# Endemism, vulnerability and conservation issues for small terrestrial mammals from the Balkans and Anatolia

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Abstract. Small mammals are just as likely to become extinct as larger species, although the latter receive disproportionate attention with respect to conservation activity and research. We focused on rarity, vulnerability to extinction and conservation status for small terrestrial mammals from the orders Soricomorpha and Rodentia occurring in the Balkans and Anatolia. Although these two regions have fewer mammalian species than Central Europe in very small biota areas (surface areas < ~$10^4$ km$^2$), they accumulate species at a much faster rate with increases in surface area. The distribution ranges of fifteen species from a total of 88 (= 17%) are confined to this studied area, with eight species being endemic to Anatolia and six to the Balkans. High endemism is indicative of small ranges, i.e. of one form of rarity of Rabinowitz's 'seven forms of rarity' model. The ranges of at least three species (*Talpa davidiana, Myomimus roachi* and *Dinaromys bogdanovi*) have declined since the Last Glacial Maximum. Although numbers of extinctions correlates strongly with the number of endemics, and species displaying both restricted distribution and low density are those most at risk of extinction, very little conservation activity and research is focused on small-range endemics.

**Key words**: Soricomorpha, Rodentia, species richness, rarity, population decline, conservation priorities, biodiversity hotspots

## Introduction

Small mammals are just as likely to become extinct as larger species, although the latter receive disproportionate attention with respect to conservation activity and research (Young 1994). Nonetheless, the majority of mammalian extinctions, both those recorded over the last 400 years and those likely to happen during the next few decades, are of smaller-bodied species (Entwistle & Stephenson 2000). Rodents, for example, the mammalian order with the greatest number of species, contribute most to this number both in absolute terms and proportionally. Slightly more than half of all mammals that went extinct over the last 500 years were rodents (= 51–52%, Ceballos & Brown 1995), which exceeds the percentage of rodent species within the class of mammals (= 42%, Wilson & Reeder 2005). Although the number of small mammals listed in the IUCN Red List of Threatened Animals increased dramatically in 1996 (Entwistle & Stephenson 2000), the conservation status of many species remains only tentatively known because of the poor taxonomic knowledge of various groups and a lack of information regarding their population status (Amori & Gippoliti 2003).

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In this paper, we focus on rarity, vulnerability to extinction and conservation status for small terrestrial mammals from the orders Soricomorpha and Rodentia occurring in the Balkans and Anatolia. The mammalian faunas of these two regions, separated only by the narrow straits of Bosporus and the Dardanelles, have rarely been studied simultaneously (but cf. H o s e y 1982). Following the declared further expansion of the European community to the south-east, the Habitat Directive will likely become a powerful instrument in biodiversity conservation in the biodiversity-rich north-eastern corner of the Mediterranean basin. However, the Habitat Directive was developed for the relatively resource rich but biodiversity poor Central and Northern Europe. This political expansion will enlarge the lists of species of conservation concern with the inclusion of many small range endemics. These are in general rare and poorly known, so the consequent lack of relevant information, which is a general problem in conservation biology (W o o d r u f f 1989), will pose additional restrictions in addressing the conservation needs of mammals in species-rich countries at the contact point between Europe and Asia.

## Geographic and Taxonomic Scope

There is no consensus on the geographic borders of either the Balkan Peninsula or Anatolia. In referring to the Balkans, we have followed our earlier arbitrary boundaries (K r y š t u f e k 2004, Fig. 2), while we considered Anatolia to be equivalent to the entire Asian part of Turkey. These two regions were consequently of comparable surface areas: 788 689 km$^2$ for the Balkans and 755 688 km$^2$ for Anatolia. Islands were ignored in this study.

We considered all small non-volant terrestrial soricomorphs and rodents < 1 kg in body mass. Those species whose ranges are the result of direct human impact were ignored (*Rattus* spp., *Mus musculus*). Similarly, introduced populations were not considered (e.g. *Sciurus vulgaris* in north-east Anatolia). This gave a total of 88 species: 13 shrews (Soricidae), six moles (Talpidae) and 69 rodents (cf. Appendix). Taxonomy and nomenclature follow W i l s o n & R e e d e r (2005).

