

SHORT COMMUNICATIONS

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PREDATION ON COMMON WALL LIZARDS: SURVIVAL PROBABILITIES OF MELANIC INDIVIDUALS

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For estimation of predation plasticine models of prey animals are often used, because the soft material preserves imprints left by predators. We assumed that melanic common wall lizards (*Podarcis muralis*) disappear by selective predation faster than cryptic individuals and habitat features have important role in this process. We studied the survival probabilities of cryptic and melanic colored plasticine common wall lizard models in habitats with different background coloration on selected places near the city of Pécs (south Hungary), where melanic common wall lizards had been observed earlier. Contrary to our expectations the daily survival rates of melanic plasticine common wall lizards were somewhat higher in all three locations (sandstone quarry, stone wall, coal pit) than those of the cryptic ones, but these differences were not significant. Predators were mostly mammals, which left more marks on plasticine models than birds, but we could not show a preference of the body parts of prey. We concluded that rare occurrence of melanic common wall lizards in habitats near the city of Pécs is not due to predation pressure.

Keywords: Hungary; plasticine; *Podarcis muralis*; survival rate.

INTRODUCTION

The behavior of predators, particularly their strategies for sampling novel, unfamiliar prey, influence the evolution of prey defenses like aposematism, crypsis, and color polymorphism (Sherratt, 2011). It is known, that avian predators mainly use visual cues to search for food (Rangen et al., 2000) thus color is important in survival of prey. As camouflage depends on the visual background, evidence suggests that discrete color morphs within species prefer habitats and backgrounds that heighten matching camouflage (e.g., Marshall et al., 2016). In many species, including reptiles, melanic individuals appear as a result of phenotypic polymorphism (Quicke, 2017). Melanism results in greater fitness in cold climates (Clusella Trullas et al., 2007; Broennimann et al., 2014), and darkness coloration might have evolved

in response to adverse conditions at high altitudes (Castella et al., 2013; Reguera et al., 2014). Therefore in higher latitudes and altitudes melanic phenotypes are proposed to have a greater frequency as shown for example on lizards (Clusella Trullas et al., 2007). Melanic forms played important roles in understanding maintenance of variation and selective pressures (e.g., predation) during evolution of adaptations (Karpestam et al., 2012).

In snakes and lizards there are only few completely black species and melanism is expressed at the levels of subspecies, subpopulations or varieties (Trócsányi and Korsós, 2004). Melanic individuals of grass snake (*Natrix natrix*) and adder (*Vipera berus*) in Hungary occur occasionally (Puky et al., 2005), while black coloured common wall lizards (*Podarcis muralis*) have been evidenced in the country only in the northern periphery of the city of Pécs (Trócsányi and Korsós, 2004). In this southern region of Hungary the climate is continental with considerable Mediterranean influences therefore

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occurrence of melanic common wall lizard is difficult to explain under the thermal-advantage hypothesis. Three melanic individuals were observed on brick walls at the locality of Dömörkapu in 1998, where the density of common wall lizards reached 36 individuals/100 m² (Trócsányi and Korsós, 2004), however part of these habitat patches later disappeared due to constructions in the area (Trócsányi et al., 2007). Inside the abandoned 2-ha quarry of Kantavár north of the city of Pécs (46°06'57" N 18°12'49" E, 390 m a.s.l.) Trócsányi (voce viva, unpubl. data) observed another totally black individual in autumn 2016. In addition to quarries, open-pit coal mining was practiced in the outskirts of Pécs for quite a long time, these special habitats (with domination of black background coloration) possibly having offered suitable conditions for melanic individuals to survive. In basking spots, common wall lizards can reach high densities, but also predation pressure by snakes, avian or mammalian predators can quite as well increase. Trócsányi and Korsós (2004) propose that data about the occurrence of melanic individuals are scarce because these animals are only rarely encountered or they soon disappear from their populations due to predation. The latter is difficult to prove, because under natural conditions it is problematic to document when small vertebrates including lizards are captured by predators. For this reason, plasticine models of prey animals are used increasingly for estimating predation, since the soft material preserves beak or tooth marks left behind by predators (Bateman et al., 2017). Using this indirect method, the daily survival rate of models, and through that predation pressure, can be estimated.

