

The chromosome complement of *Acomys* spp. (Rodentia, Muridae) from Oursi, Burkina Faso—the ancestral karyotype of the *cahirinus–dimidiatus* group?

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We present here data on chromosome banding analysis (R- and C-bands) of *Acomys* sp. (Rodentia, Muridae) from Oursi, Burkina Faso, characterized by $2n=FN=68$ and comparison of its banding patterns with those of *Acomys dimidiatus* from Saudi Arabia ($2n=38$, $FN=70$), studied previously. The study revealed complete homology between acrocentric chromosomes of *Acomys* sp. and chromosome arms of 16 pairs of metacentric and two pairs of acrocentric chromosomes of *A. dimidiatus*. In addition to monobrachial homology, one tandem translocation accompanied by a centromeric shift was identified in the karyotype of the latter species. The data obtained show that karyotypes of all the species of the *Acomys cahirinus–dimidiatus* group studied previously may be derived from that of *Acomys* sp. from Oursi by means of numerous non-homologous Rb translocations and 1–2 tandem translocations, and thus its karyotype may be considered as ancestral for the *cahirinus–dimidiatus* group.

Key words: *Acomys*, ancestral karyotype, chromosome evolution, Muridae

Introduction

From a taxonomic point of view, the spiny mice of the genus *Acomys* are very 'difficult' because of the absence of solid diagnostic external characters that result in a widely varying taxonomic content of the genus, from 38 (Ellerman 1940–41) to 14 (Musser & Carleton 1993) or even 9 (Corbet & Hill 1987) species. Within the genus, difficulty arises first of all from the so-called *cahirinus–dimidiatus* complex (Petter 1983), in which a number of forms and their taxonomic rank are the subject of continuing revision. For example, the most recent revision of the genus (Musser & Carleton 1993) included in *A. cahirinus* 16 synonyms (*airensis*, *chudeaui*, *dimidiatus*, among others) that are considered by other authors as valid distinct species (Petter 1983, Denys *et al.* 1994).

Previous chromosome banding studies of some forms of the *cahirinus–dimidiatus* group, namely *Ac-*

omys airensis ($2n=42$, $FN=68$) *A. dimidiatus* ($2n=38$, $FN=70$) (Volobouev *et al.* 1991) and *A. cahirinus* ($2n=36$, $FN=68$) have revealed that their karyotypes show complete arm homology but do not share any identical biarmed chromosomes among 13 pairs in the former species and 16 pairs in the latter two (Volobouev *et al.* 1991, 1996). In addition, it was shown that the short arm of chromosome 1 in *A. cahirinus* corresponds to biarmed chromosome 16 in *A. dimidiatus*, which, in turn, corresponds to the long arm of chromosome 7 in *A. airensis*. This means that karyotype evolution of the considered species together with numerous non-homologous Rb translocations (fusion of two acrocentric chromosomes resulted in formation of one biarmed chromosome) was accompanied by one telomere–centromere translocation that explains variation of the FN from 68 to 70. It was presumed that, as a result of these two types of chromosome rearrangements, the karyotypes of the above species as well as those of all the other species of the *cahirinus–dimidiatus* complex may easily be derived from a common ancestor that had karyotypes composed of 70 or 68 acrocentrics (if the latter have already had at least one tandem translocation) (Volobouev *et al.* 1991, 1996). The standard karyotype of previously described *Acomys* sp. from Burkina Faso comprising 68 acrocentric chromosomes (Gautun *et al.* 1985) seemed to be an appropriate candidate for the expected ancestral karyotype of the *cahirinus–dimidiatus* group.

Here, we present data on chromosome banding of the *Acomys* sp. from Oursi (Burkina Faso) and its comparison with the chromosome banding patterns of previously studied species of the *cahirinus–dimidiatus* complex in order to examine their phylogenetic relationships.

Materials and methods

The two adult specimens studied, one male and one female, came from the vicinity of Oursi, Burkina Faso, from an inselberg.

