Small Mammal Diversity and Abundance in Commercial Orchards in Relation to Habitat and Agricultural Factors

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Abstract: Diversity of small mammal communities (SMC) show sustainability of habitats, especially agricultural ones. Gathered over three years, data from 18 sites in Lithuania were used to analyse factors related to several dependent parameters, namely diversity (Shannon 's H, dominance index and number of species trapped), the relative abundance of species in SMC and the abundances and proportions of the four most numerous species, specifically common vole, striped field mouse, yellow-necked mouse and bank vole. Using the General Linear Model, we assessed the influence of habitat type (commercial orchards, berry plantations, control meadows and control forests with at least two of these present at every investigation site), age of the orchard or plantation, intensity of agriculture, season and location (central, northern, eastern, southern and western parts of the country). To control temporal data variability, year was used as a continuous predictor. The model was valid and explained 14–31% of the listed parameters with $p < 0.005$ or higher, with the exception of the dominance index and the proportion of the common vole. Time factor (year and season, $p < 0.001$), intensity of agriculture and site location ($p < 0.05$) had the highest influences on the model, while that of habitat type and its age were not significant. Univariate results suggest that old commercial orchards with low intensities of agricultural practice play a role in maintaining diversity and abundance of SMC.

Keywords: rodents; population indices; spatio-temporal variation; agricultural habitats; Lithuania.

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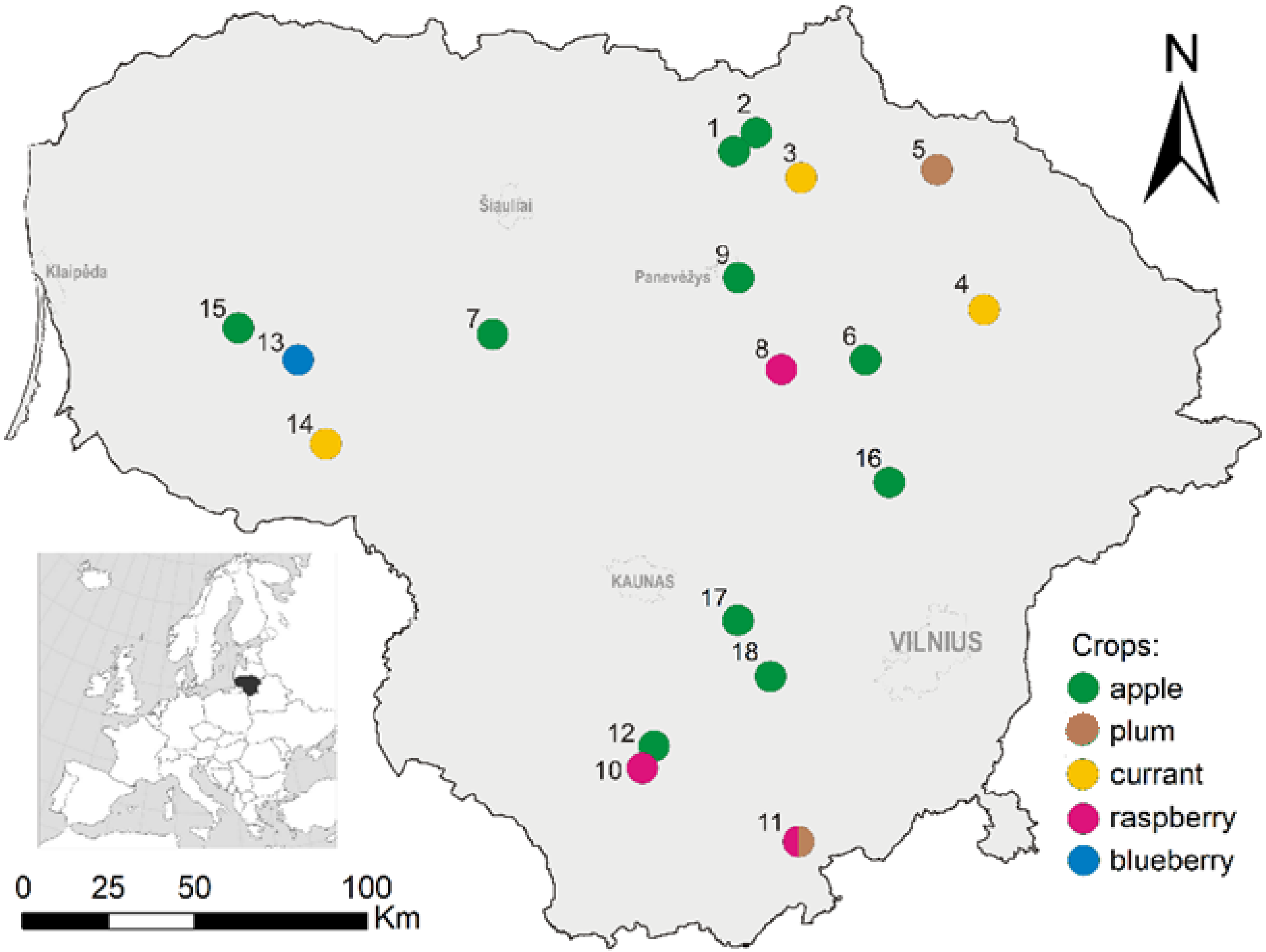
Study sites