Starting out from the assumption that melanic common wall lizards disappear by selective predation, and habitat features (firstly, background color) can have important role in this process, our aims have been: a) to study the survival probabilities of cryptic and melanic plasticine common wall lizard models in habitats with different background coloration, b) to find out whether predators are different in respect of cryptic vs. melanic models, and c) to find out whether predators show preference for any of the body parts of prey models.

MATERIAL AND METHODS

As locations of our investigations, we selected places near the city of Pécs (southern part of Hungary) which are not far from where melanic common wall lizards had been observed earlier (Fig. 1). The study was carried out in rural areas on the southern slopes of Mecsek Mts., 200 – 250 m a.s.l., 7.3 and 5.5 km to the west, and 4 km to the north from the center of the city of Pécs. The three

locations were different in their substrate and background color (Fig. 1). We assumed that brown color of sandstone substrate provide better camouflage for cryptic form while black color of substrate in open-pit coal mine is favorable for melanic individuals. On the gray background of the concrete wall possibility of camouflage is less for both forms. For our study we used non-toxic natural color plasticine (KOH-I-NOOR Hardtmuth, Czech Republic) lizard models whose body size were similar to those of adult common wall lizards (15 ± 1 cm). Half of the plasticine models ($n = 60$) were painted uniformly in brown color like the cryptic form based on the color of lizards in the study area, and the other half of lizards ($n = 60$) were painted in black like the melanic form, using tempera (Pannoncolor, Hungary). Then all models were coated with uncolored liquid rubber spray (PlastiDip, USA) and were aired for two weeks in order to eliminate the scent of plasticine and paint to reduce impacts of these factors on our study (Purger et al., 2012, 2017). This was necessary so that the effect of nocturnal predators searching for prey at night is expected to be less influential on the survival of the models representing diurnal lizards.

In all three locations differing in their substrate qualities (stone, concrete, coal) a transect of 20 cryptic and 20 melanic plasticine common wall lizards was laid out, with the individual models placed in a random pattern 10 m apart from each other, which is considered to be a moderate density in the area (Trócsányi and Korsós, 2004; Trócsányi et al., 2007; Purger et al., 2017). The lizard models were placed in an open area and were fully visible for avian predators (Pérez-Mellado et al., 2014). Plasticine models were laid out on 29th September 2016, and were then checked every six days from 8:00 to 11:00 a.m. (on 5th, 11th, 17th, 24th, 28th October and 4th, 10th, 16th November). Common wall lizard models that were found during checking to have been preyed were photographed and collected (and were not substituted with replacement models), and on the last checking day we gathered the remaining models. A common wall lizard model was considered as being attacked by a predator when bill marks of birds, tooth marks of mammals were found, or if it had disappeared (e.g., Castilla et al., 1999; Diego-Rasilla, 2003a, 2003b). We recorded which body part of the common wall lizard models (head, trunk, limbs or tail) had been damaged (Vervust et al., 2011). Based on the marks on plasticine models, mammal predators were identified by the help of our collection of mammal skulls (Purger et al., 2017). Predation rates on cryptic and melanic common wall lizard models were calculated as percentage of damaged (predated) models (Purger et al., 2017). The probability that a lizard model survives a single day was estimated using the Mayfield (1975) method. For the comparison of daily survival

