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Biologia. — *The Rodent fauna of Tanzania*: *a cytotaxonomic report from the Maasai Steppe (1999).* Nota di Carlo Fadda, Riccardo Castiglia, Paolo Colangelo, Marco Corti, Robert Machang'u, Rodes Makundi, Alessandra Scanzani, Protas Tesha, Walter Verheyen e Ernesto Capanna, presentata (*) dal Socio E. Capanna.

Abstract. — The rodent fauna of Tanzanian savannahs is poorly known. For this reason, the Accademia Nazionale dei Lincei sponsored a project together with the Biology Department of Antwerp and the Sokoine University of Agriculture (Morogoro, Tanzania) on Eastern African rodents. The aim was to study the taxonomy and systematics of rodents of these areas and the processes through which rodent biodiversity has increased in these African regions. We present here a report of the expeditions carried out in the Maasai steppe of Tanzania during 1999, with the description of the karyotypes of 13 rodent species. These are: *Saccostomus* cf. *mearnsi* (Cricetomynae), *Tatera* cf. *robusta*, *Gerbillus* cf. *pusillus* (Gerbillinae), *Acomys spinosissimus*, *Acomys wilsoni*, *Acomys ignitus*, *Aethomys* cf. *chrysophilus*, *Arvicanthis* cf. *neumanni*, *Arvicanthis* cf. *nairobae*, *Grammomys* sp., *Lemniscomys rosalia*, *Lemniscomys* cf. *zebra*, *Mastomys natalensis* (Murinae). The karyotypes of eight species are described for the first time (*Saccostomus* cf. *mearnsi*, *Gerbillus* cf. *pusillus*, *Acomys wilsoni*, *Acomys ignitus*, *Arvicanthis* cf. *neumanni*, *Arvicanthis* cf. *nairobae*, *Grammomys* sp., *Lemniscomys rosalia*).

Key words: Cytotaxonomy; Chromosome evolution; Rodents; Tanzania.

Riassunto. — *La fauna a roditori della Tanzania*: *rapporto citotassonomico dalla Steppa dei Masai (1999).* La fauna a roditori della Tanzania è scarsamente conosciuta; per questo motivo l'Accademia Nazionale dei Lincei ha finanziato, assieme al Dipartimento di Biologia di Anversa (Belgio) e al Dipartimento di Agronomia della Sokoine University di Morogoro (Tanzania), un progetto inteso, d'un lato, a chiarire la tassonomia e la sistematica dei roditori di questa area, e, dall'altro, a studiare i processi attraverso i quali viene incrementata la biodiversità di questa regione africana. In questo rapporto si riferiscono i risultati delle spedizioni effettuate in Tanzania nel 1999 nella Steppa dei Masai, con la descrizione del cariotipo di 13 specie di roditori: 1 Cricetomynae, *Saccostomus* cfr. *mearnsi*, 2 Gerbillinae, *Tatera* cfr. *robusta*, *Gerbillus* cfr. *pusillus*, e 10 Murinae, *Acomys spinosissimus*, *Acomys wilsoni*, *Acomys ignitus*, *Aethomys* cfr. *chrysophilus*, *Arvicanthis* cfr. *nairobae*, *Arvicanthis* cfr. *neumanni*, *Grammomys* sp., *Lemniscomys* cfr. *zebra*, *Lemniscomys rosalia*, *Mastomys natalensis*. Otto cariotipi risultano descritti per la prima volta e sono stati messi in evidenza casi di polimorfismo e/o politipismo.

Introduction

During the twelve years that passed between the publication of the Mammals checklist by Honacki *et al.* (1982) and the checklist completed by Musser and Carleton (1993), more than 80 new rodent taxa have been described, mostly sibling species. This has mainly been the result of an increased use in recent years of cytological and molecular methods. Particularly, in the savannah-like environments of Eastern Africa the occurrence of several new cryptic species has been recorded, resulting from speciation processes leading to an augmentation of the genetic diversity linked with little morpho-

(*) Nella seduta del 12 gennaio 2001.

logical variation. There is therefore an urgent need to identify properly already described and eventually new taxa as a tool for applied research and management programmes in those areas.

The history of the European settling process in Eastern Africa (Tanzania, Kenya and Uganda) as well as the higher suitability of certain areas for profitable farming activities, have profoundly influenced the compiling of the regional faunal inventories. This has finally resulted in an unbalanced taxonomical situation. Indeed, out of the *grosso modo* 200 described murid taxa for the Eastern African Region, more than half have been collected in Kenya (± 130), whereas Uganda (± 40) and Tanzania (± 30) score far less. For this reason there was real need to start adequate specimen-collections in Tanzania covering the whole territory, including also representative collections for biomolecular and karyological analyses.

Since 1986 a series of rodent-research projects was implemented, mostly centred around population ecology of pest-species such as *Mastomys natalensis*. In all these projects the University of Antwerp and the Sokoine University of Agriculture (Morogoro, Tanzania) were closely collaborating (the Belgian-Tanzania Joint Research project, Belgian Agency for Developmental Co-operation, 1986-1989; the E.U. Project Rodent Biology and Integrated Pest Management in East Africa, TS3-CT93-0206, 1994-1997; the Development and Capacity Building in Rodent Research, IUS programme – VLIR-SUA-Component nr. 3, 1997-2002). Recently, the University of Rome and the Accademia Nazionale dei Lincei (Commissione Musei Naturalistici, 1997) joined this co-operative research. The aim of this new collaboration was to strengthen the research-team involved in the study of the systematics and taxonomy of the savannah rodent fauna of Tanzania.

