Biodiversity and Conservation (2007) 16:347–356
DOI 10.1007/s10531-005-2354-3

Are current protections of land snails in Hungary relevant to conservation?

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Received 8 December 2004; accepted in revised form 8 August 2005

Key words: Biodiversity, Gastropoda, Mollusca, Nature reserves, Rarity, Species prioritisation

Abstract. Legal instruments for species conservation have been criticised because they take a long time to draw up and implement and because invertebrates are highly underrepresented. For these reasons legal documents need regular re-evaluation as more data and effective methods are available. The effectiveness of the Hungarian legislative texts was assessed by the congruence between protection status and conservation priority of the species. Species were prioritised according to the conservation priority index (CPI = MRI × PBR), which included mollusca rarity index (MRI) and protection-by-reserves score (PBR). Mollusca rarity index was an additive scoring method including global range size, local frequency, and a correction factor due to the biased frequency estimate or special importance of some species. PBR scores expressed the lack of congruence between distribution of reserves and distribution of species. I used the distribution data of 121 Hungarian land snail species based on 10×10 km resolution grid system. Current protection status of the species was associated with rarity, whereas the congruence between species occurrences and the location of existing reserves has been overlooked. Based on the 25% of the species with highest CPI scores, the species *Helicigona planospira* was highly recommended and 9 other species was recommended for protection. Two thirds of the occurrences of the strictly protected and endemic species *Hygromia kovacsi* and more than 25% of the occurrences of 10 protected species were located outside of current reserves. Local populations of these species need monitoring in order to detect changes in the area of occupancy.

Introduction

Conservation biology targets the preservation and management of species and their habitats, which actions rest at least partly on a set of legal instruments. Legislation on the international level has been criticised because by the time these legislative documents are drawn up and ratified, knowledge has changed considerably, and conservation needs have changed (Bouchet et al. 1999); and because invertebrates are poorly represented in such legal instruments, although invertebrates make up a large proportion of species compared with well documented vertebrate taxa (Bouchet et al. 1999; Myers et al. 2000).

In past decades in Hungary, species for protection have often been selected in ad hoc manner, based on the field experiences of experts. Because resources for conservation are always limited, it is advisable to focus on the highest conservation priorities to maximise the benefits of any actions. Recently, as more data are available, conservation priorities on the national level have been set for many taxa in Hungary, e.g., vertebrates (Bakó and Korsós 1999; Báldi et al. 2001), plants (Simon 1992; Borhidi 1995; Horváth et al. 1995), macrofungi (Pál-Fám et al. 2004), dragonflies (Dévai and Miskolczi 1987), orthopterans (Rácz 1998), bumble bees (Sárospataki et al. 2003), longhorn beetles (Medvegy 2001) and molluscs (Sólymos 2004; Fehér et al. 2006). Attempts have also been made to evaluate the ecological basis of protection lists (e.g., Báldi and Csorba 1997).

It is clearly important to decide to which species conservation efforts should be directed most urgently. For land molluscs the vulnerability of the species is often expressed as the extent of occurrence or the area of occupancy (World Conservation Union 2004). Rarity relates to vulnerability because rarity makes extinction more probable if other determinants are equal, and it is important in establishing species-based conservation priorities (Heller and Safriel 1995; Mace and Kershaw 1997; Cameron 1998). An alternative way to maximise conservation benefits is the protection of habitats, often termed the coarse-filter approach to conserving biodiversity (Hunter 1996). This approach can be an effective strategy if the distribution of protected areas corresponds reasonably well with the distribution of species. Conservation priorities can also be set based on the disparateness between distribution of reserves and distribution of species.

The purpose of the present paper is to examine how effectively the priorities in the Hungarian land snail species are addressed by Hungarian legislative texts, and to revise the protection status of the species and recommend currently unprotected species for protection. It also aims to examine how data on habitat protection can be incorporated into species prioritisation.

