among the females there are many juvenile specimens (eight with mass < 13 g and tooth wear stage 1), 29 had visible mammae with a weight greater than 34 g, and none was pregnant. Among the males only four specimens reached a mass of 50 g and only two had scrotal testes. The composition of the present sampling reflects the biological cycle of the species in Tanzania (Lalis *et al.* 2006).

The results of microsatellite analyses revealed the absence of rupture in gene flow between individuals of Morogoro and Kingu Pira indicating that the Rufiji river and its swamp does not constitute a geographic barrier important enough to limit the crossing of *Mastomys*. They exchanged high gene flows by migration phenomenon and could belong to a single panmictic unit. This migratory flow contributed to genetic mixing which tends to homogenize the populations and to limit their genetic diversification (Lalis *et al.* 2009).

The karyotype of *M. natalensis* has been described repeatedly (Britton-Davidian *et al.* 1995; Granjon *et al.* 1997; Corti *et al.* 2005). It contains 32 chromosomes and FNa varying from 54 to 52, due to pericentric inversion of chromosome pair 14. In addition, this species is characterized by appreciable heteromorphism of two submetacentric pairs of autosomes resulting from addition/deletion of C heterochromatin on the entirely heterochromatic short arms (Britton-Davidian *et al.* 1995). Four out of five KP specimens possess typical *M. natalensis* karyotype with $2n = 32$ and FNa = 54. However the fifth individual appeared unusual by having variable chromosome number in different cells, namely 78% possess 33 and 12% 34 chromosomes (the remaining 10% have $2n = 32$). This variation is caused by the presence of supernumerary or B chromosomes which often display intercellular variation or mosaicism (Volobouev 1980). In addition, the sizes of both X and Y chromosomes was variable, due to polymorphism for addition/deletion of C heterochromatin (Fig. 8) never revealed before.

Genus *Grammomys* Thomas, 1915

The narrow-footed thicket rats of the genus *Grammomys* are arboreal rodents with very long tails ending with fine hairs at the tip. They differ from *Thamnomys* in dental characters (Thomas 1915; Heim de Balsac & Aellen 1965; Misonne 1969; Rosevear 1969): postero-internal or "x" cusp of the first and second molars reduced to a mere connecting ridge running from the inner cusp of the median lamina to the hinder point of the tooth (Thomas 1915: 150) and by having a wider and shorter hindfoot (Hutterer & Dieterlen 1984). According to Kingdon (1974), *G. dolichurus* (Smuts, 1832) is found in Tanzania but it may be represented by three different forms, which have subsequently been elevated to species rank by Hutterer & Dieterlen in 1984. These forms are *G. cometes* (Thomas & Wroughton, 1908), *G. dolichurus* and *G. macmillani* (Wroughton, 1907). These authors also described a new species of the *G. dolichurus* complex: *G. caniceps* Hutterer & Dieterlen, 1984

TABLE 9. — Karyotypes of the single-striped *Lemniscomys* Trouessart, 1881 species of Africa from literature data. Abbreviations: see Material and methods.

Taxon/specimen	2n	FNa	Origin	Authors
<i>L. rosalia</i> MNHN-CG2007-1206 & 1254	54	62	KP	this work
<i>L. bellieri</i> Van der Straeten, 1975	56	60	west Africa	Van der Straeten & Verheyen 1978; Tranier & Gautun 1979
<i>L. bellieri</i>	56	?	west Africa	Orlov <i>et al.</i> 1989
<i>L. macculus</i> Thomas & Wroughton, 1910	56	62	CAR	Ducroz 1998
<i>L. mittendorfi</i> Eisentraut, 1968	56	?	Cameroon	Füllung 1992
<i>L. rosalia calidior</i> Thomas & Wroughton, 1908	48	62	RSA, Tembe	Ducroz <i>et al.</i> 1999
<i>L. rosalia</i> Thomas, 1904 s.s.	54	62	Tanzania	Fadda <i>et al.</i> 2001; Castiglia <i>et al.</i> 2002a; Corti <i>et al.</i> 2005
<i>L. cf. zebra</i> (Heuglin, 1864)	44	68?	N Tanzania	Fadda <i>et al.</i> 2001; Castiglia <i>et al.</i> 2002a
<i>L. zebra</i>	54	58	N S Tanzania	Corti <i>et al.</i> 2005

from north Kenya and south Somalia. Based on their morphology, Meester & Setzer (1971-1977) keep the distinction between *Grammomys* and *Thamnomys* by using t7 cusp disposition on the upper M1/. They also provide a character to distinguish between *G. rutilans* Peters, 1876 (small t7 but visible) from *G. cometes*/*G. dolichurus* (crestiform t7 relating t4 to t8). Later, Petter & Tranier (1975) showed that the morphology of the upper M3 molar reflects the important karyotypic diversity observed in the *G. dolichurus* group and recognized the distinction of the CAR *G. gazellae* (Thomas, 1910) today synonymized with *G. macmillani*. Musser & Carleton (2005) confirmed the distinction of the genus *Grammomys* and following Hutterer & Dieterlen (1984), restricted *G. dolichurus* to eastern and southern Africa, including subspecies in the montane areas of Nyika, Kilimanjaro and Elgon. The holotype of *G. dolichurus*, which is the type species of genus *Grammomys*, comes from Cape Town. No precisions about *G. dolichurus* occurrence in Tanzania are reported and limits of its geographical range remain unresolved according to Musser & Carleton (2005). However, in Malawi, Hanney (1965) described *G. dolichurus* and *G. cometes* in south Malawi and Nyika Plateau. *Grammomys cometes* was described from a specimen from Inhambane, Mozambique and would be distributed according to Musser & Carleton (2005) from SE Cape Province and

Mozambique south of the Zambezi river, and is an inhabitant of the savannah woodland biome in South Africa (Mugo *et al.* 1995). *Grammomys macmillani*, described from Ethiopia, would be present from Sierra Leone to Mozambique according to Musser & Carleton (2005). This range extension of the species, compared to that indicated by Hutterer & Dieterlen (1984), is based only upon morphology and it includes *G. gazellae* representatives of CAR karyotyped by Petter & Tranier (1975). Also based upon morphological analysis of type specimens, Musser & Carleton (2005) contrary to Hutterer & Dieterlen (1984) rehabilitated *G. ibeanus* Osgood, 1910 from Kenya and separated it from *G. cometes* series. According to Wilson & Reeder (2005), *G. ibeanus* would be distributed from extreme NE Zambia, Malawi to highlands of eastern Tanzania and Kenya to southern Sudan. In Zambia and Tanzania, the complex *G. surdaster* Thomas & Wroughton, 1908, that has been put in synonymy with *G. dolichurus* by Musser & Carleton (2005), should comprise at least two chromosomal formulae ($2n = 50-51$, $FNa = 61$ and $2n = 42$, $FNa = 64$), as described by Corti *et al.* (2005). For these authors, some Tanzanian specimens assigned to the *G. butingi* complex, without justification, would display a new karyotype. Finally, a new species of the genus was recently described in Kenya: *G. brevisstris* Kryštufek, 2008.

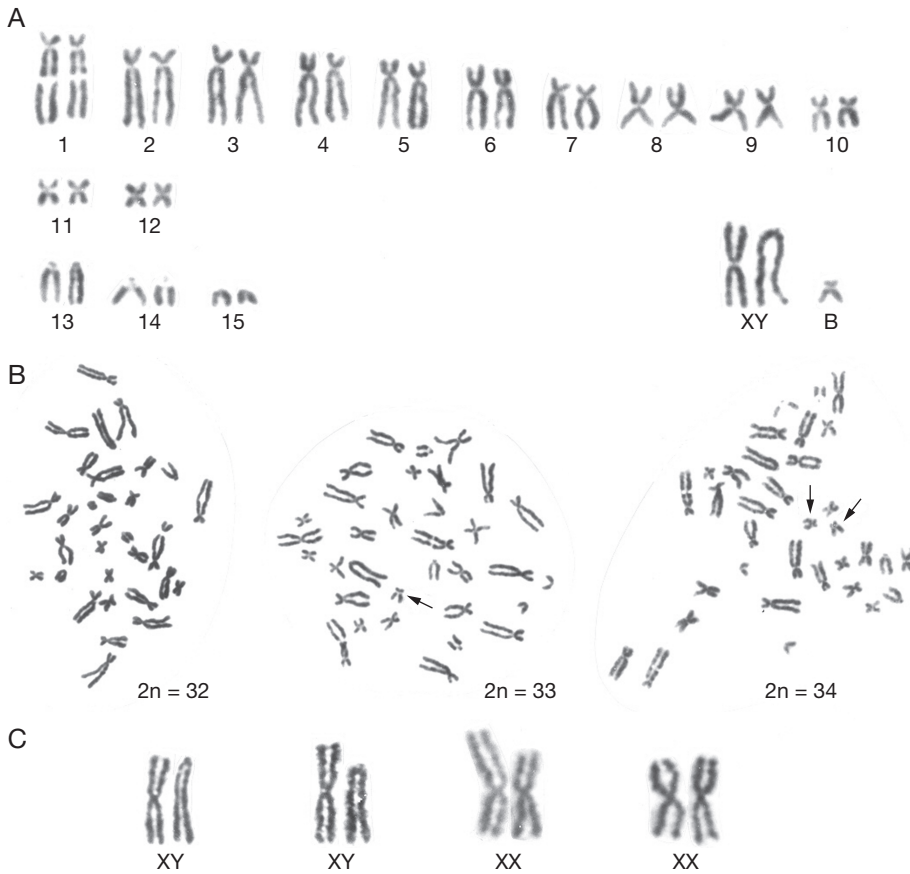


FIG. 8. — Standard karyotype of different *Mastomys natalensis* Smith, 1834 KP specimens displaying variability: **A**, specimen MNHN-CG2007-1015 ($2n = 33$, $FNa = 56$, B: supplementary chromosome); **B**, variability of the $2n$ number with arrows indicating the supernumerary chromosomes; **C**, variability of the sexual chromosomes of specimens (MNHN-CG2007-1016, 2007-1144, 2007-1205, 2007-1237).

Grammomys selousi n. sp.
(Figs 9-16)

TYPE MATERIAL. — **Tanzania**. Holotype: Kingu Pira, Kichi Forest, line F, 8.VII.2003, 1 adult ♂ KP171 (MNHN-CG2007-1231).

Paratype: same site as holotype, 9.VII.2003, 1 young ♂ KP186 (MNHN-CG2007-1252).

Both specimens have been prepared as skin, skull, liver in ethanol, fibroblast cultures. External dimensions are summarized in Table 10, skull dimensions in Table 11. Standard karyotype is displayed in Figure 11.

TYPE LOCALITY. — Tanzania, Lindi Region, Ngarembé village, Kichi Forest (08°27'14"S, 38°39'10"E).

DIAGNOSIS. — Medium sized *Grammomys* (HB: 79-107 mm) with tail length representing 147 and 156% of HB, HF: 23-23.5 mm. It is characterized by a yellow-light brown dorsal short pelage and a cream-white ventral one. The tail is yellow and does not display a terminal tuft but has some pale scattered longer hairs (2-3 mm long) at the extremity. There is no subauricular tuft visible. The skull length is 24.88-29.65 mm, nasal length relatively short (7.84-11.09 mm) and braincase round and wide delimited by rectilinear V-shaped fronto-parietal crests. There is a moderate development of stephanodonty in the molars. On the upper M1, t1 linked to t2, presence of a stephanodont crest with t7 not visible on the t4. The t9 and t8 are round and related by a little oblique crest and there is a well-developed posterior cingulum. On the labial side of the lower molars there is a continuous

TABLE 10. — External *Grammomys* Thomas, 1915 standard measurements (in millimeters) for the different type specimens of the genus. On morphological grounds, *G. surdaster* Thomas & Wroughton, 1908, *G. s. elgonis* (Thomas, 1910) and *G. s. insignis* (Thomas, 1911) have been synonymized with *G. dolichurus* (Smuts, 1832) by Musser & Carleton (2005), who ignored *G. surdaster lutosus* Dollman, 1911. The name *G. rutilans* Peters, 1876 from Gabon is not available and was changed into *G. poensis* (Eisenraut, 1965) but the type of *G. rutilans centralis* (Dollman, 1914) from Congo exists in BMNH and the name of the taxon has been synonymized with *G. kuru* (Musser & Carleton 2005). No measurements were available on the label but the tail of *G. kuru* holotype BMNH 7.7.8.176 is smaller than HB. The type specimen of *G. usambarae* (Matschie, 1915) from Amani (Tanzania) was identified by Dieterlen (pers. comm.) as *G. dolichurus*. The so-called *dolichurus* series consists of 3 individuals mentioned in Hutterer & Dieterlen (1984) as similar to the true *dolichurus*. We used the Osgood (1910) description of the *G. ibeanus* Osgood, 1910 and *G. surdaster polionops* (Osgood, 1910) holotypes and a mean value from the type series. Abbreviations: see Material and methods.

