

Dragons in desert trouble: anthropogenic wells as a potential threat to the Desert Monitor, *Varanus griseus* (Daudin, 1803), in Morocco

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Varanids are a relatively small but diverse group of lizards, currently comprising 88 recognized species (Uetz et al., 2024). These lizards are facing significant main and potential threats within their natural habitats, including habitat destruction, road mortality, human consumption, uncontrolled pet trade, and even from items discarded by humans (Koch et al., 2013; Ayob et al., 2020; Zdunek and Kolenda, 2022; Böhme et al., 2023; Zdunek and Stenger, 2023). Additionally, progressive global warming could potentially lead to a decrease in habitat patch occupancy (Jones et al., 2020; Shadloo et al., 2021).

The Desert Monitor, *Varanus griseus*, is the largest lizard species in Morocco. It is widely distributed in the Saharan zones south of the Atlas Mountains from Tantan to Figuig and has a significant presence in the Atlantic Sahara (Pasteur and Bons, 1960; Martínez del Mármol et al., 2019; Bouazza et al., 2021). According to Pleguezuelos et al. (2010), this species is regionally listed as Near Threatened in Morocco. In terms of international conservation status, it is categorized as Least Concern in the IUCN Red List despite a declining population trend (Soorae et al., 2021). However, it is included on CITES Appendix I (Convention on International Trade in Endangered Species of Wild Fauna and Flora) and listed in Annex A of the EU Wildlife Trade Regulations (Species Plus, 2023).

Varanus griseus and its close relatives face numerous threats, including road mortality (e.g., in Kazakhstan), habitat loss, illegal pet trade, local beliefs, and climate change (Bons and Geniez, 1996; Chirikova et al., 2019; Auliya and Koch, 2020; Shadloo et al., 2021; Zima and Fedorenko, 2024). In Morocco, the Desert Monitor is subject to local superstitions, such as the belief that it can attack camels and break their legs (Escoriza et al., 2011). Furthermore, these monitors are hunted by locals and upon capture undergo a traditional drying process. The locals hold the belief that placing these mummified lizards around their homes will deter snakes (Fig. 1). They may also use them for ethno-herpetological purposes, such as in traditional medicine (Nijman and Bergin, 2017; Mendoza-Roldan et al., 2023). In other countries, the Desert Monitor is victimized due to its perceived ‘malevolent features’. For instance, it is believed that if a lizard runs between a man’s legs, it can rob him of his virility, or that the monitor can steal milk from sheep and goats (Bennett, 1998). Some shepherds hold the belief that killing seven Desert Monitors can absolve them of sins (Chirikova et al., 2019).

A recently highlighted threat originates from wells used in arid regions for rainwater retention, locally referred to as *matfia*. These concrete infrastructures pose a significant anthropogenic hazard for numerous animal species, including the herpetofauna of Morocco, and particularly for monitor lizards (García-Cardenete et al., 2014; Pleguezuelos et al., 2017). Three distinct types of *matfias* are recognized, each posing potential threats to reptiles. The “cistern-big-hole” *matfia* (CBH; Fig. 2A), also known as the covered *matfia*, is a roofed water-storage structure that boasts a large capacity and is typically associated with one or two “cistern-small-hole” sedimentation catchments (CSH; Fig. 2B). These uncovered structures play a crucial role in settling out sediments, ensuring that cleaner water is stored in the covered *matfia*.

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Figure 1. Dried *Varanus griseus* in a Moroccan market on 18 May 2024. Photo by Paul Freed.

Additionally, a “cube-shaped” *matfia* (CUB; Fig. 2C), easily identified by its distinctive, frequently blue metal cover, does not serve as a water reservoir but is part of the water distribution system. It nevertheless may trap monitors.

In highlighting the threat posed by *matfias* to monitor lizards in Morocco, we present our new observations that include a compilation of data from other scientists and naturalists who are studying or observing these lizards in their natural environment. We documented a total of 42 cases involving 48 monitors trapped in *matfias* (Table 1, records 1–42). During our data collection for this research, we also observed instances of roadkilled *V. griseus* (Fig. 3A; Table 1, records 43–52), a threat that is known in other countries where this species is found but rarely documented in Morocco (Chirikova et al., 2019; Martínez del Marmol et al., 2019). In two instances (Table 1, records 53–54), locals captured live lizards, seemingly out of curiosity. However, after discussions with naturalists in both cases, they agreed to release the animals back into their natural habitat.

The most recent observations, from April, October, and November 2024, present a potentially new type of threat to *V. griseus* – a reservoir used in watermelon cultivation (Fig. 4A; Table 1, records 55–58). In the first plastic-lined reservoir we visited, we found three dead monitors (Fig. 4B; Table 1, record 55), as well as three other species of lizards (*Acanthodactylus boskianus* [Daudin, 1802], *Stenodactylus mauritanicus* Guichenot, 1850, *Tropicolotes algericus* Loveridge, 1947), one species of snake (*Cerastes cerastes* Linnaeus, 1758), and one species of toad (*Bufotes boulengeri* [Lataste, 1879]).

