



Danger underground and in the open – predation on blind mole rats (Rodentia: Spalacinae) revisited

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Abstract

1. Being totally blind with no tail and earconch, blind mole rats – found in the Balkan Peninsula, Central and Eastern Europe, Middle East and North-East Africa – are the most specialised rodents for the subterranean lifestyle. However, they come to the surface occasionally due to unusual climatic events, foraging activity, collecting hay for bedding material, dispersal of the subadults, intraspecific aggression, and illness.
2. The only review of surface activity and suffered predation of blind mole rats (published in 1991) suggests that the surface activity of and, consequently, the predation on blind mole rats are uncommon events, and that they are preyed on mainly at night by owls.
3. The present review based on 57 scientific publications, 14 unpublished reports and several personal observations (from 15 countries) reveals that altogether 26 species of birds and mammals prey on blind mole rats either regularly or occasionally. It is evidenced herewith, that not only the number of predators, but even the percentage of blind mole rats in their diet has been seriously underestimated.
5. The tight relation between the colours of the soil and the pelage of blind mole rats suggests the importance of diurnal raptors via their selective impact. Predation by mammals happens relatively often and there is a high possibility that mustelids hunt blind mole rats not only on the surface but also inside their burrows. The labyrinth-like structure of the burrows can probably play a vital role confusing the mammalian predators trying to hunt inside the burrows, and increase the prey's chances to escape.
6. With the proven importance of blind mole rats as a food resource of several threatened birds of prey, the survival, reproduction success and population size of these species may partly also depend on the density of these rodents. Although many species within the subfamily are threatened themselves to different extents, the role of blind mole rat populations in the carnivore and raptor conservation should be considered and evaluated.

Keywords: *Nannospalax*, nature conservation, predator, *Spalax*, surface activity

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INTRODUCTION

The analysis of food remains from raptors and mammalian predators provides us information on their foraging habits, ethology, and ecology as well as the distribution and frequency of their prey species. In some cases – as those of secretive or little known species – the life of the prey itself is unveiled in surprising detail.

Blind mole rats (subfamily Spalacinae) can be found in the Balkan Peninsula, on the steppes of Central and Eastern Europe, in the Middle East (Asia Minor and the coastline of the Levant) and in a narrow coastal strip in North-East Africa (Musser & Carleton 2005).

Cytogenetic (Lyapunova et al. 1971) and molecular genetic (Hadid et al. 2012, Chişamera et al. 2013) works provided evidences of deep divergences within the subfamily therefore the two genera (*Spalax* and *Nannospalax*) classification scheme has been followed here in accordance with the most recent publications (Németh et al. 2009, 2013, Arslan et al. 2011, Kryštufek et al. 2012, Chişamera et al. 2013). The species of the subfamily have adapted to subterranean life (Méhely 1909, Topachevskii 1969, Savić & Nevo 1990). These small mammals have cylindrically shaped bodies with no external ears, a vestigial tail, very short legs and are completely blind as a result of spending their entire life in their tunnel system built underground (Vásárhelyi 1926, Topachevskii 1969). This subterranean way of life protects them from almost every predator (Vásárhelyi 1926, 1929, Watson 1961, Topachevskii 1969). However, they come to the surface occasionally (Pocock 1917, Montagu 1924, Vásárhelyi 1926, 1929, Bate 1945, Nevo 1961, 1979, Heth 1991) (Fig 1.). In the literature, various elucidations can be found for the surface activity of blind mole rats such as unusual climatic events (Méhely 1909, Vásárhelyi 1926, 1929), flooding (Sterbetz 1960, Horváth & Vadnay 2006) foraging activity (Loisel 1916, Montagu 1924, Vásárhelyi 1926, Nevo 1961), collecting hay for bedding material (Vásárhelyi 1926, 1929), dispersal of the young and the subadults (Vasarhelyi 1929, Nevo 1961, Topachevskii 1969, Heth 1991, Rado et al. 1992), intraspecific aggression (Vásárhelyi 1926, 1929, Zuri & Terkel 1996) and illness (Vásárhelyi 1929). Although Nevo (1961) suggests that blind mole rats may be active on the surface during the mating season possibly searching for a mate, it has been proven that mating takes place underground (Vásárhelyi 1926, 1929, Topachevskii 1969, Gazit et al. 1996, 1998, Gazit & Terkel 2000) and recent investigations show that searching for a mate normally happens underground (Moldován 2014). During their surface movements, blind mole rats are understandably vulnerable to predation (Vásárhelyi 1926, Topachevskii 1969, Heth 1991 and references therein). A detailed review of surface activity and suffered predation of blind mole rats in Israel has been published by Heth (1991). The author's findings suggest that the

surface activity of and, consequently, the predation on blind mole rats are uncommon events, and that blind mole rats are preyed on mainly at night by owls.

