

## Short Note

Levente Barti\*, Áron Péter, István Csósz and Attila D. Sándor

# Snake predation on bats in Europe: new cases and a regional assessment

<https://doi.org/10.1515/mammalia-2018-0079>

Received May 3, 2018; accepted December 13, 2018

**Abstract:** Among reptiles only snakes are known to frequently feed on bats and even inside this group chiropterophagy is rare, with most records being noted in the tropics. In the temperate region and especially in Europe, only a handful of cases have been described. Here, we report further cases of bat predation in underground habitats of Bulgaria, highlighting the importance of the Aesculapian snake (*Zamenis longissimus*) predation on bats in the Western Palearctic. Until now, 11 species of bats have been recorded as preys of snakes in Europe. Our observations are the first records of snake hunting on Mediterranean horseshoe bats (*Rhinolophus euryale*) and on greater mouse-eared bats (*Myotis myotis*) in Europe, and only the third to fourth observation of underground predation. The observation in a short time of two incidences of hunting in a fairly small area, coupled with the regular presence of snakes in cave environments, may suggest a more common bat hunting habit for Aesculapian snakes. Bat predation of snakes in the Balkan region (or in the Mediterranean) certainly is more common than previously assumed. The number of records may increase substantially with targeted search during crepuscular and night hours in the entrance area of underground bat shelters.

**Keywords:** bat hunting; cave; chiropterophagy; *Myotis myotis*; predator-prey relationship; *Rhinolophus euryale*; *Zamenis longissimus*.

**\*Corresponding author: Levente Barti**, Romanian Bat Protection Association – Central Branch, Bld. Independentei nr. 7/10, Odorheiu Secuiesc 535600, Romania, e-mail: bartilev@yahoo.com.  
<https://orcid.org/0000-0003-4252-354X>

**Áron Péter:** Department of Parasitology and Parasitic Diseases, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Cluj-Napoca, Romania; and MTA-PE Evolutionary Ecology Research Group, Pannon University, Veszprém, Hungary

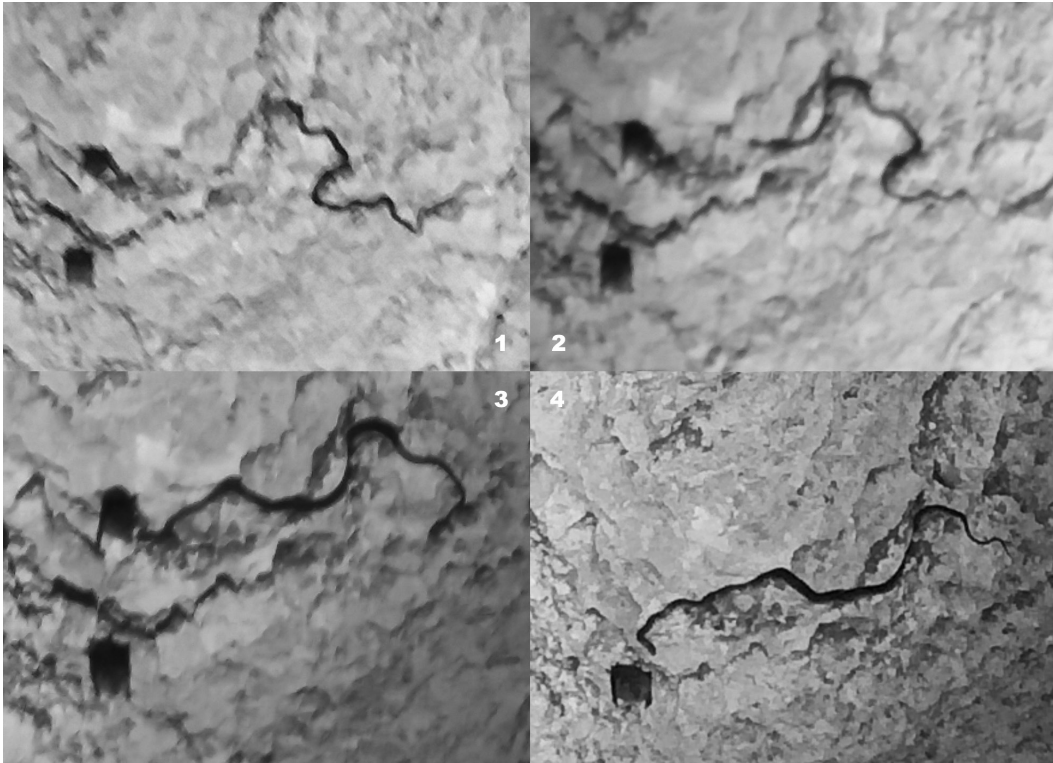
**István Csósz:** Romanian Bat Protection Association – Central Branch, Bld. Independentei nr. 7/10, Odorheiu Secuiesc 535600, Romania