## Methods

This review is based on both published information, largely contained in key compilations for the region (M i t c h e l l - J o n e s et al. 1999, K r y š t u f e k & V o h r a l í k 2001, 2005, Y i ğ i t et al. 2006, I U C N 2007), and on our unpublished data. Conclusions on spatial biodiversity patterns were derived from two types of analyses. Differences in species richness among regions were assessed by the Arrhenius equation (A r r h e n i u s 1921), which is commonly expressed using a power function of the form: $S = cA^z$, where $S$ is the number of species, $A$ is surface area, and $c$ and $z$ are constants fitted to the data. On a logarithmic scale, this relationship plots as a straight line where $c$ is the $y$-intercept and $z$ is the slope of the line: $\log S = \log c + z \log A$. Endemism scores were defined for each 100 km square according to formula:

$$E_j = \sum_{i=1}^{n} 1/A_i, \text{ for all } i \in S_j$$

where $A_i$ is the number of squares for every species with $i$ = 1 to $n$ (the maximum number of species). In each geographical cell, $j$ is the set of species $S_j$ found within it. The sum of weights of $A_i^{-1}$ for every species found in set $S_j$ produced an overall measure of endemism

$E_j$. The contribution made by a species is constant for each cell (N o t t & P i m m 1997). Species with distribution areas >$10^6$ $km^2$ were excluded from the analysis, given that their individual contribution to a cell would be <$10^{-3}$. Tests were performed using STATISTICA 5.5 (Statsoft Inc. 1999).

## Results and Discussion

### S p e c i e s r i c h n e s s

The distribution of species richness is not random, but follows a particular pattern (R o s e n z w i g 1996). At the European scale, the highest scores for species richness (i.e. hotspots) are in the latitudinal belt across the southern part of the continent, and values found in the Balkans are particularly high (G a s t o n & D a v i d 1994). The area-adjusted mammalian species density in European countries shows a pattern very similar to those by G a s t o n & D a v i d (1994); however, at the scale of the western Palaearctic there are species richness peaks further southeast in the Caucasus, Anatolia, the Levant and Iran (K r y š t u f e k 2004).

Contrarily, B a q u e r o & T e l l e r í a (2001), who scored numbers of European mammals at sampling points on interpolated distributional maps, reported the highest species density in Central Europe. Given that the scale of observation is important in assessing species richness (R o s e n z w e i g 1996), we approached this issue by applying the familiar species-area relationship in comparing three geographic regions: Central Europe (defined here as a square of 640 000 $km^2$ and roughly coinciding with Germany and the Czech Republic), the Balkans, and Anatolia. In log-log space, these regions fit lines of slope ($z$) between 0.08 (Central Europe) and 0.27 (Anatolia), and of intercept (log $c$) between 0.26 (Anatolia) and 1.04 (Central Europe, Fig. 1a). These three regions evidently contain faunas of very different histories, which is not surprising given the rapid species turnover in Central Europe at the Pleistocene-Holocene boundary (S t o r c h 1992), in contrast to the relative long-term stability in refugia in southern peninsulas (H e w i t t 1999). In line with the results by B a q u e r o & T e l l e r í a (2001), very small regions of single biotas (surface area < ~$10^4$ $km^2$) might be more species-rich in Central Europe, but the Balkans and in particular Anatolia accumulate species at a much faster rate. A re-plot of data in an arithmetic space clearly shows that the curve of the Anatolian small terrestrial mammals rises fastest, while that of Central Europe rises slowest (Fig. 1b).

All else being equal, species-rich areas are of greater conservation interest than regions with low species richness. However, numbers of extinctions correlate weakly with the area's total number of species, but strongly with the number of endemics (N o t t & P i m m 1997). Thus, we were interested in exploring endemism in the Balkans and Anatolia.

### E n d e m i s m

A taxon is endemic to an area if it occurs within it and nowhere else. As a consequence, taxa can be endemic to a geographic location on a variety of spatial scales and at various taxonomic levels (B r o w n & L o m o l i n o 1998). Fifteen species from a total of 88 (= 17%) are confined in their distributions to the region studied, and Anatolia has more endemics (eight species) than the Balkans (six species); one endemic (*Myomimus roachi*) occurs in both regions. Considering the relatively nascent condition of phylogeographic studies in the area,

