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IVème Conférence Mondiale sur les Marmottes IVth Marmot World Conference

Raymond RAMOUSSE, Dominique ALLAINE, Michel LE BERRE



Montreux, Switzerland
15-17 IX 2002

ABSTRACTS - RESUMES

International Marmot Network
Réseau Marmottes International

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Key Words: *Marmota flaviventris*, yellow-bellied marmot, climate change, population recovery.

Recovery of Yellow-Bellied Marmot Population Following a Weather-Induced Decline

The evidence that marmot populations are affected by climate changes, weather extremes, and habitat changes emphasizes the need to examine the capacity of marmot populations to recover from sudden declines. Life-history traits can vary over relatively short geographic and elevational ranges, thus sub-populations may respond differently to environmental perturbations. The yellow-bellied marmot (*Marmota flaviventris*) meta-population in the Upper East River Valley, Colorado, USA, was divided into three subpopulations that coincided with patterns of snow melt (from early to late): DV (down valley), MV (mid valley), and UV (up valley). Late summer drought in 1991 initiated a population decline that was further exacerbated by heavy and late-spring snow cover in 1995. The DV area was minimally affected whereas MV and UV areas experienced a population decline to about 20% of the pre-drought numbers. Population changes were correlated at the MV and UV sites, but were not correlated with DV sites. Seven of 10 habitat patches went extinct, major colonies in each area persisted, but underwent increased mortality and reduced reproduction. Recovery was slow and by 2001 population numbers were 59% of the pre-drought numbers. Recolonization of and reproduction at the extinct sites was erratic; only three of the seven had pre-decline numbers and reproduction by 2001. The rate of recolonization was calculated as the number of successful colonizations per site-year and was about 12% per sit-year. Population recovery was affected by stochastic events such as predation and absence of adult males and by poor reproduction, which was a consequence of the age structure of the adult female population and the presence of non-reproductive females. There was no significant variation in litter size during the decline and recovery; reproductive rate was determined by the number of females reproducing. Successful reproduction at the major colonies produced few female emigrants; on the contrary females occupied available space within the habitat patch.

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Key Words: *Marmota flaviventris*, yellow-bellied marmot, heart rate, social status, agonistic behaviour.

Heart Rates of Free-Ranging Yellow Bellied Marmots

Radio-transmitters sensitive to heart rate were implanted in four adult female marmots (*Marmota flaviventris*). Heart rate was affected by activity and psychological factors. Heart rate (beats/minute) varied from 134.8 while lying in the sun to 300.4 while running during a general alarm call response. Lowest mean heart rate (149.1) occurred when animals were lying in the sun; the second lowest rates occurred when marmots were in their burrows (170.3). Heart rates increased significantly when marmots were sitting above ground (189.9). Mean heart rate increased significantly to 215.9 during foraging and 257.3 during running. Heart rate during walking did not differ significantly from that during foraging, which indicates that the main energy cost of foraging is walking. These increased heart rates are associated with changes in activity. Mean heart rate (225.5) during alert behavior (head-up during sitting or foraging) was significantly greater than that of sitting. When marmots raised their heads during foraging, heart rate increased 6.3 to 7.9% above that of foraging, but decreased immediately when the head was lowered. During vigilance (marmot sitting upright on its haunches) mean heart rate (252) was significantly greater than that of alert. Heart rate increased by as much as 20% when a marmot was alert to another marmot. Heart rates during alert and vigilance are a response to psychological factors and prepare the marmot for action. Heart rates during sitting and alert, but not during foraging or walking, differed significantly among females. The female with the lowest heart rates was the aggressor in all agonistic interactions with the other females and the female with the highest rates made daily excursions into the area inhabited by the other females. Thus heart rate responds to social status and perceived risk and to changes in activity. Heart rate of marmots is lower than that predicted from body mass:heart rate equations, which is consistent with the lower than predicted metabolic rates derived from mass:metabolism equations.

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Key Words: *Marmota flaviventris*, yellow-bellied marmot, nesting activities, burrow.

Nesting Activities of Yellow-Bellied Marmots

Nesting activities by yellow-bellied marmots (*Marmota flaviventris*) include burrow digging, maintenance, and provisioning the burrow with dried grass for nest construction. Burrows are of critical importance because marmots spend 88% of their lives in a burrow and the burrow is where hibernation and reproduction occur. Digging, which includes



scratching the substrate with the forepaws or excavating soil and other materials from a burrow, may occur at any time during the summer or during the day, but is more likely to occur during or just after lactation and during midday or in the evening. Digging accounts for less than 0.5% of the time spent in above-ground activity. Most digging is cleaning out a burrow; old grass, stones, and sometimes marmot skulls or jaw bones are removed. New burrows are rarely dug; when dug, they are in a newly-used foraging area and dug primarily by reproductive females. Only 26 adult males participated in 38 bouts of grass-carrying whereas 172 adult females participated in 317 bouts. Carrying-grass to a burrow accounts for less than 0.6% of the time spent in above-ground activities and averages less than one minute per day. Most grass-carrying occurs during gestation and lactation by reproductive females. Grass-carrying also occurs by two-year-old females establishing residency, by an animal changing burrows, by immigrants and by all age groups prior to hibernation. When these latter instances of grass-carrying are excluded, there is a 98% probability that a marmot carrying grass is a reproductive female. Females that lose litters cease grass-carrying. Among yearlings, females that carry grass are those that become resident. Among male yearlings, grass-carrying occurs by those who become resident or who move to a new burrow to become more distant from the adult, territorial male.

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Key Words: *Marmota marmota*, Alpine marmot, essential fatty acids (EFA), white adipose tissue (WAT), diet, hibernation, energy expenditure.

Dietary fatty acids and natural hibernation in alpine marmots.

We investigated in free-living alpine marmots the effects of linoleic (18:2n-6) and α -linolenic acid (18:3n-3) on diet selection, hibernation and energy expenditure during winter. The study site was located in Grisons, Switzerland, at altitudes between 2100-2300 m a.s.l.. Marmots were trapped twice a year after emergence from hibernation and prior to immergence in fall. Animals were marked individually, weighed, and in autumn a tissue sample was surgically obtained from the inguinal subcutaneous fat depot. For investigating hibernation behavior temperature sensitive radio transmitters were implanted intraperitoneally into 57 marmots from 13 social groups. Body temperatures of these animals as well as ambient temperatures in their hibernacula were automatically recorded continuously during winters 1999 to 2001. Diet selection was investigated by comparing the stomach content of marmots shot in a regular population control program during three different periods of time per year with the plants present in an animal's home-range. Stomach contents and available forage were quantitatively analyzed for plant species composition, chemical composition (e.g. protein, fat, fiber), essential fatty acids (EFA) and energy content. Throughout the active season, marmots selectively fed on plants and plant parts of high digestibility and energy content. During the period of fattening, marmots showed additionally a clear preference for plants with high contents of 18:2n-6 and avoided plants with high concentrations of 18:3n-3. Prior to the onset of hibernation, the content of EFA in white adipose tissue (WAT) varied considerably among individuals (18:2n-6: mean

8.8%, range 5.9-13.0%; 18:3n-3: mean 24.3, range 15.1-33.8%) with important consequences for subsequent hibernation. The higher the content of 18:2n-6 was the lower were minimal body temperatures during deep torpor, and the longer lasted individual torpor bouts during winter. The concentration of 18:3n-3 in autumn WAT had, if any, contrary effects. Total mass loss during winter was significantly influenced by 18:2n-6 in an ecologically important magnitude. Natural variation in the concentration of 18:2n-6 in the autumn WAT resulted in differences in hibernation mass loss of up to 210g.

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Key Words: *Marmota camtschatica*, black-capped marmot, dispersal, Transbaikalia.

Vector of dispersal in *Marmota camtschatica*: the relationship of the marmot with some high-altitude plant community elements.

Marmots are classic herbivorous animals and their natural history expected that they have a close relationship with some plant community elements. The relationship of the marmot with some plant community elements allowed outlining their mutual ties from early historical time.

Plant communities in alpine belt of Northern Transbaikalia have restricted species composition comparing with other plant belts that make relatively lighter their analysis. It is known that *Marmota camtschatica* is the arctic alpine species and inhabits strictly alpine belt in Northern Transbaikalia.

The aim of this study is to try to find the relationship of some highland plant community elements and *Marmota camtschatica* as herbivorous animal. On the base of analysis of the plant community elements as elements of a definite flora, we try outline common ties and dispersal routes of some plant elements and *Marmota camtschatica*.

The region situated in vicinity of Lake Baikal is the important place from biogeographic point of view. There is the crossroads of different plant and animal species dispersal routes. The most important of these species from our point of view is the mountain pine *Pinus pumila*. This pine is a landscape forming species in the high-altitude plant belt and played buffer role restricting the highland belt from forest belt. According to Sochava & Lukicheva (1953), *Pinus pumila* has a Pacific origin and migrate to southwest effecting by Pacific monsoon. The general structure of *Pinus pumila* and *Marmota camtschatica* distribution ranges has a close similarity. Next plant species with such distribution range structure occur in this area.

Thus, on the base of relationship with highland plant community elements vector of dispersal in *Marmota camtschatica* seems directed distinctively from northeast to southwest.



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Key Words: *Marmota sibirica*, tarbagan marmot, reintroduction time, Transbaikalia.

Unusual time for the reintroduction in *Marmota sibirica*.

The experience from previous works, for instance, in *Marmota bobac*, led to some conclusions to get positive results in reintroduction. They listed mostly as following: i) the released group must consist of more than 100 individuals, ii) repeated release at the same place is desirable, iii) favorable time for release is important.

According to the basic ecology of *Marmota sibirica* the most favorable time for reintroduction seems to be the middle of summer - July. The springtime after emergence is undesirable because of following reproduction. Young appeared to aboveground from nesting burrows only during the second decade of June and need to grow up to July. Mothers need recover to this time too. July is time for molting of fur. Initiating from middle of July the tarbagans begin with deposition. Later (the end of August-September), it is the time to prepare a successful hibernation.

We have a two years practice to make the reintroduction in *Marmota sibirica* in Transbaikalia during September. The released groups consisted of less than 100 individuals. During 2000-2001 we have released 88 tarbagans. In this report the merits and demerits of unusual time for reintroduction in *Marmota sibirica* are discussed.

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Key Words: *Marmota monax*, woodchuck, anatomy.

Anatomy of the Woodchuck, *Marmota monax*

Of the fourteen species of Marmots in the world, *Marmota monax*, the Woodchuck of the Eastern United States is still common. This species ranges from Maine to Wisconsin, south to Mississippi, across to central Alabama, northern Georgia and the western Carolinas. It also extends from Nova Scotia on the Atlantic Coast, across southern Canada into eastern Alaska. *Marmota monax* is the most solitary of the marmot species. Mating occurs shortly after they emerge from hibernation in late winter. Gestation is less than a month and the usual litter size is four or five. After the young are weaned and feeding on their own, at about 6 weeks of age, they are forced to disperse by aggressive behaviour of both parents. The manuscript at present is 280 pages with 100 illustrations. The text is arranged by anatomical systems. All terms when first introduced are in Latin followed by the English vernacular. If a structure appears on a figure, a citation is given in the text. Each illustration has a numbered key below. There is no international Nomina for mammals other than that for the human (*Nomina Anatomica* 1989 and its successor *Terminologica Anatomica* 1997) and one for domestic animals (*Nomina Anatomica Veterinaria* 1994).

Since some rodent structures have no counterpart in human or domestic mammals, we have selected or created terms that are consistent with the principles of past anatomical terminology. The guiding principles for the Latin terms we use include simplicity as well as instructive and descriptive value. Terms derived from proper names (eponyms) have not been used. Synonymous terms that have been used in the literature are cited where appropriate and a glossary of anatomical synonyms is included. The contents include: Integument; Skeleton; Joints & ligaments; Muscles; Digestive system; Respiratory system; Urogenital apparatus; Endocrine organs; Cardiovascular system; Nervous system, and Sensory organs. The bibliography should aid in any search of the anatomical literature for reference to *Marmota*.

The drawings on display are based on dissections of wild-caught and captive-bred woodchucks from New York State. It is anticipated that the drawings and text will appear in a Special Publication of the American Society of Mammalogists printed by the Allen Press.

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Key Words: *Marmota*, communication, alarm call, acoustic environment, evolution.

Social complexity but not the acoustic environment is responsible for the evolution of complex alarm communication.

Two non-mutually exclusive hypotheses may explain the evolution of complex communication. First, complex communication may coevolve with complex sociality because more social species should benefit from complex communication. Second, the evolution of complex communication may be constrained by the 'acoustic environment' because signals excessively attenuated and degraded while transmitted through the environment cannot be properly interpreted. Using recently-developed phylogenies, I tested the relative importance of these two hypotheses in explaining the evolution of alarm communication in marmots. The number of alarm calls a species produced varied among close relatives, suggesting the potential for adaptive coevolution. Results suggest that social complexity, but not the acoustic environment, was responsible for the evolution of complex communication in marmots. These results join other recent findings and suggest that the relative importance of the acoustic environment for the evolution of communication should be re-examined.



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Key Words: *Marmota flaviventris*, yellow-bellied marmot, alarm call, individual discrimination.

Yellow-bellied marmots discriminate individuals based on alarm calls

Unlike individually distinctive territorial calls, contact calls, or calls that aid in the recognition of young by their parents, the function or functions of individually-distinctive alarm calls (vocalizations emitted in response to predators) is not immediately apparent.

Yellow-bellied marmots (*Marmota flaviventris*) produce individually distinctive alarm calls. Using an habituation-recovery playback protocol, we demonstrate that marmots can perceive differences between the calls of different adult females. A subsequent experiment sought to understand why such discriminative abilities exist. We demonstrate that at least one function of being able to discriminate among callers is to permit marmots to identify when, presumably vulnerable, young marmots are calling, and to respond by engaging in vigilance.



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Key Words: Observational data, recording tool, statistics, analysis.

JWatcher: A new tool for acquisition and analysis of observational data

We have developed, and freely distribute, *JWatcher*: an event-recording and focal data analysis program. ! *JWatcher* is written entirely in Java and consequently runs on any modern microcomputer, regardless of operating system. Our philosophy is that users should only need to score behaviour once. Flexible data post-processing allows a wide variety of analyses, all based upon the same original data file. These can consider a subset of key codes, or explore patterns of behavior using different time windows. Both event (frequency) and state (duration) descriptive statistics are available.

A batch-processing mode permits efficient analysis of large numbers of observation data files. Error-checking functions are built into the analysis algorithms. It is straightforward to export data and results to spreadsheet and statistics programs for further processing. Versions of *JWatcher* for Mac and PC, together with a 33 page manual, can be downloaded from the web site (www.jwatcher.ucla.edu).

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Key Words: *Marmota marmota*, habitat suitability, model, Eastern Italian Alps.

Habitat suitability models for the management of the alpine marmot (*Marmota marmota*) in Eastern Italian Alps.

The Alpine marmot was extinct in Easter Alps since prehistory. The reintroduction of the species in the Italian eastern Alps began in 1955 and still goes on.

The single events of reintroduction were often managed without a preparatory analysis of suitability and carrying capacity of the reintroduction area. So, some reintroductions in eastern Italian Eastern Alps failed for a lacking suitability habitat evaluation and, in the beginning especially, for a lacking knowledge of the habitat preferences of the reintroducing species. The principal problem in the management of the species in the south of the Eastern Alps consists in the isolation of the alpine prairies, because of the low altitude of the mountain chain.

It becomes so basic to evaluate, before the reintroduction, the future isolation of the reintroduced populations and their potential size in order to evaluate the risks of genetic drift and of casual extinction. The Dolomiti Friulane Natural Park (founded in 1994; Friuli-Venezia Giulia; Eastern Alps) is engaged to maximize the presence of the Alpine marmot in its territory in order to establish a vital metapopulation. In 1999 I studied the distribution of the species in the Park and I carried out with discriminant function anal-

ysis a habitat suitability model (HSM) able to identify squares 1 Km² wide suitable for the presence of the species. I thus obtained the potential distribution of the species in the Park. Then I analysed the habitat preferences of the Alpine marmot in the bigger and older (1977) population of the Park, and I carried out a HSM able to identify the squares, 1 hectare wide, suitable for the settlement of winter burrows of Alpine marmot. In 2000 and 2001 I validate both HSM in two areas of the Eastern Italian Alps (Dolomiti Friulane Natural Park and Prealpi Giulie Natural Park). Both HSM showed to be useful in evaluation and quantification of the real suitability of the areas of potential or required reintroduction.