Sites 1–3, 6–10 and 12 were investigated in 2018–2020, while sites 5, 7, 9, 11 and 13–15 were studied in 2018–2019 and sites 16–18 in 2020. Average size of the study site was 37.6±11.9 ha (63.7 ha of apple orchards, 0.81 ha of plum orchards, 22.0 ha of currant plantations, 2.3 ha of raspberry plantations and 3.80 ha of blueberry plantation).

Material and methods

Parameter	Values	Sites	Trapping effort
Crop age	old	1,2,6,7,9,12,16–18	9768
	medium	3,4,8,11,13–15	5050
	young	1,5,10,12	1900
Intensity of agriculture	high	2,6,10–13,15,17	8218
	medium	1,5,9,14	4450
	low	3,4,7,8,11,16,18	4050
Control	forest	11,17	525
	mowed meadow	1,2,4,6,8–10,12,13–16	5560
	non-mowed meadow	1,3,5,7–9,11,18	2700

- Snap trapping (approval No GGY-7), summer and autumn 2018–2020, 18 sites
- Trapping effort 25,503 trap days
- Dissection
- 1450 small mammals

Material and methods

Indices of the small mammal communities: number of species, dominance, diversity (Shannon's H) and relative abundance (individuals per 100 trap/days).

Categorical factors: habitat type (orchards, berry plantations, control habitats), age of the orchard or plantation, intensity of agriculture, year, season and location (central, northern, eastern, southern and western parts of the country).
Continuous predictor: trapping effort.

Sampling unit: trapping session (3 day trapping in one habitat, particular year and particular season, n = 168).