Nevertheless, since Heth's publication, further evidence of the predation on blind mole rats came to light from the whole distribution area of the subfamily and these data present a significant contribution to our current knowledge.

METHODS

We compiled data of the predation on blind mole rats from 57 scientific publications and from further 14 unpublished studies, reports and several personal observations. These sources have been written in 10 different languages and refer to the predation on blind mole rats from the territories of about 15 countries, representing a good coverage of the whole distribution area of the subfamily. However, information on blind mole rats' surface activity and predation phenomena are limited primarily to qualitative accounts.

RESULTS

According to our present knowledge, altogether 26 species of birds and mammals prey on blind mole rats either regularly or occasionally (Table 1).

List of predators

Owls

Athene noctua

The little owl (*Athene noctua*) is a small, mainly nocturnal species which, because of its compactness and strength, is able to catch large prey compared to its size, albeit its sizable prey is dominated by young individuals (Van Nieuwenhuysse et al. 2008). Most data on its mole rat consumption have been known from the Middle East (Kumerloeve 1955, Dor 1947a), inhabited by the smallest species of blind mole rats (Méhely 1909, Topachevskii 1969), *Nannospalax* (superspecies *ehrenbergi*). However, data was also recorded in the Carpathian Basin (Aczél-Fridrich & Hegyeli 2009) where a medium-sized member of the subfamily (*Nannospalax* (superspecies *leucodon*)) occurs.

Tyto alba

Heth referred to the barn owl as the blind mole rat's most important aboveground predator (Heth 1991). Most data were recorded in the Middle East (Abi-Said et al. 2014, Obuch & Benda 2009, Shehab 2005, Shehab & Al Charabi 2006, Charter et al. 2009, Nevo 1961, Dor 1947b, c, Heth 1991, Tores et al. 2005) and only a single, uncertain account from Central Europe is known to us (Zs. Aczél-Fridrich, pers. comm.). According to these analyses, the barn owl's diet contains blind mole rat remains in about 0.2-5%.

Asio otus

The 4 recorded data of long-eared owl (*Asio otus*) predation on blind mole rats were recorded in the Middle East (Bate 1945, Charter et al. 2012) and in Central Europe (Hungary and Romania) (Endes 1988, Hamar & Şutova 1965). The frequency of blind mole rats varies between 0.5-5% in the food remains.

Bubo bubo

Plenty of data are available in the scientific literature suggesting that the eagle owl (*Bubo bubo*) frequently preys on blind mole rats. Records came from the Middle East (Bates & Herrison 1989, Bayle & Prior 2006, Čermák et al. 2006, De Cupere et al. 2009, Inbar unpublished in Heth 1991), Central (Zs. Hegyeli unpublished, HNHM Mammal Collection) and Eastern Europe (Mitev & Boev 2006, Vetrov & Kondratenko 2006, Kondratenko & Tovpinets 2006, Atamas & Tovpinec 2006, Malovichko et al. 2012). The blind mole rats fits well into the size range of that of the most common prey species of eagle owls in Europe (Mitev & Boev 2006, Sándor & Ionescu 2009).

Raptors

Neophron percnopterus

The Egyptian vulture (*Neophron percnopterus*) is the only vulture (Aegypiinae) that has been proved to prey on blind mole rats. There are 5 accounts and observations from two countries in the region of South-eastern Europe (Milchev et al. 2012) and the Middle East (Mendelssohn 1972a, b, Heth 1991, Heth et al. 1988,). Most of the observations occurred in Israel, and Mendelssohn (1972a) noted that „...even the mole rat (*Spalax ehrenbergi* Nehring, 1989), a subterranean rodent of much lower density than voles and other field mice, appeared surprisingly often in the food of diurnal birds of prey, especially the Egyptian vulture and the black kite...”.