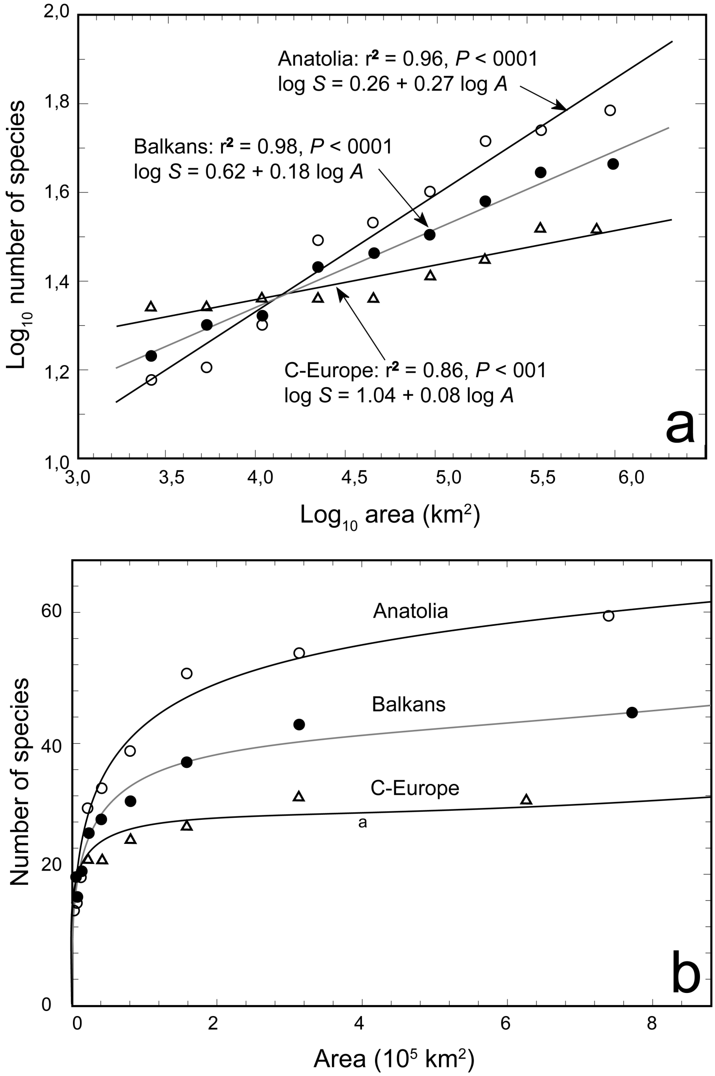


**Fig 1.** Nested species-area curves for small terrestrial mammals in Central Europe, the Balkans and Anatolia. The same data are shown on logarithmic (a) and arithmetic scale (b). The top plot emphasizes that curves follow an equation of the form $\log S = \log c + z \log A$, while bottom plot emphasizes that logarithmic curves follow an equation of the form $S = cA^z$. See text for further explanation. Surface area of the starting sub-plot was 2 500 km².

the number of endemics will likely increase. For example, an analysis of a partial cytochrome *b* sequence reveals the small-range Balkan paleoendemic *Dinaromys bogdanovi* to consist of two deeply divergent lineages, possibly indicating two independent species (K r y š t u f e k et al. 2007). Also, the excessive number of chromosomal forms in three traditional mole rat (*Spalax*) species, with over 50 different cytotypes reported so far from the Balkans and Anatolia, suggests the existence of numerous cryptic species (cf. N e v o et al. 2001). Expected taxonomic changes will thus doubtlessly elevate the status of species richness and endemism in the area.

Since there is no *a priori* reason for endemics to be confined in their distribution to the geographical borders of the region as defined for the purpose of this study, we subsequently consider endemism as a continuous rather than a categorical variable. An earlier study of rodent endemism in Europe revealed a sharp peak in endemism scores in the Balkans (K r y š t u f e k & G r i f f i t h s 2002), but no comparable approach also covers the north-eastern Mediterranean. Therefore, here we compare the spatial distribution of endemism scores in the Balkans and Anatolia. The range of $E_j$ scores was 0.020–1.399 and the distribution did not deviate significantly from normal (Kolmogorov-Smirnov $d = 0.192$, $P < 0.01$). Given that the scores were markedly skewed towards high values (skeweness = 3.121), we compared the two regions by applying a nonparametric test. The endemism scores for soricomorphs and rodents combined are higher in Anatolia (median = 0.251) than in the Balkans (median = 0.107) and the difference is significant (Kolmogorov-Smirnov $P < 0.001$). At least four centres of endemism can be easily recognised from the score dispersion (Fig. 2): the western Balkans (*Talpa stankovici, Dinaromys bogdanovi, Microtus thomasi, M. felteni*), the eastern Balkans (*Mesocricetus newtoni* and *Spalax graecus*), the Taurus (*Crocidura arispa, Dryomys laniger, Spermophilus taurensis,* and *Acomys cilicicus*) and the mountains along the Black Sea coast which share endemics with the Caucasus (*Sorex raddei, S. satunini, S. volnuchini, Neomys teres, Talpa caucasica, Prometheomys schaposchnikowi, Microtus majori, M. daghestanicus, M. schidlovskii, Chionomys gud,* and *C. roberti*).