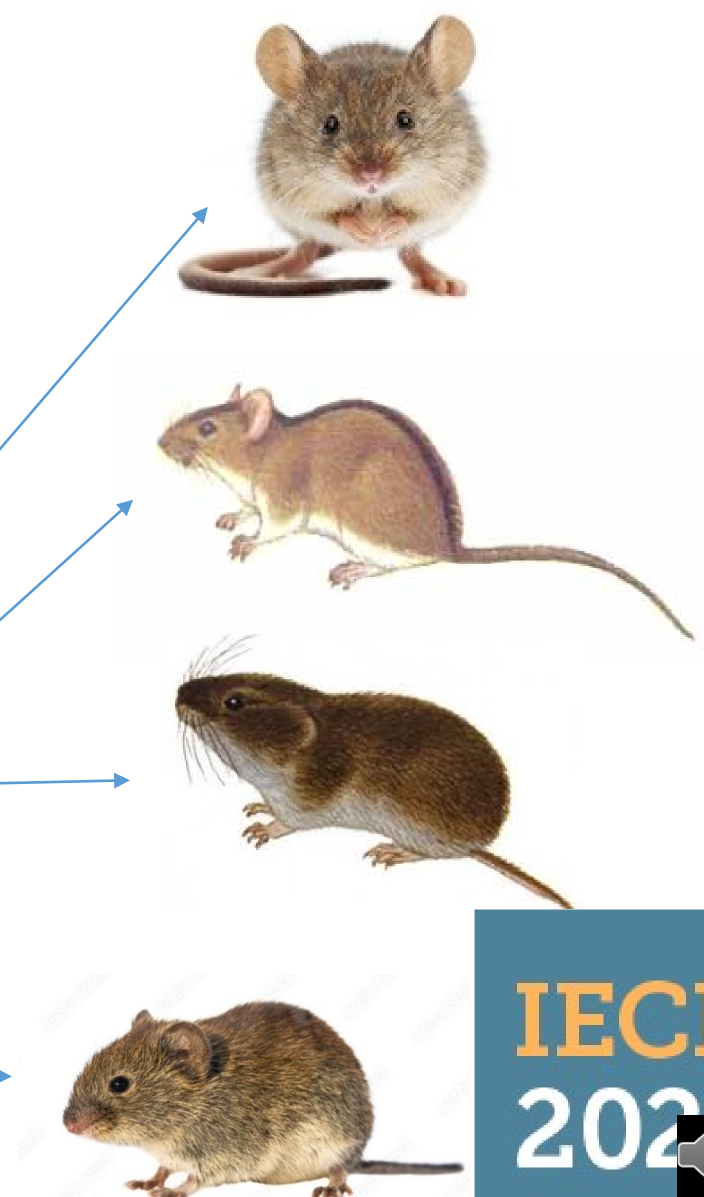
Analyses: GLMM, ANOVA, G-test

Software used: PAST version 4.01 (Paleontological Museum, University of Oslo, Oslo, Norway), OpenEpi epidemiological software, WinPepi, version 11.39, Statistica for Windows, version 6.0 (StatSoft, Inc., Tulsa, OK, USA)

Material and methods

Species	Diet
Common shrew (*Sorex araneus*)	Insectivores
Pygmy shrew (*Sorex minutus*)	Insectivores
House mouse (*Mus musculus*)	Omnivores
Harvest mouse (*Micromys minutus*)	Granivores
Yellow-necked mouse (*Apodemus flavicollis*)	Granivores
Striped field mouse (*Apodemus agrarius*)	Granivores
Common vole (*Microtus arvalis*)	Herbivores
Field vole (*Microtus agrestis*)	Herbivores
Root vole (*Microtus oeconomus*)	Herbivores
Bank vole (*Clethrionomys glareolus*)	Omnivores
Water vole (*Arvicola amphibius*)	Herbivores

