ROAD MORTALITY ON TWO SECONDARY ROADS NEAR ABRĂMUŢ LOCALITY, WESTERN ROMANIA: EFFECTS OF YEAR PERIOD AND ROAD SURROUNDING HABITATS

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Abstract. On two local roads situated near Abrămuţ locality in western Romania we studied in the year 2017 the effect of the seasons and the roads` surrounding habitats upon the fauna road mortality. We analyzed both road-killed invertebrates and vertebrates in three seasons (spring, summer and autumn) and on two road segments of the same length, bordered with different habitat types, and situated at only few kilometers from each other. One of the road segments was surrounded with a forest and the other with agricultural terrains. Totally, on the two roads 571 animals were killed by cars, from which 555 were invertebrates and only 16 vertebrates. The number of taxons and the victims` diversity were higher on the road near the forest in each season. In spring and summer the individuals` number was higher near the forest, but in autumn the individuals` number was higher on the road surrounded by agricultural terrains because of the high number of road-killed Heteroptera Pyrrhocoridae. On the road bordered with the forest animals related to humid forested areas were killed, including protected amphibian species. On the road surrounded by agricultural terrains common and generalist animals were killed, but also animals, like bees, attracted by the blooming culture plants. These results clearly indicate the negative effect of the road traffic upon the native fauna, especially on the road bordered with forests, in contrast to the road that crosses agricultural terrains, a fact that should be taken into account when upgrading or constructing new roads.

Keywords: habitat type, season, road vicinity, road-killed animals.

Rezumat. Mortalitatea rutieră pe două drumuri secundare lângă localitatea Abrămuț, vestul României: efectele perioadei din an și al habitatelor înconjurătoare. Pe două drumuri locale de lângă localitatea Abrămuț din vestul României s-a studiat, în anul 2017, efectul perioadei din an şi al habitatelor limitrofe drumurilor asupra mortalităţii rutiere a faunei. Astfel, s-au analizat atât nevertebratele cât şi vertebratele ucise de maşini în trei perioade din an (primăvara, vara şi toamna), pe câte un segement de aceeaşi lungime din două drumuri delimitate de habitate diferite, situate la doar câţiva kilometri unul de altul. Unul dintre drumuri se învecinează pe o parte cu o pădure, iar celălalt cu terenuri agricole. În total pe cele două drumuri maşinile au ucis un număr de 571 de animale, dintre care 555 nevertebrate şi doar 16 vertebrate. Numărul de taxoni şi diversitatea victimelor a fost mai mare pe drumul de lângă pădure în fiecare perioadă de studiu. Primăvara şi vara numărul de indivizi a fost mai mare lângă pădure, dar toamna numărul de indivizi uciși a fost mai mare pe drumul dintre terenuri agricole, datorită numărului foarte mare de Heteroptere Pyrrhocoridae ucise. Pe drumul delimitat de pădure au fost ucise animale legate de zone umede împădurite, inlusiv indivizi din specii protejate de amfibieni. Pe drumul delimitat de terenuri agricole au fost ucise animale comune, generaliste, dar şi grupe atrase de plantele de cultură în floare, precum albinele. Aceste rezultate indică clar că circulaţia rutieră are efecte mult mai negative asupra faunei native pe drumuri care se învecinează cu păduri decât în cazul celor care traversează terenuri agricole, fapt de care ar trebui ţinut cont la modernizare sau realizarea de drumuri.

Cuvinte cheie: tip de habitat, sezon, vecinătatea drumului, animale ucise de maşini.

