Supplementary material:

Inbreeding depresses altruism in a cooperative society

David A. Wells, Michael A. Cant, Joseph I. Hoffman*+, Hazel J. Nichols*+

+ Joint senior authors

* Correspondence addresses: joseph.hoffman@uni-bielefeld.de; h.j.nichols@swansea.ac.uk

This document contains:

Figure S1–S2

Tables S1–S6

Additional supplementary materials:

Video S1 Video showing conspicuous escorting behaviour in banded mongooses.

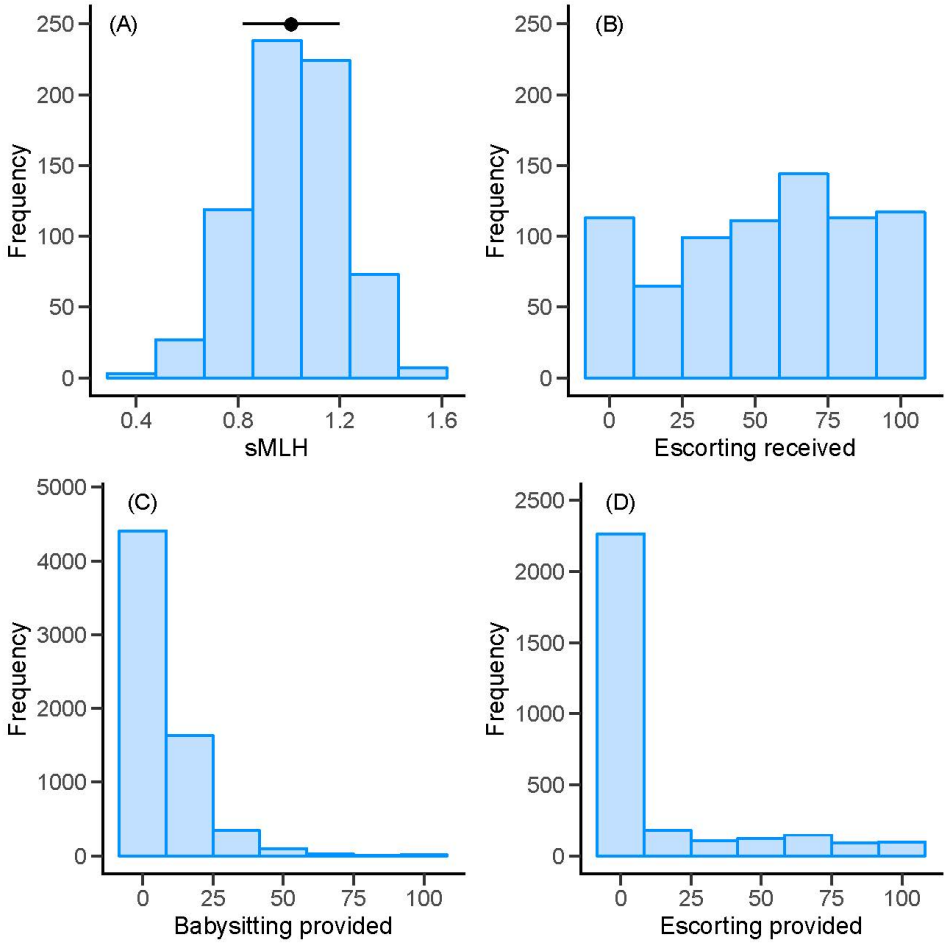

Fig. S1. The distribution of key variables analysed in our study. (**A**) individual inbreeding levels, quantified as standardised multilocus heterozygosity (sMLH) at 35–43 microsatellites. Mean sMLH +/- 1 SD (0.19) is shown above the histogram; (**B**) escorting care received, quantified as the percentage of sessions that a given pup was sighted together with an escort (**C**) babysitting care provided, quantified as the percentage of observation sessions that a potential carer was observed to babysit a litter, and (**D**) escorting care provided, quantified as the percentage of observation sessions that a potential carer was observed escorting a pup.

