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Diversity and Diet Differences of Small Mammals in Commensal Habitats

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Abstract: The stability of diversity of syntopic (inhabiting the same habitat in the same time) small mammals in commensal habitats, such as farmsteads and kitchen gardens, and, as a proxy of their diet, their isotopic niches, was investigated in Lithuania in 2019–2020. We tested whether the separation of species corresponds to the trophic guilds, whether their diets are related to possibilities of getting additional food from humans, and whether their diets are subject to seasonal trends. We analyzed diversity, dominance and distribution of hair $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values. Diversity and dominance was not stable and differed according to human influence. The highest small mammal species richness occurred in commensal habitats that provided additional food. The degree of separation of species was higher in homestead habitats than in kitchen gardens, where a 1.27% to 35.97% overlap of isotopic niches was observed between pairs of species. Temporal changes in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values in the hair of the mammals were not equally expressed in different species. The isotopic overlap may depend on dietary plasticity, minimizing interspecific competition and allowing co-existence of syntopic species. Thus, small mammal trophic ecology is likely related to intensity of agricultural activities in the limited space of commensal habitats.

Keywords: homesteads; isotopic niche; kitchen gardens; carbon-13 and nitrogen-15 isotopes; resource partitioning



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1. Introduction

The presence of rodents in rural habitats is a long-known problem [1]. The occurrence of rodents and other small mammals near humans results in various degrees of adaptation on their part, with species becoming synantropic, peridomestic or agrophilic [2,3]. These species, however, are mostly evaluated as possible carriers and reservoirs of various zoonotic pathogens [4–6] or in relation to their damage [2,7–9].

Meanwhile, investigations into the ecology of human-related rodents are also an important part of urban ecology [10–12]. Urban development tends to expand the area of peri-urban and residential gardens [13] and, therefore, the investigation of small mammals in other commensal habitats, such as homesteads and kitchen gardens, are in line with these processes [14]. The anthropogenic pressure on animals in commensal habitats is strong, forcing them to share resources and change activity patterns [15]. The pilot study of commensal habitats here is specific, as all species are syntopic and thus were all trapped in the same habitat in the same season.

Rodent ecology in commensal habitats varies geographically, as there are many related factors, including (but not limited to) resources, shelter, land use, economic activities and land cover [16–18]. Additional available food in commensal habitats is beneficial to small mammals [19], but supply of it is not stable. Depending on fluctuating resources, community changes are observed [14,20,21]. The presence of rodents in such habitats inspires negative attitudes among owners and other members of local communities [22].

Therefore, the development of various small gardening practices [23,24] requires advances in research and understanding of the biological diversity in these areas [14,25–27].

Current investigations into small mammals in commensal habitats are mainly limited to tropical, low latitude and southern parts of middle latitude countries [28–31]. In the Baltic countries (Northern Europe), there has been a single publication to date, this a preliminary assessment of small mammals in homesteads and kitchen gardens in Lithuania, emphasizing species composition, body condition and breeding parameters [14].

The aim of the present study was to test whether the diversity of small mammals in the commensal habitats (farmsteads and kitchen gardens) is related to their diet, using isotopic niches as proxies for the diets. We expected that (1) there should be separation of the species according to trophic guilds, (2) diet should be related to the possibility of getting additional food from humans, and thus there should be differences in the isotopic space of species between homesteads and kitchen gardens. We also checked if diets of small mammals have seasonal trends. This study is the first evaluation of the isotopic niches of small mammals in commensal habitats in the northern part of middle latitudes.

2. Materials and Methods

2.1. Study Site

Commensal habitats, sensu [19], were represented by a homestead and a kitchen garden, both situated in the eastern part of Lithuania (Figure 1a). Depending on the country and local specifics, these two sites are habitats similar to suburban yards [32], home gardens [25] or kitchen gardens [33,34].