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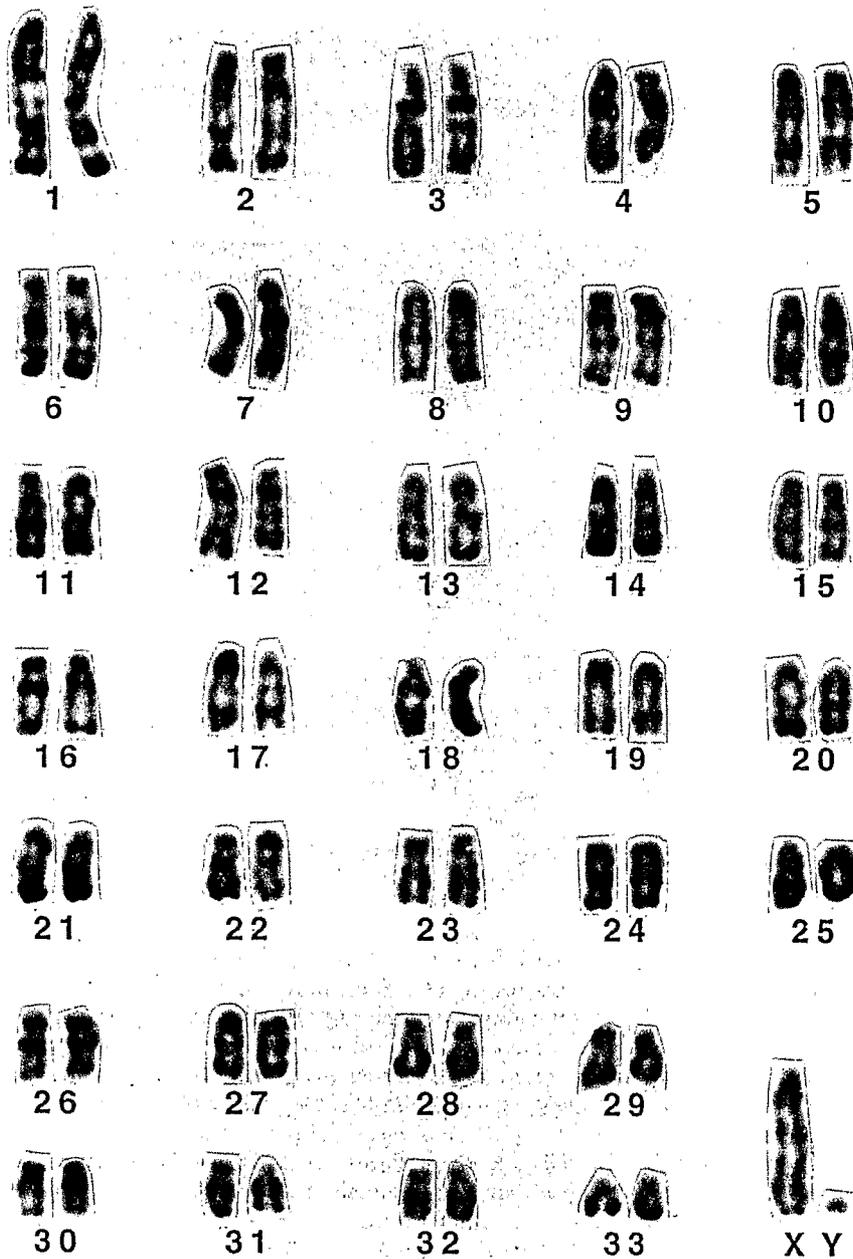


Figure 1. R-banded karyotype (RHG) of a male *Acomys* sp. from Oursi, Burkina Faso.

Chromosome analysis was performed on preparations obtained from fibroblast cell cultures established after skin biopsy of one adult male and one female with two embryos, both males. The established primary cell cultures, as well as tissue explants, are routinely cryopreserved in the cell and tissue collection of the Curie Institute (Paris). The chromosomes of each specimen were studied by R-banding (RBG) after bromodeoxyuridine (BrdU) incorporation (Viegas-Péquignot & Dutrillaux 1978), and by C-banding (CBG; Sumner 1972). At least 15 metaphases from each specimen were analysed.