Milvus migrans

There are 3 data in the scientific literature supporting that blind mole rats also occur in the black kite's (*Milvus migrans*) food. Beside the notes of Mendelssohn (1972a, b) outlined above, Topachevskii (1969) in his monograph on blind mole rats also highlighted the black kite's role as an avian enemy of the blind mole rat within the range of the former Soviet Union.

Aquila heliaca

Among the eagle species that are known to eat mole rats, most of the data pertain to the eastern imperial eagle (*Aquila heliaca*). Data were recorded in Eastern (Viter 2013, Malovychko 2012) and Central Europe (Festetics in Glutz von Blotzheim et al. 1971, Ham 1977, 1980, Misirlic 1986, Vasic & Misirlic 2002), the Balkan region (Marin et al. 2004) and in Asia Minor (M. Horváth unpublished). After revising all information collected in the former Yugoslavia, Vasic & Misirlic (2002) classified the blind mole rat as „additional prey” in the imperial eagle's diet. The blind mole rat amounts to 4.17% of the Imperial eagle's diet in the Sakar Mountain, based on the Bulgarian study (Marin et al. 2004), while the ratio was 19% in the vicinity of Gerede in Turkey (M. Horváth unpublished). The frequency of blind mole rat remains in the imperial eagle's diet can reach 33% in Ukraine (Viter 2013). Plausibly, one of the most significant diurnal predators of the blind mole rats in Eastern and Central Europe is the imperial eagle.

Aquila nipalensis

Topachevskii (1961) mentioned the steppe eagle (*Aquila nipalensis*) as an avian enemy of the blind mole rat. This account from the former Soviet Union is the only one supporting that the steppe eagle preys on blind mole rats. Tingay et al. (2008) draws the attention to a notable account of the steppe eagle's foraging behaviour in Ethiopia „...in which an eagle ambushed subterranean blind or semi-blind mole rats (*Spalax* genus) by waiting to observe heaving soil before pouncing and burying its talons just below the surface of the earth (Brown 1976)...”. As Ethiopia lies far away from the blind mole rats' distribution area, the observation must pertain to other fossorial rodents, either *Tachyoryctes* or species of the Bathyergidae family. However, with this ability the steppe eagle is potentially capable to actively hunt blind mole rats.

Aquila chrysaetos

There is only a single observation made in Israel suggesting that the golden eagle (*Aquila chrysaetos*) may feed on mole rats (Maninger unpublished, in Heth 1991).

Hieraaetus fasciatus

There are five observations of the Bonelli's eagle preying on blind mole rats in Israel (Leshem 1975).

Buteo lagopus

Stomach content analysis of 18 rough-legged buzzard individuals conducted in the winter period in Romania revealed that 1.6% of the rough-legged buzzard's food was blind mole rat (Ciochia 1967).

Buteo buteo

In the literature, three indications, all from Ukraine, show that the common buzzard (*Buteo buteo*) hunts on blind mole rats (Ponomarenko 2008, Redinov 2009, 2012). Two of them include quantitative data showing that the buzzard's food contains mole rats up to 1% (Ponomarenko 2008, Redinov 2012).

Buteo rufinus

There are 4 accounts from 3 different countries in the literature, suggesting that the long-legged buzzard (*Buteo rufinus*) preys on blind mole rats. Observations were made in the Middle East (Aderet 1973, Maninger unpublished in Heth 1991), in the Balkan region (Vatev 1987) and in Eastern Europe (Kravchenko 2008, Shevtsov 2001). Blind mole rats account to almost half (44.4%) of the long-legged buzzard's food in the Olexandriya district, Kirovograd oblast, Ukraine (Shevtsov 2001), and similarly high percentages (41-49%) were recorded in a separate study in Prysamariе, Dnipropetrovsk oblast, Ukraine (Kravchenko 2008). Among the data from the literature, this is by far the highest ratio among predators that hunt mole rats.

Circus cyaneus

The hen harrier (*Circus cyaneus*) was mentioned by Topachevskii (1969) among the avian predators of the Eurasian blind mole rat. No quantitative data is available about the degree of blind mole rat predation.