**Attila D. Sándor:** Department of Parasitology and Parasitic Diseases, University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Cluj-Napoca, Romania

Predation and diseases are the two most important forces regulating vertebrate populations (Pianka 2000). Predation in most mammalian populations involves vertebrate predators, which are established for most mammal prey species (Prevedello et al. 2013). However, we possess only limited information on predators of bats (Chiroptera), due to their night flying movements and their secretive roosting sites in daytime (Rydell and Speakman 1995, Dietz et al. 2009). Therefore, predation events on bats are rarely observed. Even so, there are a number of vertebrates which are known to be important predators of bats. Among these, birds (both diurnal birds of prey – Accipitriformes and owls – Strigiformes) are the only group, for which studies estimated bat-predation as important (Speakman 1991, Lesiński et al. 2012, Mikula et al. 2016), while most vertebrate groups are thought to only incidentally capture bats (Kowalski 1995, Rydell and Speakman 1995, Mikula 2015). Among reptiles, only snakes are known to frequently feed on bats and even inside this group chiropterophagy is rare, with most records on this habit being noted in the tropics (Schätti 1984, Esbérard and Vrcibradic 2007). In the temperate region and especially in Europe, only a handful of cases were described (Théou 2015). This may be due to the differences in roosting habits of most Palearctic bats (most populations use underground cavities, anthropic roosts inaccessible for most vertebrate predators or small tree cavities vs. open canopy roosts or hiding among leaves or flowers in many tropical species) in comparison to tropical bat populations. This is especially the case of bats roosting in deep underground cavities in the Western Palearctic for which no more than two cases are known up to now (Hammer and Arlettaz 1998, Théou 2015).

Here, we report two more cases of bat predation in underground habitats, highlighting the importance of snake predation on bats in the Western Palearctic, by assessing also the published information. The observations were made during a targeted bat-parasite study (Sándor et al. 2018).

At 07:34 p.m. on 10th of September 2017, a subadult Aesculapian snake [*Zamenis longissimus* (Laurenti, 1768)] (body length about 65–70 cm) was observed displaying



**Figure 1:** The Aesculapian snake's (*Zamenis longissimus*) catching attempt against a Mediterranean horseshoe bat (*Rhinolophus euryale*), Nanin Kamak Cave, Bulgaria (photo by Á. Péter and A.D. Sándor).

hunting behavior in the Nanin Kamak Cave (150 m a.s.l, Ruse Province, Bulgaria). The snake was creeping on the wall in the second room of the cave, used by the bats as a gathering place before emerging through a vertical exit from the ceiling. It was moving slowly toward some hanging Mediterranean horseshoe bats (*Rhinolophus euryale* Blasius, 1853) and almost caught one. The attacked bat managed to escape, then the snake quickly found another one which was abandoned eventually for unknown reasons. Low quality pictures and a video of the catching attempt were taken with a phone (Figure 1). Although this time the snake was unsuccessful, its efforts to climb those heights was of strategic importance and the perfect timing may denote a daily routine in hunting bats.

