A comparison of soil sampling and direct search in malacological field inventories

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We compared quadrate based soil sampling and time restricted direct search methods in order to evaluate their use in land snail diversity assessment. The study was conducted in a riparian alder forest in Hungary. By each of the methods, we compared the observed and estimated number of land snail species, the nature of biases due to the variation in species catchability, and the incidence based complementarity of the two methods. We tested the effect of collectors' identity on the sampling results in case of the time restricted search. Based on our results, we suggest simultaneous use of the two methods, and the use of species accumulation curves to define sampling efficiency in field inventories for exploring terrestrial mollusc faunas.

Keywords: Catchability, Clench equation, Gastropoda, Mollusca, species accumulation curve, species richness.

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Introduction

Conservation biology aims the preservation and management of species and their habitats. These actions need high quality data and efficient methods in biodiversity assessment (Williams et al., 2002; Colwell and Coddington, 1994).

Data are not always comparable and often suffer from certain biases due to preferential sampling and inadequate sample sizes. However, these biases can partly be reduced based on detailed analysis and comparison of the methods being used.

Here we compare two frequently used malacological sampling methods, i.e. soil sampling by quadrates and time restricted direct search. By each of the methods, we compared (1) the observed and estimated number of land snail species, (2) the nature of biases due to the variation in species catchability, and (3) the incidence based complementarity of the two methods. We also tested the (4) effect of collectors' identity on the sampling results in case of the time restricted search.

Material and methods

The study was conducted in a riparian alder forest, Ménes Valley (Szögliget, Aggtelek National Park, Hungary, date: 29.03.2003). The weather was wet and the vegetation was in an early stage with no developed herb layer. The micro-relief of the habitat was flat and homogenous compared to the surrounding environs.

Sampling was carried out in a 10×50 m plot of uniform vegetation, which was divided into five contagious 10×10 m subplots. Within each subplot four random samples (soil and litter samples, 25×25 cm quadrates in approximately 5 cm depth in the soil) were taken. The total of 20 samples were sieved with a 0.5 mm mesh and searched for snails indoors. Besides soil sampling, we performed time restricted direct search using 15 minutes sampling intervals. Five person collected snails in the stand for one hour, and this resulted in 20 samples, 15 minutes each. For each specimen, we measured shell dimension, determined life stage (juvenile/adult, living/dead). Afterwards, we calculated proportions of size classes and life stages. Catchability of the species was expressed as shell diameter, each specimen were measured.

We estimated species richness based on the extrapolation of the asymptotic Clench equation. The Clench equation is defined as $S(n) = an / (1 + bn)$, where S denotes species richness, n is the number of samples pooled, a and b are constants. Estimated species richness is calculated as a/b, sampling efficiency is calculated as $q(n) = bn / (1 + bn)$ (Soberon and Llorente, 1993). For the extrapolation, sample order was randomised 50 times.

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Complementarity was evaluated using the Jaccard index of similarity, which was calculated as $A / (A + B + C)$, where A is the number of joint species, B and C are the number of unique species in two compared species lists, respectively.

We compared the characteristics of the two methods by Mann-Whitney test, difference in the sampling performance of the five collecting person was tested by Kruskal-Wallis nonparametric analysis of variance.

Results

Slugs (Limacidae), freshwater species (*Stagnicola palustris, Radix peregra, Sadleriana pannonica*, Pisidiidae species) and species present only as subfossil forms (*Oxyloma elegans, Sphyradium doliolum, Vallonia pulchella*) were excluded from the data set. We used 5382 specimens of 32 species for further analyses (Table 1).

The observed number of species found by means of the two methods did not differ significantly, the estimated number of species did not differ either. Sampling efficiency was high for both methods (Table 2, Fig. 1).

The difference in the number of individuals was significantly higher in soil sampling. The proportion of adult specimens was significantly higher in direct search. The difference in the proportion of living specimens was not significant. Soil sampling showed significant bias towards smaller (<2.5 mm) and less catchable individuals, while direct search was significantly biased towards larger (>2.5 mm) specimens (Table 2).

In case of the time restricted search, the effect of collectors' identity on the observed number of species was marginally significant (Kruskal-Wallis test, H = 9.45, df = 4, n = 20, p = 0.051), while the effect on the number of individuals was not significant (Kruskal-Wallis test, H = 6.1, df = 4, n = 20, p = 0.192).

The incidence based complementarity of the two methods was 65.6 % for the pooled species lists and 40.1 % (mean) for sample-by-sample comparisons based on the Jaccard index. The total number of species was 32 (Table 1).

Table 1. Counts of the species by the two sampling methods. Species are ranked according to their abundances.