Other birds

Not only birds of prey, but members of other families, mostly opportunist species, can occasionally catch mole rats. A hooded crow (*Corvus cornix*) was observed to feed on a blind mole rat in Israel (Ben-Yzhak and Ben-David unpublished, in Heth 1991), while in Romania a predation attempt by this species on *Spalax antiquus* was described by Herman (1872). The Eurasian magpie (*Pica pica*) was found in Hungary (Vásárhelyi 1926) to eat blind mole rats. Blind mole rats were proved to be preyed on by the Smyrna kingfisher (*Halcyon smyrnensis*) in Israel (Inbar unpublished, in Heth 1991) and by the Caspian gull (*Larus cachinnans*) in Ukraine (Atamas & Tovpinec 2006).

Mammals

Vulpes vulpes

Besides mustelids, the only wild mammal species that is known to prey on blind mole rats is the red fox (*Vulpes vulpes*) (Topachevskii 1969, Hegyeli unpublished).

Mustelidae

Vásárhelyi (1926) observed in Hungary that the least weasel (*Mustela nivalis*), the stoat (*Mustela erminea*) and the steppe polecat (*Mustela eversmanii*) hunted blind mole rats. Topachevskii (1969) mentions the least weasel, the stone marten (*Martes foina*), the European polecat (*Mustela putorius*) and the steppe polecat as predators of blind mole rats within the borders of the former Soviet Union. According to Ukrainian observations, the European and the steppe polecat are able to enter blind mole rats burrows and actively hunt them there. Of the investigated 157 Podolsk blind mole rat (*Spalax zemni*) burrows, 68 were opened by polecats during the autumn and the winter period (Ablentsev 1951).

The marbled polecat (*Vormela peregusna*) is also known for hunting blind mole rats. A single surface predation was seen in Israel, but at the same time, marbled polecats were often observed to occupy blind mole rat burrows (Ben-David 1988). Although a scat analysis of the species found no signs of blind mole rat predation (Ben-David 1988), Gorsuch & Larivière (2005) mentioned blind mole rats as part of the marbled polecat's winter diet. In addition, Heth & Todrank (1995) found that Israeli blind mole rats tend to avoid the urine of the marbled polecat, which further supports that this small mammalian predator is possibly able to enter the tunnel system of blind mole rats.

Domesticated mammals

Not only wild mammalian predators, but also two domestic mammals are known for hunting blind mole rats. Most of the data was collected in Hungary (Vásárhelyi 1926, 1929, Németh et al. 2013a) and in Romania, where local farmers claim that dogs, especially herd dogs occasionally catch blind mole rats. Burrows of *Nannospalax (leucodon) transsylvanicus* and *Spalax antiquus* are sometimes opened by shepherd dogs in Transylvania, Romania (Hegyeli unpublished). Cats preying on blind mole rats are known from observations made in Israel (Brickner-Braun et al. 2007), Hungary (Vásárhelyi 1926, 1929, Csathó A. pers.com) and from the former Soviet Union (Topachevskii 1969).

DISCUSSION

As it is evidenced above, the number of predators which prey on blind mole rats, is much higher than it was suggested previously and even the percentage of blind mole rats in their diet has been seriously underestimated. As follows from the frequent occurrence and the wide variety of predators we must go through a paradigm shift concerning the ecology and behaviour of spalacines, previously thought to follow an almost exclusively subterranean lifestyle.

Heth (1991) concluded that the majority of predation is performed by owls therefore the surface activity occurs mainly at night. It is also evidenced herewith that owls are important predators of blind mole rats; however, the impact of diurnal predators was significantly underestimated by Heth (1991). The occasionally very high percentage of blind mole rats in the diet of birds of prey (Kravchenko 2008, Shevtsov 2001, Viter 2013) suggests that in areas where these rodents are abundant, raptors hunt them very effectively. This fact also serves as a proof that the blind mole rats' surface activity can not be linked directly to nights. Investigations dealing with the activity pattern of blind mole rats clearly show a mainly diurnal monophasic locomotor activity (Rado et al. 1993, Zuri & Terkel 1996). The tight relation between the colours of the soil and the pelage of blind mole rats (Heth et al. 1988) suggests the importance of diurnal predators via their selective impact on the blind mole rat's colour.