Species	Status	Specimen	Country	Value	HB	TL	HF	E
<i>G. selousi</i> n. sp.	HT	MNHN-CG2007-1231	Tanzania		107	167	23.5	17.5
<i>G. selousi</i> n. sp.	PT	MNHN-CG2007-1252	Tanzania		79.5	117.5	23	15
<i>G. macmillani</i> (Wroughton, 1907)	T	BMNH 6.11.1.38	Ethiopia		102	160	21	15
<i>G. cometes</i> (Thomas & Wroughton, 1908)	T	BMNH 6.11.8.115	Mozambique		124	195	24	20
<i>G. aridulus</i> Thomas & Hinton, 1923	T	BMNH 23.1.1.324	Sudan		115	175	24	18
<i>G. rutilans centralis</i>	T	BMNH 14.2.11.24	Congo		135	180	24	16
<i>G. surdaster surdaster</i>	T	BMNH 93.5.2.27	Malawi				22	18
<i>G. surdaster elgonis</i>	T	BMNH 10.4.1.189	Uganda		115	165	23	17
<i>G. surdaster insignis</i>	T	BMNH 10.4.1.186	Uganda		120	185	25	22
<i>G. dryas</i> Thomas, 1907	T	BMNH 6.7.1.136	Uganda		118	185	24.5	19
<i>G. gigas</i> Dollman, 1911	T	BMNH 11.4.7.93	Kenya		132	201	26.5	19
<i>G. surdaster lutosus</i>	T	BMNH 12.7.1.265	Kenya		118	198	24	22
<i>G. butingi</i> Thomas, 1911	T	BMNH 11.7.28.27	Liberia		108	170	23.5	15
<i>G. caniceps</i> Hutterer & Dieterlen, 1984	T	ZFMK84	Kenya		104	153	21.5	17.1
<i>G. usambarae</i>	T	ZMB20571	Tanzania		(77)	130	21	(8)
<i>G. poensis</i>	T	ZFMK63668	Equatorial Guinea		139	195	26	17
<i>G. minnae</i> Hutterer & Dieterlen, 1984	T	SMNS24118	Ethiopia		110	173	23	18
<i>G. ibeanus</i>	T	FMNH 17096	Kenya		136	193	26	21
<i>G. ibeanus</i>	TS	FMNH type series	Kenya	mean (N = 8)	121	184	25.3	20.7
				min-max	109-136	174-204	24-26.3	19-22
<i>G. d. dolichurus</i>		After Roberts (1951)	RSA Cape Region	mean (N = 8)	122	173	24	18
				min-max	103-124	151-178		
<i>G. dolichurus</i> series		SMNS, ZFMK	Tanzania	mean (N = 3)	111.7	150.3	23.7	16

cingular margin with small cusplets development. The upper M3 is small and round with well marked T1. It is characterized by the following chromosome formula: $2n = 49-50$, $FN_a = 56$.

At equivalent age teeth wear classes 3 to 5, it is different from *G. dolichurus*, *G. caniceps*, *G. macmillani* in being larger (skull and external dimensions). It is smaller than *G. cometes*, *G. poensis*, *G. gigas*, *G. dryas*, *G. ibeanus*, *G. breviostris*. It has about the same body and tail length proportions as *G. aridulus* but with a larger ear and HF.

It is about the same size as *G. butingi* and *G. minnae* type specimens. It differs from *G. minnae*, *G. caniceps*, *G. dolichurus* s.l. and all other karyotyped specimens by its chromosome formula. *G. ibeanus* is larger, has a brown dull pelage with long hairs, the tail tuft is more visible and at the last third of the tail one finds long brown hairs (4-5 mm long). *Grammomys ibeanus* displays a longer nasal and less globular braincase; its frontoparietal crests are not rectilinear. *Grammomys breviostris* has an isolated t1 on the upper M1 and a longer rostrum and masseteric plate.



FIG. 9. — **A**, external dorsal and **B**, ventral views of MNHN-CG2007-1231, *Grammomys selousi* n. sp. holotype.

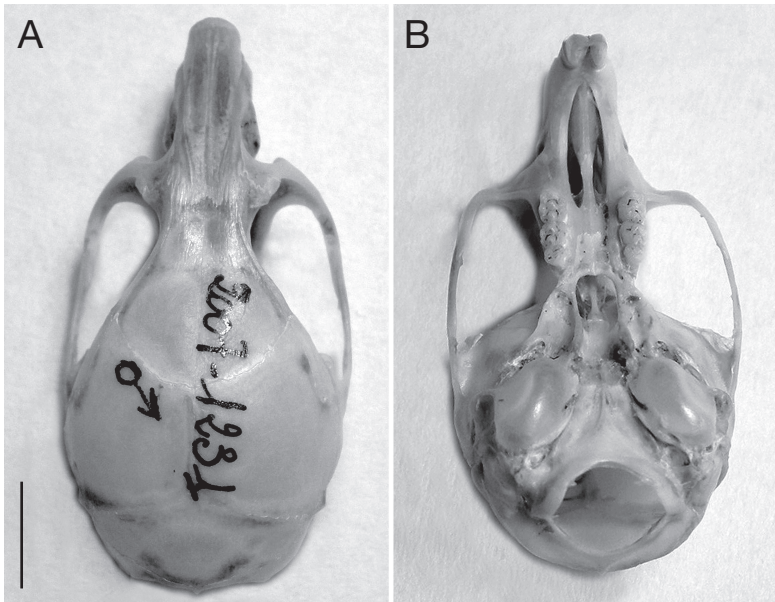


FIG. 10. — **A**, dorsal and **B**, ventral views of *Grammomys selousi* n. sp. holotype skull (MNHN-CG2007-1231). Scale bar: 5 mm.

TABLE 11. — Skull measurements of *Grammomys* Thomas, 1915 (in millimetres). Abbreviations: see Material and methods.

Species	Specimen	Locality	Country	LGT	WZYG	CIO	WNAS	LNAS	WBR	LS13	LBT	LMDB	HMDB	LI13
<i>G. selousi</i> n. sp. PT	MNHN-CG2007-1252	KP	TZ	24.88	12.46	4.4	3.41	7.84	12.71		5.05	14.77	7.1	
<i>G. selousi</i> n. sp. HT	MNHN-CG2007-1231	KP	TZ	29.65	14.29	4.53	4.05	11.09	13.82	4.48	5.4	17.71	8.38	4.42
<i>G. ibeanus</i> Osgood, 1910 T	FMNH17096	Molo-Gil-Gil	K	32.7	15.9	5.0		11.9		5.1				
<i>G. ibeanus</i> TS	FMNH	Lake Eimenteita	K	31.8	14.9	4.7		12.3		4.6				
<i>G. ibeanus</i>	FMNH151239	Chomé	TZ	31.52	14.61	4.73	4.03	12.35	12.97	4.85	5.52	19.95	9.11	5.06
<i>G. ibeanus</i>	FMNH17103	Gil-Gil	K	30.1	13.08	4.24	3.91	11.43	12.18	4.56	5.46	18.17	8.31	4.45
<i>G. ibeanus</i>	FMNH153943	Chomé	TZ	31.1	15.19	4.69	3.66	11.78	12.14	4.81	5	19.36	8.82	4.86
<i>G. ibeanus</i>	FMNH17105	Nakuru	K	31.76	15.44	4.42	3.68	11.37	12.68	4.72	5.46	19.54	9.17	4.68
<i>G. caniceps</i> Hutterer & Dieterlen, 1984 PT	ZFMK84.33	Malindi	K	25.64	11.91	4.31	3.52	8.68	11.74	3.67	4.5	15.05	6.85	4.24
<i>G. caniceps</i> PT	ZFMK84.34	Malindi	K	25.78	12.56	4.37	3.63	9.87	11.47	3.87	4.65	15.18	6.96	4.52
<i>G. caniceps</i> PT	ZFMK84.74	Malindi	K	26.4	13.25	4.58	3.72	8.92	11.78	3.65	4.38	15.22	7.47	4.48
<i>G. caniceps</i> PT	ZFMK84.31	Malindi	K	26.45	12.84	4.23	3.41	9.42	11.76	3.66	4.91	15.77	7.67	3.76
<i>G. caniceps</i> PT	ZFMK84.75	Malindi	K	25.7	12.06	4.34	3.55	8.42	11.29	3.65	4.84	14.99	7.65	3.98
<i>G. caniceps</i> PT	ZFMK84.73	Malindi	K	24.77		4.26	3.51	8.8	10.98	3.67	4.68	14.58	7.2	3.8
<i>G. caniceps</i> T	ZFMB8476	Malindi	K	27.62	13.34	4.52	3.78	9.71	11.76	3.64	5.63	16.29	8.1	3.58
<i>G. caniceps</i>	MNHN-CG1986-1091	Malindi	K	25.99	12.76	4.39	3.73	8.92	11.82	3.49	4.75	15.46	6.92	3.41
<i>G. usambarae</i> (Matschie, 1915) T	BMNH 34.8.26.2	Uluguru Mts	TZ	28.12	12.58	4.21	3.36	9.6	11.21	3.93	4.8	16.82	7.36	4.14
<i>G. dolichurus</i> (Smuts, 1832)	BMNH 84.1792	Uluguru Mts	TZ	29.14	14.14	4.37	3.49	10.1	11.9	3.82	5.04	17.06	8.9	4.11
<i>G. dolichurus</i>	BMNH 60.18	Lindi	TZ	26.48	12.59	4.56	3.43	7.7	12.18	4.51	5.35	16.02	6.27	5.06
<i>G. dolichurus</i>	BMNH 68.919	Chomé	TZ	30.78	14.51	4.49	4.07	11.12	11.62	4.33	4.53	17.84	8.37	4.46
<i>G. s. elgonis</i> (Thomas, 1910)	BMNH 28.7.19.31	Kiamosi	K	28.23	12.54	4.45	3.28	11.29	12.72	3.86	5.15	16.73	7.72	4.02
<i>G. surdaster</i> Thomas & Wroughton, 1908	BMNH 64-245	Kashoro	TZ	27.75	12.76	4.09	3.69	10.19	11.97	3.85	4.64	16.65	7.84	3.8
<i>G. s. elgonis</i>	BMNH 22.12.13.28	Bukedi	K	28.35	13.03	4.52	3.3	9.69	11.79	4.05	4.78	16.98	7.6	4.18
<i>G. s. elgonis</i>	BMNH 22.12.13.29	Bugishu	K	27.56	12.81	4.47	3.18	10.23	12.34	4.11	4.79		4.18	
<i>G. dolichurus</i>	BMNH 1986.1177	Bugishu	TZ	27.67	13.5	4.39	3.08	9.31	12.64	4.22	5.05	17.09	8.04	4.35
<i>G. s. elgonis</i>	BMNH 22.12.13.30	Bugishu	K	29.42	13.8	4.67	3.76	11.22	11.93	4.23	5.63	18.6	8.25	4.37
<i>G. s. elgonis</i>	BMNH 10.4.1.190	Elgon	K	26.96	10.98	4.25	3.65	9.11	10.3	4.31	4.96	15.76	7	4.34
<i>G. surdaster</i>	BMNH 33.10.1.8	Morogoro	TZ	27.08	12.19	4.16	3.58	10.29	11.68	4.03	4.58	15.05	7.58	4.16
<i>G. surdaster</i>	BMNH 24.1.1.137	Uluguru Mts	TZ	27.05		4.34	3.75	8.83	10.63	4.22	4.39	16.87	6.96	3.81
<i>G. macmillani</i> (Wroughton, 1907)	DM 492	Vumba height	MZ	30.59	14.63	4.66	4.02	11.88	12.81	4.65	4.61	18.67	8.53	4.34
<i>G. dolichurus</i>	DM7318	Entabeni	RSA	30.3	14.69	4.81	4.08	10.61	12.75	4.52	5.43	19.38	9.04	4.2
<i>G. dolichurus</i>	DM7320	Entabeni	RSA			4.56				4.61	5.34	15.3	7.36	3.92
<i>G. dolichurus</i>	DM7482	Everton	RSA	29.94	14.13	4.78	4.07	11.51	13.27	4.1	5.13	18.02	9.08	4.04

TABLE 11. — Continuation.