Dominant species



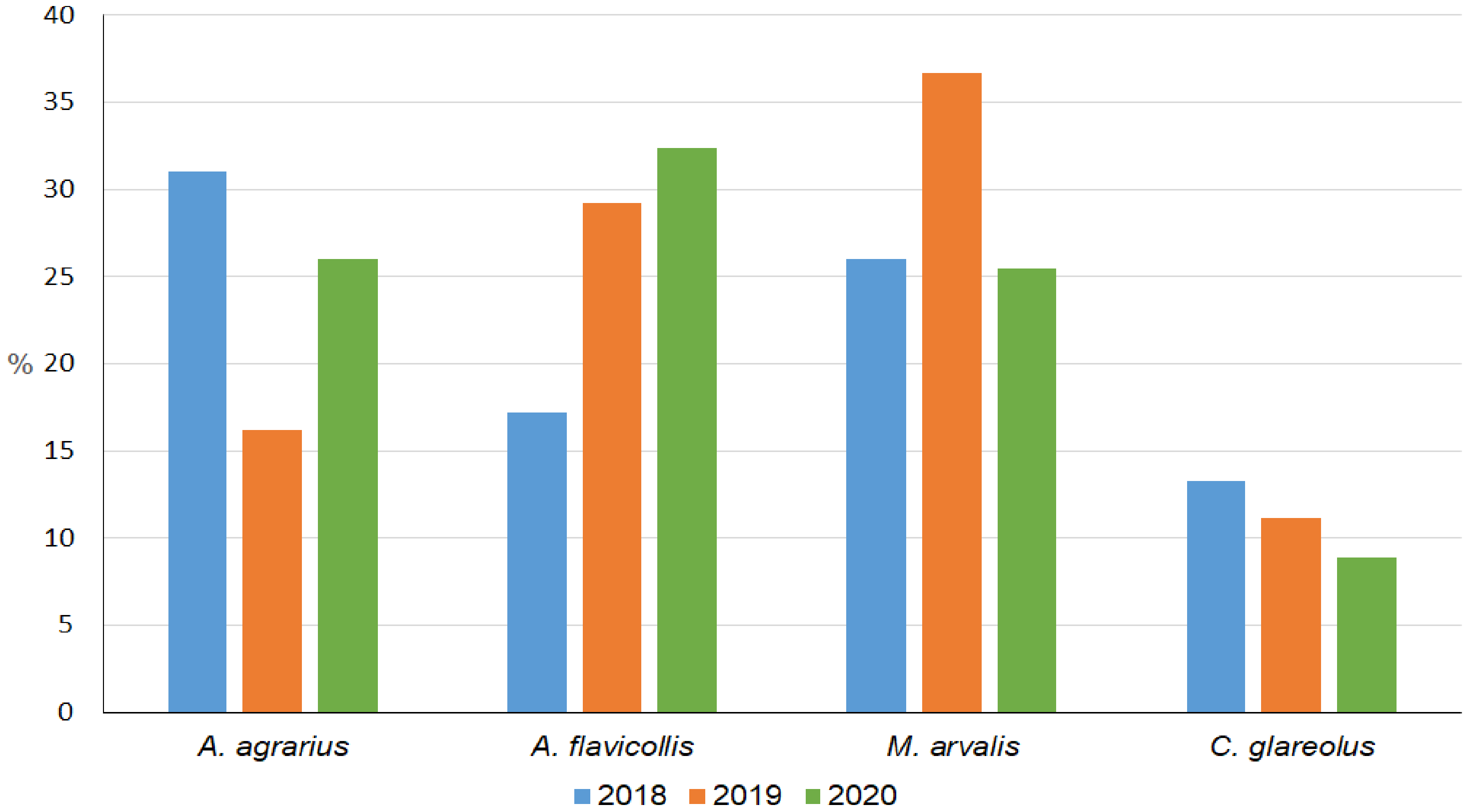
Results

Trapping effort controlled GLMM confirmed the cumulative influence of location (Hotelling's $T^2 = 0.69$, $p < 0.05$), season ($T^2 = 0.50$, $p < 0.001$), year ($T^2 = 0.79$, $p < 0.001$), habitat ($T^2 = 0.98$, $p < 0.05$) and intensity of the agricultural practices ($T^2 = 0.37$, $p < 0.05$) on the proportions and relative abundance of the most numerous species as well as on the diversity and abundance of the small mammal communities. Age of the crop had no influence ($T^2 = 0.28$, $p = 0.29$). Dominance did not depend on these factors; 18–41% of the variations of the other indices were explained:

Index	Multiple R^2	$F_{17,150}$	p <
RA of the community	0.38	4.84	0.0001
Number of species	0.37	4.46	0.0001
Diversity, Shannon's H	0.32	3.6	0.0001
Dominance in the community	0.15	1.36	0.155
RA of M. arvalis	0.24	2.52	0.001
% of M. arvalis	0.18	1.75	0.05
RA of A. flavicollis	0.26	2.67	0.001
% of A. flavicollis	0.29	3.18	0.0001
RA of A. agrarius	0.25	2.54	0.001
% of A. agrarius	0.26	2.68	0.005
RA of C. glareolus	0.41	5.34	0.0001
% of C. glareolus	0.20	3.18	0.0001