Heth (1991) also concluded that because of the „almost complete absence of evidence of surface predation by mammals” this kind of predation is very uncommon. Nevertheless, predation by mammals happens relatively often and there is a high likelihood that mustelids hunt blind mole rats not only on the surface but also inside their burrows. The complexity of

the burrow system of a subterranean rodent is affected by many factors including food availability and soil conditions (Lövy et al. 2015, Romañach et al. 2005, Spinks et al. 2000, Šumbera et al. 2003), but the role of behavioural strategies in the structure of the tunnel system has also been reported (Lövy et al. 2015). The labyrinth-like burrows of the blind mole rats' with branches obstructed with soil, dead-end tunnels, and especially a frequently present narrow channel that spiral down vertically (Bodnár 1928, Vásárhelyi 1926, Hickman 1990, Németh 2006, authors' personal observations) can probably play a vital role confusing the mammalian predators trying to hunt inside the burrows, and increase the blind mole rat's chances to either escape or hide from its enemy. The antipredatory role of the structure of the burrow system is also supported by studies on other groups of subterranean rodents (Brown and Hickmann 1973, Hickmann 1977, Šklíba et al. 2008). However, due to the general lack of detailed investigations and review papers it is difficult to compare the aboveground and underground predation pressure on blind mole rats with that on other subterranean or fossorial rodents. Although many publications discuss this question, beside the generalised statements, direct observations and personal accounts are rare (e.g. Ansell 1960, Benett & Faulkes 2000, Cutrera et al. 2006, De Graaff 1981, Genelly 1965, Pienaar et al. 1980, Vasallo et al. 1994). However, the high number of the avian and mammalian predators of blind mole rats indicates that other, less extremely adapted subterranean rodents may suffer even more significant predation both above and below the ground.

Populations and habitats of many different European blind mole rat taxa are disappearing at an alarming rate which phenomenon raises serious conservation concerns (Kryštufek 1999; Kryštufek & Amori 2008; Németh *et al.* 2009, Csorba et al. 2015). Blind mole rat populations in many European countries are facing dramatic habitat loss, serious threatening factors and frequently even the remaining habitats and populations are heavily fragmented (Csorba et al. 2015, Németh et al. 2009, 2013a, b, c). At the same time, blind mole rats have play an important role in the species composition and community structure of vascular plants in dry grassland habitats (Zimmermann et al. 2014) and many of the raptors and carnivores identified as predators of blind mole rats (Table 1) are listed in the Annexes of the EU Birds Directive or the Habitats Directive (Table 2). The eagle owl, the Egyptian vulture, the black kite, the Eastern imperial eagle, the Bonelli's eagle, the golden eagle, the long-legged buzzard and the hen harrier are in the Annex I of the Birds Directive, whereas the steppe polecat and the European marbled polecat are listed in Annexes II. and IV. of the Habitats Directive. These species were used as indicator species when designating Natura 2000 sites, the network of areas protected by the EU. Nature conservation projects of EU (LIFE projects) aiming at

the protection of the Egyptian vulture, the Eastern imperial eagle and the Bonelli's eagle receive extra priority. Many of the above mentioned species are also threatened globally (BirdLife International 2014, Tikhonov et al. 2008a). Although the steppe polecat is classified as *Least concern* (Tikhonov et al. 2008b), denoting that it's not threatened globally, it is classified in the IUCN EU 25 List as *Endangered* (Temple & Terry 2007), and its European populations were found to be generally decreasing (Šálek et al. 2013). One of the LIFE+ projects funded by the EU aims to reinforce ongoing efforts to strengthen the European core populations of the saker falcon (*Falco cherrug*) and the Eastern imperial eagle by stopping the decline of the existing small mammals' populations that serve as their prey (http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=4880).

With the proven importance of blind mole rats as a food resource of several threatened predators the survival, reproduction success and population size of these species may partly also depend on the density of blind mole rats. Although many species within the Spalacinae subfamily are threatened themselves to different extents the role of blind mole rat populations in the carnivore and raptor conservation should be considered and evaluated.

