







## Research article

## Winter activity of the snake-eyed lizard *Ophisops elegans* (Reptilia: Lacertidae) in the northwesternmost part of its range

Georgi Krastev<sup>1</sup>, Emiliya Vacheva<sup>2</sup>, Borislav Naumov<sup>3</sup>

- (1) [Corresponding author] Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 2 Gagarin Street, 1113 Sofia, Bulgaria, [georgikrastevherp@gmail.com](mailto:georgikrastevherp@gmail.com) ; <https://orcid.org/0000-0003-0184-761X> 
- (2) Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 2 Gagarin Street, 1113 Sofia, Bulgaria, [emilia.vacheva@gmail.com](mailto:emilia.vacheva@gmail.com) ; <https://orcid.org/0000-0002-3008-6648> 
- (3) Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 2 Gagarin Street, 1113 Sofia, Bulgaria, [herpetologybg@gmail.com](mailto:herpetologybg@gmail.com) ; <https://orcid.org/0000-0003-2146-208X> 

**Abstract:** There is a lack of information for potential winter activity of the snake-eyed lizard *Ophisops elegans* in Europe, where it has a limited distribution. To test the hypothesis that this species can be active during the winter months, two locations in Bulgaria were chosen. The visits were conducted in January, February and December 2022 near the village of Meden Buk and in December 2022 above the village of Mezek. A total of 19 individuals of *O. elegans* were recorded. In addition, we confirmed foraging behaviour based on faecal sample collection. To our knowledge, this is the northernmost record of winter activity in the snake-eyed lizard and the first consecutive observation of year-round activity for this species in Europe.

**Keywords:** Balkan Peninsula, hibernation, phenology, Sauria

Winter activity in lacertid lizards in temperate zones across Europe is rarely observed. In this area lizards normally are induced to hibernate during winter and show great ability to survive low temperatures (Grenot et al., 2022). In lowlands (up to 500 m a.s.l.) lizards usually hibernate between mid-October to early April, while at higher altitude this period may be prolonged from September to May (Stojanov et al., 2011; Zamora-Camacho et al., 2013) and some species may be active in hot days during this period or can escape earlier from hibernacula (Rugiero, 1995; Vongrej et al., 2008; Piccoli & De Lorenzis, 2018). These assumptions are general for all lacertids in Europe, but indeed there is lack of information for some species, like the snake-eyed lizard *Ophisops elegans* Ménétries, 1832.

The genus *Ophisops* Ménétries, 1832 includes at least eleven species, distributed across Southeast Europe, North Africa, the Middle East, and the Indian subcontinent including Sri Lanka (Bozkurt et al., 2022; Uetz et al., 2022). *Ophisops elegans* is the only

European representative of the genus. It occurs from Algeria across North Africa, Asia Minor and Iran to West Pakistan, as well as in Southeast Europe (north-eastern Greece, south-eastern Bulgaria, the islands along the Aegean coast, European Turkey and partially in the Caucasus region) (Ananjeva et al., 2006; Stojanov et al., 2011). In Bulgaria, the species has very limited distribution assigned to the easternmost part of the Rhodopes Mts up to 650 m a.s.l. (Tzankov, 2004, 2015). This area also represents the most north-western part of the species range in general. Here, *O. elegans* inhabits extremely dry and warm habitats with bare ground, stones and scarce xerophytic vegetation, rare shrubs (*Juniperus* sp.) and scattered wood (Beshkov & Nanev, 2006; Stojanov et al., 2011).

For the purpose of this study (testing the hypothesis that *Ophisops elegans* exhibits activity during the winter months) we choose two sites in Bulgaria where the presence of the species was previously known: (1) the area of Meden Buk Village (N 41.3805°, E





Fig. 1. A general view of the habitat at the area of Meden Buk Village from February 2022.



Fig. 2. A general view of the habitat at the area above Mezek Village from December 2022.

26.0230°, 120–200 m a.s.l.) – a south-southwest facing slope covered with rocks, stones and scarce vegetation, mainly *Juniperus* shrubs (Fig. 1); (2) the area above Mezek Village (N 41.7183°, E 26.0636°, 460–520 m

a.s.l.) – an area near abandoned frontier post on a south-southeast ridge of the hill, containing dry and open area with scarce vegetation surrounded with xerophytic oak forest and scarp near a dirt road (Fig. 2).



Winter activity of the snake-eyed lizard *Ophisops elegans* in the northwesternmost part of its range

Table 1. Data and time of the observation of winter activity in *Ophisops elegans* in the two sites. Age, sex and snout-vent length (SVL) for each specimen were recorded, as well as temperatures and weather (TB, TA, and TS refer respectively to body, air, and substrate temperature in °C).

