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

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**Abstract:** This paper presents the results of the third year (2006) of a four-year research programme on the occurrence of the Tatra sub-species of the Alpine marmot (*Marmota marmota latirostris*) in the Slovak part of the Western Tatra Mts. The coordinates of all the found burrows were obtained by using the highly-accurate GPS data mapper Leica GS20. All of the coordinates were put into digital maps. The area between Mt. Ostrý Roháč and Mt. Bystrá was studied. In total 3,197 burrows were found in the studied area. They form 46 colonies (family groups), 36 of which are inhabited and 10 of which are uninhabited. The largest inhabited colony consisted of 190 burrows, the smallest one consisted of 32 burrows. The horizontal amplitude of the occurrence of marmots in the studied area is 7,240 m and vertical amplitude is 383 m.

Three quarters of the whole West Tatra Mts. region have been monitored so far. A total of 12,479 burrows have been found forming 117 inhabited colonies.

*Key Words:* monitoring, GPS, digital mapping, *Marmota marmota latirostris*, endangered, colony, burrow, Západné Tatry (the West Tatra Mts.), Slovakia

## Introduction

This paper presents results of monitoring of the Tatra marmot colonies (*Marmota marmota latirostris*) in the third and penultimate section of the Slovak part of the West Tatra Mts. The area of alpine and subalpine sites between Mt. Ostrý Roháč and Mt. Bystrá was closely explored. The whole monitored sector copies the southern border of Poland.

The research was carried out in 2006 and was a continuation of the monitoring project which has been running since 2004. The results of the research which was carried out in the years 2004 and 2005 have already been published. (e. g. Ballo and Sýkora 2003; Ballo and Sýkora 2004; Ballo and Sýkora 2005a,b; Ballo and Sýkora 2006). In this paper we will present supplementary information and the results of our research from 2006 (Fig. 1).

## Material and Methods

The following monitoring of the Tatran marmot colonies in the studied section of the West Tatra Mts. follows the same research methods as applied in the previous research carried out in 2004 and 2005. The geographical coordinates of all the found burrows were ascertained using the highly-accurate

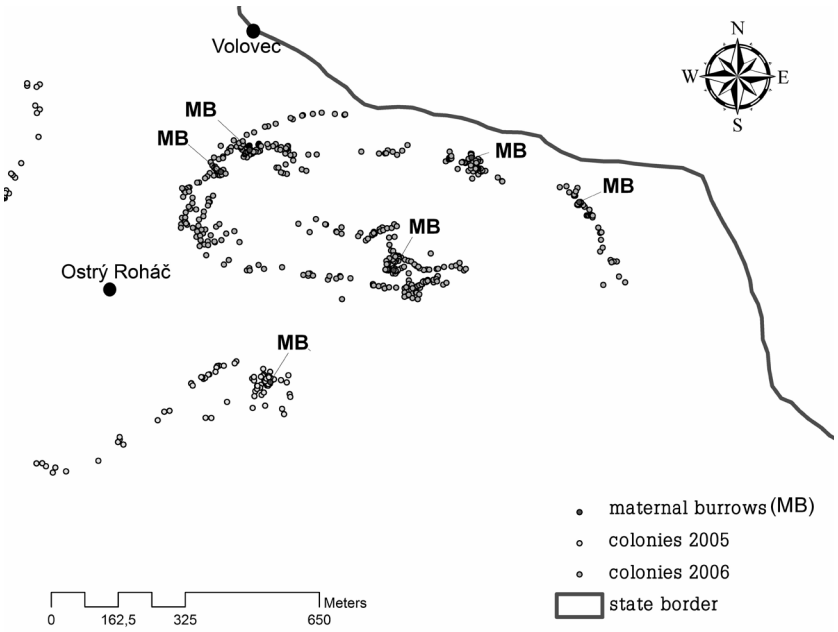


**Fig. 1**. Monitoring of colonies *Marmota marmota latirostris* in the West Tatra Mts. - Jamnicka valley in 2006.

GPS data mapper Leica GS20. The coordinates of the burrows were located in the field using the geographical coordinate system WGS84 and then converted into the coordinate system of individual Trigonometric Cadastral Networks (S-JTSK). The GPS data was processed using the software application ArcView GIS. As a base layer we used the Orthophotomap of the Slovak Republic (1:10 000, definition 1 pixel = 1 m), which was provided to The Slovak Museum of Nature Protection and Speleology in Liptovský Mikuláš under licence from the Ministry of the Environment, developed by EUROSENCE, s.r.o. (licence 66-03-4) a GEODIS SLOVAKIA, s.r.o. (licence 2003-047/F), more details see Ballo and Sýkora 2005a, 2006).

