Supplementary material to: Kraus, A., Lövy, M., Mikula, M., Okrouhlík, J., Bennett, N.C., Herrel, A. Šumbera, R. (2022) Bite force in the strictly subterranean rodent family of African mole-rats (Bathyergidae): the role of digging mode, social organisation, and ecology.

Figure S1. The maximum clade credibility tree of ten species included in the study. Clade supports are Bayesian posterior probabilities. Phylogeny of the sampled species was inferred in the multispecies coalescent framework as implemented in StarBEAST 2 (Ogilvie et al. 2017) for BEAST 2 (Bouckaert et al. 2019). We used published sequences of one mitochondrial locus – cytochrome *b* (*CYTB*) – and three nuclear – genes for growth hormone receptor (*GHR*), interphotoreceptor retinoid-binding protein (*IRBP*) and von Willebrand factor (*VWF*). GenBank accessions of the sequences are in Table S2. Only *CYTB* alignment was complete, in the nuclear data set, 16 out of 30 sequences were missing. We assumed HKY+G substitution model (Hasegawa et al. 1985, Yang 1994) with parameters unlinked across loci. Substitution rates of the loci were assumed to vary around the fixed mean. The species tree shape was given birth-death prior (Gernhard 2008) with uninformative hyperpriors on its parameters. Constant per-branch population sizes were analytically integrated with an uninformative $(1/x)$ hyperprior on the mean of population size priors. The posterior sample is represented by the maximum clade credibility tree with the mean common ancestor heights calculated in TreeAnnotator tool distributed with BEAST 2.

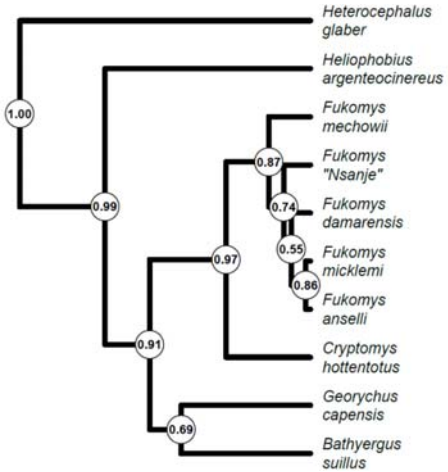

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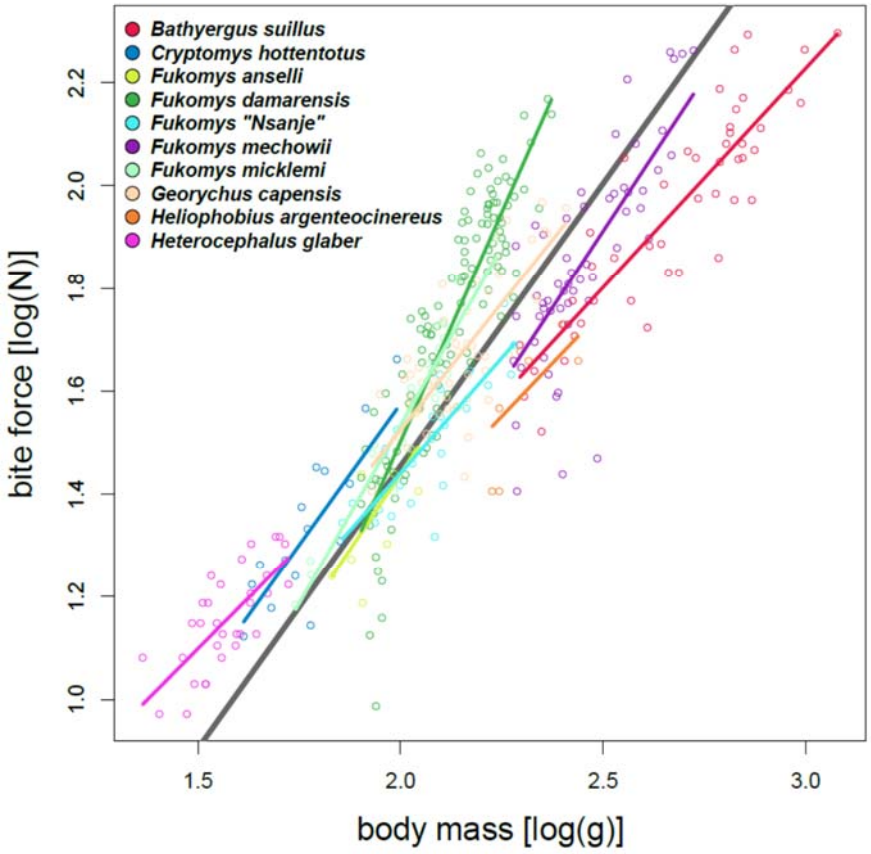
Figure S2. Species-specific allometric trends in bite force estimated by the linear mixed-effects model with the underlying inter-specific trend shown as a dark grey line in the background.