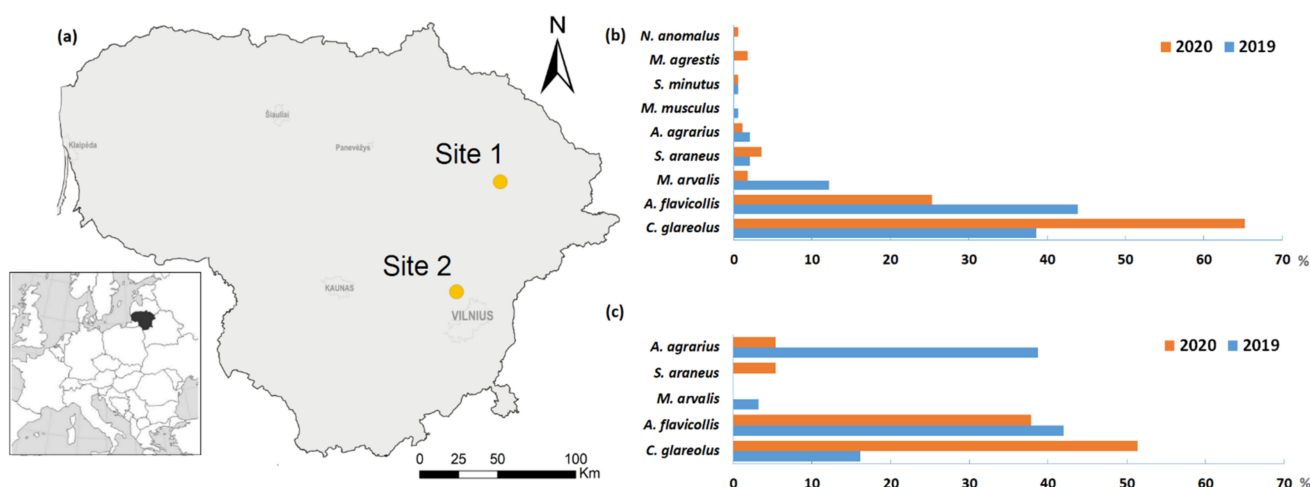


Figure 1. Location of the study sites in Lithuania (a): Site 1, homestead (55.444 N, 25.464 E), Site 2, kitchen garden (54.822 N, 25.104 E), and compositions of the small mammal community in 2019 and 2020 at Site 1 (b) and Site 2 (c).

Site 1 is a typical Lithuanian homestead, a 6000 m² territory with a garden, vegetable garden and various buildings. It is characterized by a high diversity of natural plants and grown vegetables and it is surrounded by black alder, oak trees and natural meadows. The nearest similar farms are at a distance of 200–400 m. Site 2 is typical kitchen garden, with an area of 600 m² and is surrounded by similar kitchen gardens of other owners. It consists of a vegetable garden, a summer house, a greenhouse and a toolshed. The diversity of cultures in the garden is very high. C4 plants were not grown in both sites. Neither site is permanently inhabited and production from the sites is for family needs only. No heavy machinery is used for gardening or maintenance, while chemicals and synthetic fertilizers are only used in very small amounts. A detailed description of the sites is given in [14].

To maintain compatibility with the preliminary data on small mammal diversity [14], we divided the investigated habitats into three groups: gardens (including vegetable gar-

dens and orchards), buildings with food (such as houses, porches, cellars, box-rooms, barn and greenhouses) and outbuildings without food (such as the bathhouse and toolshed).

2.2. Small Mammal Trapping

Small mammals were trapped according to [35], using randomly set snap traps covering all three habitat groups in Sites 1 and 2. Removal trapping was the only option approved by property owners. Trapping was carried out in 2019 and 2020, and the trapping effort in both years was scaled for the site area. Trapping sessions were 1–5 days long each, depending on owner presence; in most cases 20 medium size snap traps were used for one session. More details of the trapping effort are presented in Table S1. Snap traps were checked several times per day, and therefore correction for sprung traps was not used. Bait (bread and oil) was changed after rain or heavy dew or when consumed.

All trapped specimens were put into separate bags and kept frozen at $-20\text{ }^{\circ}\text{C}$ in the laboratory of Nature Research Centre, where identification of species and dissection was conducted. Species were identified morphologically, checking species of *Microtus voles* by their dental characters. Individuals were measured and weighed, and genders and age groups were recorded (the age group identified during dissection). According to Balciauskas et al. [36], we identified adults, sub-adults and juveniles based on their body weight, the status of sex organs and atrophy of the thymus, the latter of which decreases with animal age [37].

The study was approved by the Animal Welfare Committee of the Nature Research Centre, protocol No GGT-7. It was conducted in accordance with Lithuanian (the Republic of Lithuania Law on the Welfare and Protection of Animals No. XI-2271) and European legislation (Directive 2010/63/EU) on the protection of animals. In Lithuania, there is no need or legal obligation to obtain permission or approval to snap trap small mammals. This is especially relevant to the trapping of rodents on private property, which was the case.

2.3. Stable Isotope Analysis

The pilot study of isotopic space (as a proxy for their diet) was conducted using small mammals trapped in 2019. We collected hair of 164 individuals, clipping a small tuft from each individual from between the shoulders. The collected hair was refrigerated dry in separate bags at $-20\text{ }^{\circ}\text{C}$.

Before analysis, hair samples were weighed and packed in tin capsules. Dirty (covered by soil or blood) samples were washed in deionized water and methanol and then dried. Very dirty samples were discarded. The samples of hair were not pre-treated, as we earlier ascertained that this procedure did not change the obtained results [38].

Carbon and nitrogen stable isotope ratios were measured at the Center for Physical Sciences and Technology, Vilnius, Lithuania, using an elemental analyzer (EA) (Flash EA1112) coupled to an isotope ratio mass spectrometer (IRMS) (Thermo Delta V Advantage) via a ConFlo III interface (EA-IRMS). Five percent of the samples were run in duplicate, and the obtained results for these samples were averaged. Detailed analysis procedure and equipment used are described in [39].

As reference materials, we used Caffeine IAEA-600 ($\delta^{13}\text{C} = -27.77 \pm 0.04\text{ }^{\circ}\text{‰}$, $\delta^{15}\text{N} = 1.00 \pm 0.20\text{ }^{\circ}\text{‰}$), Potassium Nitrate IAEA-NO-3 ($\delta^{15}\text{N} = 4.7 \pm 0.2\text{ }^{\circ}\text{‰}$), and Graphite USGS24 ($\delta^{13}\text{C} = -16.05 \pm 0.04\text{ }^{\circ}\text{‰}$) provided by the International Atomic Energy Agency (IAEA). These standards were run every 12 samples. Repeated analysis of these reference materials gave a standard deviation of less than $0.08\text{ }^{\circ}\text{‰}$ for carbon and $0.2\text{ }^{\circ}\text{‰}$ for nitrogen [38].

