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First data on bat traffic casualties in Montenegro

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Abstract. Details on 17 bat traffic casualties (8.7% of all mammal casualties recorded) of seven bat species from the surroundings of Danilovgrad, Montenegro, are presented, which were recorded on a 20 km high traffic road transect and a 10 km stretch of low traffic road between 1 August 2012 and 15 October 2013. *Pipistrellus kuhlii* and *Rhinolophus hipposideros* were the most frequently recorded species. *Rhinolophus blasii* is here reported for the first time and *Myotis capaccinii* for the second time as victims of traffic in Europe. Most bats were hit in the vicinity of linear landscape elements such as vegetation along water courses and lines of trees. August and September were months with the highest frequency of recorded bat traffic casualties. We recommend that environmental impact assessments in Montenegro should start to include bats when evaluating the impact of different infrastructure projects.

Road traffic, bat mortality, *Rhinolophus blasii*, *Myotis capaccinii*, Montenegro

Introduction

Road transport as a form of human activity contributes to the decline of populations of amphibians, reptiles, birds and mammals (Jochimsen et al. 2004, Kociolek et al. 2011, Lesiński et al. 2011, Seiler & Helldin 2006, Smith-Patten & Patten 2008). In Europe and North America, the issue of the impact of traffic on wildlife has been present for the last 50 years, and over the recent decade, it has become important also in some other parts of the world. Intersecting roads cause fragmentation of migration routes and habitats of many animal species and could even interfere with gene exchange between populations (Jochimsen et al. 2004). The reasons for animals crossing the road are different kinds of needs that they have: the reproduction need, the hibernation need, egg-laying, expanding population, the search for food etc. Road deaths depend on the habitat quality of the area through time passes, density of population of the given species, position of migration routes, traffic density and road density as well as on characteristics of the life cycle of the species which use this habitat.

The impact of traffic has been growing and possibly becoming more destructive to biodiversity, also within the protected areas such as National Parks, by construction of new roads, reconstruction of existing roads and by increasing the density of traffic in Montenegro. Therefore pioneer monitoring of the impact of traffic on amphibians and reptiles started on two roads in Danilovgrad (Central Montenegro). During this survey, large numbers of mammal casualties were observed, including several species of bats. Impact of traffic on bats has been well documented in Central (e.g. Kiefer et al. 1995, Gaisler et al. 2009) and Eastern Europe (e.g. Lesiński 2007, 2008), however, published studies in the Mediterranean region are very scarce (e.g. Medinas et al. 2013, Presetnik et al. 2014a). Therefore the aim of this paper is to present species and numbers of bats

Table 1. Species of bats found killed by traffic on roads near Danilovgrad; for locations 1–14 see Fig. 1; details: M – male, juv – juvenile, subad – subadult, ad – adult

loc.	species	date	details	general habitat
13	*Pipistrellus kuhlii*	10 August 2012	–	near the Sušica river, at street lights
12	*Pipistrellus pygmaeus*	5 September 2012	–	near the Sušica river, at street lights
12	*Pipistrellus pygmaeus*	9 September 2012	–	near the Sušica river, at street lights
8	*Myotis mystacinus*	26 September 2012	–	grassland
9	*Rhinolophus hipposideros*	6 March 2013	subad	grassland
12	*Pipistrellus pygmaeus*	13 April 2013	M	near the Sušica river, at street lights
11	*Pipistrellus nathusii*	3 May 2013	M	near the Sušica river, at street lights
2	*Pipistrellus kuhlii*	27 May 2013	–	karst scrubs
5	*Pipistrellus kuhlii*	4 June 2013	–	karst scrubs near the Zeta river
6	*Pipistrellus kuhlii*	4 June 2013	–	karst scrubs near the Zeta river
10	*Rhinolophus hipposideros*	9 August 2013	juv M	grassland
14	*Rhinolophus blasii*	9 August 2013	juv M	near the Rimanić stream
1	*Rhinolophus hipposideros*	30 August 2013	ad M	karst scrubs close to hill cliffs
7	*Pipistrellus kuhlii*	20 September 2013	–	mix of karst scrubs and grassland
4	*Myotis capaccinii*	20 September 2013	ad	karst scrubs near the Zeta river
3	*Rhinolophus hipposideros*	27 September 2013	ad M	karst scrubs
4	*Pipistrellus kuhlii*	10 October 2013	–	karst scrubs near the Zeta rive

which became traffic victims in Montenegro and to compare these results with selected studies made in northern countries.