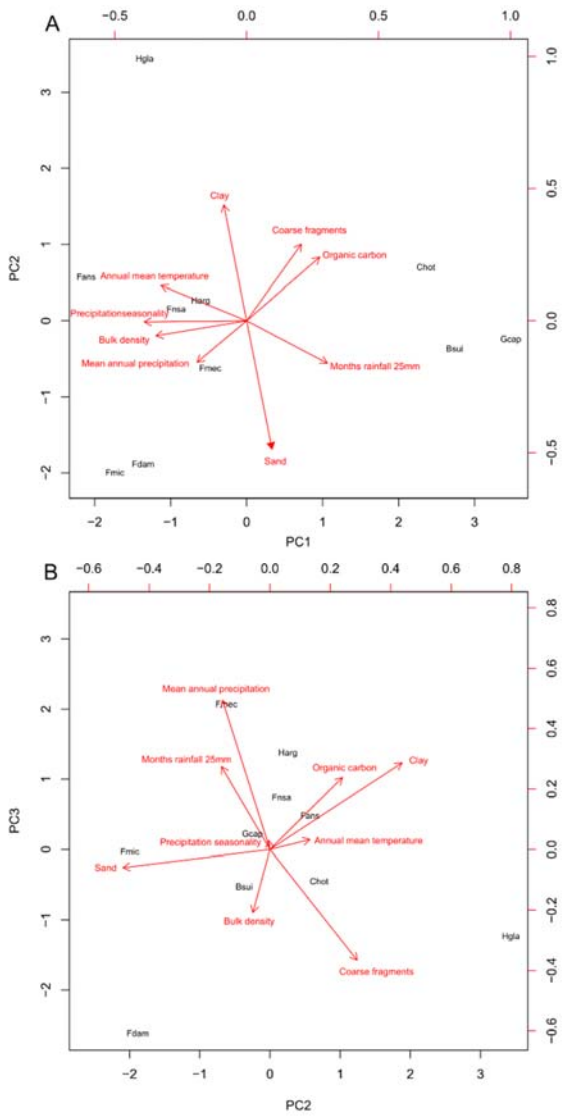


Figure S3. PCA ordination plots showing interrelationships among soil and climatic variables characterising distributional ranges of ten African mole-rat species. A - principal components 1 and 2; B - principal components 2 and 3; red arrows denote soil and climatic variables, black label mole-rat species. (Hgla – *Heterocephalus glaber*, Chot – *Cryptomys hottentotus*, Fans – *Fukomys anselli*, Fmic – *Fukomys micklemi*, Fdam – *Fukomys damarensis*, Fnsa – Fukomys "Nsanje", Gcap – *Georychus capensis*, Harg – *Heliophobius argenteocinereus*, Fmech – *Fukomys mechowii*, Bsui – *Bathyergus suillus*).

Figure S4. Summary of PCA analysis of soil and climatic parameters characterising species distributional ranges of ten African mole-rat species. Provided are percentage of explained variation by four principal components (PC) and standardized loadings of all eight variables. The soil variables were bulk (bulk density of the fine earth fraction oven-dry, g/cm^3), clay and sand contents (g/kg), coarse (volumetric content of fragments □ 2 mm, cm^3/dm^3), and Carbon (soil organic carbon density, g/dm^3); the climate variables were AnPrecip (the annual sum of precipitation, mm), PrecipSeasonality (precipitation seasonality, coefficient of variation), AnMeanTemp (the annual mean temperature, °C), and More25mm (the number of months per year with >25 mm of precipitation).