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Key Words: Palearctic, *Marmota*, marmots, chromosome, polymorphism.

Chromosomal evolution and polymorphism in gray marmots (*Marmota*, Sciuridae, Rodentia).

A Holarctic marmots group is a convenient object for the study of microevolution processes as this group consists in forms on different stages of differentiation. Nearctic marmots represented by sympatric and semisympatric well morphologically and genetically diverged species. They differ from each other by karyotype features (numbers and morphology of chromosomes). Palearctic marmots represented by allopatric forms with various grades of differentiation. There are among them as well morphologically differed species as groups of forms with inexplicit morphologically hiatus. Earlier it was showed a chromosomal evolution of most Palearctic marmots species went without changing of chromosome numbers ($2n=38$), except for *Marmota camtschatica* ($2n=40$) (Vorontsov *et al.*, 1969; Lyapunova, Vorontsov, 1969; Vorontsov, Lyapunova, 1970). We showed up a polymorphism in numbers of chromosomes in *M. baibacina* (Brandler, 1999; 2000). Now we examined marmots inhabiting in Novosibirsk region, Altai Territory and Montane Altai. On base of karyotypes study we determined that a forest-steppe marmot *M. b. kastschenkoi* inhabited in West Siberia has $2n=36$. G-banding showed that first biggest pair of chromosomes of these marmots was formed by centromeric fusion of submetacentric and acrocentric chromosomes which are homologous to 8 and 17 pairs of 38-chromosomal set of Montane-Altai marmots with deletion of little arm of submetacentric chromosome. We propose to level up the taxonomical status of *M. b. kastschenkoi* to species basing on karyotype differences (Brandler, in lit.). The clear karyotypical differentiation of 36- and 38-chromosomal species of gray marmots is accompanied by inconsiderable morphological hiatus (Galkina, 1970) and intermediate between subspecies and species levels genetic distance (Steppan *et al.*, 1999). Such pattern is characteristic for a chromosomal speciation when evolution of a karyotype goes before morphological and gene evolution (Vorontsov, 1999; King, 1993). We found two marmots with $2n=37$ in the 38-chromosomal *M. baibacina* from Montane Altai. One of these animals had depauperated sex organs. The 37-chromosomal karyotype of these marmots has one big chromosome formed, apparently, by above way. This mutation may stem from external agency repeatedly. The



place, where marmots with the aberrant karyotype were trapped, is a hyperseismic country (earthquakes intensity 8) and has gulfs of mercury and uranium ores. A hypothesis of increase of chromosomal mutations frequency in seismic active countries was offered earlier (Vorontsov, Lyapunova, 1984). Arising repeatedly in 38-chromosomal population this rearrangement could fixate in a homozygotic condition under a gene drift in West Siberian isolate of gray marmots in late Pleistocene. Maybe this mutation gave some advantage to specimens having it during Holocene landscape changing when cold steppe was replaced by forest-steppe biocenoses.

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Key Words: *Marmota marmota*, hibernation, diet, white adipose tissue (WAT), brown adipose tissue (BAT), essential fatty acids (EAC), cell membrane cellulaire, triglycerid, phospholipid.

Seasonal changes in adipose tissue triglyceride and organ phospholipid composition in free-living alpine marmots.

Results from feeding experiments show that high concentrations of linoleic acid (18:2n-6) in autumn white adipose tissue (WAT) decrease energy expenditure during hibernation. In contrast, linolenic acid (18:3n-3) seem to have opposing effects and may be preferentially metabolized during winter. Studies on free-living alpine marmots demonstrated a preference for food plants rich in 18:2n-6 but low in 18:3n-3 and confirmed the existence of considerable influences of autumn WAT composition on cold tolerance and hence energy expenditure in natural habitats (Arnold et al., this volume). Suggested explanations for these phenomenon are the need of a high degree of unsaturation in cell membranes in order to maintain functionality at low body temperatures, which, on the other hand, implies an inevitable peroxidation risk increasing with the number of double bonds. For better understanding nutritional preferences, patterns of metabolism of fatty acids and presumed trade-offs we investigated in this study the composition of four different white adipose tissue depots, axillary brown adipose tissue (BAT), and of heart muscle and liver tissue phospholipids during three different phases of the active season of marmots: after hibernation before fresh food became available, during the period of most rapid fat deposition, and prior to hibernation. During winter, 18:3n-3 was preferentially catabolized whereas 18:2n-6 was retained, the more the lower its prehibernatory concentration was. EFA concentrations in organ phospholipids and BAT were substantially higher throughout the year than in the WAT. However, concentrations of 18:2n-6 and 18:3n-3 correlated positively in all tissue during summer as it did in consumed plants. Surprisingly, this correlation changed in a strong negative relation in preparation for and during hibernation in heart and liver phospholipids. We interpret this substitution of 18:3n-3 with 18:2n-6 in membranes of vital organs, the preferential metabolism of 18:3n-3 during, and the retention of 18:2n-6 as an adaptation to maintain of a high degree of membrane unsaturation by simultaneously minimizing the associated peroxidation risk.

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Marmot Recovery Foundation

Key Words: *Marmota vancouverensis*, Vancouver Island marmot, hibernation, wildlife, captivity.

**Hibernation ecology of wild and captive Vancouver Island marmots
(*Marmota vancouverensis*)**

We used direct observation, nest-box temperature recorders, and mass data from Vancouver Island marmots (*Marmota vancouverensis*) to evaluate hibernation patterns in this critically endangered mammal and test whether behavior changes in captivity.

Hibernation duration was significantly reduced in captivity. Marmots in the wild typically began hibernation six weeks earlier (mean immergence=1 October, 95% CI=28 September-3 October, $n=49$) and ended hibernation five weeks later (emergence=28 April, 95% CI=26-30 April, $n=43$) than captive marmots (immergence=14 November, 95% CI=9-18 November, emergence=24 March, 95% CI=22-27 March, $n=69$).

Captive marmots hibernated successfully at a range of mean temperature (6-9°C) and relative humidity (28-83 %RH) conditions at four captive facilities. Relatively warm, dry and more variable conditions at Calgary Zoo produced shorter hibernation duration. Hibernating marmots typically aroused every 10-12 days although there were substantial individual variation.

Solitary wild marmots hibernate successfully in a variety of habitats, and yearlings do not necessarily hibernate with their social group (both results are contrary to the predictions of Arnold's social thermoregulation hypothesis). Mass-specific daily mass loss (DML) estimates from captive animals suggest that Vancouver Island marmots are relatively efficient hibernators (mean DML=0.95, SD=0.32, $n=69$). There was no apparent effect of group size, age or sex. These results suggest that reintroductions involving small numbers of animals should not be hindered by physiological constraints of hibernation.

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Key Words: *Marmota baibacina*, gray marmot, *Marmota sibirica*, marmotte de Mongolie, Hunting, management, conservation.

Current status of Marmot hunting in Mongolia

There are two species of Marmot namely Altai Marmot (*Marmota baibacina* Radde, 1862) and Siberian Marmot (*Marmota sibirica* Kastchenko, 1899) distributed in Mongolia. The last one distributed more densely in the steppe and mountain steppe areas is common in the rest of areas except in territory of Umnogobi and Selenge aimags. The first one is distributed in the areas of Bayan-Olgii aimag and Khovd and Erdeneburen sums of Khovd aimag. Mongolians have used marmot since the ancient time. Today the meat, skin,



internal organs of the marmot are used for food and medicinal purposes. Also marmot skin became the main raw material for overseas export. This influenced in increase of illegal hunting and illegal trading of game raw materials and succeed in new type of business. Marmot plague is occurring every year and the government is spending a lot to fight the disease. Thus, it is important to develop the hunting management to insure the sustainable use of the marmot. Considerable study has been done in field of Siberian Marmot, which has a broad distribution area in Mongolia, in terms of biology, ecology, distribution, resource, hunting, conservation and its plague. Some results of the study in distribution and hunting are shown below.

According to the latest survey (1990) the marmot distributed in the areas of 229 sums of 16 aimags, which is 16% of total territory of Mongolia. Marmot density has decreased to compare against the survey results done on density in 1990 and the following years (see table 1). Although several professional organizations under the Office of natural epidemic disease and Ministry for Nature and Environment, conducted marmot counting and survey in some aimags' and sums' territory, the result obtained is not enough to make overall evaluation on marmot distribution, density and resource in state level. In other words information obtained during these years cannot support to make extensive evaluation on marmot distribution and resource (Batbold etc, 2000). Today, state control on increasing marmot hunting is weak. Marmot hunting is exceeding several times the permitted quantity per year in every sum and aimag. This is the result of failure in not organizing the hunting management and planning which also lead to impossibility to control number of hunted marmot. In the year of 2000, 57.7% of hunted marmot belonged to household hunting and 42.3% to commercial hunting (MNE). This figure shows that household hunting is permitted more than commercial hunting in each aimag and as usual under the household hunting permission there is always much greater hunting than it is permitted. Hunting study has been carried in Eastern Mongolia and the preliminary results of the project shows that the Siberian Marmot is the most hunted species in Eastern aimags (Khentii, Sukhbaatar, Dornod aimags) and the survey made by 7 state inspectors from Eastern aimags on the issued hunting permission shows that hunters requesting official permission for marmot increased since 1995.

Marmot skin is exported mainly to China and Russia by different permitted and unpermitted ways. According to the data obtained from General Custom Office in between years of 1995-2000, there are 600,000 marmot skins exported to abroad, of those 46,1% of skin exported through Selenge border, 29,7% through Buyant-Ukhua, 14,5% through Zamin-Uud, 5,3% through Khovd and 3,2% through Bayan-Olgii border.

Only a little portion of skin sold in local market for National enterprises.

Need for improvement and strengthening of marmot study is increasing more than ever.

Table 1. Change in marmot density in Mongolia.

#	List of aimags	Average density (number of marmot in km ²)		
		In 1990	Hunting survey done after 1990	Difference in percentage
1	Bayan-Olgii	109	11,8 (1992)	10.8
2	Bulgan	116	22,4 (1998)	19.3
3	Gobi-Altai	138	7,9 (1999)	5.7
4	Dundgobi	58	10,2 (1998)	17.5
5	Ovorkhangai	142	39,7 (1997)	27.9
6	Khovd	154	11,5 (1993)	7.4
7	Khovsgol	50	2,6 (1996)	5.2
	Total	108.1	12.6	13.4

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Key Words: *Marmota marmota*, alpine marmot, Cestoda, *Echinococcus multilocularis*, parasitism, endemic.

***Marmota marmota*, intermediate host of *Echinococcus multilocularis*:
identification of 3 cases in French Alps.**

Echinococcus multilocularis is a small tapeworm of the Cestoda class. It occurs in the small intestine of the definitive host, wild or domestic canine species (primarily fox); larvae, alveolar hydatid cyst, are found in the liver of intermediate host, microtine rodents (voles, wood mouse, muskrat, sciurids ...). In normal host populations, its presence usually goes unnoticed but it becomes dangerous for human health when humans accidentally consume parasite eggs: it brings about a serious polycystic hydatid infection in liver, primarily in rural human populations.

In France, 2 areas were recognized for the parasite circulation: one in the Northeast of the country extended as far as North of Alps, and one in the Central Massif. In Alps, the endemic area is focused on the Bornes Massif and the Aravis Mountains (Haute Savoie), with a second focus in middle Tarentaise region (Savoie).

Since 1996, three cases of alpine marmot infestations by *E. multilocularis* were discovered, two in middle Tarentaise and one in Haute Savoie. They are the first descriptions of this parasite in this host species. A dog killed one of the marmots, so it seems to be important to evaluate the importance of this new host in the maintenance of the parasite life cycle in an active endemic area.



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Key Words: Morphometry, evolution, *Marmota*, ventral cranium.

Skull form and evolution in *Marmota* (Rodentia, Sciuridae)

The morphology of the ventral skull of all 14 marmot species was investigated with geometric morphometric techniques, and the results were compared with those obtained for the mandible.

1) Ontogeny. The relationship between size and shape in the ventral cranium was analysed for *M. caligata*, *M. caudata*, *M. flaviventris*, *M. himalayana*, *M. marmota*, *M. monax*. In each species males and females have similar allometric trajectories and size explains a significant proportion of shape variation. In *M. flaviventris* at least, the modest degree of shape sexual dimorphism seems to be due to ontogenetic scaling. The ontogenetic pattern of size-related shape change is similar in all the marmots. However, the allometric trajectories and the 'degree of allometry' varies among species, and the latter is correlated with the size variation in each sample and weakly related to the age of first reproduction.

2) Interspecific comparison of adults. The close relationship of the two main species of the subgenus

Petromarmota (*M. caligata* and *M. flaviventris*) is supported by the ventral cranial morphology. *Marmota vancouverensis* has autoapomorphic traits presumably related to its evolution as a peripheral isolate. However, the species of the subgenus *Marmota* do not cluster together and are mixed with those of *Petromarmota*.

The results with regard to ontogeny are closely mirrored by those from the mandible. Also the pattern of adult sexual dimorphism is very similar in both mandible and cranium. Most of the growth modifications of the skull and the mandible occur in regions directly involved in the mechanics of mastication. Both the mandibular and the ventral cranial phenetic relationships do not correspond to clear patterns of size variation or ecological convergence, and thus are not congruent with the hypothesis of the sciurid skull having a propensity to homoplasy. The marmot ventral cranium appears a relatively conservative structure compared to the mandible, which may have evolved more rapidly to fit dietary changes during the marmot evolutionary radiation or because fewer developmental constraints acts on this relatively simple bone.

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Key Words: Marmota marmota, marmotte alpine, mummification, corification.

Sissi: from the Italian Alps the first marmot natural mummy

A natural mummy of a marmot was found about 30 years ago by a mountain dweller in Val Sissone (Retic Alps, Italy): the find site explains the name given to the mummy. To our knowledge, this is the first marmot mummy ever found and one of the very few natural mummies found in the Alps. The specimen is almost devoid of all hair and the skin has a dry, leather-like appearance, but the preservation is so perfect that even the tiny ears and the thin tail are intact. Radiographs have shown that there are no evident fractures in the bones but the mandible and first vertebrae are dislocated; the incomplete ossification suggests that Sissi was a young marmot. Possibly, it was a two or three years old marmot which was killed by an avalanche or a landslide while dispersing from the parental colony. Congruent with this hypothesis is the observation that the mummy was found in superficial rock debris on a glacier on the Northern side of Mount Disgrazia, in an area where there is no historical evidence for marmot presence. Histological analyses were performed in order to verify whether the marmot underwent actual mummification or 'corification', which is more like a tanning process: the macroscopic appearance is very similar, but microscopically differences are clearly visible. Verification of whether the marmot underwent corification or mummification is crucial in order to reconstruct the immediate post-mortem environment it was exposed to. The histological analysis of a sample of skin taken from the thigh, showed intact dermal structures and residues of cells from the stratum corneum, clear indicators of mummification. As dispersal in marmot occurs early in the Spring, the extreme meagerness due to the loss of weight during hibernation may have facilitated the mummification. This process could have been the result of an unusually long dry and windy period in the Alps, immediately after snow melting that rapidly dried the marmot and stopped the decomposition. Further microscopic and endoscopic studies will possibly shed light onto the actual cause of death, traumatic or related to disease. For dating the specimen, a C14 analysis has currently been undertaken. Sissi is now housed in a permanent exhibition at Chiesa Valmalenco (Sondrio, Italy).



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Key Words: *Marmota vancouverensis*, Vancouver Island marmot, Breeding behaviour, captivity.

Breeding behaviour of captive Vancouver Island Marmots (*Marmota vancouverensis*).

