

Monitoring of Alpine Marmot (*Marmota marmota latirostris*) colonies in the West Tatra Mountains - I.

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Abstract. The study presents the data on the breeding territory, translocation and dispersal routes of the Tatra subspecies of Alpine Marmots in the part of the West Tatra Mountains, the West Carpathians, Slovakia. The maternal and emergency burrows were detailed censused and GPS-located at the territory from Sivý vrch to Tri Kopy (9,500 m in length). The horizontal range of marmot distribution in this area was 6,200 metres. GPS coordinates of 2,469 burrows were archived, twenty-four of which were the main burrows. Twenty six active inhabited colonies were found. Two of them did not have a main burrow. 172 burrows were detected in the largest inhabited colony and 23 burrows in the smallest inhabited colony. In the largest uninhabited colony 125 burrows were found. The potential effects of predators (especially the Golden Eagle) and touristic impact on marmot distribution are discussed.

Key words: *Marmota marmota latirostris*, GPS, West Tatra Mountains, colony, migration path

Introduction

The endemic alpine marmot subspecies (*Marmota marmota latirostris*, Kratochvíl, 1961) from the Tatra Mountains is a rodent hibernating species which is classified as endangered species (EN – Endangered). In 1992, the representatives of Slovak Republic and Poland raised issue of the subspecies *Marmota marmota latirostris* - Directive of the commission 92/43/EHS about the protection of biotopes of free living animals and plants.

Tatranian Alpine Marmot (*Marmota marmota* Linnaeus, 1758) is a glacial relict species which inhabits the alpine and sub-alpine zone in the Tatra National Parks (West, High, Belianske and Low Tatra Mountains). Evolution of the Tatra subspecies was separated from that of marmot populations in the Alps. Tatran marmot reaches the northernmost edge of species distribution within the conditions of European continental climate.

According to the latest information from partial monitoring efforts, numbers of the Tatran marmot have been dramatically reduced. This can be documented by the raised interest of the National Department of Nature Protection (Ondruš *et al.* 2003) The Slovak Museum of Nature Protection and Speleology was inspired by this project and developed

a subproject for marmot recovery in the West Tatras.

History of marmot research in the West Tatra Mountains

The population and abundance of Tatra marmot in the area of High and Belianske Tatra Mountains was monitored from the 1950's (Blahout 1971) till present time (e.g. Chovancová 1987, 2004, Chovancová and Karč 1992, Chovancová and Novacký 2004). However, there has not been any complex work concerned with the monitoring of marmot populations in the West Tatras, which could serve as a basis for the comparison of past and present marmot distribution. Monitoring of marmots in the West Tatra Mountains was carried out either locally (valley complexes, e.g. Halák 1984a) or with the help of graduate students, e.g. Rybaříková (2001).

Recent studies of the Tatran marmots were usually concerned with their ethology, ecology, nutrition or with human impact on their life (Blahout 1964, 1969, Chovancová 1983, 1985a,b, Chovancová and Šoltéssová 1988, Radúch 1992, Karč and Radúch 2002, Bačkor 2000, Ballo 2002). The most extensive research on the topographic distribution of the Tatran Marmot was carried out by Chovancová (1987, 2004). Present monitoring of marmot populations is being conducted within the project „TANAP Biotope Mapping“ by the State Forests of TANAP Research Station with the assistance of a Polish research team from the Agricultural College in Krakow. Location of colonies and burrows is being recorded and stored in databases using GPS receivers. (Hedrzak *et al.* 2003 in Chovancová 2004).

Until 2003, topographical relations of specific colonies and the accuracy of localisation were not sufficiently accurate, because no special equipment was used. In 2004, the Slovak Museum of Nature Protection and Speleology started a four year project on marmot research in West Tatra Mountains, using the satellite-based Global Positioning System (GPS).

Monitoring aims and outputs

Marmots are losing suitable biotopes because grazing ceased above the timber line, which allowed further spreading of dwarf pine cover. Marmot biotopes were not always considered when planting dwarf pine. Negative impact of tourism and natural predators strengthen this trend. This monitoring provides a firm base for the project of Tatra marmot recovery and forms a base for the future research on marmots.

The main aim of our project is to map thoroughly marmot colonies in West Tatra Mountains and transform the data into a digital map. In 2004, the map of marmot colonies for the first sector was developed. In the following years, additional data on the formation or extinction of marmot colonies will be collected

along with information about their dispersal and other relations.

Marmot monitoring will provide the following outputs:

- a) Referenced digital maps of the topographical distribution of marmot colonies (GPS)
- b) Identification of vital colonies on the basis of acquired data
- c) Identification of endangered colonies (vegetation distribution, human influence) based on the gathered video and photo documentation
- d) Working out possible aid to the endangered colonies
- e) Video and photo documentation archive saved on DVD, CD and VHS media
- f) Video records for educational purposes
- g) Presentation of outputs at national and foreign events
- h) Hosting an exhibition concerned with the protection of Tatra marmot with assistance of the Polish counterparts, TANAP, Slovak Agency of Nature Protection, Research Station of the National Forests of TANAP.

Foreign and national collaboration

When we approach the elevation point of Volovec (2,083 m), where Roháč part of the West Tatra Mountains meets the Polish border zone, it will be necessary to develop international collaboration with the Polish Republic. In Poland, the use of GPS and central processing in marmot monitoring is already well established. Our Polish counterpart is already carrying out topographical measurements, as well as individual characteristics of marmot colonies. They are being integrated with the stationary reference station in Krakow and Zakopane. National collaboration will be based on the collaboration with Marmot Recovery Research Project (National Department of Nature Protection, TANAP), with the TANAP rangers and with the Research Station of the National Forests of TANAP).

Range location and time table of tasks for 2004 - 2007

The Research Station of the National Forests of TANAP will research marmots in the eastern direction from the Tomanová Pass (Chovancová 2004). Therefore we deliberately chose the particular area of study in the West Tatras as a continuation of this area. With regard to the high altitudinal differences and large surface area of the monitored range, the four year monitoring was divided into several periods (Table 1).