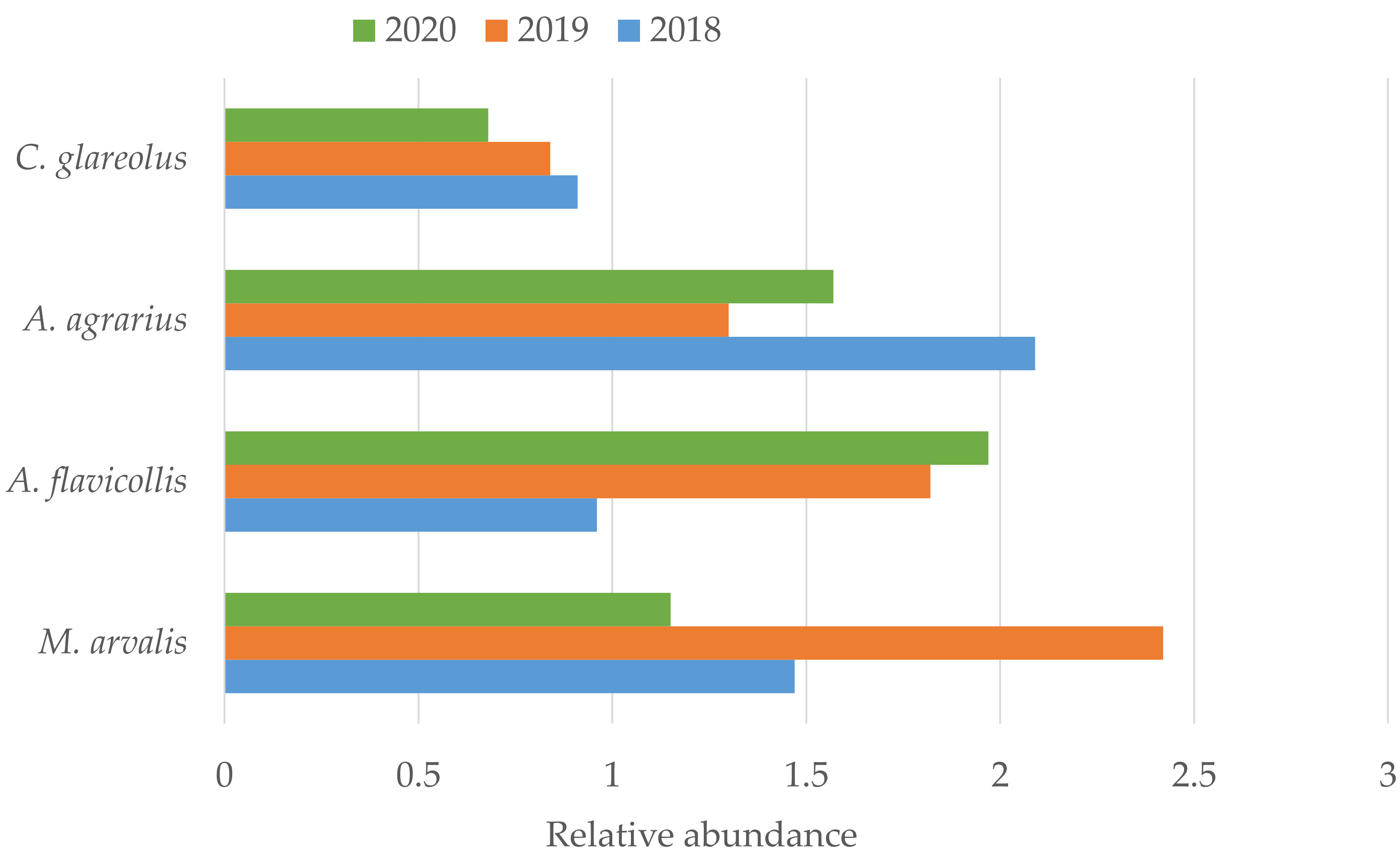
Results

Yearly changes in the proportions of the four most abundant small mammal species in the commercial orchards in 2018–2020.