INTRODUCTION

Road traffic has numerous negative effects upon biodiversity (see in: COFFIN, 2007; BENNETT, 2017). Nevertheless, many road mortality differences are not determined by the road traffic, but by some road's surrounding areas` peculiarities and the behavior of the affected species (e.g. CANAL et al., 2018). The habitat type surrounding the roads and the year period seem to be the most important parameters, which modify the road mortality intensity (e.g. BRAZ & FRANÇA, 2016; DUTTA et al., 2016; COVACIU-MARCOV et al., 2017; CANAL at al., 2018; JEGANATHAN et al., 2018). The intensity of road mortality seems lower on local roads than on more important roads, fact proven in the case of vertebrates in a survey realized from a moving car (CANAL et al., 2018). Unlike this, invertebrates` road mortality was recorded to be very high on minor roads with low traffic (CICORT-LUCACIU et al., 2016; CIOLAN et al., 2017). Moreover, recent studies clearly indicated that it is better to study the road mortality on the entire fauna, not only on certain groups (e.g. CIOLAN et al., 2017; JEGANATHAN et al., 2018). Western Romania is a region where recently some studies regarding the road mortality on minor roads were conducted (CICORT-LUCACIU et al., 2012; CIOLAN et al., 2017; COVACIU-MARCOV et al., 2017). One of those studies analyzed the seasonal road mortality changes on the entire fauna (CIOLAN et al., 2017). Despite investigating secondary roads, a high number of road killed animals was reported (CICORT-LUCACIU et al., 2012; CIOLAN et al., 2017; COVACIU-MARCOV et al., 2017). Nevertheless, the study which analyzed the road mortality of the entire fauna was made in a homogenous wooded area (CIOLAN et al., 2017), and the study which highlighted road mortality differences determined by the road surrounding habitats was made only on amphibians and reptiles (COVACIU-MARCOV et al., 2017). Consequently, we have proposed to establish to what extent the roads surrounding habitats influence the road mortality and if this influences are equally obvious in the case of invertebrates like in the case of amphibians and

reptiles (COVACIU-MARCOV et al., 2017). Therefore we have analyzed the impact of road traffic upon the entire fauna on two roads situated near Abrămuț locality, western Romania. The first road borders to one side a forest, and the second, although situated at only few km distances from the first one, crosses an agricultural area. We supposed that on the road near the forest among the road-killed animals will prevail species related to forested areas, like in other cases (CIOLAN et al., 2017), and on the other road we will encounter species characteristic to agricultural areas. Also, we presumed that the road mortality intensity will be higher on the road near the forest, compared to the road surrounded by agricultural terrains. Thus, we proposed the following three objectives: 1) to establish the road-killed animals on the roads near Abrămuț; 2) to observe the road mortality seasonal differences; 3) to determine the effect of the habitats bordering the roads from Abrămuț upon road mortality.

MATERIALS AND METHODS

The two studied roads are situated close to Abrămuț locality, western Romania, in Barcău-Crasna Plain (MÂNDRUȚ, 2006), at approximately 150 de m altitude. One of the roads is situated north of Abrămuț, leading to Marghita town. The other one is situated south of Abrămuț, leading to Sânlazăr locality. The first road is bordered at one side with an oak forest, with old trees, but which was thinned in the past. At the other side the road borders an abandoned field and a railroad surrounded by bushes, parallel with the road. The second road, situated at few kilometers from the first one, crosses an agricultural area, being bordered with bushes. Both roads are asphalted, in good condition, with two lanes. On each road we investigated an approximately 1 km length segment. The study was made in the year 2017, involving three field trips. The first one took place in spring, in May, the second one in summer, in July, and the third one in autumn, in October. The roads were walked by foot, like in previous studies in western Romania (CICORT-LUCACIU et al., 2012; CIOLAN et al., 2017; COVACIU-MARCOV et al., 2017). The field trips were made in the fist part of the day. The corpses in good condition were determined to species level, but the degraded ones were appointed to higher taxonomic units, like in other cases (e.g. CIOLAN et al., 2017; JEGANATHAN et al., 2018).

For each field trip and road we calculated an average of the cars that crossed the road during an hour. We calculated the percentage abundance and the diversity of the road killed taxons by surroundings and study period. The diversity was estimated using the Shannon Wiever index (H), and the similarity using the Jaccard index and the Bray Curtis index. The significance of the differences between periods and habitats were calculated with the help of the Mann Whitney test. The correlation between the number of cars / hour and the number of road killed individuals, between the number of cars / hour and the diversity and between the number of cars / hour and the number of road-killed taxons were established using the linear regression model. The statistics were made with the help of the free software PAST (HAMMER et al., 2001).