Methods and Study Area

We studied two roads near Danilovgrad (Central Montenegro) with the approximate central geographic latitude 42.5537 °N and longitude 19.1079 °E, at the elevations between 40 and 250 m a. s. l. (Fig. 1). 20 kilometre stretch of a regional high traffic road (HTR) with 10,300 vehicles per day, between the village of Zagorak in the northwest and the village of Bandići in the southeast, was surveyed. For comparison, we also studied 10 kilometres of a local low traffic road (LTR) with 1,100 vehicles per day, between Danilovgrad in the west and the settlement of Spuž in the east. The maximum speed limit for motor vehicles is 80 km/hon the HTR road, and 50 km/h on the LTR, but the vehicles often drive at speeds exceeding the limitations by 20–30 km/h.

Both roads pass through three general types of habitats: mostly open habitat (meadows), wetlands and Mediterranean karst scrubs. One part of the HTR passes less than 200 m from the banks of the Zeta river, and the maximum distance from the river flow is approximately 2 km. The main part of the HTR passes through a flat land and the study stretch ends in the southeast at limestone slopes of the surrounding hills. The plain is characterized by grass vegetation. Riverbeds are mostly lined by the community of floodplain forests (*Salix alba* being a dominant species). Flows of the Sušica and Gračanica rivers and the surrounding streams are characterized by the community of emergent plants. The karst scrub habitat has a distinctive limestone substrate with vegetation which is represented by the degraded association of *Querco-carpinetum orientalis* and the associations *Paliuretum adriaticum* and *Rusco-carpinetum*. Karst scrubs are present along the 10 km of the HTR which passes through a rural area but they can be also occasionally found along the LTR road and the HTR section which pass through the urban area.

The presented data were collected from 1 August 2012 until 15 October 2013, but the study continues also in 2014. In this period, 10 km stretches of HTR (NW of Danilovgrad) and LTR in a predominantly urban environment were monitored, and as a comparison, 10 km of HTR (SE of Danilovgrad) in more rural environment were also surveyed from 1 May till 15 October 2013. Each stretch of the road was examined using a bicycle on a weekly basis between 7 am and 11 am. Geographic locations of carcasses were documented by GPS, and the state of the carcases (fresh, rotting, mummified) was recorded and the remains were collected for later species determination. External characters (e.g. forearm length, ear shape, etc.) as well as the skulls and other bone characteristics were used to identify the bat species with the help of the determination keys by Dietz et al. (2009) and Schober & Grimberger (1998). If possible, sex and age were also noted.

Results and Discussion

Between August 2012 and October 2013 we found 195 mammals as victims of road traffic, and 8.7% of them were bats (17 specimens) of seven different species (Table 1). *Pipistrellus kuhlii* (6 carcases) was the most numerous, followed by *Rhinolophus hipposideros* (4) and *Pipistrellus pygmaeus* (3), all other bat species, i.e. *R. blasii*, *Myotis mystacinus* (s. str.), *M. capaccinii* and *P. nathusii*, were represented by a single specimen each. The species composition of this record probably reflects local abundance of the particular species. At least *P. kuhlii* is one of the most commonly observed bat species in Montenegro (Presetnik et al. 2014) and was also recorded as one of the most common victims of traffic in Portugal (Medinas et. al. 2013) or in Slovenia (Šemrl et al. 2012). *P. pygmaeus* was also found among the commonest road-killed bats across Europe (Presetnik et al. 2014), for example in the Czech Republic (Gaisler et al. 2009) or in France (Planckaert 2011). Findings of *R. hipposideros* are not surprising either, as this low flying species is a common traffic victim in areas where it occurs, for example in Wales in the UK (Bicmore 2003), France (Néri 2004) or Portugal (Medinas et al. 2013). However, to our knowledge our record of *R. blasii* represents the first evidence and the observation of *M. capaccinii* the second finding after that of Bafaluy (2000) of those species being victims of traffic in Europe. The number of observed bat carcasses vs. the total amount of expected traffic bat victims (e.g. Santos et al. 2011) was not calculated as the study continues also in the year 2014.

Most bats except for one *R. blasii* were killed on the HTR (Fig. 1). Considering that the habitats surrounding both roads have similar characteristics, the clear difference in numbers of bat casualties was a probable consequence of higher traffic density and higher vehicle speed on the HTR.