Carbon and nitrogen stable isotope data are reported as δX values (where X represents the heavier isotope ^{13}C or ^{15}N) or differences from given standards, expressed in parts per thousand (‰).

2.4. Statistical Analyses

Analysis of the variation of carbon (^{13}C) and nitrogen ($\delta^{15}\text{N}$) stable isotope ratios in the hair of the trapped rodents was conducted using GLMM (generalized linear mixed model). Species and habitat type (homestead or kitchen garden) were the categorical factors, while $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values were the dependent parameters. To control temporal data variability, the month of trapping was defined as the continuous predictor. Hottelling's two sample T^2 test for significance was used to test the significance of the model, while eta-squared was used for the influence of the single factor. Differences between groups were evaluated with post-hoc Tukey test, while differences between pairs of variables were evaluated with Student t -test. Before GLMM, we tested whether the distribution of the $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values conformed to normal. The online Kolmogorov–Smirnov's D test (<https://www.socscistatistics.com/tests/kolmogorov/default.aspx>, accessed on 15 February 2019) was used. Both $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values were distributed normally for all species with a sample size ≥ 5 (Table S2), and therefore parametric statistics were further applied.

The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values in the samples were expressed in terms of arithmetic mean ± 1 SE and range (min–max), their difference expressing the niche width. Outliers were not excluded as they can show specific dietary preferences. The positions of the species in the isotopic space was shown as a biplot. The isotopic niches of species in both the homestead and kitchen garden were analysed using parameters of TA (total area), SEA (standard ellipse area) and SEAc, as corrected central ellipses, unbiased for sample size [40].

The diversity of small mammals was assessed on the basis of the Shannon–Wiener diversity index H (\log_2), dominance on the basis of the dominance index D , the proportion of the species from the total number of trapped individuals, and species richness was expressed as the number of trapped species S [41]. Data from the homestead and kitchen garden were analyzed separately. Species accumulation curves were produced from individual-based data, eliminating the influence of trapping effort with the rarefaction approach [42]. Differences in community composition were evaluated using chi-square statistics with Monte Carlo permutation. A 95% confidence level for proportions was evaluated using the Wilson method. In all calculations, the significance level was set as $p < 0.05$.

Biplots were prepared in SigmaPlot ver. 12.5 (Systat Software Inc., San Jose, CA, USA). The isotopic niches of species, as central ellipses, were calculated using SIBER [40] under R ver. 3.5.0 (<https://cran.r-project.org/bin/windows/base/rdevel.html>, accessed on 2 March 2019). Diversity estimates were calculated in PAST ver. 2.17c (Ø. Hammer, D.A.T. Harper, Oslo, Norway). Proportions were calculated using WinPepi ver. 11.39 software (Abramson, J., Jerusalem, Israel). All other calculations were performed using Statistica for Windows ver. 6 (StatSoft, Inc., Tulsa, OK, USA).

3. Results

During 2019–2020, 458 individuals were trapped. These were identified as striped field (*Apodemus agrarius* Pallas, 1771), yellow-necked (*A. flavicollis* Melchior, 1834) and house (*Mus musculus* Linnaeus, 1758) mice, bank (*Clethrionomys glareolus* Schreber, 1780), common (*Microtus arvalis*) Pallas, 1778 and field (*M. agrestis* Linnaeus, 1761) voles, and common (*Sorex araneus* Linnaeus, 1758), pygmy (*S. minutus* Linnaeus, 1766) and Mediterranean water (*Neomys anomalus* Cabrera, 1907) shrews.

3.1. Species Composition and Diversity

Comparing the small mammal communities in the two types of commensal habitats, we found that they were not stable in terms of dominant species (Figure 1b,c) or dominance (Table 1): small mammal community dominance was higher in the homestead in 2020 ($t = 2.33$, $df = 160.62$, $p = 0.02$). Diversity and species richness was similar between years, with no significant differences at either site (Figure S1).

Table 1. Main parameters of small mammal diversity in the homestead and kitchen garden, 2019–2020 (bootstrap estimation in parentheses). Significant differences between years marked with *.

Parameter	Homesteads		Kitchen Gardens	
	2019	2020	2019	2020
Species richness, S	7 (4–7)	8 (5–8)	4 (4–4)	4 (4–4)
Dominance, D	0.35 (0.31–0.41)	0.48 (0.40–0.58) *	0.36 (0.31–0.40)	0.42 (0.36–0.47)
Diversity, H	1.23 (1.03–1.36)	1.05 (0.80–1.23)	1.13 (1.03–1.23)	1.01 (0.87–1.15)

Differences in species composition, however, were significant between years in both the homestead ($\chi^2 = 79.84$, $df = 8$, $p < 0.001$) and kitchen garden ($\chi^2 = 52.75$, $df = 4$, $p < 0.001$) habitats. In the homestead, the proportion of *A. flavicollis* was 43.9% (CI = 37.0–51.0%) in 2019 and 25.3% (19.4–32.3%) in 2020 ($\chi^2 = 13.6$, $p < 0.001$). The proportion of *C. glareolus* was 38.6% (32.0–45.7%) in 2019 and then it increased to 65.3% (58.9–72.0%) in 2020 ($\chi^2 = 25.5$, $p < 0.001$). The proportion of *M. arvalis* in the homestead habitat was also not stable, being 12.2% (8.3–17.6%) and 1.8% (0.6–5.1%), respectively ($\chi^2 = 15.4$, $p < 0.001$). In the kitchen garden, the proportion of *A. flavicollis* was stable across the two years. The proportion of *C. glareolus* was 16.1% in 2019 (9.0–27.2%) and increased to 51.4% (35.9–66.6%) in 2020 ($\chi^2 = 13.7$, $p < 0.001$). The proportion of *A. agrarius* notably decreased from 38.7% (27.6–51.2%) in 2019 to 5.4% (1.5–17.7%) in 2020 ($\chi^2 = 13.3$, $p < 0.001$).

