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## The Tatra Pine Vole *Microtus tatricus* will it survive in lower mountain locations?

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**Abstract:** The Tatra Pine Vole *Microtus tatricus* is the only endemic mammal species in the Carpathians Mountains. This species has not been observed in the Babia Góra massif since 1997, in the northernmost position. The paper describes the re-catching of this species on July 26, 2021. above the Beskidzverin Hostel (49.570900 N; 19.532071 E) at the altitude of 1617 m above sea level. The article discusses the likely causes of the local extinction of this species. The major factors, which have been identified are the climate changes that affect species-environment interaction.

**Key words:** distribution, Baba Góra National Park, Carpathians, Southern Poland, population dynamics, climate changes.

## INTRODUCTION

The Tatra Pine Vole *Microtus tatricus* has been described as endemic to the Carpathian mountain range (KRATOCHVÍL, 1952). It is an endemic mammal species in the Carpathians (MITCHELL-JONES *et al.* 1999). This species was considered an endemic to the Tatra Mountains until the 1960s. At the end of the 1960s, the *M. tatricus* was first discovered outside the Tatra Mountains – in Pilsko (Żywiec Beskids) (HAILLINGER 1970, CHUDOBA & HAILLINGER 1971). Currently, its known range covers the Carpathians, from Slovakia, through Poland, Ukraine, to Romania (ZAGORODNYUK & ZIMA 1992, ZAGORODNYUK *et al.* 1992, MARTÍNKOVÁ & DUDICH

2003). The range is insular (endemic) both geographically and within individual mountain ranges (JURDÍKOVÁ *et al.* 2000, MARTÍNKOVÁ & DUDICH 2003). The total area of occurrence of the *M. tatricus* is estimated at 840 km<sup>2</sup>, with a range of 18 322 km<sup>2</sup>. The population size was estimated at 200-250 thousand of individuals (MARTÍNKOVÁ & DUDICH 2003, ZIMA *et al.* 2008). The lowest population is found at an altitude of 600-650 m above sea level in the valley of Veľká Fatra (Mountain range in the Western Carpathian Mountains (Slovakia)), up to 2343 m above sea level in the High Tatras, with the largest number of observation sites in the range of 1100-1700 m above sea level (MARTÍNKOVÁ & DUDICH 2003, SHENBROT & KRASNOV 2005). The range is divided into two regions: western Slovakia and Poland, and eastern Ukraine and Romania. It is island in the scale of its entire distribution and fragmented within each inhabited mountain range (JURDÍKOVÁ *et al.* 2000, MARTÍNKOVÁ & DUDICH 2003, ZGRABCZYŃSKA & JURCZYŠYŃ 2004).

Zoological research at Babia Góra (Żywiec Beskids) was being carried out from the mid-nineteenth century, and mainly concerned some groups of insects, spiders, molluscs, fish, amphibians and birds. The interest in small mammals arose in the 1930s (HAITLINGER 1981, WOŁOSZYN & POSTAWA 2003).

In the 70's, there was found the occurrence of this species on the Slovakian side of the Beskids (DUDICH *et al.* 1981). In the 1980s, the species was found to occur both on the Polish and Slovak side of the Babia Góra range (HAITLINGER 1981). This species was mentioned in the Babia Góra range by: DUDICH *et al.* (1982), BOCHEŃSKI (1983), RACZYŃSKI (1983), HAITLINGER (1989), HUBA (1989), DUDICH (1991), DUDICH & ŠTOLLMANN (1991), PROFUS (1992, 2001), DUDICH & ŠTOLLMANN (1993), Karaska & Kocian (1993), TRNKA (2002), WOŁOSZYN & SZCZĘSNY (2002).

WOŁOSZYN & POSTAWA (2003) compiled all the available information on the *Microtus tatricus*, which inhabits the Polish part of the Babia Góra massif, including previously unpublished data. MARTÍNKOVÁ & DUDICH (2003) summarize all distribution data across the entire range of *M. tatricus* distribution (including the Babia Góra massif) and assess the species distribution at altitudes in relation to the evolutionary history of its fragmented distribution range.