Methods

Species prioritisation

I examined 121 species of Hungarian land snails. I excluded introduced species from the analysis because their conservation value is doubtful (Patten and Erickson 2001). Slugs were also excluded because of scarce data resulting from difficulties with collecting (Cameron and Pokryszko 2005) and identification (Wiktor and Szigethy 1983). Out of the 121 species, 31 were protected by the current Hungarian law order (Hungarian Ministry of Environment 2001). All the species listed in the Bern Convention (Council of Europe 1979) and the European Habitats and Species Directive (Council of Europe 1992) are protected in Hungary. Nomenclature of the species was based on Pintér (1984).

The rarity of the species was assessed by using the mollusca rarity index (MRI), which is an additive scoring index based on global range size (RS) and local frequency (LF) of the species and a special factor (SF). The sum of the scores for these three variables constitutes the mollusca rarity index (MRI = RS + LF + SF) (Sólymos 2004; modified after Heller and Safriel 1995), ranging from 2 to 10.

The geographic range size (RS) scores were as follows: (1) beyond Europe (e.g., Eurosiberian, western Palearctic, Palearctic, Holarctic species); (2) large within Europe (in more than one biogeographical region, e.g., central European, boreo-montane, Alpine–Carpathian species); (3) restricted to one well-defined biogeographical region (e.g., Carpathian endemic species); (4) narrow within one biogeographical region (e.g., endemic to northern Carpathians). Geographic range size was based on Pusanow (1928), Soós (1943), Ehrmann (1956), Jaeckel et al. (1957), and Kerney et al. (1983).

Local frequency (LF) scores were indicated as the percentage of 10×10 km Universal Transverse Mercator (UTM) grid-cells occupied by the species: (1) $>25\%$; (2) 15–25%; (3) 5–15%; (4) 1–5%; (5) $<1\%$ of the total number of grid-cells containing data on land snail distribution in Hungary. I used data from 770 (73.2%) out of 1052 grid-cells in Hungary based on Pintér et al. (1979), Pintér and Szigethy (1979, 1980), and Fehér and Gubányi (2001).

I used the special factor (SF) to add one point to the index value when the Hungarian population of a species make up a high proportion of the world population (e.g., *Hygromia kovacsi*), or a widespread species has few relictual occurrences (e.g., *Phenacolimax annularis* (Studer 1820), *Discus ruderatus*) or a sporadic distribution in Hungary (e.g., *Vertigo moulinsiana*). I also used the special factor for adjusting overestimated frequency of occurrence, caused by a bias based on subfossil shells (e.g., *Vallonia enniensis*). In the analysis I used the local frequency scores corrected by the species factor (LFC = LF + SF).

I defined the range of rare species according to the quartile definition of rarity (Gaston 1994). The MRI scores of the 25% rarest species ranged from 7 to 10.

I also examined the protection of the species' Hungarian occurrences by current reserves. Protection-by-reserves (PBR) scores were determined as the percentage of the number of occupied grid cells not containing protected areas: (1) $<15\%$; (2) 15–25%; (3) 25–33%; (4) $>33\%$ of the total number of occupied grid cells of the species. I used the same data set as for local frequency scores.

Data analysis

To explore the relationship among the studied variables I calculated Spearman rank correlations. Significance levels were adjusted for multiple comparisons by the Bonferroni correction. The rarity (RS and LFC) and PBR scores of the legally protected and unprotected Hungarian land snails were compared with the Mann–Whitney *U*-test. The association between the protection status of the species and the predictor variables used for prioritisation (RS, LFC and PBR) was analysed with binary logistic regression.

I revised the protection status of the Hungarian land snail species based on their rarity and the proportion of the species' occurrence outside of reserves. Species were ranked according to the conservation priority index (CPI), which is the product of mollusca rarity index and PBR scores (CPI = MRI ×PBR). I defined the species falling in the upper quartile range of the conservation priority scores as highest priority species. Priority status and protection status was compared to evaluate the effectiveness of current legislative actions.

Results

According to the quartile definition of rarity, 31 species fell into the 25% rarest range of the mollusca rarity index, of which only 16 (51.6%) species were currently protected. The upper quartile of the CPI ranged from 14 to 40 and involved 27 species, listed in Table 1 (the full dataset containing scores for all species is available from the author upon request). The proportion of species falling in the upper quartile range of the two indices (25.6 and 22.3% of all species respectively) slightly differed because both scoring indices were measured on ordinal scale.