Material and methods

A complete map of marmot colonies in the West Tatras has not yet been made. The global picture of marmot habitat is also not yet known. Therefore a complex approach was chosen for the monitoring of marmot colonies. Methods used in this study differ from the research methods used during previous studies. The whole marmot habitat in the studied area was physically explored vertically and horizontally, therefore e.g. binoculars were not used (a traditional aid used in previous studies of marmot distribution to observe the animals from a distant observation point).

The geographic coordinates of all colony locations were recorded. In order to create a global picture of the whole colony, not only partial gathering of coordinates (e.g. locations of the main or hibernation burrow, possibly in peripheral points of the colony) is made, but first of all the main burrow is located, where habitation by offspring can be confirmed. Then all of the lateral exits from the main burrow and full flight emergency burrows are measured. Main burrows are visually differentiated from the other burrows. Only the final number of located burrows in each colony site together with the number of main burrows yields a complex picture of the present marmot habitat. Characteristics of the individual colonies will be visualized, which could not have been done with such an accuracy in the past.

Maps can display the topographic situation of colony, orientation of burrows towards richer pasture, as the zone of growing vegetation moves up with increasing elevation (M. Ballo, J. Bistár – pers.com.). The exact location of each burrow and implicitly of the whole colonies can improve our understanding of marmot ecology and present estimations of their abundance (positive correlation – more fresh burrows represent higher abundance of marmots).

In colonies, where the main burrow could not be identified, but which were clearly inhabited (fresh burrows), the central point of the colony was estimated and coordinates to the closest burrow were taken. This burrow will be marked in the maps as the colony center. In this study the term colony site describes the site of marmot colony, where the main burrow with offspring was localized. In several cases it was necessary to return to the colony several times in order to confirm the location of the main burrow. The term former colony site refers to a colony site with uninhabited burrows. An inhabited colony site, where the main burrow was not identified, is described by the term colony without main burrow.

If the location of the hibernation burrow differs from the main burrow, it is described as a common burrow, because the hibernation burrows might not be identifiable, if the colony is being gradually explored till September - October. The identification is restrained by meteorological and geo-morphological influences (wash out of burrow grass filling and landslides). Because of high demand of work, physical effort and short monitoring season, it is not physically achievable to check the whole section for the presence of hibernation burrows immediately after hibernation. The monitoring can be started only after the complete melting of snow cover, when all marmot burrows are uncovered and accessible. The time-schedule of work - stage I.

A. Start of monitoring: 15/04/2004 – the end of marmot hibernation

B. End of monitoring: 15/10/2004 – the beginning of hibernation.

Daily schedule without overnight stay in the marmot site:

4 hours – ascend onto the mountain ridge with the technical equipment

6 hours – detection, location, documentation

3 hours – descend to the base

The start of the monitoring was moved to the beginning of June, because the detection was constrained by a layer of unmelted snow. In order

Stage (period) of monitoring /year	Territory	Length of the territory	Adjacent valleys, trenches and forks
I./2004	Sivý vrch–Baníkov Roháčske plesá	9,500 m	South:Kotliny, Grapy, Rusňačka, Podválovec, Lysec, Vreče, lower Parichvost, Skriniarky North:Teľaciarky, Predný Salatín, Spálený Trench, Salatín Valley., Zadná Spálená Valley Predná Spálená Valley, Tmavá Spálená Valley; Zelená Valley
II./2005	Baníkov – Volovec	5,200 m	South: Prislop, Kozie chrby, Ráztoka, Veľké Závraty, Prostredný grúň, Malé Závraty, Smrek, Baranec, Mládky, Repa, Maselná, Pusté, Záhradky, Jamnická Valley. North: Zelené, Smutná Valley, Rákoň
III./2006	Volovec – Bystrá	6,800 m	South: Southern slopes of Jamnická Valley, Jakubiná, Otrhance, Račkova Valley, Gáborova Valley, Lower Bystrá, Ježová, Prostredná, Bystrá Valley.
IV./2007	Bystrá – Tomanovské Pass	6,200 m	South Kobyla, Kotlová, Kamenistá Valley., Hlina, Široký Trench, Kňazová, Javorová Valley, Liptovská Tomanová, southern slopes of Tomanovská Valley

Table 1. Time table of tasks for 2004-2007 marmot monitoring project.

to study the colony in detail, several visits or overnight stays are required. In the subproject of marmot recovery, the museum uses Leica GS20 GPS receiver. Because of financial reasons, post-processing of data will be replaced by measurement correction specific for the given area. This solution was provided by the company GEOTECH, Bratislava. Software GIS DATA PRO will be used to transform the coordinates from the GPS receiver, which uses the WGS84 (World Geodetic System started in 1984) coordinate system into the unified cadastre trigonometric network coordinate system (S-JTSK), which allows the data to be completed and processed in the environment of ArcView (using Křovák cartographic projection). For better orientation after data completion and processing, the digital ZB GIS 10 raster – contour map would be added.

Coordinates of all located burrows are recorded in a digital database. Equipment used for topographical measurements: GPS Leica - 20, digital hypsometer Bräuniger dx, digital video- and photo- technology (camera SONY 3CCD VX 2000, camera OLYMPUS 8.0 mega-pixel), compass. The complete gathered material, data and documentary film shots are stored in the Slovak Museum of Nature Protection and Speleology. This material is accessible to those working on the Marmot Recovery Project or on related subprojects.

During the season of 2004 22 field trips in 22 areas were done. According to the records of the digital hypsometer approximately 1,500 meters of altitude difference per working day were covered. This included vertical movement of about 550 m in trenches and crests.

