NON ROAD HUMAN INFLUENCE UPON ROAD MORTALITY ON THREE SECONDARY ROADS IN THE VÂLSAN RIVER PROTECTED AREA, ROMANIA

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Abstract. Human activities, unrelated to road, but taking place in its proximity, can modify the amplitude of road mortality in some animal groups. This is the case of bees, wasps and Coleoptera Geotrupidae on three secondary roads from the Vâlsan river basin, Romania. Black locust plantations near a road attract bees in the blooming period, increasing their chance of falling victim on the road. Coleoptera Geotrupidae are frequently killed on roads used by the local people's cows, being attracted by manure. Wasps come on the roads for feeding on the corpses of other road killed animals, while they are sometimes killed. Only in two days on the three secondary roads there were killed 899 individuals, from 50 taxa, mostly invertebrates. The differences of the road mortality by roads and periods were not significant.

Keywords: protected area, human influence, road traffic, biodiversity, invertebrates, amphibians.

Rezumat. Influenţă umană indirectă asupra mortalităţii rutiere pe trei drumuri secundare în aria protejată Râul Vâlsan, România. Activităţile umane, fără legătură cu drumurile, dar care se desfăşoară în apropierea lor pot modifica amplitudinea mortalităţii rutiere în cazul unor grupe de animale. Aceasta este cazul albinelor şi a Coleoterelor Geotrupide pe trei drumuri secundare din bazinul râului Vâlsan, România. Plantaţiile de salcâm de lângă drum atrag albinele în perioada de înflorire, crescând posibilitatea acestora de a cădea victime traficului rutier. Coleopterele Geotrupide sunt frecvent ucise pe drumuri folosite de vacile localnicilor, fiind atrase de excremente. Viespiile se hrănesc cu cadavrele unor animale ucise pe drumuri, fiind astfel la rândul lor ucise de mașini. În numai două zile pe cele trei drumuri secundare au fost uciși 899 indivizi din 50 de taxoni, majoritatea nevertebrate. Diferenţele mortalităţii rutiere în funcţie de drumuri sau perioade nu au fost semnificative.

Cuvinte cheie: arie protejată, influenţă umană, trafic rutier, biodiversitate, nevertebrate, amfibieni.

INTRODUCTION

Upgrading the old roads for increased traffic intake is considered more advantageous instead of making new ones (RHODES et al., 2014). Nevertheless, in some cases, road upgrading doubled the number of the vehicles, tripling road mortality (JONES et al., 2014). Numerous animals are permanently killed on roads (e.g. RAO & GIRISH, 2007; GRYZ & KRAUZE, 2008; BROCKIE et al., 2009; SESHADRI & GANESH, 2011; BAXTER-GILBERT et al., 2015; GARRAH et al., 2015; KIOKO et al., 2015; MACHADO et al., 2015). As a consequence, the conservation of roadless areas was proposed (e.g. TROMBULAK & FRISSELL, 2000; SELVA et al., 2011). Nevertheless, in Romania, roads are upgraded in protected areas (CICORT-LUCACIU et al., 2012). The upgrade of a road in the Vâlsan river natural protected area is considered an important goal of tourism development (CONSTANTINESCU et al., 2010), even if in the region there are data upon the road mortality of some protected herpetofauna species (COVACIU-MARCOV et al., 2014). The protected area is known first of all for the aquatic biodiversity and especially for the endemic fish *Romanichthys valsanicola* (e.g. TELCEAN et al., 2011). Recent data prove that the terrestrial biodiversity also present peculiarities, endemic and rare species (COVACIU-MARCOV et al., 2014; DOBRESCU & SOARE, 2012, 2015; TOMESCU et al., 2015; FERENȚI & COVACIU-MARCOV, 2016). Some of these species are present in the area of the road intended to be modernized, in the Vâlsan Gorges (DOBRESCU & SOARE, 2015; TOMESCU et al., 2015). Nowadays, road mortality information is available from many protected areas (e.g. RAO & GIRISH, 2007; COELHO et al., 2008; GRYZ & KRAUZE, 2008; LESIŃSKI et al., 2011; SESHADRI & GANESH, 2011; MOLLOV et al., 2013; D'AMICO et al., 2015). In the Vâlsan protected area, there are only few data regarding herpetofauna road mortality (COVACIU-MARCOV et al., 2014). Thus, we proposed to analyze the road traffic impact upon the fauna on three secondary roads. We hypothesized that road mortality would affect numerous taxonomic groups, especially invertebrates. Also, we hypothesized that road kill differences by roads and periods would be registered.