Results

Relative abundances (individuals per 100 trap-days) of the small mammal communities and the most numerous species in commercial orchards



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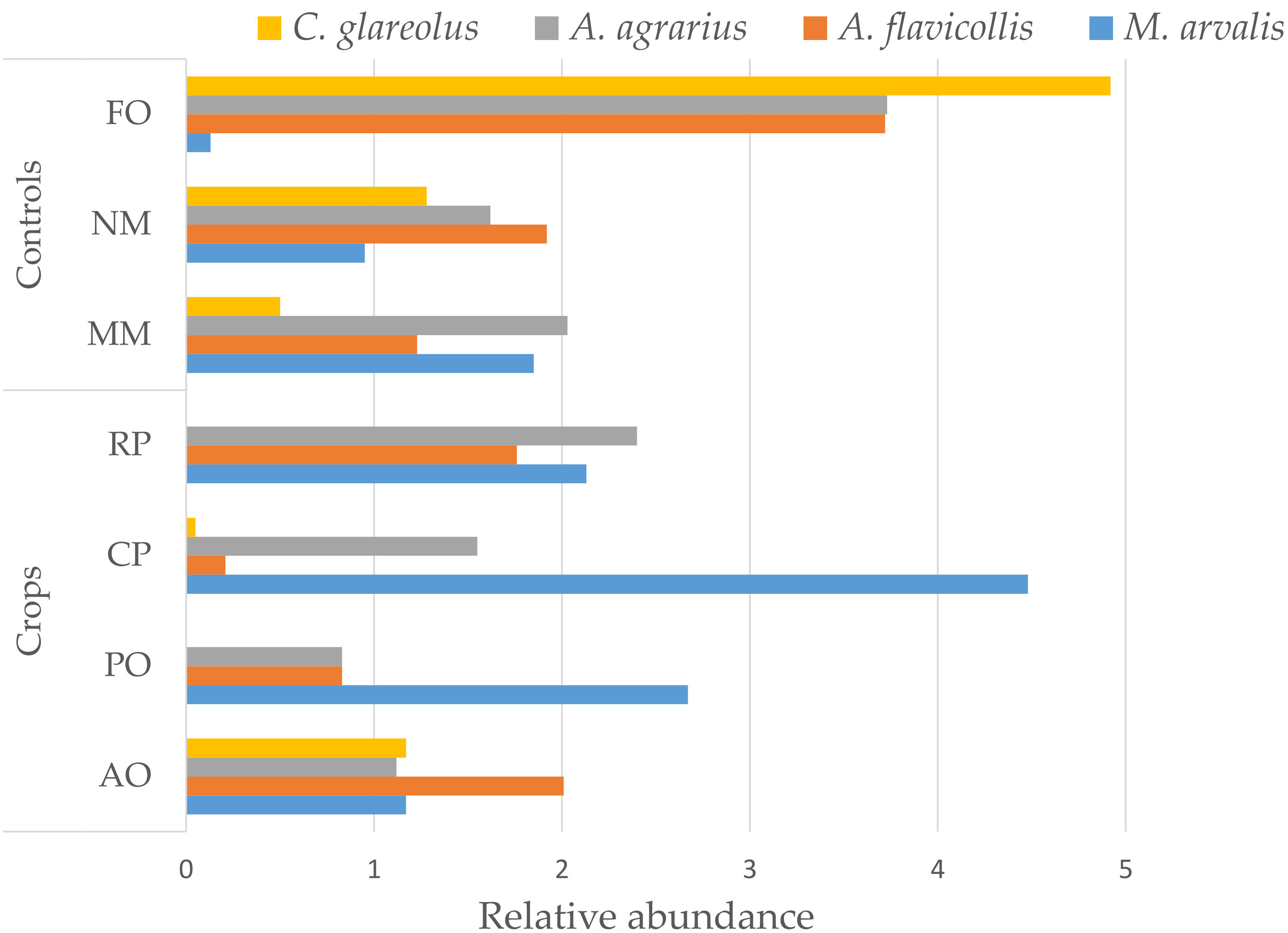
Results

Habitat-based differences of analysed small mammal populations



Crops:
AO – apple orchards,
PO – plum orchards,
CP – currant plantations,
RP – raspberry plantations,
controls:
MM – mowed meadows,
NM – non-mowed meadows,
FO – forest ecotones.