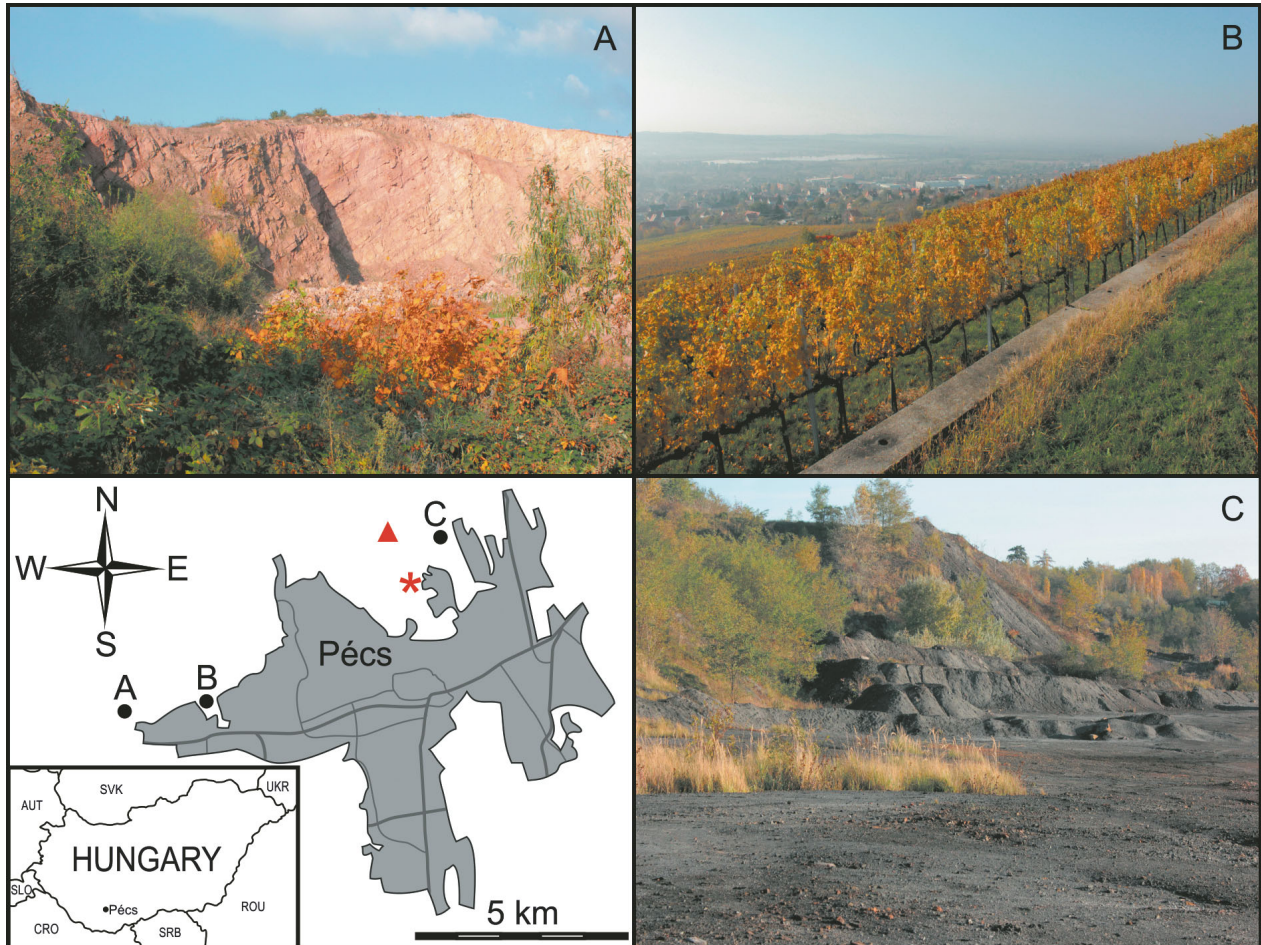


Fig. 1. Study locations in the outskirts of Pécs, a city in southern Hungary: A, periodically operated sandstone quarry; B, stone wall with concrete coping in a vineyard; C, abandoned open-pit coal mine. Locations of melanic common wall lizards (*Podarcis muralis*) found in 1998 (Dömörkapu) (Trócsányi and Korsós, 2004) and in 2016 (Kantavár) (B. Trócsányi, unpubl. data) are indicated by a red asterisk (*) and a red triangle (▲), respectively.

