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RARE TERRESTRIAL MOLLUSCS' SPECIES OF KAUNAS AND KAIŠIADORIAI DISTRICTS' RESERVES

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The diversity and distribution peculiarities of rare and other snail species in Kaunas and Kaišiadoriai districts' were the objective of research work that was carried out in 2007 July and September in different types of 15 reserves. 64 terrestrial molluscs' species belonging to 22 families were collected during this research. The biggest variety of species was in botanical-zoological reserves. Only one species of Lithuanian Red Data book was found – *Vertigo angustior* Jeffreys, 1830, but some data about other rare species in Lithuania are described. Other rare terrestrial molluscs' species were: *Acicula polita* (Hartmann, 1840), A*canthinula aculeata* (Müller, 1774), *Vertigo alpestris* Alder, 1838, *Vertigo genesii* (Gredler, 1856), *Columella aspera* Waldén, 1966, *Clausilia cruciata* Studer, 1820, *Macrogastra latestriata* (A. Schmidt, 1857), *Ruthenica filograna* (Rossmässler, 1836), *Isognommostoma isognommostomos* (Schröter, 1758). The assessment of conservation status of molluscs' species and the main conservation measures necessary for improving the status of these species are discussed. Generalization regarding the protection of terrestrial molluscs in Lithuania was made.

Key words: Mollusca, Red Data book of Lithuania, rare species, reserves, conservation.

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INTRODUCTION

All species exist for a certain time after that they disappear or form new species (Rakauskas 2001). Naturally this process needs centuries but human activities make it go faster. According to Cameron & Pokryszko (2004) forest clearance, drainage and acidification constitute a primary threat to land molluscs. It is known (Alexander 1998, Pawlowska & Pokryszko 1998) that rare terrestrial molluscs species can be found in mature broad-leaved and mixed forests (as species from family Clausiliidae), natural meadows and riversides specific biotopes (as species from family Vertiginidae) so researches in such places could give an important information for further decisions of rarity of these species. Theoretically human activity in reserves in one or other way is limited, the protection measures should lead to increasing richness of rare molluscs species. Researches about rare species allow us to perceive what causes are of their extinction and how to prevent it. All information about rare species in state level is summarized in Red Data books or Red Lists. Lithuanian Red Data Book (LRDB) was recently edited in 2007, but only four terrestrial molluscs' species have been included in it: *Vertigo angustior* Jeffreys, 1830, *V. geyeri* Lindholm, 1925, *V. moulinsiana* (Dupuy, 1849) and *Arion ater* (Linnaeus, 1758). The analysis of

literature data shows that there could be more rare species in this book. An important condition for this doubt is poor exploring of molluscs: reasons for danger of extinction or decreasing population abundance are known only in the case of single species or their groups (Skujienė et al. 2006, Skujienė 2005). There are about 40 terrestrial molluscs species (or about 50% of all Lithuanian terrestrial molluscs) that were found only in 1-5 places in Lithuania (Gurskas 1997).

All of them are real applicants for the fourth category of Lithuanian Red Book wherein are indeterminate species, which can't be included into other categories due to a lack of data. Majority of them are species from Vertiginidae (as *Vertigo modesta* (Say, 1824), *V. genesii* (Gredler, 1856), *V. ronnebyensis* (Westerlund, 1871), *V. alpestris* Alder, 1838, *Truncatellina cylindrica* (Férussac, 1807)) and Clausiliidae (as *Cochlodina orthostoma* (Menke, 1828), *Clausilia bidentata* (Ström, 1765), *C. cruciata* (Studer, 1820), *C. pumila* C. Pfeiffer, 1828, *Ruthenica filograna* (Rossmässler, 1836), *Macrogastra latestriata* (Draparnaud, 1801), *Bulgarica cana* (Held, 1836)) and other families. Another important condition for studies of these species is the protection status and inclusion into Red Data Books or Red Lists of some of these species in neighbouring countries such as Latvia (for example, such species as *V. ronnebyensis* (Westerlund, 1871), *T. cylindrica* (Férussac, 1807), *C. bidentata* (Ström, 1765), *C. cruciata* (Studer, 1820), *C. pumila* C. Pfeiffer, 1828) or Poland (for example, *V. ronnebyensis* (Westerlund, 1871), *C. cruciata* (Studer, 1820)) (LRKM 2000, Zajac 2005).

According to all of this, the objective of this research was to study the diversity and found distribution peculiarities of rare and indeterminate snail species in Kaunas and Kaišiadoriai districts' reserves.

MATERIAL AND METHODS

Research was carried out in 2007 July and September in protected territories of 5 types in Kaunas and Kaišiadoriai districts' (Fig. 1). We studied 15 reserves and in each of them we looked for molluscs in forest and in some cases in meadow (Table 1). Places for research were selected by cartographic method, analyzing

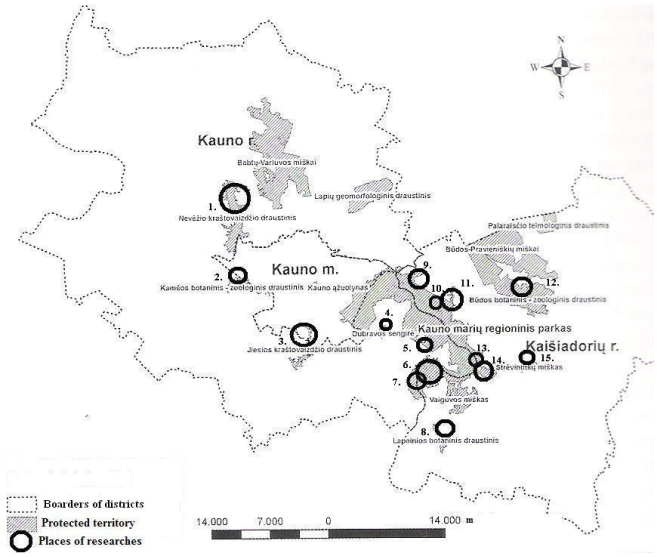

Fig. 1. Locations of studied sites within Kaunas and Kaišiadoriai districts' in central Lithuania in protected territories of 5 types: I) botanical-zoological reserves – sites 2, 6-8, 10, 12; II) landscape reserves – sites 1, 3, 5, 14; III) hydrographical reserves – sites 9, 11, 13; IV) Natura 2000 territory (important for habitat protection) – site 15; V) strict nature reserve – site 4.

