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Shrews Soricidae of the Silesian Beskid Mountains

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Abstract: During a study conducted in 2002–2008 the following 6 species of shrews were recorded in the Silesian Beskid Mts. (Western Carpathians, S Poland): *Sorex araneus*, *S. minutus*, *S. alpinus*, *Neomys fodiens*, *N. anomalus* and *Crocidura suaveolens*. The most widespread was *S. araneus* (63.4% of locations), followed by *S. alpinus* (13.4%), *S. minutus* (12.2%), *N. fodiens* (7.3%), *N. anomalus* (2.4%) and *C. suaveolens* (1.2%). Among dead shrews (n=47) *S. araneus* comprised 56.6%, *S. minutus* 21.7%, *S. alpinus* 10.9%, *C. suaveolens* 4.3%, *N. anomalus* 4.3% and *N. fodiens* 2.2%. During capture with live traps only *S. araneus* was recorded, constituting 2.5% of all small mammals captured. It was most frequently caught in deforested areas.

Key words: shrew fauna, Carpathians, mountains

INTRODUCTION

Diversity of mammal species in the Silesian Beskid Mountains is very unevenly documented (Witkowski 1997). There is relatively good knowledge regarding ungulates, carnivores and bats (Pucek & Raczyński 1983, Nowak et al. 2005, Mysłajek et al. 2007), but small rodents and shrews still require more attention (Sagan 1950, Mysłajek & Nowak 2003). Of the eight species of shrews (*Soricidae*) that occur in Poland (Pucek 1984) only four – *Sorex araneus*, *S. minutus*, *S. alpinus* and *Neomys fodiens*, have been recorded within the Silesian Beskid Mts. until now (Sagan 1950, Pucek & Raczyński 1983).

The aim of our study was to complete the list of shrew species living in the Silesian Beskid Mountains.

STUDY AREA

The Silesian Beskid Mountains (SBM) are located in the western-most part of the Polish Carpathians (18°59'–19°07' N; 49°33'–49°47' E), and are divided into two parts – Polish (ca 560 km^2) and Czech (ca 40 km^2). Research was conducted only in the Polish part. Most of the area is protected as a landscape park (386 km^2) established in 1998, and a major part (263 km^2) was recently designated as a Natura 2000 site. There are also several nature reserves, but they cover only *ca.* 1% of the total area (Wilczek 2006).

The altitude within the study area ranges from 400 to 1257 m a.s.l. The climate of the SBM is mainly determined by altitude and is divided into three climatic zones: semi-warm (below 670 m a.s.l.), semi-cold (670–980 m a.s.l.) and cold (above 980 m a.s.l.) (Hess 1965, Table 1). Climatic zones correlate to plant zones. The lowest of these was formerly covered by rich forests dominated by oak (*Quercus* sp.) and lime (*Tilia* sp.). The forest cover has changed extensively and is presently dominated by farmland, villages, and towns. The middle zone was originally covered by beech (*Fagus sylvatica*) and fir (*Abies alba*) with an admixture of spruce (*Picea alba*), while the highest zone was dominated by natural spruce forests. Currently both the middle and highest zones are predominantly covered by planted spruce monocultures

(Wilczek 2006). There are large meadows located within the forests, some are still used as pasture for livestock grazing, but the rest have not been grazed for a long time, and have subsequently been naturally re-colonized by young spruce, beech, and birch (*Betula pendula*) trees. There are numerous towns, villages, weekend cabins, and recreation centres along the forest peripheries as well as many ski lifts, ski routes, and tourist paths within the forest. Human penetration into the forest is the most intense during weekends and holidays (Mysłajek 2001). The average density of human population in the SBM is the highest in the Polish Carpathians, on average 150 inhabitants/km^2, and it reaches up to 300 inhabitants/km^2 near the town of Bielsko-Biała (Walaszek 2002).

Table 1. Characteristics of the climatic zones in the Silesian Beskid Mountains (according to Hess 1965).