Species	Catalog number	Locality	Country	LGT	WZYG	CIO	WNAS	LNAS	WBR	LS13	LBT	LMDB	HMB	DL13
<i>G. dolichurus</i>	DM7481	Everton	RSA	29.98	14.85	4.58	3.86	11.35	13.03	4.3	5.5	18.13	9.35	4.21
<i>G. dolichurus</i>	DM6863	Carrington Mts	RSA	30.17	14.44	4.87	3.61	10.8	12.96	4.48	5.55	18.17	9.06	4.24
<i>G. dolichurus</i>	DM6346	Westville	RSA	30.29	14.96	4.9	3.82	11.42	13.11	4.27	5.73	17.92	9.76	4
<i>G. dolichurus</i>	DM5938	Durban	RSA	30.77	14.44	4.9	3.8	12.19	12.05	4.33	5.87	18.18	9.08	4.09
		Blinkwater nature reserve	RSA	29.22	14.47	4.44	3.95	10.67	12.9	4.36	5.08	17.22	8.97	4.04
<i>G. cf. dolichurus</i>	DM4498	Durban	RSA	29.86	14.58	4.91	3.9	12.01	12.42	4.08	5.36	18.07	9.79	4.05
<i>G. dolichurus</i>	DM4266	Weza state forest	RSA	31.48	15.98	5.04			13.33	4.46	6.09	20.07	10.2	4.14
<i>G. dolichurus</i>	DM3551	Umhlanga Rocks I	RSA	25.75	12.85	4.52	2.75	8.18	12.57	3.94	5.31	15.58	7.28	4.1
<i>G. dolichurus</i>	DM3544	Umhlanga Rocks I	RSA	25.26		4.35	3.3	9.9	11.95	3.99	5.24	13.64		4.02
<i>G. dolichurus</i>	DM3329	Umkuzi	RSA	30.48	14.23	4.63	4.19	10.9	13.35	4.35	4.91	19.25	9.75	4
<i>G. dolichurus</i>	DM2713	Durban	RSA	30.13	13.96	4.72	4.2	11.57	12.71	4.32	5.63	17.99	8.74	4.28
<i>G. dolichurus</i>	DM1981	Hillcrest Natal	RSA	29.65	13.28	4.29	3.88	10.96	13.58	4.39	4.83	17.93	8.57	4.01
<i>G. dolichurus</i>	DM1638	Vryheid N. R.	RSA	31.63		4.91	4.43	11.65	13.9	4.7	5.3	20.27	8.79	4.21
<i>G. dolichurus</i>	DM1835	Kartloof N. R.	RSA	29.48	13.36	4.96				4.33	5.32	19.29	9.1	4.34
<i>G. dolichurus</i>	DM2428	St Lucia	RSA	32.48	14.28	5.04	4.07	12	13.41	4.5	6.58	20.02	9.18	4.51
<i>G. dolichurus</i>	DM5123	Chingamwe estates Z		30.24	12.98	4.78	3.96	10.4	12.7	4.32	5.41	18.57	8.47	4.04
<i>G. dolichurus</i>	DM5001	Chingamwe estates Z		31.65	13.72	4.8	4.2	13.05	13.54	4.5	4.98	19.95	8.61	4.27
<i>G. dolichurus</i>	DM5000	Chingamwe estates Z		26.34	11.07	4.77	3.3	10.45	12.42	4.21	4.88	15.82	7.02	4.13
<i>G. dolichurus</i>	DM4667	Chingamwe estates Z		30.27	13.8	4.83	4.32	10.81	13.09	4.22	4.71	18.87	9.34	
<i>G. dolichurus</i>	DM4668	Chingamwe estates Z		29.28	12.71	5.02	4.16	10.75	12.75	4.38	5.31	17.78	8.86	4.15
<i>G. dolichurus</i>	DM4666	Chingamwe estates Z		30.34		4.83	4.3	10.75	12.52	4.43	5.73	18.69	8.88	4.44
<i>G. cometes</i> (Thomas & Wroughton, 1908) HT	BMNH 11.8.115	Inhabame	MZ	32.74	14.75	4.89	3.95	12.41	13.36	4.58	6.42	19.99	10.12	4.29
<i>G. aridulus</i> Thomas & Hinton, 1923 HT	BMNH 23.1.1.324	Kulme	S	29.3	14.07	4.5	3.85	10.78	12.6	4.29	5.4	17.66	8.54	4.36
<i>G. gigas</i> Dollman, 1911 HT	BMNH 11.4.7.93	MKenya	K	34.86	16.45	5.08	3.91	11.82	13.84	5.53	6.34	21.41	9.94	5.23
<i>G. macmillani</i> HT	BMNH 6.11.1.38	Wouida	E	26.39	12.17	4.26			11.12	4.07	5.07	16.62	6.93	3.9
<i>G. poensis</i> (Eisenbraut, 1965) HT	ZFMK63.668	Moca	EG	34.25	15.74	5.49	3.95	12.91	11.43	5.31	5.48	21.06	8.84	5.38

DESCRIPTION

Yellowish-brown pelage on the back with grey bases (about 9–10 mm over middle rump). The yellow-brown colour is less intense on the flanks, which are lighter. There is a marked demarcation line with the nearly pure white belly. The upper part of the head has the same colour as the back, and the mouth region is white like the belly. Tail notably longer than head and body (147–156%), yellow to light-brown in colour terminated at the tip by longer hairs of the same colour (2–3 mm) (Fig. 9). There are no hairs on the tail at the base, small hairs appear about the middle of the tail and increase progressively in length till its end but they remain scarce. Top of fore and hind feet of the same colour pale yellow white turning to pale brown on the underside, ungual tufts white. Hind feet short but wide. Digit 5 longer than 1, plantar surfaces naked, with 6 small cushion pads on the hindfoot.

The skull shows the *Grammomys* microdont tooth pattern (Fig. 10). The braincase is rounded and inflated in the parietal region, the interorbital region is marked but not very narrow, the rostrum is quite short and narrow. There are supra-orbital ridges starting in the interorbital constriction region on the border of the orbital foramen at the level of the naso-frontal suture and ending in the middle of the parietal bones just above the end of the zygomatic arch. In lateral view, the braincase is convex especially in the parietal region and the occipital region where it makes a re-entrant angle with the inter-parietal plan. The tympanic bullae are not inflated quite proportional to the small size of the skull. There are long and narrow incisive foramen ending at the anterior cingulum level of the first molar. The very small posterior palatal foramina are situated at the level of the first lobe of second molar. The mesopterygoid fossa is narrow and long, its anterior border rounded. The pterygoid fossa is shallow with no obvious ventral part of foramen ovale visible. The pterygoid bridge is low and the foramen ovale small. There is a small round opening of the alisphenoid canal. The middle lacerate foramen is small and narrow; the carotid canal is long and thin (more than 2 mm). In lateral view the mastoid part of the tympanic bullae is slightly inflated. The temporal ridges are well marked and vertical. The mandible is short.

Incisors are yellow without any striation and opistodont. The molars display moderately developed stephanodont crests on the t1 and t3. The t4 cusp of the upper M12/ is prolonged by a crest not related to the t8 but there is no visible t7 on it. On the upper M12/ the t8 is high and a posterior cingulum crest is visible, the t9 is small and very round and situated very anteriorly, close to the t6 and there is a little oblique crest relating the t9 to the t8. From the t8 reaching the labial border of the M12/ one can see a posterior cingulum crest. The lower molars display a continuous cingular crest on the labial margin of the lower M/1. The Cp is large on the M/12. Some stephanodont crests are seen on the second lobe of the M/12 and the prelobe of the lower M/1 harbours a well-developed tma. The M3/3 are relatively small and have a round aspect (Fig. 11). The upper M3/ displays a t1 and a t3. There is no antero-labial cingulum on the lower M3/.

The adult specimen of the new species is smaller than *G. gigas*, *G. dryas* and *G. cometes*, *G. kempi*, *G. ibeanus* from Kenya, Sudan and RSA (Tables 10, 11). The adult specimen fits within size range of *G. dolichurus*, *G. macmillani* from Tanzania and Sudan but has a longer hindfoot. It has broadly the same size than *G. aridulus* which is a very old specimen (dental wear stage 6). It also fits within the size variation of *G. dolichurus* from Natal in RSA. But, a comparison with the type specimen of *G. dolichurus* from BMNH shows that our specimen has a more globular skull and a very short nasal (Tables 10, 11). The hindfoot length of *G. selousi* n. sp. enters into the variability of *G. dolichurus*, *G. aridulus* and *G. minnae*, as assessed by Hutterer & Dieterlen (1984), but is notably smaller compared to the types of *G. poensis*, *G. gigas* and *G. ibeanus*. The holotypes of *G. cometes* and *G. gigas*, are old adults characterized by advanced wear stages of the molars but they display much larger upper molar rows than the new Kingu Pira species. The type specimens of *G. macmillani*, *G. surdaster* and *G. dryas* have much smaller molars and the type specimens of *G. surdaster* display the smallest M3/3. The last three species are also characterized by a relatively moderate stephanodonty. The new Selous *Grammomys* also differs from *G. brevirostris* by its larger skull, longer rostrum, and like other east and south African species by the t1 not isolated from t2.

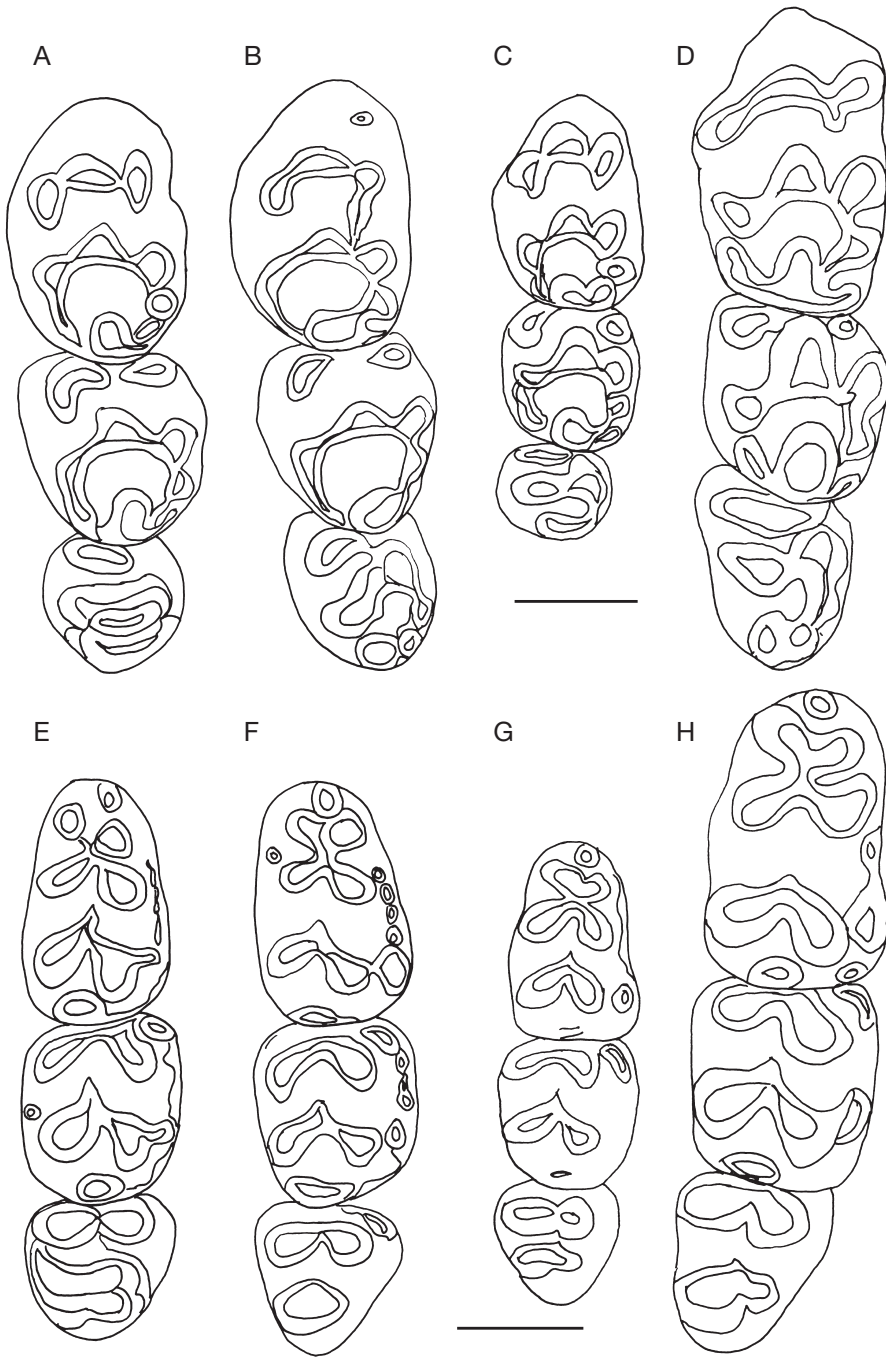


FIG. 11. — **A-D**, upper left and **E-H**, lower right molar rows of *Grammomys* species (**A, E**) *G. selousi* n. sp. holotype; **B, F, G**, *G. ibeanus* Osgood, 1910 (FMNH 17103), Gil-Gil, Kenya; **C, G**, *G. caniceps* Hutterer & Dieterlen, 1984 holotype; **D, H**, *G. poensis* (Eisentraut, 1965) holotype. Scale bars: 1 mm.

TABLE 12. — *Grammomys* Thomas, 1915 species karyological characteristics. Abbreviations: see Material and methods.