RESULTS

During the three field trips we identified on the two roads from Abrămuț 571 road-killed animals. Among them only 16 were vertebrates and the other 555 were invertebrates. The highest number of corpses was registered in spring (226). On the second position was autumn (179 corpses) and then summer (166 corpses). More animals were killed by cars on the road surrounded by agricultural terrains (291 compared with 280 near the forest). More corpses were registered in autumn on the road near agricultural areas (139). Animals belonging to 38 taxons were killed by cars on the roads from Abrămuț (Table 1). Among vertebrates, amphibians, reptiles, birds and mammals felt victims to the road traffic. In the case of amphibians we could determine two species (*Triturus cristatus* (Laurenti, 1768) and *Rana dalmatina* Fitzinger, 1839), and in the case of reptiles only one species (*Natrix natrix* (Linnaeus, 1758)). In the case of birds the one killed in autumn could be determined, belonging to the species *Turdus merula* Linnaeus, 1758. The number of the road-killed amphibians near the forest was higher in autumn. The variation of corpses` number was higher near agricultural areas. The number of the road-killed individuals and taxons differed greatly between the two roads, being influenced by the neighboring habitats. On the road near the forest the number of road-killed taxons was higher (35 compare with 24), even if the number of corpses was lower in autumn (Table 1).

The highest percentage abundance was registered by Heteroptera, Coleoptera and Diptera (Table 1). Coleoptera (generally considered), Lepidoptera larvae and Hymenoptera Vespidae were the only taxa killed on each road in each period (Table 1). The total diversity of road-killed animals at Abrămuț was H=2.71. The diversity and percentage abundance varied a lot between periods. The highest diversity was registered in spring (H=2.75) and the lowest in autumn (H=1.42). The victims` diversity was much higher on the road near the forest (H=2.88) compared to the road surrounded by agricultural terrains (H=1.95). Diptera Brachicera had a high percentage abundance, both in spring (18.58) and in summer (28.91), but no flies were killed in autumn (Table 2). Heteroptera Pyrrhocoris were killed only on the road from the agricultural areas, representing almost half of the victims (49.82%). On the road near the forest none of the taxons registered such high percentage abundance, the taxon with the highest percentage abundance, Diptera Brahicera, registering a value of only 21.78%. The highest diversity was on the road near the forest (H=2.88).

The number of cars that crossed the roads during an hour varied both between roads and periods (Table 1), but this number did not affect significantly the abundance (r=-0.02, p=0.95), the taxons` richness (r=+0.45, p=0.36) or diversity (r=0.31, p=0.53). The variation of the road killed taxons by habitat types was significant (p=0.01). The overlap

between taxons identified on the two roads was 0.55 by the Jaccard index, and 0.38 by the Bray-Curtis index. Significant differences were registered between the road mortality in spring and autumn (p=0.005). The distinct taxonomic composition in autumn is reflected by the similarities between seasons: between spring and summer the Jaccard index showed a high similarity (0.57), but between spring and autumn (0.32), respectively summer and autumn (0.44) the similarity was lower. The same pattern can be observed when abundance is taken into account (Bray-Curtis index), the resemblance between the first two seasons being more obvious (0.51), than between summer or spring and autumn (0.28 an 0.23). The similarity between all samples shows the same thing (Fig. 1).

Table 1. The percentage abundance (P%), number of individuals, number of taxons, diversity and evenness of the taxons killed on the roads from Abrămuț (Agr. – agricultural field).