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Table 1. The known predators of blind mole rats

Predator species			Country or territory	Blind mole rat taxon	ratio of blind mole rats in the food (%)	Reference
Owls	Little owl	<i>Athene noctua</i>	Turkey	<i>Nannospalax</i> (superspecies <i>xanthodon</i>)	-	Kumerloeve 1955
			Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Dor 1947c
			Romania	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Aczél-Fridrich & Hegyeli 2009
	Barn owl	<i>Tyto alba</i>	N Lebanon	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	0,40%	Abi-Said et al. 2014
			SW Lebanon	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Obuch & Benda 2009
			S Syria	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	5,17%	Shehab 2005
			N Syria	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	0,15%	Shehab & Al Charabi 2006
			W Syria	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Obuch & Benda 2009
			Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	0,2-1,4%	Charter et al. 2009
					-	Nevo 1961
					-	Dor 1947 b, c
					0,30%	Heth 1991
			N Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	0,35%	Obuch & Benda 2009
					0,20%	Tores et al. 2005
	Romania	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Aczél-Fridrich, unpublished		
Long-eared owl	<i>Asio otus</i>	Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	0,53%	Charter et al. 2012	

		Lebanon	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Bate 1945	
		Hungary	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Endes 1988	
		Romania	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	1-5%	Hamar & Şutova 1965	
	Eagle owl	<i>Bubo bubo</i>	SW Turkey	<i>Nannospalax</i> (superspecies <i>xanthodon</i>)	-	De Cupere et al. 2009
			E Turkey	<i>Nannospalax</i> (superspecies <i>xanthodon</i>)	-	Čermák et al. 2006
			Jordan	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Bates & Harrison 1989
			Lebanon	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Bayle & Prior 2006
			E Ukraine	<i>Spalax microphthalmus</i>	3,66-4,14%	Vetrov & Kodratenko 2006
				<i>Spalax microphthalmus</i>	8%	Kodratenko & Tovpinets 2006
			Ukraine	<i>Spalax microphthalmus</i>	-	Atamas & Tovpinec 2006
			SW Russia	<i>Spalax microphthalmus</i>	0,50%	Malovichko et al. 2012
			Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Inbar, unpublished in Heth 1991
			Bulgaria	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	0,88-4,24%	Mitev & Boev 2006
Romania	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Hegyeli, unpublished			
Raptors	Egyptian vulture	<i>Neophron percnopterus</i>	Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Mendelssohn 1972a, b
					-	Heth et al. 1988
					-	Levi & Shela, unpublished in Heth 1991
	E Bulgaria	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Milchev et al. 2012		
	Black kite	<i>Milvus migrans</i>	Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Mendelssohn 1972a, b
former Soviet Union			not determined	-	Topachevskii 1969	

	Eastern imperial eagle	<i>Aquila heliaca</i>	N Serbia	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Festetics, unpublished in Glutz von Blozheim et al. 1971	
						-	Ham 1977, 1980
						-	Vasic & Misirlic 2002
			E Ukraine	<i>Spalax microphthalmus</i>	33%	Viter 2013	
			Bulgaria	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	4,17%	Marin et al. 2004	
			NW Turkey	<i>Nannospalax</i> (superspecies <i>xanthodon</i>)	19,00%	Horváth, unpublished	
			SW Russia	<i>Spalax microphthalmus</i>	3,5-5,7%	Malovychko 2012	
	Steppe eagle	<i>Aquila nipalensis</i>	former Soviet Union	not determined	-	Topachevskii 1969	
	Bonelli's eagle	<i>Hieraetus fasciatus</i>	Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Leshem 1975	
	Golden eagle	<i>Aquila chrysaetos</i>	Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Maninger, unpublished in Heth 1991	
	Long-Legged buzzard	<i>Buteo rufinus</i>	Bulgaria	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Vatev 1987	
			E Ukraine	<i>Spalax microphthalmus</i>	41-49%	Kravchenko 2008	
			Ukraine	<i>Spalax zemni</i>	44,40%	Shevtsov 2001	
Israel			<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Aderet 1973		
Common buzzard	<i>Buteo buteo</i>			-	Maninger, unpublished in Heth 1991		
		SW Ukraine	not determined	-	Redinov 2009		
		Ukraine	<i>Spalax microphthalmus</i>	1,09%	Ponomarenko 2008		
		Ukraine	<i>Spalax microphthalmus</i>	1,10%	Redinov 2012		
Rough-Legged buzzard	<i>Buteo lagopus</i>	Romania	<i>Spalax antiquus</i>	1,60%	Ciochia 1967		
Hen harrier	<i>Circus cyaneus</i>	former Soviet Union	not determined	-	Topachevskii 1969		
Other birds	Hooded crow	<i>Corvus cornix</i>	Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Ben-Yzhak & Ben-David, unpublished in Heth 1991	
	Eurasian magpie	<i>Pica pica</i>	Hungary	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Vásárhelyi 1926	