Previously documented specimens caught in the Babia Góra massif in 1997 are in the museum collection of the Institute of Systematics and Animal Evolution of the Polish Academy of Sciences in Kraków (GAŁOZ 1997, south-west of Gówniak and south of the ruins of the Beskidenverin Hostel) (WOŁOSZYN & POSTAWA 2003). In the years 1997-1998 WOŁOSZYN & POSTAWA (2003) collected (using a trap-line), semi quantitative samples of small mammals but no Tatra Pine Vole was captured. MAKOMASKA-JUCHIEWICZ *et al.* 2022 they indicate the occurrence of the *M. tatricus* from 2009 (Babia Góra). These data, however, are not confirmed in the data of the Babia Góra National Park. Inventory work was also carried out between 6 and 23 August 2012 (BAJOREK-ZYDRON & JĘDRZEJCZAK 2012, MIKA 2012). Tatra pine vole has not been found. WAŻNA & CICHOCKI (2014) monitored the *M. tatricus* species and natural habitats in the Tatra Mountains, in the Babia Góra and Pilsko massif in 2013. Catches did not bring any data on the population of *Microtus tatricus* in Babia Góra. The monitoring studies were carried out on 3 sites, in section 28 within the *Plagiothecio-Piceetum tatricum* community. In 2021, the species was monitored, harvested at 2 monitoring sites, no species was recorded (BAJOREK-ZYDRON & JĘDRZEJCZAK 2012).

The aim of the article is to confirm the occurrence of *Microtus tatricus* in the Babia Góra massif and to provide possible reasons for the reduction in numbers.

## RESEARCH METHODOLOGY

The research was carried out on the basis of the Agreement on cooperation concluded on June 16, 2021 in Zawoja between the University of Opole with its headquarters in Opole and the Babiogórski National Park with its headquarters in Zawoja and the permit of the Minister of Climate and Environment (Decision DOP-WPN.055.3.2021.AD1574716.5269500.4214654 dated May 14, 2021). The aim of the research, which lasted from July 1, 2021 to July 28, 2021, was to supplement the data on the distribution of small mammals in the background of plant communities of the Babia Góra National Park.

The research area covered the of the Babia Góra National Park. From the proposed plant communities, the following have been partially recognized: fragments of the lower montane forest, the upper montane forest, *Athyrio-Sorbetum*, *Pinetum mugi carpaticum*, herb and grass communities, montane clearing coalitudemunities, high-mountain grassland communities in fragments of forest compartments: 72A have been partially explored; 72; 73; 74; 11A; 22; 23. 28.

Catching of small mammals was carried out with the use of traps – Humane rodent traps and cylinders. Traps equipped with food were placed on trap routes along the contour. The distance between the traps was about 10 m. Traps were placed on each transect for a minimum of 3 days. The traps were checked twice a day. The caught specimens were marked with regard to species and sex, and also the basic biometric measurements were made. The caught specimens were marked non-permanently by cutting a fragment of fur in the dorsal part of the body. After performing the activities, the specimens were released in the place of capture.

## RESULTS

As a result of almost monthly catches (July 1-28, 2021), one individual of the *Microtus tatricus* was caught (July 26, 2021) above the Beskidenverein Hostel (Fig. 3), slightly east of the Głodna Woda spring (49.570900; 19.532071) (compartment 28a) at an altitude of 1617 m above sea level. An adult male (Fig. 1) had brown fur with a chestnut shade, turning into a whitish belly, very small eyes, ears slightly protruding from the fur. Body weight was 19 g, body length 9.2 cm, tail length 3.6 cm, hind foot length 1.8-2.0 cm. These data are consistent with the morphological differences compared to the species of rodents (WAŻNA & CICHOCKI 2015) with which the Tatra pine vole can be confused (*Microtus subterraneus*, *Microtus arvalis* and juvenile *Clethrionomys glareolus*). For additional verification of the species, photos of the foot were also taken and compared with the diagnostic drawings of KRATOCHVIL (1970) (Fig. 2).

## DISCUSSION

*Microtus tatricus* uses a wide range of habitats (HAILINGER 1981, JURDÍKOVÁ *et al.* 2000), first, it is relatively open, wet terrain in a natural mountain forest – usually located in inverted valleys, or wet rocky meadows in the subalpine zone (ROSICKÝ & KRATOCHVIL 1955, PELIKÁN 1955, KOWALSKI 1960, KRATOCHVIL 1964, KRATOCHVIL & GAISLER 1967, CHUDOBA & HAILINGER 1971, FLOUSEK *et al.* 1985, ZAGORODNYUK 1989, ZAGORODNYUK *et al.* 1992, ADAMSKI 1996, JURDÍKOVÁ *et al.* 2000, CICHOCKI *et al.* 2011). *Microtus tatricus* was also occasionally caught in the thickets of dwarf mountain pine (CHUDOBA & HAILINGER 1971, WAŻNA & CICHOCKI 2015). DUDICH *et al.* (1981) and JURČOVIČOVÁ & RUDÁ (2006) found Tatra vole on shady slopes.