Date	Time	Locality	Age & sex	SVL	TB	TA	TS	Weather
January 3	13:00	Meden Buk	ad. M	n/a	n/a	18.9	21.1	Sunny
February 19	11:47	Meden Buk	subad. M	40	31.1	19.4	20.4	Sunny
February 19	13:10	Meden Buk	ad. F	51	34.3	20.7	16.2	Sunny
February 19	13:52	Meden Buk	ad. M	42	29.8	20.2	n/a	Sunny
February 19	14:38	Meden Buk	ad. M	48	31.7	21.4	n/a	Sunny
February 19	15:04	Meden Buk	ad. M	42	28.4	19.2	n/a	Sunny
February 19	16:06	Meden Buk	ad. M	47	27.1	16.9	21.3	Sunny
February 20	11:59	Meden Buk	subad. M	40	22.8	16.9	26.2	Sunny
February 20	13:11	Meden Buk	subad. M	36	24.5	24.6	21.1	Sunny
February 20	13:51	Meden Buk	subad. F	40	26.5	21.6	25.5	Sunny
February 20	14:49	Meden Buk	ad. M	51	23.0	18.7	21.4	Sunny
February 20	15:10	Meden Buk	ad. F	42	20.6	17.8	20.6	Sunny
December 29	13:03	Meden Buk	ad. F	42	23.3	16.5	21.8	Sunny
December 29	13:16	Meden Buk	ad. F	47	26.1	15.4	25.9	Sunny
December 29	13:21	Meden Buk	ad. undet.	n/a	n/a	n/a	n/a	Sunny
December 29	13:26	Meden Buk	ad. M	n/a	n/a	n/a	n/a	Sunny
December 29	14:35	Meden Buk	ad. F	n/a	23.3	16.0	19.6	Sunny
December 30	13:34	Mezek	ad. M	43	29.1	19.0	26.3	Sunny
December 30	13:40	Mezek	ad. F	52	29.6	16.2	24.3	Sunny

The first site was visited three times (January, February and December 2022), and the second – only in December 2022. Individual visits lasted two days, taking into account the following factors: body, air and substrate temperatures (using a digital thermometer with probe – Multi Thermometer, Möller-Therm, with 1.0°C precision) and snout–vent length (SVL) of caught individuals; in several cases, faecal samples were also collected (preserved in ethanol and examined later under a stereomicroscope; for a more detailed description of the methodology see Vacheva & Naumov, 2020).

As a result of the conducted research, a total of 19 *Ophisops elegans* (8 males, 6 females, 1 indeterminate adult and 4 subadults) were recorded, respectively 1 in

January, 11 in February and 7 in December (Table 1; Fig. 3). The body temperature of the captured lizards varied between 20.6 and 34.3°C, and the temperature of the air and substrate (at the place and time of registration of each individual) – between 15.4 and 24.6°C and 16.2 and 26.3°C, respectively. All individuals were registered in the afternoon, between 11:30 and 16:00 h. No other reptile species were observed, with the exception of one juvenile *Lacerta viridis* (Laurenti, 1768), spotted on January 3 at the site of Meden Buk. The analysis of the contents of the collected fecal samples (from 5 individuals from February and 1 from December) showed the presence of remains from the following invertebrate groups: order Araneae (in 5 individuals), order Opiliones (in 1