Table 1. Habitats and data of studied sites in different reserves within Kaunas and Kaišiadoriai districts' in 2007

Reserves			Month-day	Meadow (TGs and MAe) and forest (all others) habitat types and coordinates of study
Type Name/ Type	Name & Site No.			
I Botanical-zoological	Arlaviškių	6.	07-16	hox: *Hepatito-oxalido-Quercetum* (005-09-622R, 060-75-947S and 005-09-647R, 060-75-960S).
	Būdos	12	07-09/10	cmp: *Carico-mixtoherbo-Faxinetum* (005-22-320R, 060-82-863S and 005-22-577R, 060-82-803S), oxn: *Oxalido-nemoroso-Piceetum* (005-22-952R, 060-82-792S), chm: *Carico-Betuletum pubescentis* (005-23-243R, 060-82-978S). aeg: *Aegopodio-Quercetum* (005-22-749R, 060-84-561S). TGs: *Trifolio-Geranietea sanguinei* (005-22-251R, 060-82-802S).
	Dabintos	7	07-19	vm: *Vaccinio-myrtillo-Pinetum* (005-10-101R, 060-73-619S). MAe: *Molinio-Arrhenatheretea elatioris* (005-09-298R, 060-74-042S).
	Gastilionių	10	07-17	ox: *Oxalido-Piceetum* (005-10-864R, 060-82-686S and 005-09-496R, 060-81-775S).
	Kamšos	2	07-12	hox: *Hepatito-oxalido-Quercetum* (004-88-841R, 060-84-984S).
	Lapainios	8	09-04/05	hox: *Hepatito-oxalido-Quercetum* (005-12-493R, 060-66-287S), ox: *Oxalido-Piceetum* (005-11-842R, 060-66-612S), mox: *Myrtillo-oxalido-Piceetum* (005-11-672R, 060-66-683S).
II Landscape	Jiesios	3	09-26	hox: *Hepatito-oxalido-Quercetum* (004-95-788R, 060-79-204S).
	Kauno marių	5	07-16/17	ox: *Oxalido-Piceetum* (005-12-241R, 060-78-231S; 005-12-296 R, 060-78-286S; 005-01-823R, 060-79-735S; 005-10-113R, 060-81-771S).
	Nevėžio	1	07-11/12	hox: *Hepatito-oxalido-Quercetum* (004-87-637R, 060-96-680S; 004-87-617R, 060-96-668S; 004-87-328R, 060-94-269S; 004-87-058R, 060-88-295S; 004-86-789R, 060-91-599S; 004-86-724R, 060-91-822 S). MAe: *Molinio-Arrhenatheretea elatioris* (004-87-137R, 060-94-186S).
	Strėvos	14	07-18	hox: *Hepatito-oxalido-Quercetum* (005-16-623R, 060-74-907S).
III Hydro-graph-ical	Karčiupio	9	07-18/19	ox: *Oxalido-Piceetum* (005-08-270R, 060-84-872S).
	Pravienos	11	07-18	ox: *Oxalido-Piceetum* (005-13-021R, 060-83-149S). MAe: *Molinio-Arrhenatheretea elatioris* (005-12-937R, 060-82-955S).
	Uolės	13	07-18	ox: *Oxalido-Piceetum* (005-16-377 R, 060-76-536 S).
IV Natura -2000	Strėvininkų for-est	15	09-05	hox: *Hepatito-oxalido-Quercetum* (005-22-104R, 060-75-267S and 005-22-484R, 060-75-472S). MAe: *Molinio-Arrhenatheretea elatioris* (005-22-332R, 060-75-374S).
V - Strict nature	Dubravos	4	07-05	ox: *Oxalido-Piceetum* (005-04-762R, 060-79-305S, 005-04-945R, 060-80-017S and 005-05-062R, 060-79-527S).

relief, location of water bodies and data from Lithuanian State Enterprise Forest Inventory and Management Institute database about habitat (Karazija 1988). Molluscs were sampled using the methods described by Valovirta (1996). In each biotope monitoring square of 100 m^2 was chosen for study. Molluscs were collected from five 1x1 m plots in chessboard order. We surveyed herbage, tree stems (below about 2m), dead wood (dead standing trees, logs and stumps), stones and crevices within 1x1 m and collected all visible specimens for later identification. Additionally, small samples of soil with litter (25x25x4 cm) were taken inside each sampling plot. Thus, for each studied biotope we had 5 samples (5 from plot and 5 from litter inside the plots, latter recount for 1x1 m and added to plot number).

Molluscs were sieved, collected and identified in laboratory, using several books (Kerney et al. 1983, Pokryszko 1990). Overall 175 samples were taken and 7483 individuals identified. The collection was given to Vilnius University Zoological Museum.

RESULTS

Species richness

A total of 64 species (56 snails and 8 slugs) belonging to 22 families was recorded in the study. Appendix 1 shows the mean number of each snail and slug species in one square meter recorded at each site. The mean number of molluscs species recorded per site was 10 (SD = 5,03, range 0-24 species, n = 15 sites). 13 of 64 species (20 %) were represented at one or two sites only, whereas 24 species (38 %) occurred in more than half of all sites. Species, represented at one or two sites only were: *Oxyloma elegans* (Riso, 1826), *O. sarsii* (Esmark, 1886), *Clausilia cruciata* Studer, 1820, *Isognommostoma isognommostomos* (Schröter, 1784), *A. arbustorum* (Linnaeus, 1758), *V. antivertigo* (Draparnaud, 1801), *Vertigo genesii* (Grendler, 1856), *Vertigo alpestris* Alder, 1838, *Columella aspera* Waldén, 1966, *Pupilla muscorum* (Linnaeus, 1758), *A. silvaticus* Lohmander, 1937, *D. leave* (O.F. Müller, 1774), *L. marginata* (O.F. Müller, 1774).

One species – *Columella aspera* Waldén, 1966 was found in Lithuania for the first time. During this research this species was found only in Dabintos botanical-zoological reserve, which protects old pine woods and swampy shores of Kaunas' sea (Dapkus et al. 2008). Species was found in *Vaccinio-myrtillo-Pinetum* habitat. This forest habitat isn't rich in malacofauna, so there were no detail studies in such places and we think that we could find *C. aspera* in similar biotopes in other Lithuanian sites too.