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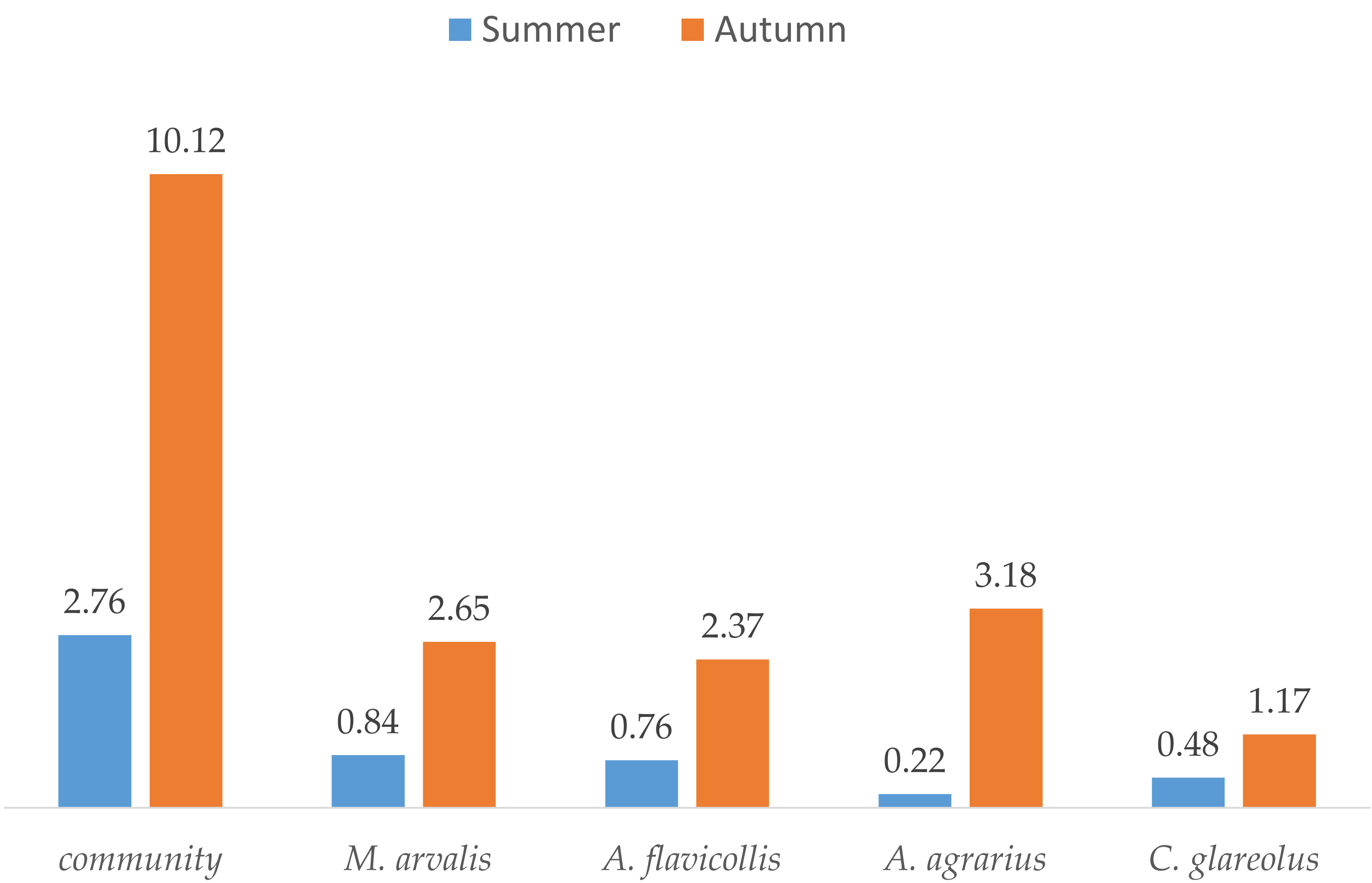
Results