Taxon/specimen	2n	FNa	MC+SM	ST	AC	Origin	Authors
<i>G. selousi</i> n. sp. MNHN-CG2007-1231 MNHN-CG2007-1252	49-50	56	?	?	?	KP	This work
<i>G. dolichurus</i> (Smuts, 1832)	52	66	7		19	RSA	Petter & Tranier 1975
<i>G. dolichurus</i>	52	66				RSA	Matthey 1971
<i>G. dolichurus</i>	52					RSA	Dippenaar <i>et al.</i> 1984; Kryštufek <i>et al.</i> 2008
<i>G. butingi</i> Thomas, 1911	52	FN = 66	7		19	Ivory Coast, Foro	Petter & Tranier 1975
<i>G. cometes</i> (Thomas & Wroughton, 1908)	52				x	RSA	Kryštufek <i>et al.</i> 2008
<i>G. dolichurus</i>	54-61	70-75				Somalia	Roche <i>et al.</i> 1984
<i>G. sp. butingi</i>	20	31	7	2		Tanzania	Corti <i>et al.</i> 2005
<i>G. ex gazellae macmillani</i> (Wroughton, 1907)	68-76	>82	>7		>20	CAR	Petter & Tranier 1975
<i>Grammomys</i> sp.?	44					RSA	Dippenaar <i>et al.</i> 1984
<i>Grammomys</i> sp.	27	39				N Tanzania	Fadda <i>et al.</i> 2001
<i>G. minnae</i> Hutterer & Dieterlen, 1984	32	64	15	1		Ethiopia	Olert <i>et al.</i> 1978
<i>G. poensis</i> (ex <i>rutilans</i>) (Eisenbraun, 1965)	36	FN = 50				Ivory Coast	Tranier & Dosso 1979
<i>G. caniceps</i> Hutterer & Dieterlen, 1984	56	78	11		17	Kenya, Malindi	Hutterer & Dieterlen 1984
<i>G. dolichurus?</i> (ex <i>surdaster</i>)	52	FN = 66?	6+1		19	Katanga	Matthey 1971
	52					Katanga	Petter & Tranier 1975
<i>G. kuru</i> (ex <i>rutilans</i>) (Musser & Carleton, 2005)	50	50				DRC	Matthey 1963
<i>G. sp. surdaster</i> Thomas & Wroughton, 1908	50-51	61				Zambia	Corti <i>et al.</i> 2005
<i>G. sp. surdaster</i>	42	64	12		8	Tanzania	Corti <i>et al.</i> 2005

External and skull quantitative comparisons

The PCA performed upon the four standard external measurements for all the holotypes available (after Table 10) displays, on the graph of axes 1 and 2, 99.11% of the variability. Axis 1 is positively correlated with all the variables and represents a size axis. Thus the PCA graph shows the relative intermediate size of *G. selousi* n. sp. (Fig. 12), which is larger than *G. caniceps* and *G. macmillani* and smaller than *G. poensis*, *G. ibeanus*, *G. gigas*, *G. dryas*, *Grammomys kempi*, *G. cometes* and *G. rutilans* holotypes. *G. selousi* n. sp. is here close to *G. aridulus*, *G. macmillani*, *G. minnae* and *G. butingi*. Compared to the latter holotypes, *G. selousi* n. sp. is at wear stage 4, while *G. aridulus* and *G. butingi* display very worn molars (stage 6), *G. macmillani* holotype is at wear stage 3 and the *G. minnae* one is at wear stage 4. The scatter plots display the same pattern and show the proximity of *G. selousi* n. sp. with *G. butingi* (Fig. 13).

We performed also a PCA on 11 skull measurements based upon 50 individuals only (after data in Table 11). The graph of axis 1 and 2 displays 89.51% of the total variability. Axis 1 is explained and correlated positively with LGT, LMDB, LNAS, HMDB, WZYG while axis 2 is explained by WBR and LS13, LI13. We observe here the relatively wide variability of *G. dolichurus* from RSA while *G. selousi* n. sp. is again in the middle of the graph and close to the type specimen of *G. aridulus*. The holotypes of *G. gigas*, *G. cometes* and *G. poensis* (the largest) are opposed along axis 1 to the smallest *G. caniceps* (Fig. 14). In order to include some of the damaged holotypes to the analyses, we used also bivariate analyses and the scatter plot of LGT versus WZYG confirms the large size of *G. ibeanus*, the small size of *G. macmillani* as well as the very wide skull of *G. brevirostris* (Fig. 15A). By looking at the molar row length versus skull length we confirm the same result and do not see any microdontology trend

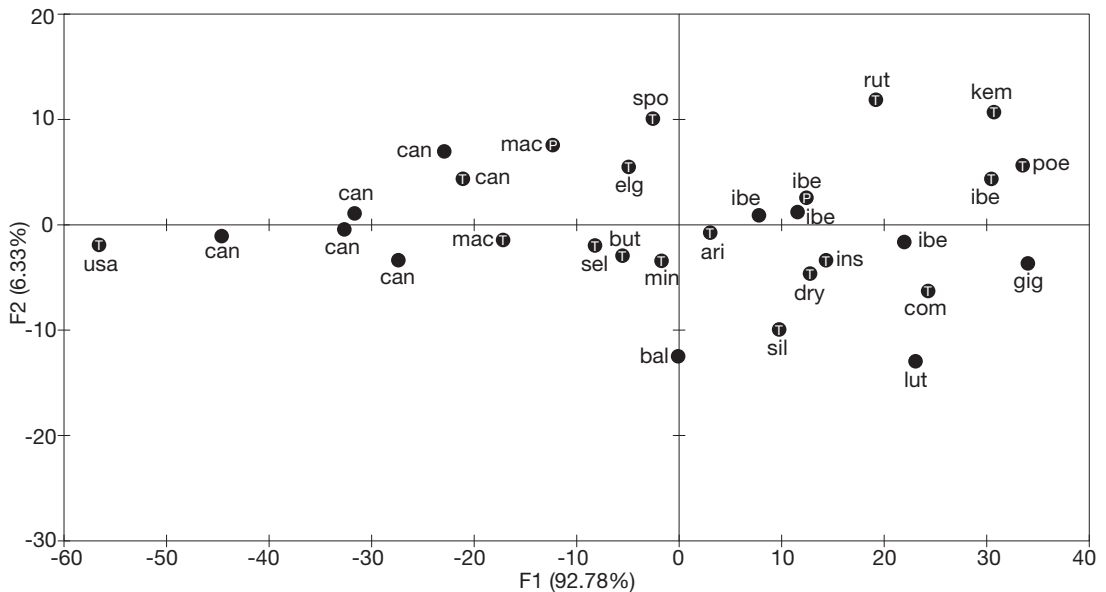


FIG. 12. — PCA performed on four external standard measurements of *Grammomys* Thomas, 1915, with comparisons across the different BMNH, ZFMK type specimens. Axes F1 × F2: 99.11%. Abbreviations: see Material and methods. Symbols: P, paratype; T, holotype.

(reduction of LS13 length) among the species we compared (Fig. 15B).

Karyological description

The new species is characterized by its peculiar chromosome formula and morphology. Two specimens of our study possess 49 and 50 chromosomes respectively and similar $FN_a = 56$ (Fig. 16). The variability of diploid numbers results from Robertsonian polymorphism well-known in mammals and especially in rodents and previously described for Somalian *Grammomys* (Roche *et al.* 1984). Although karyotypically the Kingu Pira individuals display some affinities with the specimens called *G. kuru* (*ex rutilans*) by Matthey (1963) from Pointe Noire (CDR), they are clearly different from all earlier descriptions of karyotypes (Table 12) in *Grammomys*. Notably, this karyotype is strongly different from those of *G. dolichurus* from RSA, *G. butingi* and *G. poensis* from Ivory Coast, *G. gazellae* from CAR, *G. minnae* of Ethiopia and from that of the *Grammomys* sp. described in northern Tanzania by Fadda *et al.* (2001). There still is some debate in *Grammomys* taxonomy (Corti *et al.* 2005).

According to Musser & Carleton (2005), *G. poensis* (*ex rutilans*), whose type specimen comes from Bioko island (Equatorial Guinea) and was found in Ivory Coast by Tranier & Dosso (1979), is characterized by $2n = 36$ chromosomes. This chromosome formula is different from that of the Congo specimen from Pointe Noire, which would better be attributed to *G. macmillani sensu* Musser & Carleton (2005). Therefore, the *G. poensis* (*ex rutilans*) *sensu* Musser & Carleton (2005) is probably a complex of sibling species whose revision is urgently needed. When looking at all the karyotypes formulae, we see that sibling species may also exist among *G. dolichurus*, *G. surdaster* and *G. butingi* complexes.

There is no available karyotype for *G. aridulus* which comes from Darfur region (Sudan) but the latter is greyish brown in colour and proportionally has a long tail (152%). Because the holotype is at wear stage 6, we infer that the repeated proximity with *G. selousi* n. sp., which is at stage 4, is not reflecting the mean size of *G. aridulus* populations which must be smaller than *G. selousi* n. sp. Moreover, there is a considerable geographic distance between Kulmé and Kingu Pira

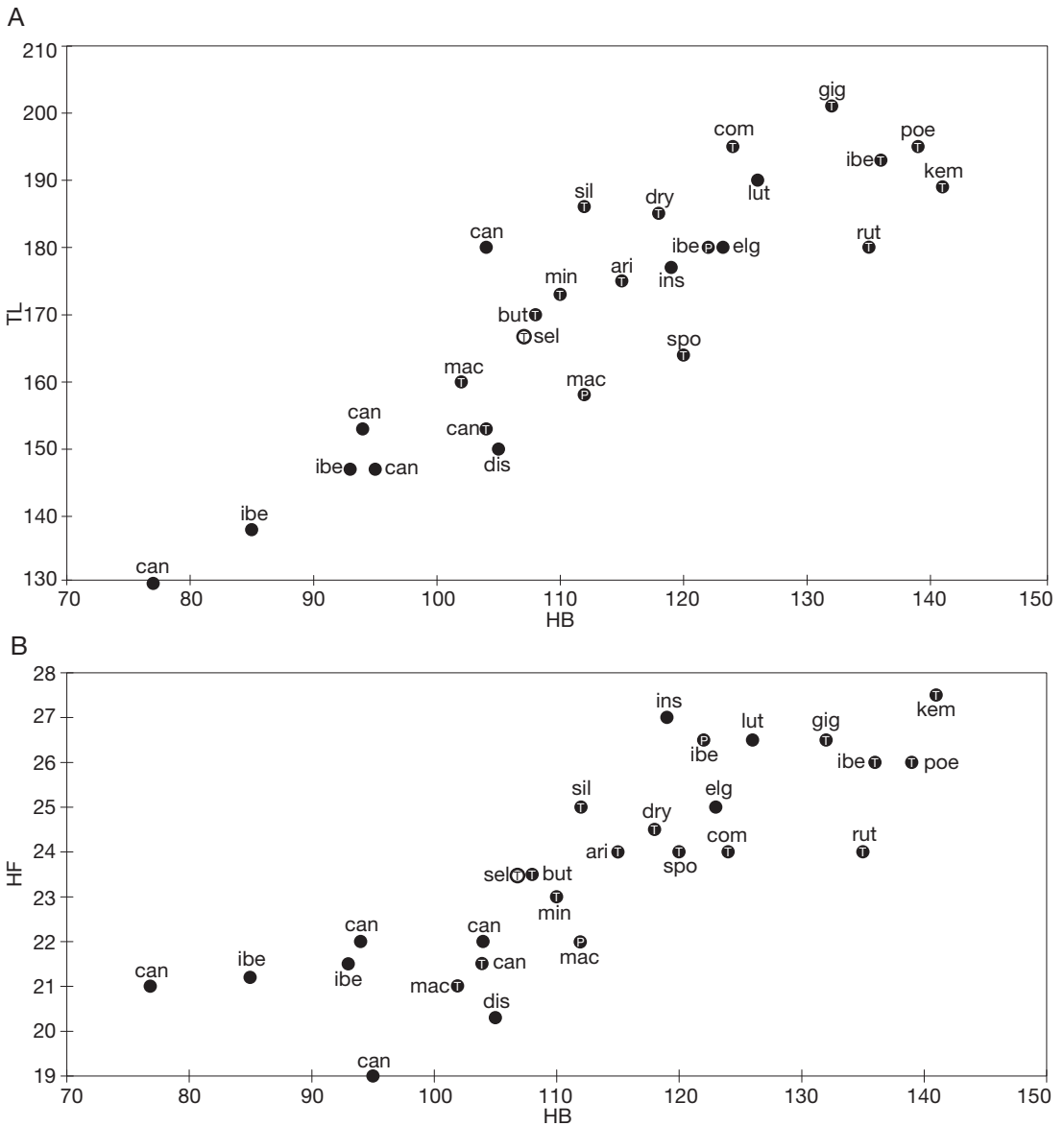


FIG. 13. — Scatterplots upon external measurements (in millimetres) for different *Grammomys* Thomas, 1915 type specimens: **A**, HB versus TL; **B**, HB versus HF. Abbreviations: see Material and methods. Symbols: P, paratype; T, holotype.

(about 3000 km) and both places are respectively situated in different ecoregions (sudanian savanna for *G. aridulus* versus Miombo woodland for *G. selousi* n. sp.). Similarly, *G. brevisrostris* is not known by karyotypes but its wider skull and shorter rostrum indicate that it is very different from *G. selousi* n. sp.

In conclusion, because our new specimens display important morphological and size differences with holotypes specimens and chromosomal ones of other Tanzanian forms, we propose to attribute our Selousian individuals to a new *Grammomys* species pending further molecular and cytogenetical analyses in the genus.

