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SHORT NOTE

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Aggregation and movements of male ocellated lizards *Timon lepidus* during hibernation in mainland France observed with an endoscope

GREGORY DESO* & ALOYS CROUZET

AHPAM - Association Herpétologique de Provence Alpes Méditerranée, Maison des Associations, 384 route de Caderousse, 84100 Orange, France

*Corresponding author e-mail: ahpam.contact@gmail.com

INTRODUCTION

Due to environmental constraints, winter aggregations of squamates otherwise considered solitary are becoming increasingly common worldwide (Gardner et al., 2015). Community aggregations in lizards are little known and probably underestimated (Gardner et al., 2015) although certain European species are known to aggregate for hibernation, for example *Agama stellio* (Loumbourdis, 1983), *Chalcides chalcides* (Capula et al., 2003), *Anguis fragilis* (Karch, 2022), and *Zootoca vivipara* (Hodges & Seabrook, 2022).

Ocellated lizards generally hibernate from November to March depending on temperature (Matéo, 2017) but for reptiles suitable hibernation sites are scarce in the wild (Whiting & Wile, 2017) and crucial for their survival (Bonnet et al., 2009). Ocellated lizards occupy a network of refuges both to avoid predation in the reptile active period and to act as a hibernacula (Tatin et al., 2013), but only two or three of these refuges are used regularly (Grillet et al., 2010). It would appear that in continental Europe the ocellated lizard is a territorial and solitary species (Vincente, 1989) but, in contrast, island populations have developed pronounced social behaviour due to environmental constraints. Consequently, in France, on the island of Oléron, communal refuges are known (Doré et al., 2015) and in Portugal, on the island of Berlenga, a communal hibernaculum has been reported (Paulo, 1988).

Given that suitable hibernation sites are essential for the survival of ocellated lizards, a knowledge of their physical characteristics and how they are used is crucial for effective conservation. We set out to characterise a hibernaculum in a small population of ocellated lizards in a Mediterranean almond grove. After the discovery and confirmation of the existence of a communal hibernaculum, we filmed the occupants during hibernation and made several associated temperature measurements. The research reported here was undertaken in the framework of the French PNA (National Action Plan) on the ecology of this threatened species (Thienpont, 2020).

MATERIALS & METHODS

Ocellated lizards are known to frequent old almond groves in the French Mediterranean region. In May 2016, a suitable population for our study was found in a former almond grove at the foot of the Luberon massif in the commune of Mérindol (43° 45’ N, 5° 15’ E, 166 m a.s.l.) (AHPAM, 2016; Thienpont, 2020) where, during the reptile active season, there was high occupancy of tree roosts by ocellated lizards (AHPAM, 2016). In order not to disturb resting animals, we searched for hibernacula in the middle of winter (from the beginning of January) when the animals were in ‘deep’ hibernation. We located a hibernaculum that was in the remains of an old tree stump, below ground level (Fig. 1A). This contained two males that could be differentiated by their morphology and colour pattern as well as by the presence of a patch (of undetermined origin) on the back of male #1 and the same on the head of male #2. In order to avoid contact and disturbance, we observed the lizards with an endoscope (Ancel WF100 equipped with a lamp and relayed by Wifi). This allowed us to view and film the two lizards in the hibernaculum with a mobile phone (Fig. 1B). We made ten insertions of the endoscope with the first on 4 January and the last on 6 February. The endoscope probe is semi-rigid, which allowed us to work around obstacles. In order to be able to record potential movements during the resting period, the hibernaculum was photographed and filmed each time the endoscope was inserted. On seven occasions, we collected temperature data from the hibernaculum by inserting the probe of a Thlevel Mini LCD digital thermometer (Fig. 1A) to depths of 15 cm and 37.5 cm; the latter depth was level with the resting lizards. We obtained data on air temperature outside the hibernaculum from a weather station (43° 45’08” N, 5° 11’34” E) that is 1.5 km from the site.