MATERIALS AND METHODS

The field work took place on May 28 and September 16, 2015, dates which are in peak periods of road mortality (e.g. KAMBOUROVA-IVANOVNA et al., 2012; MOLLOV et al., 2013). We monitored three road segments situated in the upper, middle and lower sectors of the Vâlsan river basin (see in: FERENȚI & COVACIU-MARCOV, 2016). They are minor asphalted roads, surrounded by forests. The first road sector (1692 m length) is situated at the lower entrance to the Vâlsan Gorges, upstream Brădetu village, at 710 meters altitude. It was asphalted in 2011 being a part of the road that crosses the Vâlsan Gorges going to the Vâlsan Glades (CONSTANTINESCU et al., 2010), but only the studied sector and a section from the Vâlsan Glades were asphalted. The road is parallel to the river course, being surrounded by broad and wet beech forests, and sometimes by open grassy areas. It is a narrow road, the asphalted section having only one car width. The second road (1786 meters in length) is situated in the middle sector of the Vâlsan basin, upstream Mușătești locality, going to Robaia Monastery. It is situated only some tens of meters from the last houses from Mușătești, neighbouring orchards. On the other side, the road is surrounded by an oak forest and sometimes black locust plantations. It is situated at 540 meters altitude, being as narrow as the previous one, sometimes the neighbouring bushes reaching the asphalted area. The third road is situated in the lower sector of the basin, at 420 meters altitude, going to Toplița locality. The studied sector (926 m length) was recently asphalted being in good condition, but it is as narrow as the previous ones. It is surrounded by oak and hornbeam forests and partially by the alder from a small meadow of a stream. We made pedestrian surveys on the roads, like in other studies (e.g. SESHADRI & GANESH, 2011). The corpses were determined at the lowest possible taxonomic level according to their integrity or the author's knowledge, as in other studies (SEIBERT & CONOVER, 1991). The herpetofauna was determined by the species level, but in case of invertebrates only higher groups (orders, classes, etc.,) were determined. In some Coleoptera, we managed to determine the families. Well preserved Curculionidae were collected for a possible specific determination. Also we counted the passing vehicles per hour on each of the roads.

The results were processed both totally and also by periods or by the studied roads. We calculated the percentage abundance and the frequency of occurrence of the taxa by roads and periods. The diversity of the corpses was calculated by Shannon-Wiever index (SHANNON & WIEVER, 1949). Also, we estimated the similarity between the road kill on the three roads using the Jaccard index. Significances of the differences were estimated with the Kurskal Wallis and Mann-Whitney tests. The relation between the number of the cars, the length of the sectors and the number of the taxa or individuals was estimated by the linear regression model, using the Past 3.x software (HAMMER et al., 2011). In addition, we calculated the number of the killed taxa or individuals per meter of the road.

RESULTS

The number of cars/hour differs between roads and periods, but it was higher on the road from Topliţa (11.2 cars/hour in both dates) (Table 1). On the three roads, 899 corpses were identified, mostly invertebrates. Traffic victims belong to 50 taxonomic groups (Table 1). Among vertebrates, amphibians, reptiles and mammals were identified. The highest number of road killed taxa (38) was registered on the road from Robaia, and the lowest number (27) in the Vâlsan Gorge. The differences between the number of killed taxa and individuals on the three roads are also obvious between the periods (Table 1, 2). Of the 50 taxa, 18 were observed on all three roads. Diplopoda registered the highest percentage abundance, followed by Coleoptera Geoutrupidae and Hymenoptera Apidae (Table 3). 14 taxa were represented by only one killed individual.