Results and discussion

The diploid number of the four studied specimens of *Acomys* sp. from Oursi is 68 (Figure 1). All autosomes and both sex chromosomes are acrocentric, thus resulting in an FN (number of chromosome arms) equal to 68. The X chromosome is similar in size to the largest pair of autosomes, whereas the Y chromosome is tiny and probably one of the smallest among the mammals karyotyped up until now. After R-banding, each pair of

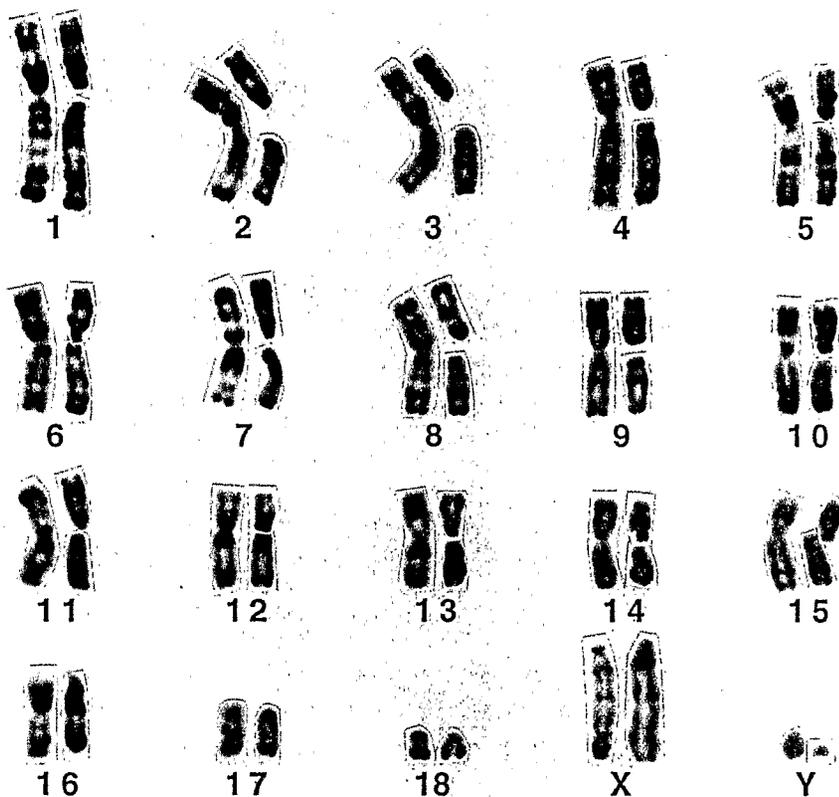


Figure 2. Side-by-side comparison of chromosomes of *Acomys dimidiatus* and an *Acomys* sp. from Oursi. Each pair contains one chromosome of *A. dimidiatus* (at left), whereas its homologue is composed of acrocentric chromosomes of *Acomys* sp. from Oursi. Note that in relation to karyotype of *A. dimidiatus* presented in Volobouev et al. (1991), pairs 6 and 10 have changed places.

autosomes and the X chromosome are characterized by a specific banding pattern and may be easily recognized. The C-banding technique revealed the small blocks of centromeric heterochromatin on some pairs of autosomes and the X chromosome (not shown).

Side-by-side comparison of R-banded chromosomes of *Acomys* sp. with the chromosome arms of 16 pairs of metacentric and two pairs of free acrocentrics of *A. dimidiatus* studied previously (Volobouev et al. 1991) established a complete homology of their banding patterns, except that the Y chromosome is many times smaller in *Acomys* sp. (Figure 2 & Table 1). As may be noticed, the banding pattern of acrocentric chromosome 4 of *Acomys* sp. is identical to metacentric chromosome 16 of *A. dimidiatus*. A similar situation was previously found in the karyotype comparison of *A. dimidiatus* and *A. airensis* (Volobouev et al. 1991) and *A. dimidiatus* and *A. cahirinus* (Volobouev et al. 1996). From this observation, it follows that chromosome 4 of *Acomys* sp. is of a composite nature as a result of the centromere-telomere fusion of two ancestral acrocentric chromosomes and thus has two centromeres: one active and the other one inactivated or latent. As was demonstrated in a series of studies of the karyotype evolution of mammals, the centromere inactivation-reactivation process may switch on and

off any of these centromeres, resulting in different chromosome morphology in different species. This phenomenon was observed in numerous mammalian taxa belonging to Insectivora, Primates, Carnivora and Rodentia (reviewed in Searle 1993). Among the studied species of *Acomys*, such a chromosome is acrocentric in *Acomys* sp. from Oursi, *A. airensis* and *A. cahirinus* (Egypt), and metacentric in *A. dimidiatus* and *A. cahirinus* from Sinai (Volobouev et al. 1991, 1996).