To obtain more exhaustive information on the occurrence and the distribution of the Tatra marmot colonies, it was necessary to involve a higher number of participating researchers to search for the marmot burrows more thoroughly. Therefore, two more researchers, the climbers Ing. Martin Horvát and Ing. Karol Horvát cooperated on the research in 2006.

Sixteen localities were explored in the studied area totally: the head of the Jamnická dolina valley and the surroundings of its tarns (mountain lakes), the Pod Deravou Saddle, Mt. Hrubý vrch, Mt. Jakubiná, Mt. Otrhance, the head of the Račková dolina valley and the surroundings of its tarns, Mt. Končistá, Mt. Klin, the Gáborová dolina valley, Mt. Grúň, Mt. Nižná Bystrá, the surroundings of the Anitino očko Tarn, Mt. Hrbáč, Mt. Bystrá and the surrounding tarns, Mt. Kobyla and Mt. Kotlová. The main ridge was studied in great detail, vertically and horizontally, at the sub-alpine and alpine level up to the border with Poland. All of the side ridges, ravines, neighbouring gullies, glacial cirques and the surroundings of the tarns were searched.

Work on monitoring of the studied area began on 15th June, 2006 after the snow cover had melted, when all of the burrows were accessible, even those in the snow beds. The research was concluded on the 12th October, 2006 when the marmots plugged their burrows before hibernation. To monitor avalanche activity in the marmot habitat and the influence of above-ground temperatures on hibernation, the research was prolonged until 8th May, 2007. The avalanche equipment for this purpose (needles for measuring the snow depth, special