Table 2 summarizes data on species richness and abundance by habitat. No single site or habitat contained all the species recorded. Overall 10 habitats were examined during this research (8 forest habitats and 2 meadow plant association classes). Generally meadow habitats were richer in specimens (till 1791 specimens/ 1 m^2) and poorer in species neither forest habitats. The richest forest habitat was *Oxalido-Piceetum* (Table 2, ox) where the biggest variety of snail and slug species (i.e. 51 species), specimens (i.e. 259 ± 277,5 specimens / 1 m^2 ± SD) and range (i.e. 0-1476) in 1 m^2 were observed. The poorest habitat was *Vaccinio-myrtillo-Pinetum* forest (Table 2, vm) where only one land snail species - *Columella aspera* Waldén, 1966 - was found. Only one snail species from Lithuania Red Data book *Vertigo angustior* Jeffreys, 1830 was found in 4 habitats (Table 2, hox, mox, Mae, TGs): in *Hepatito-oxalido-Quercetum* and *Myrtillo-oxalido-Piceetum* forests and in *Molinio-Arrhenatheretea elatioris* and *Trifolio-Geranietea sanguinei* meadow plant association classes. During this research we found only 4 habitat specific species: *Columella aspera* Waldén, 1966 in *Vaccinio-myrtillo-Pinetum* forest, *Vertigo alpestris* Alder, 1838 in *Hepatito-oxalido-Quercetum* forest, *Vertigo genesii* (Grendler, 1856) in *Myrtillo-oxalido-Piceetum* forest and *Isognommostoma isognommostomos* (Schröter, 1784) in *Oxalido-Piceetum* forest. All of them could be considered as rare.

Analysis of variance (Kruskal-Wallis ANOVA: H (7, N = 150) = 24,71; p = 0,0009 and Median Test χ^2 = 20,05, df = 7, p = 0,0055) showed significant differences between numbers of

Table 2. Number of molluscs species and specimens in various habitats - plant association types (forest types: ox - *Oxalido-Piceetum,* hox - *Hepatito-oxalido-Quercetum,* mox - *Myrtillo-oxalido-Piceetum,* vm - *Vaccinio-myrtillo-Pinetum,* cmp - *Carico-mixtoherbo-Faxinetum,* oxn - *Oxalido-nemoroso-Piceetum,* aeg - *Aegopodio-Quercetum,* chm - *Carico-Betuletum pubescentis;* meadow plant association classes: MAe - *Molinio-Arrhenatheretea elatioris,* TGs - *Trifolio-Geranietea sanguinei*)

Parameter	Habitat (Number of studied sites, where habitat was found)									
	ox (7)	hox (7)	mox (1)	oxn (1)	vm (1)	cmp (1)	aeg (1)	chm (1)	MAe (4)	TGs (1)
Total number of species	51	44	26	19	1	28	18	14	39	15
Mean species/ 1 m^2 ± SD	10 ± 5,1	11 ± 4,5	10 ± 3,3	7 ± 2,2	1 ± 0	14 ± 5	6 ± 3,5	6 ± 2,4	12 ± 4,5	9 ± 2,4
Range of species	0-24	4-19	5-13	4-10	1-1	6-18	2-9	3-9	8-18	6-12
Number of species in all sites of habitat	5	3	26	19	1	28	18	14	6	15
Number of species found in one habitat only (specific)	1	1	1	-	1	-	-	-	-	-
LT Red Book species	-	1	1	-	-	-	-	-	1	1
Mean specimens/ 1 m^2 ± SD	259 ± 277,5	238 ± 260,8	249 ± 138,5	48 ± 34,8	5 ± 3,9	50 ± 16,7	29 ± 28,5	44 ± 43,4	421 ± 263,3	792 ± 387,4
Range of specimens	0-1476	5-854	79 - 441	13 - 97	1-11	32 - 71	2-74	4-109	38 - 1791	376 - 1309

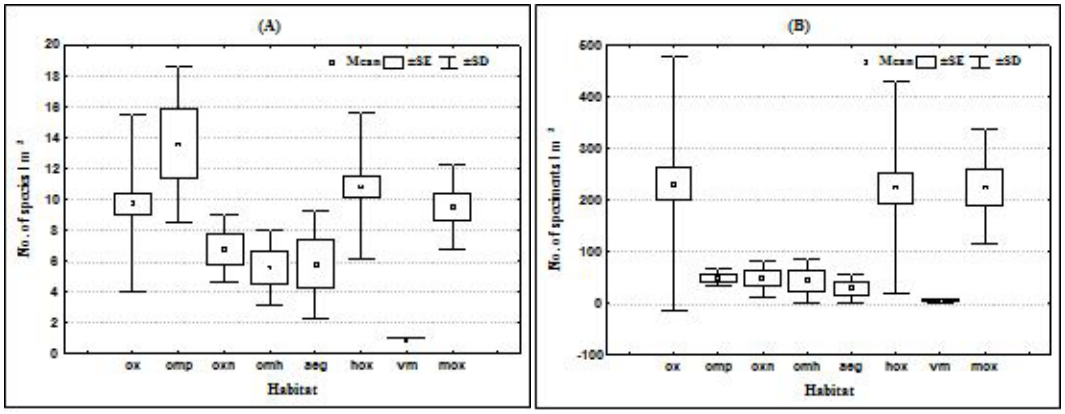

Fig. 2. Relationship between (A) species richness and forest habitat, and specimens' richness (B) and forest habitat. Habitat symbols as in Table 2.

species in different forests' habitats (Fig. 2, A). *Oxalido-Piceetum*, *Hepatito-oxalido-Quercetum, Myrtillo-oxalido-Piceetum* and *Carico-mixtoherbo-Faxinetum* forests (Table 2: ox, hox, mox, cmp) have the largest number of species (26-51 species) and reliably diverge from species abundance in other forest habitats (Fig. 2, A: oxn, cmh, aeg, vm). As a result of investigation there were the significant differences between numbers of specimens in different forests' habitats (Fig. 2, B) too: Kruskal-Wallis ANOVA: H (7, N = 150) = 30,48, p = 0,0001 and Median Test χ^2 = 33,98, df = 7, p = 0,0000. Again *Oxalido-Piceetum* (the maximum 1476 specimens per 1 m^2 (Table 2, ox)), *Hepatito-oxalido-Quercetum* (the maximum 854 specimens per 1 m^2 (Table 2, hox)), and *Myrtillo-oxalido-Piceetum* (the maximum 441 per 1 m^2 (Table 2, mox)), forest habitats diverged from all others (Fig.2, B: cmp, oxn, cmh, aeg, vm) as having bigger number of specimens and *Vaccinio-myrtillo-Pinetum* was the poorest forest habitat (Fig. 2, B: vm)

