Was Zambia a cradle of the genus *Cryptomys* (Bathyergidae, Rodentia)?

A further new ancestral (?) species of *Cryptomys* from Zambia

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Introduction

African mole-rats of the genus *Cryptomys* Gray, 1864, (Bathyergidae), are subterranean rodents occurring from semi-arid to mesic habitats in different soil types over a wide geographic range from Ghana to the Cape Province in South Africa. Pronounced polymorphism in body size, coloration and many cranial features makes taxonomic treatment of this genus very difficult. Accordingly, different authors recognised different numbers of species. Thus for instance, 44 to 49 species of *Cryptomys* have been named by ALLEN (1939) or ELLERMANN (1940), respectively, whereas only three have been considered by NOWAK (1991). It has been repeatedly demonstrated (ROSEVEAR, 1969; ANSELL, 1978; WILLIAMS *et al.*, 1983; NEVO *et al.*, 1986, 1987; HONEYCUTT *et al.*, 1987, 1991; JANECEK *et al.*, 1992) that classical morphological qualitative and quantitative traits are not sufficient for the species diagnosis in *Cryptomys*, and additionally, cytology, serology, and molecular genetics should be considered.

Taking these aspects into account, HONEYCUTT *et al.* (1991) have recognised seven species: *Cryptomys bocagei* (De Winton, 1897); *Cryptomys damarensis* (Ogilby, 1838); *Cryptomys foxi* (Thomas, 1911); *Cryptomys hottentotus* with subspecies *C. h. hottentotus* (Lesson, 1826); *C. h. natalensis* (Roberts, 1913), *C. h. darlingi* (Thomas, 1895); *C. h. amatus* (Wroughton, 1907); *C. h. whytei* (Thomas, 1897); *Cryptomys mechowi* (Peters, 1881); *Cryptomys ochraceocinereus* (Heuglin, 1864); *Cryptomys zechi* (Matschie, 1900). However, the authors had studied *Cryptomys* mole-rats originating from the Southern African Subregion and had no molecular or karyologic data on more northern populations. Based on the relative uniformity of *Cryptomys* from South Africa they considered also the common mole-rats from subequatorial central Africa to belong mainly to the *C. hottentotus* species. Subsequent karyological studies demonstrated, however, that *Cryptomys darlingi* and *Cryptomys amatus* should be considered distinct species (AGUILAR, 1993; MACHOLÁN *et al.*, 1998). Besides that, our allozyme and karyotype studies (FILIPPUCCI *et al.*, 1994, 1997; BURDA *et al.*, 1999) identified two additional species within the small form of *Cryptomys* in Zambia: *C. anselli* and *C. kafuensis*. Furthermore, we showed that *Cryptomys* from the Malawian Nyika, characterised by the karyotype 2n = 46 should be considered a distinct species which we call here (on the grounds of geographical vicinity to the type locality of *C. hottentotus whytei*) *C. whytei* (CHITAUKALI *et al.*, this volume).

In this paper we report finding of another population of *Cryptomys* from Kasama, Zambia, which constitutes a distinct species and the karyotype of which may provide new insight into (chromosomal) speciation of *Cryptomys*.

Material and methods

Two mole-rats were obtained from Kasama, Zambia, (S 10: 16; E 31: 0; altitude about 1 500 m). The habitat is characterised by cultivated fields within savanna woodland (miombo), with an average annual rainfall of 1 073 mm (monthly range 1-2 750, with 4 virtually rain-

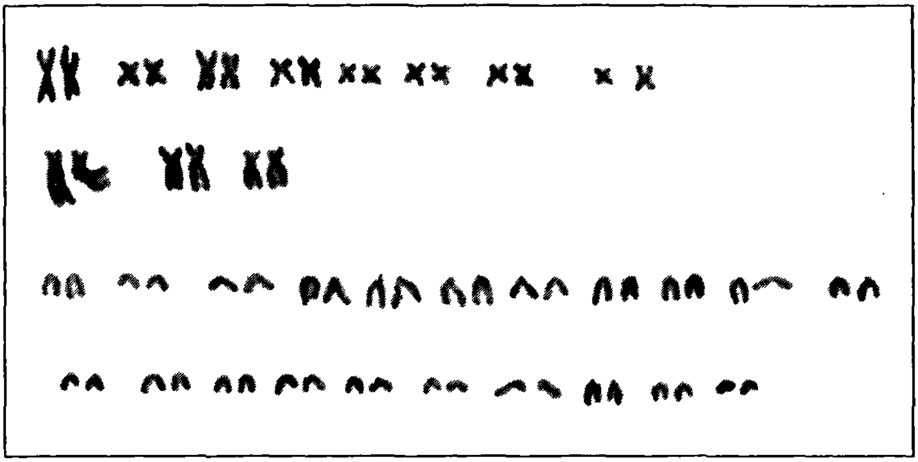

Figure 1
The karyotype of a female *Cryptomys* from the locality Kasama, Zambia.

less months per year) and mean temperatures (monthly averages) varying between 22-24°C (October) and 16-18 °C (July).

Chromosome preparations were obtained from one adult female (body weight 100 g), directly from the bone marrow of long bones using the standard method (LEE, 1969; LEE and ELDER, 1977).