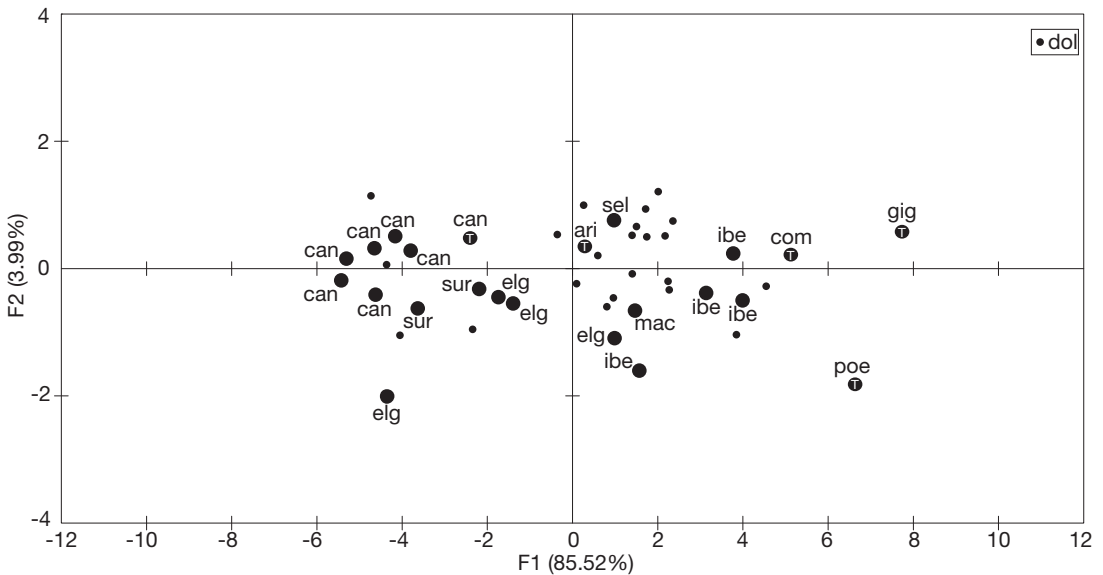


FIG. 14. — PCA performed on 11 skull measurements and 50 individuals of *Grammomys* Thomas, 1915. Axes F1 × F2: 89.51%. Abbreviations: see Material and methods. Symbol: T, holotype.

Genus *Mus* Linnaeus, 1758

According to Musser & Carleton (2005), *M. neavei* Thomas, 1910 (group *sorella*) and *Mus minutooides* Smith, 1834 occur in south Tanzania. *Mus minutooides* is found in southern and eastern regions of South Africa from Mozambique (south of the Zambezi river) to the Cape and according to Musser & Carleton (2005) its northern limits are unknown. Previous cytogenetical works have already focused the important genetic variability in this group which is subjected to Robertsonian fusions (Matthey 1966, 1967, 1970a, b; Jotterand-Bellomo 1984, 1986; Veyrunes *et al.* 2004).

Mus (Nannomys) minutooides Smith, 1834

Leggada minutooides Smith, 1834: 157.

One individual was trapped by hand (out of any trap line) close to the village, two others in Lines C and D. They belong to a very small sized *Mus* species and show a brown back and white belly and a relatively long tail which places them into the

M. minutooides or *M. tenellus* group in Kingdon's (1974) key to east African *Mus*. The upper M1/ has a very elongated prelobe and the upper M3/ is very reduced. In order to get more morphological criteria of discrimination we have performed skull measurements on karyotyped series of both species and some morphological analysis. The three KP specimens fit well with the karyotyped *M. minutooides* specimens from Matthey for their sizes, except the HF length, which is smaller, and under the minimum value of the karyotyped sample. Skull dimensions fit well into the *M. minutooides* variability (Table 13).

From a chromosomal point of view, pygmy mice have a strong variability in their diploid and fundamental numbers as described by Matthey (1970a, b), Aniskin *et al.* (1998), Veyrunes *et al.* (2004) and Kan Kouassi *et al.* (2008). A molecular analysis (Verhuynes *et al.* 2005) has shown that the KP *Mus (Nannomys)* fits well within the *M. minutooides* group together with Guinean and South African specimens and this group diverges from *M. musculoides* (Kan Kouassi *et al.* 2008). The variation of diploid numbers observed here in KP results from Rb polymorphism often occurring in the species

TABLE 13. — External and skull measurements (in millimetres) of *Mus (Nannomys)* Smith, 1834 karyotyped specimens. Specimens of *M. minutooides* Smith, 1834 belong to the karyotyped series of Matthey (1966, 1967) whose vouchers are in the MNHN collections. Abbreviations: **NMI**, number of measurements taken in the sample; others, see Material and methods.

Taxon/specimen	HB	TL	E	HF	LGT	WZYG	LNAS	WNAS	CIO	WBR	LBT	LS13	LMDB	HMDB	LI13
MNHN-CG2007-1250	40	34	4.5	12											
MNHN-CG2007-1207	53	40.5	9.5	12.5	17.71	8.13	6.58	2.2	3.14	8.02	3.55	3.07	10.49		2.42
MNHN-CG2007-1061	55.5	41	9.5	11.59	18.46	8.57	6.94	2.54	3.27	8.41	3.52	3.19	11.33	4.52	2.6
<i>M. minutooides</i> E & S Africa Matthey															
Mean	54.32	45.16	10.1	13.8	17.9	8.55	6.78	2.52	3.28	8.14	3.53	3.14	11.43	4.8	2.67
NMI	28	25	26	25	22	17	23	23	23	22	22	24	22	20	24
Minimum	45	24	8	13	16.27	7.86	5.59	2.16	2.96	7.61	3.03	2.86	10.34	3.69	2.1
Maximum	63	56	12	15	19.57	9.07	7.96	2.96	3.67	8.9	4.02	3.54	12.84	5.34	3.31
SD	4.9	5.8	0.93	0.57	0.95	0.38	0.61	0.19	0.19	0.30	0.21	0.19	0.71	0.38	0.31

TABLE 14. — Chromosomal data for *Mus (Nannomys)* Smith, 1834 of the *M. minutooides* Smith, 1834-*M. musculooides* Temminck, 1853 complex species. Abbreviations: see Material and methods.

Taxon/specimen	2n	FNa	Origin	Authors
MNHN-CG2007-1061	34	32	Tanzania	this work
MNHN-CG2007-1250	35	32	Tanzania	this work
<i>M. minutooides</i>	18	35	South Africa	Veyrunes <i>et al.</i> 2004
<i>M. minutooides</i>	34	36	South Africa	Veyrunes <i>et al.</i> 2004
<i>M. minutooides</i>	18	36	South Africa	Veyrunes <i>et al.</i> 2004
<i>M. minutooides</i>	34	36	Bantou, Guinea	Kan Kouassi <i>et al.</i> 2008
<i>M. musculooides</i>	19	36	Djoliba, Mali	Veyrunes <i>et al.</i> 2004
<i>M. musculooides</i>	18-19	36	Samaya, Mali	Veyrunes <i>et al.</i> 2004
<i>M. minutooides</i> / <i>M. musculooides</i>	33-36	36	Ivory Coast	Jotterand-Bellomo 1986
<i>M. minutooides</i>	24-25	32	NW Zambia	Castiglia <i>et al.</i> 2002b
<i>M. minutooides bellus</i> (Cabrera, 1924)	30-32	?	Tanzania	Matthey 1966, 1967

of the sub-genus *Nannomys* (Veyrunes *et al.* 2004) (Table 14, Fig. 17). By all karyotypic features these individuals belong to the “*minutooides*” group (Table 14). In both *M. minutooides* and *M. musculooides*, lineages polymorphism would be found and a contact or a gap zone would occur between both species either in central or north Tanzania.

Genus *Rattus* Fischer, 1803

Rattus rattus (Linnaeus, 1758)

Mus rattus Linnaeus, 1758: 61.

The black rat is well known in east Africa where it came from a variety of countries brought by human traffic along the Indian Ocean coast. Three individuals were trapped, all in the village houses. They all correspond to the black rat morphology

and their karyotype show some variability. Two of the three animals karyotyped display $2n = 38$ and 39 , and $FNa = 58$ and 60 respectively (Fig. 18). The $2n = 39$ individual possesses one supernumerary or B chromosome, a phenomenon detected in numerous subspecies and populations of *R. rattus* (Yosida 1977).

Family NESOMYIDAE Major, 1897

Subfamily CRICETOMYINAE Roberts, 1951

Genus *Beamys* Thomas, 1909

Among the pouched rats of the endemic African family, *Beamys* is the rarest and one of the two species of the genus is classified as Vulnerable by the IUCN. The holotype of *B. hindei* Thomas, 1909 comes from Taveta in Kenya while *B. major*

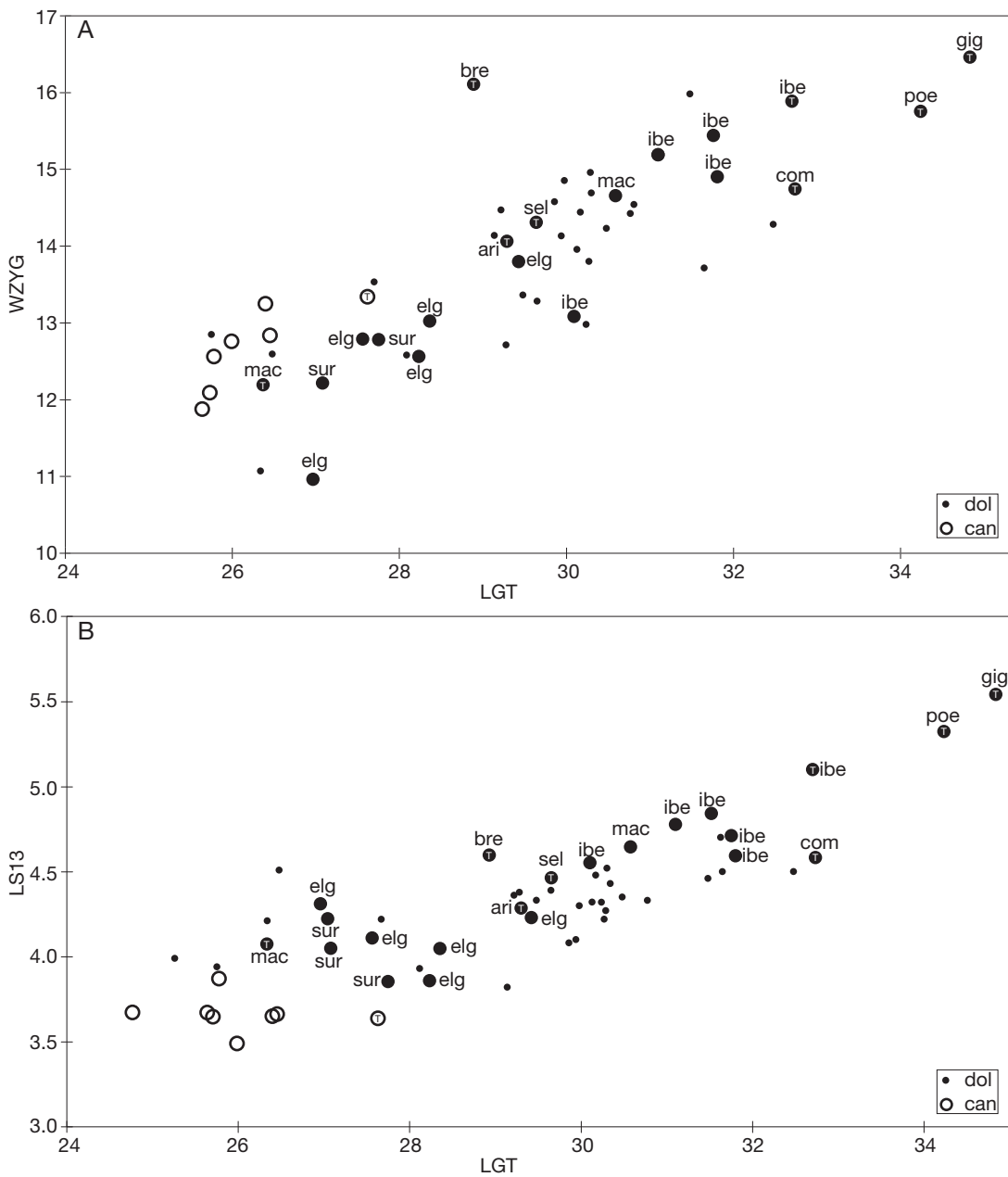


FIG. 15. — Scatterplots of skull proportions for different *Grammomys* Thomas, 1915: **A**, WZYG versus LGT (in millimetres); **B**, LS13 versus LGT. Abbreviations: see Material and methods. Symbol: T, holotype.

Dollman, 1914 holotype is from Mulanje in Malawi. Dieterlen (1979) described an old skull collected in Moshi, Tanzania and attributed it to *B. hindei*

claiming it is the earliest specimen of the genus *Beamys* described in 1909 by Thomas. Classical determination keys emphasize a difference in size and

TABLE 15. — External measurements (in millimetres) of *Beamys major* Dollman, 1914 and *B. hindei* Thomas, 1909 specimens from type series localities. Abbreviations: see Material and methods.