The highest diversity of road killed victims was registered on the road from Robaia (H=2.79), followed by the road from Topliţa (H=2.78) and the Vâlsan Gorge (H=1.82). The total diversity was H=2.61, being different on each road by the collecting date (Table 3). By the Kruskal Wallis test there are no significant differences nor between the periods (p=0.308), neither between the roads (p=1). According to Mann Whitney test, the less significant are the differences between the roads from Topliţa and Robaia (p=0.409), followed by Robaia and the Vâlsan Gorge (p=0.389) and the roads from Topliţa and the Vâlsan Gorge (p=0.103). According to the Jaccard index, the similarity between the two collecting dates is J=0.42. On the roads, the highest overlap is registered between the Vâlsan Gorge and Topliţa (J=0.578), then between Robaia and Topliţa (J=0.541) and finally between Robaia and the Vâlsan Gorge (J=0.5).

On the road sector from the Vâlsan Gorge, 0.26 individuals/m and 0.01 taxa/m were killed. At Robaia, 0.16 individuals/m and 0.02 taxa/m were killed. At Topliţa, 0.17 individuals/m and 0.03 taxa/m were victims of the road traffic. A strong positive relation was registered between the length of the roads and the number of killed individuals (r=+0.8). There is no relation between the roads` length and the number of the killed taxa (r=0.15). The relation is weak to moderate negative between the length of the roads and diversity (r=-0.4). In both periods, the relation between the number of passing cars/hour and diversity was strongly positive (r=+0.81, r=+0.75). Between the number of the passing cars/hour and the number of killed individuals and taxa no relation was registered.

DISCUSSION

The animal groups killed on the three roads in the Vâlsan protected area are comparable with those recorded in the few studies that globally evaluated road mortality (SEIBERT & CONOVER, 1991). To our best knowledge, this is the first global road mortality evaluation in Romania, the previous studies focusing only on some vertebrate groups (HARTEL et al., 2009; CICORT-LUCACIU et al., 2012; COVACIU-MARCOV et al., 2012). Thus, comparing our data with other information from the country is difficult. Nevertheless, the number of road killed amphibians is smaller than in other cases (HARTEL et al., 2009), even if the majority of the killed species were reported in the roads of the surrounding regions (COVACIU-MARCOV et al., 2014). The small casualty number is a consequence of the fact that we did not catch the period of the amphibian spring migration. Aquatic habitats favourable to the amphibians were also absent near the roads. Amphibians are frequently killed on roads situated near waters (e.g. SANTOS et al., 2007; CICORT-LUCACIU et al., 2012; D'AMICO et al., 2015).

Generally, the road mortality differences between periods were influenced by the life cycle of the victims (e.g. ASHLEY & ROBINSON, 1996; GLISTA et al., 2007; D'AMICO et al., 2015; GARRAH et al., 2015). The high number of road killed bees in May is a consequence of the blooming period of black locusts near the road. At Robaia, two apiaries were situated near the road, the bees being very active in the black locusts. Thus, being brought in contact with the road by people, numerous bees fell victims to cars. If the black locust had not been planted next to the roadside and the apiaries had not been brought by people here, the road mortality of the bees would have been much lower. As in

September no apiaries were placed near the road, the percentage of bee corpses decreased. Extremely high road mortality of pollinating insects was previously registered, this fact being alarming also because of its economic consequences (BAXTER-GILBERT et al., 2015). The data from the Vâlsan open a new perspective upon black locust plantations, which are considered very useful (see in: RÉDEI et al., 2008; ENESCU & DĂNESCU, 2013). Nevertheless, it seems that they not only have a reduced fauna in certain groups (e.g. TOMESCU et al., 2008; FERENŢI et al., 2012), but also increase the road mortality of important animals, like pollinating insects.

Table 1. The percentage abundance (P%) and the frequency of occurrence (f%) of the road killed taxa on May 28, 2015.