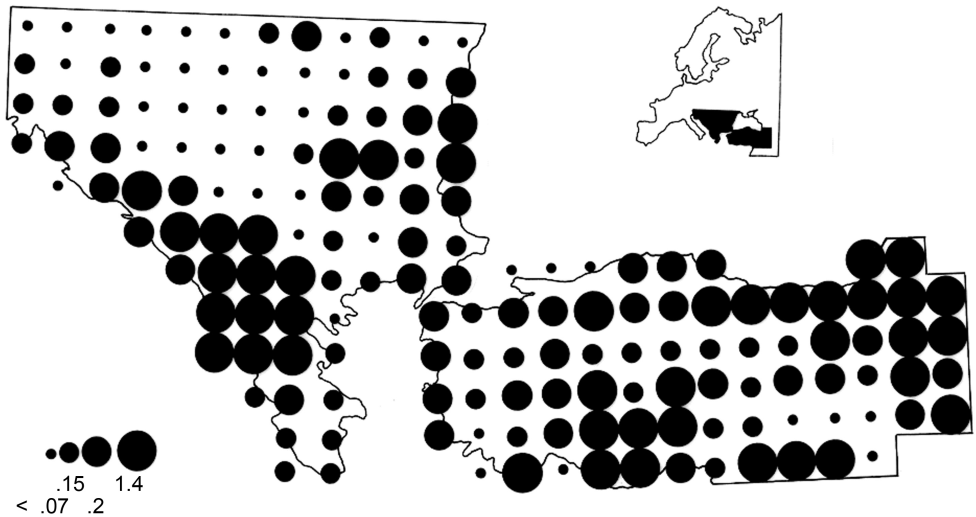


**Fig. 2.** Map of the Balkans and Anatolia, showing spatial patterns of rodent endemism. Filled circles reflect the magnitude of endemism score of a particular square (circle sizes according to quartiles of the endemism score).

High endemism is indicative of small ranges, i.e. of at least one form of rarity of Rabinowitz's 'seven forms of rarity' model. Even though rarity does not necessarily indicate a threat of extinction, species generally become rare before they go extinct (D o b s o n et al. 1995). Also, species displaying both restricted distribution and low density, i.e. two of the criteria of Rabinowitz's rarity model which are common in small terrestrial mammals, are those most at risk of extinction (A r i t a et al. 1990).

### R a r i t y

Rabinowitz's 'seven forms of rarity' model (R a b i n o w i t z 1981, R a b i n o w i t z et al. 1986) focuses on three characteristics of species: (i) the species distribution area, (ii), the variety of habitats occupied by a species and (iii) the local population density. Each of these three measures is a simple dichotomy yielding eight possible categories, seven of them indicating rarity. Species can be rare with respect to one, two, or all three criteria.

High endemism postulates small ranges; thus, unsurprisingly, 17 species from the total of 88 (= 19.3%) occurring in the Balkans and Anatolia have ranges <$10^5$ $km^2$. An even higher proportion of small terrestrial mammals (40 species or 45.5% of the total species pool) are specific regarding their habitat. The classification is rather tentative and also does not capture all forms of habitat specialisations. The majority of habitat specialists as defined here (27 species from a total of 40) depend on various types of steppe, which we focused on because of their large scale transformation to agricultural land. In particular, ploughed steppes become unsuitable habitat for ground squirrels (*Spermophilus* spp., Ružić 1979), jerboas (*Allactaga* spp., Çolak & Yiğit 1998), hamsters (*Mesocricetus* spp., Gattermann et al. 2001), and mole rats (*Spalax* spp., IUCN 2007), and pristine grasslands continue to shrink.