Complete homology of chromosome banding patterns established between the chromosome arms of *A. airensis*, *A. dimidiatus* (Volobouev et al. 1991) and *A. cahirinus* (Volobouev et al. 1996), on the one hand, and acrocentric chromosomes of *Acomys* sp. from Oursi, on the other hand, allows the derivation of the karyotypes of all species of the *cahirinus-dimidiatus* complex from that of *Acomys* sp. by means of numerous non-homologous Robertsonian and two centromere-telomere translocations, and, thus, this last may be considered as the living ancestor of the *cahirinus-dimidiatus* group.

It is interesting to note that, in terms of chromosome numbers and their morphology, the 'Oursi' form is similar to some other species of the genus *Acomys*, such as an *Acomys* sp. from the Ethiopian Rift Valley ($2n=68$, FN=68) (Sokolov et al. 1992) and the South African *A. subspinosus* ($2n=64$, FN=74) and *A. spino-*

Table 1. Corresponding chromosomes and chromosome arms of *Acomys* sp. and *Acomys dimidiatus*

<i>Acomys</i> sp. (2n=68, FN=68)	<i>Acomys dimidiatus</i> (2n=38, FN=70)
1.	1q
2	4q
3	5q
4	16pq*
5	1p
6	6q
7	7q
8	3q
9	2q
10	2p
11	8q
12	3p
13	8p
14	7p
15	11q
16	9q
17	11p
18	6p
19	12q
20	4p
21	10q
22	10p
23	15q
24	9p
25	13q
26	5p
27	17
28	13p
29	14q
30	12p
31	14p
32	15p
33	18
X	X
Y	Y -

*See text for explanation.

sissimus (2n=60, FN=72) (Dippenaar & Rautenbach 1986). However, if the *Acomys* sp. from Oursi is morphologically very close to the species of the *cahirinus-dimidiatus* group (Gautun *et al.* 1985), as is the *Acomys* sp. from the Rift Valley (Sokolov *et al.* 1992), the other high-number chromosomal forms, including *A. russatus*, *A. subspinosus*, *A. spinosissimus*, *A. wilsoni* and *A. ignitus* (see Table 1 in Volobouev *et al.* 1991 and references therein), belong to the other morphological group in accordance with the classification of Petter (1983) and Denys *et al.* (1994), and further chromosome banding studies are needed to establish relationships between them and to understand the pathways of karyotype evolution in the whole genus.

In many ways, karyotype evolution of the *cahirinus-dimidiatus* group is similar to that of the *Sorex araneus* species complex studied in much more detail (Searle 1993, Searle *et al.* 1990). Both include the species that

preserved the acrocentric karyotypes (*S. granarius*—*Acomys* sp. Oursi) along with those whose karyotypes contain only biarmed chromosomes (*S. coronatus*—*A. cahirinus*). In some species, the Rb process is ongoing nowadays, as is the case in most of the species of the *S. araneus* group and at least *A. airensis* and *A. chudeaui* among six studied species of the *cahirinus-dimidiatus* group (unpublished observation). These regularities, probably typical of all Rb species complexes, resurrect an old question about the mechanisms that expose some taxa to extensive chromosome reorganization, whereas other closely related taxa preserve an unchanged karyotype. There is a greater probability that it is an accumulation in centromeric regions of certain types of repeated sequences promoting the process of Rb fusions, as was shown in mice (Garagna *et al.* 1995, Nanda *et al.* 1995), in shrews (V. Volobouev *et al.* in preparation) and in a group of South American cricetid rodents (Zambelli & Vidal-Rioja 1995). Now, using *in situ* hybridization studies, we have tried to examine the situation in *Acomys* species too.

In conclusion, the species of the *cahirinus-dimidiatus* group give another example of an evolving Rb complex similar to that of shrews and mice (Searle *et al.* 1990). By analogy with these, it seems possible to predict the existence of new 'chromosomal' species inside the *cahirinus-dimidiatus* group, the detection of which may be done exclusively by chromosome banding analysis. In addition, this species group represents another suitable model for the study of the speciation process *in statu nascendi*, namely the relationships between its molecular, chromosomal and morphological aspects.

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