The Vancouver Island marmot (*Marmota vancouverensis*) is the most endangered animal in Canada. Less than 30 animals remain in the wild and 47 are in a captive breeding program, at four Canadian facilities. Although a total of 10 pups were born in three litters at the Calgary Zoo in 2000 and 2001, reproductively mature individuals have failed to breed otherwise. Subsequently, Canadian agencies determined that a thorough investigation of potential behavioural factors associated with breeding success is essential to improve reproduction. In response to this need, we launched a detailed behaviour study of captive Vancouver Island marmot breeding pairs in 2002. Using video data from enclosure and nest box cameras at three breeding facilities, we are intensively monitoring 9 pairs in 2002 and 9-12 pairs in 2003 to develop comparative behavioural profiles of pairs that reproduce and those that do not. Here we present behavioural profiles of Vancouver Island marmots for successful and unsuccessful breeders between the hibernation and parturition period in 2002. The applications of behavioural correlates to reproductive success from this study are two-fold: 1) Management practices will be implemented to favour environmental conditions that are positive correlates to the breeding of Vancouver Island marmots; 2) While details of the reproductive behaviours of relatively asocial *Marmota* species such as woodchucks and yellow-bellied marmots have been investigated, those of more social marmots are relatively unknown. Consequently, we project that the results from this study will also be pertinent in better understanding other highly social marmot species.

CAZZOLA Marcello & PANSERI Maurizio

Key Words: *Marmota marmota*, alpine marmot, time budgets, summer.

Behaviour of Alpine marmot (*Marmota marmota*) during the summer months: time budgets from a colony in valle Brembana (Bergamo, Italy).

A study of summer behaviour time budgets was carried out on a monofamiliar colony of the alpine marmot (*Marmota marmota*) in Valley Brembana, Orobic Alps, Province of Bergamo, Italy. The aim was to examine the variation of activity and behaviour of the family unit and each single individual throughout two summer seasons (May-September, 1998 & 1999). Eleven behavioural types were defined: postures, cohesive behaviour, greetings, feeding, vigilance, burrowing, hay-carrying, tail movement, toilet, scent marking

and locomotion. Daily and monthly distributions of each behavioural type were analysed for each individual and for the family as a unit. Behaviours were seen to vary according to hour of the day and season. In particular: posturing was more frequent in the middle hours of the day, greetings and cohesion behaviours occurred at a constant rate during the early summer period and they decreased with time; the animals were observed to feed during two different periods of the day and was more frequent in late season; locomotive behaviour was most common in mid summer (especially July). The behavioural types in decreasing order of time spent were: feeding, postures, locomotion, greetings, cohesion; all others had very similar frequencies.

The influence of hiking activities on the behaviour of marmots, due to the presence of a footpath near the colony, was considered.

A different temporal distribution of activity types and an increasing in scent marking behaviour in summer of 1999 occurred, probably due to the presence of three cubs.

The data show the importance of the underlying seasonal effect on the temporal distribution of behaviours. Other factor such as the social composition of the colony and anthropic presence were also influential.

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Key Words: *Marmota monax*, woodchuck, hepatitis B virus, model.

Woodchuck (*Marmota monax*) model for study of chronic hepatitis B virus infection.

Hepatitis B infection remains a major health problem with 400 millions of chronic Hepatitis B Virus (HBV) carriers which are of high risk to develop cirrhosis and primary liver cancer. Due to the narrow host range of HBV that infects only humans and chimpanzees, the closely related woodchuck HBV (Woodchuck Hepatitis Virus or WHV) provides a particularly useful model, which played a pivotal role in study of HBV life cycle, virus-host interactions, virus related carcinogenesis and antiviral strategies. The WHV infection seems to be restricted to one species of marmots (woodchucks), *Marmota monax* and remarkably only animals living in North Eastern coast of the U.S.A. We have shown that the alpine marmots (*Marmota marmota*) are not susceptible to WHV infection. A colony of WHV-infected woodchucks was established in our laboratory using animals trapped in the wild and imported from USA. The study of natural course of infection showed that infection by WHV is not only limited to the liver but does also involve lymphocytes. Importantly 100% of WHV-infected woodchucks develop liver cancer 17-36 months after infection. Study of the mechanism of oncogenesis in the woodchuck model showed that WHV can contribute to the neoplastic process through insertional activation of cellular oncogenes of the myc family. In addition, we have used WHV-infected (American) woodchuck to test several new antiviral compounds and identified nucleoside analogs, which are able to efficiently inhibit viral replication and appear therefore to be of interest for clinical use. Therefore *Marmota monax* model appears as particularly useful



and it will be of particular importance to investigate whether other marmot species are susceptible to WHV infection.

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Key words!: *Marmota marmota*, heterozygosity, juvenile survival, body mass.

Effects of phenotypic and genotypic quality on juvenile alpine marmots survival!: preliminary results

Many studies have found a correlation between some measures of phenotypic quality and components of fitness in free ranging animals. However, the relative importance of the genetic basis in such a relationship is poorly known. The recent developments in molecular biology provided useful tools to investigate the effect of individual genetic quality on individual phenotypic quality and fitness. Based on the assumption that homozygous individuals suffer an inbreeding depression effect, different measures of individual genetic quality have been proposed (mean individual heterozygosity, mean d2, mean d2 outbreeding). Recent analyses of the effect of individual genetic quality on phenotypic quality and on fitness have shown contradicting results.

In this presentation, we investigate the relationship between individual genetic quality, phenotypic quality and fitness in free ranging juvenile alpine marmots. Each individual has been typed for 9 microsatellites and the genetic quality has been measured as the mean individual heterozygosity. Phenotypic quality was measured by body mass corrected for the age, litter size and body length. Finally, the component of fitness considered was the survival during the first year. Results indicate that the juvenile survival was positively correlated with heterozygosity only in males and was independent of phenotypic quality in both sexes. Consequently, phenotypic quality was not correlated with the mean individual heterozygosity but was rather determined by territory quality.

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Key Words: *Marmota menzbieri menzbieri*, *Marmota m. zachidovi*, Distribution, Conservation, Western Tien Shan, Kazakhstan, Ouzbekistan, Kirghistan

The modern status of Menzbier's marmot in Uzbekistan

Menzbier's Marmot is an endemic to the western Tien Shan. Its range comprises two isolated sites: a smaller one, Talass (Kazakhstan), inhabited by a typical subspecies, *M. m. menzbieri*, and a bigger one, Chatkal (Uzbekistan and Kyrgyzstan), inhabited by *M. m. zachidovi*, a Chatkal subspecies. The minimal distance between these sites is about 60 km. Until 1980's, an isolated settlement of Marmot was recorded on the Kurama Ridge (Tadjikistan). The area of the Talass site is about 400 km², while the Chatkal site is about

1300 km². The latter is fragmented into a number of isolated sites (northern Chatkal, 520 km²; southern Chatkal, 260 km²; Chimgan, 87 km²; Angren, 433 km²; Sumsar, 43 km²).

In the last 50 years, a continuous dwindling of the range and number of this species has been observed, which is confirmed by the availability of numerous empty holes in the peripheral parts of the area. The reduction of the range in this period has reached approx. 50% due to a shift of the lower border of distribution of this species, as well as the expansion of gaps in the area. Therefore, in this period marmots have disappeared from the slopes of summits Takali and Havlya (the western extremity of the species range); they are on the brink of vanishing from Kyzyl'nura and the Chimgan. By modern expert estimates, a notable reduction is also observed in the central parts of the range. The current number of Menzbier's Marmot in Uzbekistan reaches approx. 30,000 individuals. By expert estimates, the reduction rate of Menzbier's Marmot inhabiting the Chatkal ridge is assessed at over 5,000-6,000 individuals in 10 years. There are apparently several factors affecting the range and number of this species, namely, poaching, overgrazing, which results in the degradation of pastures and a shift of a daily activity of Menzbier's Marmot, and predation by shepherd dogs. However, in some cases, e.g. in Chatkal Nature Reserve, it is impossible to explain the reduction of number by the above-mentioned factors. There are assumptions of diseases of marmots and an increasing pressure of natural predators (wolves) in the protected territory. Despite the fact that previously popular shooting with rifles is practically not practised now because of prohibition of the use of firearms in frontier areas, the intensity of poaching has not decreased. Shepherds continue to hunt marmots with the help of traps and wire loops. The hunt of marmots is prohibited in Uzbekistan. This animal is included with the National Red Data Book and is under protection in Chatkal Biosphere Reserve and Ugam-Chatkal National Park. From 2000 to 2005, a project directed at the preservation of biodiversity in the western Tien Shan is carried out in Central Asian states with a GEF (Global Environment Facility) support. In its framework, a three-year program aimed at the assessment of the modern status and rehabilitation of the number of Menzbier's Marmot is under way. To this end, the Uzbek side is preparing a package of proposals for the government on the expansion of the territory of Chatkal Nature Reserve through the joining of Akbulak site located in the basin of the River Chatkal, as well as several other sites adjoining this territory, which are inhabited by Menzbier's Marmot. Besides, establishment of a buffer zone free from cattle pasturing along the border of this nature reserve is planned.

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Key Words: *Marmota marmota*, alpine marmot, mating, pregnancy, hormon.



Hormonal changes during the mating season and the course of pregnancy in the Alpine marmots (*Marmota marmota*)

Under natural and artificial conditions Alpine marmots are true hibernators with a single breeding season starting immediately upon the emergence from hibernation. In captive marmots the clinical and behavioural parameters during this transition were monitored. During three mating and breeding seasons 8 colony housed reproductive female marmots with a weight between 1740 and 3210 g were investigated. The study started on day 2 after hibernation and lasted till the end of pregnancy. Blood samples were taken for progesterone, oestrogen and relaxin and ultra sound investigations were performed, as well. The mating activities were recorded in one year.

Ten animals became pregnant which was proven by ultrasound diagnosis in all cases. The first positive findings of amniotic sacs dated at day 9 of gestation, while the embryos itself were found at day 14. In the first week post hibernation progesterone values were above the detection level in half of the samples. Progesterone levels obtained during the second week of pregnancy and were higher than in non-pregnant marmots (9.0 ± 0.8 nmol/l vs. 4.2 ± 1.8 nmol/l; $p < 0.01$). Instantaneously after the arousal from hibernation all successfully breeding females also showed higher serum relaxin values than non-successful animals (1.21 ± 0.1 vs. 0.32 ± 0.02 ; $N=10$; $n=5$; $p < 0.01$); this elevation in relaxin remained until the end of pregnancy. The total concentration of oestrogen did not differ between pregnant and non-pregnant animals. Progesterone as well as relaxin are known as pregnancy-related hormones. The data presented here suggest that both hormones can be marker for an early stage of pregnancy in Alpine marmots.

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Key Words: *Marmota bobak*, steppe marmot, breeding, allele frequency, albumin, transferrine, erythrocytes, heritage.

Connection between the allele frequency of polymorphous loci and their complexes and polygenetic heritable signs in prairie marmots

In the process of marmots' adaptation to the condition of cage breeding there was noticed movement in spectrum and concentration of allele and genotype frequencies of blood polymorphous systems in 5 loci – albumin, postalbumin, transferrin and posttransferrin of serum and hemoglobin of blood erythrocytes. Albumin synthesis is determined by two allele genes, synthesis of postalbumin, transferrin and posttransferrin – by three, hemoglobin locus has four alleles.

Level of homozygosity in albumin, postalbumin, transferrin and posttransferrin and hemoglobin of studied marmots' population is varied at the range of 50.4-63.0 %. There was established a stable correlation between the females' live weight and posttransferrin A allele in posttransferrin locus. Quantity of marmot females with live weight that higher than a middle meaning in population is trustworthy higher among animals with allele

posttransferrin A in comparison with marmots with alternative alleles and with quantity of females in the whole population ($P < 0.001$).

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Key Words: *Marmota*, physiology, hibernation, body temperature, body weight

Marmot Physiology: Lessons to be learned about body temperature and weight gain.

Marmots (*Marmota*) have been studied for more than 100 years and are still providing us with many insights about basic mammalian physiology. The history of marmot physiology is rich with examples of how marmots adapt to specific environmental conditions and these examples help to us to explain how many animals, besides marmots, survive under difficult environmental conditions. In this talk I will review some of the historical high points of marmot physiology, discuss marmot physiology over the recent decades, and talk about future directions in marmot physiology. The hallmark of hibernation has been the dramatic change in body temperature and body weight of animals and therefore, I will specifically highlight these physiological mechanisms.

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Key Words: *Marmota flaviventris*, dispersal, microsatellites DNA, Genetic drift, Great Basin, USA.

Marmots on Great Basin mountaintops: Using microsatellites to test for dispersal between ranges

For three decades, boreal mammals on mountaintops in the Great Basin of North America have been portrayed as island populations surrounded by an “uncrossable sea” of desert scrub. This theory is supported by ecological and paleontological studies showing a pattern of widespread extinction throughout the Holocene, but no recolonization. Recent work, however, has used updated species lists to argue that patterns of boreal mammal distributions are, in fact, consistent with dispersal between Great Basin ranges. Since dispersal is rarely witnessed, though, indirect methods are often needed to document it. One promising indirect method is provided by highly variable genetic markers, such as microsatellite DNA. The geographic distribution of microsatellite variation can be used to measure gene flow (an outcome of dispersal). We used microsatellites to test whether gene flow occurs among mountaintop populations in the Great Basin. Our model organism was the yellow-bellied marmot, *Marmota flaviventris*, a boreal species found in montane meadows on Great Basin mountain ranges. If marmots disperse between ranges, then there should be a positive correlation between genetic distance and geographic distance. That is,



mountaintop marmot populations should be more closely related to populations on nearby ranges than to those on more distant ranges. In our results, we found no relationship between genetic and geographic distance, though mountaintop populations were strongly differentiated genetically. We argue that marmot populations in the Great Basin have experienced substantial genetic drift throughout the Holocene, and that this drift is largely unmitigated by immigration.

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Key Words: *Marmota marmota*, Alpine marmot, subordinate, dispersal, Berchtesgaden National Park.

Long- and short-distance dispersal in subordinate alpine Marmots (*Marmota marmota*)

To breed, juveniles of most animal species disperse from their birthplace. Generally dispersal is believed to effect high costs or even more to be risky. By this, natal dispersal has profound consequences for an individual's fitness. Species typically have a characteristic pattern of dispersal, often biased by sex in terms of probability or distance.

In alpine marmots (*Marmota marmota*) younger animals take a subordinate rank towards the dominant, territorial animals. In each group the territorial male and female defend the group's home range against same-sex adult intruders. Among females, reproduction is restricted to territorial animals. In contrast, subordinate males are not entirely excluded from reproduction. Marmots may become territorial (i) by evicting a territory owner, or (ii) by taking over a vacant territorial position, either at home or after dispersal in other territories. Dispersal patterns of mature subordinate alpine marmots were studied in the Berchtesgaden National Park, Germany, from 1982 to 1996 with behavioural observations, life-trapping and telemetry.

Only long-distance dispersers (>500m, n= 22, mortality: 31.8%), but not short-distance dispersers (<500m, n=20, 5.0%), had much higher mortality risk during summer than those staying in their group as subordinates (n=75, 2.7%, $p=0.002$). In this investigated male biased population (sex-ratio at weaning 1.5:1, n= 464, $p<0.005$), females became territorial closer to their home territory than males. In both sexes the distance of resettlement did not affect (i) winter mortality after dispersal, (ii) the time period in territorial position, or (iii) reproductive success. This sex-biased dispersal pattern may be a consequence of the stronger competition among males for territorial positions and the high mortality risk in long-distance dispersal.

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Key Words: *Marmota baibacina*, Gray or Altai or forest-steppe marmot, morphology, range

Morphological and range peculiarities of forest-steppe marmot.

When investigating the taxonomy of marmots of South Siberia we showed the peculiarities of the forest-steppe marmot concerning hair-colour, cranium and os penis structure (Galkina, 1962, 1970). The following peculiarities should be noted: marmot is dark-coloured, with black-brown hair tips on back, with well noticeable white wedge-shaped spot on chin. Abdomen coloration is not bright; it is yellow- or gray-red. The hair is thick with a length of guard-hair of 45-55 mm. The lateral projections on the front end of baculum are widely arranged, and the ripples are sharp. Marmot is large (n=25 males and 12 females). By mistake Gromov and Erbaeva (1995) regard it as the smallest form. The body length is 495 mm, the tail length is 130-200 mm, the foot length is 80-110 mm, and the mass is 3-6.3 kg in spring and 4.6-9.0 kg in autumn. The cranium is large, massive, with well-developed combs and relatively narrow cheekbones and not wide in mastoid part, comparatively small in height (in frontal part and occiput zone). The length of cranium is 96.0-108 mm.