Table 3. Species of conservation interest in studied reserves within Kaunas' and Kaišiadoriai' districts in 2007. Abreviations: LT – Lithuania; RL PL – Red List of Poland (Zajac 2005); RB LV - Red Book of Latvia and regulations (LRKM 2000); Status in documents: V – vulnerable species; R – rare species; EN – endangered species; IN – indeterminate species; NT- near threatened species; (1) – listed in 1 annex as protected in Latvia); Literature*: books (Gurskas 1997, 2002, LRDB 2007) and data of Woodland Key Habitat inventory in Lithuania from database of State Enterprise Lithuanian Forest Inventory and Management Institute (Kaunas 2005)

Criterion Species (found in study)	Occurrences in study			Literature*	Status in Documents		
	No. of habitats	No. of sites	Mean ± SD spec./m²	No. of sites in LT	RL PL	RB LV	ES Habitat directive
Acicula polita (Hartmann, 1840)	3	5	0,4 ± 2,4	7	-	IN	-
Acanthinula aculeata (Müller, 1774)	2	4	0,4 ± 3,8	7	-	-	-
Bulgarica cana (Held, 1836)	5	8	1,8 ± 6,2	84	-	R	-
Clausilia cruciata Studer, 1820	2	1	0,1 ± 0,3	92	NT	R	-
Clausilia pumila Pfeiffer, 1828	5	10	5,1 ± 13,9	9	-	R	-
Cochlodina orthostoma (Menke, 1830)	3	8	0,5 ± 2,2	27	-	R	-
Macrogastra latestriata (A. Schmidt, 1857)	3	7	0,4 ± 2,2	8	-	(1)	-
Ruthenica filograna (Rossmässler, 1836)	6	3	0,5 ± 2,3	8	-	R	-
Isognommostoma isognommostomos (Schröter, 1784)	1	2	0,14 ± 0,9	4	-	R	-
Vertigo angustior Jeffreys, 1830	4	6	0,7 ± 3,9	16	EN	V	Annex II
Vertigo genesii (Grendler, 1856)	1	1	0,1 ± 0,4	2	-	-	Annex II
Vertigo alpestris Alder, 1838	1	1	0,2 ± 2,5	3	-	(1)	-
Columella aspera Waldén, 1966	1	1	0,1 ± 1,1	1	-	-	-

Species of conservation interest

Not all species, found at one or two sites only were attributed to rare species. For example, slugs were not the object of our interest in this study and they were found only occasionally and we did not use special sampling methods for slugs (Wiktor 2004). There was a total list (Appendix 1) of picked species, reconsidered for detachment of species of conservation interest detachment of species of conservation interest and 13 species were distinguished (Table 3) according to their distribution rate in Lithuania and conservation status in ES Habitat Directive and neighboring countries (Latvia and Poland). Thus we included two species which are listed in II appendix of ES Habitat Directive, six species which are listed as rare in Latvia (Red Book of Latvia), one species which conservation status is different in Latvia and Poland and four species which aren't listed in ES habitat Directive or Red books or Red lists of neighboring countries. But the data from literature and our study all together show us, that they are not very common in Lithuania than species listed above. These four species are *Acanthinula aculeata* (Müller, 1774), *Columella aspera* Waldén, 1966, *Macrogastra latestriata* (A. Schmidt, 1857) and *Vertigo alpestris* Alder, 1838. The last two of them are listed only in the regulations of Latvian Cabinet of Ministers Nr. 369 (2000.14.11) as officially protected in Latvia (1 – Annex).

Some of the 13 species (Table 3) were found only in one kind of habitat: *Columella aspera* Waldén, 1966 – in *Vaccinio-myrtillo-Pinetum* forest, *Isognomostoma isognomostomos* (Schröter, 1758) – in *Oxalido-Piceetum* forest, *Vertigo genesii*

(Gredler, 1856) – in *Myrtillo-oxalido-Piceetum* forest, *V. alpestris* Alder, 1838 - in *Hepatito-oxalido-Quercetum* forest. As stated above *Columella aspera* Waldén, 1966 was found in Lithuania for the first time. *Isognomostoma isognomostomos* (Schröter, 1758) earlier was found in 4 sites on the left shore of the Nemunas' river. During this research the species was found in protected territories of 2 types and both of them are around Kauno marios (Seas of Kaunas'): it was found in Gastilionių botanical-zoological and Kauno marių landscape reserves. Only 2 old data concerning the locality of *Vertigo genesii* (Gredler, 1856) were known in Lithuania: M. Valius found few snails near Obelija and Metelys lakes (Valius 1951) and I. Šatkauskienė found some snails in Viešvilės reserve (2001). Only 7 individuals of this species were found during this research in Lapainia botanical reserve. Althought this species belongs to ES Habitat Directive, it was not included in Lithuania Red Data book. According to literature data *Vertigo alpestris* Alder, 1838 was discovered in three locations in Lithuania: by M. Valius near Obelija lake (1951), by P. Šivickis in Rietavas (Gurskas 1997) and by G. Skujienė and G. Vaivilavičius, in Verkių Regional Park, Vilnius (2001). This research revealed only one place of this species in Nevėžio landscape reserve, in the slope woods of the Nevėžis river (Dapkus et al. 2008).

Two species (Table 3) were found in habitats of two kinds: *Acanthinula aculeata* (Müller, 1774) - in *Oxalido-Piceetum* forest and in *Molinio-Arrhenatheretea elatioris* meadow plant association class; *Clausilia cruciata* (Studer, 1820) - in *Carico-mixtoherbo-Faxinetum* and in *Oxalido-nemoroso-Piceetum* forests. There are 7 places in Lithuania where *Acanthinula aculeata* (Müller, 1774) have been found and one site of them - in surroundings of Kaunas' district (Gurskas 1997). During these studies it was found in three different protected territories in *Oxalido-Piceetum* forest: in Gastilionių botanical-zoological, Kauno marių landscape and Karčiupio hydrographical reserves. Also species was found in Pravienos hydrographical reserve in *Molinio-Arrhenatheretea elatioris* meadow plant association class. Only 3 places for *Clausilia cruciata* Studer, 1820 were known before Woodland Key habitat inventory in Lithuania (duration: 2001 - 2005) in vicinities of Ukmergė, in Viešvilės sanctuary and Verkių regional park in Vilnius (Skujienė & Vaivilavičius 2001, Šatkauskienė 2001). During our research it was found only in one reserve - Būdos botanical-zoological reserve in *Oxalido-nemoroso-Piceetum* and *Carico-mixtoherbo-Faxinetum* forests.