In this paper we report on the karyotype analysis performed in the course of the first year of activity, during which more than 250 specimens have been analysed.

Among mammals, chromosomal rearrangements occur in rodents at a particular high rate (Capanna and Corti, 1991), and several models of incipient speciation, accompanied or favoured by structural rearrangements of the karyotype have been described (Bush *et al.*, 1977; King, 1993; White, 1978). For this reason any qualified study on rodent taxonomy should, if possible, include the analysis of the karyotype.

We present here the description of the karyotypes of 13 murid species, including their diploid and the autosomal Fundamental Number (aFN). However, due to the complexity and the inadequacy in the present systematics of most of the genera, species names will be preceded by cf. since the specific name often cannot be determined with absolute certainty. For each genus the current knowledge of the karyotypes is presented, including the diploid number, the autosomal Fundamental Number (aFN) or, if impossible to determine, the Fundamental Number (FN).

Habitat description.

As already mentioned, our attention focused on the rodent-fauna of the savannahs between the great lakes and the Indian Ocean coast (fig. 1). It is obvious that the system constituted by the great Eastern Africa lakes and its mountain ridges and the

mountain ranges of the Eastern Arch has no doubt greatly affected species distribution, and is of great interest in terms of biogeography. The rifting occurring between 12 and 5 MY has altered the geomorphologic features as well as the climatic regimes of the entire area (Crossley, 1979; Downie and Wilkinson, 1972; Werger, 1978). Before and during this period, several mountain chains and Rift-lakes (Tanganyika and Nyasa) were formed in Tanzania. Together with Lake Victoria, which has a more recent origin (30.000 years Bp.; Beadle, 1974), the system constitutes a physical and environmental barrier to terrestrial plant and animal dispersal (fig. 1). Roughly sketched the area in Tanzania surrounded by the Eastern and the Western highlands is characterised by a rather pronounced aridity since it does not receive the moister winds neither from the Atlantic nor from the Indian Oceans. This «arid corridor» also extends North into Kenya.

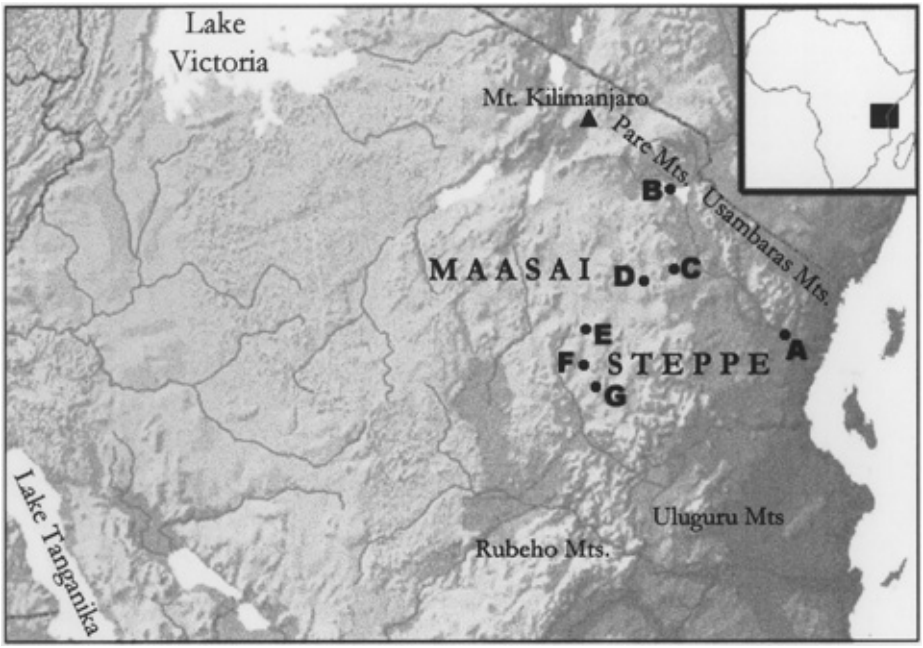

Fig. 1. – Map of Tanzania with the location of the collecting localities (see table I for further details). A = Mombo; B = Lwami; C = Ngasumet; D = Grid J; E = Ndaleta; F = Zoissa; G = Matongolo.

Several collecting trips have been carried out in the Maasai steppe during 1999. Roughly speaking this area is delimited at the North by the Usambaras, the Pare Mts., Mt. Kilimanjaro and Mt. Meru, to the South by the Rubeho Mts., to the West by the Rift Plateau and to the East by the Uluguru and Ukaguru Mts. (fig. 1). This steppe is particularly dry with an average rainfall of less than 700 mm of rain per year. Generally, the vegetation type is either grassland savannah, with few scattered bushes, or bushy savannah with few scattered trees (fig. 2). However, locally and in the vicinity of some hills, there are occasional patches of woodland savannah mainly characterised by *Acacia*.

Fig. 2. – Picture taken during November 1999 in the bushy savannah of Lwami as representative of a trapping site. In the background is the Kilimanjaro Mt.