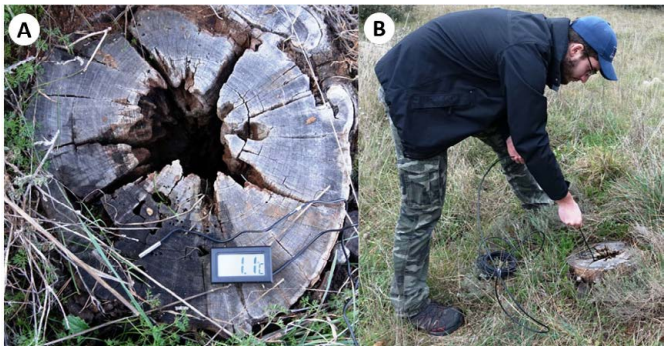

Figure 1. Old tree stump used as a hibernaculum by two male ocellated lizards - **A**. The tree stump and equipment used to measure temperatures within the hibernaculum (Thlevel Mini LCD digital thermometer), **B.** Insertion of the Ancel WF100 endoscope into the hibernaculum

Table 1. Temperatures (°C) at a depth of 15 cm and 37 cm (alongside the hibernating male ocellated lizards) within the hibernaculum and maximum and minimum external air temperatures from a local weather station

Date	Hibernaculum temperature		Air temperature	
	15 cm deep	37.5 cm deep	Maximum	Minimum
15/01/2022	2.3	3.2	11.7	-4.2
19/01/2022	4.3	3.7	9.9	-0.4
23/01/2022	1.1	3.1	12.1	-4.4
23/01/2022	4.5	4.2	12.4	-2.7
28/01/2022	2.8	3.4	12.8	-4.4
31/01/2022	6.4	4.5	12.8	-1.8
06/02/2022	7.3	6.4	13	0.4

RESULTS

The films and photographs taken during the insertion of the endoscope show the movements of the individuals throughout the hibernation period (BHS video, 2022). Although the hibernaculum provided sufficient space for the two lizards to sleep at a distance from each other, the males were lying one on top of the other. The sleeping position adopted by male #2 on male #1 shows an almost total overlap with its body lines following very closely those of the male below (Fig. 2). The overlap of male #1 on male #2 was brief and mainly observed in early January, male #1 remained under the slightly smaller male #2 for a longer period. During the coldest periods of the year, from 4 January to 6 February 2022 (Table 1), they swapped their top and bottom positions. On two occasions, the individual on top completely covered the one below, potentially insulating it from the cold exterior. While male #1 was observed to make only one movement during the coldest period, male #2 was awake on 4 January and thereafter had several repositioning movements including one filmed live on 23 January.

Even though the minimum air temperatures fell well below freezing during the study period, on all seven occasions when temperatures were measured by us within the hibernaculum they were well above freezing; the lowest observed temperature adjacent to the lizards was 3.1 °C (Table 1) and closer to the surface at a depth of 15 cm the lowest observed was 2.3 °C (Table 1). At the time of our observations, the temperatures at the two depths differed little as at 15 cm and