Differences in species composition between homestead and kitchen garden were significant in 2019 ($\chi^2 = 52.45$, $df = 6$, $p < 0.001$) and had a strong trend in 2020 ($\chi^2 = 13.13$, $df = 7$, $p < 0.07$). These differences also depended on the changing proportions of the dominant species (Figure 1b,c).

Our pilot study showed that the small mammal communities in the commensal habitats were subject to temporal changes (Figures S2 and S3). In the homestead, the highest species richness was recorded in buildings with food available (six species in 2019, seven species in 2020), with the opposite trend in outbuildings without food (three species in both years). These tendencies were confirmed by rarefaction analysis (Figure S4). In the kitchen garden, the highest species richness and diversity was found in the garden, four species in both 2019 and 2020 (Figure S2), with the diversity parameters being even lower in both types of buildings (Figure S4).

Across the year, an increase in species richness and diversity was observed in the autumn months (Figures S3 and S5). This tendency was characteristic to both the homestead (September–November, five–eight species) and kitchen garden (August–October, four species) habitats (Figure S3). Diversity estimates followed this tendency (Figure S5). However, these are data of a pilot study with limitations in trapping time, thus we have not provided extensive statistics for temporal trends.

3.2. Interspecific Differences of Isotopic Niche of Small Mammals in Commensal Habitats

In the investigated commensal habitats, the widest trophic niche according to the range of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values was that of *A. flavicollis*. With respect to habitat, the trophic niches of *A. agrarius* and *C. glareolus* were wider in the kitchen garden habitats. In the kitchen garden, outliers in the $\delta^{15}\text{N}$ values were observed in both *A. flavicollis* and *A. agrarius*. Statistics of the distribution of the stable isotope values of all the investigated species in both the homestead and kitchen garden habitats are presented in Table 2. In *A. flavicollis*, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values in the kitchen garden significantly exceeded those in the homestead ($t = 3.64$ and 3.63 respectively, $df = 66$, $p < 0.001$).

Table 2. Central position (mean ± SE) and ranges of stable isotope ratios in the hair of syntopic small mammals in the commensal habitats.

Species	N	$\delta^{13}\text{C}$ Values, ‰			$\delta^{15}\text{N}$ Values, ‰		
		Mean ± SE	Min–Max	Range	Mean ± SE	Min–Max	Range
Homestead habitat							
<i>A. agrarius</i>	2	−24.58 ± 0.62	−25.20–(−23.96)	1.24	6.10 ± 0.52	5.58–6.61	1.03
<i>A. flavicollis</i>	57	−24.06 ± 0.11	−27.13–(−22.85)	4.28	3.99 ± 0.14	0.15–8.35	8.20
<i>M. arvalis</i>	18	−26.82 ± 0.09	−27.59–(−26.22)	1.37	5.98 ± 0.46	2.92–9.09	6.17
<i>C. glareolus</i>	56	−25.91 ± 0.11	−27.90–(−23.98)	3.92	5.94 ± 0.26	2.44–10.70	8.26
<i>S. araneus</i>	3	−25.36 ± 0.20	−25.64–(−24.97)	0.67	7.30 ± 0.69	6.27–8.60	2.33
Kitchen garden habitat							
<i>A. agrarius</i>	7	−21.08 ± 1.90	−24.69–(−13.35)	11.34	6.61 ± 0.76	3.70–9.60	5.90
<i>A. flavicollis</i>	11	−21.69 ± 1.40	−25.56–(−12.24)	13.32	5.53 ± 0.62	2.40–9.16	6.76
<i>C. glareolus</i>	5	−25.40 ± 0.28	−27.43–(−24.57)	2.86	6.14 ± 0.26	4.78–7.06	2.28

Both the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ distributions were under the cumulative influence of small mammal species, habitat and month of trapping as the time factor ($F_{7,156} = 17.21$ and $F_{7,156} = 10.26$, both $p < 0.001$), these factors explaining 41.0% of the variation of $\delta^{13}\text{C}$ and 28.4% of the variation of $\delta^{15}\text{N}$ values. The strongest influence was that of species (Hotelling’s $T^2 = 1.07$, $p < 0.001$, $\eta^2 = 0.35$), followed by habitat ($T^2 = 0.12$, $p < 0.001$, $\eta^2 = 0.11$) and month ($T^2 = 0.08$, $p < 0.002$, $\eta^2 = 0.08$).