A remarkably high proportion of species (seven) is strictly rock-dwelling. This is in sharp contrast with situation in Europe, where only three rodents are specialised for rock substrates, two of which are Balkan endemics: *Dinaromys bogdanovi* (Kryštufek & Bužan 2008), *Chionomys nivalis* (Kryštufek & Kovačić 1989) and *Apodemus epimelas* (Storch 2004). A rare specialisation is exemplified by *Meriones dahli*, a small-range species which is strictly confined to isolated patches of sand and stones (Pavlinov et al. 1990) and to moving sands (Ejgelis 1980). We also focused on species which depend on aquatic and riparian habitats (five species), largely because such situations are scarce in the arid southern Balkans and major portions of Anatolia.

Local population densities are nearly unknown for the majority of small terrestrial mammals from the Balkans and Anatolia. Given that at least seven species are represented in museum collections by only a handful of voucher specimens, this also indirectly suggests their low densities: *Crocidura arispa, Microtus felteni, Mesocricetus* spp., *Dryomys laniger* and *Myomimus* species. Perception of this form of rarity however is easily biased by the (in) appropriateness of the sampling technique applied. Hamsters from the genus *Mesocricetus* are considered naturally rare, and the rarity of the golden hamster (*M. auratus*) is particularly legendary (Kittel 1975, Gattermann et al. 2001). The Turkish hamster (*M. brandti*), which has the largest distributional area in the genus, occurs in Anatolia, Transcaucasia (Armenia, Georgia, and Azerbaijan; Šidlovskij 1976) and in northwest Iran (Qazvin in the east, Lurestan in the south; Lay 1967). It lives in dry, rocky steppe country between 250 and 3,000 m a.s.l. (Bukhnikashvili & Kandaurov 1998) but avoids wooded and bushy regions, damp and wet areas, and desertified places (Šidlovskij 1976, Lyman & O'Brien 1977). The Turkish hamster is fairly widespread, and Yiğit et

**Table 1.** Turkish hamster (*Mesocricetus brandti*) in small mammal samples collected in Anatolia and Iran by two different sampling methods. Based on Lay (1967), Obuch (1994, 2001), Čermák et al. (2006), and our own unpublished data.

| Region | Method | Small mammals | *Mesocricetus brandti* | |
|---|---|---|---|---|
| | | N | N | % |
| Anatolia | Snap-trapping | 1057 | 3 | 0.3 |
| Anatolia | *Bubo bubo* pellets | 5889 | 1970 | 33.5 |
| Iran | Snap-trapping | 211 | 0 | 0.0 |
| Iran | *Bubo bubo* pellets | 6049 | 821 | 13.6 |

al. (2003) found it in nine localities of 19 sampled throughout Anatolia. In spite of this, the species is considered to be rare throughout its range. Its relative abundance in small mammal assemblages as estimated through trapping results is ca. 0.3% in Anatolia (Table 1) and 0.3–1% in Georgia (Bukhnikashvili & Kandaurov 1998). On the other hand, this hamster is abundant in eagle owl (*Bubo bubo*) pellets both in Iran and Anatolia (Table 1), and differences in relative density between the two sampling techniques are more than 100-fold in Turkey. One can only guess which estimation of relative abundance more closely reflects the actual situation in nature.

## Vulnerability to extinction and conservation priorities

Small endemic-rich areas contribute disproportionately to the total number of global extinctions by chance alone (Nott & Pimm 1997). In the western Palaearctic, a major faunal turnover took place on Mediterranean islands, where human colonization since the early Holocene resulted in a profound transformation of insular ecosystems and an unprecedented extinction of insular endemics (Alcover et al. 1999). This chain of human-caused extinctions has not yet affected mainland biotas, which are intrinsically less vulnerable than islands (Nott & Pimm 1997). A rare example of the extinction of a species and genus of small mammal in the late Pleistocene is the vole *Pliomys lenki*, which survived in Northern Spain until approximately 29 000–30 000 yr BP, but is not found in later sediment layers (Stuart 1991). What is noteworthy in this context is that the only surviving member of the *Pliomys* lineage is the small-range Martino's vole (*Dinaromys bogdanovi*), which is also the only genus endemic to our study region. As suggested by fossil evidence, Martino's vole evolved in the upper Pliocene along the north-eastern Adriatic coast, from where its extinction progressed southwardly into the early Holocene (Kryštufek & Bužan 2008). Competitive exclusion of Martino's vole by the relatively r-selected European snow vole (*Chionomys nivalis*) might be the main reason for the continuous decline of this Balkan paleoendemic, but in the absence of any long term monitoring, supporting evidence is scarce (Kryštufek & Bužan 2008).