rates the test proposed by Johnson (1979) was applied, calculating with the free software “J-test” developed by K. Halupka (2009). For comparing the proportions of predation causes and number of attacks on different body parts, chi-square goodness of fit for two and four categories were used (Zar, 1999). A minimum tail probability level of $P < 0.05$ was accepted for all the statistical tests, and all P -values were two-tailed.

RESULTS AND DISCUSSION

During one and a half month, a total of 18 (30%) of cryptic plasticine common wall lizard models and 26 (43%) of the melanic ones were predated in the three study locations. The difference was not significant ($\chi^2 = 1.11$, $df = 1$, $P = 0.708$), thus the hypothesis that me-

lanic common wall lizards are affected by selective predation can be rejected. Moreover, the daily survival rates of melanic common wall lizard models were somewhat higher in all three locations than those of the cryptic ones, but these differences were not significant either, in any of the cases (Table 1). The apparent success of melanic common wall lizard models is due to the fact that the method for estimating daily survival rates takes exposition time into account (Mayfield, 1975). Predation events on melanic common wall lizard models happened somewhat later in time (they stayed intact for longer — more success days), than in cryptic common wall lizards. With plasticine models placed in several different habitats Castilla et al. (1999) measured different predation rates (20 – 60%), but predators were not found to differentiate between plasticine lizard models with different tail color-

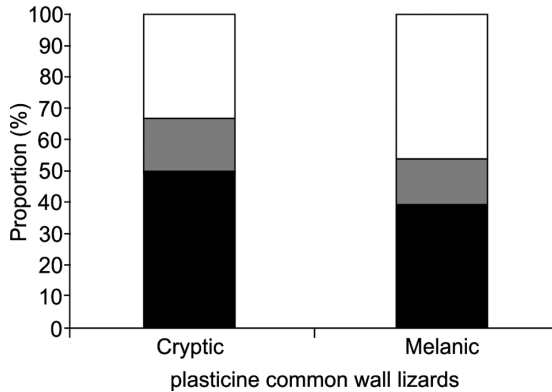


Fig. 2. Distribution of predation events on cryptic vs. melanic plasticine common wall lizards in the outskirts of city Pécs (Hungary). Marks by different predators: black bars, gnawing by mammals; gray bars, pecking by birds; white bars, model taken away.

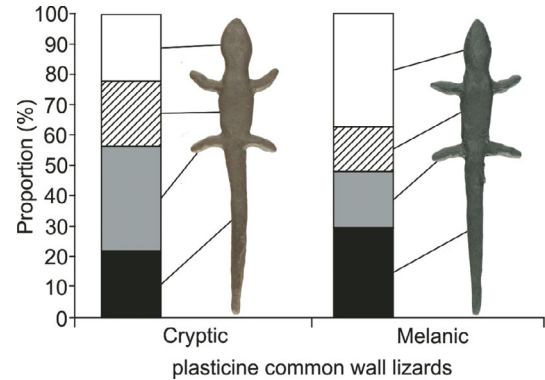


Fig. 3. Proportion of attacks on various body parts of cryptic and melanic plasticine common wall lizards (black bars, tail; gray bars, limbs; striped bars, trunk; white bars, head) in the outskirts of city Pécs (Hungary).