The remaining seven species (Table 3) were found in habitats (habitat symbols as in Table 2) of three and more kinds: *Acicula polita* (Hartmann, 1840) – in ox, hox and mox, *Bulgarica cana* (Held, 1836) – in ox, hox, oxn, aeg and cmp, *Clausilia pumila* Pfeiffer, 1828 – ox, hox, mox, cmp and MAe, *Cochlodina orthostoma* (Menke, 1830) – ox, hox and cmp, *Macrogastra latestriata* (A. Schmidt, 1857) – ox, hox and aeg, *Ruthenica filograna* (Rossmässler, 1836) – ox, hox, aeg, oxn, cmp and chm, *Vertigo angustior* Jeffreys, 1830 – hox, mox, MAe and TGs. Whereas *Vertigo angustior* Jeffreys, 1830 belongs to this group, this shows us that some other species are more rare than aforesaid species of Red Data book. Moreover, this species was found in 6 sites and 4 very different habitats – both forest and meadows. During this research species was found in Lapainios botanical reserve in *Myrtillo-oxalido-Piceetum* and in Strėvininkų forest in *Hepatito-oxalido-Quercetum* habitats. Strėvininkų forest is surrounded by cultivated fields, which are not suitable for this species, but in the forest broad-leaved trees are predominant, whereas wood-cutting areas and oaks are dominant (Dapkus et al. 2008). Also species was found in *Molinio-Arrhenatheretea elatioris* meadow plant association class in Dabintos botanical-zoological, in Nevėžio landscape reserves and Pravienos hydrographical reserves. It was found in Būdos botanical-zoological reserve in *Trifolio-Geranietea sanguinei* meadow plant association class. Fertile soils, broad-leaved and nut-trees are predominant in all these reserves and this creates favourable conditions for terrestrial molluscs (Dapkus et al. 2008).

Table 4. Protection measures in reserves that might have influenced terrestrial molluscs' distribution and diversity and some total data of species number in studied reserves. Types of reserves as in Table 1

Protection measures	Type of reserve				
	I	II	III	IV	V
1. Not to change relief, make mining works.	-	+	-	-	-
2. Not to install new quarries for mineral.	+	+	+	+	+
3. Not to change hydrological regime (to drain land).	+	+	+	+	+
4. Not to straighten or deepen natural river course, to build dams, to change shore lines of water bodies.	+	+	+	-	-
5. Not to fertilize or cultivate natural meadows and pastures or transform them to other land properties.	+	+	-	-	-
6. Not to plant forest clearings, natural meadows and pastures with trees.	+	-	-	-	-
7. Not to make clear cuttings, except of reconstruction cuttings.	+	+	-	+	+
8. Not to use pesticides.	+	+	-	+	+
9. Not to plant trees which do not match forest type.	+	-	-	+	-
10. Not to introduce new plant and animal species.	+	-	-	-	-
11. Not to subvert leaf litter, lichen, moss, grass and shrub cover in forest.	-	-	-	+	-
Total number of measures:	9	7	3	6	4
Total number of species in studied reserves:	62	53	39	27	17
Total number of rare species in studied reserves:	12	10	6	1	0

Protection measures and species richness in reserves

Distribution of species in all reserves differed. As a rule, almost all reserves included 15 species (Appendix 1). 19 species of all (No. 64) were discovered in 10-14 reserves. 6 species were found almost in all reserves (*Carychium tridentatum* (Risso, 1826)*, Cochlicopa lubrica* (O.F. Müller, 1774), *Nesovitrea hammonis* (Ström, 1765), *Cochlodina laminata* (Montagu, 1803)*, Vitrea crystalina* (O.F. Müller, 1774), *Fruticicola fruticum* (O.F. Müller, 1774)). Other species were found in 10-12 reserves (*Columella edentulla* (Draparnaud, 1805)*, Vallonia costata* (O.F. Müller, 1774)*, C. pumilla* C. Pfeiffer, 1828*, Macrogastra ventricosa* (Draparnaud, 1801)*, M. plicatula* (Draparnaud, 1801)*, Laciniaria plicata* (Draparnaud, 1801)*, Trichia hispida* (Linnaeus, 1758), *Cepaea hortensis* (O.F. Müller, 1774), *Aegopinella pura* (Alder, 1830), *Nesovitrea petronella* (L. Pfeiffer, 1853)*, Perforetella bidentata* (Gmelin,1791), *Euomphalia strigella* (Draparnaud, 1801), *Chilostoma faustinum* (Rossmässler, 1835)).

The variety of molluscs in the same types of reserves particularly differed (Table 5). The biggest variety of terrestrial molluscs' species, as well as rare species, was in botanical-zoological reserves. There were found 62 molluscs species altogether (or 74% of all Lithuania terrestrial mollusc species) and 12 rare species (or 14% of all Lithuania terrestrial mollusc species) in this type, but range of rare species in different reserves vary from 2 (Dabintos, site No. 7) to 5 (Būdos, site No. 12) species. Similar number (5 species) of rare species was established in Jiesios (site No. 5) landscape reserve, although the general number of species there was not the biggest one (26 species). The least variety of terrestrial molluscs' species (only 17 species) and none of rare species were found in Dubravos (site No. 4) Strict nature reserve.