A significant long-term decline in range is evident in two other small-range species, Père David's mole (*Talpa davidiana*) and Roach's mouse-tailed dormouse (*Myomimus roachi*). Père David's mole is known from only eight localities along the southern margin of the Anatolian – Iranian high plateau (Kryštufek & Vohralík 2001). The current range of Roach's mouse-tailed dormouse is one of the smallest among rodents in the western Palaearctic: the species is known only from Thrace in Turkey and Bulgaria and from three localities along the Aegean coast of Anatolia (Kryštufek & Vohralík 2005). Its habitat requirements are known only tentatively and published sources are contradictory regarding its terrestrial vs. arboreal mode of life (Peshev et al. 1960, Kurtonur & Özkan 1991, Buruldağ & Kurtonur 2001). It is noteworthy that both these species were independently discovered in the Upper Pleistocene material from Tabun Cave in Israel and reported as *Talpa chthonia* and *Philistomys roachi*, respectively (Bate 1937). Since any of them is a member of the recent Israeli fauna (Mendelssohn & Yom-Tov 1999), their ranges evidently shifted ca. 400 km northward during the Holocene. Roach's mouse-tailed dormouse, or a closely related form, was much more widespread in the eastern Mediterranean during the Pleistocene, being common on the eastern Aegean islands since the Early Ruscinian (Meulen & Kolfshoten 1986, Kotsakis 1990), and occurred during the Middle Pleistocene in Turkish Thrace (Santel & Koenigswald

1998), in south-central Anatolia (M o n t u i r e et al. 1994), and in Israel (T c h e r n o v 1975). The latest records outside its current range are from the early Holocene in the Taurus Mts. (c. 7000 yr BP) and from the Late Bronze Age in Israel (1600-1300 yr BC; C o r b e t & M o r r i s 1967).

What is common to the three case species listed above is a lack of biological information, particularly on their population dynamics and trends. None of them has been studied beyond simple faunal surveys, and nearly all our knowledge is derived from voucher specimen tags. Both regions lack a tradition of monitoring animal populations, and are facing economic problems, and thus poor funding for faunal surveys. Only long-term and non-invasive population monitoring, however, can provide the biological information necessary for the proper assessment of population trends (V a l o n e et al. 1995). A shortage of information also hampers risk assessment for little-known species (W o o d r u f f 1989).

Finally, small terrestrial mammals receive very little attention with respect to conservation activity and research. Allocation of resources within the EU is indicative of the wider situation. The LIFE-Nature programme of the EU, as the main financial instrument for *in situ* conservation, financed 76 projects involving mammals between 1992 and 2006 (Table 3). More than half of these projects focused on carnivores (64.5%), and 67 projects (= 88.2%) were allocated for three taxonomic groups (carnivores, bats and cetaceans) with 104 species from a total of 220 (= 47.3%) in the EU 25 countries. Only nine projects (= 11.8%) focused on the remaining groups containing 116 species (= 52.7%), including 25 of the region's 33 endemics (= 75.8%). All rodent projects were on species of broad Palaearctic (beaver and flying squirrel) or even boreal Holarctic occurrence (*Microtus oeconomus*). At the European scale, these discrepancies among mammalian groups are further exacerbated by the polarization between the geographic north which is rich in resources but poor in biodiversity, and the biodiversity rich but resource poor south. Further south in the Near and Middle East, the discrepancy becomes even more pronounced. Conservation projects outside the EU countries are largely financed by international agencies, which nearly invariably invest in conservation programmes for charismatic albeit widely distributed large carnivores. Of course, immediate action is required to preserve local populations, but none of them is globally threatened. On the other hand, small mammal endemics attract little conservation interest. Given that global extinction is effectively the study of extinctions in a few centres of endemism (N o t t & P i m m 1997), one can expect that the majority of future extinctions in the western Palaearctic will occur among small bodied and small range mammals.