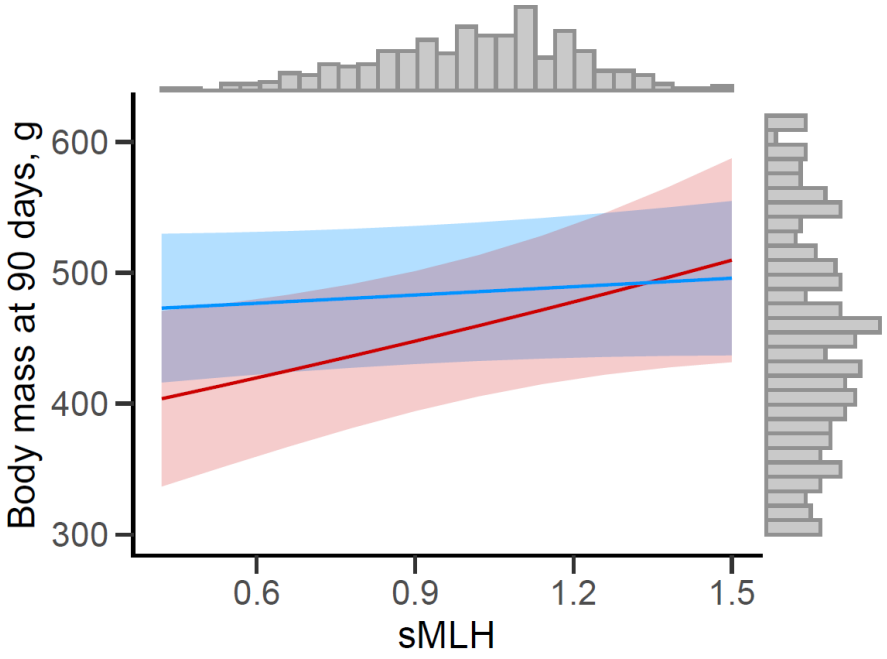

Fig. S2. A non-significant trend for care to reduce inbreeding depression for body mass.

Shown is body mass at 90 days for offspring receiving no escorting care (in red) versus offspring receiving the average non-zero amount of escorting care (i.e. escorting was observed during 63% of observations, in blue), conditional on sMLH. Trend lines show predicted values from the fitted model and the shaded regions refer to the associated 95% CIs. Grey marginal histograms show the distribution of data.

35 **Table S1. Definitions and units of variables analysed in our statistical models.**

Variable	Definition
Survivorship to nutritional independence	Pup survival to 90 days (1 = survived, 0 = died).
Weight at nutritional independence	Weight (g) at as close to 90 days of age as possible, with over 70% of measurements taken within a week of this time point (range 61–119 days old).
Escorting care received	The proportion of observation sessions that a focal pup was observed to have an escort.
Babysitting care provided	The proportion of observation sessions that a focal adult was observed to babysit a litter.
Escorting care provided	The proportion of observation sessions that a focal adult was observed to escort a pup.
Inbreeding	Standardised multilocus heterozygosity (sMLH) at 35–43 microsatellite loci.
Rainfall	Rainfall (mm) across the relevant time period (see descriptions of each model for details). Rainfall influences food abundance/quality and therefore impacts growth, survival and behaviour.
Sex	Whether the focal pup or potential carer is male or female.
Age	Age (days) of the focal pup or potential carer.
Litter size	Number of pups present in the communal litter at emergence (at 30 days).
Parentage	Whether or not a potential carer was assigned as a mother or father to pups in the communal litter (1 = yes, 0 = no) using genetic data.
Relatedness	The average pedigree relatedness of the focal potential carer to other potential carers present in the social group.

Table S2. Results of the GLMM of pup survival to independence. Shown are model estimates and standard errors together with log likelihood ratios (2LL) and associated *p*-values obtained by removing the term in question from the full model. This model was based on data from a total of 776 pups from 142 litters belonging to 11 social groups.

	Estimate	Std. Error	2LL	*p*-value
(Intercept)	-3.047	1.130		
Rainfall	0.266	0.103	6.735	0.009
Escorting:sMLH	-4.229	1.707	6.292	0.012
Escorting	5.112	1.765		
sMLH	2.607	1.059		

Table S3. Results of the GLMM of pup weight at independence. Shown are model estimates and standard errors together with log likelihood ratios (2LL) and associated *p*-values obtained by removing the term in question from the full model. This model was based on data from a total of 443 pups from 120 litters belonging to 10 social groups.

	Estimate	Std. Error	2LL	*p*-value
(Intercept)	5.757	0.113		
Escorting:sMLH	-0.272	0.159	2.902	0.088
sMLH	0.216	0.102		
Escorting	0.365	0.165		
Age at weighing	0.15	0.01	188.959	<0.001
Rainfall	0.067	0.018	13.208	<0.001

Table S4. Results of the GLMM investigating whether escorting care is directed towards inbred pups. Model estimates and standard errors are shown together with log likelihood ratios (2LL) and associated *p*-values obtained by removing the term in question from the full model. This model was based on data from a total of 762 pups from 138 litters belonging to 11 social groups.

	Estimate	Std. Error	2LL	*p*-value
(Intercept)	0.968	0.239		
Sex (male)	0.094	0.052	3.173	0.075
Rainfall	0.041	0.077	0.29	0.59
sMLH	0.03	0.147	0.042	0.837
Litter size	-0.066	0.019	11.876	<0.001

Table S5. Results of GAMMs investigating whether the amount of babysitting care provided is affected by inbreeding. Models with binary response variables (A and B) investigated whether or not individuals babysat the focal litter, while models with binomial response variables (C and D) investigated the amount of babysitting care provided. Shown are model estimates and standard errors together with log likelihood ratios (2LL) and associated *p*-values obtained by removing the term in question from the full model. Estimated degrees of freedom (EDFs) provide a measure of the non-linearity of the smoother term. The male models (A and C) were based 4,006 samples where each sample represents all care provided to a specific litter by a given individual. Of these, 2,270 included some care and so were included in the binomial model. The male dataset included 395 potential babysitters of 389 litters in 14 social groups. The female models (B and D) were based on 2,486 samples of which 1,198 included some care. The female dataset included 292 potential babysitters over 377 litters belonging to 14 social groups.