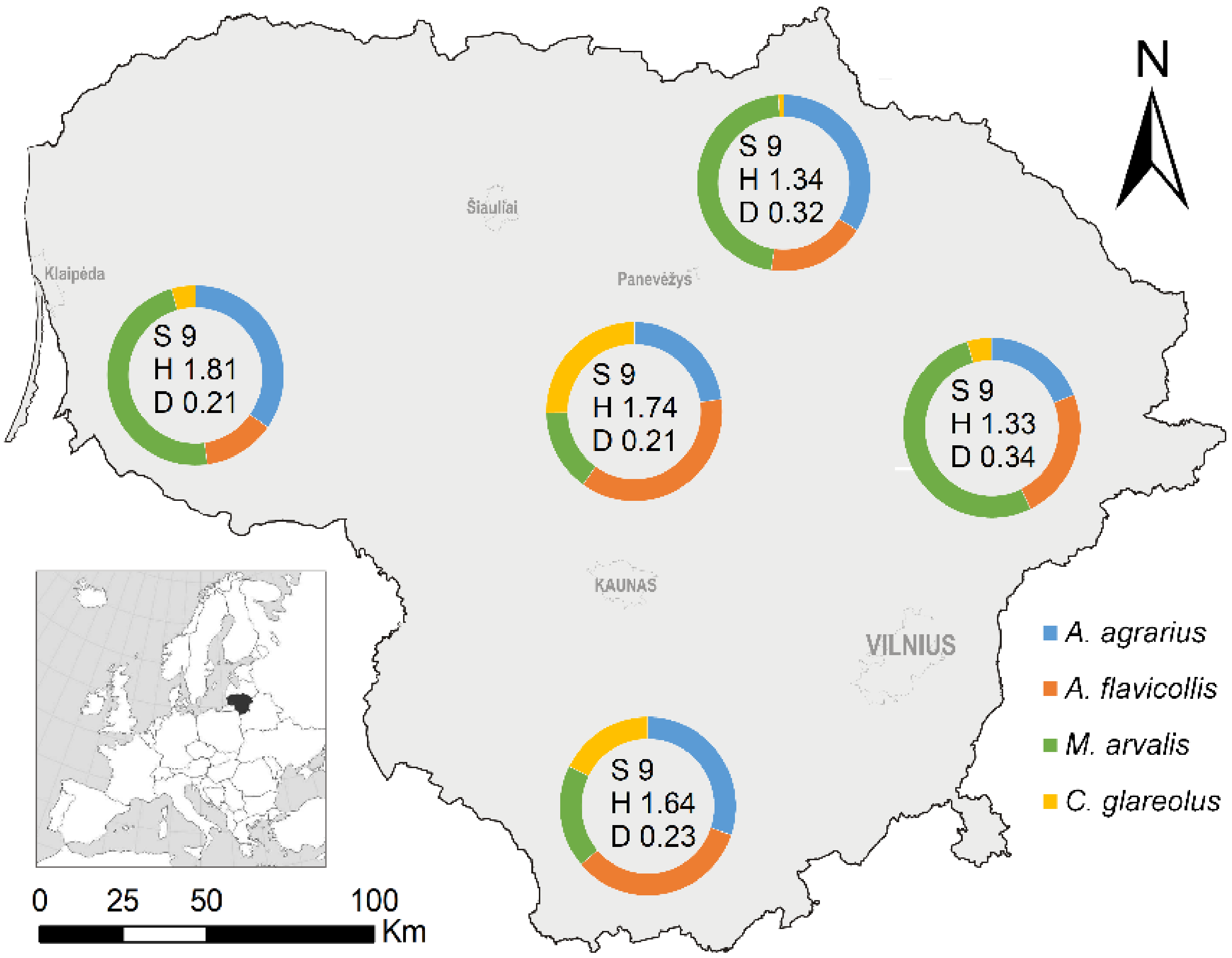
Season-based differences of analysed small mammal populations



Relative abundances (individuals per 100 trap-days)

Results

Location-based differences of small mammal diversity and abundance



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Conclusions

1. In Lithuania, the proportions and relative abundances of the most numerous small mammal species and the diversity of their communities in commercial orchards mainly depend on the season and the region within the country, with crop type being less significant.
2. In comparison to the summer season, the relative abundance of *C. glareolus* doubled in autumn, while that of *M. arvalis* and *A. flavicollis* tripled and *A. agrarius* increased by nearly 15 times.
3. The proportions of the most abundant small mammal species exhibited significant regional and crop based differences, while differences in relative abundances were less expressed.

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