Season	**Spring**		**Summer**		**Autumn**		**P% total**
The road's surrounding habitat	**Forest**	**Agr.**	**Forest**	**Agr.**	**Forest**	**Agr.**	
Cars/h	42	22	69	13	61	31	
Oligochaeta Annelida	5.26	-	4.67	1.69	5.00	-	2.62
Mollusca Gasteropoda others	13.53	7.52	2.80	-	10.00	-	5.60
Mollusca Gasteropoda Limax	3.00	1.07	-	-	-	-	0.87
Arahnida Araneidea	3.00	4.30	1.86	-	-	0.71	1.92
Myriapoda Diplopoda	2.25	-	-	-	-	-	0.52
Myriapoda Chilopoda	0.75	-	0.93	-	-	-	0.35
Dermaptera	-	-	0.93	-	-	-	0.17
Orthoptera	-	-	20.56	10.16	10.00	3.59	6.47
Mantodea	-	-	-	-	12.50	-	0.87
Odonata	-	-	-	1.69	-	-	0.17
Blattoidea	1.50	-	-	-	-	-	0.35
Heteroptera others	-	-	1.86	1.69	10.00	-	1.22
Heteroptera Pyrrhochoris	-	19.35	-	10.16	-	87.05	25.39
Coleoptera Tenebrionidae	-	-	0.93	-	-	-	0.17
Coleoptera Cantharidae	6.76	-	-	-	-	-	1.57
Coleoptera Scarabeidae	12.78	4.30	5.60	-	-	-	4.72
Coleoptera Lucanus	-	1.07	0.93	-	-	-	0.35
Coleoptera Carabidae	11.27	11.82	4.67	-	5.00	1.43	6.12
Coleoptera Elateridae	0.75	-	-	-	-	-	0.17
Coleoptera Curculionidea	3.00	2.15	-	-	-	-	1.05
Coleoptera Cerambicida	1.50	-	0.93	-	-	-	0.52
Coleoptera Chrysomelidae	5.26	3.22	-	-	-	-	1.75
Coleoptera Coccinelida	0.75	-	0.93	3.38	2.50	-	0.87
Coleopotera Staphylinidae	-	-	-	-	5.00	0.71	0.52
Lepidoptera adults	0.75	-	1.86	1.69	-	-	0.70
Lepidoptera larvae	3.75	8.60	6.54	1.69	12.50	2.87	5.25
Diptera Brachicera	18.04	19.35	34.57	18.64	-	-	15.76
Diptera Nematocera Typulidae	0.75	5.37	-	-	-	-	1.05
Hymenoptera Formicidae	0.75	-	0.93	-	-	-	0.35
Hymenoptera Vespidae	0.75	4.30	0.93	10.16	12.50	2.87	3.67
Hymenoptera Apis	0.75	6.45	2.80	35.59	2.50	-	5.60
Hymenoptera others	0.75	-	-	1.69	-	-	0.35
Amphibia Anura	-	-	-	1.69	-	-	0.17
Amphibia *Rana dalmatina*	0.75	-	1.86	-	7.50	-	1.05
Amphibia *Triturus cristatus*	-	-	-	-	2.50	-	0.17
Reptilia *Natrix natrix*	0.75	-	-	-	-	-	0.17
Aves	-	1.07	1.86	-	2.50	0.71	0.87
Mammalia Rodentia	0.75	-	0.93	-	-	-	0.35
No. of individuals	133	93	107	59	40	139	571
P%	23.29	16.28	18.73	10.33	7.00	24.34	100
No. of taxons	26	15	22	13	14	8	38
H (Shannon-Wiever index)	2.67	2.37	2.28	1.97	2.48	0.61	2.71
H` (Pielou index)	0.81	0.87	0.71	0.77	0.91	0.27	0.72

Table 2. The variation by season and habitat of the percentage abundance, number of taxons and individuals, diversity and evenness of taxons killed on the roads from Abrămuț.