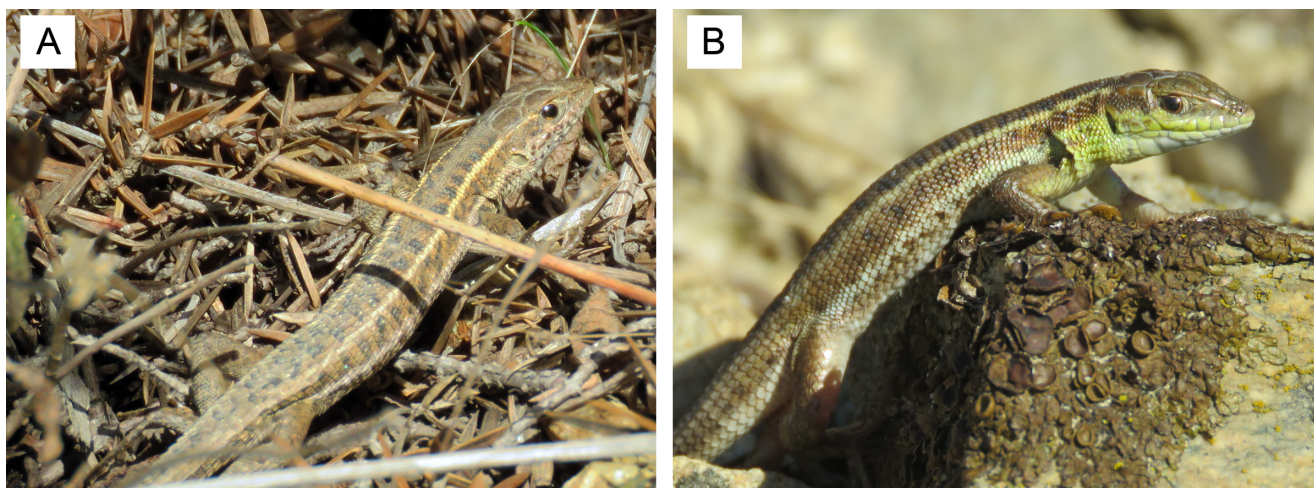


Fig. 3. Two of the observed *O. elegans*: A – adult male (3.01.2022); B – adult female (19.02.2022).

individual), order Diptera (in 1 individual), and order Hemiptera (in 2 individuals).

Our results provide strong evidence of regular activity in all winter months, as well as for foraging during winter. At least half of the captured specimens in February were fed, as well as one captured in December. This finding shows that the Snake-eyed lizards not incidentally emerge from hibernation during hot and sunny winter days, but they continue with their activities such as feeding. A similar type of activity seems to have been proven only for the İzmir Region (the Aegean Coast of Asia Minor, ca. 350 km south of Bulgarian localities), where according to Öktem (1963) it is possible to find *O. elegans* all the year round, except on rainy or cold days when the temperature is generally below 5°C. For other parts of the range however (e.g., Central Anatolia and Armenia), the species is known to hibernate from November to March (Darewskij & Beutler, 1981 and references therein). There are a number of occasional observations on the winter activity of *O. elegans* in the more southern parts of its range (e.g. Franzen, 1986 for the southern coast of Asia Minor). Among them, the data given by Özgül et al. (2022) are the most interesting, since the observations of *O. elegans* from the Bozcaada Island are of the same dates (February 19–20, 2022) as ours from Meden Buk (ca. 170 km north of the island), and the comparison shows a similar number of observed individuals in a similar time interval: 16 individuals in Bozcaada (between 11:00 and 16:00) vs. 11 individuals in Meden Buk (between 11:00 and 16:00).

For some other lacertid species in the temperate zone, winter activity was also documented, e.g.: *Podarcis muralis* (Laurenti, 1768) (Italy: Rugiero, 1995, Piccoli & De Lorenzis, 2018; Bulgaria: authors' personal data), *Darevskia* spp. (Turkey: Franzen, 2000), *Lacerta viridis* (Slovakia: Vongrej et al., 2008), *Anatololacerta danfordi* (Günther, 1876) (Turkey: Özkan & Bülbül, 2021), etc. Most of these data represent observations only of individuals going outside during warm and sunny days (i.e., basking), while other types of behaviour, such as feeding or breeding, have been observed rarely (e.g., Sahin, 2021). It should be noted that despite the relatively large number of lacertid species that are generally found in the sites we studied (Meden Buk: 4 species according to personal observations; Mezek: 6 species according to Tzankov, 2004), during the winter months of 2022, apart from *O. elegans*, it was only one specimen of another species observed (a juvenile *L. viridis*). In all probability, this is due to a significant difference in the temperature requirements of *O. elegans* compared to the other lacertids in Bulgaria.

In conclusion, it can be stated that in the temperate zone (in the sense of geographical region defined by latitude), *Ophisops elegans* seems to be active all year round, even in the northernmost parts of its range, as long as they are at low altitude. It is possible that this is only a consequence of more intensive and targeted research (as it is for the Eastern Rhodopes Mts), but in our opinion, it is also possible that the manifestation of year-round activity is a relatively recent phenomenon, reflecting the impact of global warming on *O. elegans*.



Further research with a larger geographic scope is needed to clarify this question.

## Acknowledgements

This study was partially supported by the National Science Fund of Bulgaria under Grant contract No. KP-06-M61/4 from 13.12.2022. Handling of animals was carried out in accordance with the Ministry of Environment and Water of Bulgaria's Permit No. 861/13.01.2021.