ation. Here too, difference in predation rates can suggest that different habitats have different predator communities, and the activities of particular predators can also have different effects. Similarly, according to Capula et al. (2009) frequencies of wall lizards with broken/regenerated tails did not differ significantly among two color morphs within each studied habitat type. Working with plasticine dart frog models including two cryptic (brown coloured familiar, and black coloured novel) forms similarly to our study Stuart et al. (2012) found that absolute predation rates did not differ among color forms. Natural selection is widely noted to drive divergence of phenotypic traits. Predation pressure can facilitate morphological divergence, for example the evolution of both cryptic and conspicuous coloration in animals (Dreher et al., 2015). Using models has a number of advantages (the true living organisms are not jeopardized, the models can be used at any time, in numbers and layout patterns of our choice, etc.) but there are also drawbacks (e.g., the models do not show fleeing behavior), and these models do not provide an estimation of natural predation rates but they represent an estimate of relative measures of predation across treatments (González-Gomez et al., 2006). Similar results

were obtained in all three locations, and the high daily survival rates suggest that potential common wall lizard predators in the three sampling locations outside the city of Pécs are either rare or less active, or, maybe not perceiving the models as prey and then not interested.

Imprints left on plasticine common wall lizard models included larger mammalian tooth marks, bird beak and claw marks in the case of 12 cryptic and 14 melanic plasticine common wall lizards (Fig. 2). Marks left behind by mammalian predators (martens, foxes, one badger, and one wild boar) had higher percentage (73%) in the predation of both cryptic ($n = 9$) and melanic ($n = 10$) plasticine common wall lizards than avian predators (27%) ($n = 3$, $n = 4$). The study have shown that the survival probability of plasticine common wall lizard models were not significantly influenced by their color. This may partly be due to the fact that the majority of marks preserved on the plasticine were left behind the teeth of mammalian predators, whereas predators normally attacking wall lizards are birds (e.g., Costantini et al., 2010) or snakes (e.g., Rugiero et al., 1995). Medium-sized or large mammals only rarely hunt for lizards (e.g., Lanszki, 2012). In our study predation events were

TABLE 1. Comparison of daily survival rates (DSR) of cryptic and melanic plasticine common wall lizards on three substrate types

ST	Cryptic plasticine common wall lizards				Melanic plasticine common wall lizards				Z	P
	SD	F	DSR, %	±SE	SD	F	DSR, %	±SE		
A	129	5	96.24	1.637	237	9	96.34	1.197	0.036	0.971
B	66	4	94.29	2.774	105	5	95.45	1.986	0.343	0.732
C	159	9	94.64	1.737	288	12	96.00	1.131	0.655	0.513
Σ	354	18	95.16	1.113	630	26	96.04	0.762	0.649	0.516

Note. ST, substrate types; A, stone; B, concrete; C, coal; SD, success days; F, failure.

caused by such predators and explanation for this could be the fact that the beech marten (*Martes foina*) and the fox (*Vulpes vulpes*) are common in the central parts of the city of Pécs, just like the pine marten (*Martes martes*), the badger (*Meles meles*) and the wild boar (*Sus scrofa*) in the outskirts (our observations). Lizard consumption by martens and foxes is facultative (Lanszki et al., 2019), and is even less typical in the other mentioned mammal species (Lanszki, 2012). Common wall lizards are diurnal, thus it is not expected to becoming prey to mostly nocturnal predators as martens, foxes, badgers or wild boars. This is exactly why we used scentless plasticine, so that nocturnal mammals searching for prey by their smell would not distort the results of our experiment. Certain bird species occurring in the study area such as the buzzard (*Buteo buteo*), the kestrel (*Falco tinnunculus*), the hooded crow (*Corvus cornix*), and the jay (*Garrulus glandarius*) can mean a threat to lizards, but our experiments using plasticine lizard models could not identify either of these potential predators.

