

**The burrow structure, colony composition and  
reproductive biology of the giant mole-rat (*Fukomys  
mechowii*) Peters 1881 from the Copperbelt of  
Zambia.**

By

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## Abstract

African mole-rats (Bathyergidae) are subterranean hystricomorph rodents offering an excellent system with which to test theories relating to the evolution and maintenance of sociality in mammals. The aridity food distribution hypothesis (AFDH) suggests that, within the bathyergids, sociality has evolved in response to patterns of rainfall, its effects on food distribution, and the subsequent costs and risks of foraging and dispersal. Here, in the first detailed study of burrow architecture in a social mole-rat species, with data from 32 burrows, we show that in the giant mole-rat *Fukomys mechowii*, burrow fractal dimension increases with colony size and is higher during the rainy season than during the dry season. The mass of food in the burrow increases with fractal dimension and is higher during the rainy season than during the dry season. These results link for the first time colony size, burrow architecture, rainfall and foraging success and provide support for two assumptions of the AFDH, namely that (1) in arid conditions burrowing may be severely constrained by the high costs of digging; and (2) the potential risks of failing to locate food may be mitigated by increases in colony size.

It was also fundamental in this study to assess whether the *Fukomys mechowii* is (1) An aseasonal or seasonal breeder (2) To investigate whether non-reproductive female giant mole-rats exhibit induced or spontaneous ovulation and finally (3) To estimate the age variation and sexual dimorphism of this little studied giant mole-rat species. Thus in a field study that involved the complete excavation of 32 burrow systems with a mean colony size of 9.9 individuals (range 7-16), it was evident that *Fukomys mechowii* is a cooperatively breeding mole-rat exhibiting a reproductive division of labour in which usually one, or occasionally two, females are responsible for procreation. Pregnant reproductive females

were found throughout the study period (September 2005 until June 2006), supporting preliminary evidence that reproduction occurs throughout the year. Of the 32 colonies sampled, 14 of 18 (87.5%) in which the reproductive female could be identified as pregnant contained a single reproductive female, while four (12.5%) had two females breeding simultaneously (plural breeding). The population sex ratio was skewed towards females at 1:1.46. Autopsy of pregnant reproductive females (n=18) revealed that the production of two (10/18 pregnancies) or three (7/18) offspring was the norm, with one case of four embryos being present. These new data increase our fragmentary knowledge of the natural history of this little studied species.

Six non-reproductive females were removed from their natal colonies and housed individually without a male for a period of 12 weeks as a control group. They were then subsequently housed for a further 6 weeks as experiment 1, on their own before being allowed non-physical contact in experiment 2, with a mature adult male for a further 6 weeks. The non-reproductive females were given a further period of isolation for a month prior to being physically paired with vasectomized males, in experiment 3. Urine was collected every second day for all three experiments and urinary progesterone profiles were generated. The progesterone values measured during the first part of Experiment 2 and 3 were markedly higher than those measured during the first part of Experiment 1 ( $Z = -2.201$ ,  $p = 0.028$  for both comparisons), however, this was not significant after Bonferroni correction. Similarly progesterone values tended to be elevated during the second phase of Experiment 2 and 3 but not significantly so (Experiment 1 vs. 2:  $Z = -1.782$ ,  $p = 0.075$ , Experiment 1 vs. 3:  $Z = -2.201$ ,  $p = 0.028$ ). Thus, chemical or physical stimulation by a male

does not appear to be necessary for ovulation in female giant mole-rats. The giant mole-rat is a spontaneous ovulator.

Due to difficulties in estimating absolute age in mammals, different methods for its estimation have been proposed, and among these, the degree of molar eruption and wear are considered to be one of the most reliable indicators of relative age. Consequently, maxillary molar tooth-row eruption and wear were used to assign individuals of the giant mole-rat, *Fukomys mechowii* (Peters, 1881) from two geographically proximal and ecologically similar localities in the Copper-belt Province of Zambia to 9 relative age classes. These were in turn used to assess the nature and extent of sexual dimorphism and age variation in this little-studied social mole-rat based on cranial morphometric data, reference to body mass and a series of both univariate and multivariate statistical analyses. Both univariate and multivariate analyses showed morphological differences between individuals of age classes 1–3 and those of age classes 5–9, while individuals of age class 4 were intermediate between these age class groupings, suggesting that this age class lies at a point on a hypothetical growth curve where it begins to stabilize. The analysis of the nature and extent of sexual dimorphism revealed its absence in the younger individuals of age classes 1–4 and its presence in older age classes 5–9. These results may allow an insight into our understanding of the population social structure, and reproductive strategies in the giant mole-rat.

In conclusion, it is worth mentioning that; (1) A number of studies have examined burrow architecture, although not necessarily fractal dimensions in the Bathyergidae but the majority of these have concentrated on solitary species in which when there is plural occupancy it is during the breeding season or when the mother has a litter. This study is thus the first to examine in detail the dynamic nature of social mole-rat burrows, with respect to



seasonal changes. The burrow fractal dimension is a good indication of the mole-rats ability to burrow to find food and thus results support the critical assumption which underlies the aridity food distribution hypothesis. The results accord well with previous data in social mole-rats indicating that larger colonies have greater survival and link colony size, burrow architecture and foraging success for the first time; (2) the giant mole-rat is an aseasonal breeder which in a few instances can have two queens per colony; (3) the giant mole-rat is a spontaneous ovulator and finally (4) the giant mole-rat *Fukomys mechowii* exhibits a sexual dimorphism amongst its older age classes 5-9. Suggesting that there are different growth curves in males versus females, whereby males attain much larger size (skull size and body mass) than females after puberty and finally intimating that opportunistic mating competition among males is very high.

## **Preface**

***“To get something you never had, you had to do something you never did! Thus, the will of God will never take you where the Grace of God will not protect and guide you!”***

### **Zambia**

I collected the giant mole-rats *Fukomys mechowii* from 32 burrow systems, from Kakalo and Mushishima Farm blocks in Chingola District, Copperbelt Province of Zambia. I would like to thank my field Assistants; Timothy Salupeni and Fredrick Chama for their tireless work in excavating the burrow systems. I thank the District Veterinary and Nature conservation offices in Chingola for having provided my permit to capture mole-rats in Chingola. I am grateful to Dr. G. Monga, the Provincial Veterinary Officer in Copperbelt Province for providing all export permits that I needed for the shipment of live mole-rats from Zambia to South Africa.

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***“We may be hard pressed on every side, but not crushed; perplexed, but not in despair; persecuted, but not abandoned; struck down but not destroyed. (1 Corinthians 4:8-9)”***

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