Climatic zones	Elevation [m a.s.l.]	Average temperature [°C]	Annual precipitation [mm]	Snow occurrence [days]	Length of vegetation season [days]
Cold	> 980	2	1600	250	140
Semi-cold	670 – 980	4	1400	210	170
Semi-warm	< 670	6–8	800–1000	110–165	200–220

METHODS

The main method used to search the shrew fauna of the SBM was accidental collection of dead individuals, mainly killed and left uneaten by predators. In total we found 47 dead shrews between 2002–2008. We obtained additional data by capturing small mammals in live traps between 2004–2007. Wooden box traps baited with grain were originally set up to study rodents, so shrews were captured only occasionally. In main habitats occurring within the study area – deciduous forests, coniferous forests and deforested areas (11 plots), distributed in every elevation zone, we set a line of 7–10 traps 10 m apart each other. Trapping was conducted in every September for 7 consecutive days. During 2389 'trap-nights' we captured 38 shrews. All collected and captured individuals were identified by external features and tooth characteristics according to the taxonomic key of Pucek (1984). We combined our data with published observations made in 1936–1938, which were obtained by capturing shrews with snap and pitfall traps (Sagan 1950). Altogether we analyzed 82 locations of 128 individual shrews within the SBM.

For each location of a given species we recorded: the latitude and longitude, the code of the Universal Transverse Mercator (UTM) grid, the elevation above sea level in metres. We obtained the position and altitude for every location in the field with GPS unit GPSMap 60CSx (Garmin, USA), while we derived the UTM grid by conversion of latitude and longitude with Gnomon software version 3.1 (Desmodus, Poland). For data published by Sagan (1950), we were able to define only an elevation and UTM grid, as the author has not used geographic coordinates, but only general descriptions of places.

RESULTS

In the SBM we recorded the following 6 species of Soricidae – *Sorex araneus* Linnaeus, 1758; *Sorex alpinus* Schinz, 1837; *Sorex minutus* Linnaeus, 1758; *Neomys fodiens* (Pennant, 1771); *Neomys anomalus* (Cabrera, 1907) and *Crocidura suaveolens* (Pallas, 1811). Shrews were recorded at 82 locations presented in Appendix 1.

S. araneus was the most widespread species in the SBM, accounting for 63.4% of known shrew locations. It was followed by *S. alpinus* (13.4%) and *S. minutus* (12.2%), *N. fodiens* (7.4%), *N. anomalus* (2.4%) and *C. suaveolens* (1.2%) (Appendix 1).

Among dead shrews found within the SBM (n=47) the dominant species was *S. araneus* (56.6%), also common were *S. minutus* (21.7%) and *S. alpinus* (10.9%), while the remaining three species were sparse – *C. suaveolens* (4.3%), *N. anomalus* (4.3%) and *N. fodiens* (2.2%).

In the case of *C. suaveolens*, the only location found was near buildings in a village, where two adults were killed by a cat. We also discovered a nest with four young below plastic foil covering a small heap of gravel at the same location.

During capture with live traps, we caught 1510 small terrestrial mammals. However shrews, solely *S. araneus*, constituted only 2.5% of them (38 individuals). We captured *S. araneus* most frequently in deforested areas (meadows and clearcuts), while it was rarely trapped in all types of deciduous forests (beech, oak and riparian forests) (Table 2).

Table 2. Common shrews *Sorex araneus* caught with live traps in main habitats within climatic zones in the Silesian Beskid Mountains 2004–2007. Recalculated to number of individuals per 100 trap-nights.

Habitat type	Semi-warm zone	Semi-cold zone	Cold zone	Average
Deforested areas	3.5	1.8	5.0	3.4
Deciduous forests	0.0	0.5	-	0.1
Coniferous forests	0.5	0.9	1.8	1.1
Average	1.2	1.1	3.4	1.6

DISCUSSION

Although there are many methods for the census of small mammals (Krebs 2006), the species composition of shrew fauna has mostly been studied by trapping and analysis of owl pellets (e.g. Bryja & Rehák 1998, Górecki et al. 2000). During trapping effort, shrews show preferences for pitfall traps and are rarely captured with either live or snap traps (Pucek 1969). The collection of dead individuals we used in order to assess species composition of shrew fauna is rarely used as a research method because it is considered very labour intensive. However, dead shrews can frequently be found, as they are often killed and left uneaten by mammalian predators (Jędrzejewska & Jędrzejewski 1998).

In comparison with data on shrew fauna of the SBM obtained in 1936–1938 (Sagan 1950), we recorded two additional species – *N. anomalus* and *C. suaveolens*. Altogether, the shrew fauna of the Silesian Beskid Mts. includes 6 out of 8 shrew species of Poland (Pucek 1984). This is probably a complete list of species occurring within SBM. Amongst the remaining shrew species, *Sorex caecutiens* Laxmann, 1788 was recorded exclusively in the Białowieża Forest (Pucek & Raczyński 1983, Pucek 2001a), while *Crocidura leucodon* (Hermann, 1780) occurs in south-east Poland and has not been recorded in areas adjacent to the SBM until now (Chudoba & Haitlinger 1971, Pucek & Raczyński 1983, Adamski 1996, Bryja & Rehák 1998, Bryja et al. 2002, Wołoszyn & Postawa 2003).