Fig. 1. A specimen of an adult male, caught on July 26, 2021. above the Beskidenverein Hostel (Babia Góra).  
Ryc. 1. Okaz dorosłego samca, złowiony 26 lipca 2021 roku nad schroniskiem Beskidenverein (Babia Góra).

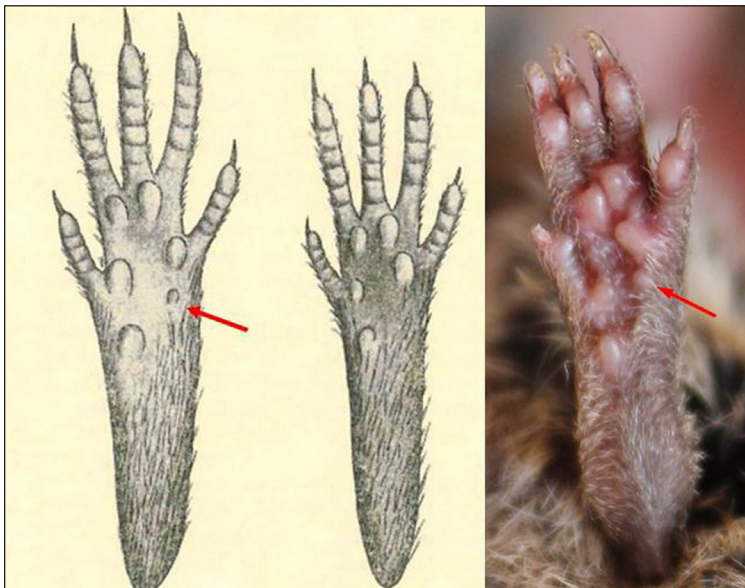


Fig. 2. Differences in the feet of the Tatra pine vole (from the left) according KRATOCHVÍL (1970) and the caught specimen (at right). Arrows mark the sixth callus on the hind foot.

Ryc. 2. Różnice w wyglądzie stóp nornika tatrzańskiego (od lewej) i nornika zwyczajnego (w środku) wg KRATOCHVÍLA (1970) oraz złowionego okazu (po prawej). Strzałki oznaczają szósty kallus na tylnej nodze.



Fig. 3. Trapping place for *Microtus tatricus* (July 26, 2021) above the Beskidenverein Hostel.

Ryc. 3. Miejsce odłowu *Microtus tatricus* (26.07.2021) powyżej schroniska Beskidenverein.

The specimen caught in July 2021 in Babia Góra was found on the sunny southern slope at an altitude of 1617 m. The species is also reported from Sokolica, about 1680 m above sea level (WOŁOSZYN & POSTAWA 2003) – we do not know if the location has been given precisely) and KARASKA & KOCIAN (1993) from Babia Góra (860-1710 m above sea level).

Historical data usually points to lower locations (only a specimen from the collection of the Institute of Systematics and Evolution of Animals of the Polish Academy of Sciences – Sagan: 21.07.1933 is given as Diablak-Sokolica, approx. 1680 m above sea level (WOŁOSZYN & POSTAWA 2003). However, specimens were most often caught in the range of 1200-1600 m a.s.l. (CICHOCKI *et al.* 2011) above the yellow line. For comparison, in the Tatra Mountains, the *Microtus tatricus* was found most often at an altitude of 1100-2300 m above. The population of Pilsko (Żywiec Beskids) is located at an altitude of 1100-1350 m above sea level (CICHOCKI *et al.* 2011). This would mean that the *Microtus tatricus* could be found much higher than the peak of Babia Góra but the height of Babia Góra is 1725 m above sea level.

The authors suggest that the northernmost population of *Microtus tatricus* (Babia Góra massif) may be disappearing or these are unrecognized fluctuations of this species.

Most researchers state that no population fluctuations or outbreaks are known (HAPOLD 1998, JURDIKOVÁ *et al.* 2000, MARTÍNKOVÁ & DUDICH 2003, MARTÍNKOVÁ *et al.* 2004, ZIMA *et al.* 2008). However, the studies of WAŻNA & CICHOCKI (2014) conducted in 2013 did not provide any data on the population of the Tatra Vole population in Pilsko and Babia Góra.

The authors argue that the absence of *Microtus tatricus* on these surfaces should not be taken as indicative of poor condition, but it is worrying that for years there has been no data on that species from the Babia Góra massif. The situation of the species in Pilsko

is also unclear. The species was not found in locations that theoretically meet all habitat requirements, although it was found in 2010–2011 (CICHOCKI *et al.* 2011, WAŻNA & CICHOCKI 2014).