Univariate analysis revealed that $\delta^{13}\text{C}$ variation depended only on species ($F = 16.67$, $p < 0.001$), while $\delta^{15}\text{N}$ variation was influenced by habitat ($F = 13.99$, $p < 0.001$), species ($F = 10.05$, $p < 0.001$) and month ($F = 18.65$, $p < 0.005$). According to these results, we further analyzed the trophic niches of small mammal species split by habitat type (Figure 2).

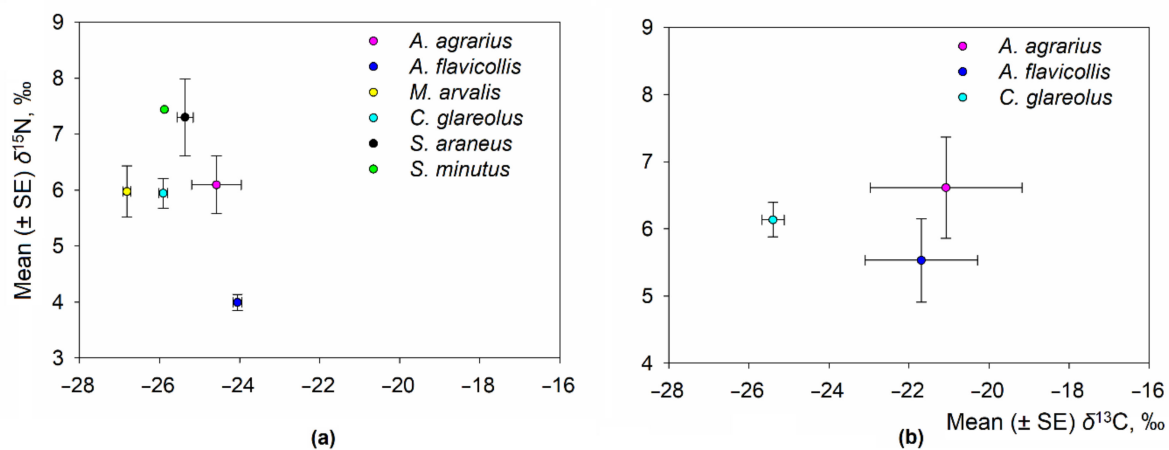


Figure 2. Position of syntopic small mammal species in isotopic space according to stable isotope ratios in the homestead (a) and kitchen garden (b).

In the homestead (Figure 2a), both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ distribution was significantly species-dependent ($F_{5,131} = 49.4$ and $F_{5,131} = 10.9$, both $p < 0.001$, explained variation was 64.0% and 26.7% respectively). The two granivorous species, *A. flavicollis* and *A. agrarius*, both had higher $\delta^{13}\text{C}$ values in their hair than the omnivorous *C. glareolus* (Tukey’s HSD, $p < 0.001$) and herbivorous *M. arvalis* ($p < 0.001$). Minimal $\delta^{15}\text{N}$ values were found in *A. flavicollis*, which were significantly lower than those in *C. glareolus* ($p < 0.001$) and *M. arvalis* ($p < 0.005$). Other differences were not significant. The central ellipses of the species in isotopic space, representing fundamental niches, did not intersect in the homestead habitat, thus confirming separation of the most numerous small mammal species according to their diet (Figure 3). In *A. flavicollis* and *C. glareolus*, the total area of the isotopic niche was nearly equal (TA = 18.09 and 19.70‰² respectively), three times that of *M. arvalis* (TA = 6.30‰²).

The area of the corrected central ellipses in these species was less different ($SEAc = 2.89$, 2.51 and $5.04\%{}^2$ in *A. flavicollis*, *M. arvalis* and *C. glareolus*).