Results

In the first monitored section, the main range from the peak Sivý vrch to the peak Tri Kopy with a length of 9,500 m (excluding the length of forks, valleys, adjacent trenches, corries and lake surroundings) was physically explored. The horizontal range of marmot distribution in this

area was 6,200 m. Coordinates of 2,469 burrows were taken, 24 of which were main burrows. We detected 26 active inhabited colonies. Two of them did not have a main burrow. Five former colonies were found. 172 burrows were detected in the largest inhabited colony with main burrow and 23 burrows in the smallest inhabited colony. In the largest uninhabited colony 125 burrows were found.

Field exploration proved the existence of “inter-valley translocations” of marmots. In the section Brestová-Salatín-Skriniarky-Predná Spálená, a translocation path was discovered in the traverse below the ridge. The path consisted of 199 burrows and was interrupted by 7 colony sites (8a,b, c; 6a,b, c; 10). It had a length of 3,300 m (Fig. 1). We also observed inter-valley translocation of marmots through this communication corridor. The dispersal is allowed by the specific configuration of terrain, which is typical for the West Tatra Mountains (clear-felled character of peak zones and wide glacial corries).

The main results achieved during the first year of the project are listed in Table 2. The expression “elevation” stands for the elevation of localized main burrows (or central point of the colony, if the main burrow could not be detected).

1. Sivý vrch (1,788 m)

The westernmost situated former colony site in the West Tatra, currently uninhabited. In its terminal part, located in the sub-alpine vegetation zone, remnants of 5 burrows were localized, lying just a few meters apart from each other. The last report confirming the occupation of these burrows came from 1970-1971 (TANAP rangers J. Čajka and J. Majerčák).

2a. Grapy (1,899 m)

Former colony site located 30m eastwards from the meteorologic station of the SAV (Slovak academy of sciences), located at an elevation of 1,893.6 m. In this colony site only one short uninhabited burrow could be localized. The colony was abandoned and has most likely moved to the nearest southern trench of Grapy, due to the frequent visits

of the area during the construction of the weather station. The uninhabited colony site behind the the station is facing westwards and thus is exposed to north-western winds. Negative meteorological and geological influences might have been another cause for the abandonment of the colony site. In the 1990's a large marmot colony was observed in this area (M. Ballo – pers. com.).

2b. Grapy (1,868 m)

This is currently the westernmost inhabited colony in the West Tatras, located just 80 m northwest from the recently localized fresh burrows found in the northern massif of Zuberec. It is a recently established colony, which probably moved in from the area of the weather station, situated just 109 m away. The colony site lies in a trench on grassland slopes without scree, facing southwest (Fig.2.)

2c. Grapy (1,915 m)

The colony site with the second highest number of localized emergency burrows in the 1. section in the massif of Salatín and Brestová. The main burrow is situated off center, east of the emergency burrows. The large colony site is very active, with 121 burrows. It is situated on a south facing slope, east of the westernmost inhabited colony, in the alpine meadow zone.

3. Podvávalovce (1,812 m)

Inhabited colony site at the end of a west facing valley. The main burrow could not be located even after repeated visits. 45 fresh emergency burrows were found. According to the number of burrows it can be predicted, that the colony site is progressive and should be observed also in future years. We cannot exclude the possibility that the main burrow just waits to be established.

4. Salatín (1,870 m)

Uninhabited colony site, situated on the southwestern convex ridge of Salatín, follows the closed marked trail from Vreče to Salatín. 14 burrows have been localized, no fresh one. The colony site was probably left because of an unsuitable locality chosen, unprotected against marmot's natural predator – golden eagle (suitable thermic air flow, sun is heating the slope from early morning and eagles can attack from any direction).

5. Zuberec – northern crest (1,725 m)

Four northernmost localized, uninhabited, freshly worked burrows. Burrows were most likely made by migrant marmots from the nearest colony site at the foot of Parichvost Pass at the ending of Bobrovecká valley. Burrows are just 80 m east of the westernmost localized inhabited colony site found on Grapy.

6. Bobrovecká valley – Valley ending Parichvost Pass (6a – c, 1,804; 1,795; 1,830 m)

The closed glacial relief is suitable for marmot colonies, well protected against golden eagles. It presents a suitable refuge where three interconnected colonies have been localized. The colonies are active with very intensive acoustic communication. Emergency burrows were detected in the direction of the Parichvost Pass. Burrows are facing east to the adjacent Salatín valley. The colony site "6c" is medium sized and lower situated burrows are intensively inundated in the early summer months. This is proved by the existence of many snow beds at the end of the basin.

7. Brestová - upper eastern part (1,872 m)

It is a former colony site, where only ruins of burrows remained. No fresh burrows were found. 18 burrows were found, though they were scarred by unfavourable alpine weather conditions. The colony site perished likely because of the close bivouac