Materials and methods

Trapping localities were chosen in function of the different typical savannah habitats, *i.e.* open savannah (grassland, scattered bushes, trees limited), bushy savannah, and woodland savannah.

All specimens were live collected by using Sherman folder traps baited with peanut butter mixed with flour and for karyotyping transported to the Rodent Research Project, Sokoine University of Agriculture, Morogoro. Seven short field trips were carried out in December 1998, January, February, May, September, October and November 1999. A total of 251 animals were collected. Localities, trapping efforts and trapping success are shown in table I. A selected sub-sample of 62 specimens was used for karyotype assessment.

Chromosome metaphases were obtained from the bone marrow following Hsu and Patton (1969). Cell suspensions in fixative were transported at the Dipartimento di Biologia Animale e dell'Uomo, Università degli Studi di Roma «La Sapienza» where slides were prepared. Metaphases were stained by the Giemsa standard method (pH7). Picture of metaphases were collected using a digital camera Photometrics Sensys 1600 and the software Iplab (Scanalytics, Inc., version 2.420).

All specimens are stored at the permanent collection of the Museo di Anatomia Comparata «G. B. Grassi», Dipartimento di Biologia Animale e dell'Uomo, Università degli Studi di Roma «La Sapienza»; the Rodent Research Project, Sokoine University of

TABLE I. – *Trapping localities with latitude, longitude, altitude, trapping effort, trapping success (%), and the number of specimens collected.*

Locality	Latitude	Longitude	Altitude	Trapping effort (n. of trap nights* n. of traps)	Percentage of trapping success	n. of specimens
Ngasumet						
Grid I	4°31′06″S	37°12′27″E	1314	3*150	1.5	7
Grid J	4°31′06″S	37°12′27″E	1283	3*150	7.7	35
Zoissa						
Grid D	5°40′20″S	36°25′39″E	1542	3*150	4	18
Grid E	5°41′38″S	36°24′06″E	1464	3*150	6.4	29
Matongolo						
Matongolo Village	5°46′12″S	36°28′06″E	1280	–	–	43
Grid A	5°46′56″S	36°28′46″E	1245	3*100	21.6	65
Grid B	5°46′24″S	36°29′10″E	1237	3*100	8	24
Grid C	5°46′24″S	36°29′10″E	1237	3*100	6	18
Ndaleta						
Grid F	5°12′30″S	36°30′07″E	1490	3*100	5.6	17
Grid G	5°12′27″S	36°30′47″E	1410	3*100	2.3	7
Grid H	5°14′12″S	36°29′38″E	1610	3*100	1.7	5
Mombo	4°54′04″S	38°13′54″E	507	4*150	3	18
Lwami	3°41′09″S	37°31′58″E	923	3*150	1.1	5

Agriculture; and the Biology Department of the University of Antwerp. Cell suspensions and tissues for DNA extraction have been preserved as well for further examination through differential staining, *in situ* hybridisation, gene amplification and sequencing. Results are in progress and will be published elsewhere.

KARYOTYPES DESCRIPTION

CRICETOMYNAE ROBERTS, 1951

Saccostomus Peters, 1846.

According to Musser and Carleton (1993), this genus includes two species, *S. campestris* and *S. mearnsi*, but the taxonomy is still confused. The distribution of *S. campestris* covers all of the southern Africa region up to southwestern Tanzania, while *S. mearnsi* is an eastern African species, with its Southern border in Northeastern Tanzania. According to Hubert (1978) the two species are clearly differentiated morphologically and karyotypically. Matthey (1958) obtained in the Cape region $2n = 43$-46, while Hubert (1978) found $2n = 40$-42 in the Omo Valley, Ethiopia. Gordon and Rautenbach (1980) have showed an extreme karyotypic variability in sympatric and allopatric populations from South Africa and Zimbabwe, with diploid numbers of $2n = 28$, 29, 30, 32, 33, 36, 45, 46, 50; FN ranges between 46 and 66. Due to this extraordinary chromosomal variability, there is no doubt that the two species should be treated as a species complex and that an extensive taxonomic revision is needed.

Saccostomus cf. *mearnsi* 2♂♂. The specimens have been collected in two localities: Matongolo (TZ37 ♂) and Ndaleta (TZ38 ♂) (table I), both occurring within the general accepted range of *S. mearnsi*. The diploid number is $2n = 32$ and the autosomal fundamental number is 48. The karyotype is composed by 7 pairs of large biarmed chromosomes, 6 pairs of small acrocentrics and two pairs of small metacentrics (fig. 3). The X chromosome is a medium size subtelocentric and the Y is a small acrocentric. However, this karyotype shows several differences from the one described by Hubert (1978) for this species, therefore suggesting that it might belong to a different taxon of the species-group *S. mearnsi*. A direct comparison by one of us (W. Verheyen) of the two skulls of our specimens to the type specimens of *S. umbriventer* Miller 1910 (type loc.: Njori Osalali Sotik, Kenya), *S. mearnsi* Heller 1910 (type loc.: Changamwe, Kenya), *S. isiolae* Heller 1912 (type loc.: Isiola river, Kenya) and *S. cricetulus* G.M. Allen & Lawrence 1936 (type loc.: south bank of Greeki river north of Mt. Elgon, Uganda) has shown clearly that our specimens belongs to the *Saccostomus mearnsi* species group, but it can be easily characterised by skull morphology and it should be considered a new species.