Results

The karyotype of the female *Cryptomys* from Kasama was 2N = 64 (NF = 86) and consisted of 11 biarmed (four metacentic, six submetacentric, and one subtelocentric) and 21 acrocentric chromosome pairs (figure 1). The largest chromosome pair was subtelocentric, three other distinctly large pairs were biarmed, submetacentric. Two submetacentric pairs differed in their arm ratio: the length of the arms was fairly similar in one pair, whereas it was distinctly different in the other. A biarmed pair of medium size was submetacentric, the

Table 1
Characteristics of known karyotypes (representing different species) of *Cryptomys*.
M – metacentric,
SM – submetacentric,
ST – subtelocentric,
A – acrocentric,
NF – fundamental number of chromosome arms in a female karyotype.

Species	Occurrence	Karyotype (2n)	Autosomes M, SM	Autosomes A, ST	Sex chromosomes X	Sex chromosomes Y	Arms (NF) a NF	Arms (NF) NF (XX)	Authors
C. mechowi	Zambia (Copperbelt Province)	40	18	1	M/SM	SM	76	80	MACHOLÁN *et al.* 1993
C. whytei	Malawi (Nyika)	46	15 M, 8 A					92	BURDA, CHITAUKALI, BRÜGGERT (unpubl.)
C. amatus	Zambia (Central Province)	50	22	2	M	A	92	96	MACHOLÁN *et al.* 1997
C. h. hottentotus	South Africa (Transvaal)	54	25	1	SM	?	102	106	NEVO *et al.* 1986
C. h. natalensis	South Africa (Natal)	54	24	2	SM	A	100	104	NEVO *et al.* 1986
C. darlingi	Zimbabwe	54	14	12	A	M	80	82	AGUILAR 1993
C. kafuensis Zambia	(Southern Province)	58	9	19	M	dot	74	78	BURDA *et al.* 1999
KASAMA Zambia	(Northern Province)	64	11 M, 21 A					86	present paper
C. foxi	Cameroon	66 (70)	26 (28)	6	SM	M	116 (124)	120 (128)	WILLIAMS et *al.* 1983
C. anselli	Zambia (Lusaka Province)	68	5	28	M	A	76	80	BURDA *et al.* 1999
C. damarensis	Namibia	78	8	30	M	SM	92	96	NEVO *et al.* 1986

remaining four biarmed pairs were metacentric. The acrocentric chromosomes formed an array with continually diminishing size. The largest acrocentric chromosomes were similar in size to the medium-sized submetacentric pair.

Discussion

Earlier studies of bathyergid karyotypes indicated, in contrast to the situation in many other subterranean rodents (particularly spalacids and ctenomyids) remarkable chromosome stability and conservatism. Thus, only one karyotype (2N = 60, GEORGE, 1979) was described in the eusocial naked mole-rat (*Heterocephalus glaber*), the distribution of which covers 14 latitude degrees. Two karyotypes (2N = 60, GEORGE, 1979; 2N = 62, SCHARFF, 1999) are known in solitary *Heliophobius argenteocinereus*, distributed across 18 latitude degrees, and three chromosome species of *Cryptomys* were defined in the Southern African Subregion, covering about 17 latitude degrees: 2N = 78 (or 74) in *C. damarensis* and 2n = 54 in *C. hottentotus* (NEVO *et al.*, 1986), and 2N = 54 in *C. darlingi* (AGUILAR, 1993).

Contrary to those earlier findings on bathyergids from other regions of Africa, within a relatively narrow belt covering 3 latitude degrees in Zambia, we have already identified five distinct karyotypes, representing five different species of *Cryptomys*: 2N = 40 (MACHOLÁN *et al.*, 1993), 2N = 50 (MACHOLÁN *et al.*, 1998), 2N = 58 and 2N = 68 (BURDA *et al.*, 1999), 2N = 64 (present study). Since only few populations were studied within the given belt and since Zambia itself extends from north to south over ten latitude degrees, many more karyotypes are expected to occur there. Systematic faunistic, taxonomic and ecological study of *Cryptomys* in Zambia may be thus of high interest for an assessment of chromosomal evolution in this "hotspot" region and its historical/ecological causes, compared to the relative stability in the Southern Africa Subregion.

Among the karyotypes of *Cryptomys* known to date, only *C. anselli*, *C. damarensis*, *C. kafuensis* and *Cryptomys*-Kasama have markedly more acrocentrics than metacentrics in their karyotypes (Table 1,

anselli	*damar.*	*kafuens.*	Kasama	*darlingi*	*whytei*	*mecho.*	*amatus*	*natal.*	*hottent.*	*foxi*
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Table 2
Schematic representation
of known karyotypes of *Cryptomys*.
X - metacentric and submetacentric chromosomes;
V - subtelocentric and acrocentric chromosomes.

table 2). Assuming that different chromosomal fusions might have taken place in the evolution of individual lineages we suggest that the named species form an ancestral clade. Interestingly, they all occur in Zambia along a SW-NE axis, eastwards of the Muchinga Escarpment, along the presumed site of the "arid corridor". We suggest that the other karyotypes (species): *C. amatus*, *C. mechowi*, *C. darlingi*, *C. hottentotus*, *C. whytei*, and the supraequatorial (Central and West African) *Cryptomys* descended from the above named lineage.

We are aware that chromosomal evolution of *Cryptomys* may have involved also rearrangements other than fusions (fissions, pericentric inversions). Unless banded karyotypes are available and compared, the above suggestion remains a hypothesis which should be tested. Nevertheless, our scenario suggesting that *C. anselli*, *C. damarensis*, *C. kafuensis*, and *Cryptomys* Kasama (all with more acrocentrics than metacentrics) represent an ancestral clade from which other species have separately evolved is more parsimonious with respect to the geographical distributional pattern and paleoecological (course of the arid corridor) aspects.

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