In the summertime, this cave is a nursing place for several hundreds of bats from different bat species including *Rhinolophus euryale*, *Rhinolophus mehelyi* Matschie, 1901, *Myotis capaccinii* Bonaparte, 1837 and *Myotis emarginatus* (E. Geoffroy Saint-Hilaire, 1806); smaller groups of the above species use the cave during the swarming period as well (Ivanova 2005). During our survey, we observed about 50 middle-sized horseshoe bats (mostly *R. euryale* and a few individuals of *R. mehelyi*) and 50 *M. capaccinii* in the cave.

One day later, at 11:40 p.m. on 11th of September 2017, another case was recorded: an adult Aesculapian snake (body length not measured, but much thicker than the previous individual) was spotted at the entrance of Orlova Chuka Cave (150 m a.s.l, Ruse Province, Rusenski Lom Nature Park, Bulgaria) swallowing its prey (Figure 2). The



**Figure 2:** A greater mouse-eared bat (*Myotis myotis*) swallowed by the Aesculapian snake (*Zamenis longissimus*), Orlova Chuka Cave, Bulgaria (photo by L. Barti).

**Table 1:** Predation events by snakes on bats in Western Palearctic.

	Bat species	Snake species	Location of predatory event	Reference
1	<i>Eptesicus isabellinus</i>	<i>Hemorrhois hippocrepis</i>	Building	Migens et al. (2002)
2	<i>Eptesicus isabellinus/serotinus</i>	<i>Hemorrhois hippocrepis</i>	Building	Garrido-García et al. (2013)
3	<i>Myotis oxygnathus</i>	<i>Hemorrhois hippocrepis</i>	Building	Migens et al. (2002)
4	<i>Myotis punicus</i>	<i>Hemorrhois hippocrepis</i>	Cave	Hammer and Arlettaz (1998)
5	<i>Pipistrellus pipistrellus</i>	<i>Hemorrhois hippocrepis</i>	Building	Migens et al. (2002)
6	<i>Plecotus austriacus</i>	<i>Hemorrhois hippocrepis</i>	Building	Garrido-García et al. (2013)
7	<i>Barbastella barbastellus</i>	<i>Hierophis viridiflavus</i>	Not indicated	Bruno et al. (1973) in Scaravelli and Aloise (1999)
8	<i>Nyctalus noctula</i>	<i>Hierophis viridiflavus</i>	Not indicated	Bruno et al. (1973) in Scaravelli and Aloise (1999)
9	<i>Barbastella barbastellus</i>	<i>Zamenis longissimus</i>	Not indicated	Bruno et al. (1973) in Scaravelli and Aloise (1999)
10	<i>Eptesicus serotinus</i>	<i>Zamenis longissimus</i>	Building	Kaňuch and Baláž (2005)
11	<i>Eptesicus serotinus</i>	<i>Zamenis longissimus</i>	Not indicated	Bruno et al. (1973) in Scaravelli and Aloise (1999)
12	<i>Miniopterus schreibersii</i>	<i>Zamenis longissimus</i>	Cave	Théou (2015)
13	<i>Myotis myotis</i>	<i>Zamenis longissimus</i>	Cave	This study
14	<i>Myotis mystacinus</i>	<i>Zamenis longissimus</i>	Not indicated	Bruno et al. (1973) in Scaravelli and Aloise (1999)
15	<i>Nyctalus noctula</i>	<i>Zamenis longissimus</i>	Not indicated	Bruno et al. (1973) in Scaravelli and Aloise (1999)
16	<i>Rhinolophus euryale</i>	<i>Zamenis longissimus</i>	Cave	This study
17	<i>Rhinolophus hipposideros</i>	<i>Zamenis longissimus</i>	Building	Koselj and Zagamajster (2000) in Kaňuch and Baláž (2005)