Furthermore, forest-steppe marmot differs from the other *M. baibacina* according to its karyotypes, it has diploid number of chromosomes equal to 36 (Brandler, 1999; Brandler *et al.*, 1999).

The range has a relict character. It is located between rivers Ob and Tom, including the Right Bank of Tom near Tomsk and Kemerovo. The whole area of forest-steppe Salair, Kolivan-Tomsk height, Kuznetsk hollow are inhabited by this animal. The area of its distribution does not cover the left bank of the river Ob (Galkina, 1964, 1967, 1970).

This marmot is one of the common representatives of Pleistocene tundra-forest-steppe complex of mammals that is widespread in southeastern Siberia (Galkina, Epiphantseva, 2000). One can suppose that similar forms of marmot still live in forest-steppe part of European Russia among the "bobac" group. Thereby, taking into account the character of morphological, karyological and range peculiarities of forest-steppe marmot, it is possible to revise its taxonomic status.



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Key Words: *Marmota marmota*, alpine marmot, endocrinology, reproduction, prenatal environment.

Prenatal influences on reproductive life history in female Alpine marmot (*Marmota marmota*).

Behavioural endocrinologists uncovered surprising relationships between levels of prenatal exposure to gonadal hormones and variation in reproductive behaviour in adulthood. For example, prenatal effects on reproductive phenotype can have far-reaching consequences and may help to explain the physiological bases of biases in sex ratios, differences in adult competitive abilities and alternative reproductive tactics. In mice, female foetuses located between male foetuses (2M females) have higher testosterone titres than do their sisters located between two female foetuses (2F females). The latter females are less aggressive as adults, have shorter oestrus cycles, are sexually attractive to males and have a longer reproductive life than 2M females. In contrast to laboratory studies, where hormonal exposure of foetuses can be determined, evidence for the described phenomenon from the field is extremely rare or even absent. In this study we analysed if there are any effects of the intra-uterine environment on reproductive life history in female Alpine marmots. In sum, we included information on social status, reproduction and survival from 191 adult females, collected during a 14-year study in the Berchtesgaden National Park, Germany. The analysis revealed that the phenomenon found in the laboratory has obviously an important impact on reproductive life history in free-ranging Alpine marmots.

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Key Words: *Marmota marmota*, Alpine marmot, social stress, reproduction.

Reproduction and social stress in female Alpine marmots (*Marmota marmota*).

We studied mechanisms responsible for reproductive skew in female Alpine marmots (*Marmota marmota*). In each social group, only dominant females produced weaned young although subordinate females had similar body condition, were fertile as indicated by high levels of estradiol during the mating season, and started pregnancies occasionally. During the time window of gestation, dominant females initiated significantly more agonistic interactions against subordinate females. This results in significantly increased levels of glucocorticoids and decreased levels of progesterone in the latter. Our study suggest that reproductive suppression in female Alpine marmots is mediated via the negative

effects of stress (glucocorticoids) on the activity of the hypothalamic-pituitary-gonadal axis. The strength of competition between subordinate and dominant females was affected by their relatedness. Unrelated subordinate females performed more attacks against the dominant female whereas amicable behaviour was observed mainly between dominant females and their daughters. These differences could be explained by differences between the level of indirect fitness for subordinate females by warming the offspring of the dominant female during hibernation. Reproductive suppression was apparently costly for dominant females, too, because reproductive success decreased with increasing numbers of adult subordinate females present in a group.

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Key Words: *Marmota caligata*, hoary marmot, *Marmota marmota*, alpine marmot, rodent, digestive function.

Aspects of digestive function in marmots.

Marmots are the largest members of the rodent family Sciuridae (squirrels), and share with the rest of the 267 species in the family a dentition and digestive tract that are best suited for a diet of seeds. This is potentially a problem for marmots, which are predominantly herbivorous rather than granivorous. How then can marmots be successful herbivores? A comparative study of digestive performance in one microtine rodent (a vole) and three sciurid rodents including *Marmota caligata* (hoary marmot) provided the answer. Voles are small herbivores with a highly developed colonic separation mechanism.

Digestive efficiency was significantly higher in the vole than in the two smaller sciurids but, at the body size of the marmot, sciurid digestive efficiency was similar to that of the vole despite the simple morphology and function of the marmot digestive tract. Even so, high digestive efficiency is likely to be achieved in marmots only if feeding on forage of low fibre content.

The importance of the hindgut (caecum and colon) to the nutrition of marmots is reflected in the relatively rapid hypertrophy of this part of the digestive tract in spring after emergence of *Marmota marmota* (alpine marmot) from their long winter hibernation.



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Key Words: *Marmota marmota*, alpine marmot, *Marmota bobak*, steppe marmot, *Marmota primigenia*, Pleistocene, phylogeny.

Late Pleistocene marmots from the Middle Rhine Region (Germany) and their phylogenetic relationships to the extant European species

Marmots were rather common in Late Pleistocene faunas. These large sciurids were widely spread in the European lower mountain ranges which is in contrast to the distribution of the two recent European species living only in the higher mountain ranges. Since a long time there is a debate whether the remains of the Pleistocene marmots should be assigned to the recent Alpine Marmot *Marmota marmota*, or to the Steppe Marmot *M. bobak*, or to the extinct Pleistocene *M. primigenia*.

Rich new finds of the genus *Marmota* from Late Pleistocene loess deposits of the Neuwied and Mainz basins represent for the first time an adequate basis to evaluate the taxonomic status of Late Pleistocene marmots north of the Alps. In the Middle Rhine Region two species can be distinguished: firstly the relatively big and well documented *M. primigenia* which is closely related to *M. marmota*, and secondly scarce finds of *M. bobak*. The latter is an immigrant from the east and migrated as far west as the Mainz basin. These results show that a taxonomic separation of the two recent European species was already established in the Late Pleistocene. Osteological comparison of the marmots from the Middle Rhine Region with fossil marmots from the Alps indicates that the today's Alpine marmot descended from these Late Pleistocene Alpine populations and not from the "Rhenish" *M. primigenia*. With the reforestation at the end of the last glaciation *M. primigenia* became extinct in its habitats north of the Alps.

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Key Words: *Marmota caligata*, Hoary marmot, environmental change, demography.

Demographic responses of hoary marmots (*Marmota caligata*) to environmental variation.

Hoary marmots (*Marmota caligata*) are the most widespread alpine dwelling marmot in North America. Only several studies have been conducted on this species and virtually no studies have been conducted during the last 20 years. The status of hoary marmot populations in North America is unknown and it is uncertain how hoary marmot populations respond to climate change and climate variability. In 1999, we initiated an intensive

demographic and behavioural study of hoary marmots in the southwest Yukon, Canada. Over three years we monitored 160 marmots in a 3 km² area. Variation in social group size (mean=13±4 S.E. individuals; range=2–29) was correlated with standing crop biomass of forbs ($r^2=0.57$, $P<0.01$) indicating that social group size is limited by food abundance. Differences in reproduction reflected interannual variation in climate. In 2000, snowmelt was unusually late (12 days later than in 2001). Reproductive rates of adult marmots were greater in 2001 (birthrate=83%, weaning rate=79%) when snowmelt was early, compared to 2000 (birthrate=65%, weaning rate=67%) when snowmelt was late. Juvenile overwinter survival from 1999 to 2000 was 74% while survival from 2000 to 2001 was only 38%. Adult female was constant (80%) over both winters. Therefore it appears that hoary marmot populations are food limited, and that reproduction and juvenile survival are sensitive to interannual variation in spring conditions.

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Key Words: *Marmota vanancouverensis*, Vancouver Island Marmot, reproductive behaviour, endocrinology, captivity.

Reproductive behaviour and endocrinology of the Vancouver Island Marmot for use in Captive breeding programs.

The Vancouver Island Marmot (*Marmota vanancouverensis*) is one North America's most endangered species with fewer than 100 individuals remaining. Captive breeding programs have been established in four facilities in Canada in hope of rebuilding the wild population through future reintroduction programs however, very little is known about the reproductive physiology of the Vancouver Island Marmot. A better understanding of reproduction and breeding behaviors is essential to improve current captive breeding husbandry programs. Fecal samples were obtained from adult marmots 3 years and older on a daily basis as a non-invasive method of monitoring reproductive status. Enzyme immunoassays were validated for quantifying testosterone, estrogen and progesterone metabolites in fecal samples for this species. Security cameras in animal enclosures and infrared cameras mounted in nestboxes connected to 24-hour time-lapse VCRs and monitors provided the behavioral data for analysis. Preliminary results suggest fecal pregnanes can be used to monitor ovulation and conception with a non-pregnant luteal phase of 7-14 days and a gestation of 30 days. Hormone profiles correlated strongly with changes in breeding behavior. Breeding behavior determined through examination of duration, frequency and sequence of all behaviors indicates that 95% of all copulation occur within the nestbox and is preceded by wrestling 50% of the time. Observational data combined with hormonal analysis suggests Vancouver Island Marmots are induced ovulators and multiple breeding attempts may be required for ovulation and conception. Animal age, environment, and quality of copulation may also be factors affecting ovulation. Monitoring breeding behavior is a useful means of indicating of estrus, conception and pregnancy, which can also be supported by the hormonal analysis of daily fecal samples of the individual animals.



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Key Words: Eurasian marmots, mammals, call, collection.

The digital collection of Eurasian marmots' calls.

From 1967 by the research fellows of the department of vertebrate zoology of Moscow State University marmots' calls are collected in field conditions. The recordings of 6 species were taken on the vast area in former Soviet Union and in Mongolia. The whole length of the recordings is about 30 hours. Volume and structure of the data represents both population and geographic variability of vocalization of each species (in brackets - number of geographical places of recording, number of animals): *M. bobak* (15, 522); *M. baibacina* (14, 48); *M. sibirica* (27, 164); *M. camtschatica* (3, 26); *M. caudata* (35, 243); *M. menzbieri* (1, 53); *M. bobak* x *M. baibacina* (14, 116). The originals of records and field journals with the information on the recordings are kept in the department of vertebrate zoology of the Moscow State University. Besides marmots, the collection includes recordings of 60 species of mammals taken in field conditions as well. Unfortunately, a tape on which originals of phonograms are kept, lose their quality, so it is possible that very important material will be lost. Modern methods of computer processing of sound let us prolong the time of keeping of phonograms by transforming them in digital form and re-recording them on compact discs. To save this unique collection, State Darwin Museum gave the opportunity to digit whole collection of the Moscow University. Nowadays all marmots' calls are digitised. Those recordings are kept on CDs in WAV-files. The collection includes 18 CDs, each of them is represented by 2 copies - working and reserve. Text information from field journals is kept in database. Information about the collection place of each record is represented in the database by two ways - text description and geographic coordinates and can be reflected in graphic form by using GIS-technologies. Details of the organisation of database of digital collection will be demonstrated in our report.

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Mots Clés: *Marmota bobak*, steppe marmot, survival rate, population.

Some peculiarities of steppe marmot survival rate

The survival rate – a reverse function of the death rate. That is the probability to live till the next year. The survival rate index is necessary for mathematical and electronic modeling of populations. The problem is that it is difficult to obtain population characteristics. Observations of many years on the marked steppe marmots give an opportunity to find those characteristics for a number of populations and compare them. The survival rate value is associated with the most important events in the life of animals. For example, in steppe marmots: the first year of life is a difficult period, and so the survival rate is low; the second year is a passive period, and the survival rate is usually the highest. The period of sexual maturity and search for a partner falls on the third and fourth years of life. The

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survival rate during that period is slightly lower and depends on the opportunity to create a new family or to take the place of died parents in breeding pairs. The survival rate of adults is higher than that of fingerlings, but lower than that of sub-adults. That may be caused by the fact that adults are endangered when guarding their sites, preserving their families and breeding their offspring. It was found that in females when giving birth to kits the survival rate decreases (the coefficient of correlation between the activity in reproduction and the death rate is from 0.81 to 0.94). The irregularity of giving birth between years equalizes the survival rate average index to the level of adult males.

The Figure shows that in the Don population (don) the survival rate in all age groups is higher. It is evident that the animals live in more optimal conditions than others. And the northernmost population – the Udmurtian one (udm) has been created artificially. It is obviously on the verge of survival. The opportunities of marmot survival are approximately between «don» and «udm».

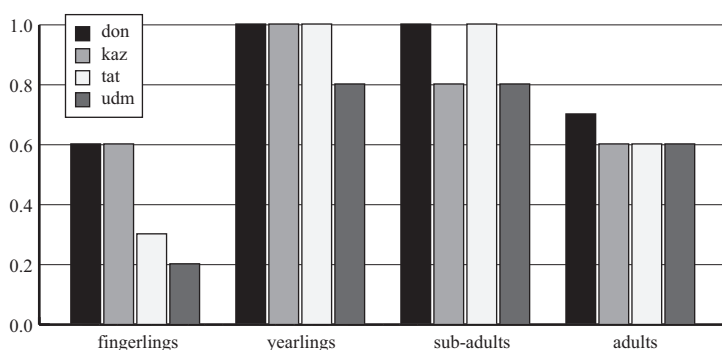


Fig. Survival rate of various steppe marmot groups according to their sex and age structure. On the left – males; on the right – females. don – Russia, Voronezh region, Kantimirovka district; kaz – Kazakhstan, Akmola region, Yermantau district; tat – Russia, Tatarstan, Aznakaevo district; udm – Russia, Udmurtia, Karakulino district.

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Key Words: *Marmota marmota*, Alpine marmot, habitat choice, census.

Habitat choice and census techniques in alpine marmot: a review of current literature.

In the last decades studies were performed on density and distribution (LENTI BOERO 1988, 1999; SALA et al. 1988, SOLARI 1988a,b, PERACINO & BASSANO 1990, GRIMOD et al. 1991, BASSANO et al. 1992, CHIESURA CORONA 1992, MACCHI et al. 1992, MULLER 1992, NEBEL et al. 1992, NEET 1992, RODRIGUE et al. 1992, VENTURA LUINI 1992, VITA 1992, LEONI et al. 1993, FRIGERIO et al. 1996, PANSERI et al. 1996).



Many studies suggest that altitude, sun-exposure, sun-shine duration, slope, anthropic pressure, available food period, soil composition, and the interactions among them, influence distribution and habitat choice in alpine marmots.

Unfortunately not all authors include the same parameters in their studies, thus comparison among studies is difficult. In this presentation all known studies are reviewed and discussed and compared with published and unpublished data gathered during a long term field study in the Alps. The aim is to devise some preliminary common grids for marmot census.

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Social interactions in a colony of alpine marmots (*Marmota marmota* L.)

Introduction. The alpine marmot (*Marmota marmota* L.) is a territorial species which lives in family groups made of a monogamous pair and offspring. The social interactions within a colony are differentiated because amicable interactions most frequently happen within a familiar group and agonistic interactions are observed mostly between neighbours and at the boundaries of territories (Lenti 1987, 1992). In this presentation the type and function of social interactions in keeping social bonds in the colony are fully described and further investigated.

Methods. The data were collected during a field study which took place from 1985 until 1992 during the months of July, August and September at the Gran Paradiso National Park, Valle d'Aosta, Italy. The study area was located at 2300 m asl, above timberline and animals were individually recognized by means of trapping.

Results. Both amicable and agonistic interactions can be further subdivided in many subcategories which serve a highly differentiated social communication: amicable interactions consist in play, grooming, greetings and sniffing, agonistic interaction consist in chasing and fighting. In the monogamous pair social grooming seems to be more reciprocated than in other age and sex classes, social play bouts can be observed across different age and sex class of siblings until two or three years of age. Marmots belonging to different families never forage at distance shorter than five m without developing agonistic interactions.

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Key Words: *Marmota*, palearctic marmots, Hybridization, molecular genetic.

Study of remote hybridization in Palearctic marmots (*Marmota*, *Sciuridae*, *Rodentia*) based on molecular genetic data.