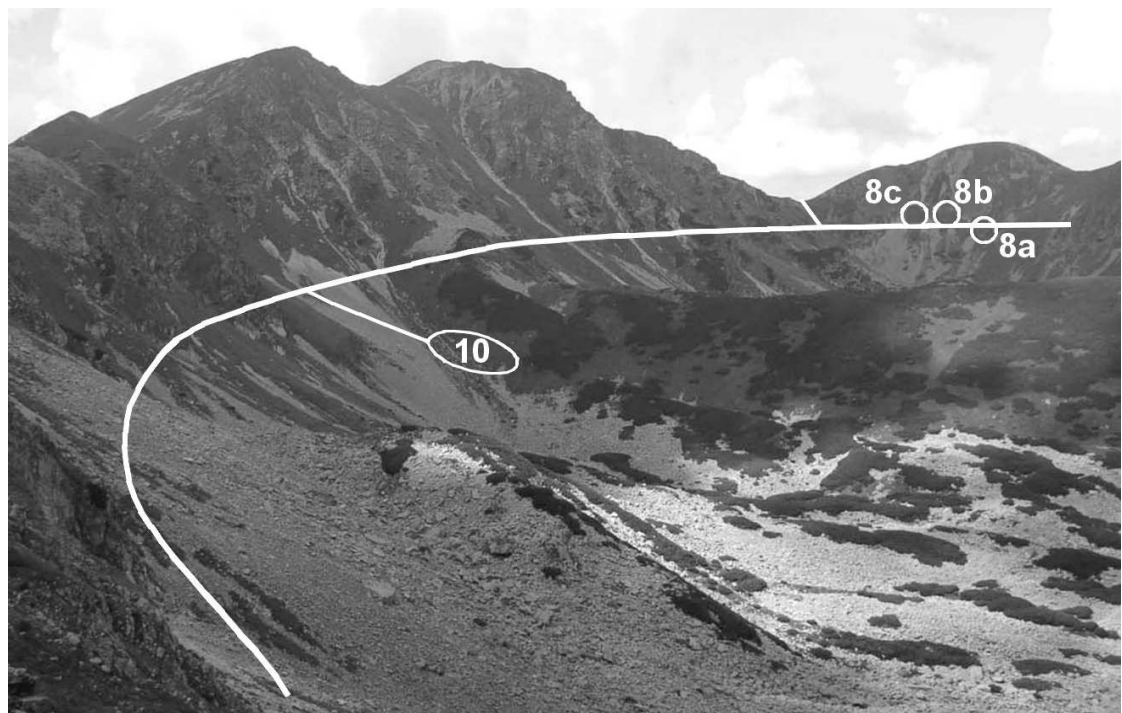


Fig. 1. Translocation and dispersal path of marmots, Brestová - Salatín, and some colony locations.

Locality	Coordinates	Elevation /m a.s.l.	Exposition	Slope	Burrow inhabitation	Number of burrows
1. Sivý vrch						
coordinates of the westernmost burrow	x: 377 772.4888 y: 1 178 310.3064	1,788	W	40°	Uninhabited	5
2. Grapy						
2a) coordinates of the abandoned burrow above the meteo station	x: 375 542.1681 y: 1 177 846.0281	1,899	W	20°	Uninhabited	1
2b) coordinates of the westernmost main burrow	x: 375 580.2243 y: 1 177 956.6509	1,868	SW	30°	Uninhabited	57
2c) coordinates of the main burrow	x: 375 146.9239 y: 1 178 103.5756	1,915	S	20°	Inhabited	121
3. Podvátovce						
coordinates of the colony center	x: 374 899.9942 y: 1 178 496.011	1,812	NW	30°	Inhabited, main burrow not found	45
4. Salatín						
coordinates of the colony center	X: 374 293.753 y: 1 178 833.0595	1,870	SE	30°	Uninhabited	14
5. Zuberec – northern ridge						
coordinates of the northernmost burrow in the northern massif of Zuberec	x: 375 548.4841 y: 1 176 632.0671	1,725	N	30°	Inhabited, main burrow not found	4
6. Bobrovecká Valley – ending under Parichvost Pass						
6a) coordinates of the main burrow in the northern slope	x: 374 984.2783 y: 1 177 443.3742	1,804	S	30°	Inhabited	65
6b) coordinates of the main burrow in the southern slope	x: 374 967.0266 y: 1 177 525.5469	1,795	N	40°	Inhabited	23
6c) coordinates of the main burrow in the center of the glacial basin	x: 375 040.8004 y: 1 177 490.8164	1,830	W	30°	Inhabited	39
7. Brestová – top section						
Coordinates of the center of an uninhabited colony	x: 374 694.0187 y: 1 177 222.7763	1,872	E	30°	Uninhabited	18
8. Salatín Valley (Fig.1)						
8a) coordinates of the main burrow in the northern slope	x: 374 344.4837 y: 1 177 393.242	1,800	S	30°	Inhabited	107
8b) coordinates of the main burrow in the northern slope	x: 374 548.553 y: 1 177 476.8897	1,775	S	30°	Inhabited	70
8c) coordinates of the main burrow in the northern slope	x: 374 740.1917 y: 1 177 456.9489	1,857	S	40°	Inhabited	67
8d) Marmot cave	x: 374 775.918 y: 1 177 418.6333	1,854	V	40°	Flight burrow	1
9. "Migratory path" Brestová, Salatín, Skriniarky – northern traverse on the contour line	3,200 m long traverse	1,850	SZ-V	20°-50°	Fresh burrows	199
10. Zadný Salatín (Fig.1)						
coordinates of the main burrow	x: 374 060.2654 y: 1 178 463.645	1,826	SE	30°	Inhabited	33
11. Tmavá Spálená Valley						
coordinates of the main burrow	x: 372 760.3543 y: 1 178 913.7806	1,825	E	30°	Inhabited	77
12. Uninhabited abandoned colony under Spálená in the Zelená Valley	coordinates of the colony center	x: 372 576.9955 y: 1 179 260.1784		1,750	S	20° Unin-
13. Eastern Trench of Spálená, ending in the Zelená Valley	coordinates of the main burrow	x: 372 803.4448 y: 1 179 191.7972	E	45°	Inhabited	119
14. Spálená – Vreče	coordinates of the main burrow	x: 373 473.3213 y: 1 179 199.6451	W	50°	Inhabited	99
15. Tri Kopy – north						
15a) coordinates of the main burrow	x: 371 352.0133 y: 1 179 757.9364	1,928	N	50°	Inhabited	75
15b) coordinates of the main burrow	x: 371 634.5616 y: 1 179 760.4817	1,939	N	50°	Inhabited	91
15c) coordinates of the main burrow	x: 371 693.3175 y: 1 179 739.998	1,947	N	40°	Inhabited	153
16. Colony under Hrubá Kopa - north	coordinates of the main burrow	x: 371 832.6389 y: 1 179 513.0027	N	40°	Inhabited	64
17. Under Lúčne Pass - north	coordinates of the main burrow	x: 372 363.0076 y: 1 179 535.3014	N	40°	Inhabited	132
18. North face of Baníkov	coordinates of the main burrow	x: 372 872.6639 y: 1 179 840.1339	N	60°	Inhabited	68
19. Under Baníkov Pass	x: 373 056.191	1,850	E	30°	Inhabited	63

continued...