**Table 1**. Summarization of results (2006).

| Locality | Location | Altitude m a.s.l. | Exposition | Slope Inclination | Character of colony | Num.of burows |
|---|---|---|---|---|---|---|
| 1a) Below the Jamnické sedlo Saddle | X: 369 068,7746 Y: 1 179 689,1726 | 1,883 | E | 5-35° | inhabited | 96 |
| 1b) Below Mt. Volovec | X: 368 998,8285 Y: 1 179 636,7201 | 1,875 | S | 40° | inhabited | 154 |
| 1c) Mt. Volovec, towards Mt. Deravá | X: 368 668,0533 Y: 1 179 644,3581 | 1,814 | S | 25° | abandoned | 9 |
| 1d) Mt. Deravá slope | X: 368 460,3636 Y: 1 179 654,9079 | 1,972 | S | 25° | inhabited | 49 |
| 1e) Mt. Deravá slope | X: 368 198,9214 Y: 1 179 762,965 | 1,770 | S | 30° | inhabited | 48 |
| 1f) The Jamnické pleso tarn (the lower one) surroundings, South | X: 368 649,4154 Y: 1 179 927,8 | 1,746 | N | 10° | inhabited | 127 |
| 2) Glacial corrie of Mt. Jakubiná, West | X: 366 820,3316 Y: 1 181 182,9647 | 1,839 | W | 35° | inhabited | 143 |
| 3) Mt. Jakubiná, West ravine | X: 367 141,9531 Y: 1 181 666,7777 | 1,830 | W | 40° | abandoned | 30 |
| 4a) The Velký kotol valley of Mt. Jakubiná above a tourist chalet below Mt. Klin | X: 366 237,1048 Y: 1 181 734,7545 | 1,802 | E | 25° | abandoned | 29 |
| 4b) The Velký kotol valley of Mt. Jakubiná above a shed below Mt. Klin | X: 366 360, 1721 Y: 1 181 673,725 | 1,854 | E | 35° | abandoned | 20 |
| 4c) The Velký kotol valley of Mt. Jakubiná above a a tourist chalet below Mt. Klin | X: 366 509,0408 Y: 1 180 719,8835 | 1,899 | E | 30° | inhabited | 44 |
| 5) Below ridge of Mt. Jakubiná | X: 366 114,3005 Y: 1 180 995,4919 | 1,968 | E | 50° | abandoned | 9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6a) Glacial corrie of Mt. Jakubiná – Hrubý vrch | X: 366 251,2139<br>Y: 1 180 697,2022 | 1,881 | E | 20° | inhabited | 73 |
| 6b. Glacial corrie between Mt. Jakubiná – Hrubý vrch | X: 366 315,2261<br>Y: 1 180 630,8094 | 1,855 | E | 20° | inhabited | 72 |
| 6c) Glacial corrie between Mt. Jakubiná – Hrubý vrch | X: 366 479,7523<br>Y: 1 180 525,9291 | 1,887 | E | 30° | inhabited | 67 |
| 6d) Glacial corrie between Mt. Jakubiná – Hrubý vrch | X: 364 481,4287<br>Y: 1 180 430,1941 | 1,880 | E | 40° | inhabited | 84 combined |
| 6e) Glacial corrie between Mt. Jakubiná – Hrubý vrch | X: 366 478,8147<br>Y: 1 180 423,0474 | 1,881 | E | 40° | inhabited | |
| 6f) Glacial corrie between Mt. Jakubiná – Hrubý vrch | X: 366 345,0651<br>Y: 1 180 343,6321 | 1,844 | E | 35° | inhabited | 79 |
| 7) The Račkové pleso tarn surroundinds | X: 366 006,664<br>Y: 1 180 493,1667 | 1,715 | SE | 10° | inhabited | 114 |
| 8a) Below Mt. Končistá | X: 366 044,9009<br>Y: 1 180 145,346 | 1,792 | S | 30° | inhabited | 130 |
| 8b) Below Mt. Končistá | X: 365 959,8517<br>Y: 1 179 981,6944 | 1,850 | S | 30° | inhabited | 33 |
| 9a) Below Mt. Klin, West | X: 365599,4827<br>Y: 1 180 488,7834 | 1,770 | W | 30° | inhabited | 81 |
| 9b) Below Mt. Klin, West | X: 365 566,1977<br>Y: 1 180 700,1707 | 1,752 | W | 30° | inhabited | 32 |
| 10a) The Gáborova dolina valley – Mt. Klin, East | X: 364 606,1641<br>Y: 1 181 097,7305 | 1,791 | E | 30° | inhabited | 62 |
| 11a) Below Mt. Banistá | X: 364 057,8211<br>Y: 1 180 994,4264 | 1,792 | SW | 35° | inhabited | 95 |
| 11b) Below Mt. Banistá | X: 363 838,5261<br>Y: 1 181 589,0033 | 1,863 | SW | 30° | abandoned | 53 |
| 11c) Glacial corrie of Mt. Nižná Bystrá, West | X: 364 422,3147<br>Y: 1 182 402,2293 | 1,781 | NW | 30° | inhabited, without maternal burrow | 59 |
| 12) Mt. Nižná Bystrá, ravine towards the Račková dolina valley | X: 364 179,9057<br>Y: 1 183 367,7377 | 2,000 | SW | 40° | abandoned | 7 |
| 13) East slope of Mt. Ježová | X: 363 952,9372<br>Y: 1 183 938,2905 | 1,985 | E | 30° | abandoned | 2 |
| 14a) Glacial corrie of the Anitino očko tarn, South | X: 363 900,6012<br>Y: 1 183 028,0682 | 1,887 | E | 50° | inhabited | 42 |
| 14b) Glacial corrie of the Anitino očko tarn, above the tarn | X: 363 964,9781<br>Y: 1 182 960,3167 | 1,900 | E | 60° | inhabited | 61 |
| 14c) Glacial corrie of the Anitino očko tarn, above the tarn | X: 364 062,7952<br>Y: 1 182 831,7382 | 1,935 | E | 40° | inhabited | 60 |
| 14d) Glacial corrie of the Anitino očko tarn | X: 364 013,7885<br>Y: 1 182 598,0146 | 1,923 | S | 30° | abandoned | 62 |
| 14e) Glacial corrie of the Anitino očko tarn | X: 363 750,0686<br>Y: 1 182 574,8173 | 1,922 | SW | 30° | inhabited | 81 |
| 15a) The Bystrá dolina valley, ridge of Mt. Hrbáč | X: 363 464,7128<br>Y: 1 182 768,2961 | 1,884 | S | 25° | inhabited | 94 |
| 15b) Below Mt. Hrbáč | X: 363682,8743<br>Y: 1 182 357,7109 | 1,995 | E | 40° | abandoned | 63 |
| 15c) Between Mts. Bystrá a Hrbáč | X: 363 559,9556<br>Y: 1 182 137,8225 | 1,970 | S | 40° | inhabited | 77 |
| 15d) Below Mt. Bystrá | X: 363 421,1037<br>Y: 1 182 208,618 | 1,974 | SW | 40° | inhabited | 44 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 15e) Below Mt. Bystrá | X: 363 340,0215<br>Y: 1 182 330,3042 | 1,936 | W | 40˚ | inhabited | 125 |
| 15f) Below Mt. Bystrá | X: 363 144,9533<br>Y: 1 182 555,7033 | 1,909 | W | 30˚ | inhabited | 146 |
| 15g) Traverse path to Mt. Bystrá | X: 363 089,8523<br>Y: 1 182 644,2251 | 1,895 | W | 30˚ | inhabited | 190 |
| 15h) Below traverse path to Mt. Bystrá | X: 362 991,4146<br>Y: 1 182 887,7504 | 1,872 | W | 30˚ | inhabited | 78 |
| 15i) Below traverse path to Mt. Bystrá | X: 362 997,1296<br>Y: 1 182 926,4909 | 1,855 | W | 30˚ | inhabited | 42 |
| 15j) Mt. Kobylá slope | X: 362 962,8719<br>Y: 1 183 021,2865 | 1,857 | W | 40˚ | inhabited | 57 |
| 15k) Mt. Kobylá slope | X: 362 969,027<br>Y: 1 183 160,2178 | 1,818 | W | 30˚ | inhabited | 89 |