**Table 2.** The number of LIFE-Nature projects targeted towards mammals between 1992 and 2006. Source: T e m p l e & T e r r y (2007).

| Taxonomic group | Projects | |
|---|---|---|
| | N | % |
| Carnivora | 49 | 64.5 |
| Chiroptera | 10 | 13.2 |
| Cetacea | 8 | 10.5 |
| Ungulata | 5 | 6.6 |
| Rodentia | 4 | 5.2 |
| Soricomorpha | 0 | 0.0 |
| Total | 76 | 100.0 |

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**Appendix.** List of small terrestrial mammals in the Balkans (B) and Anatolia (A). × - present in the area; **×** - endemic to the area; * – small range species (area < $10^5$ $km^2$). H – habitat specialist: R – rock-dwelling; D – sandy desert; W – (semi)aquatic and riparian, S – steppes and forest steppes suitable for cultivation.

| Species | B | A | H | Species | B | A | H |
|---|---|---|---|---|---|---|---|
| *Sorex araneus* | × | | | *Chionomys gud* | | × | R |
| *Sorex minutus* | × | | | *Chionomys roberti* | | × | |
| *Sorex alpinus* | × | | | *Cricetus cricetus* | × | | S |
| *Sorex volnuchini* | | × | | *Cricetulus migratorius* | × | × | S |
| *Sorex satunini* | | × | | *Mesocricetus auratus* | | ×* | S |
| *Sorex raddei* | | × | | *Mesocricetus brandti* | | × | S |
| *Neomys anomalus* | × | × | W | *Mesocricetus newtoni* | **×*** | | S |
| *Neomys fodiens* | × | | W | *Tatera indica* | | × | S |
| *Neomys teres* | | × | W | *Meriones persicus* | | × | |
| *Crocidura leucodon* | × | × | | *Meriones vinogradovi* | | × | S |
| *Crocidura suaveolens* | × | × | | *Meriones tristrami* | | × | S |
| *Crocidura arispa* | | **×*** | R | *Meriones crassus* | | × | |
| *Suncus etruscus* | × | × | | *Meriones dahli* | | ×* | D |
| *Talpa europaea* | × | | | *Gerbillus dasyurus* | | × | |
| *Talpa caeca* | × | | | *Micromys minutus* | × | | |
| *Talpa levantis* | × | × | | *Apodemus sylvaticus* | × | | |
| *Talpa caucasica* | | × | | *Apodemus flavicollis* | × | × | |
| *Talpa davidiana* | | × | | *Apodemus witherbyi* | | × | |
| *Talpa stankovici* | **×** | | | *Apodemus uralensis* | × | × | |
| *Sciurus vulgaris* | × | | | *Apodemus mystacinus* | | × | R |
| *Sciurus anomalus* | | × | | *Apodemus epimelas* | × | | R |
| *Spermophilus citellus* | × | | S | *Apodemus agrarius* | × | | |
| *Spermophilus xanthoprymnus* | | **×**[1] | S | *Mus spicilegus* | × | | S |
| *Spermophilus taurensis* | | **×*** | | *Mus macedonicus* | × | × | S |
| *Ellobius lutescens* | | × | S | *Acomys cilicicus* | | **×*** | |
| *Prometheomys schaposchnikowi* | | ×* | | *Nesokia indica* | | × | W |
| *Dinaromys bogdanovi* | **×*** | | R | *Spalax leucodon* | × | | S |
| *Myodes glareolus* | × | × | | *Spalax nehringi* | | **×**[1] | S |
| *Arvicola amphibius* | × | × | W | *Spalax ehrenbergi* | | × | S |
| *Microtus subterraneus* | × | × | | *Spalax graecus* | **×*** | | S |
| *Microtus majori* | | × | | *Glis glis* | × | × | |
| *Microtus daghestanicus* | | × | | *Eliomys quercinus* | × | | |
| *Microtus thomasi* | **×** | | | *Eliomys melanurus* | | × | |
| *Microtus felteni* | **×*** | | | *Muscardinus avellanarius* | × | × | |
| *Microtus liechtensteini* | × | | | *Dryomys nitedula* | × | × | |
| *Microtus socialis* | | × | | *Dryomys laniger* | | **×*** | R |
| *Microtus schidlovskii* | | × | | *Myomimus roachi* | **×*** | **×*** | S |
| *Microtus guentheri* | × | × | S | *Myomimus setzeri* | | × | S |
| *Microtus dogramacii* | | **×*** | S | *Allactaga elater* | | × | S |
| *Microtus anatolicus* | | **×*** | | *Allactaga williamsi* | | × | S |
| *Microtus arvalis* | × | × | S | *Allactaga euphratica* | | × | S |
| *Microtus levis* | × | × | S | *Sicista subtilis* | × | | S |
| *Microtus agrestis* | × | | | *Sicista betulina* | × | | |
| *Chionomys nivalis* | × | × | R | *Calomyscus bailwardi* | | × | |

[1]Of very marginal occurrence in Transcaucasia.