

**SURVIVORSHIP OF GOLDEN MARMOTS  
(*Marmota caudata aurea*) IN PAKISTAN  
ВЫЖИВАЕМОСТЬ ЗОЛОТЫХ (КРАСНЫХ) СУРКОВ  
(*Marmota caudata aurea*) В ПАКИСТАНЕ  
LA SURVIE DES MARMOTTES DORÉES (*Marmota caudata aurea*)  
AU PAKISTAN**

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**Abstract**

We studied survivorship of golden marmots (*Marmota caudata aurea*) in Pakistan's Khunjerab National Park from 1988 to 1993. First year mortality was high for both sexes but then leveled off. We compared golden marmot survivorship to survivorship in other highly social species (*M. vancouverensis* and *M. olympus*), and to survivorship in a less social species (*M. flaviventris*). Like other highly social marmots, golden marmots have relatively high annual survivorship and thus provide further support for the hypothesis that a benefit of sociality is increased survivorship.

**Key-words:** golden marmots, Pakistan, sociality, survivorship.

**Резюме**

Мы изучали выживаемость золотого (красного) сурка (*Marmota caudata aurea*) в Пакистане в национальном парке Кундджераб с 1988 по 1993 гг. В первый год смертность была высока среди обоих полов, но затем начала снижаться. Мы сравнили выживаемость красного сурка с выживаемостью у других высоко социальных видов (*M. vancouverensis* и *M. olympus*), а также с выживаемостью у менее социального вида (*M. flaviventris*). Подобно другим высоко социальным суркам, у красного сурка относительно высока годовая выживаемость, что подтверждает развиваемую далее гипотезу о том, что на выживаемость положительно влияет социальность.

**Ключевые слова:** золотые сурки, Пакистан, социальность, выживаемость.

**Résumé**

La survie des marmottes dorées a été étudiée, entre 1988 et 1993, dans le Parc National de Khundjerab au Pakistan. La mortalité au cours de la première année est élevée pour les deux sexes, puis se stabilise. La survie des marmottes dorées a été comparée à celles d'autres espèces très sociale (*M. vancouverensis* et *M. olympus*), ainsi qu'à celle d'une autre espèce moins sociale (*M. flaviventris*). Comme les autres marmottes à niveau de socialité élevé, les marmottes dorées ont une survie annuelle relativement élevée, ce qui fournit un appui supplémentaire à l'hypothèse selon laquelle une meilleure socialité accroît la survie.

**Mots clés :** Marmottes dorées, Pakistan, socialité, survie.

**HOLARCTIC MARMOTS AS A FACTOR OF BIODIVERSITY**  
*D.T. Blumstein et al. SURVIVORSHIP OF GOLDEN MARMOTS ...*

**Introduction**

Comparing life tables for closely related species may identify species-specific constraints and are required to test hypotheses about social evolution. Survivorship curves for yellow-bellied (*M. flaviventris*) (Schwartz et al. MS), Vancouver Island (*M. vancouverensis*) (Bryant 1996), and Olympic marmots (*M. olympus*) (Barash 1973) suggest that non-pup annual mortality is relatively lower for the highly social Vancouver Island and Olympic marmots than for the somewhat less social yellow-bellied marmot.

We predicted that if sociality and mortality rates are related, the highly social golden marmot (*M. caudata aurea*) will have a relatively low annual mortality rate.

**Methods**

From 1988 to 1993, we studied the behavior and ecology of golden marmots in Khunjerab National Park, Pakistan (Blumstein and Arnold 1998). We collected sufficient data to calculate a partial survivorship curve: infrequent reproduction prevented further life table analyses. The fates of all animals caught in the core study site in 1988, and all pups born in or before 1991, were followed through 1993.

Our data had two potential biases. First, we may have conflated mortality with dispersal. The study site was insular but intensive investigations around the periphery never revealed dispersal out of the core area. Second, we may have underestimated adult age. We estimated the age for animals first caught in 1988 and assigned all animals of indeterminate age to the "age class 2" category. In both cases we would overestimate mortality. Thus, our analyses are conservative: overestimating mortality makes it more difficult to detect a survivorship benefit of sociality.