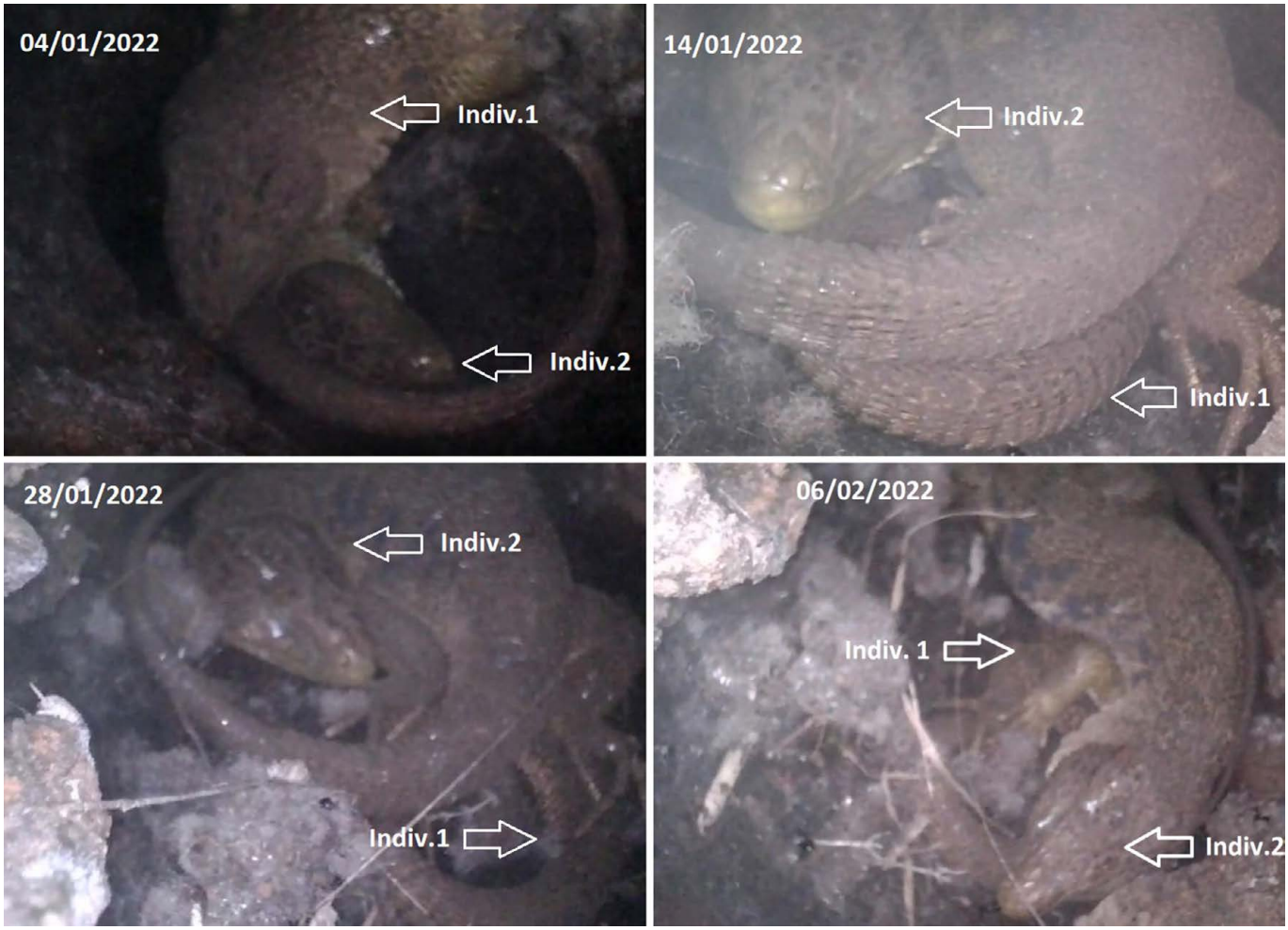

Figure 2. Two male ocellated lizards hibernating in a tree stump, below ground, observed and filmed using an endoscope and mobile phone. The four images demonstrate movements of the two lizards during hibernation

37.5 cm the mean (±sd) temperatures were 4.10±2.22 °C and 4.07±1.14 °C respectively.

DISCUSSION

Refuges must provide effective protection from predation but also from extreme thermal conditions (Mohanty, 2021). However, a refuge chosen as a hibernaculum should also have good exposure to sun light so that it will warm rapidly (Pringle et al., 2003; Webb et al., 2005). Such ideal hibernacula are a limited resource for ocellated lizards (Grillet et al., 2010) and furthermore they need to be clearly visible as these lizards search for them by sight (Tatin & Renet, 2016). Given that the occupancy rate of tree roosts by the lizards during the reptile active season was high (AHPAM, 2016), it can be inferred that there is likely considerable competition for the ground refuges that will serve as hibernacula. Such scarcity of suitable refuges is expected to lead to lizard aggregations at available hibernacula (Gregory, 1984). Sharing of overnight refugia between adult males of similar build is known in other European lacertids (Aubret et al., 2014) but also for hibernation (Hodges & Seabrook, 2022) and given that external air temperatures fell below 0 °C it is understandable that the lizards would choose to hibernate at considerable depth to avoid freezing. On the island of Oleron, an artificial hibernaculum located at 40 cm depth had very similar thermal conditions, with a minimum of 3.5 °C at the coldest time of the year (Grillet et al., 2008).

Once reptiles have taken up residence below ground for hibernation they may then move about within the hibernaculum as an adjustment to thermal conditions (Zuffi et al., 1999; Cobb & Peterson, 2008). The movements observed in this study confirm this mobility, which is interspersed with waking. The longer period of time spent by male #1 under the shelter of male #2 may indicate that male #1 may be the dominant individual. The position adopted by male #2, in which it is shielding individual #1 from cold air, potentially put it at a physical disadvantage. Nevertheless, there are a significant number of benefits conferred by an aggregation, including - a reduced risk of being located by a predator (Meddis, 1975; Shine et al., 2003; Bors et al., 2020), the prevention of heat loss (Boersma, 1982; Lanham, 2001; Aubret & Shine, 2009), and a reduction in water loss by evaporation (Lancaster et al., 2006). While aggregations increase the risk of parasitic cross-infection (Leu et al., 2010; Sih et al., 2018), the stability of squamate aggregations may increase immune control capabilities (Gardner et al., 2015).