The study of genetic differences between all of marmots' species of Holarctic was made by the method of sequencing of cytochrome *b* gene (Lyapunova et al., 1995 ; Stepan et al., 1999), and between 5 Palearctic species *Marmota baibacina*, *M. bobak*, *M. camtschatica*, *M. caudata*, *M. menzbieri* by the protein electrophoresis method (Mezhzherin et al., 1999). Sequencing of mtDNA region about 800 bp concerning gene of cytochrome *b* has shown that species distinctions in this group are equal 8-10 % of replacements of the bases. Though there are smaller distinctions between some closely related species, for example, *bobak/baibacina*-6 %. The level of subspecies distinctions at marmots, for example *M. flaviventris*, averages 3-4 %. Small distinctions between such well differentiated species as *M. caudata* and *M. menzbieri* (4-5 %) are surprised on this background, especially because the electrophoresis researches have shown the greatest divergence between just these species. Two subspecies of *M. caudata*, from Tian-Shan and Himalayas are investigated. The distinctions between them average 3-4 %. Thus, the distinctions between *M. caudata* and *M. menzbieri* based on cytochrome *b* corresponds to subspecies level. As known, mtDNA, in which a gene of cytochrome *b* is located, has a cytoplasmic inheritance. The obtained results can be explained if mtDNA of *caudata* had transmigrated to *menzbieri* by hybridization. The level of *caudata* / *menzbieri* distinctions (6%) accumulated since these forms developed independently impels us to conjecture that this event was earlier of the last glaciation, when areas of these two species became semisympatric. In every case, we can say that an area of *menzbieri* was very little when the speculative *caudata* / *menzbieri* hybridization intervened. The presumable existence of marmots' hybrids is described earlier for *bobak/baibacina* and *baibacina/sibirica* (Nikol'skii et al., 1983; Formozov et al., 1986). However hybridization between such well differentiated forms as *caudata* and *menzbieri* has seemed impossible. Many data indicating existence of terrestrial vertebrate hybridization have appeared recently. This problem was already investigated thoroughly on amphibians, reptiles and birds. Its role in speciation was shown. The natural hybridization in mammals became known only recently due to application of genetic methods of researches. By an opportunity of hybridization of the so distant forms, apparently, it takes place in mammals too and can play some role in their speciation.



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Key Words: *Marmota vancouverensis*, Vancouver Island Marmot, genetic, reintroduction.

Genetic approaches for rehabilitation of Vancouver marmot population

Species *Marmota vancouverensis* was described in 1911 by H.S. Swarth. Fur coloration is a very important feature for marmots' taxonomy. *M. vancouverensis* was described by its melanistic coloration and insular distribution (Vancouver Island, Canada). These two criteria are used in the diagnostic tables for the species (Hall, 1981).

The recent ecological studies of *M. vancouverensis* made on Vancouver Island were performed, because of abrupt decreasing of the species numbers. There were about 300 specimens at the beginning of 90s, to this millennium only several dozens remain.

M. vancouverensis has chromosomal set with 42 chromosomes. *M. flaviventris* and *M. caligata* have the same numbers of chromosomes (Rausch, Rausch, 1965; 1971). The molecular data (cytochrome *b* sequences) obtained by us (Steppan *et al.*, 1999) showed that *M. vancouverensis* is closely related to *M. caligata* (99% ML bootstrap) comparing other marmots (63-80%).

Such close relationship testifies that *M. vancouverensis* is not a species but only melanistic form of *M. caligata*. Specific patterns of behaviour of insular and continental forms mentioned by some scientists (Barash, 1989) depend on variability of habitats as in other marmot species, for example, *M. bobak*. Such differences can not be used for dividing these forms into two species. Other morphological characteristics don't show up species' differences. We propose to consider *vancouverensis* as a subspecies of *M. caligata*.

Practical recommendations for rehabilitation of *Marmota caligata vancouverensis* ensure the molecular phylogeny analysis. The cause of extinction is lack of genetic diversity and closely related crossing caused homozygotization of lethals. As we consider *M.c. vancouverensis* as a melanistic form of *M. caligata* we recommend for recovery of numbers of very interesting insular form to introduce melanists of *M. caligata* from continent to the island. Marmots often have melanists in nature, it is possible to catch black *M. caligata* in the wild habitat. The second way is to cross *vancouverensis* and *caligata* in captivity and select black specimens for further breeding and reintroduction.

This allows restoring the genetic diversity and taking off negative impact of inbreeding, especially homozygotization of lethals. Such approaches to conservation of insular isolate not in the least diminish necessity of the Vancouver marmot conservation. Strategy for species conservation includes conservation of populations as a structural unit of species. It is especially important for this very interesting and peculiar insular population which is undoubtedly a national property of Canada and world nature.

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Key Words: *Marmota vancouverensis*, Vancouver Island marmot, captivity,

**Captive Management of the Endangered Vancouver Island marmot
(*Marmota vancouverensis*)**

The Vancouver Island marmot (*Marmota vancouverensis*) is one of six recognized marmot species occurring in North America. Since the early 1970s the range of this species has been restricted to a total of 47 colony sites on 15 mountains, all of which are located on south-central Vancouver Island. *Marmota vancouverensis* naturally inhabits subalpine meadows, which are relatively small in size and patchy in distribution on Vancouver Island. During the early 1980s the Vancouver Island marmot was also found to be colonizing recently logged, high elevation clear cut habitat located in the vicinity of their natural meadows. Based upon this habitat expansion, the population was considered to be stable or increasing, and was estimated to be between 300 and 350 individuals. Unfortunately this modest expansion into clear cut habitat was short-lived and it was followed by dramatic population decreases and colony extinctions at both clear cut and natural colony sites. In 1998 the wild population had declined to less than 100 individuals, making it rarer than endangered species icons such as the Giant Panda and the Mountain Gorilla. As VIM numbers continued to steadily drop through the mid-1990s it became apparent that recovery efforts involving only field manipulation of the wild population would not prevent the extinction of this species. Therefore, a rigorous captive breeding program was initiated in order to (1) serve as a genetic lifeboat to safeguard this species against catastrophic events in the wild, (2) determine appropriate management and husbandry guidelines for the successful captive maintenance of this species, and (3) provide sufficient numbers of individuals for a restocking program. In 1997, the first Vancouver Island marmots were captured and sent to the Toronto Zoo. Since that time the project has come to involve the participation of two other Canadian zoological institutions, the Calgary Zoo (in 1998) and the Mountain View Conservation and Breeding Centre (in 2000). In October, 2001, the captive VIM program was further enhanced by the completion of a dedicated marmot breeding facility on Mount Washington, Vancouver Island, which is located in close proximity to the marmots' natural habitat. This presentation will provide a summary of the first six years of the Vancouver Island marmot captive breeding program. It will give a history of the project, and provide an overview of the successes and failures we have experienced. It will also summarize management protocols, disease issues, and research priorities. Because this project represents an incredibly dynamic situation much of the information presented in this lecture will be made current to the end of the 2002 summer season.



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Key Words: *Marmota bobak*, Ground temperature, Ambient temperature, Burrow temperature.

Influence of temperatures of ground and ground surface atmosphere to the temperature in marmot burrow.

Two environments control the temperature in marmot burrows like in burrows of other mammal species: ground pattern in which the burrow is located and atmosphere of ground surface where the entrances come out. Heat exchange between these two environments and the burrow goes through heat conduction in the former case and convection in the latter. Temperature regime of the burrow is a result of interaction of these two processes. Monitoring of temperature in marmot burrows (*M. bobak*) was performed in field conditions in Ukraine to verify the influence of ground pattern and above ground atmosphere to the temperature in burrows. Sensors of electronic thermometers were put in burrows to 2 m depth and 285 cm length from the entrance and to the same depth in the artificial hole nearby. At the same time temperature of atmosphere of ground surface was measured in shadow 10 cm above ground. The following results were obtained.

1. In marmot burrows convection is slowed down; air is in condition of quasi-stable thermal regime.
2. Microclimate of burrows is relatively stable because the temperature of underground shelters is influenced mainly by ground pattern. For instance, amplitude of air temperature measured from 18 August till 30 October 2001 at ground surface was 40.0°C, of ground 4.0°C, and of air in the burrow 5.4°C.
3. Degree of convection rises sufficiently when air temperature at ground surface drops lower than air temperature in the burrow not less than by 5°C. In this case the burrow temperature quickly gets colder.
4. Convection in the burrows is asymmetric to air temperature at ground surface. Due to asymmetry microclimate of the burrows is more resistant to high temperature of ground surface atmosphere, than to the low one. As a result, even during very hot weather marmot burrows are not overheated. And on the contrary, significant drop of temperature in surface atmosphere leads to quick burrow cooling.
5. Marmots plug their burrows prior to beginning of intensive convection; thus they prevent overcooling of underground shelters before hibernation.

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Key Words: *Marmota camtschatica bungei*, Yakutian black-capped marmot, competition, reindeer.

Influence of Domestic Reindeer Husbandry on Black Capped Marmot Population in Verchoyansk Mountains.

Marmota camtschatica bungei Kastschenko (1901) inhabits the Verchoyansk, Chersky, Momsky and Kharaulakhsky mountain ridges (northeast Yakutia). We studied the species population of Central Verkhoyanie mountains within the period of 1986-2001. In 1986 the state of Black Capped Marmot population were relatively successful. Within this period the marmot colonies were found almost in all the tributaries of the Nyamni river, and in the upper reaches of the Gnaas, Kimbe, Jaran, Sytylindja, Tekenyuk and in the uppers of the tributaries of the Sartang, as well as in the mountains round the lake Ilderkey. When extrapolation of the whole available area for habitat the population density was 9 individuals per 100 km². The situation was greatly changed within the period of 1987-1994 when more than 2000 heads of domestic reindeer of three collective farms begun grazing there. For these years the marmot population decreased to 2-3 individuals per 100 km². Practically the species habitations were completely destroyed in the uppers of the Jaran and Tekenyuk rivers and in the vicinity of the lake Ilderkey. First of all there was negative impact on marmots from reindeer farmers getting marmots from the holes when hibernation. By such way of hunting the reindeer farmers could get 22 individuals at a stretch. The indirect factor of influence on the state of marmot population was the grazing of large herds that pasture in mountain tundra and tundra-steppes which are common habitats for marmots. The grazing of many days leads to the complete disturbance of forage reserve and soil compaction that is not favourable to hole mining and hole arrangement. By roaming of reindeer herds to new pastures the marmot population was gradually restored within the period of 1995-2000 and in 1998-2000 it was 9-10 individuals per 100 km².

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Key Words: *Marmota camtschatica*, black-capped marmot, breeding, conservation.

Towards Possible Introduction of Black Capped Marmot in Zooculture

Being a rare and highly tailored species the Black Capped Marmot is very vulnerable to the negative impact of technogenic factors. In recent decade the tendency of range reduction of the Black Capped Marmot population remained and intensified. One of the way



of preservation of Black Capped Marmot population is to keep and breed them in captivity and further to set their descendants free, to those places from where marmots were driven out before. In 1994 the group of 20 marmots was delivered from the mountains of Central Verkhoyanie. In the summer the marmots lived in the cages under the shade by 2 individuals, and during the winter hibernation they were kept in the storage place where the temperature was optimal. Their hibernation begins in late October or early November, and awakening-in late April or early May. After hibernation the animals feed much. In June or July there is a peak of food consumption, and in August the feeding activity decreases. In May 1996 one female gave the birth of the first 4 offsprings. The young marmots of this year grew well and had enough weight for winter hibernation. In 1997 the same female gave birth only of one dead baby, and in 1998 -four babies that hibernated well. At present 17 marmots are in captivity: 9 -adults, 4- of three years and 4 - of this year marmots. The sex composition: among adults- 4 males and 5 females; among young marmots-3 males and 5 females.

The first experience of breeding shows the prospect of marmot domestication study for their resources restoration and conservation of endemic genofond of the North-East Asia.

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Key Words: *Marmota flaviventris*, yellow-bellied marmot, fitness, reproduction.

Sociality and individual fitness in yellow-bellied marmots

Using complete survival and reproductive histories of 428 female yellow-bellied marmots (*Marmota flaviventris*) from a 40-yr study (1962-2001), we investigated the fitness consequences of delayed maturity. Most females (85.98%) died without realizing reproduction. Females that survived to reproduce at least once (n=60) attained sexual maturity between two to six years of age. Individual fitness (IF) ranged from 1.40 to 1.52, with an overall mean IF of 1.45. Females that attained sexual maturity as 2-yr-olds had a significantly higher fitness than those that matured later. Females that attained sexual maturity as 2-yr-olds had a shorter lifespan than those that waited, suggesting that a reduced lifespan was the primary cost of early maturity. However, females maturing later did not have a larger lifetime number of breeding events or offspring production, nor did they produce larger average litters. These results suggest that the costs of earlier maturity (primarily reduced lifespan) were outweighed by associated benefits in fitness currency, and that age at first reproduction in our study population is under substantial directional selection favoring early maturity. We concluded that female yellow-bellied marmots delay

reproduction not because of fitness benefits of foregoing reproduction at an earlier age, but due to the social suppression of reproduction by adult females, which enhances their own fitness at the detriment of the fitness of other young females.

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Key Words: *Marmota menzbieri menzbieri*, Conservation, Kazakhstan.

Menzbier's marmot (*Marmota menzbieri*) in Kazakhstan.

Menzbier's marmot (*Marmota menzbieri* Kashkarov, 1925) is one out of four kinds of *Marmota* species of the fauna of Kazakhstan. In Republic it meets in northern part of mountains Karzhantau and on Ugham ridge. It is endemic of Western Tianshan. It lives here in the Alpine and subalpine belts, at heights 2100-3300 m above a sea level. In Kazakhstan is located one of three isolated sites of its world range, the other two are in Uzbekistan, Kirghizstan and in Tajikistan. Kazakhstan's part of Menzbier's marmot area - most northern and second largest, its area is about 400 km². One of two it subspecies-lives in Republic. Menzbier's marmot is brought in to the Red book of Kazakhstan, as a species with sharply reduce by number (status-second category).

The present researches are executed in 1990-1992 on the area of 44 km² and in 2001 (63,25 km²). Result established, that the basic features of ecology Menzbier's marmot (use all suitable habitats, rather high number and density of the population in comparison with other species of marmot, limited number of contacts with other populations both rather stable and homogeneous set of the limiting factors) allow to attribute it to a category "of island species". The range of Menzbier's marmot in Republic continuous, without geographical breaks, all selected sites (Ugham's, Sairam's and Badam's) are closed with each other. The distinctions between separate sites in character of use habitats and density of the population of a species change depending on its number. The number of Menzbier's marmot in Kazakhstan is subject to significant fluctuations, but in whole its level is much higher, than about it was considered earlier. For last years it gradually reduced, and now has reached 25-30 thousand animals (in comparison with 50-55 thousand marmots in 1990-1992). The basic limiting factors influencing this species in Republic-poaching, epizootic and destruction by shepherd's dogs. For effective preservation of Menzbier's marmot in Kazakhstan are necessary: constant monitoring of its populations, revealing of the true sizes its range, regular roads of the inspectors on protection of fauna in places it habitats, creation of natural territories especially-protected in limits of a species range, for the east site it is necessary to attach to reserve Aksu-Dzabagli, and for the western site to organise zoological natural reserve.



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Key Words: Marmot, Plague, History, Community of Independent States (CIS).

Marmots and zoonotic infections in CIS.

The most complete information about morbidity by various zoonotic infections is assembled on to 4 species of marmots from 6, living on territory of CIS. First of all it concerns to carriers of a plague microbe-grey (*M. baibacina*), red (*M. caudata*) marmots and tarbagan (*M. sibirica*), the study morbidity which was carried out for a long time in the different natural foci of a plague and others zoonosis. In the accessible literature there is an information that the listed species of marmots are carriers of agents of the 17 infections: Anthrax, Brucellosis, Dicroceliosis, Encephalitis tick-born, Erysipeloid, Leptospirosis, Listerosis, Pasteurellosis, Plague, Pseudotuberculosis, Q. Fever, Rickettsiosis, Salmonellosis, Toxoplasmosis, Tularemia, Virus hepatitis and Yersiniosis (Bibikov, 1979; Shekhanov, 1979; Stepanov *et al.*, 1991). From all listed illnesses the greatest danger to the man is represented by a plague.