Table 1.

Survivorship of female and male golden marmots at Dhee Sar,  
 Khunjerab National Park, Pakistan (1988-1993).

<b>F e m a l e s</b>									
<b>age</b>	<b>act. n</b>	<b>a<sub>x</sub></b>	<b>L<sub>x</sub></b>	<b>d<sub>x</sub></b>	<b>q<sub>x</sub></b>	<b>p<sub>x</sub></b>	<b>log(a<sub>x</sub>)</b>	<b>log(L<sub>x</sub>)</b>	<b>k<sub>x</sub></b>
0	18	97	1000	722	0.72	0.28	1.99	3.00	0.56
1	5	27	278	0	0.00	1.00	1.43	2.44	0.00
2	27	27	278	82	0.30	0.70	1.43	2.44	0.15
3	19	19	195	62	0.32	0.68	1.28	2.29	0.16
4	13	13	134	21	0.15	0.85	1.11	2.13	0.07
5	11	11	113	21	0.18	0.82	1.04	2.05	0.09
6	9	9	93	21	0.22	0.78	0.95	1.97	0.11
7	7	7	72				0.85	1.86	
<b>M a l e s</b>									
<b>age</b>	<b>act. n</b>	<b>a<sub>x</sub></b>	<b>L<sub>x</sub></b>	<b>d<sub>x</sub></b>	<b>q<sub>x</sub></b>	<b>p<sub>x</sub></b>	<b>log(a<sub>x</sub>)</b>	<b>log(L<sub>x</sub>)</b>	<b>k<sub>x</sub></b>
0	23	130	1000	609	0.61	0.39	2.12	3.00	0.41
1	6	51	391	130	0.33	0.67	1.71	2.59	0.18
2	34	34	261	69	0.26	0.74	1.53	2.42	0.13
3	25	25	192	54	0.28	0.72	1.40	2.28	0.14
4	18	18	138	31	0.22	0.78	1.26	2.14	0.11
5	14	14	107	15	0.14	0.86	1.15	2.03	0.07
6	12	12	92	31	0.33	0.67	1.08	1.96	0.18
7	8	8	61				0.90	1.79	

## Results and discussion

We have three main results:

- i) First year mortality was relatively high for both sexes (Table 1, Fig. 1);
- ii) Male and female survivorship did not differ (Table 2);
- iii) Once golden marmots survived their first year, survivorship did not differ significantly from the two other highly social species, but was significantly greater than that for the less socially complex yellow-bellied marmot (Figure 1, Table 2).

Blumstein & Armitage (1997a) suggested that a benefit of complex social behavior is reduced mortality. Schwartz et al. (unpublished MS) proposed a mechanism for this phenomenon—sociality stabilizes access to resources and thereby reduces annual mortality. The highly social golden marmots at Dhee Sar had relatively high annual survivorship and thus provide support for the hypothesis that a benefit of sociality is increased survivorship.

Ultimately, increased survivorship must be traded-off with reduced per-capita reproductive success (Blumstein & Armitage 1997a). More social species are notable in that all individuals in a social group do not breed; reproductive suppression is often suspected (Blumstein & Armitage 1997 b). Thus, sociality has benefits, in terms of increased survival, but costs in terms of reduced per-capita breeding.

Table 2.

P-values (Wilcoxon-Gehan survival analysis) testing the hypothesis that the species' median survival times do not differ.