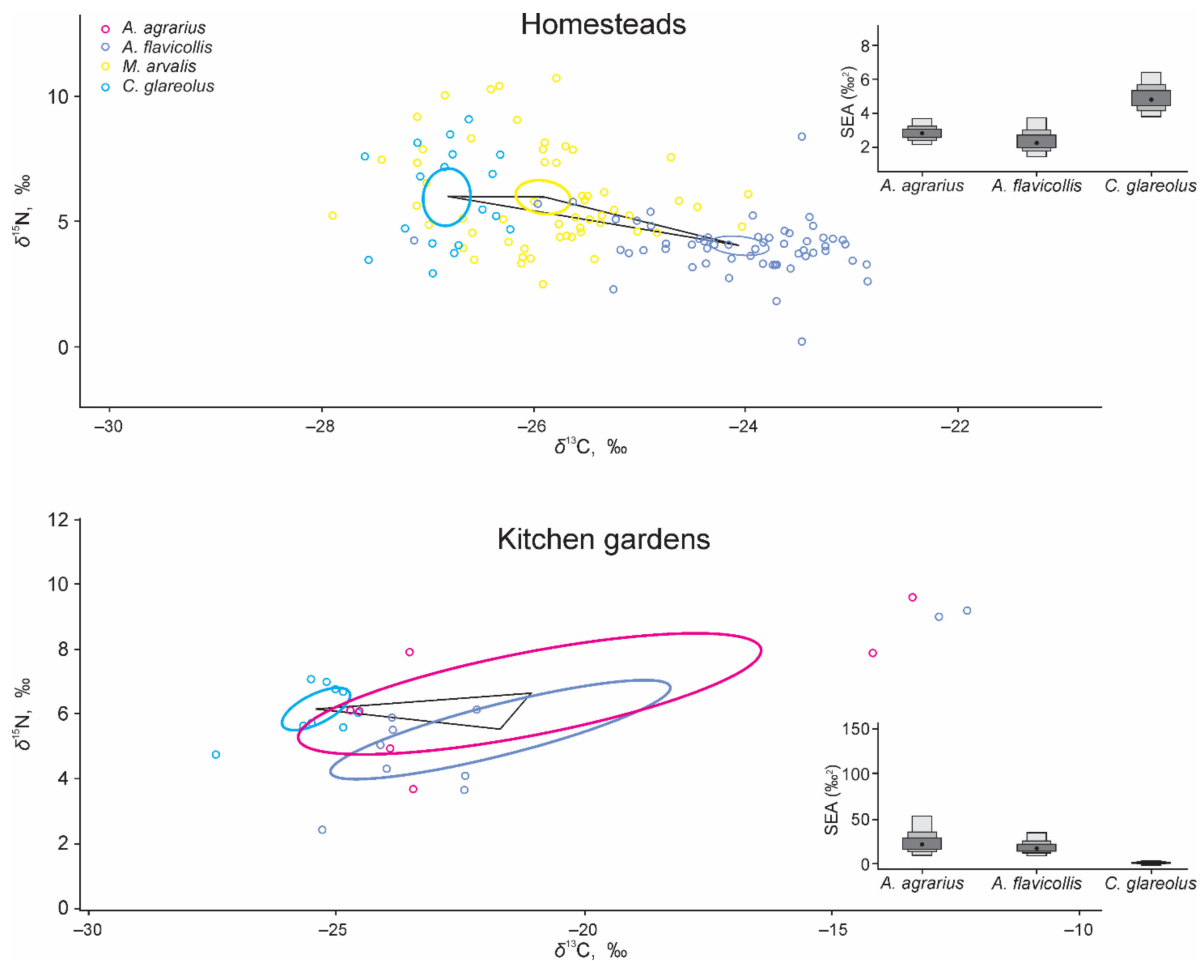


Figure 3. Central ellipses of small mammal species in isotopic space, representing fundamental niches in the homestead and kitchen garden habitats. Statistics of the total areas of isotopic spaces for these species is shown as insets for both habitats, dots representing their mode and the shaded boxes representing the 50%, 75% and 95% CI, shown from dark to light grey.

In the kitchen garden (Figure 2b), the distribution of $\delta^{13}\text{C}$ showed a trend of dependence on species ($F_{2,24} = 3.05$, $p = 0.066$, 20.2% of explained variation), while the distribution of $\delta^{15}\text{N}$ was not species dependent ($F_{2,24} = 0.88$, $p = 0.43$). The central ellipses of the species in isotopic space had overlaps (1.27% between *A. agrarius* and *C. glareolus*, 35.97% between *A. flavicollis* and *A. agrarius*). The total area of the isotopic niche of *A. agrarius* was close to that of *A. flavicollis*, both of these exceeding the niche of *C. glareolus* by approximately 10 times ($TA = 30.07$, 23.12 and $2.68\%{}^2$ respectively), with these differences remaining the same for the areas of the central ellipses (Figure 3).

Based on the limited data series (three months of sampling, July to September), a decrease in the $\delta^{13}\text{C}$ values was observed in the hair of the herbivorous *M. arvalis*, while an increase was observed in the hair of the granivorous species *A. flavicollis* and *A. agrarius*. As for $\delta^{15}\text{N}$ values, a decrease towards autumn was observed in the hair of the herbivorous *M. arvalis* and omnivorous *C. glareolus* (Figure 4).