Species	Soil sampling	Direct search
Carychium tridentatum (Risso, 1826)	1702	3
Zonitoides nitidus (O. F. Müller, 1774)	516	268
Cochlicopa lubrica (O.F. Müller, 1774)	407	107
Succinea oblonga Draparnaud, 1801	217	24
Columella edentula (Draparnaud, 1805)	217	2
Perforatella rubiginosa (A. Schmidt, 1853)	216	252
Discus perspectivus (Megerle von Mühlfeld, 1816)	157	61
Aegopinella pura (Alder, 1830)	154	3
Bradybaena fruticum (O. F. Müller, 1774)	116	321
Aegopinella minor (Stabile, 1864)	30	38
Balea biplicata (Montagu, 1803)	22	49
Euconulus fulvus (O. F. Müller, 1774)	22	3
Helicigona faustina (Rossmässler, 1835)	19	86
Macrogastra ventricosa (Draparnaud, 1801)	14	88
Vitrea diaphana (Studer, 1820)	10	6
Isognomostoma isognomostomos (Schröter, 1784)	4	35
Helicodonta obvoluta (O. F. Müller, 1774)	3	70
Laciniaria plicata (Draparnaud, 1801)	1	15
Oxychilus glaber (Rossmässler, 1838)	1	4
Perforatella incarnata (O. F. Müller, 1774)	1	26
Helix pomatia Linné, 1758	1	7
Vertigo antivertigo (Draparnaud, 1801)	20	-
Daudebardia rufa (Draparnaud, 1805)	9	-
Vertigo pygmaea (Draparnaud, 1801)	8	-
Vertigo angustior Jeffreys, 1830	5	-
Vitrina pellucida (O. F. Müller, 1774)	2	-
Truncatellina cylindrica (Férussac, 1807)	1	-
Cochlodina laminata (Montagu, 1803)	-	21
Clausilia pumila C. Pfeiffer, 1828	-	9
Euomphalia strigella (Draparnaud, 1801)	-	5
Macrogastra latestriata (A. Schmidt, 1857)	-	3
Vitrea contracta (Westerlund, 1871)	-	1

Discussion

Both methods had characteristic and systematic biases. The catchability of the small individuals and species was higher in soil sampling than in direct search, while for larger species the tendency was the opposite. Based on the selectivity and the observed complementarity of the methods, simultaneous use of the two methods is highly recommended.

The observed and estimated number of species did not differ significantly, although the number of collected individuals was much higher in soil samples. This indicates that one can reach same species numbers based on either methods, but indoor labour and identification effort is much less in direct search than in soil sampling. Based on this, we suggest the use of species accumulation curves to define sampling efficiency in field inventories for exploring terrestrial molluscan faunas, with respect to the available resources.

In case of direct search, the effect of collectors' identity was not significant. This could be due to the relatively heterogeneous character and the rich land snail fauna of the habitat. We plan to extend these methodological studies to various types of habitats.

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Table 2. Comparison of the two methods. Data are given as pooled totals (first three rows) and sample means ± SD with the results of the Mann-Whitney test (subsequent rows). ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$, ns: not significant.

	Soil sampling ($n = 20$)	Direct search ($n = 20$)	***Mann-Whitney*** **U**
Observed total No. of species	27	26	
Estimated total No. of species	27.9	27.7	
Sampling efficiency (%)	93.54	94.01	
Average No. of species	13.2 ± 2.14	14 ± 2.22	161.5ns
Average No. of individuals	222.1 ± 140.23	77.75 ± 26.16	31.5***
Proportion of adult specimens	0.560 ± 0.12136	0.624 ± 0.11914	122*
Proportion of living specimens	0.615 ± 0.19502	0.652 ± 0.12594	174.5ns
Proportion of shell dimension categories:			
<2.5 mm	0.678 ± 0.15698	0.050 ± 0.05420	0***
2.5-5 mm	0.236 ± 0.10325	0.401 ± 0.19001	85.5**
5-10 mm	0.062 ± 0.05562	0.257 ± 0.11893	19.5***
>10 mm	0.014 ± 0.01705	0.299 ± 0.12453	1***

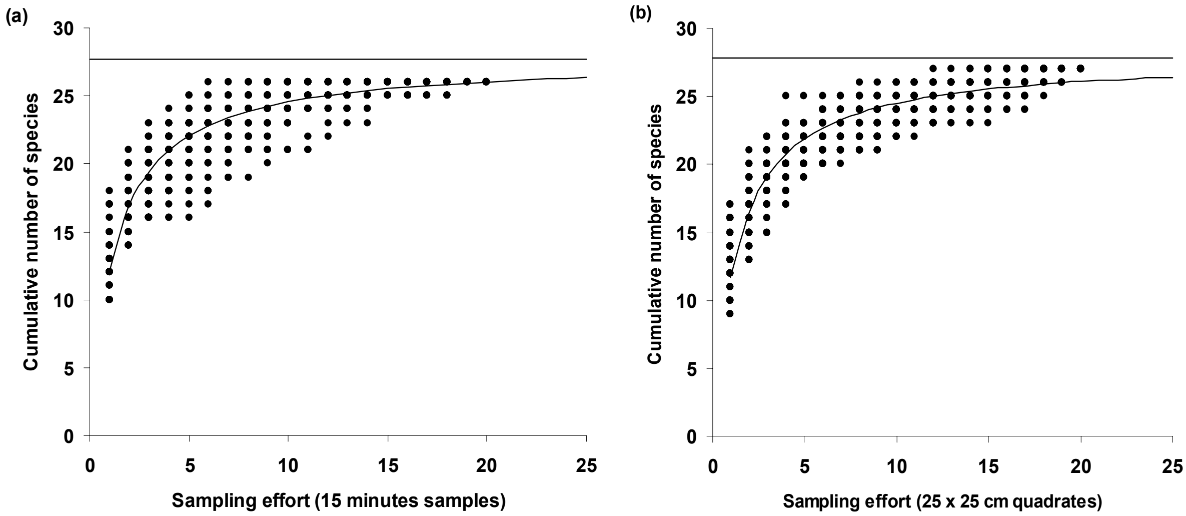

Fig. 1. Species accumulation curves of direct search (a) and soil sampling (b). For the scatter, sample order was randomised 50 times, accumulation curve was fitted by using the Clench equation, horizontal line indicates the estimated total number of species.

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