A detailed analysis of habitats where the bats of the particular species were collided by vehicles would not be realistic because of the small sample size, however, we can comment on some general patterns. Bats collided with vehicles practically all along the HTR, with two apparent concentrations. The first concentration of carcasses was found on a stretch of the road NW of the

Fig. 1. Locations of bats killed by traffic on roads in the vicinity of the Danilovgrad town in Montenegro.
Note: HFR = HTR, LFR = LTR

Danilovgrad town at the locations 4–7 (Fig. 1), where the road was closest to the Zeta river and crossed its tributary, the Gračanica river. The second carcass concentration was recorded on the part of the road SE of the researched area, where the road was closest to the hill SW of the road, at the crossing with the Sušica river (locations 10–13, Fig. 1). Such locations of higher traffic casualties are expectable, as the habitats along waters are rich foraging grounds used by bats, especially where street lights are present. Most bats from the genus *Pipistrellus* were found in those locations. Carcasses of *R. hipposideros* were found at the parts of the road in the general area of grassland or karst scrub vegetation, but near a line of trees or in patches of trees near the road. Similarly also Lesiński (2007, 2008) found the highest incidence of bat road casualties in the environment with bat flyways along linear landscape elements. Interestingly, *M. capaccinii* was found in open habitats characterized by grass vegetation, at the distance of about 500 m from the Sušica river and 1.000 from the Zeta river, where the expected foraging grounds of this species were present. A roost of this species may be located in the nearby hills (caves have not yet been registered in the area, but are highly likely to occur there) and the individual was hit when flying from its roost towards its river foraging grounds. The only killed species on the LTR, *R. blasii*, was found near the Rimanić stream, close to limestone hills NE of the Bijelopavlići plain, where several caves are known to be available as potential roosts for this species. In general, this is only the third site of *R. blasii* in Montenegro and since the individual was a juvenile, it is also the first confirmation of the species reproduction in the country (Presetnik et al. 2014b).

No bat traffic casualties were registered during winter months (November – February), when the bats mostly hibernate (Fig. 2). The seasonal pattern clearly shows that the highest number of road-killed bats was found in August and especially in September (Fig. 2). This pattern corresponds to the situation observed in other areas of Europe, e.g. by Šemrl et al. (2012), Geisler et al. (2009) and Lesiński (2008), approximately 500, 750 and 1,000 km to the N(W), respectively. Therefore also in our case the late summer – early autumn peak in road casualties can be probably attributed to the period of dispersal of young bats (we also found several of them, Table 1) and general migration to swarming sites and hibernacula (e.g. Lesiński 2008).

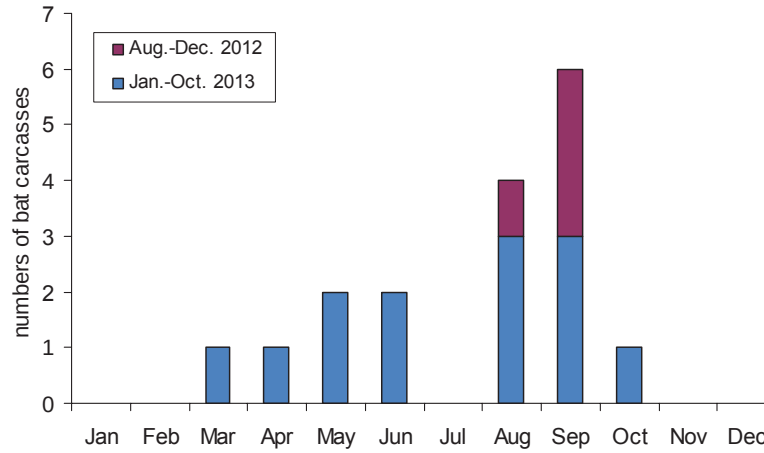

Fig. 2. Frequency of bat carcasses found in the study area during the particular months (August 2012 – October 2013).

Conclusions

Our study brought evidence that also in the Mediterranean areas of SE Europe, bats are victims of traffic, including rare and endangered species such as *R. blasii* and *M. capaccinii*. The season when most casualties were found (August–September) and microhabitats in which collisions occurred (linear features, watercourses) were similar to the results of other studies carried out in Europe. On the other hand, our study can also be taken as a proof of the lack of basic knowledge of the distributional status of bats in Montenegro pointed out by Paunović et al. (2010), since our observations provided the first data on the presence of the majority of the recorded bat species in the wider region of Danilovgrad, with the exception of *R. hipposideros* (Presetnik et al. 2014b).

So far, the impact of traffic on many different groups of animals including bats has not been taken into account, thereby totally ignoring the intrinsic value of the bat populations and the economic value of services they provide to ecosystems. However, based on the evidence presented in this article it is clear that traffic did have impact on the mortality of bats and therefore, attention has to be paid to this issue when planning new roads or reconstruction of old roads or another transportation infrastructure. We recommend that the first measures for the protection of bats should be a detailed preconstruction inventory, careful environmental impact assessment and post-construction monitoring of the efficiency of mitigation measures.

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