Fig. 3. – The karyotype of *Saccostomus* cf. *mearnsi* ($2n = 32$, XY).

GERBILLINAE GRAY, 1825

Tatera Lataste, 1882.

The genus includes 12 species, 11 from Africa and one from southern Asia. Chromosomal data are available for the following African species: *T. afra* ($2n = 44$, aFN = 66; Matthey, 1954; Qumsiyeh, 1986), a South Africa endemic. *T. brantsi* ($2n = 44$, aFN = 66; Matthey, 1954; Qumsiyeh, 1986), ranging from South Africa to Zambia. *T. leucogaster* ($2n = 40$, aFN = 66; Gordon and Rautenbach, 1980; Qumsiyeh, 1986), ranging from South Africa to Southwest Tanzania; Matthey (1954) classified a specimen from the Central African Republic as *T. schinzi* but this species is now considered

synonymous of *T. leucogaster*. *T. nigricauda* ($2n = 40$, aFN = 64/66; Matthey, 1969; Qumsiyeh *et al.*, 1987), ranging in Kenya, Somalia and Tanzania. *T. robusta* ($2n = 36$, aFN = 64; Qumsiyeh *et al.*, 1987), occurring from Burkina Faso to the Horn and East Africa; two specimens from Central African Republic with $2n = 46$ and aFN = 64 have been identified by Matthey and Petter (1970) as *T. robusta* but this was probably incorrect, and Qumsiyeh *et al.* (1987) ascribed the two specimens to *T. phillipsi* (ranging in Somalia, Kenya, and Ethiopia). *T. valida* ($2n = 48/50$, aFN = 60/66; Matthey and Petter, 1970; Tranier, 1974; Benazzou *et al.*, 1984), ranging from Chad to Zaire, Zambia and Angola. *T. kempi* ($2n = 48$, aFN = 62-64; Colangelo *et al.*, in press); Gautun *et al.* (1986) referred a specimen from Guinea with $2n = 46$ as *T. kempi*; Matthey and Petter (1970), Gautun and Petter (1972) and Gautun *et al.* (1986) identified some specimens from Burkina Faso and Ivory Coast as *T. hopkinsoni*, now synonymous of *T. kempi*; Matthey and Petter (1970) identified a specimen form Central African Republic with $2n = 36$ and aFN = 62 as *T. kempi*, but this attribution appears incorrect and probably the specimen is referable to *T. robusta*. *T. gambiana* ($2n = 52$; Hubert, 1973); Matthey (1969) identified a specimen from Senegal with $2n = 52$ and aFN = 64 as *T. valida* but probably it is referable to *T. gambiana*. *T. guineae* ($2n = 50$, aFN = 64; Matthey and Petter, 1970; Benazzou *et al.*, 1984; Gautun *et al.*, 1985).

Tatera cf. *robusta* (Cretzschmar, 1826). 1 ♀, 1 ♂. Specimens come from Matongolo (TZ62 ♀) and Ndaleta (TZ7 ♂). The diploid number is $2n = 36$ and the aFN = 68. The karyotype is composed by 17 autosomal pairs of biarmed chromosomes (fig. 4). The X chromosome is one of the largest chromosomes of the whole karyotype and it is biarmed. The Y chromosome is small and it is difficult to interpret its morphology. This karyotype corresponds to the one described by Matthey and Petter (1970) for this species. Matthey and Petter (1970) described two karyotypes with $2n = 36$ and aFN = 62 as *T. kempi* but these specimens are likely *T. robusta* rather than *T. kempi* (Qumsiyeh *et al.*, 1987). Qumsiyeh *et al.* (1987) attributed the karyotype of some

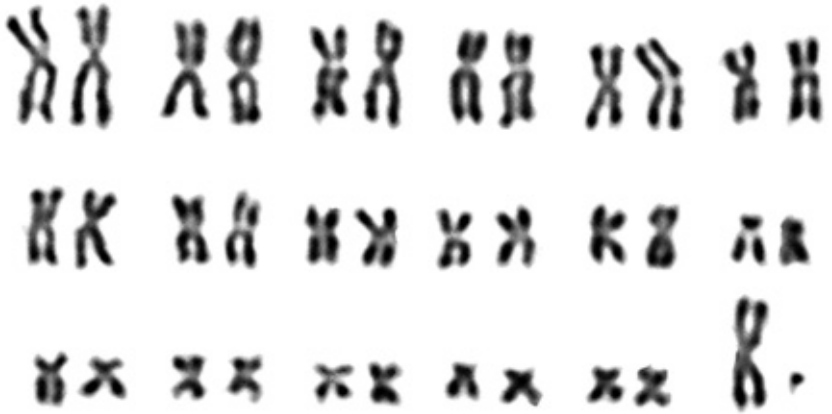

Fig. 4. – The karyotype of *Tatera* cf. *robusta* ($2n = 36$, XY).

specimens from Kenya with $2n = 36$ and aFN = 64 to *T. robusta*. This karyotype differs however from the one reported here for the autosomal fundamental number, probably in consequence of a pericentric inversion.

Gerbillus Desmarest, 1804.