Ten out of the 31 rarest species (with MRI scores more than or equal to 7) were not involved in the 25% highest priority species list based on lower conservation priority scores (CPI). These species were: *Acicula banatica* (Rossmässler 1842), *Cochlodina fimbriata* (Rossmässler 1835), *Macrogastra densestriata* (Rossmässler 1836), *Balea stabilis* (L. Pfeiffer 1847), *Vertigo substriata* (Jeffreys 1833), *Pseudofusulus varians* (C. Pfeiffer 1828), *Clausilia cruciata* (Studer 1820), *Bulgarica cana* (Held 1836), *Aegopinella nitens* (Michaud 1831) and *Helicigona faustina* (Rossmässler 1835).

The global range size scores and corrected local frequency scores of the protected species were significantly higher than that of the unprotected species, the difference in the PBR scores of the protected and unprotected species was not significant (Table 2).

A significant positive correlation was found between global range size scores and corrected local frequency scores (Spearman $r = 0.599$, $n = 121$, $p < 0.001$ after adjusting for multiple comparisons). Significant negative correlation was found between range size scores and PBR scores (Spearman $r = -0.574$, $n = 121$, $p < 0.001$ after adjusting for multiple comparisons) and between corrected local frequaency scores and protection-by-reserves scores (Spearman $r = -0.369$, $n = 121$, $p < 0.001$ after adjusting for multiple comparisons).

Logistic regression revealed that there are significant associations between protection status and the predictor variables (−2 Log likelihood = 110.3, $\chi^2 = 27.4$, $df = 3$, $p < 0.001$, Nagerkerle $r^2 = 0.289$). Global range size scores and corrected local frequency scores showed significant positive nonrandom association with protection status of the species (odds ratio = 2.598, $p < 0.05$, and odds ratio = 1.900, $p < 0.01$, respectively). The association between protection status and the PBR scores was not significant (odds ratio = 1.270, $p = 0.304$).

Table 1. List of the highest priority land snail species in Hungary ranked according to their conservation priority scores.

Species[a]	Recent distribution[b]	Variables[c]			Comments[d]
		MRI (RS + LFC)	PBR	CPI	
Hgromia kovacsi Varga & Pintér, 1972	Endemic	10 (4 + 6)	4	40	SP, RB
Helicigona planospira (Lamarck 1828)	Dinaric and S Alpine	8 (3 + 5)	4	32	
Pomatias rivulare (Eichwald 1829)	Pontic, N Balcanic	7 (2 + 5)	4	28	P, RB
Oxycilus hydatinus (Rossmässler 1838)	Circum-mediterranean	7 (2 + 5)	4	28	?
Aegopis verticillus (Lamarck 1822)	E Alpine (Dinaric)	6 (2+4)	4	24	
Semilimax semilimax (Férussac 1802)	Alpine, central European	6 (2 + 4)	4	24	
Trichia erjaveci (Brusina 1870)	NW Balcanic	6 (2 + 4)	4	24	
Trichia filicina (L. Pfeiffer 1841)	E Alpine and Carpathian	6 (2 + 4)	4	24	
Perforatella dibothrion (M. Kimakowicz 1884)	Carpathian	8 (3+5)	3	24	P, RB
Helix lutescens Rossmässler, 1837	Dacic	6 (3 + 3)	4	24	P
Discus ruderatus (Férussac 1821)	Palaearctic (Boreo-Alpine)	7 (1 + 6)	3	21	P
Perforatella vicina (Rossmässler 1842)	Carpathian	7 (3+4)	3	21	P
Perforatella bidentata (Gmelin 1788)	E European	5 (2+3)	4	20	P
Perforatella umbrosa (C. Pfeiffer 1828)	E Alpine and Carpathian	5 (2 + 3)	4	20	
Cepaea nemoralis (Linné 1758)	W European	5 (2 + 3)	4	20	P
Cepaea hortensis (O.F. Müller 1774)	W and central European	5 (2 + 3)	4	20	P
Aegopinella ressmanni (Westerlund 1883)	E Alpine	6 (3 + 3)	3	18	
Helicopsis striata (O.F. Müller 1774)	Central European	4 (2 + 2)	4	16	
Orcula dolium (Draparnaud 1801)	Alpine and Carpathian	5 (2 + 3)	3	15	P
Vallonia enniensis (Gredler 1856)	Central and S European	5 (2 + 3)	3	15	RL
Vertigo moulinsiana (Dupuy 1849)	European (Holarctic?)	5 (1 + 4)	3	15	P, HD2, RL
Helicodonta obvoluta (O.F. Müller 1774)	Central European	5 (2 + 3)	3	15	
Macrogastra latestriata (A. Schmidt 1857)	Carpathian-Balthic	7 (3 + 4)	2	14	
Clausilia parvula (Férussac 1807)	Central European	7 (2 + 5)	2	14	
Bulgarica vetusta (Rossmässler 1836)	SE European	7 (2 + 5)	2	14	
Hygromia transsylvanica (Westerlund 1876)	Carpathian	7 (3 + 4)	2	14	P
Helicigona banatica (Rossmässler 1838)	E and S Carpathian	7 (3 + 4)	2	14	P, RB