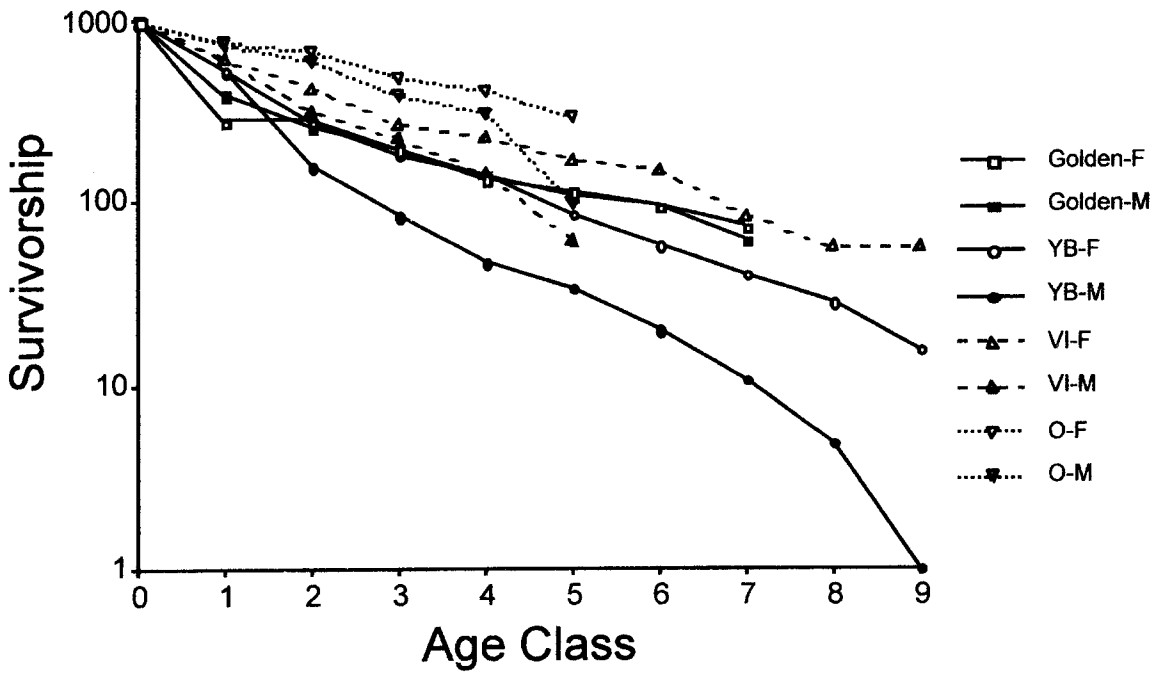
We 'censored' *M. olympus* at age class 5, and *M. flaviventris* at age-class 9. In this analysis sexes were pooled. There are no detectable sex differences in all species but *M. flaviventris*. We obtained similar results if sexes are not pooled. Median survival times at birth are: *M. caudata* = 0.76; *M. vancouverensis* = 0.81; *M. olympus* = 2.43; *M. flaviventris* = 1.11.

Species (Median lifespan given first-year survival)	<i>caudata</i> (2.94 yrs)	<i>vancouverensis</i> (3.58 yrs)	<i>olympus</i> (3.19 yrs)	<i>flaviventris</i> (1.83 yrs)
<i>caudata</i>				
<i>vancouverensis</i>	P = 0.59			
<i>olympus</i>	P = 0.56	P = 0.65		
<i>flaviventris</i>	P < 0.0001	P < 0.0001	P < 0.0001	

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**FIGURES / РИСУНКИ**



**Fig. 1.** A comparison of survivorship of golden marmots (Golden), yellow-bellied marmots (YB), Vancouverisland marmots (VI), and Olympic marmots (O). The less social yellow-bellied marmot has significantly lower survivorship than the more social species.

**Рис. 1.** Сравнение выживаемости у красных сурков (Golden), желтобрюхих сурков (YB), ванкуверских сурков (VI) и олимпийских сурков (O). Выживаемость менее социального желтобрюхого сурка достоверно ниже выживаемости более социальных видов. (вертикальная линия - выживаемость горизонтальная - возрастные классы)

**Holarctic Marmots as a Factor of Biodiversity** (K.B. Armitage & V.Yu. Rumiantsev Eds). - *Proceedings of The 3d International Conference on Marmots, Cheboksary, Russia, 25-30 August 1997*. - Moscow: ABF P.H., 2002, 411 p.

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The results of researches on marmots carried out mainly during the 1990th in Russia and abroad are discussed: theoretical and practical problems of marmots' ecology and ethology, their protection and population management.

The book may be useful for wide range of zoologists, specialists on animals' protection and management, students of biology, etc.

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