The location of marks ($n = 50$) left behind on the bodies of cryptic and melanic common wall lizard models did not suggest preference for any regions or parts of the body ($\chi^2 = 2.861$, $df = 3$, $P = 0.414$) (Fig. 3). Plasticine model animals are stationary, allowing any predator to attack multiple times and possibly leaving marks on several parts of the prey animal's body. This is why the number of marks preserved on various body regions is nearly twice as much ($n = 50$) as the number of confirmed predation events ($n = 26$). Working with plasticine models Castilla et al. (1999) reported that damage to the heads of brown models were more frequent, but this was a tendency only, and no significant difference was found. Our earlier studies showed a similar tendency in one of the study locations (walls of the vineyard), but we were not able to detect a statistically proven preference (Purger et al., 2017). Plasticine animal models placed on the ground are more likely to be found by mammals with a good sense of smell than birds (e.g., Salvidio et al., 2017), so their color is less important.

Our experiments with plasticine common wall lizard models have shown that their color did not influence the degree of predation. The high daily survival rates in all three locations suggest that the survival chances of common wall lizards actually living there are probably even higher, because large mammals whose tooth marks were left behind on the majority of the plasticine models do not mean serious threat to the real lizards. Predation by birds was negligible, and not a single case of predation by snakes was recorded. The rare occurrence of melanic common wall lizards in habitats near the city of Pécs seems not due to predatory selection pressure. We pre-

sume that it is result of genetic background, but further studies are needed to prove it.

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REFERENCES

- Bateman P. W., Fleming P. A., and Wolfe A. K. (2017), "A different kind of ecological modeling: the use of clay model organisms to explore predator-prey interactions in vertebrates," *J. Zool.*, **301**(4), 251 – 262.
- Broennimann O., Ursenbacher S., Meyer A., Golay P., Monney J.-C., Schmocker H., Guisan A., and Dubey S. (2014), "Influence of climate on the presence of colour polymorphism in two montane reptile species," *Biol. Lett.*, **10**, 20140638.
- Capula M., Rugiero L., and Luiselli L. (2009), "Ecological correlates of colour pattern polymorphism along the transition zone between two morphs of the common wall lizard, *Podarcis muralis*," *Ital. J. Zool.*, **76**(4), 376 – 380.
- Castella B., Golay J., Monney J. C., Golay P., Mebert K., and Dubey S. (2013), "Melanism, body condition and elevational distribution in the asp viper," *J. Zool.*, **290**(4), 273 – 280.
- Castilla A. M., Gosá A., Galán P., and Pérez-Mellado V. (1999), "Green tails in lizards of the genus *Podarcis*: Do they influence the intensity of predation?," *Herpetologica*, **55**(4), 530 – 537.
- Clusella Trullas S., van Wyk J. H., and Spotila J. R. (2007), "Thermal melanism in ectotherms," *J. Therm. Biol.*, **32**(5), 235 – 245.
- Costantini D. and Dell'Omo G. (2010), "Sex specific predation on two lizard species by Kestrels," *Russ. J. Ecol.*, **41**(4), 99 – 101.
- Diego-Rasilla F. J. (2003a), "Influence of predation pressure on the escape behavior of *Podarcis muralis* lizards," *Behav. Process.*, **63**(1), 1 – 7.
- Diego-Rasilla F. J. (2003b), "Human influence on the tameness of wall lizard, *Podarcis muralis*," *Ital. J. Zool.*, **70**(3), 225 – 228.
- Dreher C. E., Cummings M. E., and Pröhl H. (2015), "An analysis of predator selection to affect aposematic coloration in a poison frog species," *PLoS ONE*, **10**(6), e0130571.
- González-Gomez P. L., Estades C. F., and Simonetti J. A. (2006), "Strengthened insectivory in a temperate fragmented forest," *Oecologia*, **148**(1), 137 – 143.
- Halupka K. (2009), *J-test — to Compare Two Mayfield's Estimators of Daily Survival Rates*, <http://zeb.uni.wroc.pl/halupka>
- Johnson D. H. (1979), "Estimating nest success: the Mayfield method and an alternative," *Auk*, **96**(4), 651 – 661.