snake profited obviously from the intense flux of emerging bats and the prey (likely caught in flight) was an adult individual of the greater mouse-eared bat (*Myotis myotis* Borkhausen, 1797). Only the first third of the snake's body was visible, hanging from a wall gap at 1.3 m height, ca. 2 m behind the grids closing the main entrance of the cave. Unfortunately we missed the moment of capture and the strangling which probably took part before, but the swallowing struggle followed for more than 30 min. The snake had major problems swallowing the wings of the bat, but finally made it and has retracted in the wall's gap. The Orlova Chuka Cave is home to at least 15 species of bats, with more than 10,000 individuals (Ivanova 2005). During our survey on that day, we caught 863 bats belonging to nine species, the most abundant being *Rhinolophus euryale* (48.55%), *M. myotis* (27.23%), *Myotis capaccinii* (7.64%), *Myotis blythii* Tomes, 1857 (7.41%) and *Rhinolophus mehelyi* (5.33%). The snake's prey was not the most abundant species, but the second most abundant one, a greater mouse-eared bat. The snake's choice could be explained by the fact that in narrow spaces Mediterranean horseshoe bats maneuver more skilfully than greater mouse-eared bats (Dietz et al. 2009), exploring every corner in order to bypass the obstacles. In contrast, the greater mouse-eared bats flew in line mostly in the middle of the corridor, a rather predictable route for a hunting snake.

Chiropterophagy is not uncommon in some snake species, especially in the tropics (Schätti 1984, Esbérard

and Vrcibradic 2007). Most of the observations were recorded for giant snakes and larger climbing species from American, African and Asian continents (Schätti 1984). Snakes catch bats mainly in caves but also in other types of roosting places where bats are concentrated in roosting assemblages. Sometimes, bats can present a large portion in a snake's diet (Schätti 1984, Kaňuch and Baláž 2005).

European records are scarce, based mostly on accidental observations (see Table 1); systematic surveys of snakes' diets (e.g. Luiselli and Rugiero 1993, Capizzi et al. 1995, Capula and Luiselli 2002, Lelièvre et al. 2012) failed to record any bats in snakes' diets. Only a few notes mention bats in the diet of the Aesculapian snake (Scaravelli and Aloise 1999, Koselj and Zagamajster 2001, Kaňuch and Baláž 2005, Théou 2015). Based on the information collected, most cases of bat predation is localized in the Mediterranean region in Europe, with only one known case of snake predation on bats in Central Europe (Slovakia). Here, a serotine bat [*Eptesicus serotinus* (Schreber, 1774)] was strangled by an adult Aesculapian snake in open space, close to a house-dwelling bat colony (Kaňuch and Baláž 2005).

In the Balkan region, the first Aesculapian snake presenting hunting behavior toward bats was observed in a roof attic under a nursery colony of lesser horseshoe bats [*Rhinolophus hipposideros* (Bechstein, 1800)] (Koselj and Zagamajster 2001). Another observation regarding a successful bat capture was registered in a cave from Albania,

where a Schreiber's bent-winged bat [*Miniopterus schreibersii* (Kuhl, 1817)] was observed to be swallowed by an adult snake (Théou 2015).