This is a very controversial genus as it has never been adequately reviewed. Musser and Carleton (1993) listed 60 species, 53 of which occur in Africa and 7 in Asia or in the Arabic peninsula. Among the African species, 15 occur in the Horn or in East Africa, but the karyotype has only been described for *G. dunni* (Somalia, $2n = 38$, aFN = 98; Capanna and Merani, 1981) and *G. pusillus* (Somalia, $2n = 34$, aFN = 50; Capanna and Merani, 1981), However, within this genus some species display high karyotypic variability, such as *G. pyramidum* with diploid numbers ranging from $2n = 40$ to $2n = 66$ (Wahrman and Gourevitz, 1973; Wahrman and Zahavi, 1955).

Gerbillus cf. *pusillus* Peters, 1878. 3 ♂♂, 1 ♀. The four specimens are from Matongolo (TZ16 ♀, TZ18 ♂, TZ27 ♂, TZ137 ♂). The diploid and Autosomal Fundamental numbers are 48 and 50, respectively. The karyotype is composed by 2 autosomal pairs of biarmed chromosomes (fig. 5). The X chromosome is a large submetacentric and the Y chromosome is a medium acrocentric. The other autosomal chromosomes are all acrocentric from medium to small size. This karyotype is described here for the first time.

The specimens have been compared by one of the authors (Verheyen) with material from south-eastern Kenya and north-western Tanzania and it is clear that they are to be classified near the typical *G. pusillus* described by Peters 1878 from Ndi (Taita Hills – South-eastern Kenya).

Fig. 5. – The karyotype of *Gerbillus* cf. *pusillus* ($2n$ = 48, XX).

MURINAE ILLIGER, 1815.

Acomys I. Geoffroy, 1838.

The genus includes fourteen species, but 3 do not occur in Africa. According to Musser and Carleton (1993), four species are recorded in Tanzania: *A. ignitus*, *A. kempi*, *A. spinosissimus*, and *A. wilsoni*. *A. ignitus* is considered related by Ellerman (1941) to *pulchellus*, *kempi*, and *montanus*, and by Janecek *et al.* (1991) to *cahirinus*. The karyotype of *A. spinosissimus* has been described by Matthey (1965) from specimens which were identified as *A. selousi* (the $2n = 60$ and FN = 70-72). The author also reported that the X chromosome is very large. However, Dippenaar and Rautenbach (1986) reported $2n = 60$ and FN = 68 and a smaller X chromosome for specimens captured in Transvaal (South Africa). Karyotypes are known for other species and are as follows: *A. cahirinus*, $2n = 36$ and FN = 68 (Volobouev *et al.*, 1996); *A. dimidiatus* (cf. *A. airensis*, Agades, Niger, $2n = 42$, aFN = 66), $2n = 38$ and FN = 70 (Volobouev *et al.*, 1991); *A. ignitus*, $2n = 50$ and FN = 66-68; *A. russatus*, $2n = 66$ and FN = 66. Also for this genus there is no comprehensive systematic revision available.

Three different karyotypes have been found in the specimens collected in the Maasai Steppe. The *Acomys* specimens have been determined after comparison with other Tanzanian material and directly compared (by W. Verheyen) with the *ad hoc* type-material.

Acomys spinosissimus Peters, 1852. 2 ♀ ♀, 2 ♂ ♂. Specimens have been collected in Zoissa (TZ5 ♀, TZ22 ♀, TZ42 ♂, TZ54 ♂), and show $2n = 60$ and aFN = 70. The karyotype (fig. 6) consists of 5 pairs of metacentrics and submetacentrics, 22 pairs of acrocentrics decreasing in size, and one pair of small metacentrics. The X-chromosome is a large acrocentric and the Y-chromosome is a small subtelocentric.

Fig. 6. – The karyotype of *Acomys spinosissimus* ($2n = 60$, XY).

Fig. 7. – The karyotype of *Acomys wilsoni* ($2n$ = 62, XY).

Acomys wilsoni Thomas, 1892. 2 ♀ ♀, 2 ♂ ♂. Specimens are from Ngasumet (TZ 138 ♀, TZ139 ♂, TZ140 ♂, TZ141 ♀) and display $2n = 62$ and aFN = 76 (fig. 7). The differences between the two karyotypes consist in an inversion of a large acrocentric which leads to the formation of a large metacentric, and a pair of small metacentrics which are not found in the *A. spinosissimus* karyotype. This karyotype is described here for the first time.

Acomys ignitus Dollman, 1910. 1 ♀, 2 ♂ ♂. Specimens have been collected in Lwami (TZ114 ♂, TZ257 ♂, TZ258 ♀) and show $2n = 36$ and aFN = 68. The chromosomes are all biarmed (meta- and submetacentrics) (fig. 8). The X is a medium subtelocentric and the Y is a small acrocentric or telocentric. This karyotype is described here for the first time but it may resemble that of *A. cahirinus*.

Aethomys Thomas, 1915.

The genus includes 10 species, of which three probably exist in Tanzania: *A. chrysophilus*, *A. hindei*, and *A. kaiseri*. Karyotypes are known only for *A. chrysophilus*, however with different diploid and autosomal fundamental numbers found ($2n = 44$, aFN unknown, Ivory Coast, Matthey, 1954; $2n = 44$, aFN = 58 or $2n = 50$, aFN = 58, Zimbabwe, Gordon and Rautenbach, 1980) and *A. namaquensis* ($2n = 24$, aFN = 32, from Namibia and South Africa; Baker *et al.*, 1988).