		Gorge (P%)	**Robaia (P%)**	**Topliţa (P%)**	**Total (P%)**	**f%**
Oligochaeta		4.48	4.14	8.08	5.18	100
Gastropoda Limax		0.64	2.36	-	1.17	66.66
Gastropoda undetermined		4.48	20.11	3.03	10.37	100
Arachnida Opiliones		-	0.59	1.01	0.47	66.66
Arachnida Araneae		0.64	3.55	3.03	2.35	100
Diplopoda		53.84	10.65	8.08	25.94	100
Chilopoda		-	-	-	-	-
Insecta Odonata		-	-	-	-	-
Insecta Blattodea		-	0.59	-	0.23	33.33
Insecta Orthoptera Gryllotalpa		-	1.18	-	0.47	33.33
Insecta Orthoptera undetermined		-	-	2.02	0.47	33.33
Insecta Dermaptera		-	-	-	-	-
Insecta Homoptera Cicadoidea		-	0.59	-	0.23	33.33
Insecta Heteroptera		-	-	-	-	-
Insecta Coleoptera Carabidae		1.92	1.77	1.01	1.65	100
Insecta Coleoptera Staphylinidae		-	-	-	-	-
Insecta Coleoptera Silphidae		-	0.59	-	0.23	33.33
Insecta Coleoptera Geotrupidae		14.10	3.55	1.01	6.83	100
Insecta Coleoptera Tenebrionidae		-	-	-	-	-
Insecta Coleoptera Scarabeidae Melolontha		0.64	-	-	0.23	33.33
Insecta Coleoptera Lucanidae Dorcus		0.64	3.55	-	1.65	66.66
Insecta Coleoptera Elateridae		-	0.59	-	0.23	33.33
Insecta Coleoptera Cantharidae		0.64	2.95	6.06	2.83	100
Insecta Coleoptera Coccinellidae		-	0.59	-	0.23	33.33
Insecta Coleoptera Meloidae		-	1.18	1.01	0.70	66.66
Insecta Coleoptera Chrysomelidae		1.92	-	1.01	0.94	66.66
Insecta Coleoptera Curculionidae		0.64	0.59	1.01	0.70	100
Insecta Coleoptera undetermined		6.41	2.36	-	3.30	66.66
Insecta Lepidoptera imago		-	-	2.02	0.47	33.33
Insecta Lepidoptera larvae		1.28	-	7.07	2.12	66.66
Insecta Mecoptera Panorpa		-	-	23.23	5.42	33.33
Insecta Diptera Tipulidae		-	-	3.03	0.70	33.33
Insecta Diptera Muscidae		2.56	1.77	3.03	2.35	100
Insecta Hymenoptera Ihneumonidae		-	-	1.01	0.23	33.33
Insecta Hymenoptera Apidae Apis		0.64	28.40	20.20	16.27	100
Insecta Hymenoptera Apidae Bombus		0.64	-	-	0.23	33.33
Insecta Hymenoptera Vespidae		-	-	-	-	-
Insecta Hymenoptera Formicidae Camponotus		-	0.59	-	0.23	33.33
Insecta Hymenoptera Formicidae undetermined		-	-	-	-	-
Insecta Hymenoptera undetermined		-	-	1.01	0.23	33.33
Amphibia	*Triturus cristatus*	-	-	1.01	0.23	33.33
	Salamandra salamandra	1.28	-	-	0.47	33.33
	Bufo bufo	1.92	2.36	-	1.65	66.66
	Bombina variegata	-	1.18	-	0.47	33.33
	Rana dalmatina	0.64	2.95	2.02	1.88	100
	Rana temporaria	-	-	-	-	-
Reptilia	*Lacerta viridis*	-	0.59	-	0.23	33.33
	Natrix natrix	-	0.59	-	0.23	33.33
	Zamenis longissimus	-	-	-	-	-
Mammalia	Rodentia	-	-	-	-	-
No. of individuals		156	169	99	100	-
P%		36.79	39.85	23.34	-	-
No. taxa		20	27	22	-	-
Cars/hour		4.5/h	7.2/h	11.2/h	-	-

Road killed invertebrates were both flying and non-flying forms. Flying invertebrates were represented by more taxa, but the non-flying ones by more individuals, especially because of the high number of diplopods. These are slow, terrestrial animals, which in other cases were also killed in high number by the road traffic (SESHADRI & GANESH, 2011). Even if they seem to be negatively affected by the vicinity of the roads (ROTHOLZ & MANDELIK, 2013), the road from the Gorge, where they register the highest mortality, was recently asphalted having low traffic hereupon it has not affected the neighbouring populations yet. Being common in the forests from the Vâlsan Gorges (CICORT-LUCACIU, personal observation), Diplopoda are frequently killed by cars.