thermometers for measuring the snow temperature) were borrowed from the Centre for Avalanche Prevention in the Jasná dolina valley.

The third studied sector of the West Tatra Mts. is less technically demanding than the second one in the central part of the Roháče region. The marmot habitat reaches up to about 2,100 m a. s. l. in the gullies along the main ridge. However, longer walking distances from lower altitudes to the marmot habitat at alpine level had to be overcome in the third studied sector. The recording of marmot burrows was carried out on slopes with gradients of up to 60˚ .

Altogether 71 working days on 16 localities were accomplished by 3 cooperating researchers, which adds up to 213 man-days. Each researcher overcame about 1,600 altitudinal metres during one working day, which is 400 altitudinal metres more than in the II. section (due to the longer ascents from the montane level to the marmot biotopes). Each researcher ascended and descended another c. 550 metres during the searching and recording work along the ridges and gulleys at the alpine levels. During the research in the whole III. sector each researcher ascended around 95,000 altitudinal metres, around 17,000 more than in the II. section.

Both marmot habitats and anthropic influences, such as tourism, rock-climbing, skialpinism and poaching (snares, traps) were documented using a digital camera and a digital video camera.

## Results and Discussion

In total 3,197 marmot burrows were found in the third monitored sector of the West Tatra Mts. They form 46 colonies, 35 of which are inhabited with a maternal burrow, one of them inhabited without a maternal burrow and 10 colonies are uninhabited. The main results of the research carried out in 2006 are summarised in the Table 1. The altitude and the geograpical coordinates for the localised maternal burrows or for the colony centre (if the maternal burrow was not found) are given in the table. The number of burrows also includes the maternal burrow, if it was found.