Species	Specimen	Country	HB	TL	E	HF
<i>B. hindei</i>	MNHN-CG2007-1232	Tanzania	138	113.5	20.5	23
<i>B. hindei</i>	MNHN-CG2007-1251	Tanzania	125	118	19.5	21.5
<i>B. hindei</i>	MNHN-CG2007-1257	Tanzania	137	70+	22	23
<i>B. hindei</i>	BMNH 10.9.22.32	British East Africa	131	129		21.5
<i>B. hindei</i>	BMNH 1993-22	Kenya	140	128		21
<i>B. hindei</i>	BMNH 1993-23	Kenya	129	128	20	21
<i>B. hindei</i>	BMNH 1993-18	Kenya	123	123	19	20
<i>B. hindei</i>	BMNH 1993-25	Kenya	137	120	21	21
<i>B. hindei</i>	BMNH 1993-21	Kenya	125	120	20	21
<i>B. hindei</i>	BMNH 1993-20	Kenya	131	116	20	20
<i>B. hindei</i>	BMNH 1993-24	Kenya	112	125	22	22
<i>B. major</i>	BMNH 62.333	Malawi	168	135	19	25
<i>B. major</i>	BMNH 61.463	Malawi	135	142	19.5	24
<i>B. major</i>	BMNH 61.462	Malawi	136	110	20	23.5
<i>B. major</i>	BMNH 78.2750	Malawi	117	124		22

TABLE 16. — Skull measurements (in millimetres) of *Beamys hindei* Thomas, 1909 and *B. major* Dollman, 1914 specimens from Tanzania and Malawi. Abbreviations: see Material and methods.

Specimen	Country	LGT	WZYG	CIO	WNAS	LNAS	WBR	LS13	LBT	LFOINC	WT4	LMDB	HMDB	LI13
MNHN-CG2007-1232	TZ	35.03	15.32	4.69	4.55	13.67	12.92	4.75	5.85	4.13	3.51	23.37	10.4	4.95
MNHN-CG2007-1251	TZ	34.69	15.55	5.12	4.6	12.4	13.22	4.86	5.41	4.63	3.67	23.52	11.19	4.69
MNHN-CG2007-1257	TZ	35.05	16.11	4.89	4.59	12.6	13.35	5.05	6.33	4.64	3.46	23.59	11.62	4.88
Type <i>major</i>														
BMNH 14.10.22.2	MW	36.25		5.41	5.33	13.91	13.18	5.5	5.79	3.83	3.96	24.96	11.51	5.72
BMNH 62.336 <i>major</i>	MW	39.27	18.7	5.35	4.57	-14.5		5.37	6.25					5.41
BMNH 61.463 <i>major</i>	MW	37.05	16.3	5.25	4.14	13.91		5.54	5.92					5.51
Type <i>hindei</i>														
BMNH 9.6.12.23	BEA	32.05		4.79			12.81	4.71	6.26	3.73	3.95	21.13	9.59	5.06
BMNH 10.9.22.32 <i>hindei</i>	BEA	34.08	14.65	5.13	3.8	11.85		4.98						

especially in hindfoot length to separate between the two species. New discoveries of *B. hindei* in coastal Kenya as well as in south Tanzania by Fitzgibbon *et al.* (1995) suggest that there is a clinal variation in size from north to south coastal populations. Animals from lower latitudes appeared to be larger than those from near the Equator but the sample was too small to be statistically significant.

Beamys cf. hindei Thomas, 1909

Beamys hindei Thomas, 1909: 61.

Three relatively young individuals (one male and two females) of the lesser pouched rat were collected

exclusively in the Kichi Forest. Their general size fits within the lower range of the species value provided by Kingdon (1974). By studying the distribution and morphology of *B. hindei* from new localities of Kenya and Tanzania, Fitzgibbon *et al.* (1995) concluded that there is a size cline among the populations from north to south. Because of the taxonomic confusion about which species is present in coastal area of Tanzania, we have compared our specimen with the two *Beamys* species holotypes and the populations of Kenya, south Tanzania and Malawi. As suggested by its name, *B. major* is larger compared to Tanzanian *B. hindei* specimens, despite some overlap in the HB and TL proportions (Table 15). We confirmed that *B. hindei* HF is

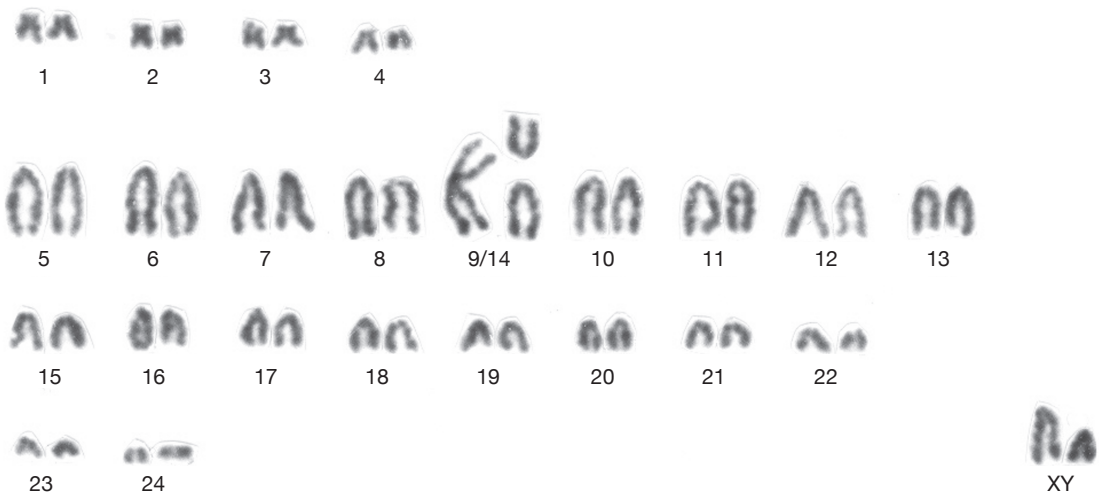


Fig. 16. — Standard karyotype of *Grammomys selousi* n. sp. (MNHN-CG2007-1231) holotype.

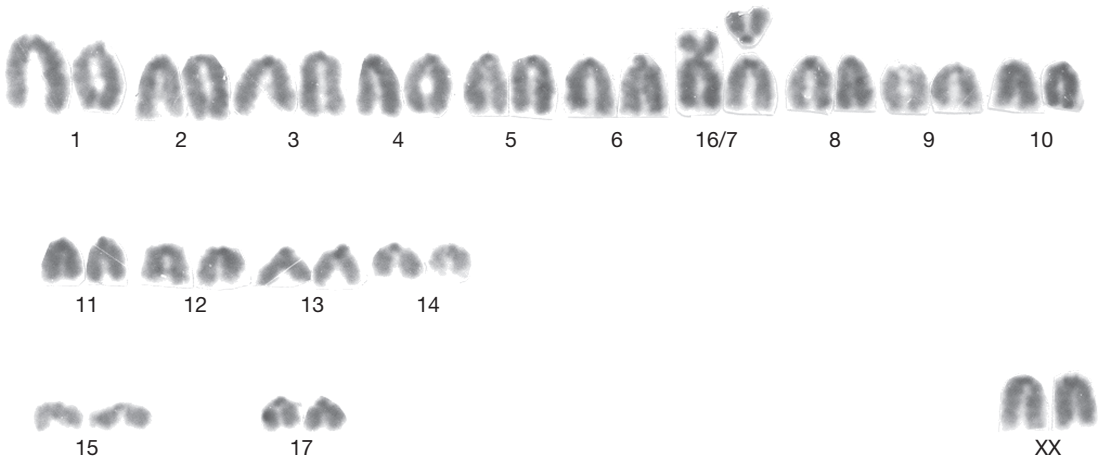


Fig. 17. — Standard karyotype of KP *Mus minutoides* Smith, 1834 specimen (MNHN-CG2007-1061).

smaller than that of *B. major*, but the KP specimens fit well between the two groups. When comparing the skulls and molars proportions (Table 16) it is clear that the Selous Kingu Pira *Beamys* share with *B. hindei* the smaller molars and slightly smaller general size of the skull.

Fitzgibbon *et al.* (1995) have made standard karyotypes of four specimens of Arabuko, Sokoke Forest, Kilifi district, Kenya (BMNH 1993.18 to 25, cf. Table 15) and found a diploid chromosome number

of $2n = 52$ with no more precision. The karyotype of Kingu Pira *Beamys* cf. *hindei* displays a chromosomal set consisting of 54 autosomes and two gonosomes ($2n = 56$, $FNa = 72$) (Fig. 19). Both sex chromosomes, metacentric X and submetacentric Y, are the largest in the set and thus may probably represent distinctive karyotypic feature of this species. Because the type specimen of *B. hindei* comes from Taveta in SE Kenya (at the Tanzanian border), we may confirm that the Kenya specimens of *B. hindei* may represent

TABLE 17. — External standard *Gerbilliscus* Thomas, 1897 measurements (in millimetres). Abbreviations: see Material and methods.

Taxon/specimen	Country	Value	HB	TL	E	HF
<i>G. leucogaster</i> MNHN-CG2007-1134 & 2007-1135	Tanzania		107.5	116.5	21	30.5
	Tanzania		115	134	21.5	32.5
<i>G. robustus</i> Cretzschmar, 1826 after Bates 1985 (N = 74)	E Africa	mean	148.6	178.1	21.1	35.4
		min	111	150	15	25
		max	180	203	25	40
<i>G. nigricaudus</i> Peters, 1878 after Bates 1985 (N = 24)	E Africa	mean	157.7	193.9	22	37.5
		min	130	170	19.5	34
		max	193	212	24	40.5
<i>G. sp.</i> MNHN-CG1998-1603 (genetically typed specimen)	Tanzania, Berega		145	184	20	34.5
MNHN-CG1998-1604	Tanzania, Berega		130	162	20.5	29.4
MNHN-CG1998-1602	Tanzania, Berega		140	166	34	21
<i>G. leucogaster</i> (Peters, 1852) MNHN-CG1990- 618	Zimbabwe		120	161	20	32.5
<i>G. leucogaster</i> MNHN-CG1990-619	Zimbabwe		124	138	19	36
<i>G. l. nyasae</i> (Wroughton, 1906) BMNH11.3.14.5	MA, Karonga		127	149	21	32.5
<i>G. l. nyasae</i> BMNH11.3.14.4	MA, Karonga		187	126	22	35
<i>G. l. nyasae</i> BMNH10.9.21.2	Tanzania, S Rukuru		115	138	18	31

a different species than the southern Tanzanian ones. Such a chromosomal differentiation may result from the fragmented distribution of the species.

Subfamily GERBILLINAE Gray, 1825

Genus *Gerbilliscus* Thomas, 1897

Gerbilliscus leucogaster (Peters, 1852)

Meriones leucogaster Peters, 1852: 274.

In the Selous, there are four potential species of *Gerbilliscus* that can be found according to Kingdon (1974): *G. validus* Bocage, 1890, *G. inclusus* Thomas & Wroughton, 1908, *G. robustus* Cretzschmar, 1826 and *G. nigricaudus* Peters, 1878. According to Bates (1985), there is a size difference in the external measurements between *G. robustus* and *G. nigricaudus*. The bushveld gerbil *Gerbilliscus leucogaster* occurs in southern savannas and was recorded in SW Tanzania and north Malawi according to Musser & Carleton (2005). It was not found in Masai Steppe (north Tanzania) by Fadda *et al.* (2001) but was recovered in Dakawa by Corti *et al.* (2005) and Colangelo *et al.* (2005). *Gerbilliscus boehmi* Noack, 1887 was also known in Tanzania (Swynnerton & Hayman 1951) but is clearly distinguished from our specimen by its unique feature of double grooved incisors.

Only two young *Gerbilliscus* individuals (one male and one female) were caught in line C. One shows a medium haired brown tail with a tuft at the end, the other, smaller, has a yellow light tail with no tuft at the end. Both show a small HF compared to *G. inclusus* and *G. nigricaudus* specimens.

Their feet are dark coloured, which places them into the *G. robustus* group, according to Kingdon (1974). Both KP specimens show a small HF compared to *G. validus*, *G. nigricaudus* and *G. inclusus* specimens. They are slightly smaller than *G. robustus* and *G. nigricaudus*. By comparison with south Tanzanian *G. leucogaster*, the size of the KP specimens is rather smaller, as is the HF (Table 17).

After the chromosome number and morphology, the two specimens karyotyped here belong to *G. leucogaster* studied by Qumsiyeh (1986) and Colangelo *et al.* (2005) (Table 18, Fig. 20).

Family SCIURIDAE Fischer, 1817

Tribe PROTOXERINI Moore, 1959

Genus *Paraxerus* Forsyth Major, 1893

Paraxerus flavovittis (Peters, 1852)

Sciurus flavovittis Peter, 1852: 274.