	Habitats		Seasons		
	Forest	**Agr.**	**Spring**	**Summer**	**Autumn**
Oligochaeta Annelida	5.00	0.34	3.09	3.61	1.11
Mollusca Gasteropoda others	8.92	2.40	11.06	1.80	2.23
Mollusca Gasteropoda Limax	1.42	0.34	2.21	-	-
Arahnida Araneidea	2.14	1.71	3.53	1.20	0.55
Myriapoda Diplopoda	1.07	-	1.32	-	-
Myriapoda Chilopoda	0.71	-	0.44	0.60	-
Dermaptera	0.35	-	-	0.60	-
Orthoptera	9.28	3.78	-	16.86	5.02
Mantodea	1.78	-	-	-	2.79
Odonata	-	0.34	-	0.60	-
Blattoidea	0.71	-	0.88	-	-
Heteroptera others	2.14	0.34	-	1.80	2.23
Heteroptera Pyrrhochoris	-	49.82	7.96	3.61	67.59
Coleoptera Tenebrionidae	0.35	-	-	0.60	-
Coleoptera Cantharidae	3.21	-	3.98	-	-
Coleoptera Scarabeidae	8.21	1.37	9.29	3.61	-
Coleoptera Lucanus	0.35	0.34	0.44	0.60	-
Coleoptera Carabidae	7.85	4.46	11.50	3.01	2.23
Coleoptera Elateridae	0.35	-	0.44	-	-
Coleoptera Curculionidea	1.42	0.68	2.65	-	-
Coleoptera Cerambicida	1.07	-	0.88	0.60	-
Coleoptera Chrysomelidae	2.50	1.03	4.42	-	-
Coleoptera Coccinelida	1.07	0.68	0.44	1.80	0.55
Coleopotera Staphilinidae	0.71	0.34	-	-	1.67
Lepidoptera adults	1.07	0.34	0.44	1.80	-
Lepidoptera larvae	6.07	4.46	5.75	4.81	5.02
Diptera Brachicera	21.78	9.96	18.58	28.91	-
Diptera Nematocera Typulidae	0.35	1.71	2.65	-	-
Hymenoptera Formicida	0.71	-	0.44	0.60	-
Hymenoptera Vespidae	2.50	4.81	2.21	4.21	5.02
Hymenoptera Apis	1.78	9.27	3.09	14.45	0.55
Hymenoptera others	0.35	0.34	0.44	0.60	-
Amphibia Anura	-	0.34	-	0.60	-
Amphibia *Rana dalmatina*	2.14	-	0.44	1.20	1.67
Amphibia *Triturus cristatus*	0.35	-	-	-	0.55
Reptilia *Natrix natrix*	0.35	-	0.44	-	-
Aves	1.07	0.68	0.44	1.20	1.11
Mammalia Rodentia	0.71	-	0.44	0.60	-
No. of individuals	280	291	226	166	179
P%	49.03	50.96	39.57	29.07	31.34
No. of taxons	35	24	29	26	16
H (Shannon-Wiever index)	2.88	1.95	2.75	2.44	1.42
H` (Pielou index)	0.81	0.61	0.81	0.74	0.51

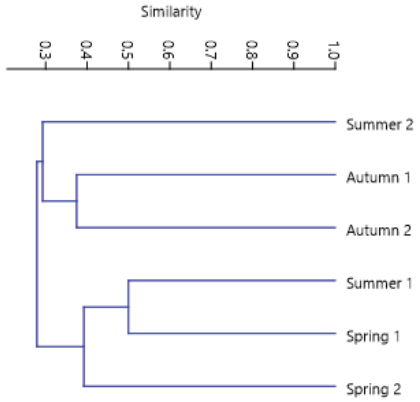

Figure 1. The similarity between the samples from different seasons and habitat types (1 – forest, 2 – agricultural area).

DISCUSSIONS

The hypothesis of our study was largely verified, the road mortality being influenced both by period and by the aspect of the habitats near the roads (e.g. D'AMICO et al., 2015; BRAZ & FRANÇA, 2016; DUTTA et al., 2016; COVACIU-MARCOV et al., 2017; CANAL et al., 2018; JEGANATHAN et al., 2018). Thus, on the road near the forest the number of road-killed taxa and diversity was much higher than on the road surrounded by agricultural areas, although the number of road-killed individuals was slightly higher on the last one. These differences were clear in each period, even very obvious in autumn in the case of diversity. Thus, although each season` conditions are modifying the road mortality intensity, the surrounding habitats` aspect is extremely important, the differences in roads mortality determined by them being clear in each season. The period influences the dynamics of the road mortality (e.g. GARRIGA et al., 2017; CIOLAN et al., 2017), but its composition is determined by the roads surrounding habitats. Even in areas where the road is surrounded with uniform habitats, road mortality differences determined by some habitat disparities were mentioned (CIOLAN et al., 2017).