The Aesculapian snake is considered to be a generalist as regards the exploitation of available prey in its habitat (Capula and Luiselli 2002, Lelièvre et al. 2012). The literature concerning the foraging ecology of this species refers to a wide dietary spectrum dependent on varying snake body sizes. Aesculapian snakes can forage on the ground or on the trees taking advantage of their climbing skills. They feed primarily on small terrestrial mammals (rodents, insectivores), small birds (especially juveniles), bird eggs and frogs, while juvenile snakes hunt mostly lizards (Luiselli and Rugiero 1993, Capizzi et al. 1995, Capula and Luiselli 2002, Lelièvre et al. 2012). Sometimes it can forage also on non-typical prey, e.g. bats roosting in roof attics or tree hollows can provide well concentrated amounts of food (Kaňuch and Baláž 2005). Besides the Aesculapian snake, chiropterophagy was observed in another two European colubrid species as well, the horseshoe whip snake [*Hemorrhois hippocrepis* (Linnaeus, 1758)] in Spain (Garrido-García et al. 2013) and the green whip snake [*Hierophis viridiflavus* (Lacépède, 1789)] in Italy (Scaravelli and Aloise 1999) and a third species, the grass snake [*Natrix natrix* (Linnaeus, 1758)] was spotted near colonies of bats in Slovenia and Albania (Théou 2015). It seems that, in general, bats represent local and occasional prey for European snakes (Garrido-García et al. 2013).

Until now, 11 species of bats have been recorded to be preyed by snakes in Europe (Table 1). To the best of our knowledge, our observations are the first records of snake hunting on *Rhinolophus euryale* or *Myotis myotis* in Europe, and only the third to fourth observation of underground predation. The observation in a short time of two incidences of hunting in a fairly small area, coupled with the regular presence of snakes in cave environments, may suggest a more common bat hunting habit for Aesculapian snakes. While our observations cover a short period of time, we managed to witness both techniques used by snakes for hunting bats (Esbérard and Vrcibradic 2007). While in Nanik Kamak Cave the subadult Aesculapian snake used the active pursuit to locate roosting bats, at Orlova Chuka Cave the adult snake most likely used the ambush technique to catch flying bats at the cave entrance. Likely Aesculapian snakes may be regular predators of bats in those areas which present high abundance of both snakes and bats.

In conclusion, bat predation by snakes should be considered as a possible factor that may influence the variation of bat populations in caves (Théou 2015). Locally,

some individuals may be specialized for eating bats, similar to cases observed in tropical regions (Kaňuch and Baláž 2005). In our opinion, the more or less abundant bat effectives from the Orlova Chuka and Nanin Kamak caves favored the appearance of snake individuals which hunt bats on a regular basis. Several conservation measures such as grids installed to limit human disturbance (Hammer and Arlettaz 1998), or narrowing the cave entrances and corridors with artificial walls (the case in Orlova Chuka Cave), may increase snake predation on bats.

Bat predation of snakes in caves of the Balkan region (or in the Mediterranean) certainly is more common than previously assumed. The number of records may increase substantially with targeted search during crepuscular and night hours in the entrance area of underground bat shelters.

**Acknowledgments:** The authors are grateful to G. D'Amico and D. Scaravelli for their help in locating crucial references. Permission for bat research was provided by the Bulgarian Ministry of Environment and Water (permit no. 718/24.08.2017), the research was supported from the grant PN-II-RU-TE-2014-4-0919: TE/36/2015, while ADS was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences.

## References

- Capizzi, D., L. Luiselli, M. Capula and L. Rugiero. 1995. Feeding habits of a Mediterranean community of snakes in relation to prey availability. *Rev. Écol. Terre Vie* 50: 353–363.
- Capula, M. and L. Luiselli. 2002. Feeding strategies of *Elaphe longissima* from contrasting Mediterranean habitats in central Italy. *Hystrix, It. J. Zool.* 69: 153–156.
- Dietz, C., D. Nill and O. von Helversen. 2009. Bats of Britain, Europe and Northwest Africa. A&C Black, London. p. 400.
- Esbérard, C.E. and D. Vrcibradic. 2007. Snakes preying on bats: new records from Brazil and a review of recorded cases in the Neotropical Region. *Rev. Brasil. Zool.* 24: 848–853.
- Garrido-García, J.A., G. Schreur and J.M. Pleguezuelos. 2013. Occasional bat predation by the horseshoe whip snake (Reptilia, Colubridae). *Galemys* 25: 59–61.
- Hammer, M. and R. Arlettaz. 1998. A case of snake predation upon bats in northern Morocco: some implications for designing bat grilles. *J. Zool.* 245: 211–212.
- Ivanova, T. 2005. Important Bat underground Habitats (IBuH) in Bulgaria. *Acta Zool. Bulg.* 57: 197–206.
- Kaňuch, P. and P. Baláž. 2005. Bat as a prey of *Elaphe longissima* (Laurenti, 1768). *Herpetozoa* 18: 92–93.
- Koselj, K. and M. Zgamajster. 2001. Interesting observations in caves inhabited by bats in Slovenia. *Temporaria, Informativni bilten Societas herpetologica Slovenica* 5: 21–22. (in Slovenian).