coordinates of the main burrow	x:	y:					
20. Glacial corrie of Baníkov – Parichvost valley (Fig.3)							
20a) Colony in the central trench of Pachola, coordinates of the main burrow	x: 373 683.8074	y: 1 179 741.9109	2,110	S	40°	Inhabited	62
20b) Colony in the trench under the top of Pachola, coordinates of the main burrow	x: 373 420.8286	y: 1 180 025.5388	2,003	S	40°	Inhabited	172
20c) Colony, top section of Baníkov southwestern slope, coordinates of the main burrow	x: 373 082.0808	y: 1 180 286.6795	2,083 2,161=	SW	50°	Inhabited	88
			highest altitude of burrow in the 1. section				
20d) Colony, center of the glacial corrie of Baníkov, coordinates of the main burrow	x: 373 197.9991	y: 1 180 392.8648	1,952	W	30°	Inhabited	113
20e) Colony in the central trench under Prislop, coordinates of the main burrow	x: 373 284.4158	y: 1 180 721.6437	1,998	W	30°	Inhabited	99

Table 2. Summary of results for the year 2004.

site (e.g. on 4 July 2004, 9 unallowed bivouac tents of Czech mountain hikers were found). The colony site could have been exposed to frequent attacks of golden eagles from any direction, just as the colony on the old access trail to Salatín.

8. Salatín valley (8a – c, 1,800; 1,775; 1,857, cave 1,854 m)
Three large inhabited colony sites are situated in the southern slope of Brestová and all of them are interconnected (Fig.1.). Inter-valley migration could be observed from the end of Bobrovecká valley, through the Parichvost Pass as far as Salatín valley (M. Ballo, TANAP ranger, 9. June 2004). The inter-connection of the valleys is apparent from the digital topographical plan. In this colony site, the lowest detected burrow in the first section was found at an elevation of 1,690 m. In the central colony site “8b”, at an elevation of 1,790 m, a remarkable phenomenon could be observed. A patch of dwarf pine (*Pinus mugo turba*; size of the dwarf pine patch was 5 and 10 m) harbored several marmot burrows. The patch was veined with tunnels and bark of the pines was nibbled in several places (the dwarf pine was approximately 80 cm tall). Marmots used the dwarf pine cover as a useful shelter against the attacks of golden eagles. In the vicinity of Brestová Mountain, in an elevation of 1,854 m, a pseudo-carst cave (Fig. 2., biotical granodiorites, characteristic type particular for the High Tatras) was detected. It had a length of 4 m, ended by a conic opening, with two meter high entrance. The cave was named the “Marmot cave” (Ballo 2005), because it was used for escapes (from golden eagles). There is a path leading to the cave with worn vegetation. Behind the rocky wall can be found a thin stripe of vegetation, four meters wide. Next to the stripe is nothing but scree, unsuitable for digging burrows (because of possible burying of burrows). Marmots usually look for more nutritional feeding below the cold shady rock, where new vegetation starts growing in the late summer. Snow beds under the rocky cliffs are covered by snow even in the beginning of June.

Note: In a visibility of up to 25 m a man was attacked by golden eagle quite close to the Marmot cave (13. July 2004). The eagle emerged from the fog and because of poor visibility mistook me for its marmot prey. After recognising its mistake, the eagle broke off the attack some 5 m away from me and disappeared in the fog again. This experience shows that eagles hunt also in unfavourable weather conditions. They scan their alpine territory several times a day. In order to keep visual contact with the ground, the eagle observes the slope from a distance allowed by the fog. Eagles are mostly attracted to the main burrows, where often reside juvenile marmots, that are more likely to hide with less success. Eagles know exactly what kind of flight level they have to choose in poor visibility conditions. They keep in memory the locations of main burrows. The upright standing marmot at watch does not have time enough to make a whistle warning about the air-borne danger. Even this kind of attack, which might be considered by man as a “felonious assault”, belongs to the manifold repertoire of golden eagle hunting skills, which tries to gain food by tricks (A word to the ethology of Golden Eagle – Ballo 1997).

Colonies with south exposure are disturbed during summer season by tourist activity in the already mentioned bivouac site on the top of Brestová. The area is crowded in the winter, but mainly in the spring, with numerous groups of ski tourists, coming from the tourist centre of Roháčska valley. Marmot population growth, as well as the above mentioned human influences, cause that adult marmots look for new territories (Fig.1).

9. Dispersal path Salatín valley, Brestová – south, Salatín and Skriniarky – north, Predná Spálená (average traverse elevation of 1,850 m, approximately 3,300 m long)

The physically most demanding area to explore was the section from Brestová, under the Parichvost Pass and traverse under Salatín, through the ending of the Salatín Valley in direction Skriniarky - north, ending with Predná Spálená. The ending