One individual was trapped in Line G (open dry woodland). This individual exhibits the typical brown

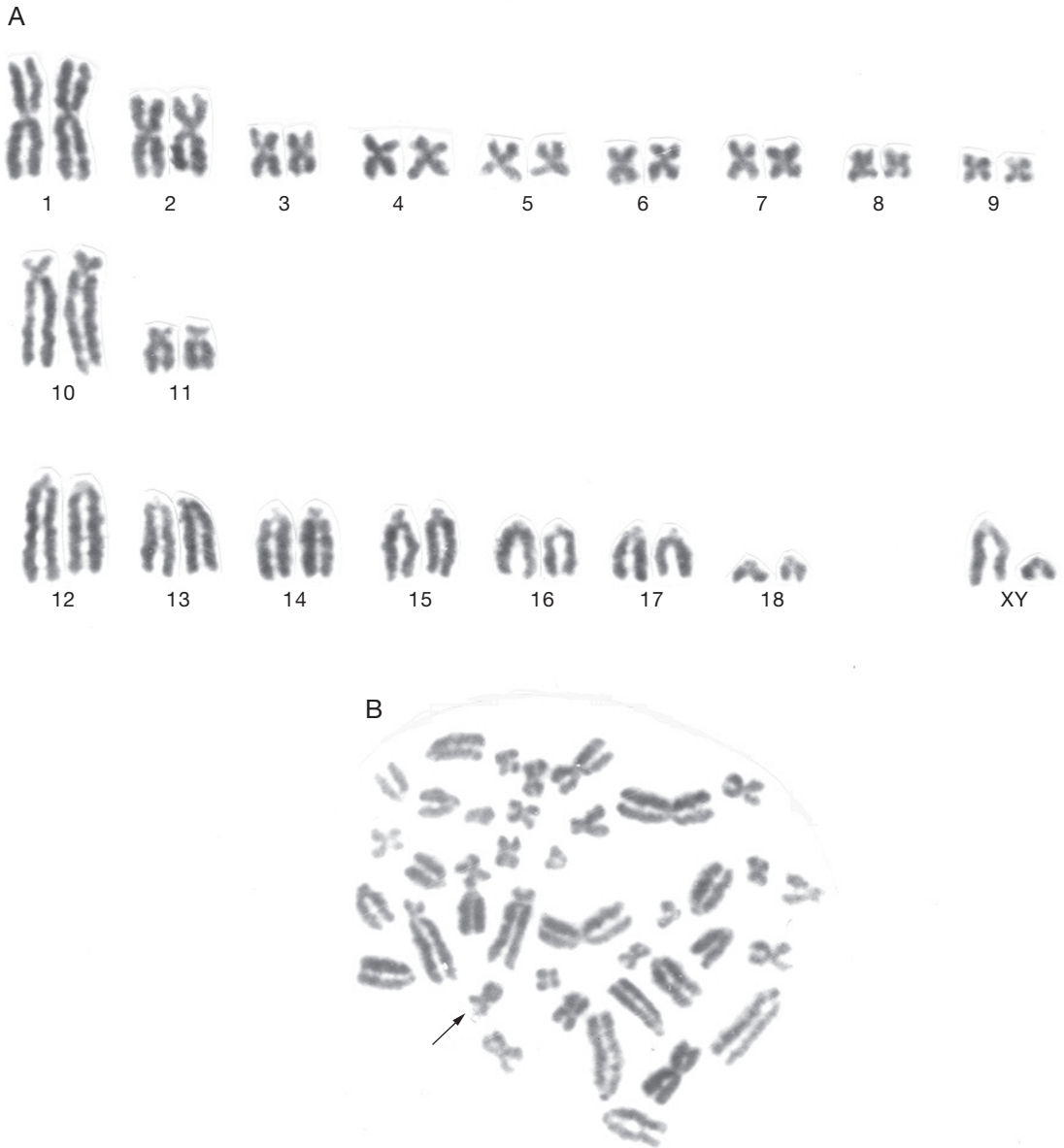


FIG. 18. — Standard karyotype of KP *Rattus rattus* Linnaeus, 1758 specimens: **A**, ♂ (MNHN-CG2007-1210); **B**, ♀ (CG2007-1209). The arrow indicates the supernumerary or B chromosome.

yellow dorsal pelage and displays a white stripe on the flanks which identifies it as *P. flavovittis* Peters, 1852 rather than *P. cepapi* Smith, 1836 or *P. ochraceus* Huet, 1880, which also live in the region. It is also different from the red-bellied coast squirrel *P. palliatus*

Peters, 1852, that is found in the coastal forests of Kenya, Tanzania and Mozambique. Kingdon (1974) described intermediate forms between *Paraxerus cepapi*, a typical squirrel of the southern savannas and miombo woodlands occurring between the Rufiji river

TABLE 18. — Standard karyotype data for east and south African *Gerbilliscus* Thomas, 1897 species from the literature and this work. Abbreviations: see Material and methods.

Taxon/specimen	2n	FNa	Country	Authors
<i>G. leucogaster</i> MNHN-CG2007-1134 & 2007-1135	40	66	Tanzania	This work
<i>G. robustus</i> Cretzschmar, 1826	36	68	Chad	Granjon & Dobigny 2003
<i>G. robustus</i>	36	64	Kenya	Qumsiyeh <i>et al.</i> 1987
<i>G. robustus</i>	36	68	Ethiopia	Colangelo <i>et al.</i> 2005
<i>G. gambiana</i> (Thomas, 1910)	52	64	Senegal	Matthey & Petter 1970
<i>G. nigricaudus</i> Peters, 1878	40	68	Kenya	Qumsiyeh <i>et al.</i> 1987
<i>G. nigricaudus</i>	36	68	Tanzania	Corti <i>et al.</i> 2005
<i>G. leucogaster</i> (Peters, 1852)	40	66	RSA Namibia	Qumsiyeh 1986
<i>G. leucogaster</i>	40	66	Tanzania	Colangelo <i>et al.</i> 2005
<i>G. leucogaster</i>	40-42	66	RSA	Gordon & Rautenbach 1980
<i>G. robustus?</i>	46	68	west Africa	Matthey & Petter 1970
<i>G. kempfi</i> Wroughton, 1906	36	66	CAR	Matthey & Petter 1970
<i>G. brantsii</i> Smith, 1836	44	66?	RSA	Qumsiyeh 1986
<i>G. vicinus</i> (Peters, 1878)	36	68	Kenya, TZ	Corti <i>et al.</i> 2005
<i>G. afra</i> Gray, 1830	44	66?	RSA	Qumsiyeh 1986

and east of lake Malawi, and *P. palliatus*, which he interpreted as a hybridization zone between the two species. Similarly, he indicates that *Paraxerus flavovittis* is common in all habitats between Rufiji and Rovuma rivers, but very rare in the north of Tanzania and is not known in the south of Mozambique.

A comparison of external and skull dimensions shows that our specimen fits well with the Tanzanian *P. flavovittis* specimens and the latter species is smaller than *P. palliatus* and *P. ochraceus*. *Paraxerus flavovittis* has a longer tooth row than *P. palliatus* and rounder, larger tympanic bullae (Table 19), but the size range of these two species are not well documented.

The standard karyotype of *P. flavovittis* ($2n = 38$) consists in 19 pairs, which, except one pair of acrocentric autosomes, are bi-armed, thus giving $FN_a = 70$ (Fig. 21). To our knowledge, it is the first description of karyotype in the genus *Paraxerus*.

Order SORICOMORPHA Gregory, 1910

Family SORICIDAE G. Fischer, 1814

Genus *Crocidura* Wagler, 1832

Crocidura hirta Peters, 1852

Crocidura hirta Peters, 1852: 78.

Despite a great number of individuals, there is very little morphological and size variability among the

collected specimens (Table 20), which belong to a relatively large sized shrew species.

Twelve studied specimens invariably display similar karyotype characterised by $2n = 50$ and $FN_a = 62$ (Fig. 22). Chromosome banding studies are needed to establish phylogenetic affinities with the other congeneric species occurring in east and west Africa and having similar or slightly different karyotypes after standard chromosome analysis. Meylan (1971), Meylan & Vogel (1982), Maddalena *et al.* (1987) and Schlitter *et al.* (1999) also studied the karyotypes of the large representatives of the genus in many parts of Africa and found some variations in the chromosome numbers (Table 21). Here the KP specimens have similarities with the west and east African shrews of the “*olivieri*” complex like *C. spurelli* Thomas, 1910, *C. manni* Peters, 1878, *C. kivu* Osgood, 1910 and *C. olivieri* Lesson, 1827, which share a common karyotype of $2n = 50$, $FN = 66$, $FN_a = 62$. A comparison with *C. flavescens* I. Geoffroy, 1827 from South Africa shows that the karyotype differs from that of the previous species by displaying a $2n = 50$ with $FN = 74$ and $FN_a = 62$ (Maddalena *et al.* 1987). Meylan & Vogel (1982) have grouped the forms *kivu*, *spurelli*, *olivieri* and *manni* under the name *C. occidentalis* (Pucheran, 1855) but the correct name according to Maddalena *et al.* (1987) would be *C. olivieri*.

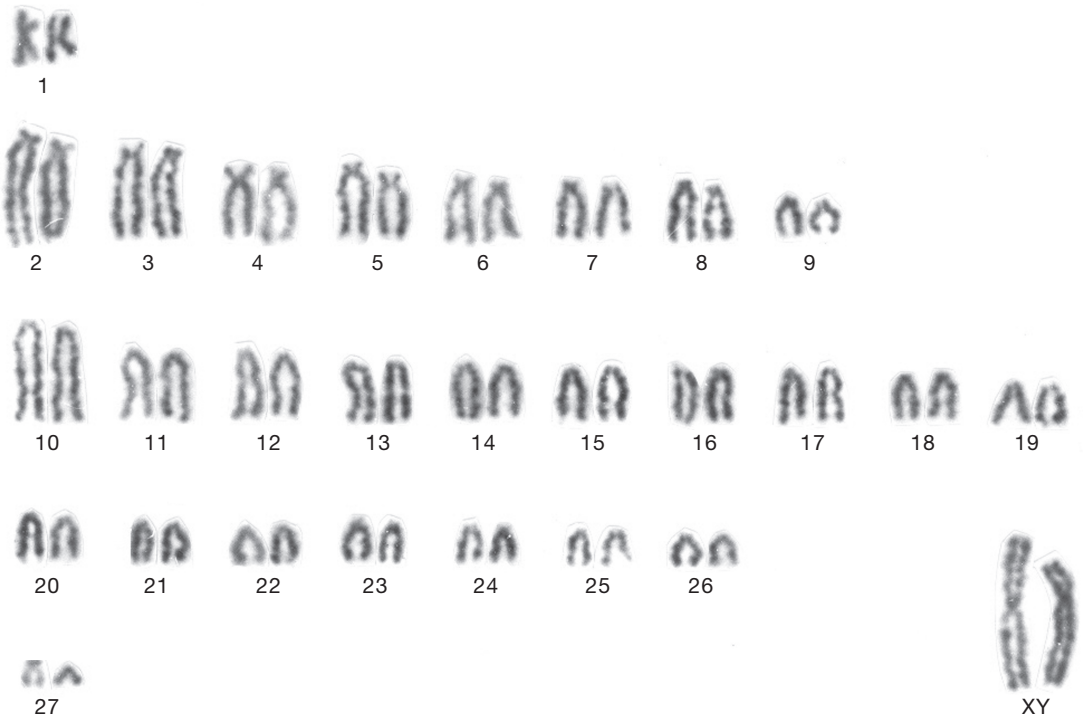


FIG. 19. — Standard karyotype of *Beamys cf. hindei* Thomas, 1909 specimen from Kichi forest (MNHN-CG2007-1232).

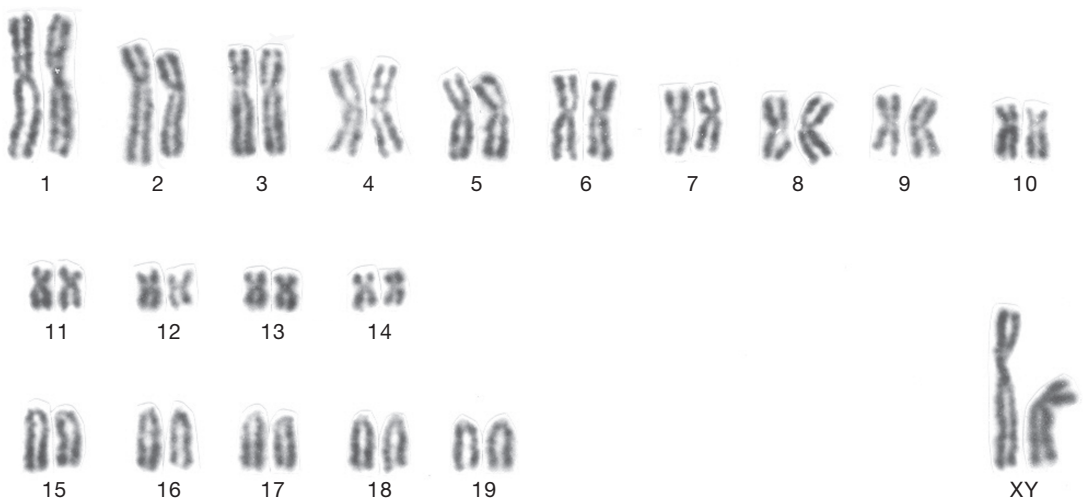


FIG. 20. — Standard karyotype of KP *Gerbilliscus leucogaster* (Peters, 1852) specimen (MNHN-CG2007-1135).