Although butterflies are frequently killed on roads (e.g. SEIBERT & CONOVER, 1991; RAO & GIRISH, 2007; MCKENNA et al., 2001; SKÓRKA et al., 2015; SONY & ARUN, 2015), in the Vâlsan area, they appear accidentally. This is probably a consequence of the compact forests that surround the roads, a high road mortality being registered in open habitats, grasslands generating a butterfly influx to the roads (SKÓRKA et al., 2015). Even if usually numerous dragonflies are killed on roads (e.g. RIFFELL, 1999; RAO & GIRISH, 2007; SOLUK et al., 2011), we encountered only one individual on the road to Robaia. Probably, like in the case of amphibians, the absence of stagnant aquatic habitats near the roads reduces the dragonflies contact with the roads.

Table 2. The percentage abundance (P%) and the frequency of occurrence (f%) of the road killed taxa on September 16, 2015.

		Gorge (P%)	Robaia (P%)	Toplita (P%)	Total (P%)	f%
Oligochaeta		1.76	0.78	4.76	1.89	100
Gastropoda Limax		0.35	0.78	-	0.42	66.66
Gastropoda undetermined		0.7	0.78	1.58	0.84	100
Arachnida Opiliones		-	-	-	-	-
Arachnida Araneae		0.7	-	-	0.42	33.33
Diplopoda		58.80	12.5	38.09	43.57	100
Chilopoda		1.05	0.78	-	0.84	66.66
Insecta Odonata		-	0.78	-	0.21	33.33
Insecta Blattodea		-	-	3.17	0.42	33.33
Insecta Orthoptera Gryllotalpa		-	-	-	-	-
Insecta Orthoptera undetermined		3.87	8.59	7.93	5.68	100
Insecta Dermaptera		0.35	2.34	1.58	1.05	100
Insecta Homoptera Cicadoidea		-	-	-	-	-
Insecta Heteroptera		1.40	5.46	9.52	3.57	100
Insecta Coleoptera Carabidae		9.50	3.9	1.58	6.94	100
Insecta Coleoptera Staphylinidae		1.05	-	-	0.63	33.33
Insecta Coleoptera Silphidae		-	0.78	-	0.21	33.33
Insecta Coleoptera Geotrupidae		7.39	38.28	1.58	14.94	100
Insecta Coleoptera Tenebrionidae		-	0.78	-	0.21	33.33
Insecta Coleoptera Scarabeidae Melolontha		-	-	-	-	-
Insecta Coleoptera Lucanidae Dorcus		-	-	-	-	-
Insecta Coleoptera Elateridae		-	-	-	-	-
Insecta Coleoptera Cantharidae		-	-	-	-	-
Insecta Coleoptera Coccinellidae		-	-	-	-	-
Insecta Coleoptera Meloidae		-	-	-	-	-
Insecta Coleoptera Chrysomelidae		0.7	-	-	0.42	33.33
Insecta Coleoptera Curculionidae		-	-	-	-	-
Insecta Coleoptera undetermined		0.7	7.81	1.58	2.73	100
Insecta Lepidoptera imago		1.40	-	-	0.84	33.33
Insecta Lepidoptera larvae		3.16	4.68	7.93	4.21	100
Insecta Mecoptera Panorpa		-	-	-	-	-
Insecta Diptera Tipulidae		-	-	-	-	-
Insecta Diptera Muscidae		4.22	0.78	6.34	3.57	100
Insecta Hymenoptera Ihneumonidae		-	-	-	-	-
Insecta Hymenoptera Apidae Apis		1.05	0.78	-	0.84	66.66
Insecta Hymenoptera Apidae Bombus		-	-	-	-	-
Insecta Hymenoptera Vespidae		1.05	3.12	1.58	1.68	100
Insecta Hymenoptera Formicidae Camponotus		-	-	-	-	-
Insecta Hymenoptera Formicidae undetermined		-	1.56	-	0.42	33.33
Insecta Hymenoptera undetermined		-	-	-	-	-
Amphibia	*Triturus cristatus*	-	-	-	-	-
	Salamandra salamandra	-	-	-	-	-
	Bufo bufo	0.7	-	3.17	0.84	66.66
	Bombina variegata	-	-	1.58	0.21	33.33
	Rana dalmatina	-	3.12	3.17	1.26	66.66
	Rana temporaria	-	0.78	-	0.21	33.33
Reptilia	*Lacerta viridis*	-	-	1.58	0.21	33.33
	Natrix natrix	-	-	1.58	0.21	33.33
	Zamenis longissimus	-	-	1.58	0.21	33.33
Mammalia	Rodentia	-	0.78	-	0.21	33.33
No. individuals		284	128	63	100	-
P%		59.78	26.94	13.26	-	-
No. taxa		20	22	19	-	-
Cars/hour		2.5/h	4.9/h	11.2/h	-	-