[a]Species names follow Pintér (1984).
[b]Based on Kerney et al. (1983) and Soós (1943).
[c]MRI: mollusca rarity index (MRI = RS + LFC), RS: global range size score, LFC: corrected local frequency score, PBR: protection-by-reserve scores, CPI: conservation priority index (CPI = MRI ×PBR).
[d]SP: strictly protected species, P: protected species (Hungarian Ministry of Environment 2001), RB: Hungarian Red Data Book species (Rakonczay 1989), RL: IUCN Red List species (World Conservation Union 2005), HD2 and HD5: species listed in the 2nd and 5th Annexes of the European Union Habitats and Species Directive respectively (Council of Europe 1992), BC: species listed in the Bern Convention (Council of Europe 1979), ?: supposedly non-indigenous species.

Table 2. Basic statistics (mean ± SD) of the studied variables grouped according to protection status and the results of the Mann–Whitney *U*-test.

Variables	Total (n = 121)	Protected (n = 31)	Unprotected (n = 90)	Mann–Whitney *U*
Global range size score	1.95 ± 0.705	2.42 ± 0.807	1.79 ± 0.590	802***[a]
Corrected local frequency score	3.06 ± 1.439	4.03 ± 1.048	2.72 ± 1.407	687***
Protection-by-reserves score	2.48 ± 1.155	2.19 ± 1.250	2.58 ± 1.111	1123ns

[a]***: $p < 0.001$, ns: not significant.

Discussion

As Cameron (1998) demonstrates, both the area and location of a region may influence the utility of additive scoring methods and the quartile definition of rarity. He argues that Rapoport's rule (average range size declines towards the equator) applies in land snails, consequently the quartile definition may complicate prioritisation in tropical and Mediterranean regions, where the majority of all species would be characterised as rare based on global range size. In temperate and boreal regions, by contrast, the majority of the species have large ranges, but many have intermittent distributions within them, thus prioritisation based on detailed distribution data is a better estimate of rarity than global range size. The Hungarian land snail fauna shows transition between Mediterranean and north-western European countries concerning the proportion of range-restricted species. Thus the use of an additive index combining both local distribution and global range size can be justified in practical conservation planning.

Cameron (1998) also criticises additive scoring indices based on the significant positive correlation between range size and local frequency. In Hungary, endemic species with ranges restricted to the Alps and the Carpathians tend to occur in areas near the country border, thus local frequency values are also low. However, there are cases of discrepancies between local frequency and global range size, where wide ranging species have sporadic distributions (e.g., the species *Vallonia enniensis*, *Vertigo moulinsiana* and *Vertigo angustior* Jeffreys, 1830 listed in European Habitats and Species Directive and in the World Conservation Union Red List), either because their habitats are naturally patchy, or because the effects of human disturbance (Bouchet et al. 1999; Pokryszko 2003). In such cases, the protection of habitats can be extremely effective (Cameron 1998) thus the PBR scores can be applied.

The significant negative correlation between PBR scores and rarity scores indicates that the occurrences of the rare species are more extensively covered by protected areas than the occurrences of the more common species. This can be explained by the fact that with a given number of 10×10 km squares in which there are protected areas, the more squares a species occupies the greater the proportion of unprotected squares in which it is found, of necessity.