Aethomys cf. *chrysophilus* (de Winton, 1897) 8 ♀ ♀, 5 ♂ ♂. Specimens come from Ndaleta (TZ153 ♂), Matongolo (TZ39 ♀, TZ2 ♀), Mombo (TZ115 ♀), Zoissa (TZ15 ♀) and Ngasumet (TZ31 ♂, TZ10 ♀, TZ14 ♂, TZ9 ♀, TZ60 ♀, TZ61 ♂, TZ23 ♂,

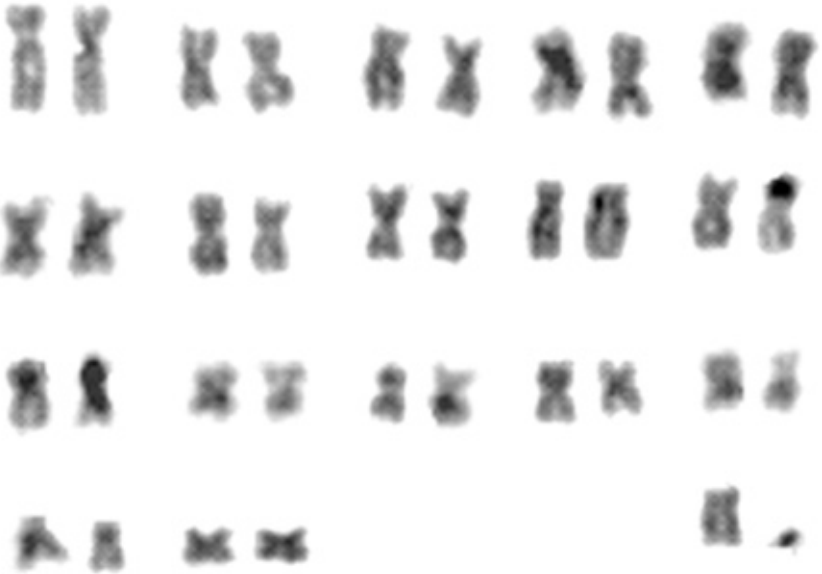

Fig. 8. – The karyotype of *Acomys ignitus* ($2n$ = 36, XY).

TZ14 ♀). The diploid number is $2n = 50$ and the Autosomal Fundamental number is aFN = 58. The autosomal set is composed by nineteen pairs of acrocentric chromosomes decreasing in size and five pairs of small metacentrics (fig. 9). The X chromosome is a large acrocentric and the Y chromosome is a large sub-telocentric. The karyotype corresponds to the one reported by Baker *et al.* (1988) and by Gordon and Rautenbach (1980; their figure 2), but it is very different from another one with $2n = 44$ described for *A. chrysophilus* in the same paper of Gordon and Rautenbach (1980).

Fig. 9. – The karyotype of *Aethomys* cf. *chrysophilus* ($2n$ = 50, XX).

Arvicanthis Lesson, 1842.

The genus is currently under revision. The genus includes formally 5 species but recent studies have shown the occurrence of several cryptic species or cytotypes. Chromosomal data are know for *A. abyssinicus* ($2n = 62$, aFN = 64; Orlov *et al.*, 1992; Corti *et al.*, 1996), *A. blicki* ($2n = 48$, aFN = 64; Corti *et al.* 1995, 1996), *A. somalicus* (Ducroz, 1998; $2n = 54$, aFN = 62; as a matter of fact *A. neumanni*), *A. dembeensis* ($2n = 62$, aFN = 62; Orlov *et al.*, 1992; Corti *et al.*, 1996). This latter has probably the same karyotype of *A. niloticus* (Volobouev *et al.*, 1988).

The species *A. niloticus* should be considered as a chromosomal species complex, for which there are provisional names: ANI1, widely distributed from Egypt to Senegal ($2n = 62$, aFN = 62/64; Volobouev *et al.*, 1988; Ducroz *et al.*, 1997); ANI-2, from Central African Republic ($2n = 58$, aFN = 70; Volobouev *et al.*, 1988); ANI-3, from Western Africa ($2n = 62$, aFN = 74 – 76; Volobouev *et al.*, 1988; Ducroz *et al.*, 1998); ANI-4 from Benin (Civitelli *et al.*, 1995) and South Senegal (Granjon *et al.*, 1992). Additionally, an evident X and Y chromosomal polymorphism was described in specimens from Benin (Civitelli *et al.*, 1995; Garagna *et al.*, 1999).

Arvicanthis cf. *neumanni* Matschie, 1894. 9 ♂♂, 6 ♀♀. The specimens come from Ndaleta (TZ40 ♂), Zoissa (TZ25 ♂, TZ64 ♀, TZ65 ♀), Matongolo (TZ13 ♂, TZ19 ♀, TZ48 ♂, TZ49 ♂, TZ50 ♀, TZ51 ♀, TZ55 ♂, TZ56 ♂, TZ57 ♂, TZ58 ♀, TZ63 ♂). Specimens show different diploid numbers ($2n = 53$-54 and the aFN = 62). The autosomal set of the $2n = 54$ specimens is composed by four pairs of large biarmed chromosomes, one pair of small metacentrics and 21 pairs of telocentric chromosomes (fig. 10). The reduction of the diploid number in the $2n = 53$ specimens is due to the presence of an additional metacentric arisen from a new Robertsonian fusion. In all the specimens the X chromosome is a large submetacentric and the Y chromosome is a medium size metacentric. The two karyotypes are in Hardy-Weinberg equilibrium. This karyotype is described here for the first time.