	Smyrna kingfisher	<i>Halcyon smyrnensis</i>	Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Inbar, unpublished in Heth 1991
	Caspian gull	<i>Larus cachinnans</i>	Ukraine	<i>Spalax microphthalmus</i>	-	Atamas & Tovpinec 2006
Wild mammals	Red fox	<i>Vulpes vulpes</i>	Romania	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Hegyeli, unpublished
			former Soviet Union	not determined	-	Topachevskii 1969
	Least weasel	<i>Mustela nivalis</i>	Hungary	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Vásárhelyi 1926
	Stoat	<i>Mustela erminea</i>	Hungary	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Vásárhelyi 1926
	Stone marten	<i>Martes foina</i>	former Soviet Union	not determined	-	Topachevskii 1969
	European polecat	<i>Mustela putorius</i>	Ukraine	<i>Spalax zemni</i>	-	Ablentsev 1951
	Steppe polecat	<i>Mustela eversmanii</i>	Hungary	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Vásárhelyi 1926
			Ukraine	<i>Spalax zemni</i>	-	Ablentsev 1951
Marbled polecat	<i>Vormela peregusna</i>	Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Ben-David 1988, Gorsuch & Larivière 2005, Heth & Todrank 1995	
Domesticated mammals	Dog	<i>Canis lupus familiaris</i>	Hungary	<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Vásárhelyi 1926, 1929
					-	Németh et al. 2013a
			Romania	<i>Nannospalax</i> (superspecies <i>leucodon</i>), <i>Spalax antiquus</i>	-	Hegyeli, unpublished
	Cat	<i>Felis silvestris catus</i>	Israel	<i>Nannospalax</i> (superspecies <i>ehrenbergi</i>)	-	Brickner-Braun et al. 2007
			former Soviet Union	not determined	-	Topachevskii 1969
Hungary			<i>Nannospalax</i> (superspecies <i>leucodon</i>)	-	Csathó, unpublished	
				-	Vásárhelyi 1926, 1929	

Table 2. Nature conservation classification of the predator species

species		EU Directives	LIFE priority	IUCN Red List	IUCN EU25 List
Eagle owl	<i>Bubo bubo</i>	Bird Directive Appendix I.	no	Least concern	not evaluated for birds
Egyptian vulture	<i>Neophron percnopterus</i>	Bird Directive Appendix I.	yes	Endangered	not evaluated for birds
Black kite	<i>Milvus migrans</i>	Bird Directive Appendix I.	no	Least concern	not evaluated for birds
Eastern imperial eagle	<i>Aquila heliaca</i>	Bird Directive Appendix I.	yes	Vulnerable	not evaluated for birds
Bonelli's eagle	<i>Hieraetus fasciatus</i>	Bird Directive Appendix I.	yes	Least concern	not evaluated for birds
Golden eagle	<i>Aquila chrysaetos</i>	Bird Directive Appendix I.	no	Least concern	not evaluated for birds
Long-legged buzzard	<i>Buteo rufinus</i>	Bird Directive Appendix I.	no	Least concern	not evaluated for birds
Hen harrier	<i>Circus cyaneus</i>	Bird Directive Appendix I.	no	Least concern	not evaluated for birds
Steppe polecat	<i>Mustela eversmanii</i>	Habitat Directive Appendix II., IV.	no	Least concern	Endangered
Marbled polecat	<i>Vormela peregusna</i>	Habitat Directive Appendix II., IV.	no	Vulnerable	Vulnerable

Figure caption

Fig. 1. Greater blind mole rat (*Spalax microphthalmus*) on the surface (Photo: G. Csorba)

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Greater blind mole-rat (*Spalax microphthalmus*) on the surface
1066x711mm (72 x 72 DPI)

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