Model	Predictor	Coefficient	SE	2LL	*p*-value	EDF
(**A**) Male binary	(Intercept)	-0.121	0.396			
	Parentage	0.198	0.16	1.482	0.223	
	Rainfall	0.341	0.084	16.174	<0.001	
	sMLH	0.973	0.323	8.862	0.003	
	Relatedness	-2.613	0.762	11.573	<0.001	
	Age	2.248	0.768	157.41	<0.001	7.226
(**B**) Female binary	(Intercept)	-0.54	0.388			
	Parentage	0.166	0.146	1.247	0.264	
	Rainfall	0.158	0.089	3.096	0.078	
	sMLH	0.686	0.315	4.729	0.030	
	Relatedness	-0.997	0.865	1.299	0.254	

	Age	0.724	0.65	25.222	<0.001	5.658
(**C**) Male binomial						
	(Intercept)	-2.364	0.195			
	Parentage	-0.168	0.047	12.84	<0.001	
	Rainfall	0.013	0.023	0.329	0.566	
	sMLH	0.419	0.176	5.618	0.018	
	Relatedness	0.596	0.341	3.078	0.079	
	Age	1.676	0.286	151.3	<0.001	7.613
(**D**) Female binomial						
	(Intercept)	-1.947	0.218			
	Parentage:Rainfall	-0.105	0.049	4.845	0.0278	
	Parentage	-0.070	0.055			
	Rainfall	-0.016	0.033			
	sMLH	-0.119	0.159	1.039	0.308	
	Relatedness	0.458	0.406	1.243	0.265	
	Age	0.039	0.028	1.951	0.377	5.65

Table S6. Results of GAMMs investigating whether the amount of escorting care provided is affected by inbreeding. Models with binary response variables (A and B) investigated whether or not individuals escorted the focal pup, while models with binomial response variables (C and D) investigated the amount of escorting care provided to the focal pup. Shown are model estimates and standard errors together with log likelihood ratios (2LL) and associated *p*-values obtained by removing the term in question from the full model. Estimated degrees of freedom (EDFs) provide a measure of the non-linearity of the smoother term. The male models (A and C) were based 1,804 samples where each sample represents all care provided to a specific litter by a given individual, of which 540 included some care and so were included in the binomial model. The male dataset included 310 potential escorts of 156 litters in 9 social groups. The female models (B and D) were based on 1,206 samples of which 244 included some care. The female dataset included 233 potential escorts over 156 litters belonging to 10 social groups.

Model	Predictor	Coefficient	SE	2LL	*p*-value	EDF
(A) Male binary	(Intercept)	-3.439	0.738			
	Parentage	0.466	0.216	4.630	0.031	
	Rainfall	-0.356	0.115	9.834	0.002	
	Litter size	0.168	0.028	33.395	<0.001	
	sMLH	1.363	0.595	5.225	0.022	
	Relatedness	-3.065	1.474	4.414	0.036	
	Age	3.542	1.529	106.06	<0.001	7.206
(B) Female binary	(Intercept)	-1.942	0.776			
	Parentage	1.255	0.23	32.256	<0.001	
	Rainfall	-0.351	0.149	5.807	0.016	
	Litter size	0.161	0.035	18.616	<0.001	
	sMLH	-1.196	0.557	4.369	0.037	

	Relatedness	-2.251	1.585	2.070	0.150	
	Age	5.839	1.861	29.894	<0.001	6.682
(C) Male binomial						
	(Intercept)	-0.955	0.513			
	Parentage	-0.065	0.107	0.369	0.544	
	Rainfall	-0.147	0.103	1.975	0.160	
	Litter size	-0.01	0.023	0.194	0.660	
	sMLH	0.304	0.415	0.528	0.467	
	Relatedness	4.521	1.022	19.428	<0.001	
	Age	-0.272	0.207	9.811	0.007	2.749
(D) Female binomial						
	(Intercept)	0.298	0.669			
	Parentage:rainfall	-0.505	0.164	9.659	0.002	
	Parentage	0.136	0.16			
	Rainfall	0.39	0.172			
	Litter size	-0.062	0.032	3.836	0.050	
	sMLH	-0.17	0.544	0.097	0.756	
	Relatedness	1.839	1.329	1.896	0.169	
	Age	1.447	0.721	10.892	0.004	4.729