*Assessment of the knowledge of the studied colonies*

The monitoring of the colonies of the Tatra marmot (*Marmota marmota latirostris*) in the West Tatra Mts. was carried out at the area between Mt. Ostrý Roháč and Mt. Bystrá in 2006. Both the length of the third studied sector and the horizontal amplitude of the marmot distribution along the main ridge is 7,240 m. The length of the I. sector (6,200m) is similar. The II. sector was twice as long (13,300m), as it was necessary to include the long sections of the side ridge Baníkov – Ráztoka (2,800 m) a Plačlivé – Brišné pod Mládkami in the southern side ridge of Mt. Baranec (5,100 m).

The highest situated burrow was found at 2,031 m a. s. l. (colony 14b/2006) above the Anitino očko Tarn, which is 130 m lower than the highest burrow found so far at 2,161 m a. s. l. at Mt. Baníkov slope (the first sector, colony 3b/2004).

However, I expected that the highest situated burrow would be found in the third sector, on the slopes of the Mt. Bystrá massif, the highest peak of the West Tatra Mts. Marmots have not colonised the summit areas of Mt. Bystrá probably due to the anthropic vegetation changes, as we explain later in the description of the side ridges.

The lowest situated burrow in the III. sector was recorded at 1,648 m a. s. l on the rocky ledge of the Jamnické pleso Tarn (colony 1f/2006). In the whole territory of the West Tatra Mts. studied so far the lowest situated burrow was found in the II. sector at 1,496 m. a. s. l. (colony 19/2005), at the entrance to the Smutná dolina valley.

Thus, the vertical amplitude of the marmot distribution in the third monitored sector is 383 m, whereas in the I. sector it was 471 m and in the II. sector it was 635 m.

A total of 190 burrows were counted in the biggest inhabited colony with a maternal burrow in the third studied sector (colony 15g/2006) at 1,895 m a. s. l. near the path to the summit of Mt. Bystrá. A summary of the inhabited colonies according to the number of burrows is included in Table 2. The most numerous colony in the first sector had 199 burrows (colony 9/2004), in the sector it was 359 burrows (colony 19/2005). The burrow density in the third sector is 2,13x times lower than in the second sector. Therefore the central section of the Roháče range has the most abundant marmot population, even though it also has the highest tourist visitor numbers in the summer and in the winter.

The average elevation of the 46 maternal burrows recorded in the III. sector is 1,862m. Of the 35 inhabited colonies with a maternal burrow, the

| Colony | | Number of burrows per colony | | | |
|---|---|---|---|---|---|
| | | 1-49 | 50-99 | 100-149 | 150-199 |
| 1. | 15 g | | | | 190 |
| 2. | 1b | | | | 154 |
| 3. | 15f | | | 146 | |
| 4. | 2 | | | 143 | |
| 5. | 8a | | | 130 | |
| 6. | 1f | | | 127 | |
| 7. | 15e | | | 125 | |
| 8. | 7 | | | 114 | |
| 9. | 1a | | 96 | | |
| 10. | 11a | | 95 | | |
| 11. | 15a | | 94 | | |
| 12. | 15k | | 89 | | |
| 13. | 10b | | 88 | | |
| 14. | 6d+6d | | 84 | | |
| 15. | 9a, 14e | | 81 | | |
| 16. | 6f | | 79 | | |
| 17. | 15h | | 78 | | |
| 18. | 15c | | 77 | | |
| 19. | 6a | | 73 | | |
| 20. | 6b | | 72 | | |
| 21. | 6c | | 67 | | |
| 22. | 10a | | 62 | | |
| 23. | 14b | | 61 | | |
| 24. | 14c | | 60 | | |
| 25. | 11c | | 59 | | |
| 26. | 15j | | 54 | | |
| 27. | 1d | 49 | | | |
| 28. | 1e | 48 | | | |
| 29. | 4c, 15d | 44 | | | |
| 30. | 14a, 15i | 42 | | | |
| 31. | 8b | 33 | | | |
| 32 | 9b | 32 | | | |

**Table 2.** Overview of inhabited colonies based on numbers of burrows.

average is 83 burrows per colony.