The first documentary items of information on epidemics of a plague connected with marmots, are dated the end of 19 century. For territory of Russia epidemics which have arisen as a result of contacts of the people with the patients tarbagan for the first time are described in Transbaikalia (Cherkasov, 1884; Belyavski, 1895; Reshetnikov, 1895). There is a detailed chronology of epidemics of a plague (connected with marmots): 190 - for Mongolia for 1866-1957 (Smirnov, 1961) and 84 - for Transbaikalia and adjacent with it of regions for 1863-1930 (Golubinski *et al.*, 1987). Most terrible of them, under the right, considers Manchurian epidemic of a plague 1910-1911, which victims of steel, on different sources, from 60 up to 100 thousand the man (Martinevski, Mollaret, 1971; Bibikov, 1979). For of the peoples occupying mountain areas Tien-Shan and Pamir-Alai, the connection of epidemics of a plague with a hunt on marmots is known for a long time, that is reflected in legends and documents. Epidemics of a plague in this region arose frequently: In 1888-90, 1905, 1907, 1908, 1910-13, 1914, 1923, 1928, 1929 also have carried away about 1000 human life. Is widely known, and is in detail described Anzob's epidemic of a plague in 1898 (Tadjikistan) is confirmed bacteriologically, during which 238 men were lost. (Levin, 1899; Kalina, 1935; Derlyatko, 1967; Kuraev *et al.*, 1984). The direct proofs natural focality of this illness to this were received in Transbaikalia and Tien-Shan, after D.K. Zabolotni in 1911 for the first time has isolated microbe of a plague from tarbagan (*M. sibirica*), and in 1914 N.I. Tikhomirov has isolated a plague from grey marmot (*M. baibacina*). First anti-plague of laboratories with the purpose of study of epidemics in territory of the marmot's foci were open in 1897 in Kirghizia and in 1913 in Transbaikalia, and the time of formation modern of a anti-plague service in marmot's foci of a plague of Central Asia, Kazakhstan and Russia covers the period with 1921 on 1956. In parallel with study of laws of circulation of a plague microbe in the marmot's foci the development of methods of suppression of epizootic of this infection was carried out.

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Restoration of number fleas after disinsection of grey marmot holes in Kokpak mezofocus of plague.

Kokpak mezofocus of plague open in 1940, long time concerned to the most active sites of the Tien-Shan natural focus of this infection. In its territory from 1940 till 1984, more than 560 strains of plague microbe from 8 species of mammalian (mainly marmot) and 10 arthropods out of 37 species living in its territory, were isolated (Ageev *et al.*, 1997). With the purpose of suppression of plague epizooty on the most part of its territory (about 82 thousand ha) in 1985-1986, the disinsection of Grey marmot burrows with use of dust DDT was carried out. As a result, the number of fleas has decreased in hundreds time: in 1987, the abundance index of ectoparasites on marmot has fallen up to 0,008, and at excavation of 35 nests and tamponing of 550 of holes no fleas were found (Ageev *et al.*, 1996).

Analysis of the data showed, that from 1987 to 2001, the number of fleas in mezo-focus increased non-uniformly. In 1990 the abundance of fleas on marmots reached 0.03 (in their nests-1.7), in 1992-0.14, in 1993-0.3. Indexes of the fleas infesting the marmots all these years did not exceed 10 %. In 1995 on Grey marmots three species of fleas were assembled: *Oropsylla silantiewi* (99%), *Rhadinopsylla li ventricosa* (0.5%) and *Ceratophyllus garei* (0.5%). The abundance index of fleas on marmots reached 3.0 (exceeding 2.5 times the index before disinsection); index of the fleas infesting the marmots reached 32.4%.

In 1996 the abundance index of fleas on marmots made 3.1, the index of the fleas infesting the marmots raised up to 45.8%. *Oropsylla silantiewi* dominated the specific fleas of marmot. In 1997, the abundance index decreased up to 1.8, but on some sites this index was very high - 3.5-10.3. In 1999 and 2000, abundance indexes of fleas in the fur of marmots reached respectively 1,1 and 2,4. In 2001, three species of fleas met on marmots: *Oropsylla silantiewi*, *Pulex irritans*, *Frontopsylla protera*. The average abundance index on marmots made 4.0, and index of the fleas infesting the marmots-about 63%. The dominant flea was *Oropsylla silantiewi* (91.3%).

Thus, in territory, where disinsection of the marmot burrows was carried out, the abundance of the specific flea *O. silantiewi* on Grey marmot for 15 years was restored completely and even exceeded the level before disinsection, but the process of restoration of the parasitocoenosis structure was not finished. During the 15 years following the disinsection process, only one epizooty of plague was revealed - in 1993.



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Key Words: *Marmota baibacina*, poaching, predation, status.

Grey forest-steppe marmot habitat in Kemerovo oblast

The investigation area is situated in the forest-steppe of the Kemerovo oblast' foothills. The country relief is not rugged enough. The main vegetation in open woodland is birch. The present investigation of grey forest-steppe marmot state was carried out in spring-summer period 1998-2001. The number of marmots in Kuzbass is about 3000 heads. The experimental station was installed in the suburbs of the village Horosheborka Topki region Kemerovo oblast'. Three registration observation posts with good vision were working at 60-200 metres' distance from the nearest family habitat. From three sites 5-8 marmot families were in the field of vision simultaneously. The station observations were combined with simultaneous route records. In 1998 there were 10 families on the first site, 24 families on the second site and 15 families on the third site. During 1999-2000 the number of families and animals was relatively constant. In the village Horosheborka during spring and summer months marmot is the only source of meat people. In 2001 alone marmots were considerably annihilated (2 families with three one-year old young's left) on the "Chyornaya Koloda". There were 85 marmots (among which 25 mature animals, 25 two-year old and three-year old animals and 35 one-year old animals) in this village in 1998. 49 individuals were killed by poachers during one hunting season, 20 young's were annihilated by homeless dogs and about 10 were eaten by beast of prey. We observed the marmots during feeding from midnight to the small night more than once. At that time the marmots became a prey for badgers (three families of which lived near the marmot habitat). Cattle route to watering place was 4 times a day on the territory of the marmot habitat. Besides sheep ate up the vegetation under roots on a large area. So the marmot food reserve was greatly decreased.

The state of two other habitats was relatively all right. There are haylands, not numerous farms and cattle route pastures on the territory. These factors promote the habitat improvement. On these two sites poaching is practically absent for lack of fuel for private transport. The family habitat area is average 0,2 ha; the distance between them is 20-30 metres. The family consists as a rule of one mature male, 2-3 females, 3 two-year old and three-year old young's and 3-4 on year old young's. The family has 1-2 winter burrows on the highest place of a hill, 2-3 summer burrows located at 10-14 metres' distance from the first burrows and 5-8 safe burrows located on feed paths. Trough marmot is entered in the list of endangered species, its protection is still problematic.

Ученые
и
специалисты
в области
зоологии
и
охраны
природы

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Key Words: *Marmota baibacina*, Altai grey marmot, marmot distribution, density, Altai, Kazakhstan.

Materials on ecology grey marmot (*Marmota baibacina* Kastschenko) in East Altai.

In East Kazakhstan Grey marmot is represented by the subspecies *M. b. baibacina* Kastschenko, 1899 - Altai Grey marmot. It is widely widespread in Western, Southern and Kalbinsk Altai, Saur, Tarbagatai and Monrak (Ognev, 1947; Kuznetsov, 1948; Bazhanov, 1953; Afanasiev, 1960; Kapitonov, 1969). In Western Altai the number of marmots is small and they are settled sporadic on foothills. Southern Altai is populated by marmots above the upper tree-line. The general stocks average there about 8800 animals, and average density of the population - 21 marmot on 1 km².

In Kalbinsk Altai settlement of marmots are located in river valleys, humid hollows, on grass-steppe sites among bushes from 400 up to 1500 m above sea level, with an aggregate number - about 23900 marmots, and average density of the population - 20 animals on 1 km².

In Saur mountains marmots are usual, and settlements are numerous in subalpine and alpine belts between 1900-2300 m above sea level.

In Monrak rocky and dry mountains marmots are widespread widely from 600 up to 1600 m above sea level, but they are everywhere few.

In Tarbagatai settlement of marmots are located in steppe sites and slopes. In Saur-Tarbagatai mountain array the general stocks of marmots makes about 19000 animals, and average density of the population - 33 marmot per km². The ecologic features of marmots in different landscape and high-altitude conditions habitat in East Kazakhstan (terms of withdrawal from hibernation, accumulation of fat, moult, intensity of a reproduction, structure of burrows, lengths of hibernation), and also loss population of marmots, plotted by predators and hunting are discussed.

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Key Words: *Marmota marmota*, alpine marmot, remote sensing, Geographic Information System (GIS), Vanoise Massif, France.

Rating potential distribution of alpine marmot in Vanoise Massif using remote sensing and GIS.

Ecological factors of the alpine marmot (*Marmota marmota*) settlements can be pointed out using tools of Geography.



From remote sensing images we map the favourable habitats of the specie on a large area, the Vanoise Massif (France). A geographical information system (GIS) permit us to compile and cross check all the information influencing the marmot choice of settlement.

We used a method based on a cartographic analysis of data relative to marmot settlements and to local marmot census.

Analysis of the ecological environment of marmots was performed in two scales: at local level for census sites, and then at global scale in the Vanoise massif, in order to integrate the impact of anthropic activities on marmot distribution.

Human pressure (different degrees of disturbance) was analysed at local scale (the smallest French territorial division).

Ecological parameters of settlement: altitude, vegetation, slope and sun exposure, are quantified in the study area and mapped.

Using census data on four test sites, we were able to rate marmot density under each ecological parameter.

Considering four test sites as reference models, we are able to rate the number of marmots potentially present in this area, taking in account, other than ecological factors, the data linked to human activities.

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Key words: *Marmota marmota*, alpine marmot, introduction, subalpine level.

An introduction of alpine marmots in the Central Massif (France): twenty years of survey.

In the South-East border of the Central Massif, the Mount Mézenc, culminating at 1754 m, is located on the watershed between the Atlantic Basin and the Mediterranean Basin. In spite of the historical absence of marmots on this massif, marmots have been released in the mountain and subalpine levels of this massif since 1980. An area of 100 km² was surveyed annually by federal gamekeepers since 1988. The history of the release is clarified.

Till 1994, the number of settled marmots was lower than the number of released marmots. Nevertheless, population size increased regularly and is now sevenfold that observed in 1988, in spite of the absence of release since 1991. Fifty-seven family groups are now settled.

Characteristic parameters (altitude, sun exposure, relief, vegetation, rocks, water, release data, colonization date, distance between the studied site and the site of the release sites, distance between the studied site and its nearest neighbour) of each familial group were ranked in classes. The resulting matrices (family groups x parameters) were analyzed by Multiple Correspondence Analysis (MCOA) to describe the colonizing process.

Former colonizations (1980-85) settled between 1400-1500 m, near the first release

site and had short distances to the nearest site, but occupation of these sites were discontinuous, in spite of reinforcements, contrarily to later colonizations. The first marmots released settled in screes and then formed new family groups close to the first release. During the first decade they colonized mainly the upper levels until 1700 m on the Mediterranean Basin. During the second decade, marmots settled farther and farther from the first release site and more and more on the plateau of the Atlantic Basin. The last settlements occurred in pastures close to ruins.

This introduction in the Central Massif was compared to the only other one surveyed in the Pyrenees.

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Key Words: *Marmota bobak*, steppe marmot, habitat, Ukraine.

Estimation of the suitability of habitats for *Marmota bobak* in north-eastern Ukraine

The investigations carried out by many authors show that the population density of steppe marmots (*Marmota bobak* Müll.) depends on the character and degree of cattle grazing pressure on their habitats (Seredneva, 1978, 1985; Seredneva, Nezgovorov, 1977; Borovik, 1996; Kolesnikov, 1997; Tokarsky, 1997; etc.). However, the reasons for it are insufficiently clear. Any detailed observations on food preference of animals in habitats with different grazing pressure are lacking as well as the detailed study of ground-cover vegetation.

The purpose of our work was to study forage preferences and plant characteristics of habitats with different grazing pressure as well as the estimation of these habitats suitability for steppe marmots. Qualitative and quantitative composition of vegetation cover, foraging and diet of the steppe marmot were studied in 1990-2001 at a stationary site in northeast of Kharkov region. The green food intake rate was chosen as a criterion for the foraging quality evaluation of different steppe marmot habitats.

We assume that the dead plant mass together with the species rejected by marmots' limit the access to forage species. Consequently, the absolute mass of presented available food cannot serve a suitability index for foraging area. On the contrary, the specificity in foraging behavior of steppe marmots is connected with a relative plant accessibility which plays an important part and may be expressed as the proportion of the phytomass of forage species (or vice versa of dead plants and of the species rejected by animals) relative to the total aboveground phytomass. This proportion, probably, determine the green food intake rate for steppe marmot.

Cattle grazing leads to diminishing of the vegetation cover diversity and to disappearing of those patches where the green food intake rate by the steppe marmot is the least one. Accordingly the values of the food intake rate, the high proportion of dead plants together with species rejected or eaten in low quantities (for similar mass of forage plants) relative to total aboveground plant mass diminishes the accessibility to forage and worsens foraging conditions for marmots. Providing during the whole activity season a high accessibili-



ty to young parts of forage plants for the steppe marmot, cattle grazing improves foraging resources for them and makes suitable for foraging practically the whole pasture cover.

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Key Words: *Marmota caudata*, *Marmota menzbieri*, range, reintroduction, Tajikistan, Uzbekistan.

Modern state of Marmots populations in Tajikistan.

Genus *Marmota* in Tajikistan included two species: *Marmota caudata* and *Marmota menzbieri*. *M. menzbieri* is endemic Western Tien Shan. Its modern number on all area is estimated about 22 thousand specimens (Abdunazarov, 2002). In Tajikistan *M. menzbieri* has the limited distribution. Its isolated settlements for the first time were found out by summer of 1960 in east part of Curaminskii range in area of mine Actash (Davydov, 1964). Two separate island settlements of species occupied in the gorges Actash and Jakhshibai. In the beginning of 60 years 20 centuries the common habitats area *M. menzbieri* on Curaminskii range made 4600 hectare and its stocks were estimated 70-72 specimens. In 1980 of *M. menzbieri* settlements on Curaminskii range completely have disappeared. Probably, the island settlements of species saved in boundary with Uzbekistan of territory in the up of gorge Jakhshibai. The reasons of disappearance *M. menzbieri* are repasture, poaching and industrial development it habitats. For the restoration of population and reproduction *M. menzbieri* in Tajikistan it is necessary its reacclimatization in Actash reserve (Curaminskii range) by delivery marmots from Chatcal reserve of Uzbekistan, where its population now is totaled about 5000 specimens (Dustov *et al.*, 2002).

In Tajikistan *M. caudata* has a rather wide distribution. With the exception Curaminskii range and low mountains region it occupies almost all others mountain and high-mountainous ranges of Central Tajikistan, Badakhshan and Pamirs. The vertical distribution red marmot is defined in heights 1500-4900 m above the sea level. The projected area of *M. caudata* in Tajikistan makes 25 thousand km² and its general stocks are estimated about 180-200 thousand specimens. Red marmot population on territory of mountain Tajikistan is distributed extremely non-uniformly. In the subalpine zone mountain ranges of Central Tajikistan live till 35-40 specimens on 1 km². At present the high red marmot population is observed in Pamirs. Here red marmot is distributed in regular intervals and in optimum for it habitats (subalpine meadows) on 1 km² can be seen up to 155 specimens. The general stocks red marmot of Pamirs accounted about 100 thousand specimens. The radical changes in structure of a population red marmot have taken place on Gissarskii, Vakhshskii and Hazratisho ranges of Central Tajikistan. For last 10 years in mountain files these ranges have appeared many new human settlements. Thereof the area of red marmot distribution in Tajikistan reduced approximately on 10-12 thousand km². Development of mountain territories, repasture, poaching are the limiting factors of reduction of red marmot populations.

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Key Words: *Marmota flaviventris*, yellow-bellied marmot, growth rate, hibernation mass, weaning mass, weaning date, Colorado, USA.

Variation in growth rates of yellow bellied marmots.