REFERENCES

AHPAM (2016). Une population de lézards ocellé dans les amandiers du Lubéron. https://ahpam.fr/une-population-de-lezard-ocelle-dans-les-amandiers-du-luberon-84

Aubret, F. & Shine, R. (2009). Causes and consequences of aggregation by neonatal tiger snakes (*Notechis scutatus*, Elapidae). *Austral Ecology* 34: 210–217.

Aubret, F., Tort, M., Michniewicz, R.J., Blanvillain, G. & Coulon, A. (2014). Cooperate or compete? Influence of sex and body size on sheltering behaviour in the wall lizard, *Podarcis muralis*. *Behaviour* 151: 1903–1920.

BHS Video (2022). Aggregation and movements of male ocellated lizards *Timon lepidus* during hibernation in mainland France observed with an endoscope https://youtu.be/eJzK-FfDisg

Boersma, P.D. (1982). The benefits of sleeping aggregations in marine iguanas, *Amblyrhynchus cristatus*. In *Iguanas of the World: Their Behavior, Ecology, and Conservation*, 292–299 pp. Bughardt, G.M. & Rand, A.S. (Eds.). New Jersey: Noyes Publishing.

Bonnet, X., Brischoux, F., Pearson, D. & Rivalan, P. (2009). Beach-rock as a keystone habitat for sea kraits. *Environmental Conservation* 36: 62–70.

Bors, M., Mohanty, N.P. & Shankar, P.G. (2020). Anti-predatory sleep strategies are conserved in the agamid lizard *Monilesaurus rouxii*. *Behavioral Ecology and Sociobiology* 74: 121.

Capula, M., Filippi, E. & Luiselli, L. (2003). *Chalcides chalcides* (three-toed skink): communal hibernacula. *The Herpetological Bulletin* 83: 30–31.

Cobb, V.A. & Peterson, C.R. (2008). Thermal ecology of hibernation in a population of Great Basin rattlesnakes, *Crotalus oreganus lutosus*. In *The Biology of Rattlesnakes*, 291–302 pp. Hayes, W.K., Beaman, K.R., Cardwell, M.D & Bush. S.P. (Eds.). Loma Linda University Press, USA.

Doré, F., Grillet, P., Thirion, J.M., Besnard, A. & Cheylan, M. (2011). Implementation of a long-term monitoring program of the ocellated lizard (*Timon lepidus*) population on Oleron Island. *Amphibia-Reptilia* 32: 159-166.

Doré, F., Cheylan, M. & Grillet, P. (2015). Le lézard ocellé: un géant sur le continent européen. Mèze: Biotope éditions, 192 pp.

Gardner, M.G., Pearson, S.K., Johnston, G.R. & Schwarz, M.P. (2015). Group living in squamate reptiles: a review of evidence for stable aggregations. *Biological*. Review 91: 925–936. doi: 10.1111/brv.12201

Gregory, P.T. (1984). Communal denning in snakes. In Vertebrate Ecology and Systematics: *A Tribute to Henry S. Fitch. Lawrence, KS*. pp. 57–75. Seigel, R.A., Hunt, L.E., Knight, J.L., Malaret, L. & Zuschlag, N.L. (Eds.) The University of Kansas Museum of Natural History Special Publication N° 10.

Grillet, P., Doré, F., Thirion, J.M., Cheylan, M. & Dauge, C. (2008). Étude et suivi de la population de Lézard ocellé *Timon lepidus* sur l'île d'Oléron. *Rapport de l'Office National des Forêts région Poitou Charentes*. 99 pp.

Grillet, P., Cheylan, M., Thirion, J.M., Doré, F., Bonnet, X., Dauge, C., Chollet, S. & Marchand, M.A. (2010). Rabbit burrows or artificial refuges are a critical habitat component for the threatened lizard *Timon lepidus* (Sauria, Lacertidae). *Biodiversity and Conservation* 19(7): 2039–2051.

Hodges, R. & Seabrook, C. (2022). Hibernation cell construction by the viviparous lizard *Zootoca vivipara*. *The Herpetological Bulletin* 159: 41-43.

How, T.L. & Bull, C.M. (2002). Reunion vigour: an experimental test of the mate guarding hypothesis in the monogamous sleepy lizard (*Tiliqua rugosa*). *Journal of Zoology* 257: 333–338.

Karch, (2022). Centre de Coordination pour la Protection des

Amphibiens et Reptiles de Suisse. http://www.karch.ch/karch/home/reptilien/reptilienarten-der-schweiz.html Accessed on 11/02/2022.