Table 4 presents eleven protection measures in reserves that might have influenced terrestrial molluscs' distribution and diversity. Some of them are listed (Table 4, No: 1, 3, 5, 7) as protection measures for *Vertigo angustior* Jeffreys, 1830 in Red Book but some other measures in

Table 5. Abundance (specimens/m^2) and mean number of terrestrial molluscs' species in protected territories of Kaunas and Kaišiadoriai districts'. Numbers of protected territories as in Table 1

Species Territories	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Acicula polita (Hartmann, 1840)	-	-	0,2	-	1,7	3,2	-	1,6	-	-	-	-	-	0,2	-
Carychium tridentatum (Risso, 1826)	8,3		27	0,1	10,1	122	0,1	19,2	57,8	35,4	9,8	0,1	3,4	16,4	82,9
Carychium minimum (O.F. Müller, 1774)	17	-	13,4	-	-	-	3	28,4	-	1,6	-	0,8	-	-	93,4
Succinea putris (Linnaeus, 1758)	3,5	-	13,2	-	-	0,4	3,5	13,6	-	1,7	-	0,1	-	-	6,2
Succinella oblonga (Draparnaud, 1801)	-	-	-	-	-	-	-	-	4	0,1	1,7	19,3	-	-	-
Oxyloma elegans (Risso, 1826)	-	-	-	-	-	-	-	5,8	-	0.1	-	-	-	-	-
Oxyloma sarsii (Esmark, 1886)	1,1	-	-	-	-	-	0,4	-	-	-	-	-	-	-	-
Cochlicopa lubrica (O.F. Müller, 1774)	39,8	-	7,2	0,5	9,2	3,8	3,4	9,5	-	7	26,1	0,7	14	0,4	3,6
Cochlicopa lubricella (Porro. 1838)	10,3	3,2	18,2	-	19,2	-	2,1	11,6	-	7,2	16,7	0,7	-	9,8	12,9
Vallonia costata (O.F. Müller, 1774)	3,2	-	0,4	-	0,2	-	-	4,1	16	57,6	5,5	8,8	6,4	-	8
Vallonia excentrica Sterki, 1893	27,1	-	-	-	-	-	4,8	0,1	-	-	8,2	12,7	-	-	-
Vallonia pulchella (O.F. Müller, 1774)	25,1	-	-	-	1,6	-	10,3	13,2	9,6	-	-	87,2	-	-	-
Acanthinula aculeata (O.F. Müller, 1774)	-	-	-	-	0,2	-	-	-	13	0,3	0,1	-	-	-	-
Merdegerana obscura (O.F. Müller, 1774)	2,4	13,8	4	-	4,2	3,4	-	-	68,6	1,7	8,2	-	-	8	-
Punctum pygmaeum (Draparnaud, 1805)	0,6	-	-	-	-	-	1,1	0,4	16	0,1	0,2	0,1	-	3,2	1
Discus ruderatus (Férussac, 1821)	-	-	-	0,2	2,6	-	-	0,1	-	1,8	-	0,7	-	-	3,3
Discus rotundatus (O.F. Müller, 1774)	-		-	0,1	20,7	2,2	-	-	-	-	-	-	-	-	-
Euconulus fulvus (O.F. Müller, 1774)	-	-	-	0,2	0,3	-	-	-	-	0,1	-	-	-	-	-
Pupilla muscorum (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	0,3	14,3	-	-	-
Deroceras laeve (O.F. Müller, 1774)	0,1	-	-	-	-	-	-	-	-	-	-	-	-	-	0,1
Malacolimax tenellus (O.F. Müller, 1774)	-	-	-	0,1	0,1	-	-	0,1	0,2	0,1	-	-	-	-	-
Limax cinereoniger Wolf, 1803	0,1	-	-	-	1,3	1	-	-	-	-	-	0,1	-	-	-
Lehmania marginata (O.F. Müller, 1774)	-	-	-	-	-	-	-	-	-	-	-	-	0,2	-	-
Columella edentula (Draparnaud, 1805)	-	-	0,6	1,2	0,7	0,2	-	0,2	35,2	3,1	-	1	6,8	1,2	1,7
Columella aspera Waldén, 1966	-	-	-	-	-	-	2,5	-	-	-	-	-	-	-	-
Vertigo alpestris Alder, 1838	1,6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vertigo angustior Jeffreys, 1830	0,2	-	-	-	-	-	0,6	1,2	-	-	0,1	0,1	-	-	8,7
Vertigo genesii (Gredler, 1877)	-	-	-	-	-	-	-	0,4	-	-	-	-	-	-	-
Vertigo pygmaea (Draparnaud, 1801)	0,1	-	-	-	-	-	1,1	-	-	-	0,9	4,5	-	-	-
Vertigo antivertigo (Draparnaud, 1801)	-	-	-	-	-	-	1,3	9,8	-	-	-	-	-	-	-
Vertigo substriata (Jeffreys, 1833)	-	-	-	-	-	-	-	1,3	3,2	0,2	-	0,1	-	-	-