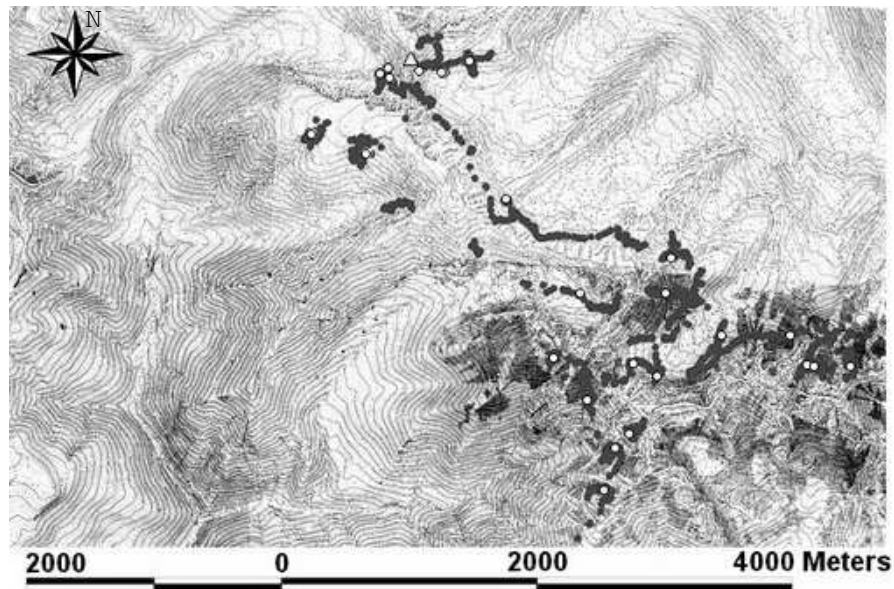


Fig.2. Distribution of Alpine Marmot maternal (white circles) and emergency (black circles) at the territory from Sivý Vrch to Roháčske lakes, the West Tatra mountains. Triangle denotes the "marmot cavern"

of the valley is divided into two parts by the crest of Zadný Salatín. Slopes are covered by fixed scree cones and large screes. Dwarf pine cover reaches into the lower parts of the slopes. There was an intensive acoustic communication among the marmots in the whole amphitheatre of Brestová, Salatín, Skriniarky and Spálená during the whole period of localization. The continuous interest of a Golden Eagle in this locality also proves the active presence of marmots. No marmot colony could be found in the second part of the "translocation path" from Skriniarky to Spálená.

At an average elevation of 1,850 m on the traverse, short and freshly dug emergency burrows could be found in the stripes of vegetation between screes and sometimes also within the screes. The complete translocation path was apparent only after the input of GPS data into the digital map. The burrows were located 2 – 15 m, at most 25 m apart. The route is intercepted by rock screes composed of large rock blocks, which are used by marmots as natural shelters. This was the main reason, why burrows could not be found closer than 25 m apart. There is a corridor of burrows branching off the main "migration path" over the Parichvost Pass, which leads to the ending of Bobrovecká Valley. This branch proves the existence of inter-valley translocations in West Tatras. Under detailed examination of burrows in the corridor, it was found that marmots dig them driven by self-preservation instinct or an innate urge for digging. They are 20, 70 and 150 cm long.

Dispersal of marmots on the 3,300 m long path is mostly caused by the highest concentration of marmots found in the whole area. Dispersing marmots are mostly adolescents or adults in their 3rd year, when they detach from the mother colony and start looking for new territories. The observation of marmot dispersal:

16. April 2004 – a marmot was observed on the paved road from Rákoň to Roháčska Valley. It moved over the forest zone to the opposite

side of the valley

9. June 2004 – a marmot track was found at the tourist path, it ran from the end of Bobrovecká valley up on the top of Salatín, where footprints disappeared

29. June 2004 – a marmot was observed on the tourist trail, moving from the top of Salatín to Skriniarky. The animal descended down the Oravian side of the Tatras before reaching the safety chains.

10. Zadný Salatín (1,826 m)

The colony is located on the eastern slope of Zadný Salatín at an altitude of 1,826 m a.s.l. in the close neighbourhood of the migration path. It's connected to the migratory path by a scree, which is used by marmots as a natural shelter. Therefore no burrows and shelters could be found or localized. This colony is not very large, 32 lateral emergency burrows could be located. It has a favourable geographical situation far from any tourist and ski touring trails.

The "dispersal path" continues traversing from the colony at approximate elevation of 1,850 m a.s.l. under Skriniarky – north and ends with last burrows in the Zadná Spálená Valley at altitude of 1,935 m a.s.l. The end of the path is most probably restricted by the unpassable sharp rocky crest of Predná Spálená. With addition of the three inter-connected colonies under Brestová, the total length of the corridor reaches 3,300 m.

The inter-connection to the next valley – Tmavá Spálená, where another active colony of marmots is located, could not be confirmed. The distance from the last burrow in the corridor under the rocky face of Predná Spálená to the closest burrow in Tmavá Spálená is 250 m.

11. Tmavá Spálená valley (1,825 m)

There is a large active colony in the eastern central trench. It is connected to the burrows in Zelená Valley in the direction to the spring at Žerucha. The colony has a favourable situation far from any touristic trails. The area of the colony is intersected

by a strongly eroded – 12m wide inundation trench. The connection with the “dispersal path” in the upper parts was not confirmed (dispersal path is 250 m away from the burrows). The communication path leads south from Zelená Valley over Žerucha.

12. Uninhabited colony site below Spálená and above Žerucha, in Zelená valley (1,922 m)

Some burrows of older origin could be detected. There was a total number of 125 burrows. Some of them were already overgrown by mosses. This was the last located uninhabited colony under our study. It was most probably abandoned because of continuous disturbance. Burrows extend into the frequented trail leading to the Baníkov Pass. The inter-connection is confirmed in the direction to the localities 11 and 13.

13. The eastern trench of Spálená, ending in Zelená valley (1,922 m)

The colony has probably moved in from the original, abandoned colony from the access trail to the Baníkov Pass to Žerucha. It is not disturbed by tourist activity and protected against Golden Eagles in a narrow trench with solitary rocks without screes. An inter-connection with the closest colony in the west at Vreće has not been confirmed. The main barrier is probably presented by the large bivouac site on the top of Spálená, and a frequented trail of the central ridge Skrinaričky- Pachola.

14. Spálená-Vreće (1,886 m)

Active colony, burrows lead from the top of Spálená in a strip of vegetation on a 50° steep slope westwards to Vreće. The site is located in a glacial basin and well protected against predating golden eagles. It could be threatened by falling rocks from the crest trail from Pachola to Spálená, as well as from a bivouac site on the top of Spálená.