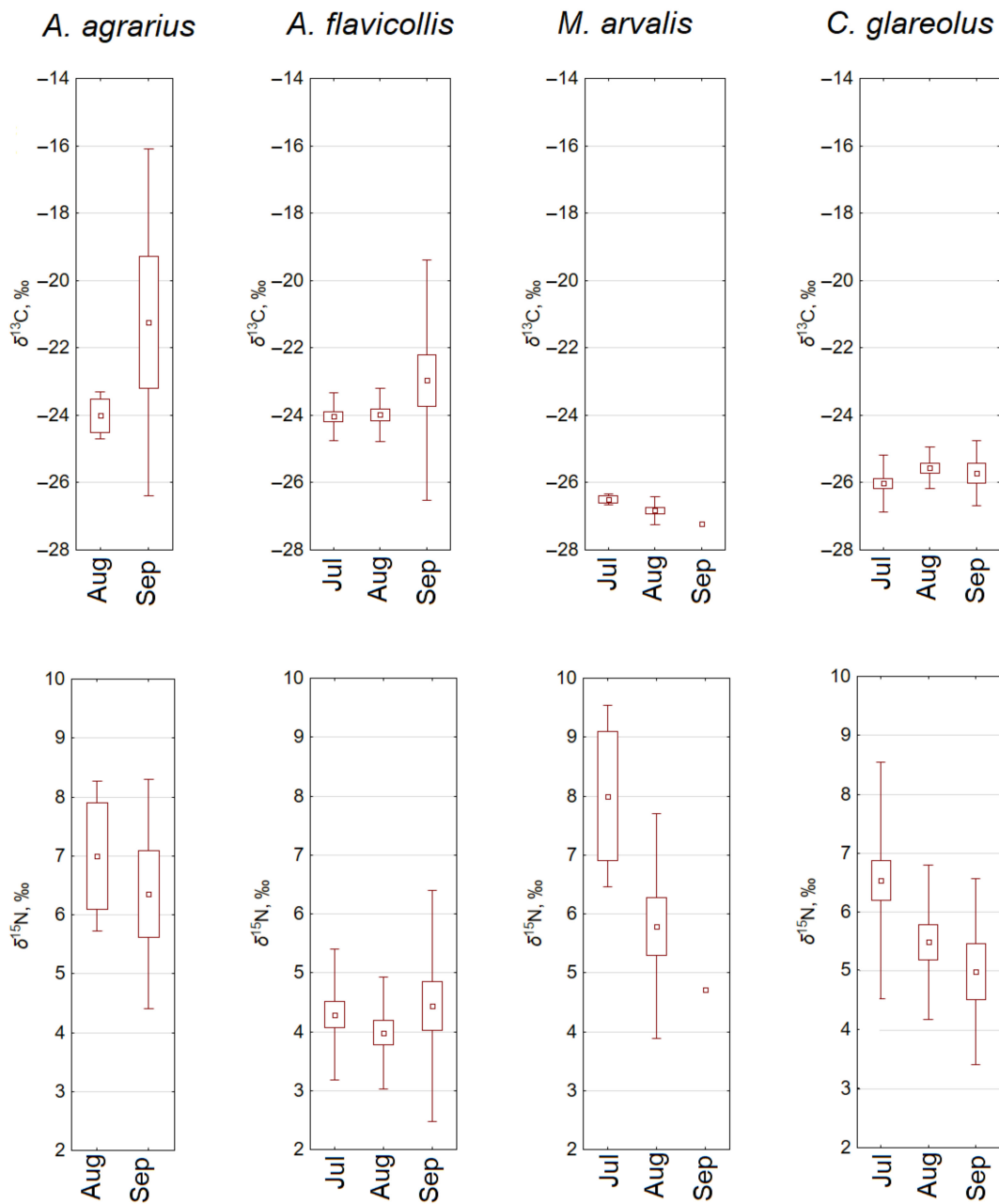


Figure 4. Temporal trend of stable $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ isotopes in small mammal hair (depending on the month of sampling).

4. Discussion

Our study showed a lower small mammal species richness in the kitchen garden than that in the homestead habitats, and an unstable community composition depending on changes of dominants and their numbers. The highest species richness was related to habitats supplying food (buildings with food available and garden habitats). Supported by differences in the species in the isotopic space (see Figure 2), this confirmed our first two predictions. The central ellipses of isotopic space were different between the most numerous species in the homestead habitat, showing a higher degree of dietary separation than in the kitchen garden, where a 1.27% to 35.97% overlap of SEAc between species was observed (see Figure 3). Temporal changes of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values were not equally expressed in all species (see Figure 4). However, we need additional investigations to check if differences are related to the availability of plant production from gardening practices in the commensal habitats.

The wide variability of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ is difficult to interpret in terms of diet—it may also reflect individual variation and the availability of human food products [43]. The presence of other species may affect stable isotope levels and diets, especially when species richness is limited [44].

Likewise, anthropogenic activities resulting, for example, from degradation of forest habitat resulted in higher N values in rats and mice [45]. We, however, failed to find any publications presenting stable $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ isotope values in similar small mammal species in commensal habitats in other countries. Available data from the territories of lower latitudes [28–31,46,47] relate to completely different small mammal faunas, and thus are not comparable.

We, therefore, compared the central positions of the stable isotope ratios in the hair of syntopic small mammals in the commensal habitats with data on the same species from other disturbed habitats in Lithuania, namely commercial orchards and berry fields [48,49], flooded meadows [50] and flooded forest (Balčiauskas et al. unpublished). In two species, *A. flavicollis* and *C. glareolus*, a comparison was also possible with the environment of a cormorant colony in Juodkrantė, which was characterized by the ultimate level of disturbance in the form of biological pollution [39].

In *A. agrarius* in the homestead habitat, the central positions of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values (−24.58 and 6.10‰) were closest to those in flooded meadows (−24.66 and 6.78‰ respectively). *A. flavicollis* in the kitchen garden had the highest central position of $\delta^{13}\text{C}$ values (−21.69‰), being distinct from all other compared habitats, while the $\delta^{15}\text{N}$ values were highest at the cormorant site in Juodkrantė (16.31‰), and were more than two times higher than the values in agricultural or flooded habitats. *M. arvalis* in the homestead had the highest central position of $\delta^{15}\text{N}$ values (5.98‰), significantly exceeding those in orchards and plantations (3.29–4.86‰) and natural meadows (4.85‰) by at least 1‰. In *C. glareolus* from the homestead and kitchen garden, the central positions of $\delta^{13}\text{C}$ values (−25.91 and −25.40‰ respectively) significantly exceeded that in flooded forest (−27.91‰), while the central positions of $\delta^{15}\text{N}$ values (5.94 and 6.14‰) exceeded those in flooded forest (5.19‰) and natural meadows (5.09‰). In the cormorant colony, the $\delta^{15}\text{N}$ values in *C. glareolus* were extremely high (17.86‰). We, therefore, may presume that agricultural, flooding-based and biogenic disturbances are reflected by heightened levels of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in the hair of small mammals, which was mostly visible in omnivore species.