Growth rates of yellow-bellied marmot (*Marmota flaviventris*) populations living in Colorado, USA were calculated for 31 consecutive years (1965-1996). Active season growth rates of marmots from three sites varying from low to high elevation were categorized by age (young, yearlings, non-reproductive adults, and reproductive adults) and analyzed with a repeated measures general linear model ANOVA. Age, site, sex, and year significantly affected growth rates. Overall, males had higher growth rates than females and young and yearlings generally had higher growth rates compared to adults at all sites. In post-hoc tests, we calculated the significant differences in growth rates across all ages and sex for the 89 possible site(year) combinations. Sixty-three of the possible site(year)s showed some significant differences to the other site(year)s and eight site(year)s had 15 or more significant differences; all eight occurred in years in which rainfall deviated largely from the mean. Lower than average rainfall was associated with lower growth rates and lower survivorship for young, but not for adults. Young males on average had higher growth rates and were larger at hibernation than young females at all sites, but growth rates did not differ significantly at the high elevation site. The environmental constraints of the high altitude site may limit the variation between the sexes as they are forced to follow similar growth trajectories. Hibernation mass of female young was unaffected by weaning mass or weaning date at low and mid elevation sites, but was negatively correlated with weaning date at the high elevation site. Weaning mass of male young was negatively correlated with growth rate at low elevation and weaning mass was positively correlated and weaning date, negatively correlated with hibernation mass at mid and high elevations. The results of this study deviate considerably from previous trends reported for this population. The larger data set and the site designation of the current study may account for these differences.

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Key Words: *Marmota flaviventris*, yellow-bellied marmot, demography.

Demography of Yellow-bellied Marmots: A 40 Year Perspective.

Yellow-bellied marmots (*Marmota flaviventris*) were live trapped, marked and released in the Rocky Mountains of western Colorado (USA) from 1962 to 2002. At the study site marmots live in scattered patches of suitable habitat where they form polygy-



nous social groups, typically an adult male and from 1 to 5 adult females, and their young from the previous and current year. Females establish matriline. Demography of marmots must be considered at the level of the social group, population, and metapopulation.

Social groups: Habitat sites were not equal in quality and survivorship and reproduction varied widely among sites. Matriline of three females had the highest fitness as shown by reproduction and survival. Young females that are members of matriline produce female biased litters. More than 50% of females were residents of their natal colony, but most males were immigrants.

Population: Beyond the first year, survivorship was greater for females than males. Survivorship was Type II with equal mortality on all age classes. This population does not have a stable age distribution. Litter size average 4.1. Reproductive value was approximately equal across age classes. Generation length at 4.49 yr was 2.4 times the average life expectancy of 1.7 yr. Weather conditions, principally those that affected length of growing season, affected survivorship and reproduction. Social groups of mostly related females and immigrant males created a genetically dynamic system where inbreeding was avoided and high levels of genetic variation were maintained.

Metapopulation: The net reproductive rate (R_0) was 0.85, yet the population was not declining. The desirable habitat sites in the study area received immigrants from the surrounding metapopulation. Dispersing marmots were shown to travel up to 15 km.

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Key Words: *Marmota marmota*, alpine marmot, vegetation, specific richness, diversity, equitability.

Impact of the alpine marmot (*Marmota marmota*) on floristic diversity of the alpine stage in Northern Alps (France)

The impact of alpine marmots on alpine vegetation of northern Alps was examined by descriptive and quantitative methods in three marmot home ranges with different habitats: alpine meadow, dry heathland, and grazed meadow. In each home range, plots (0.5x0.5 m) were sampled at increasing distance from main burrow: home range core (<5 m from the main burrow, P1), median zone (5-<15 m from the main burrow, P2) and peripheral zone (>15 m apart the main burrow, P3).

On the whole, 18 monocotyledon species and 85 dicotyledon species were listed. Four plant families: *Asteraceae*, *Rosaceae*, *Fabaceae* and *Poaceae*, had a higher specific richness in the three habitats. Specific richness, diversity and equitability were highest in alpine meadow and decreased in dry heathland and in grazed meadow. Within each habitat, specific richness and diversity were significantly lower in the home range core areas (P1) than in median zones (P2) and in peripheral zones (P3) of alpine meadow and dry heathland. But, no difference appeared between plots in grazed meadow. A correspondence analysis revealed that floristic structure and composition in home range core areas

(P1) differed from vegetation of the median zones (P2) and the peripheral zones (P3). Vegetation near main burrows was dominated by grass species: *Poa alpina*, *P. pratensis* (colonizing ruderal species) and *Phleum alpinum* (nitrophilous species), which decreased as a function of distance from main burrows. Some forbs: *Trifolium repens*, *T. pratense* (creeping species) and *Taraxacum alpinum* were also more often found around marmot main burrows. This suggest that through burrowing, trampling and excretion, alpine marmot modify the floristic structure and composition of alpine meadow and dry heathland. This marmot impact is probably concealed by the greater impact of cattle pasture in grazed meadow.

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Key Words: *Marmota camtschatica*, *M. c. bungei*, *M. c. doppelmayeri*, black capped marmot, Northeastern Yakutia, South Yakutia.

***Marmota camtschatica* Pall. (1811) in Yakutia (Russia)**

The black-capped marmot in Yakutia is represented by two subspecies: *M. c. bungei* and *M. c. doppelmayeri*. The first inhabits all large mountain systems in the northeastern regions; the other – a small mountain part in the Stanovoi Mountain Range in South Yakutia. The nearest points of their present-day existence are remote as far as 1500 km from each other. The aboriginal people of Yakutia put continuous pressure upon the marmot populations. In large dense locations the animal harvesting by man was not of a destructive nature for a long time, though their populations were decreasing. In the 20th century this process accelerated and finally resulted in the extinction of some populations in the marginal parts of their area. This situation is shown in the first edition of “The Red Data Book of Yakutia” (1987) in which the black-capped marmot is considered as species having population groups of a threatened status. The extinction of marmot colonies inhabiting before the 50s of the last century in the Kondakov plateau (the right riverside of the Indigirka lower reaches) has been established. The marmot colonies populating the Zverev Ridge (South Yakutia) are now registered. The number of the animals here is evaluated only in a thousand individuals. In the 80s of the last century the species census was performed in different sections of its range. By the expert appraisal based on extrapolations the total marmot population gave a decrease from 80 000 to 30 000 animals for the recent 30-40 years. If this rate of the marmot decrease remains, then in the coming 20-30 years the black-capped marmot may disappear in Yakutia. So, it is necessary to take effective measures to conserve this species. In the prepared new edition of “The Red Data Book” the status of the black-capped marmot is essentially changed: it is recognized as threatened all over its area. In practice a mere prohibition against harvesting is little effective for its nonobservance. The species conservation may be ensured only under the system of particularly protected territories covering its population diversity. The program of the marmot population restoration supposes also the local animal introductions in the places of their former residence.



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Key words: *Marmota baibacina*, grey marmot, hunting, reproductive strategy, Tien Shan, Kazakhstan.

Reproduction of grey marmot on game-shooting territory in Northern Tien-Shan

The researches are carried out in 1986-1990 (March-September) in Narynkol region of Almaty oblast on southern slopes of Karatau ridge and western extremity of Sarytau ridge (ketmen's geographical marmot population, karatau's local population) at height 1800-2300 m above sea level. On 3 experimental sites (area of 1,5 kms², density of the population 90-150 marmots on 1 km²) observed of 78 families. Marmots shot from carbine. Annually extracted 10-25 % of the population on sites. The share of families without young changed from 25,6 % (in 1986) up to 6,4 % (in 1988-89). The number animals in families varied within the limits of 2 - 18 (M+m = 7,8±0,7 in 1987; M+m = 9,0±0,7 - in 1990). Average of the litter size are changed from 4,1±0,45 (in 1987, 1990) up to 4,6±0,4 (in 1988). The share of young in a population varied from 21 up to 53 %, and share of adult - from 28 up to 37 %. Among the adult marmots prevailed 3-4 year-olds (28,1 and 29,3 % accordingly). In reproduction took part females in the age of 2-9 year-olds, and only 11,4 % two-year-olds females had litter. Most reproductive females in the age 5-8 year-olds, on the average number embryo in this age group made 6,8±0,3. The received data testify that a moderate shooting was stimulated reproduction in marmot families. So, in 1987 from 56 families is extracted 100 marmots (69 from them adult). In 1988 only at 5,3 % of these families has not litters. On a control site, where game shooting did not carry out, the next year had no young 9,1 % of families. In 1988 in 27 families have extracted of 41 adults animals. The next year only in one of them was not litter. The negative consequences of extraction were showed in the raised death rate young in families, in which were extracted reproduced females. In 1987-88 in such 15 families 49 % of young was lost.

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Key words: *Marmota monax*, chronic hepatitis, cancer, virus.

Seroepidemiology of Hepatitis B-Like Virus (Hepadnavirus) Infection in Woodchucks (*Marmota monax*) and Related Species of the Family Sciuridae

The hepatitis B virus (HBV) is the prototype member of the family Hepadnaviridae, a group of hepatotropic DNA viruses that infect several other mammalian (Genus: *Orthohepadnavirus*) and avian (Genus: *Avihepadnavirus*) species. The second member of the

hepadnavirus family to be identified was in the Eastern woodchuck (*Marmota monax*) and named the woodchuck hepatitis virus (WHV). The virus was described originally by Summers and his colleagues in a colony of woodchucks that originated in their native habitat and that subsequently were maintained by Snyder in conventional laboratory animal environment. For some years, the colony experienced high rates of chronic hepatitis and hepatocellular carcinoma (HCC), hepatic diseases known to be associated with chronic HBV infection. WHV was present in the serum of many of the woodchucks and on the basis of morphological and molecular analyses, it was concluded that the woodchuck virus should be considered a member of the family of viruses to which HBV belonged. The natural habitat of the woodchuck extends from northern Georgia, Alabama and Mississippi in the southern United States, west to Oklahoma, Kansas, Nebraska, and North and South Dakota, north to Quebec and Labrador, and across Canada to British Columbia and the Yukon Territory, including a region in southeastern Alaska. A comprehensive, seroepidemiologic study of WHV infection has not yet been performed, and the prevalence of WHV infection throughout most of this range remains unknown. WHV infection, however, is hyperendemic in the Mid-Atlantic states, and the woodchucks originally studied by Summers et al. were from Pennsylvania. Woodchucks from Pennsylvania, New Jersey and Maryland have been shown to be test positive for WHsAg in 23 percent of cases, and an additional 36 percent were positive for anti-WHs antibody, demonstrating an overall infection rate of 59 percent. In some regions of Maryland, the rate of chronic WHs antigenemia in woodchucks is 33 percent and similar high rates of WHV infection in the Mid-Atlantic states have been confirmed by others. In contrast, the rate of WHV infection in central New York State has been estimated to be approximately 1-2 percent based on the presence of anti-WHs antibody, and the rate of persistent WHs antigenemia is approximately 0.2 percent. Although the number of woodchucks tested is small, we have found no serologic evidence of WHV infection in Vermont, Massachusetts, or in Iowa. Since the description of WHV, several closely-related hepadnaviruses have been described in other mammalian and avian species. The genetic organization, morphology, and replicative strategies of all these viruses are similar. The ground squirrel hepatitis virus (GSHV) has been described in California ground squirrels (*Spermophilus beecheyi*), Persistent GSHV infection is associated with chronic hepatitis and HCC, although the frequency HCC is said to be lower than that associated with chronic WHV infection develops at an older age in California ground squirrels. A closely related hepadnavirus has been described recently in the arctic ground squirrel (*Spermophilus parryi*) and named the arctic ground squirrel hepatitis virus (ASHV). The prevalence of ASHV infection appears to be high in certain Alaskan populations and persistent ASHV infection is associated with a high rate of infection and HCC. Evidence a hepadnavirus infecting Eastern gray squirrels (*Spermophilus carolinensis*) has been reported from Pennsylvania. Although lesions of hepatitis were described, there was no evidence of HCC. There is evidence for a hepadnavirus of Richardson's ground squirrels (*Spermophilus richardsonii*) originating in Alberta, Canada. The hepatic lesions of Richardson's ground squirrels including HCC were remarkably similar to those described in woodchucks. The duck hepatitis B virus (DHBV) has been described in domestic Pekin ducks (*Anas domestica*) and apparently has a worldwide distribution. Closely related avian hepadnaviruses have been described in grey herons (*Ardea cinerea*, the heron hepatitis B virus, HHBV) and in snow geese (*Anser caerulescens*, SGHBV) have been reported in Germany. The association of HCC with DHBV infection is very unusual and the hepatocarcinogenicity of DHBV in ducks remains questionable. Hepatic neoplasms have not been associated with HHBV or SGHBV infection.



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Key words: *Marmota monax*, chronic hepatitis, cancer, virus.

Chronic Hepatitis and Primary Liver Cancer in Woodchucks (*Marmota monax*) Associated with Chronic Woodchuck Hepatitis Virus (WHV) Infection

The hepatitis B virus (HBV) World wide is among the most important human pathogens and the etiologic role of HBV in chronic hepatitis and in hepatocarcinogenesis is well recognized. Similar viruses now have been reported in several mammalian and avian species. WHV was described originally by Summers and his colleagues in a colony of woodchucks that had been trapped in the native habitat and maintained in a laboratory setting. For some years, these woodchucks experienced high rates of chronic hepatitis and hepatocellular carcinoma (HCC). WHV was identified in the serum of many of the woodchucks and on the basis of molecular analyses, it was concluded that WHV was a member of the family of viruses to which HBV belonged. WHV now is classified as a member of the genus *Orthohepadnavirus*, family Hepadnaviridae. The morphology and genetic organization of WHV is similar to HBV and to other mammalian hepadnaviruses. Hepatocellular neoplasms have been described since the early part of the twentieth century, in woodchucks from the Philadelphia Zoological Garden. Woodchucks with hepatic tumors were later described from the Washington Zoological Park and from Bethesda, Maryland. Since these initial observations, other cases of HCC have been reported in laboratory-maintained woodchucks originally trapped in Pennsylvania, New York, Maryland, and Delaware. To exploit the woodchuck as an experimental animal model, it became necessary to breed and rear woodchucks in laboratory animal facilities. This allowed the genetic background of experimental woodchucks to be known, their diet to be defined, and it was possible to prevent natural exposure to WHV infection and to other diseases that are endemic in wild woodchuck populations. A breeding colony of WHV negative woodchucks was established at Cornell University in 1979. The colony now serves as the source of woodchucks for experimental studies of WHV infection and hepatocarcinogenesis. Woodchucks born in the laboratory animal setting are inoculated at birth with serum from standardized infectious pools obtained from chronic, WHV carrier woodchucks. Following inoculation, woodchucks are monitored using specific serologic markers of WHV infection (WHV DNA, WHsAg, anti-WH core antibody, and anti-WH surface antibody). The rate of chronic WHV infection following neonatal inoculation was 60 percent or higher. Kaplan-Meier survival analysis of chronic WHV carriers infected experimentally at birth with WHV have been compared to woodchucks that recovered from neonatal WHV infection and to control woodchucks not infected with WHV but that were born and raised under similar laboratory conditions. All WHV carriers were dead by 56 months of age, and the lifetime risk of HCC was 100 percent. The median time-to-death from HCC in WHV carriers was 29 months. In contrast, 42 percent of the woodchucks with resolved WHV infection and 62 percent of uninfected controls were alive at 56 months of age. Although the rate of HCC in WHV carriers was significantly lower than that of chronic WHV carriers,

17 percent of the woodchucks in which neonatal WHV infection was resolved developed HCC. HCC was not observed in uninfected, laboratory-reared, control woodchucks. The rate of HCC in woodchucks with experimentally induced chronic WHV infection was similar to that observed in woodchucks with naturally acquired chronic WHV infection.

These results provide direct experimental evidence for the carcinogenicity of WHV and, by analogy, for other hepadnaviruses including HBV.

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Key Words: *Marmota sibirica*, Mongolian marmot, vegetation, soil, humidity.