The data from Abrămuţ confirms the negative impact of road modernization upon the fauna (e.g. JONES et al., 2014). On the road with the most road-killed individuals, the one from agricultural areas, the traveling speeds 10 years ago were much reduced because the road was not asphalted. After its modernization, the road became more circulated and the speed increased, nowadays reaching 80-90 de km/h, causing a high number of road killed animals. Nevertheless, because the road is surrounded by uniform habitats, which are highly affected by humans, like agricultural terrains, the victims` diversity is reduced. Like in other cases, at Abrămuţ the invertebrates' road mortality was much higher compared to the vertebrates (e.g. SEIBERT & CONOVER, 1991; CICORT-LUCACIU et al., 2016; CIOLAN et al., 2017).

The invertebrates registered on the road near the forest belonged to taxa linked with more humid and forested habitats, like on other road surrounded by forests (CIOLAN et al., 2017). On the road near the forest more Oligocheta and Gastropoda individuals were killed compared with the road from agricultural terrains. Nevertheless, in the case of some flying insects the number of road-killed individuals was lower on road surrounded by forests than on roads surrounded by open areas (KEILSOHN et al., 2018). At Abrămuţ however the road without forest borders with agricultural terrains not natural areas, thus the diversity is reduced. On the road surrounded by agricultural terrains were killed only two taxons that were missing on the road near the forest (Heteroptera Pyrrhocoris and Odonata). On the road near the forest only one Dermaptera individual was killed, probably at night, they generally being nocturnal animals which avoid daylight, in the daytime staying under different shelters (RADU & RADU, 1967). Ortoptera were killed by cars on both roads, but only in summer and autumn, like in other cases (CIOLAN et al., 2017). Nevertheless, they were killed in much higher number in the forested area than in the agricultural one. We found only one road-killed dragonfly in summer on the road in the agricultural area. It was identified at approximately 1 km from Barcău River and some ponds near its course; after the emergence adult dragonflies usually fly far from the water, not turning back before the reproduction period (e.g. CORBET, 1980). The existence of the river could explain its presence on this road. Contrary, on the road near the forest, where permanent waters are missing, no dragonfly was killed. On roads bordering with wet areas dragonflies were killed by cars in large numbers (RIFFELL, 1999). The five Mantodea individuals were killed in autumn, on the road near the forest, in a clear and relatively warm day, which corresponds to their demands (RADU & RADU, 1967). Heteroptera were killed in a high percentage especially in the agricultural area. Heteroptera Pyrrhocoris are adapted to feed on extremely dried out seeds (SOCHA, 1993), thus the harvest of sunflower seeds could explain their high number on the road from the agricultural area in autumn.

Among butterflies, the larvae were killed in higher number compared to adults. Like in other cases, the high number of larvae could be a consequence of the rich vegetation near the roads (CIOLAN et al., 2017), vegetation which they can feed on. Like in other cases (CICORT-LUCACIU et al., 2016; CIOLAN et al., 2017), adult butterflies were only accidentally killed, they being more frequent in grasslands areas (e.g. SKORKA et al., 2015; KEILSOHN et al., 2018). The number of bees was much higher in summer in the agricultural areas. The bees were probably attracted by sunflower crops near the road, becoming victims of the cars. Also in other cases the existence blooming plants, like black locust, near the roads greatly increased the bees` road mortality (CICORT-LUCACIU et al., 2016). The wasps were probably attracted by the corpses on the road, on which they were observed feeding (CICORT-LUCACIU et al., 2016). Wasps were killed in both habitats in each period unlike bees which lacked in autumn in the agricultural area. The road's negative impact on pollinating insects not only causes the alteration of biodiversity but also has negative economic consequences (BAXTER-GILBERT et al., 2015).