- Kowalski, K. 1995. Taphonomy of bats (Chiroptera). *Geobios* 28: 251–256.
- Lelièvre, H., P. Legagneux, G. Blouin-Demers, X. Bonnet and O. Lourdaïs. 2012. Trophic niche overlap in two syntopic colubrid snakes (*Hierophis viridiflavus* and *Zamenis longissimus*) with contrasted lifestyles. *Amphibia-Reptilia* 33: 37–44.
- Lesiński, G., K. Kasprzyk and J. Gryz. 2012. Bats taken by the tawny owl in relation to its roosting site. *North-West J. Zool.* 8: 247–251.
- Luiselli, L. and L. Rugiero. 1993. Food habits of the Aesculapian snake, *Elaphe longissima*, in Central Italy: do arboreal snakes eat more birds than terrestrial ones? *J. Herpetol.* 27: 116–117.
- Migens, E., J. Quetglas and C. Ibáñez. 2002. Predación de culebra de herradura sobre el murciélago ratonero mediano en Tarifa (Cádiz, Andalucía). *Almoraima* 28: 69–71.
- Mikula, P. 2015. Fish and amphibians as bat predators. *Eur. J. Ecol.* 1: 71–80.
- Mikula, P., F. Morelli, R.K. Lučan, D.N. Jones and P. Tryjanowski. 2016. Bats as prey of diurnal birds: a global perspective. *Mammal Rev.* 46: 160–174.
- Pianka, E.R. 2000. *Evolutionary ecology* (6th Ed.). Harper and Row, New York. p. 528.
- Prevedello, J.A., C.R. Dickman, M.V. Vieira and E.M. Vieira. 2013. Population responses of small mammals to food supply and predators: a global meta-analysis. *J. Anim. Ecol.* 82: 927–936.
- Rydell, J. and J.R. Speakman. 1995. Evolution of nocturnality in bats: potential competitors and predators during their early history. *Biol. J. Linnean Soc.* 54: 183–191.
- Sándor, A.D., M. Földvári, A.I. Krawczyk, H. Sprong, A. Corduneanu, L. Barti, T. Görföl, P. Estók, D. Kováts, S. Szekeres, Z. László, S. Hornok and G. Földvári. 2018. Eco-epidemiology of novel *Bartonella* genotypes from parasitic flies of insectivorous bats. *Microbial Ecol.* 76: 1076–1088.
- Scaravelli, D. and G. Aloise. 1999. La predazione sui Chiroterri in Italia. In: (G. Dondini, O. Papalini and S. Vergari eds.) *Proceedings of the First Italian Bat Congress, Castell’Azzara (Grosseto), March 28–29, 1998*. pp. 223–228.
- Schätti, B. 1984. Fledermäuse als Nahrung von Schlangen. *Bonn. Zool. Beitr.* 35: 335–342.
- Speakman, J.R. 1991. The impact of predation by birds on bat populations in the British Isles. *Mammal Rev.* 21: 123–142.
- Théou, P. 2015. Putative predation of *Miniopterus schreibersii* (Vespertilionidae, Chiroptera) by *Zamenis longissimus* (Colubridae, Reptilia) in the Albanian National Park of Prespa Lakes. *Mammalia* 80: 571–572.