- Karpestam E., Merilait S., and Forsman A. (2012), “Reduced predation risk for melanistic pygmy grasshoppers in post-fire environments,” *Ecol. Evol.*, **2**(9), 2204 – 2212.
- Lanszki J. (2012), “Trophic relations of carnivores living in Hungary,” *Nat. Somogy.*, **21**, 1 – 310.
- Lanszki Z., Purger J. J., Bocz R., Szép D., and Lanszki J. (2019), “The stone marten and the red fox consumed predominantly fruits all year round,” *Acta. Zool. Acad. Sci. Hung.*, **65**(1), 45 – 62.
- Marshall K. L. A., Philpot K. E., and Stevens M. (2017), “Microhabitat choice in island lizards enhances camouflage against avian predators,” *Sci. Rep.*, **6**, 19815.
- Mayfield H. F. (1975), “Suggestions for calculating nest success,” *Wilson. Bull.*, **87**(1), 456 – 466.
- Pérez-Mellado V., Garrido M., Ortega Z., Pérez-Cembranos A., and Mencía A. (2014), “The yellow-legged gull as a predator of lizards in Balearic Islands,” *Amphibia-Reptilia*, **35**(2), 207 – 213.
- Puky M., Schád P., and Szövényi G. (2005), *Herpetological Atlas of Hungary*, Varangy Akciócsoport Egyesület, Budapest.
- Purger J. J., Kurucz K., Tóth A., and Batáry P. (2012), “Coating plasticine eggs can eliminate the overestimation of predation on artificial ground nests,” *Bird Study*, **59**(3), 350 – 352.
- Purger J. J., Lanszki Z., Szép D., and Bocz R. (2017), “Predation of common wall lizards: experiences from a study using scentless plasticine lizards,” *Acta Herpetol.*, **12**(2), 73 – 78.
- Quicke D. L. J. (2017), *Mimicry, Crypsis, Masquerade and other Adaptive Resemblances*, John Wiley & Sons Ltd., Chichester.
- Rangen S. A., Clarc R. G., and Hobson K. A. (2000), “Visual and olfactory attributes of artificial nests,” *Auk*, **117**(1), 136 – 146.
- Reguera S., Zamora-Camacho F. J., and Moreno-Rueda G. (2014), “The lizard *Psammodromus algirus* (Squamata: Lacertidae) is darker at high altitudes,” *Biol. J. Linn. Soc.*, **112**(1), 132 – 141.
- Rugiero L., Capula M., Filippi E., and Luiselli L. (1995), “Food habits of the Mediterranean populations of the smooth snake (*Coronella austriaca*),” *Herpetol. J.*, **5**(4), 316 – 318.
- Salvidio S., Palumbi G., Romano A., and Costa A. (2017), “Safe caves and dangerous forests? Predation risk may contribute to salamander colonization of subterranean habitats,” *Sci. Nat.*, **104**(3 – 4), 20.
- Sherratt T. N. (2011), “The optimal sampling strategy for unfamiliar prey,” *Evolution*, **65**(7), 2014 – 2025.
- Stuart Y. E., Dappen N., and Losin N. (2012), “Inferring predator behavior from attack rates on prey-replicas that differ in consciousness,” *PLoS ONE*, **7**(10), e48497.
- Trócsányi B. and Korsós Z. (2004), “Recurring melanism in a population of the common wall lizard: numbers and phenotypes,” *Salamandra*, **40**(1), 81 – 90.
- Trócsányi B., Schäffer D., and Korsós Z. (2007), “A review of the amphibian and reptile fauna of Mecsek Mountains, with new herpetofaunistic data (SW Hungary),” *Acta Nat. Pannon.*, **2**, 189 – 206.
- Vervust B., Van Loy H., and Van Damme R. (2011), “Seeing through the lizard’s trick: do avian predators avoid autotomous tails?” *Cent. Eur. J. Biol.*, **6**(2), 293 – 299.
- Zar J. H. (1999), *Biostatistical Analysis. 4th Edition*, Prentice Hall, Upper Saddle River.