Both flying and non-flying invertebrates killed by cars reach the road accidentally; they not avoiding the roads thus fall victims to its traffic. However, like in case of bees, this is not always totally at random. The fact that road mortality is not a completely stochastic phenomenon was previously reported, some zones being more exposed (SKÓRKA et al., 2015). Beside bees, whose mortality is anthropogenically influenced, in case of other two groups the contact with the road is favoured artificially, increasing the road mortality. Thus, wasps were identified near large sized corpses (frogs or orthopterans). Alive wasps were observed while feeding on corpses on the road. Like some vertebrates (RAO & GIRISH, 2007), wasps are attracted by the corpses from the road, thus being killed by cars while they feed. Thus, wasps are indirect victims of the road traffic. Alike, the genus Geotrupes presents high percentage abundance on roads with excrements, especially towards Robaia, where the road is crossed every day by cows. On the roads without manure (Toplіţa) this genus abundance is negligible. Alike, wasps, which come to the corpses for food, the Geotrupes individuals come to the manure, and being numerous and less mobile, they are killed by cars. If bees are not attracted by the road but by the black locust next to it, wasps and Geotrupes are attracted by something which is situated on the road. A similar situation was observed in India where scorpions and centipedes, which hunt during nighttime on the roads, are killed by cars (SESHADRI & GANESH, 2011).

Table 3. The total percentage abundance (P%) and the frequency of occurrence (f%) of the road killed taxa.

		Gorge (P%)	**Robaia (P%)**	**Toplіţa (P%)**	**Total (P%)**	**f%**
Oligochaeta		2.72	2.69	6.79	3.44	100
Gastropoda Limax		0.45	1.68	-	0.77	66.66
Gastropoda undetermined		2.04	11.78	2.46	5.33	100
Arachnida Opiliones		-	0.33	0.61	0.22	66.66
Arachnida Araneae		0.68	2.02	1.85	1.33	100
Diplopoda		57.04	11.44	19.75	35.26	100
Chilopoda		0.68	0.33	-	0.44	66.66
Insecta Odonata		-	0.33	-	0.11	33.33
Insecta Blattodea		-	0.33	1.23	0.33	66.66
Insecta Orthoptera Gryllotalpa		-	0.67	-	0.22	33.33
Insecta Orthoptera undetermined		2.5	3.70	4.32	3.22	100
Insecta Dermaptera		0.22	1.01	0.61	0.55	100
Insecta Homoptera Cicadoidea		-	0.33	-	0.11	33.33
Insecta Heteroptera		0.90	2.35	3.70	1.89	100
Insecta Coleoptera Carabidae		6.81	2.69	1.23	4.44	100
Insecta Coleoptera Staphylinidae		0.68	-	-	0.33	33.33
Insecta Coleoptera Silphidae		-	0.67	-	0.22	33.33
Insecta Coleoptera Geotrupidae		9.77	18.51	1.23	11.12	100
Insecta Coleoptera Tenebrionidae		-	0.33	-	0.11	33.33
Insecta Coleoptera Scarabeidae Melolontha		0.22	-	-	0.11	33.33
Insecta Coleoptera Lucanidae Dorcus		0.22	2.02	-	0.77	66.66
Insecta Coleoptera Elateridae		-	0.33	-	0.11	33.33
Insecta Coleoptera Cantharidae		0.22	1.68	3.70	1.33	100
Insecta Coleoptera Coccinellidae		-	0.33	-	0.11	33.33
Insecta Coleoptera Meloidae		-	0.67	0.61	0.33	66.66
Insecta Coleoptera Chrysomelidae		1.13	-	0.61	0.66	66.66
Insecta Coleoptera Curculionidae		0.22	0.33	0.61	0.33	100
Insecta Coleoptera undetermined		2.72	4.71	0.61	3.00	100
Insecta Lepidoptera imago		0.90	-	1.23	0.66	66.66
Insecta Lepidoptera larvae		2.5	2.02	7.40	3.22	100
Insecta Mecoptera Panorpa		-	-	14.19	2.55	33.33
Insecta Diptera Tipulidae		-	-	1.85	0.33	33.33
Insecta Diptera Muscidae		3.63	1.34	4.32	3.00	100
Insecta Hymenoptera Ihneumonidae		-	-	0.61	0.11	33.33
Insecta Hymenoptera Apidae Apis		0.90	16.49	12.34	8.12	100
Insecta Hymenoptera Apidae Bombus		0.22	-	-	0.11	33.33
Insecta Hymenoptera Vespidae		0.68	1.34	0.61	0.88	100
Insecta Hymenoptera Formicidae Camponotus		-	0.33	-	0.11	33.33
Insecta Hymenoptera Formicidae undetermined		-	0.67	-	0.22	33.33
Insecta Hymenoptera undetermined		-	-	0.61	0.11	33.33
Amphibia	*Triturus cristatus*	-	-	0.61	0.11	33.33
	Salamandra salamandra	0.45	-	-	0.22	33.33
	Bufo bufo	1.13	1.34	1.23	1.22	100
	Bombina variegata	-	0.67	0.61	0.33	66.66
	Rana dalmatina	0.22	3.03	2.46	1.55	100
	Rana temporaria	-	0.33	-	0.11	33.33
Reptilia	*Lacerta viridis*	-	0.33	0.61	0.22	66.66
	Natrix natrix	-	0.33	0.61	0.22	66.66
	Zamenis longissimus	-	-	0.61	0.11	33.33
Mammalia	Rodentia	-	0.33	-	0.11	33.33