To ascertain the movements of marmots with the potential for digging new burrows, either of a translocational character (movements of adult marmots), or dispersal (spread of sub-adult marmots), digital mapping will be used in further research. To save time and to enable faster movements during the measuring work in the colonies, it is not practically possible to determine the current details of the marmot movements. Therefore, we use the term communion connection in this work. According to the research carried out so far, around 90 % of the colonies are at traditional marmot localities.

A comparison of the main results recorded in the I., II. and III. monitored sectors is presented in Table 3.

The positions of the colonies in each of the researched sectors is different from in the other sectors. The different character of the connectivity between the colonies is due to the various terrain configuration in each of the individual sectors. The natural small ridges between the individual gullies (ravines) lie on the border of the territory. The most densely populated marmot colonies are the connected colonies around the mountain lakes. After transferring the geographical coordinates onto the maps, the marmot communication corridors appear at an average traverse altitude of maternal burrows at 1,860 m a. s. l.

From the period of the Wallachian colonisation around 500 years ago to the middle of the 20$^{th}$ century, this region was grazed by sheep and other farm animals (cattle and horses). The botanical composition of the herb layer was previously different and had a higher species diversity. After mountain grazing was stopped a gradual unification of the plant communities took place, which led to the development of grass species and dry grass mass, which were no longer regulated by grazing. This led to a reduction in the species diversity in the herb layer, with a retreat by species such as *Gentiana punctata, Rhodiola rosea, Veratrum lobelianum* and other juicy high mountain herb species which the marmots prefer to graze on (more on the trophic requirements of marmots see Chovancová and Šoltésová 1988). Similarly unsuitable conditions for the occurrence of marmots were found on the main ridge between Mt. Deravá, Mt. Hrubý vrch and Mt .Jakubiná, in the summit areas of Mt. Klín and on the southern ridge of Mt. Bystrá towards Mt. Ježová. Problems concerning the end of grazing in the High Tatras National Park in relation to the occurrence of chamois (Rupicapra rupicapra), which inhabit the same biotopes as the marmots, were published by Janiga and Zámečníková (2002).

## Conclusion

The monitoring of the colonies of the Tatran subspecies of the Alpine marmot (*Marmota marmota latirostris*) in 2006 was carried out according to the schedule for work on a four-year project and provided detailed information on the occurrence of marmots in the area between Mt. Ostrý Roháč and Mt. Bystrá with the neighbouring side ridges. Detailed maps of all marmot burrows found in this

| | Number of burrows | Number of colonies (inhabited/ uninhabited) | Horizontal amplitude of burrow distribution | Vertical amplitude of burrow distribution* | The largest colony (number of burrows) |
|---|---|---|---|---|---|
| I. sector (2004) | 2,469 | 31 (26/5) | 6,200 m | 471 m (1,690-2,161) | 172 |
| II. sector (2005) | 6,813 | 50 (48/2) | 11,600 m | 635 m (1,496-2,131) | 359 |
| III. sector (2006) | 3,197 | 46 (36/10) | 7,24 | 383 (1,648-2,031) | 154 |

**Table 3.** Comparison of the main results in the I., II. a III. monitored sectors

sector were created. In addition to digitalisation of the research data, video film and photographic documentation of the natural biotope of the marmots were also produced. During the last three years, three-quarters of the territory of the West Tatra Mountains have been researched, starting from the western edge of the range and moving eastwards. A total of 12,479 burrows have been recorded, forming 117 inhabited and 17 abandoned colonies.

In order to understand the complex bionomy of the marmots, it was also necessary to carry out field research in the wintertime, as we did in the II. sector (winter 2005/2006). The research in the III. sector finished as late as 8th May, 2007 (nearly 11 months after research in the III. sector began), so that we could collect information before and after the winter hibernation.

The monitoring will continue in the final planned sector between Mt. Bystrá and the Tomanovo sedlo Saddle. According to preliminary field observations, we can predict that the number of burrows in the IV. sector will probably display a falling tendency.

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