The marmot's (*Marmota sibirica*) influence on vegetation and soil of needle grass steppe of Hustai National Park, Mongolia

The territory of Hustai National Park, Mongolia is 50600 ha and marmots spread in 26% or 12870 ha area and density is 1.6 individual per one ha of marmot distributed area. Marmot distributed 25 % in the area is belongs to needle grass steppe, where were registered 63 species of 45 genres, 22 families on the marmot's mounds. The mound's vegetation preserves species composition of the needle grass steppe and there are some differences in the species frequencies and abundance. The mound's vegetation is mostly consists of 4 micro communities: *Stipa Krylovii*, *Artemisia Adamsii*, *Carex duriuscula* and *Leymus chinensis*. We studied soil humidity, yield and nitrogen, phosphorus, potassium of soil and plants of pasture and the marmot's mounds. The marmot mound includes from 3 different communities: grasses (dominated by *Stipa Krylovii*), herbs (*Potentilla bifurca*), and semishrubs (*Artemisia Adamsii*). The soil humidity of mounds is lower than pasture's (Table1). Depending on less of vegetation cover of the mound and light, stony mechanic structure of the soil. Nitrogen of soil in pasture is higher than the mound's. Because of no changes in soil structure and more vegetation cover, roots (Figure1). The nitrogen's ion compound should be explained by the dissolve in the water. There are more phosphorous in mounds soil and plant (Figure 2) than pasture (Table2). Because the mound usually fertilizes marmot faces. These are no differences between of nitrogen and potassium in mounds and pasture plants.



Table 1. The yield and soil humidity distinction on the marmot's mounds and pasture

	grasses		herbs		semi shrubs		total		Statistic significant
	mound	pasture	mound	pasture	mound	pasture	mound	pasture	
Yield (g/m ²)	165.2±53	84.4±23.77	44±18.11	133.6±22.06	77.2±18.49	84±11.89	15.16±6.06	13.71±1.43	0.555
Soil humidity (g)	2.15±0.75	3.52±0.56	1.82±0.38	2.82±0.33	1.75±0.68	2.57±0.80	1.91±0.68	2.97±0.75	0.001
Species number	7	6	2	7	3	10	8	13	

Table 2. Comparison of statistic significant (<0.05) of N, P, K in soil & plant of mounds and pasture

	Soil		Plants	
	Between groups (grass, herbs, semishrubs)	Between mound and pastured	Between groups (grass, herbs, semishrubs)	Between mound and pastured
Nitrogen	0.129	0.000	0.671	0.550
Phosphorous	0.162	0.000	0.522	0.042
Potassium	-	-	0.441	0.487
Soil humidity yield		0.001		0.818

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Key Words: *Marmota bobak*, dispersal, Ukraine.

Intrapopulative migrations of boback marmots (*Marmota bobak*, Mull.)

By the beginning of XX century the number of bobak marmots in Ukraine had a sharp decrease. Only two settlements of marmots (lasted) have maintained in north-east of Ukraine. Their numbers were 226 and several thousands animal units.

During the 20th century, due to the taken security measures (implemented) and the high ecological plasticity of this species, a large increase of numbers and expansion of bobak marmots range took place. Its contemporary range in Ukraine is represented by two natural populations, which are now uniting. During the last several tens years those populations areas have been increasing by 15-25 km during each following 20 years. Analysis of scientific statistic has shown that new colonies of marmots were being created in distance no more than 4 km from parent colony.

Investigation conducted in “Velikoburlukskaya Step” regional National Park using methodic individual marking allowed to get a pool of new data about social structure of

natural settlings of bobak marmots, their territorial relationships, migration processes and creation of new families.

During investigation many crossings and establishments of young and rarely adult marmots have been observed as well in the neighbor family areas as in those at a distance up to the 850 m from their areas and not in the straight vision. Males migrated more actively than females and young marmots migrated more actively than adults.

Territorial aggression of territory dominants is decreasing at the end of marmot's active period. Least grade of aggression is applied to the animal unit younger than 1 year and animal units from neighborhood areas. Highest grade of aggression is applied to the migrating adult animal units.

Five adult marmots released at 1 km from their areas have found way to home without any doubts. In the observed settling it is possible to highlight as well stable families, situated in relative isolation, as non-stable in which total change of all family members and constant rotation of animals among neighbor groups has been happening.

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Key Words: *Marmota marmota*, Alpine marmot, hunting, using, Pleistocene.

Hunting and using of marmot (*Marmota marmota* L.) in western Alps and southern Jura from late Pleistocen to Holocen.

Ancient and modern excavations in various alpine and jurassian settlements delivered numerous remains of marmots.

Bones are essentially found in caves and rock-shelters occupied at the end of the Pleistocene to the beginning of Postglacial, between 12.000 and 8.000 BP.

A detailed study show that theses animals were hunted for their fur and skin but for their meat and grease too.

A scapula presents the fragment of an arrow-head, testifying of bow-hunting during summer months.



the aim of this study was to 1) assess the quality of anaesthesia with 3 different anaesthetic combinations, 2) to investigate seasonal differences in response to anaesthesia, and 3) to examine the influence of anaesthesia on body temperature. Anaesthesia was performed with 3 different combinations: ketamine + xylazine (KX), ketamine + medetomidine (KM) and tiletamine + zolazepam + xylazine (TZX). Anaesthesia was monitored with clinical parameters such as heart and respiratory rate, body reflexes, colour of mucous membranes, blood oxygen saturation and body temperature. No mortalities occurred. Surgical depth of anaesthesia necessary for the procedures could be obtained with all 3 combinations, but best results (sufficient analgesia, stable cardio-vascular functions) were obtained with the combination TZX. To obtain surgical depth in the months August/September higher doses of all 3 combinations were necessary than in the months April/May due to the larger proportion of stored body fat. Minimum dose (mg/kg) required for fat biopsies in spring were: KX: 40+3, KM: 35+0.25, TZX: 7.5+7.5+3. Minimum dose required for fat biopsies in late summer were: KX: 80+20, KM: 70+0.5, TZX: 10+10+10. All anaesthetized animals responded with a decrease in body temperature. The lowest temperature observed after anaesthesia was 18.1°C. Apparently the described anaesthesia combinations produced a torpor-like condition.

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Key Words: *Marmota monax*, woodchuck, biological rhythm, hibernation.

Biological rhythms during hibernation in free-ranging woodchucks (*Marmota monax*)

Body core temperatures were collected on a continuous basis from 21 free-ranging woodchucks (*Marmota monax*) during four hibernation seasons from fall 1998 to spring 2002. Animals were captured from the study area in southeastern Pennsylvania and an intraperitoneal radio transmitter was surgically implanted. After release, temperature and activity data were collected hourly using a specially designed data acquisition system. The average dates of immergence and emergence varied significantly among the four hibernation seasons. However, the average length of hibernation was not significantly different among hibernation seasons and averaged 117 days. In the fall a significant number (72%) of the declines into the first torpor bout occurred at night, between 1800 and 0400h, while in the spring a significant number (68%) of arousals from the final torpor bout occurred between 1400 and 1600. During hibernation, animals aroused from bouts of torpor randomly throughout the day with no discernable pattern. However, the time of initiation into torpor was not randomly distributed. Forty-six percent of the initiations occurred between 1800 and 0000h. The randomness of arousal and the rhythmicity of torpor entrance indicate a resynchronization of the internal clock during arousal periods. Analyzing the torpor bouts for integer multiples of free-running periods showed periodicities ranging from 22.8 to 26.2 h in 16 of the 21 animals tested. This preliminary analysis of data collected over four hibernation seasons indicates that some rhythmic behavior is maintained during hibernation in woodchucks.



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Key Words: *Marmota baibacina*, *M. bobak*, *M. sibirica*, immunology, subspecies, population.

Review of immunological study of interspecific and interpopulation differentiation of Eurasian marmots.

Being semi-quantitative method immunodiffusion did not justify entirely all the hopes. However, longstanding studies of closely related species of Eurasian marmots allowed us to trace the congener relationships between closely related species and populations of some species. It has been shown that species independence from “bobak” group (*Marmota baibacina*, *M. bobak* and *M. sibirica*) usually united in one species raises any doubt. At that baibak slightly distinguished, and more similarity is observed between gray marmot and tarbagan. For Menzbir marmot the substantial distance relatively to the species of “bobak” group and its close relationship with red marmot have been found. All the Eurasian marmot species clearly distinguished on the level of subspecies and populations. Sometimes these differences turn to be comparable with interspecific ones. The estimation of intraspecific variability of black-capped marmots allowed us to conclude that distinct immunogenetic differences exist between three subspecies *M. camtschatica*, as well as between two geographical forms of these marmots from Yakutia. Immunogenetic peculiarity of Baikal subspecies (*M. c. doppelmayri*) is too deep, what justifies the expediency of adding to it a special species status. The results of intraspecific variability analysis of tarbagans proved to be interesting. Clear differences were revealed between tarbagans from different regions. West-Mongolian subspecies (range Khangai, *M. sibirica caliginosus*) is the most peculiar. It demonstrates a close similarity with gray marmot from Altai Mountain. At the same time tarbagans from Chita, central and eastern Mongolia are very far from the gray marmot from Altai. It is obvious that Baikal black-capped marmot is closer to the gray marmot from Altai than most all the tarbagans (except Khangai animals). Relative to baibak the Baikal blackcap marmot behaves itself as tarbagans from Chita and from Khangai do. One of the shortcomings of immunodiffusion method is that the data could be interpreted relative to only one species of animals, against which the antiserum is obtained. Speculative conclusion allows nevertheless to suppose that Baikal blackcap marmot and some tarbagans have stronger similarity between each other, than with other marmots. Antiserum against baibak allows to divide studied gray marmots in two groups. One group is *M. b. baibacina* from Mongolian Altai and *M. b. baibacina* from Altai. Another group is *M. b. centralis* from Tien Shan and *M. b. baibacina* from eastern Kazakhstan. It is worth to note that marmots from the first group differ from each other very slightly, and marmots from the second group are quite different. One of the most important result of immunodiffusion analysis in respect of its usage for comprehension of history of group development is the suggestion that ancient marmot form most probably are gray marmots, but not the tarbagans or blackcap marmots. The most ancient elements are peculiar in most degree to gray marmots from Altai. This suggestion is possible only if supposing that Menzbir and red marmots are the most ancient among the modern mar-

Ученые
и
исследователи
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Дивизиона
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Университета

mots. I assume that these results in some way did initiate more active and successful study of marmots by other modern methods, which is obviously seen reviewing corresponding publications of the last years.

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Key Words: Coleoptera, Scarabaeoidea, Histeridae, Marmot holes, *Marmota baibacina*, Siberia.

The fauna of west Siberia and Altai region beetles (Insecta, Coleoptera) the inhabitants of marmot (*Marmota baibacina* Kastsch.) holes.

The materials for these researches obtained from the author's treatments, in the West Siberia (WS): Novosibirsk, Kemerovo and Tomsk Provinces; in Altai Region (AR): East-Kazakhstan Province and Kosh-Agach District. The beetles were collected from the upper part of hole entrance (up to 1,5 m depth), near it and from the lavatories' excrements. 15 families of beetles were collected. The superfamily Scarabaeoidea and family Histeridae is the most numerous and diverse in species composition. Family Histeridae: WS-9 species. AR-13 species. 16 species were collected as whole. Superfamily Scarabaeoidea consists of to 2 families: Geotrupidae-2 species and Scarabaeidae-50 species. WS-27 species. AR-45 species were collected. The beetles may be divided in at 3 ecological groups.*Phleobionte-typical hole inhabitants: 3 species of Histeridae and 6 species of Scarabaeoidea. **Phleophile-Is the holes prefer species, but they also inhabit other biotopes: 6-Scarabaeoidea. Phleoxene-eurytropics species: 12 species of Histeridae and 400 species of Scarabaeoidea.

The beetles fauna structure of marmots holes

Taxon	<i>M.b. baibacina</i>	<i>M.b. kastsch</i>	Taxon	<i>M.b. baibacina</i>	<i>M.b. kastsch</i>
	AR	WS		AR	WS
Familia Histeridae			Superfamilia Scarabaeoidea		
1. <i>Gnathonus suturifer</i> Rtt.*	+		1. <i>Geotrupes baicalicus</i> Rtt.	+	+
2. <i>Saprinus lateralis</i> Motsch.	+		2. <i>G. stercorosus</i> Scriba	+	
3. <i>S. aeneus</i> F.	+	+	3. <i>Copris lunaris</i> (L.)	+	
4. <i>Chalcionellus amoenus</i> (Er.)	+		4. <i>Gymnopleurus flagellatus</i> (F.)	+	
5. <i>C. decemstriatus</i> Rossi	+	+	5. <i>Onthophagus gibbosus</i> (Scriba)	+	
6. <i>Pholioxenus</i> (?gobicus Kryzh.)*	+		6. <i>O. semicornis</i> (Panz.):**	+	
7. <i>Dendrophilus proditor</i> Rehdtd*	+		7. <i>O. gibbulus</i> (Pall.)	+	+



8. <i>Hister quadrinotatus</i> Scriba	+		8. <i>O. nuchicornis</i> (L.)	+	
9. <i>Margarinotus cadaverinus</i> Hoffm.	+	+	9. <i>O. marginalis</i> Geb.	+	
10. <i>M. striola</i> (C. Sahlb.)		+	10. <i>O. pygargus</i> Motsch.	+	
11. <i>M. carbonarius</i> (Ill.)	+		11. <i>O. leucostigma</i> Stev.**	+	
12. <i>M. silantjevi</i> Schir.*		+	12. <i>O. fracticornis</i> Preys.		+
13. <i>M. ventralis</i> Mars.	+	+	13. <i>O. scabriusculus</i> Har.**	+	+
14. <i>M. purpurascens</i> Herbst	+	+	14. <i>O. vitulus</i> (F.)*	+	+
15. <i>M. stercorarius</i> Hoffm.	+	+	15. <i>Euoniticellus fulvus</i> (Goeze)	+	+
16. <i>M. bipustulatus</i> Schr.	+	+	16. <i>Onitis humerosus</i> (Pall.)	+	
			17. <i>Psammodyus germanus</i> (L.)		+
Taxon	<i>M.b. baibacina</i>	<i>M.b. kastsch</i>	Taxon	<i>M.b. baibacina</i>	<i>M.b. kastsch</i>
	AR	WS		AR	WS
Superfamilia Scarabaeoidea			35. <i>A. kerzhneri</i> Nikolajev*	+	
18. <i>Heptaulacus carinatus</i> (Germ.)	+	+	36. <i>A. prodromus</i> (Brahm.)		+
19. <i>Aphodius erraticus</i> (L.)	+	+	37. <i>A. punctatosulcatus</i> Sturm	+	+
20. <i>A. subterraneus</i> (L.)	+	+	38. <i>A. rectus</i> Motsch	+	+
21. <i>A. fossor</i> (L.)	+		39. <i>A. zangi</i> A. Schm.*		+
22. <i>A. haemorrhoidalis</i> (L.)	+	+	40. <i>A. scrofa</i> (F.)	+	
23. <i>A. brevis</i> Erich.	+	+	41. <i>A. pusillus</i> (Hbst.)	+	+
24. <i>A. putridus</i> (Fourc.)*	+	+	42. <i>A. biguttatus</i> Germ.**	+	+
25. <i>A. rufipes</i> (L.)	+		43. <i>A. citellorum</i> Sem. et Medv.*	+	
26. <i>A. depressus</i> (Kug.)	+	+	44. <i>A. frater</i> Muls. et Ray	+	
27. <i>A. luridus</i> (F.)	+	+	45. <i>A. fimetarius</i> (L.)	+	+
28. <i>A. menetriesi</i> Men.	+		46. <i>A. foetens</i> (L.)	+	
29. <i>A. tenebricosus</i> A. Schm.*	+	+	47. <i>A. ater</i> (De Geer)		+
30. <i>A. comma</i> Rtt.	+		48. <i>A. vittatus</i> Say	+	
31. <i>A. grafi</i> Rtt.	+		49. <i>A. lapponum</i> Gyll.	+	
32. <i>A. transvolgensis</i> Sem.**	+	+	50. <i>A. piceus</i> Gyll.**	+	
33. <i>A. distinctus</i> (Muller)	+	+	51. <i>A. granarius</i> (L.)	+	+
34. <i>A. melanostictus</i> W.Schm.		+	52. <i>A. suturifer</i> Rtt.	+	