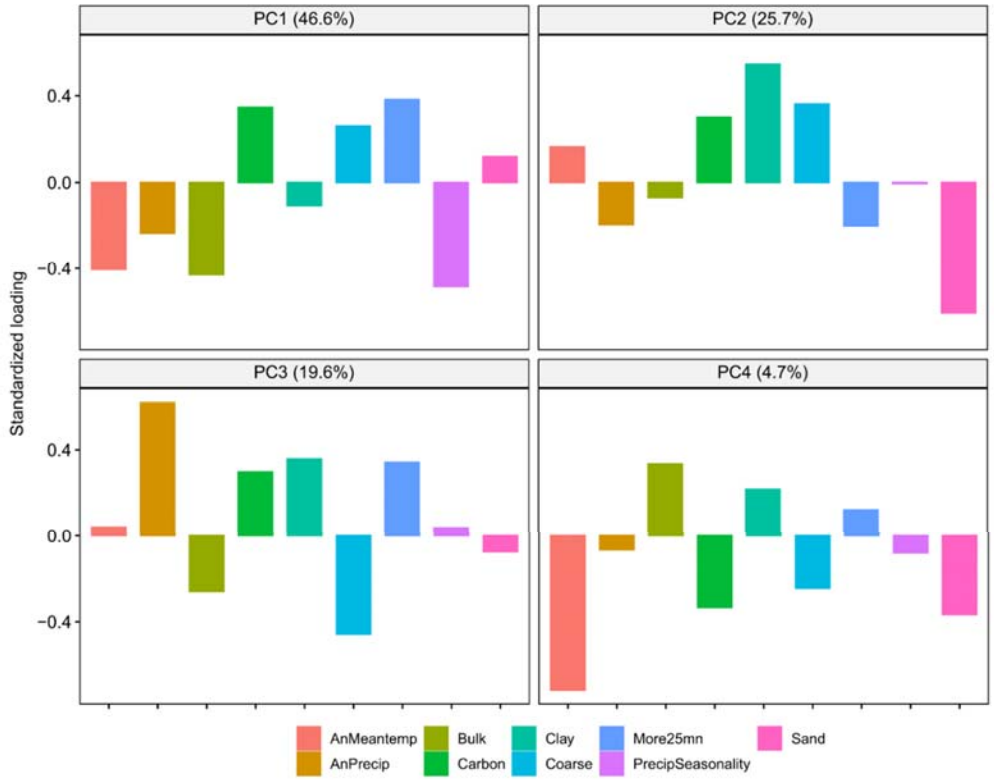


Table S1. Digging mode, sociality, capture location, number, and minimum weight of included specimens for each species. Mass cut off was defined by approximate weight of reaching adulthood.

Species	**Mode of digging**	**Sociality**	**Locality of origin**	**N ♂ / ♀**	**Mass cut off [g]**
Bathyergus suillus	scratch	solitary	South Africa: Darling, Waylands farm, (33°23'S 18°25'E)	20/26	160 [a]
Cryptomys hottentotus	chisel	social	South Africa: Darling, Waylands farm (33°23'S 18°25'E)	11/4	30 [f]
Fukomys anselli	chisel	social	Zambia: Lusaka East Forest Reserve (15°28'S, 28°25'E)	7/3	30 [e, c]
Fukomys damarensis	chisel	social	South Africa: Kuruman River Reserve (26.99°S, 21.81°E)	65/57	60 [a, h]
Fukomys "Nsanje"	chisel	social	Malawi: Nsanje (16°55′S, 35°16′E)	7/19	60 [j]
Fukomys mechowii	chisel	social	Zambia: Ndola, Kapiri Mposhi (exact GPS not known)	14/42	120 [d]
Fukomys micklemi	chisel	social	Zambia: Sekute area (17°39'S, 25°37'E)	13/10	50 [i]
Georychus capensis	chisel	solitary	South Africa: Darling, Waylands farm (33°23'S 18°25'E)	20/36, 2 NA	80 [a]
Heliophobius argenteocinereus	chisel	solitary	Malawi: Mpalaganga estate (15°27'S, 35°16'E)	3/4	80 [g]
Heterocephalus glaber	chisel	social	Kenya: Meru, Lerata, Mtito (exact GPS not known)	16/15	20 [b]