The shrew fauna of the SBM is heavily dominated by the *Sorex* genera, especially by *S. araneus*. Such a pattern was observed in the most of the mountain ranges of the Polish Carpathians (Chudoba & Humiński 1968, Chudoba & Haitlinger 1971, Adamski 1996, Górecki et al. 2000, Taborska 2004). *S. araneus* was captured with higher frequency in deforested areas such as clearcuts and meadows. This can be explained by the higher availability of soil invertebrates, mainly earthworms, in such environments (Rożen & Mysłajek 2005), which form a substantial part of the diet of *S. araneus* (Churchfield 1982, Churchfield & Rychlik 2006). *S. minutus* occurs in every mountain range in Poland, where it can be quite abundant (Chudoba & Haitlinger 1971). In the SBM it was rarely found above 1000 m a.s.l., contrary to the neighbouring mountain ranges, where it constituted up to 22.7% of captured individuals in areas of higher elevation (Chudoba & Haitlinger 1971). In Poland, *S. alpinus* occurs exclusively in mountains – the Carpathians and Sudetes (Pucek & Raczyński 1983), and can be relatively numerous in some locations (Haitlinger & Humiński 1964). The lowest recorded location for this species was at 600 m a.s.l. (Sagan 1950, this study), but in the neighbouring Beskid Żywiecki Mts. it was also found at 500 m a.s.l (Chudoba & Haitlinger 1971).

Similarly to Sagan (1950), we confirmed occurrence of *N. fodiens* only in the lowest climatic zone, while *N. anomalus* occurs also at higher elevations. However, in European mountains both species have been recorded far above elevations where we observed them within the SBM (Mitchell-Jones et al. 1999), and due to the small sample size collected by us we were unable to define their altitudinal distribution in this area.

We observed only a few individuals of *C. suaveolens* in the SBM, all of them at the same low elevation location near buildings. This species is frequently observed in the neighbourhood of human settlements, near buildings, around irrigation channels, at the edges of fields, and walls or fences surrounding houses (Tez 2000). It is rarely observed at higher elevations. However, in Poland, it was recorded up to 1250 m a.s.l., e.g. near the tourist shelter in the Beskid Żywiecki Mts. (Haitlinger 1967). The SBM are densely inhabited by people and there are many buildings at higher elevations (Mysłajek 2001), that could provide suitable conditions for *C. suaveolens.*

Among the taxa we recorded in the SBM, the most valuable from the conservation point of view is the occurrence of both *N. anomalus* and *S. alpinus*. They are not globally endangered (Stone 1995), but their conservation is regionally important. *N. anomalus* is included in the Polish Red Data Book (Pucek 2001b) and is protected by the Bern Convention, while *S. alpinus* is mentioned as near threatened by IUCN Red List of Threatened Species Regional Assessment for Europe (Temple & Terry 2007).

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STRESZCZENIE

[Ryjówki (Soricidae) Beskidu Śląskiego]

W Beskidzie Śląskim stwierdzono występowanie 6 gatunków ryjówek. Były to: ryjówka aksamitna *Sorex araneus* Linnaeus, 1758, ryjówka malutka *Sorex minutus* Linnaeus, 1758, ryjówka górska *Sorex alpinus* Schinz, 1837, rzęsorek rzeczek *Neomys fodiens* (Pennant, 1771), rzęsorek mniejszy *Neomys anomalus* (Cabrera, 1907) i zębiełek karliczek *Crocidura suaveolens* (Pallas, 1811). Najczęściej notowana była ryjówka aksamitna (63,4% stanowisk), następnie ryjówka alpejska (13,4%), ryjówka malutka (12,2%), rzęsorek rzeczek (7,3%), rzęsorek mniejszy (2,4%) i zębiełek karliczek (1,2%) (Appendix 1). Wśród martwych ryjówek odnalezionych w Beskidzie Śląskim (n=47) *S. araneus* stanowił 56,6%, *S. minutus* 21,7%, *S. alpinus* 10,9%, *C. suaveolens* 4,3%, *N. anomalus* 4,3% a *N. fodiens* 2,2%. W trakcie odłowów w drewniane pułapki żywołowne rejestrowano wyłącznie ryjówkę aksamitną, która była najczęstsza na powierzchniach bezleśnych (Tab. 2).