Vertigo pusilla (O.F. Müller, 1774)	0,6	-	-	0,1	1,7	-	-	0,1	4	0,4	-	0,6	0,2	-	0,6
Cochlodina laminata (Montagu, 1803)	9,2	9,2	10,6	1,1	27,4	13	-	5,2	15,2	13,9	7,3	4,2	18,4	108,4	-
Cochlodina orthostoma (Menke, 1830)	0,3	0,6	3,2	-	0,6	4	-	-	-	0,3	-	0.1	-	4	-
Clausilia pumilla C. Pfeiffer, 1828	1	0,2	21,6	-	11,6	10,8	-	0,1	-	7,1	29,5	0,6	-	28,8	-
Clausilia cruciata Studer, 1820	-	-	-	-	-	-	-	-	-	-	-	0,3	-	-	-
Clausilia dubia Draparnaud, 1801	2	24,4	-	-	-	-	-	-	3,2	1,7	3,2	0,2	-	-	-
Bulgarica cana (Held, 1836)		7,2	21,6	-	2	2,4	-	0,7	15	0,8	-	1	-	-	-
Macrogastra ventricosa (Draparnaud, 1801)	0,3	1,8	31,2	-	7,9	26	-	9,4	10,2	3,6	-	0,8	3,4	-	-
Macrogastra plicatula (Draparnaud, 1801)	2,6	6,8	24,8	-	3,5	7,4	-	1,9	0,4	7,1	0,1	1,6	-	3,2	0,1
Macrogastra latestriata (A. Schmidt, 1857)	-	1,2	1,2	-	1,6	-	-	-	-	0,2	-	0,1	5	1,6	-
Ruthenica filograna (Rossmässler, 1836)	-	-	-	-	2,6	-	-	1,5	-	-	-	1,3	-	-	-
Laciniaria plicata (Draparnaud, 1801)	0,4	10,2	0,8	-	0,7	2	-	0,3	4,2	0,9	0,1	0,3	1,6	12	-
Vitrea crystallina (O.F. Müller, 1774)	11,8	3,2	46	1,5	93,3	55,2	-	39,3	23,8	46,6	11,4	3,8	16,4	20,2	59,4
Vitrea contracta (Westerlund, 1871)	-	-	-	0,1	-	-	-	1,2	71,4	0,3	4,8	0,2	-	6,4	-
Zonitoides nitidus (O.F. Müller, 1774)	-	-	0,2	1,3	-	-	0,6	8,1	-	-	-	0,1	-	-	-
Oxychillus allarius (O.F. Müller, 1774)	-	-	25	-	-	3,2	41,6	3,2	-	-	-	0,7	-	6,2	0,5
Aegopinella pura (Alder, 1830)	3,4	-	3,2	-	7,4	12,8	-	11	68,8	39,6	1,6	1,3	-	0,6	-
Nesovitrea hammonis (Ström, 1765)	5,4	-	3,2	7,1	21,4	3,2	8,2	32,5	67,2	12,4	0,2	1	21	6,4	22,5
Nesovitrea petronella (L.Pfeiffer, 1853)	5,8	6,4	46,8	4,4	42,6	-	-	3,4	5	0,9	6,4	3,1	3,2	-	6,4
Vitrina pellucida (O.F. Müller, 1774)	2,8	-	-	0,1	1,6	-	1	-	-	1,6	0,7	0,8	0,2	0,2	10,8
Arion fuscus (O.F. Müller, 1774)	0,3	-	-	-	0,3	-	-	0,6	-	0,2	-	0,4	-	-	0,2
Arion circumscriptus Johnston, 1828	0,4	-	-	0,1	0,4	0,4	-	-	-	-	0,3	-	-	-	0,2
Arion fasciatus (Nilsson, 1822)	-	-	-	-	-	-	-	-	-	0,2	-	-	-	1,6	0,2
Arion silvaticus Lohmander, 1937	-	-	-	-	-	-	-	0,1	-	-	-	-	-	-	0,3
Fruticicola fruticum (O.F. Müller, 1774)	4,8	0,4	42,6	-	2,4	2,2	0,1	5,2	4	1,6	35,5	4,6	-	2	4,5
Euomphalia strigella (Draparnaud, 1801)	1,4	-	-	-	-	12,8	-	0,1	0,4	4,7	34,1	0,1	3,6	24,4	1,6
Chilostoma faustinum (Rossmässler, 1835)	0,1	3,6	4	-	2,7	12,4	-	0,1	0,4	-	7,7	0,8	4,2	6,8	-
Perforatella bidentata (Gmelin, 1791)	9,6	1	56,4	0,1	8	4,4	3,1	25,7	-	2,9	31,5	8,6	8	-	9,3
Trichia hispida (Linnaeus, 1758)	25,9	0,2	-	-	0,3	12,8	-	10,5	-	0,2	20	4,6	3,4	8,8	17,5
Isognommostoma isognommostomos (Schröter, 1758)	-	-	-	-	2,4	-	-	-	-	0,1	-	-	-	-	-
Arianta arbustorum (Linnaeus, 1758)	-	-	-	-	-	-	-	-	-	-	-	0,1	-	-	-
Cepaea hortensis (O.F. Müller, 1774)	2,8	10,4	-	-	3,4	0,2	-	3,3	6,6	5,1	10,5	1,1	0,2	0,4	-
Helix pomatia Linnaeus, 1758	1,3	4	-	-	-	4,4	-	-	-	0,9	-	-	-	1,6	17,9
Total Number of 64 species:	38	19	26	17	37	27	19	41	26	41	30	45	19	26	27

Red Book are different, for example, use extensive pasturage and slash willowy places.

No reliable dependence on protected territory type, the number of protection measures, with species ($r = 0,73$, $p = 0,16$, at dependence level $p<0,05$) and number of individuals ($r = 0,85$, $p = 0,07$, at dependence level $p<0,05$) were observed. Though there are only 3 protection measures in hydrographical reserves, but the number of species still is high (39 species). The reason for that might be one protection measure that forbidden changing shore lines of water bodies, which is very important for hygrophilous molluscs' communities.

DISCUSSION

Who is prior? Either habitat or protected territory is?

There are some published accounts (Götmark et al. 2008) that surrounding conservation landscape determine local land molluscs species richness and, contrarily, some of researches consider that "mollusc faunas can survive more-or-less intact in very small fragments of suitable habitat" (Cameron & Pokryszko 2004, p. 157). Our results showed the significant differences between number of species in different habitats (Fig. 2), but any reliable dependence on protected territory type and number of protection measures and species or specimens richness was not observed when all protected territories had been included in the analysis. However it is obvious that surrounding conservation landscapes has an impact on species richness. For example, species richness in *Oxalido-Piceetum* forests (Table 1, ox) was studied in four protected territory types (all except Natura 2000 forest) and evidently, Strict nature reserve is the least appropriate for protection of molluscs no species of conservation value was found (Table 4, V), while even 8 species of conservation interest (*Acicula polita* (Hartmann, 1840), *Acanthinula aculeata* (Müller, 1774), *Cochlodina orthostoma* (Menke, 1830), *Clausilia pumila* Pfeiffer, 1828, *Bulgarica cana* (Held, 1836), *Macrogastra latestriata* (A. Schmidt, 1857), *Ruthenica filograna* (Rossmässler, 1836), *Isognomostoma isognomostomos* (Schröter, 1758)) were found in reserves of other types. Species richness in *Hepatito-oxalido-Quercetum* forest is also high (8 species of conservation interest: *Acicula polita* (Hartmann, 1840), *Vertigo alpestris* Alder, 1838, *Vertigo angustior* Jeffreys, 1830, *Cochlodina orthostoma* (Menke, 1830), *Clausilia pumila* Pfeiffer, 1828, *Bulgarica cana* (Held, 1836), *Macrogastra latestriata* (A. Schmidt, 1857), *Ruthenica filograna* (Rossmässler, 1836)) and it was studied in reserves of three types (Table 1, hox): in botanical-zoological, landscape reserves and in Natura 2000 forest. It is obvious that Natura 2000 forest is the least appropriate for protection of molluscs as only one species (*Vertigo angustior* Jeffreys, 1830) of conservation value was found (Table 4, IV) and as this species was not typical for this habitat only– it was found in 3 more very different habitats – both forest and meadows.