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a) Bennett, N. C., Jarvis, J. U. M., Aguilar, G. H., & McDaid, E. J. (1991). Growth and development in six species of African mole-rats (Rodentia: Bathyergidae). *Journal of Zoology*, *225*(1), 13–26. https://doi.org/10.1111/j.1469-7998.1991.tb03798.x

b) Jarvis, J. U. M., O'Riain, M. J., & McDaid, E. (2017). Growth and Factors Affecting Body Size in Naked Mole-Rats. In P. W. Sherman, J. U. M. Jarvis, & R. D. Alexander (Eds.), *The Biology of the Naked-Molerat* (pp. 358–383). Princeton University Press

c) own observation

d) Scharff, A., Begall, S., Grütjen, O., & Burda, H. (1999). Reproductive characteristics and growth of Zambian giant mole-rats, *Cryptomys mechowi* (Rodentia: Bathyergidae). *Mammalia*, *63*(2), 217–230

e) Schielke, C. K. M., Begall, S., & Burda, H. (2012). Reproductive state does not influence activity budgets of eusocial Ansell's mole-rats, *Fukomys anselli* (Rodentia, Bathyergidae): A study of locomotor activity by means of RFID. *Mammalian Biology*, *77*(1), 1–5. https://doi.org/10.1016/j.mambio.2011.09.004

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g) Šumbera, R., Burda, H., & Chitaukali, W. N. (2003). Reproductive biology of a solitary subterranean batyergid rodent, the silvery mole-rat (*Heliophobius argenteocinereus*). *Journal of Mammalogy*, *84*(1), 278–287. https://academic.oup.com/jmammal/article-abstract/84/1/278/2373387

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i) van Daele, P. A. A. G., Desmet, N., Šumbera, R., & Adriaens, D. (2019). Work behaviour and biting performance in the cooperative breeding Micklem's mole-rat *Fukomys micklemi* (Bathyergidae, Rodentia). *Mammalian Biology*, *95*, 69–76 https://doi.org/10.1016/j.mambio.2019.02.002

j) Zemanová, M., Šumbera, R., & Okrouhlík, J. (2012). Poikilothermic traits in Mashona mole-rat (*Fukomys darlingi*). Reality or myth? *Journal of Thermal Biology*, *37*(7), 485–489. https://doi.org/10.1016/j.jtherbio.2012.04.001

Table S2. GenBank accessions of sequences used for the species tree inference.

Species	***CYTB***	***GHR***	***IRBP***	***VWF***
Bathyergus suillus	AF012242	FM162080	AJ427251	AJ238384
Cryptomys hottentotus	AF012240	FJ855202		AJ251132
Fukomys anselli	AF012233			
Fukomys damarensis	AY425857	FN984748	FN984749	FN984751
Fukomys "Nsanje"	AF012232			
Fukomys mechowii	EF043452			
Fukomys micklemi	EF043494			
Georychus capensis	MG496777	MH186377		
Heliophobius argenteocinereus	MG911074	FJ855204		AJ251133

Table S3. Detailed information about soil and climatic parameters of the distribution range for each mole-rat species.
soil variables: www.soilgrids.org (Poggio et al. 2021); climatic variables: WorldClim database, www.worldclim.org (Fick and Hijmans 2017).

Species		**Clay (g/kg)**	**Sand (g/kg)**	**Organic carbon (g/kg)**	**Bulk density (g/cm^3)**	**Coarse fragments (cm^3/dm^3)**	**Annual precipitation (mm)**	**Precipitation Seasonality coeff. variation**	**Months with >25mm rainfall (n)**	**Annual mean temperature (°C)**
B. suillus		191	688	163	1.280	116	445	49	8	17.0
C. hottentotus		258	564	118	1.338	130	407	46	9	16.1
F. anselli		288	501	84	1.495	41	846	120	6	20.9
F. damarensis		159	743	41	1.489	92	433	102	6	21.9
F. darlingi		255	634	126	1.404	60	862	95	7	25.6
F. mechowii		260	590	94	1.342	32	1272	90	9	21.4
F. micklemi		191	691	60	1.473	30	856	111	7	21.4
G. capensis		212	639	155	1.279	115	452	40	12	16.9
H. argenteocinereus		280	575	98	1.348	59	1050	98	8	22.7
H. glaber		326	396	104	1.423	182	377	103	5	25.8