TABLE 19. — External measurements (in millimetres) for *Paraxerus* spp. Forsyth Major, 1893 from Tanzania, Kenya and Mozambique. Abbreviations: see Material and methods.

Taxon/specimen	Locality	Country	HB	TL	HF	E
<i>Paraxerus flavovittis</i> (Peters, 1852)						
MNHN-CG2007-1236	Kingu Pira	Tanzania	169	161	42	19
ZBM88739		Tanzania	166	180	40	15
DM681301		Tanzania	200	160	40	20
ZFMK64838		Tanzania	177	114	38	18
<i>Paraxerus palliatus</i> Peters, 1852						
BMNH65.3015	Kizimbani	Tanzania	146	165	39	16
BMNH65.3011	Kitandi	Tanzania	169	166	41	16
BMNH54.763	Nambungu	Tanzania	180	145	34	25
BMNH65.3006	Nangale	Tanzania	164	153		16
BMNH65.3005	Nangale	Tanzania	142	131	39	16
BMNH65.3014	Kizimbani	Tanzania	158	151	39	16
BMNH65.2999	Mayombo	Tanzania	173	179	28	15
BMNH34.1.11.22		Mozambique	165	165	38	18.5
<i>Paraxerus cepapi</i> Smith, 1836						
ZBM5342		Kenya?	156	167	32	16
<i>Paraxerus ochraceus</i> Huet, 1880						
ZFMK60171	Arusha	Tanzania	163	115	36	19
ZFMK60178	Arusha	Tanzania	129	142	35	16

To clarify the latter point, a molecular study based on mtDNA cytochrome b and mitochondrial control region (ctr) has been performed with KP106, KP122 and KP159 specimens (Dubey *et al.* 2007) included in a large panel of *C. olivieri* s.l. group from various geographic origins. This work provided evidence of different well-sustained groups among which, the close proximity of the KP specimens with *C. hirta* from the north of South Africa. *Crocidura hirta* has been already collected by Stanley *et al.* (1996) in the Chome Forest, South Pare Mountains, Tanzania, with only one specimen captured close to a river.

DISCUSSION

A comparison of our results with studies in Masai steppe and Serengeti (northwestern Tanzania) by Misonne & Verschuren (1966), Fadda *et al.* (2001) and Magige & Senzota (2006) shows some differences with the KP species communities. However, our sample is very limited and we may not have recovered the whole small mammals diversity of the area. However, the coastal Kichi Forest harbours a new *Grammomys* species and a new cytotype of *Beamys hindei*. We did

not recover the typical squirrel representative of the Zanzibar-Inhambane coastal forest mosaic, *Paraxerus palliatus*, nor the southern miombo woodland one (*P. cepapi*), but found *P. flavovittis*, which has a parapatric distribution with *P. ochraceus*, separated by the Rufiji river. These large transverse rivers and swamps around the Rufiji river may also act as a barrier to some other rodent species, especially the arid adapted ones like Gerbillinae species, which are known to be unable to swim (Duplantier & Bâ 2001). *Gerbilliscus robustus* and *G. nigricaudus* are present in the north of Tanzania (Corti *et al.* 2005), while *Gerbillus pusillus* is present in the Serengeti only (Fadda *et al.* 2001), but all species were absent from our survey; we found only *G. leucogaster* which is here in its northern limit of range.

For *Acomys* sp., the Rufiji river seems not to have played a role of barrier, because our Kingu Pira populations are very close from the northern populations of Dakawa and Morogoro, situated about 300 km north west. The same situation occurs for the very anthropic *Mastomys natalensis* and *Mus minutoides*.

A new bridge on Rufiji river has been inaugurated in 2003, a few days after our survey. By allowing trucks to cross the river, this may allow some other

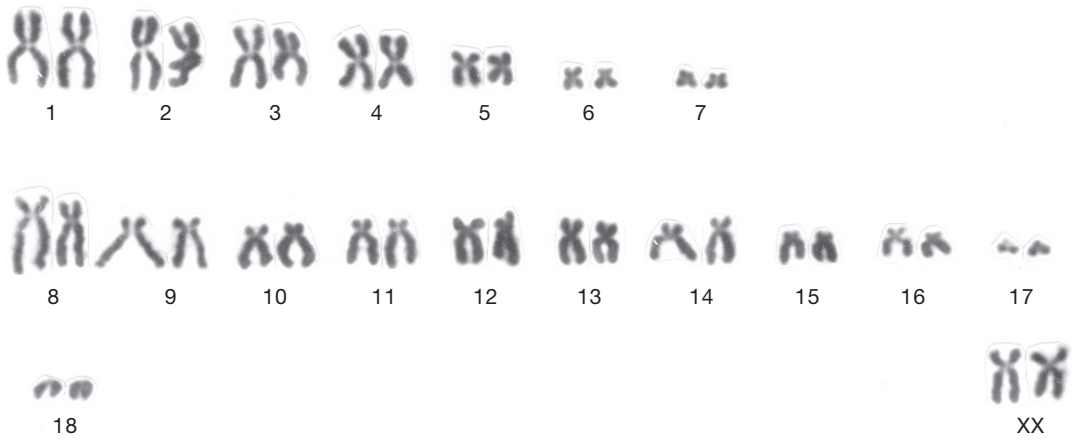


FIG. 21. — Standard karyotype of KP *Paraxerus flavovittis* (Peters, 1852) specimen (MNHN-CG2007-1236).

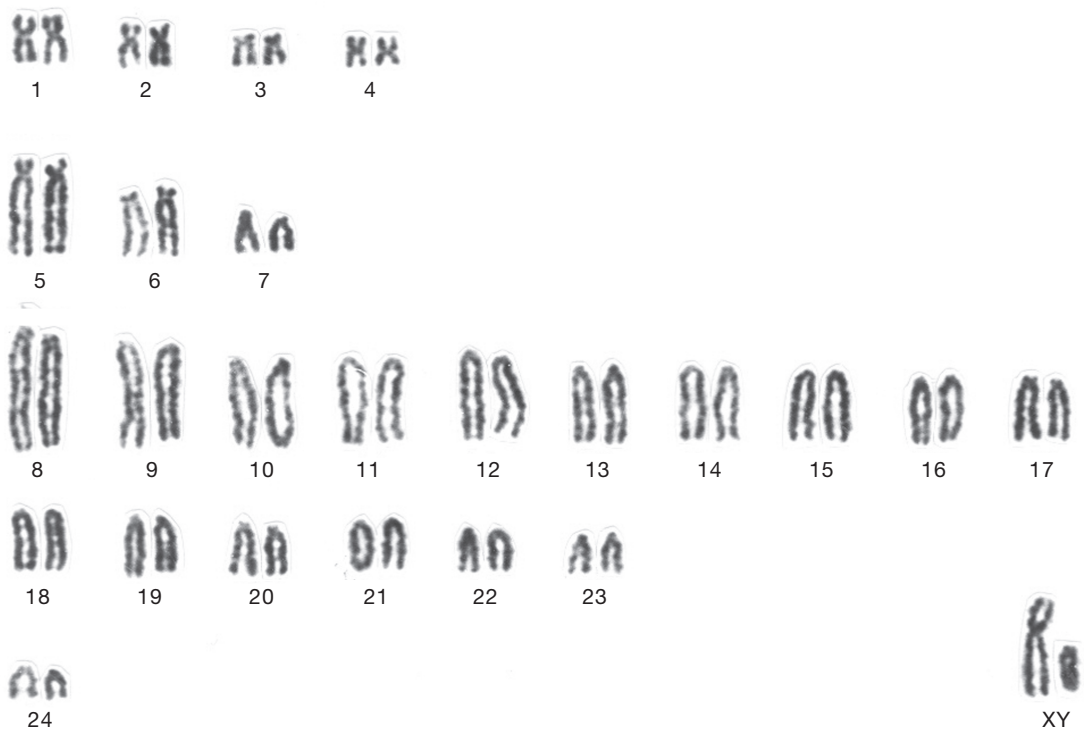


FIG. 22. — Standard karyotype of KP *Crocidura hirta* Peters, 1852 specimen (MNHN-CG2007-1212).

small mammals species to invade the Selous miombo woodlands and contribute to the reduction of its unique fauna. The intensification of car traffic and

the proximity of the capital Dar es Salaam increased forest exploitation on the south side of the Rufiji river (Havnevik unpubl. data).

TABLE 20. — Weight (in grams) and external measurements (in millimetres) for *Crocidura hirta* Peters, 1852 population of Kingu Pira. Abbreviations: see Material and methods.

	W	HB	TL	HF	E
N individuals	23	23	23	23	23
Minimum	10.0	76.0	51.5	14.5	8.0
Maximum	18.0	105.0	67.0	16.0	11.5
Mean	12.37	93.04	56.2	15.26	10.2
CV	0.157	0.088	0.064	0.039	0.092
SD	1.901	8.023	3.525	0.587	0.908

TABLE 21. — Standard karyotypic data for *Crocidura* Wagler, 1832 from Africa. Abbreviations: see Material and methods.

Taxon/specimen	Country	2n	FNa (or NF)	Authors
<i>C. hirta</i> MNHN-CG2007-1145		50	62	this work
<i>C. hirta</i> MNHN-CG2007-1219		50	62	this work
<i>C. hirta</i> MNHN-CG2007-1101		50	62	this work
<i>C. bolivari</i> Morales Agacino, 1934	Morocco	50	(62)	Vogel <i>et al.</i> 1988
<i>C. flavescens</i> Geoffroy, 1827	RSA	50	62	Maddalena <i>et al.</i> 1987
<i>C. wimmeri</i> Heim de Balsac & Aellen, 1958	Ivory Coast	50	(84)	Meylan & Vogel 1982
<i>C. nigeriae</i> Dollman, 1915	Nigeria	52	(76)	Meylan & Vogel 1982
<i>C. poensis</i> (Fraser, 1842)	Ivory Coast	52	(70)	Meylan & Vogel 1982
<i>C. occidentalis</i> (Pucheran, 1855)	WC Africa	50	(66)	Meylan & Vogel 1982
<i>C. odorata</i> Leconte, 1857	Burkina Faso	50	(66)	Meylan & Vogel 1982
<i>C. cf. gracilipes</i> Peters, 1870	EC Nigeria	52	(68)	Meylan & Vogel 1982
<i>C. cf. nimbae</i> Heim de Balsac, 1956	Ivory Coast	46	(68)	Meylan & Vogel 1982
<i>C. cf. planiceps</i> Heller, 1910	Ivory Coast	44	(72)	Meylan & Vogel 1982
<i>C. crossi juvenetae</i> Heim de Balsac, 1968		44	(66)	Meylan 1971
<i>C. lamottei</i> Heim de Balsac, 1968		52	(68)	Meylan & Vogel 1982
<i>C. theresae</i> Heim de Balsac, 1968		50	(82)	Meylan & Vogel 1982

The mosaic of landscapes, the number of barriers like rivers or highlands, observed in this region are highly in favour of an exceptional small mammals' diversity. By the fact, it has been shown in Congo and also in the Amazonian basin (South America) that mammal speciation may be promoted in fragmented blocs of forests separated by rivers (Colyn 1991; Gascon *et al.* 2000; Nicolas *et al.* 2005; Katuala *et al.* 2008). Moreover, most of the rodents trapped here are primary consumers and dependent of the vegetation for their subsistence so, further molecular and morphometric studies are now required in order to test the cytogenetics hypotheses that a high cryptic component of the small mammals' species diversity still remains to be discovered in southern Tanzania.

CONCLUSION

From this survey, it has been possible to obtain for the first time new cytotypes for some genera (*Paraxerus*) or some species (*Pelomys fallax*, *Crocidura hirta*). This leads to the description of a new species of *Grammomys* in conjunction with morphological and morphometric analyses. This also allowed to precise some identifications as for *Lemniscomys rosalia*, *Aethomys chrysophilus*, *Mus minutooides*, *Gerbilliscus leucogaster*. This also raised new taxonomical problems for some species complexes as in the case of *Acomys* sp. and *Beamys* cf. *hindei*. This study demonstrates the necessity to improve our biodiversity survey efforts, using an integrative approach, even in relatively well-known countries like Tanzania. This also points the importance of

mosaic, vegetation landscape and rivers barriers as structuring the diversity. This new study confirms that small mammals' taxonomy knowledge is far from being achieved in all tropical regions of Africa. Finally, we must also attract attention towards the coastal forest of south Tanzania, which is becoming increasingly threatened (Burgess *et al.* 1992, 1998) due to intensive palm tree, fruit and wood exploitations. However, our study shows that it hosts a new *Grammomys* species and also a possible new *Beamys* species, which highlights the importance of preserving this habitat as urgently as possible.

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