Since rare species tend to be those with rather demanding ecological requirements (Gaston 1994), met mainly in surviving areas of more-or-less natural vegetation, this is not surprising: rarities in many taxa tend to be found in the same places, and these attract protection (Dobson et al. 1997). Because common species are not as vulnerable to local extinction as rare ones, PBR score alone is not going to provide a universal guide to priority setting. Its value lies in identifying those rare species least protected by reserves. It is thus reasonable to incorporate PBR scores into the CPI. With the use of the CPI, those species can be identified, whose protection is ensured neither by species nor by area protection.

The spatial resolution of the data can influence the accuracy of the PBR scores through the mismatch between the spatial resolution of data for species and reserves (Araújo 2004). The PBR scores at the 10×10 km scale are underestimates if we assume an even distribution of the species within the occupied 10×10 km grid cells. For this reason, PBR scores are indicative to national conservation planning.

According to the results of the Mann–Whitney test and the binary logistic regression, protection status reflects primarily the local or global rarity of the species, whereas the protection of the species' occurrences outside of reserves is of minor importance.

About 66.7% of the occurrences of the strictly protected and endemic species *Hygromia kovacsi* are located outside of current reserves. More than 25% of the occurrences of 10 protected species falling in the upper quartile range of the conservation priority index (see Table 1) were also located outside of protected areas. Local populations of these species need monitoring in order to detect changes in the area of occupancy.

About 75% of the occurrences of the rare and unprotected species *Helicigona planospira* are located outside protected areas, therefore this species is highly recommended for protection based on its rarity and the high PBR scores. The indigenous status of the locally rare species *Oxychilus hydatinus* is questionable, and the local frequency score can be overestimated resulting from the cryptic life style of this soil dwelling snail. Thus this species does not require protection.

The unprotected species *Aegopis verticillus*, *Semilimax semilimax*, *Trichia erjaveci*, *Trichia filicina*,*Perforatella umbrosa*, *Aegopinella ressmanni*, *Helicopsis striata*, *Vallonia enniensis* and *Helicodonta obvoluta* are not rare according to the MRI scores (less than 7 points), although more than 25% of their occurrences are located outside protected areas. These species are also recommended for protection based on the high conservation priority scores and PBR scores. These species need monitoring to detect changes in the area of occupancy.

The species *Macrogastra latestriata*, *Clausilia parvula*, *Bulgarica vetusta*, *Hygromia transsylvanica* and *Helicigona banatica* are rare according to the MRI scores (more than or equal to 7 points), and less than 25% of the occurrences of these species is located outside of protected areas. These species, along with the 10 rare species (with MRI more than or equal to 7 points) not involved in the 25% highest priority species list (listed in the results section), can be adequately protected *in situ* by the protection of their habitats, because less than 25% of the occurrences of these species is located outside protected areas. Monitoring can be indicative of changes in the area of occupancy of these species.

The efficiency of additive scoring indices in conservation planning has been often criticised, but national conservation priorities need to strike a balance between local and global perspectives, which are scale dependent manifestation of the same phenomenon (Hartley and Kunin 2003). Current protection status of the species is associated with rarity, whereas the congruence between species occurrences and the location of reserves has been overlooked. The CPI takes the rarity and the proportion of the species' occurrences uncovered by reserves into account at the same time. This method provides a rapid and effective tool in national conservation planning, by means of which deficiency of legislative actions can be evaluated and corrected.

Acknowledgements

I am indebted to R.A.D. Cameron for his enduring criticism on compound indices and for improving the English. I am also grateful to A. Varga, Z. Fehér, P. Sümegi and Z. Varga for suggestions and criticisms on previous manuscripts. I also benefited from interactions with G. Majoros, E. Hornung, T. Domokos, Z.P. Eröss and A. Nagy. I thank to T. Magura for his help in determining the UTM squares of the protected areas. This research was partly supported by the National R&D Programme, title: The origin and genezis of the fauna of the Carpathian Basin: diversity, biogeographical hotspots and nature conservation significance; contract no: 3B023-04.

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