15. Tri Kopy- north (15a-c, 1,928; 1,939; 1,947 m)

This was the easternmost colony found during the first etape of monitoring (2004), located at an elevation of 1,928 m a.s.l. above the last Roháčske lake under the mountain Tri Kopy, on a 40° - 50° steep slope. Three colonies were detected. The highest located burrow in the colony “15c” is located at an altitude of 2,040 m. All three colonies are being disturbed from the upper crest trail of Tri Kopy. During the field research in good weather conditions, it was necessary to watch out for rocks falling from above, released by the activity of continuous flow of tourists on the ridge. The most active colony seems to be “15c”, which is situated on the crest of the last point of Tri Kopy with an east exposure. Human impact in this area was eliminated through closing of the access trail from the last Roháčske Tarn to the mountain of Tri Kopy. On the slope of Tri Kopy, bear feces, found in several places, confirm the regular presence of bear in this locality (on 16. August 2005, after the end of field research, we met a 3-year-old bear at an altitude of 1,820 m). We did not find any signs of bear attempts to dig out marmot burrows.

16. Colony site below Hrubá Kopa- north (1,734 m)

There was a young colony site detected in this area,

with burrows leading from Tri Kopy. Only 64 burrows were found. The substrate is not suitable for the construction of burrows. Construction progresses from the center of the colony westwards under the pass Lúčne. It continues in a traverse over the trail in Zelená Valley to the Baníkov Pass at an average traverse altitude of 1,750 m. It ends at the colony under the pass Lúčne.

17. The colony site below pass Lúčne - north (1,765 m)

The colony site below the pass Lúčne is situated on a north facing slope. The central part of the colony is dominated by a marmot viewing point located on a mound. This colony marks the end of communication of burrows coming from Tri Kopy.

18. The northern face of Baníkov (1,918 m)

This colony is located on an extremely steep (60°) slope. There is a large snow bed in the upper part, often covered by snow even at the beginning of August. The colony is attacked by rocks falling from the access trail that leads from Baníkov Pass to Baníkov.

19. Foot of the Baníkov Pass - east (1,850 m)

There is an active colony in the middle of glacial corrie, connected with the last colony. Burrows start in the Baníkov Pass, where they disappear most probably due to high tourist activity and hard substrate. Some migration probably occurs between Zelená valley and Parichvost Valley.

20. Glacial corrie Baníkov – Parichvost valley (20 a-e, 2,110; 2,003; 2,083; 1,952; 1,998 m) - Fig. 3.

20a. Central trench of Pachola

This colony has 62 burrows, which is slightly less than average. It is not isolated, the connection leads under the top of Pachola.

20b. Trench below the top of Pachola

This is a large colony with the highest (172) number of burrows in the glacial corrie of Baníkov and in the whole first section. The connection leads over Baníkov Pass into Zelená Valley.

20c. The upper part of Baníkov- southwestern slope The highest located burrow in the first monitoring section was localized in this colony at an altitude of 2,161 m.

20d. The center of glacial corrie Baníkov

Large colony, in the upper part isolated from the top colony by a rock bar. This is the second largest colony in the glacial corrie (113 burrows)

20e. The central trench below Príslop

This is the last localized colony site. Lateral burrows are oriented westward, towards the Jalovecké Pass. It is a medium sized colony (99 burrows).

Discussion

The most extensive past studies were published by Halák, (1984 a, b) – West Tatras and Rybaříková (2001) – southern slopes of the West Tatras: Sivý vrch – Kamenistá Valley. However, the sites of marmot colonies were not located worked into a detailed map. Only a short description of the locality was made. The most extensive geographical distribution studies in the area of High Tatras were published by Chovancová (e.g. 1987, 2004). GPS first started to be used for the location of marmot burrows in 2003 in

the Polish part of the High Tatras, as well as in the TANAP area (Chovancová 2004). Monitoring of marmot distribution in the first year (2004) of the planned four year study period enabled to recognize the westernmost border of marmot distribution in the West Tatras. The westernmost range of marmots in the past was known to be situated at Sivý vrch, with latest observation in 1970-71 (Čajka in verb). Later presence was described by Rybaříková (2001, who found three abandoned burrows. In 2004, only five remnants of abandoned burrows were found in the top section of Sivý vrch.

During our study, the westernmost active colony in the area of West Tatras (Locality 2b, 57 burrows) was found 1,900 m north-east from Sivý vrch. The westernmost active colony in the West Tatras known at present was though to be located in Bobrovecká Valley (according to the Tatra Marmot Recovery Program, Ondruš *et.al.* 2003; localities 6a – c). The newly discovered locality at Grapy is situated another 800 m westward. The second colony at Grapy (Locality 2c, 121 active burrows) is the largest in the massif of Salatín and Brestová. The easternmost colony found during the first part of the monitoring is located under Tri Kopy (Locality 15 a).

In the north-south axis, the northernmost fresh burrows without the main burrow in the northern ridge of Zuberec (Locality 5). These burrows were made by marmots migrating from the end of the Bobrovecká valley. The southernmost active colony with the main burrow is located in the trench below Príslop (Nr. 20e). The vertical range of marmot colonies was found to extend from 1,690 m asl (Salatín Valley – geographically lowest recorded burrow) to 2,161 m (top section of Baníkov - geographically highest recorded burrow). Hence the amplitude of vertical range of marmots in the West Tatras is 471 m. The horizontal range in the first section in direction west – south was 6,200 m. The highest concentration of burrows which indicates the highest concentration of colonies was found in the massif of Brestová, connected through the Pass of Parichvost to the end of Bobrovecká Valley.