In recent decades, many species of plants and animals in Europe have moved north and uphill. The flora of mountain peaks across Europe has shown significant changes in species composition, with species adapted to cold decreasing their ranges and species adapted to heat expanding their ranges (GOTTFRIED *et al.* 2012). Changes in ecosystems, climate change have the greatest dynamics and may soon be among the leading causes of biodiversity loss (MAXWELL *et al.* 2016), including the local disappearance of The Tatra Pine Vole. In the report (DÍAZ 2019), climate change is already in third place on the list of factors with the greatest impact on species extinction. Species have been known to shift to higher or lower latitudes, or to move up or down slopes, depending on whether the climate has been warming or cooling (PARMESAN 2006). It is also related to cyclical changes in the Pleistocene. Species migrated either to higher or lower latitudes, or moved up or down mountain slopes, depending on whether the climate was warming or cooling.

We may probably be dealing with a decrease in the range of this species with a shift to higher mountainous areas. When it cools down again, the lost areas will be repopulated. The distribution of many terrestrial animals has recently shifted to higher height (CHEN *et al.* 2011). These shifts in range can be partly attributed to the observed changes in climatic conditions, cold-adapted species are losing territory the fastest (JIGUET *et al.* 207). ISAAC (2009) and DIRNBÖCK *et al.* (2011) predicts a continued northward and uphill movement of many plant and animal species over the next century. Endemic species with specific biotope requirements or a small range of occurrence will be the most vulnerable, in particular if they face migration barriers.

The current research conducted by the authors (2021) indicates that small mammals of the genera such as *Apodemus*, *Myodes* dominate the theriofauna of Babia Góra and their occurrence reaches the height of 1725 m above sea level, which may also have an impact on the decline in *M. tatricus* number. WOŁOSZYN & POSTAWA (2003) mention only since 2012 the species *Apodemus flavicollis* from mountain ecosystems. Previously, no data were available on catches of this species from this level of mountain ecosystems.

Historically, *Apodemus flavicollis* co-occurred with *Microtus tatricus*, however, the current population of *A. flavicollis* is more numerous (own observations 2021) and perhaps more aggressive in relation to *Microtus tatricus*.

The Tatra Pine Vole lives about 1.5–2 years and the female gives birth to a litter of 2–4 young (KRATOCHVIL 1969) only after overwintering and reaching a weight of about 23 g (ZGRABCZYŃSKA & JURCZYSZYN 2004). The reasons for the disappearance (reduction in numbers) should also be sought in the short age of the animals.

DEVICTOR *et al.* (2012) show species expansion by extending the range north and/or uphill. These authors found that the movement of animal species is unable to keep pace with climate change. The observed northward and uphill movement of many plant and animal species is projected to continue into the current century. Climate change is one of the most serious contemporary threats to biodiversity in the world (ISAAC 2009) and the negative effects of climate change are already visible in various taxa and ecosystems (WALTHER *et al.* 2002). These changes are often favorable for common species, which become competitors for rare species. This phenomenon can have catastrophic consequences for many rare, endemic mammals that have evolved and survived in ecologically stable refuges, such as mountain cloud forests (GRAHAM *et al.* 2006) and observed Tatra Pine Vole.

Understanding the body's response to changing environmental conditions is particularly relevant in the era of increasing anthropopressure and climate change, in the context of rare and protected species, which include habitat specialists, including Arctic-Alpine species. In this case, it is a valuable research area that is protected as a National Park. There seems to be no comparable research on endemic mammals of this mountainous area at present, and a lack of knowledge about the complex interactions between the various factors.

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## STRESZCZENIE

### Czy darniówka tatrzańska *Microtus tatricus* przetrwa w niższych rejonach górskich?

Darniówka tatrzańska *Microtus tatricus* jest jedynym endemicznym gatunkiem ssaków w Karpatach. Niestety od 1997 r., na najbardziej wysuniętym na północ stanowisku w masywie Babiej Góry nie obserwowano tego gatunku. W pracy opisano ponowne odłowienie tego gatunku w dniu 26 lipca 2021 r. nad schroniskiem Beskidenverin (49.570900 N; 19.532071 E) na wysokości 1617 m n.p.m. W artykule omówiono prawdopodobne przyczyny lokalnego wymierania tego gatunku. Głównymi zidentyfikowanymi czynnikami są szybkie zmiany klimatu, które wpływają na interakcje między gatunkami a środowiskiem.

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