## References

- Ananjeva N., Orlov N., Khalikov R., Darevsky I., Ryabov S., Barabanov A. 2006 The Reptiles of Northern Eurasia. Taxonomic Diversity, Distribution, Conservation Status. Pensoft Publishers, Sofia, 245 pp.
- Beshkov V., Nanev K. 2006 Amphibians and Reptiles in Bulgaria. Pensoft Publishers, Sofia–Moscow, 120 pp.
- Bozkurt E., Korkmaz E.M., Ilgaz C., Yilmaz C., Üzümlü N., Avci A., Doğan O., Budak M. 2022 Molecular and morphological assessment of the snake-eyed lizard, *Ophisops elegans* Menetries, 1832 (Sauria, Lacertidae) in Anatolia. *Biharean Biologist* 16: 98–112.
- Darewskij I., Beutler A. 1981 *Ophisops elegans* Ménétries 1832 – Schlangenaue. In: Böhme W. (Hrsg.) *Handbuch der Reptilien und Amphibien Europas*. Band 1. Echsen (Sauria) I. Aula Verlag, Wiesbaden, pp. 461–477.
- Franzen M. 1986 Zur Winterlichen Aktivität Einiger Echsen in der Südlichen Türkei. *Herpetofauna* 8 (45): 6–10.
- Franzen M. 2000 Winteraktivität von *Darevskia*-Arten in der Nordost-Türkei. *Die Eidechse*, 11 (3): 77–81.
- Grenot C.J., Garcin L., Dao J., Hérold J.-P., Fahys B., Tséré-Pages H. 2000 How does the European common lizard, *Lacerta vivipara*, survive the cold of winter? *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology* 127: 71–80.
- Öktem N. 1963 Investigations on the Subspecific Division of *Ophisops elegans* Ménétries in Turkey and its Biology in Izmir Region. *Scientific Reports of the Faculty of Science, Ege University*, 14: 1–47.
- Özgül C.N., Kurtul D., Gül C., Tosunoglu M. 2022 Unusual Winter Activity of Some Amphibian and Reptile Species Living in Bozcaada (Çanakkale, Türkiye). *Journal of Anatolian Environmental and Animal Sciences* 7 (3): 244–250. <https://doi.org/10.35229/jaes.1123314>
- Özkan H., Bülbül U. 2021 The Winter Activity of the Endemic Lizard Species, *Anatololacerta danfordi* (Günther, 1876). *Journal of the Institute of Science and Technology* 11 (1): 99–105. <https://doi.org/10.21597/jist.775094>
- Piccoli A.P., De Lorenzis A. 2018 Seasonal Phenology of Reptiles in a Mediterranean Environment (“Castel di Guido” Natural Park, Northern Latium, Italy). *International Journal of Environment, Agriculture and Biotechnology* 3 (4): 1340–1347. <https://doi.org/10.22161/ijeab/3.4.27>
- Rugiero L. 1995 Winter activity of a common wall lizard (*Podarcis muralis*) population in Central Italy. *Russian Journal of Herpetology* 2 (2): 148–152.
- Sahin M.K. 2021 Unusual mating behavior of *Apathya cappadocica* in the winter season from southeastern Anatolia. *Scientific Reports in Life Sciences* 2 (2): 49–53. <https://doi.org/10.22034/srls.2021.525110.1012>
- Speybroeck J., Beukema W., Bok B., Van Der Voort J. 2016 *Field guide to the Amphibians and Reptiles of Britain and Europe*. Bloomsbury Publishing Plc, London, 432 pp.
- Stojanov A., Tzankov N., Naumov B. 2011 *Die Amphibien und Reptilien Bulgariens*. Chimaira, Frankfurt am Main, pp. 366–371.
- Tzankov N. 2004 Sympatric distribution of six lacertid lizards. *Annuaire de l'Université de Sofia “St. Kliment Ohridski”* 96 (4): 235–242.
- Tzankov N. 2015 Snake-eyed Lizard *Ophisops elegans* (Ménétries, 1832) ssp. *macroductylus* Berthold, 1932. In: Golemanski V. et al. (eds) *Red Data Book of the Republic of Bulgaria*. Volume 2. Animals. IBEI – BAS & MOEW, Sofia, p. 297.
- Uetz P., Freed P., Reyes F., Hošek J. 2022 *The Reptile Database*. <http://www.reptile-database.org> (accessed: 26 January 2023)
- Vacheva E., Naumov B. 2020 Diet of the Viviparous lizard *Zootoca vivipara* (Lichtenstein, 1823) (Reptilia: Lacertidae) from its southern range.

North-Western Journal of Zoology 16 (2): 178–190.

<https://doi.org/10.3897/aca.2.e46484> 

Vongrej V., Smolinsky R., Bulánková E., Jandzik D. 2008 Extraordinary winter activity of the Green Lizard *Lacerta viridis* (Laurenti, 1768) in southwestern Slovakia. Herpetozoa 20 (3/4): 173.

Zamora-Camacho F.J., Reguera S., Moreno-Rueda G., Pleguezuelos J.M. 2013 Patterns of seasonal activity in a Mediterranean lizard along a two thousand and two hundred meters altitudinal gradient. Journal of Thermal Biology 38 (2): 64–69.

<https://doi.org/10.1016/j.jtherbio.2012.11.002> 

---