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Appendix 1. Locations of shrews in the Silesian Beskid Mountains. For data derived from Sagan (1950) only the UTM grid and elevation were available

1	2	3	4	5
Species	Latitude N	Longitude E	UTM grid	Elevation [m a.s.l.]
Crocidura suaveolens	49° 39' 30"	19° 05' 33"	CA60	530
Neomys anomalus	49° 40' 11"	19° 00' 34"	CA50	1110
	49° 37' 52"	19° 03' 41"	CV59	870
Neomys fodiens			CA40	450
			CA51	650
			CA51	600
			CA51	550
			CA51	500
	49° 39' 42"	19° 03' 22"	CA50	570
Sorex alpinus			CV59	780
			CV59	900
			CV59	900
			CV59	900
			CA51	650
	49° 37' 07"	19° 00' 54"	CV59	1070
	49° 39' 10"	19° 02' 40"	CA50	600
	49° 39' 10"	19° 02' 40"	CA50	600
	49° 40' 32"	19° 02' 44"	CA50	950
	49° 37' 09"	19° 04' 03"	CV69	1030
	49° 38' 54"	19° 04' 30"	CA60	520
Sorex araneus			CA40	550
			CA40	550
			CA40	600
			CA40	450
			CA40	550
			CV49	700
			CV59	780
	49° 41' 20"	18° 57' 29"	CA50	950
			CV59	1000
	49° 37' 44"	18° 58' 36"	CV59	899
			CV59	900
			CV59	700
			CV59	850
			CA51	1050
			CV59	800
			CV59	900
	49° 39' 56"	19° 00' 31"	CA50	1150
	49° 37' 58"	19° 00' 36"	CV59	1053
			CV59	1200
	49° 39' 03"	19° 00' 50"	CA50	950
			CA51	600
	49° 39' 10"	19° 00' 59"	CA50	990
	49° 40' 33"	19° 01' 05"	CA50	1150
			CA51	550
	49° 39' 36"	19° 01' 56"	CA50	796
	49° 40' 31"	19° 02' 29"	CA50	960
	49° 37' 45"	19° 02' 37"	CV59	1090
	49° 40' 32"	19° 02' 37"	CA50	960
	49° 37' 43"	19° 02' 45"	CV59	1070
	49° 39' 11"	19° 02' 45"	CA50	600
	49° 40' 24"	19° 02' 47"	CA50	830
	49° 40' 23"	19° 02' 49"	CA50	880
	49° 38' 26"	19° 02' 57"	CV59	990
	49° 40' 26"	19° 03' 03"	CA50	930
	49° 39' 44"	19° 03' 05"	CA50	580
	49° 38' 52"	19° 03' 06"	CA50	880

1	2	3	4	5
	49° 37' 43"	19° 03' 11"	CV59	1020
	49° 39' 29"	19° 03' 11"	CA50	575
	49° 39' 27"	19° 03' 14"	CA50	600
	49° 39' 43"	19° 03' 33"	CA50	575
	49° 37' 39"	19° 03' 46"	CV59	980
	49° 39' 47"	19° 03' 47"	CA60	550
	49° 37' 53"	19° 03' 58"	CV69	942
	49° 42' 46"	19° 04' 00"	CA60	520
	49° 38' 54"	19° 04' 33"	CA60	633
	49° 38' 06"	19° 04' 37"	CV69	952
	49° 39' 06"	19° 04' 48"	CA60	600
	49° 40' 01"	19° 05' 20"	CA60	505
	49° 39' 46"	19° 05' 20"	CA60	517
	49° 39' 29"	19° 05' 33"	CA60	530
	49° 39' 43"	19° 05' 38"	CA60	530
	49° 39' 37"	19° 05' 47"	CA60	520
Sorex minutus	49° 41' 21"	18° 53' 27"	CA40	680
			CV59	700
	49° 36' 51"	19° 02' 15"	CV59	730
	49° 38' 25"	19° 02' 56"	CV59	990
	49° 39' 44"	19° 02' 57"	CA50	580
	49° 39' 44"	19° 03' 01"	CA50	580
	49° 39' 45"	19° 03' 12"	CA50	565
	49° 42' 30"	19° 03' 23"	CA50	571
	49° 39' 09"	19° 03' 48"	CA60	920
	49° 39' 30"	19° 05' 33"	CA60	530