The specimens have been compared to extensive material covering the central plateau of Tanzania as well as to the relevant type-specimens. The conclusion is that further analysis is needed before deciding on the exact systematic position of the different *Arvicanthis* populations of this part of Tanzania.

Arvicanthis cf. *nairobae* Allen, 1909. 2 ♀♀. Two specimens from Lwami (TZ112 ♀, TZ113 ♀) display a different karyotype, with $2n = 62$ and aFN = 78. The chromosomal complement of *Arvicanthis nairobae* is composed by 9 pairs of biarmed autosomes and 20 pairs of telocentric chromosomes decreasing in size (fig. 11). The biarmed complement is composed by two large submetacentrics, four pairs of medium size submetacentrics or subtelocentrics and three pairs of small metacentrics. The X chromosome is a large subtelocentric, and the Y chromosome is a medium size submetacentric (subtelocentric). This karyotype is described here for the first time.

Grammomys Thomas, 1915.

The genus includes 11 species (Musser and Carleton, 1993). Petter and Tranier

Fig. 10. – The karyotype of *Arvicanthis* cf. *neumanni* ($2n$ = 53, XY). In the upper right corner are the metacentric and homologous acrocentrics of the $2n$ = 53 karyotypic form.

(1975) described the karyotypes of *G. buntingi* (Ivory Coast $2n = 52$ FN = 66) and *G. gazellae* (Central African Republic) with diploid numbers ranging from 68 to 71. Tranier and Dosso (1979) reported $2n = 36$ for an individual captured in Ivory Coast; which contrasts with the $2n = 50$ usually recorded for *G. rutilans* (Matthey, 1963) in the same areas.

A variation in B chromosomes has been documented by Civitelli *et al.* (1989) in *G. macmillani* from Central Africa (under the name of *gazellae*) ($2n$ ranging from 56 to 71). Among these chromosomes, a constant fraction of A-chromosomes was identified, composed by 9 pairs of medium-sized acrocentrics, 2 pairs of small metacentrics and 9 pairs of small acrocentrics decreasing in size. The X is a large submetacentric chromosome and the Y a medium acrocentric. The occurrence of B-chromosomes and Robertsonian fusion has been found also by Roche *et al.* (1984) in five specimens (a mother and four pups) of *Grammomys* from Somalia ($2n$ = 56-61, aFN = 70-75; $2n$ = 55-57; $2n$ = 54-59).

Fig. 11. – The karyotype of *Arvicanthis* cf. *nairobae* ($2n$ = 62, XX).

Grammomys sp. 1 ♀. The only specimen comes from Ndaleta (TZ12 ♀). The karyotype shows $2n = 27$ and aFN = 39. It is composed by 6 pairs of biarmed chromosomes decreasing in size, two pairs of medium acrocentrics, two pairs of small metacentrics, 3 pairs of small acrocentrics and one subtelocentric (fig. 12). The X chromosome is a medium submetacentric. This is the lowest diploid number detected in the genus. The karyotype is characterised by the occurrence of at least one B-chromosome. This karyotype is described here for the first time.

The craniological and craniometrical comparison (by W. Verheyen) of our extensive Tanzanian material with most of the relevant type-specimens has revealed that the taxonomic situation of the *Grammomys-Thamnomys* complex of this part of Africa is far

Fig. 12. – The karyotype of *Grammomys* sp. ($2n$ = 27, XX).

from being elucidated and that for the moment it is not justified to allocate our specimen to a specific taxon.

Lemniscomys Trouessart, 1881.

The genus includes 10 species, several of which should be the object of a taxonomic revision. Three species occur in Tanzania, *i.e.* *L. zebra*, *L. rosalia*, and *L. striatus*. Carleton and van der Straeten (1997) considered as *L. barbarus* only those populations from north-west Africa, and included all the sub-Saharan populations under *L. zebra*, considered to be synonymous of *L. barbarus* by Musser and Carleton (1993). In this paper we adopt the nomenclature proposed by Carleton and van der Straeten (1997). Karyotypes are known for *L. zebra* ($2n = 54$, aFN = 58; Matthey, 1954; Filippucci *et al.*, 1986), *L. bellieri* (Ivory Coast: $2n = 56$, aFN = 74; van der Straeten and Verheyen, 1978), *L. striatus* (Ivory Coast: $2n = 44$, aFN = 68; van der Straeten and Verheyen, 1978; Burkina Faso: $2n = 44$, aFN = 84; Benin: $2n = 44$, aFN = 72-74; Capanna *et al.*, 1997).

Lemniscomys rosalia (Thomas, 1904). 3 ♂♂. Specimens come from Ngasumet (TZ29 ♂, TZ30 ♂) and Zoissa (TZ24 ♂). The diploid number is $2n = 54$ and the aFN is 64. The karyotype is composed by three pairs of large biarmed chromosomes, two pairs of small metacentrics, and twenty-one pairs of acrocentrics decreasing in size (fig. 13). The X chromosome is a large sub-telocentric, and the Y chromosome is a medium size submetacentric. The first description of the karyotype of this species is given here.

Fig. 13. – The karyotype of *Lemniscomys rosalia* ($2n = 54$, XY).