Let us return to the statements that any reliable dependence on protected territory type or number of protection measures and species or specimens richness was not observed when all protected territories were included in the analysis. This is right, but there is an obvious tendency to existing dependence on number of protection measures and species richness when from analysis we excluded data from Hydrographical reserves: correlation coefficient is very high and shows us a strong dependence ($r = 0,93$) while likelihood is nearly reliable ($p = 0,07$).

However we should be careful with generalization as all protected territories that we have studied are only in two closely situated districts of Lithuania, but not in all districts of Lithuania, and number (only 15 in total) of studied protected territories was different. More detailed studies in all Lithuania should be more statistical significant and could show us the other representation.

The assessment of conservation status of molluscs' species

Assessment of species distribution, abundance and conservation status are just several of themes in conservation biology (Groom et al. 2006). Some species merit more attention from

conservation biologists: they are on the verge of extinction and majority of them depends on human action. But we must not confuse the phrases ,,Rare“ and ,,Endangered“. As M.L. Hunter claimed (2002, p. 43): ,,not all species that are quite rare are highly endangered with extinction, and conversely, not all endangered species are particularly rare”. For example, *Arianta arbustorum* (Linnaeus, 1758) was found only in one reserve, but it is not rare and we know that it is an invasive species in Lithuania (Gurskas 1997). Otherwise *Vertigo angustior* Jeffreys, 1830 is not as rare species in Lithuania as *Vertigo alpestris* Alder, 1838*, Vertigo genesii* (Grendler, 1856), *Isognommostoma isognommostomos* (Schröter, 1784)*, Acanthinula aculeata* (Müller, 1774)*, Acicula polita* (Hartmann, 1840)*, Macrogastra latestriata* (A. Schmidt, 1857)*, Ruthenica filograna* (Rossmässler, 1836)*, Clausilia pumila* Pfeiffer, 1828*,* but *V. angustior* is known as highly endangered species in Europe. Therefore Lithuania as all other ES countries must warrant appropriate protection. It is interesting, that only *Vertigo angustior* Jeffreys, 1830 is under protection in Lithuania, though during our researches two species listed in ES Habitat Directive were found (other species - *Vertigo genesii* (Grendler, 1856)). Furthermore, if we tried to asses the conservation status of species listed in ES Habitat Directive, we would see that 50% of the species listed in ES Habitat Directive are in unfavourable-inadequate/ bad or unknown conservation status in the different ES regions (Spyropoulou 2008). So protection of species and their conservation status foremost is the task of every State. In our opinion all 13 species listed as rare species above should be protected in Lithuania. We examined the distribution data of these species (Table 3) and assessed that all of them are more or less rare in Lithuania. Mean abundance of majority of these species balanced between 0,1 and 0,7 specimens for 1x1 m (Table 3) and only two species were more numerous – mean number of *Bulgarica cana* (Held, 1836) was 1,8 ± 6,2 for 1x1 m and mean number of *Clausilia pumila* Pfeiffer, 1828 was 5,1 ± 13,9 for 1x1 m. But this is because of local and microhabitat factors were favorable for these species in studied sites that the upper species richness was influenced. The conservation status of *Bulgarica cana* (Held, 1836) might be under discussions as the status of *Clausilia cruciata* Studer, 1820 too, as they are known in 84-92 sites of Lithuania. But we must not forget that all Clausiliidae were specially studied in Lithuania during Woodland Key Habitat inventory (Andersson et al. 2005) when total studied sites were 8902. Now we have the real view of distribution of this family in Lithuania. Moreover may be more species of Clausiliidae should be under protection in Lithuania than listed above.

In conclusion we can agree with scientists who state that conservation prioritization has to be based not only on general species richness but on assessment of distribution of each land mollusc in all territory of the country as well.

How many lists of protected molluscs divers in neighbour states?

Comparison of lists of terrestrial molluscs' fauna with neighbour states (Kerney et al. 1983, Rudzite et al. 1997, Wiktor 2004, Skujienė 2002) showed that the majority of species in Latvia, Poland and Lithuania are the same. Differences in majority (of species) are concerned with the relief of Poland: uplands are characterized by absolutely another kind of land mollusc species. As geographically Lithuania is located between these two countries, presumable rare species list should be similar to lowland species of both of them. Comparative analysis of lists of protected molluscs' species in Latvia and Poland showed that only five species are the same, and two of them – *Vertigo angustior* Jeffreys, 1830 and *V. moulinsiana* (Dupuy, 1849) - are protected in Lithuania.The new edition of the Red List of Threatened Species of Animals in Poland includes 75 terrestrial mollusc species or 43% of a total of over 173 terrestrial mollusc species known in Poland (Zajac 2005). Similar situation is in Latvia, according to species listed in the regulations of Latvian Cabinet of Ministers No. 396 (2000.14.11) as officially protected in Latvia (LRKM 2000) are 30 terrestrial mollusc species or 35% of a total of over 86 terrestrial mollusc species known. And only 4 terrestrial mollusc species or 4,8% of a total of over 83

terrestrial mollusc species known in Lithuania are protected (LRDB 2007). How good do these situations reflect reality? General remarks in malacological literature show that with respect to protection and research on the main threats, land molluscs are in the worst situation, because conservation planning often omits invertebrates (Cameron 1998, Pawlowska & Pokryszko 1998, Meyers et al. 2000, Sólymos & Fehér 2005). As claimed M.L. Hunter (2002, p. 43):„The decision to list or not list a species as endangered is likely to be controversial when it is made by a government agency". Believably the situation in Lithuania is the worst.

GENERALIZATIONS AND CONCLUSIONS

1. One way to maximize the conservation benefit of species today is to identify hotspots (Reid 1998) — areas with supreme concentration of species richness and narrow range endemics that face exceptional degrees of threat (Götmark et al. 2008). During our study we made conversely research – we looked for „hotspots" of land molluscs in established reserves. Some of reserves were established in 1960's as Jiesios, Kamšos, other just several years ago but none of them are committed for molluscs especially. Our study displayed that some of reserves and protection measures there are also suitable for protection of molluscs. These reserves are: Būdos, Dabintos, Gastilionių botanical-zoological, Lapainios botanical, Nevėžio and Jiesios landscape, Pravienos hydrographical reserves and Strėvininkų forest.

2. Our study of rare terrestrial mollusc species of Kaunas and Kaišiadoriai districts' reserves exposes the absolute necessity of reconsideration of their legal status and protection in Lithuania.

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