The diet of small mammals is a very important factor that limits population numbers and other traits of their biology [51]. Therefore, the seasonality of resources and the answers of the species to their changes are of importance [14,20,21]. For example, de Camargo et al. [47] found no changes in the individual niche width in the resource-rich period, despite a high variability in the isotopic niches of individuals. Stable isotope niches in anthropogenic habitats are wide and variable [46].

Living near humans has an impact on diet (or, as a proxy, on the isotopic niche) of small mammals. It was shown that carbon-13 and nitrogen-15 isotopes in small mammal hair are good indicators to investigate the long term effects of urbanization [12,52]. However, it remains unclear whether there are changes of evolutionary nature in the isotopic niche to adapt to human activities. Other parameters (occurrence of species, cranial parameters, mobility, etc.), are also changing and this is well documented [53–55].

On *Peromyscus* mice, it was shown that use of agricultural land is not reflected in $\delta^{13}\text{C}$ values [56], but feeding ecology and population density is affected. Densities are also affected by human-related food in other omnivorous mammals, including carnivores [57]. It also remains unclear though whether $\delta^{13}\text{C}$ levels depend on the use of processed food and other human-related products. In our case, the omnivore in the commensal habitats was *C. glareolus*, and its central position of $\delta^{13}\text{C}$ was fully separated in the kitchen garden from its nearest competitor *A. agrarius*, with the central trophic niche overlapping by just 1.27% (see Figures 2 and 3).

It is known that, depending on foods of animal origin in their diet, rodent omnivores have higher $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values than herbivores [58]. However, instead of expanding the

width of the trophic niche (as reflected by a wider isotopic niche), small rodents increase their use of secondary habitats or change their habitat-specific diet items [59]. In small-sized commensal habitats, migration possibilities are limited but cannot be ignored, though we have not investigated this factor so far. Farms and surrounding natural habitats are not comprehensively known as yet in terms of small mammals [14,16,60], especially the traits that enable them to persist in modified habitats [15] where changes are unpredictable [61] and do not occur according to seasons. This results in a decrease in species richness and diversity [42].

Our study showed that human influence in commensal habitats may have different effects on the diets of different species of small mammals, their separation according to $\delta^{15}\text{N}$ being better expressed than that according $\delta^{13}\text{C}$. This is similar to the effects of forest use described by Nakagava et al. [45]. In the most limited space of the kitchen garden, we observed overlapping of the central ellipses in isotopic space. According to Baltensperger et al. [62], this may be a result of dietary plasticity, minimizing interspecific competition and allowing co-existence of syntopic species. Temporal changes in both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values allow us to presume that small mammal trophic ecology is influenced by intensity of agricultural activities in the limited space of commensal habitats. This certainly deserves dedicated and more detailed follow-up study, such as diet analysis [63]. We recognize that agroecosystems may be quite complex isotopically. The most complex situation is with the nitrogen-15 isotope, as $\delta^{15}\text{N}$ values are influenced by many internal and external fluxes, such as atmospheric deposition, fixation, loss of denitrification products, hydrologic leaching, ammonification, nitrification, denitrification, immobilization of inorganic and organic N, uptake by plants, etc. [64]. Therefore, we need to replicate our study in other commensal habitats and in different sites, yielding a much larger dataset. Fortunately, differently from the more southern European countries [65], in the commensal habitats of Lithuania, protected species of small mammals have not been trapped so far, therefore, widening of the research will not cause conservation conflicts.

5. Conclusions

- (1). We present the first data on small mammal trophic ecology in commensal habitats (homestead and kitchen garden) in the northern part of the middle latitudes.
- (2). The highest small mammal species richness occurred in commensal habitats that provided food. It was low in the kitchen garden, which was under the highest human influence.
- (3). The most numerous small mammal species in the homestead had a higher degree of dietary separation (central ellipses not overlapping) than the kitchen garden (1.27% to 35.97% overlap of SEAc between species).
- (4). Temporal changes of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values in the hair were not equally expressed in different species.
- (5). Human influence in commensal habitats may have different effects on the diets of different species of small mammals, where separation according to $\delta^{15}\text{N}$ is better expressed.

Supplementary Materials: The following are available online at <https://www.mdpi.com/article/10.3390/d13080346/s1>, Figure S1: Small mammal species richness (S) and diversity (H) estimations, based on individual rarefaction, in the homestead (a,c) and kitchen garden (b,d) habitats, Figure S2: Changes in small mammal community composition in the gardens (G), buildings with food (F) and outbuildings without food (O) in the commensal habitats, 2019–2020, Figure S3: Temporal (monthly) changes in small mammal community composition in the commensal habitats, 2019–2020, Figure S4: Temporal changes of individual rarefaction based on small mammal species richness (S) and diversity (H) estimations, in the gardens (G), buildings containing food (F) and outbuildings (O) of the homestead and kitchen garden habitats, Figure S5: Monthly changes of small mammal species richness (S) and diversity (H) estimations in the homestead and kitchen garden habitats, Table S1: Timing of small mammal trapping dates, trapping effort and main trapping results in the commensal habitats of Lithuania, 2019–2020, Table S2: Normality test results for distribution of $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ values (if $n \leq 5$, test not performed).

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