There are 6 strong colonies (localities 8a-c, 6a-c), which are intersected by the ridge trail connecting Brestová and Salatín. There is a frequented bivouac site on the top of Brestová, where marmots are often disturbed by hikers. The end of Salatín Valley is often visited by ski tourers from Roháčska Valley even after its closing (15. april), where marmots first emerge after hibernation on the southern slopes of Brestová, without regard to the thickness of the snow cover. After the input of geographical coordinates into the digital map, the inter-connection of three colonies in the end of Salatín Valley emerged, what continues in a traverse on the contour line with average altitude of 1,850 m asl and has a length of 3,300 m. These are likely to be the burrows of dispersing marmots. The inter-connection has an asymmetrical horseshoe shape with one prolonged arm, which is 2,800 m long. There are three colonies in the shorter arm under Brestová (localities 8 a-c). The horseshoe bends at the Marmot cave (8c). The corridor continues to traverse from there through the end of Salatín Valley, passes under Skriniarky and ends 250 m before the colony in Tmavá Spálená (Locality 11). It is separated from the Locality 11 by the sharp rocky ridge of Predná Spálená, which may present an untraversable barrier for the marmots.

This communication corridor between valleys (“dispersal path”) Salatín – Zadná Spálená Valley probably has its origin in the exploration of new territories. Future research in the following sections will show, if this phenomenon is specific for the West Tatras. It is necessary to explore thoroughly any possible connections of marmot colonies over the clear-cut passes and identify other possibilities of inter-valley translocations in the whole Tatra Mountains Range.

The marked trail over Skriniarky is secured by chains and very frequented. There are often rocks from the crumbling path falling into the northern scree. Similar situation is at Vreče, where tourists often used to throw rocks from the pass between Spálená and Pachola for their amusement. The most undisturbed colony lies in the Tmavá Spálená Valley (locality 11). This

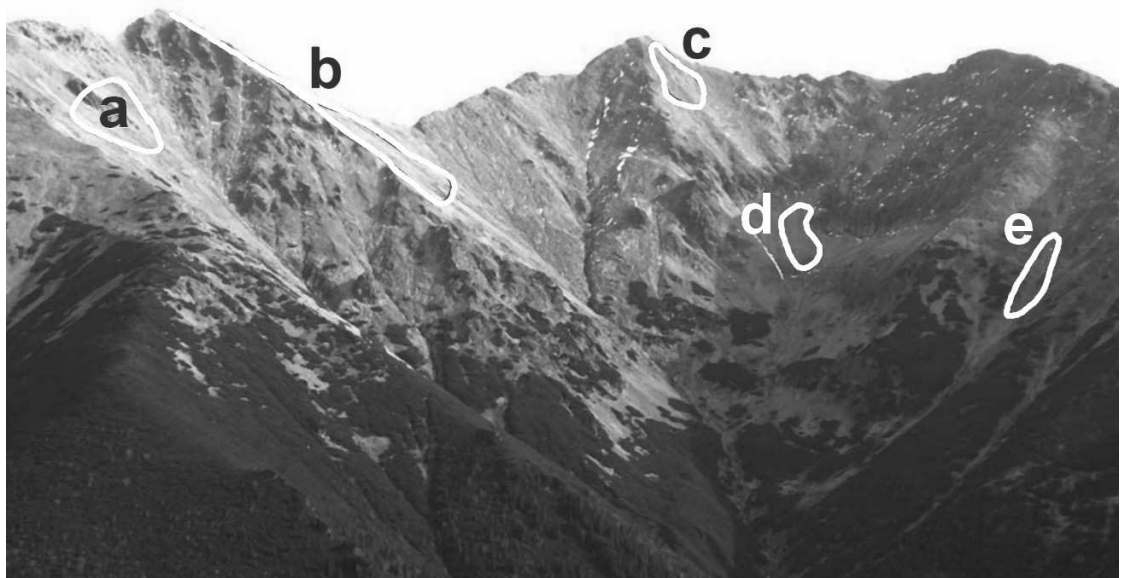


Fig. 3. Distribution of marmot colonies in Parichvost valley.

refuge could be proposed as a model locality for the research on marmots undisturbed by human influence.

In contrast, the adjacent uninhabited colony under Spálená in Zelená Valley (locality 12) is an example of negative impact of the close frequented trail with the last source of water for tourists walking towards the Baníkov pass. We have found 125 abandoned burrows providing evidence that there has been once a strong colony in the past, which was however forced to leave its territory because of the disturbance from tourists. Negative influence of tourists can be seen also on the colonies in the glacial corrie of Baníkov and at the end of Parichvost Valley. This marmot amphitheater with south-western exposure is 1,500 m wide. There were five marmot colonies located in the area, which are disturbed by tourists from the main ridge trail, as well as from the large bivouac site and tourists gathering in the Baníkov Pass.

Three inter-connected communicating colonies under Try Kopy are located far enough from the trail in Zelená Valley. The whole locality was relieved from disturbances by the closure of the tourist trail leading from the last Roháčske Tarn to Tri Kopy before the beginning of the tourist season in 1989.

There is a marmot colony at the end of Zelená Valley under the Baníkov Pass, which occupies the locality under the northern face of Baníkov at an altitude of 1,918 m a.s.l. (locality 18). The active colony on an extremely steep slope has 68 burrows. Numbers of rocks fallen in the scarce vegetation show great negative geological and human influences disturbing the colony (rocks falling from the access trail to Baníkov). There were five abandoned and uninhabited colonies found in the study area (basic characteristics of former colonies and presumed disturbing influences likely to cause the abandonment are given in brackets):

- Sivý vrch (Locality 1; 5 burrows, active burrows observed in 1970-1971, disturbing touristic influence
- Meteorological station on Grapy (Locality 2a; 1 burrow, strong active colony observed in 1990's, disturbing influence of the meteo-station;
- Old trail to Salátin (Locality 4; 14 burrows, open area exposed to the attacks of golden eagles);
- Top section of Brestová (Locality 7; 18 burrows, several disturbing influences: tourism – bivouac site, unfavourable climatic conditions on the ridge, open area exposed to the attacks of golden eagles);
- Under Spálená, close to Žerucha in Zelená Valley (Locality 12, 125 burrows, disturbing influence of tourism, open area exposed to the attacks of golden eagles).

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