The vertebrates killed by cars on the roads from Abrămuţ were fewer than invertebrates, many individuals belonging to species related to forest areas. The most road-killed vertebrates belong to amphibians, like in other cases (e.g. ASHLEY & ROBINSON, 1996; D'AMICO et al., 2015; GARRIGA et al., 2017; CIOLAN et al., 2017; JEGANATHAN et al., 2018). At Abrămuţ *R. dalmatina* prevailed, a forest species well represented in Romania (FUHN, 1960). This species was killed in each period but also on the road near the forest. The first field trip was made at the beginning of May, after the reproduction period of this species (FUHN, 1960). Probably this is the explanation for the low individuals` number registered in spring. *R. dalmatina* is often killed on roads (e.g. CICORT-LUCACIU et al., 2016; COVACIU-MARCOV et al., 2017), roads with high traffic strongly affecting it in the reproduction season (HARTEL et al., 2009). The individuals killed in autumn could result from the more intense activity period before hibernation, the species using open habitats during spring and autumn migrations

(e.g. HARTEL et al., 2009). The negative impact of roads upon amphibians is very strong and well known for many years (e.g. FAHRIG et al., 1995; HELS & BUCHWALD, 2001). In Romania both *R. dalmatina* and *T. cristatus* are protected (O.U.G. 57/2007). Among reptiles, only one *N. natrix* individual was killed. In Europe this species is frequently killed on roads (e.g. CIESIOŁKIEWICZ et al., 2006; MEEK, 2009; KAMBOUROVA-IVANOVA et al., 2012; COVACIU-MARCOV et al., 2017). Because the road killed *N. natrix* was identified in a warm spring day, it may come to the road for thermoregulation, like in other cases (MCCARDLE & FONTENOT, 2016). Although they are faster than amphibians, snakes are disadvantaged on roads by their greater length (CICORT-LUCACIU et al., 2012), the number of road-killed individuals increasing in some regions because of the traffic increase (TÓTH et al., 2017). Asphalted roads have a negative impact also upon birds, both directly because of the road mortality (e.g. ASHLEY & ROBINSON, 1996; D'AMICO et al., 2015; CANAL et al., 2018) and indirectly because of the noise and habitats` alteration (e.g. BROTONS & HERRANDO, 2001; MCCLURE et al., 2013). At Abrămuţ, birds were killed by cars on the entire study period, lacking in spring in the forested region and in autumn from the agricultural region. Although forests seems to reduce the birds road mortality intensity (CIOLAN et al., 2017), which is higher on roads surrounded by pastures (BRAZ & FRANCA, 2016), at Abrămuţ birds were killed on both roads. At Abrămuţ, the road from the forested area is bordered only on one side by forest, on the other side being neighbored with open areas. This could advantage birds, the more open area favoring their flight, on contrast to roads which cross dense forested areas, where not a single bird was killed (CIOLAN et al., 2017). Forest seems to reduce the road mortality of other flying vertebrates, like bats (SECCO et al., 2017). Mammals were represented by a very low number of rodents, which were killed in spring and summer in the forested area.

The number of road-killed animals on the two roads from Abrămuţ is very high taking into account the short distance that we investigated and the fact that we made only three surveys. Although the surveys were made by walking on the roads, the most efficient methods in the case of small animals (e.g. SLATER, 2002; LANGREN et al., 2007), the number of road-killed animals was probably much higher, as in other cases (CIOLAN et al., 2017). Our results confirm the road mortality seasonal differences (e.g. ASHLEY & ROBINSON, 1996; GARRIGA et al., 2017; JEGANATHAN et al., 2018) and the influence of road`s surrounding habitats upon them. Because of the fact that on the road near the forest the diversity and number of road-killed taxons were much higher, it is clear that roads should not be constructed near forest, but only near degraded habitats like agricultural areas, where even if the number of road killed individuals can be high, the diversity and number of taxons are low.

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