Although, generally there is a relation between the traffic intensity and road mortality (e.g. SESHADRI & GANESH, 2011; DE CARVALHO et al., 2014; SKÓRKA et al., 2015), in our case, on the road with the most passing cars / hour, we found the less corpses. This fact is a consequence of the reduced length of this road, because by taxa number/m it is on the first place. The road from the Gorge, recently asphalted, has the lowest diversity and the less killed taxa/m. The low diversity is a consequence of the high number of killed millipedes compared to the other taxa, the road from the Gorge having the highest number of killed individuals/m. The differences between the roads are not significant, they being surrounded by similar forested habitats, which were checked in the same day. In other cases, although the road mortality varied between habitats, the highest values were registered in humid forests (SESHADRI & GANESH, 2011). The high overlap between the roads can also be a consequence of the high and relatively uniform biodiversity of the region. The three roads are surrounded by forests and, although in some invertebrates like isopods, there are differences between the three zones of the Vâlsan river basin, forest species are the most frequent ones in each sector (FERENȚI & COVACIU-MARCOV, 2016). In the same time, being roads which cross similar habitats in the same region, the affected taxonomic groups are the same, the roadside habitats influencing the occurrence of road mortality (KIOKO et al., 2015).

The diversity of the road traffic victims on low traffic minor roads from a protected area urges to reflection on the impact amplitude, even more that this is probably underestimated in insects (BAXTER-GILBERT et al., 2015). These data confirm the role of the minor roads in road mortality (VAN LANGEVELDE et al., 2009). The taxonomic diversity shows clearly the difficulty in reducing the impact. Differences by the groups or in time between the protection measures and road mortality hot spots were previously observed (e.g. D'AMICO et al., 2015; GARRAH et al., 2015). In case of butterflies from open areas, the black spots represent only 4% of the length of the road (SKÓRKA et al., 2015), but in case of roads surrounded by forests from the Vâlsan these are hard to delimit, the uniform natural habitats unifying the black spots too. The fact is even more difficult due to the differences by the group and the anthropogenic activities, which modify additionally the phenomenon. In this moment, it is obvious that roads greatly affect the fauna of the protected area, including protected amphibian species (O.U.G 57 / 2007). Thus, in the protected area, new roads should not be built, and the upgrade of the existing ones should be realized carefully, in protected areas the creation of roadless sectors being beneficial for conservation (D'AMICO et al., 2016). Nevertheless, because the roads are considered important for tourism in the region (CONSTANTINESCU et al., 2010), their pressure upon the fauna will probably increase in the future.

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