Fig. 14. – The karyotype of *Lemniscomys* cf. *zebra* ($2n$ = 54, XX).

Lemniscomys cf. *zebra* (Heuglin, 1864) 4 ♀♀, 1 ♂. Specimens come from Zoissa (TZ1 ♀), Matongolo (TZ6 ♀, TZ53 ♂), Ndaleta (TZ20 ♀) and Ngasumet (TZ36 ♀). The diploid number is $2n = 54$ and the aFN is 58. The karyotype is composed by one pair of large subtelocentric chromosomes, two pairs of small metacentrics, and by twenty-three pairs of acrocentrics decreasing in size (fig. 14). Heterochromosomes are composed by a large sub-telocentric X chromosome and by a small sub-metacentric Y chromosome. The X chromosome is characterised by a polymorphism in the heterochromatine of the short arm.

Mastomys Thomas, 1915.

The genus includes 8 species, but the need of a careful taxonomic revision has been suggested by Musser and Carleton (1993). Chromosomal data are known for the following species: *M. natalensis* ($2n = 32$ and aFN = 54), from Southern Africa (Green *et al.*, 1980), Senegal (Duplantier *et al.*, 1990*a*, *b*) Tanzania (Leirs, 1994), and Somalia (Capanna *et al.*, 1982; but referred as *M. huberti*); Britton-Davidian *et al.* (1995) described a chromosomal polymorphism for the Senegal specimens, with autosomal fundamental numbers ranging from 52 to 54. *M. coucha* ($2n = 36$ and aFN = 56), from Southern Africa (Green *et al.*, 1980) and Zimbabwe (Lyons *et al.*, 1977). *M. erythroleucus* ($2n = 38$, FN = 52), from Southern Africa (Hubert *et al.*, 1983), Senegal (Duplantier *et al.*, 1990*a*), but with a polymorphism ($2n = 38$, aFN = 51-54) found in Senegal by Britton-Davidian *et al.* (1995). *M. huberti* from Senegal, Mauritania and Burkina Faso (see Granjon *et al.*, 1997, for a discussion on this species) with $2n = 32$ and aFN = 44-46 (Britton-Davidian *et al.*, 1995; Granjon *et al.*, 1997).

Fig. 15. – The karyotype of *Mastomys natalensis* ($2n$ = 32, XY).

Mastomys natalensis (Smith, 1834). 4 ♀ ♀, 1 ♂. This species has been collected in Ngasumet (TZ21 ♂, TZ10 ♀, TZ9 ♀), Matongolo (TZ28 ♀) and Ndaleta (TZ8 ♀). All specimens share the same karyotype described by Green *et al.* (1980) and Leirs (1994). The diploid number is $2n = 32$ and the aFN is 54 (fig. 15). The karyotype consists of 12 biarmed chromosomes and three pairs of small acrocentrics. The X chromosome is the largest, metacentric chromosome and the Y is the largest, acrocentric chromosome.

Discussion

Eight karyotypes are described here for the first time (*Saccostomus* cf. *mearnsi*, *Gerbillus* cf. *pusillus.*, *Acomys wilsoni*, *Acomys ignitus*, *Arvicanthis* cf. *neumanni*, *Arvicanthis* cf. *nairobae*, *Grammomys* sp., *Lemniscomys rosalia*).

There are several interesting novelties found in these rodents of the Maasai steppe. Three genera, *Acomys*, *Arvicanthis*, and *Lemniscomys*, are represented by more than one species. The systematics and taxonomy of these genera is still not clear for this region of Africa and although some of them, *e.g. Arvicanthis*, have been extensively studied during the past ten years, there is no comprehensive review of the taxonomic status of the east African representatives of these genera. In fact, most of the data available, including cytogenetics, allozyme electrophoresis, gene sequencing, and morphometrics come from other African regions. As a result, there are no recent taxonomical publications on these rodent genera of the savannahs of East Africa.

Also the distribution of some of the species across the capture area presents interesting patterns. For example *Arvicanthis* cf. *neumanni* ($2n = 54$) occurs throughout the steppe up to Ngasumet, but in the North (Lwami) apparently is replaced by *Arvicanthis* cf. *nairobae* ($2n = 62$). However, the other common genera (*Aethomys*, *Mastomys*,

Tatera) do not show any karyological variation across the capture localities, although this cannot be entirely excluded.

Even for the other less known genera, *i.e. Saccostomus*, *Gerbillus*, *Grammomys*, this report presents new findings. Their taxonomy, systematics and distribution are poorly known, and the data reported here are the first descriptions of their karyotypes for this region of eastern Africa. It should be reminded here that the karyotype of *Saccostomus mearnsi* has been described only for an Ethiopian population, but with a clearly different diploid number ($2n = 42$-44), suggesting that we are dealing with a new species.

Grammomys is another complex savannah-genus with complicated links with the forest-living genus *Thamnomys*. The karyotype reported here is very peculiar compared to the others known for the genus, as it presents the lowest number of chromosomes, including B-chromosomes.

The present report constitutes an important help when revising the systematics and taxonomy of these genera in Tanzania. It should also be considered in the assessment of biodiversity of the savannahs occurring between the great Eastern Africa lakes and the mountain chains of the Eastern Arch, as it contributes to the understanding of the biogeographical problems in these fragile ecosystems.

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