Table S4. Correlation matrix and their significance (in parentheses) among five soil and four climatic variables characterising the distribution ranges of ten African mole-rat species (significant correlations are in bold). The soil variables were Bulk (bulk density of the fine earth fraction oven-dry, g/cm^3), Clay and Sand contents (g/kg), Coarse (volumetric content of fragments > 2 mm, cm^3/dm^3), and Carbon (soil organic carbon density, g/dm^3); the climate variables were AnPrecip (the annual sum of precipitation, mm), PrecipSeasonality (precipitation seasonality, coefficient of variation), AnMeanTemp (the annual mean temperature, °C), and More25mm (the number of months per year with >25 mm of precipitation).

	Bulk	Clay	Coarse	Sand	Carbon	AnPrecip	AnMeantemp	PrecipSeasonality
Clay	0.03 (0.944)							
Coarse	-0.30 (0.397)	0.18 (0.609)						
Sand	-0.07 (0.840)	**-0.95 (<0.001)**	-0.37 (0.293)					
Carbon	**-0.85 (0.002)**	0.12 (0.745)	0.41 (0.245)	-0.10 (0.791)				
AnPrecip	0.09 (0.795)	0.24 (0.510)	**-0.84 (0.002)**	-0.01 (0.977)	-0.26 (0.460)			
AnMeantemp	0.55 (0.096)	0.43 (0.218)	-0.13 (0.729)	-0.33 (0.352)	-0.42 (0.222)	0.34 (0.340)		
PrecipSeasonality	**0.86 (0.001)**	0.27 (0.454)	-0.47 (0.168)	-0.22 (0.538)	**-0.78 (0.008)**	0.47 (0.165)	**0.78 (0.008)**	
More25	**-0.79 (0.007)**	-0.24 (0.502)	-0.03 (0.944)	0.28 (0.430)	0.57 (0.082)	0.03 (0.931)	**-0.68 (0.030)**	**-0.77 (0.009)**

Table S5. Summary of post hoc comparisons of corrected bite force among ten African mole-rat species. The matrix shows the estimated marginal means (EMMs) along the diagonal, *P* values in the upper triangle, and the differences in the lower triangle. (Hgla – *Heterocephalus glaber*, Chot – *Cryptomys hottentotus*, Fans – *Fukomys anselli*, Fmic – *Fukomys micklemi*, Fdam – *Fukomys damarensis*, Fmech – *Fukomys mechowii*, F"Nsanje" – Fukomys "Nsanje", Gcap – *Georychus capensis*, Harg – *Heliophobius argenteocinereus*, Bsui – *Bathyergus suillus*).

	Bsui	Fans	Fdam	F"Nsanje"	Fmec	Fmic	Gcap	Harg	Hgla	Chot
Bsui	[-0.2486]	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.9907	<.0001	<.0001
Fans	-0.22604	[-0.0225]	<.0001	1.0000	0.3788	0.0818	0.3495	0.0044	<.0001	0.0052
Fdam	-0.38038	-0.15434	[0.1318]	<.0001	<.0001	0.5917	<.0001	<.0001	0.4720	1.0000
F"Nsanje"	-0.22030	0.00574	0.16008	[-0.0283]	0.0626	0.0014	0.0098	0.0006	<.0001	<.0001
Fmec	-0.14908	0.07696	0.23131	0.07123	[-0.0995]	<.0001	<.0001	0.1363	<.0001	<.0001
Fmic	-0.33620	-0.11015	0.04419	-0.11589	-0.18712	[0.0876]	0.9443	<.0001	0.0403	0.9515
Gcap	-0.30434	-0.07830	0.07604	-0.08404	-0.15526	0.03186	[0.0558]	<.0001	<.0001	0.2045
Harg	-0.04014	0.18590	0.34025	0.18017	0.10894	0.29606	0.26420	[-0.2084]	<.0001	<.0001
Hgla	-0.42278	-0.19674	-0.04239	-0.20247	-0.27370	-0.08658	-0.11844	-0.38264	[0.1742]	0.9040
Chot	-0.37816	-0.15211	0.00223	-0.15785	-0.22908	-0.04196	-0.07382	-0.33802	0.04462	[0.1296]