Lancaster, J.R., Wilson, P. & Espinoza, R.E. (2006). Physiological benefits as precursors of sociality: why banded geckos band. *Animal Behaviour* 72: 199–207.

Lanham, E.J. (2001). Group-living in the Australian skink, *Egernia stokesii*. PhD Dissertation. Flinders University of South Australia, Australia. 250 pp.

Leu, S.T., Bashford, J., Kappeler, P.M. & Bull, C.M. (2010). Association networks reveal social organization in the sleepy lizard. *Animal Behaviour* 79: 217–225.

Loumbourdis, S.N. (1983). Hibernation of the lizard *Agama stellio* in northern Greece. *Israel Journal of Zoology* 33(3): 79–83.

Márquez-Rodríguez, J. (2014). La importancia de los refugios de *Timon lepidus* en los yacimientos arqueológicos. *Boletín de la Asociación Herpetológica Española*, 25: 85–87.

Mateo, J.A. (2004). Lagarto ocelado. *Timon lepidus* (Daudin, 1802). In *Enciclopedia virtual de los vertebrados españoles*. Carrascal, L.M. & Salvador, A. (Eds.). Museo Nacional de Ciencias Naturales, Madrid. http://www.vertebradosibericos.org

Mateo, J.A. (2017). Lagarto ocelado. *Timon lepidus*. In *Enciclopedia Virtual de los Vertebrados Españoles*. Salvador, A. & Marco, A. (Eds.). Museo Nacional de Ciencias Naturales, Madrid. http://www.vertebradosibericos.org

Meddis, R. (1975). On the function of sleep. *Animal Behaviour* 23: 676–691.

Mohanty, N.P., Wagener, C., Herrel, A. & Thaker, M. (2021). The ecology of sleep in non-avian reptiles. *Biological Review* (published online, https://doi.org/10.1111/brv.12808).

Paulo, O. (1988). Estudo eco-etologico da populaçao de *Lacerta lepida* (Daudin, 1802) da ihla de Berlenga. *Relatorio de estagio de licencatura en biologia*. FCUL. Lisboa.

Pringle, R.M., Webb, J.K. & Shine, R. (2003). Canopy structure, microclimate, and habitat selection by a nocturnal snake, *Hoplocephalus bungaroides*. *Ecology* 84: 2668–2679.

Shine, R., Bonnet, X. & Cogger, H.G. (2003). Antipredator tactics of amphibious sea-snakes (Serpentes, Laticaudidae). *Ethology* 109: 533–542.

Sih, A., Spiegel, O., Godfrey, S., Leu, S. & Bull, C.M. (2018). Integrating social networks, animal personalities, movement ecology and parasites: a framework with examples from a lizard. *Animal Behaviour* 136: 195–205.

Tatin, L. & Renet, J. (2016). Créer des gîtes artificiels afin de restaurer des populations de Reptiles : retour d'expériences sur le lézard ocellé *Timon lepidus* (Daudin, 1802) en Crau (Bouches-du-Rhône). *Bulletin de la Société Herpétologique de France* 159: 47–59.

Tatin, L., Renet, J. & Besnard, A. (2013). Le lézard ocellé. In *Écologie et conservation d'une steppe méditerranéenne. La plaine de Crau*. Tatin, L., Wolff, A., Boutin, J., Colliot, E. & Dutoit, T. (Eds.) Éditions Quae, Versailles, 384 pp.

Thienpont, S. (2020). Plan national d'actions 2020-2029 en faveur du Lézard ocellé *Timon lepidus*. *Ministère de la Transition Ecologique*. 125 pp.

Vicente, L.A. (1989). Novos dados sobre o comportamento de *Lacerta lepida* (Daudin 1802) (Sauria-Lacertidae). Uma populacao insular-Ilha da Berlenga (Portugal). *Treballs Societat Catalana d'Ictiologia i Herpetologia* 2: 232–249.

Webb, J.K., Shine, R. & Pringle, R.M. (2005). Canopy removal restores habitat quality for an endangered snake in a fire suppressed landscape. *Copeia* 2005: 894–900.

Whiting, M. & While, G. (2017). Sociality in lizards. In *Comparative Social Evolution*, 390–426 pp. Abbot, P. & Rubenstein, D.R. (Eds.),. Cambridge University Press.

Zuffi, M.A.L., Macchia, M., Loale, P. & Giudicci, F. (1999). Winter activity in a coastal population of *Vipera aspis*. *Annual Review of Ecology, Evolution, and Systematics* 54: 365–374.

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