In the second reservoir we found two adult *V. griseus*, one dead and one alive (Table 1, record 56), and a live adult *C. cerastes*. Two *V. griseus* skeletons make up the remaining two observations, and the state of the bodies did not allow their age to be assessed (Table 1, records 57–58).

Monitors trapped in *matfias* (Fig. 3B). In 26 of the 42 observations, lizards were found to have died in the *matfia* ($n = 28$ of 48, 58%). In the remaining 16 instances, lizards were rescued by an observer ($n = 19$ of 48, 40%). Monitors were most frequently found trapped in CUB ($n = 19$ of 48; 40%), followed by CSH ($n = 13$; 33%). This was closely followed by CBH at 27 ($n = 13$; 27%). A chi-square test shows that there is no significant difference in monitor trapping between the three *matfias*. Almost half of trapped monitors were adults ($n = 22$, 46%), followed by subadults ($n = 13$, 27%), juveniles ($n = 9$, 19%), and four individuals of unidentified age. There was a significant difference in the number of adult monitors trapped in CBH (45%) when compared with subadults or juveniles (8% and 11%, respectively), perhaps because the larger entrance of the cistern-big-hole is significantly more dangerous for adults than younger life stages. More than half of the events occurred in the Smara Region of the Atlantic Sahara ($n = 27$, 56%), followed by the Assa Region ($n = 12$, 25%).

A common threat in warm climates. The issue of desert wells as a threat to wildlife extends far beyond monitor lizards in Morocco. These wells endanger a wide range of animals inhabiting the surrounding areas, including invertebrates, mammals, birds, amphibians, and reptiles (García-Cardenete et al., 2014; Hinckley et al., 2020; Carreras and Martínez del Marmol, 2021).

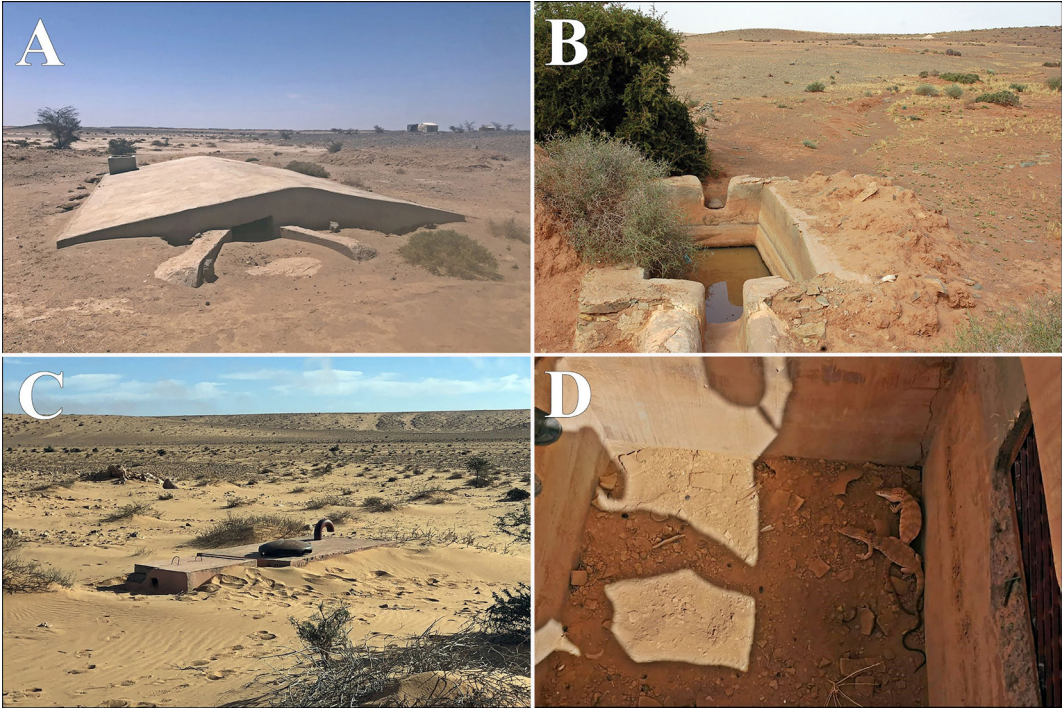


Figure 2. Different structures (*matfias*) where *Varanus griseus* were found in Morocco. (A) Cistern-big-hole *matfia*. (B) Cistern-small-hole *matfia*. (C) Concrete cube *matfia*. (D) Example of (B) with two trapped subadult *Varanus griseus* (Table 1: 6). Photos by Gabriel Martínez del Mármol (A–C) and Ignazio Avella (D).

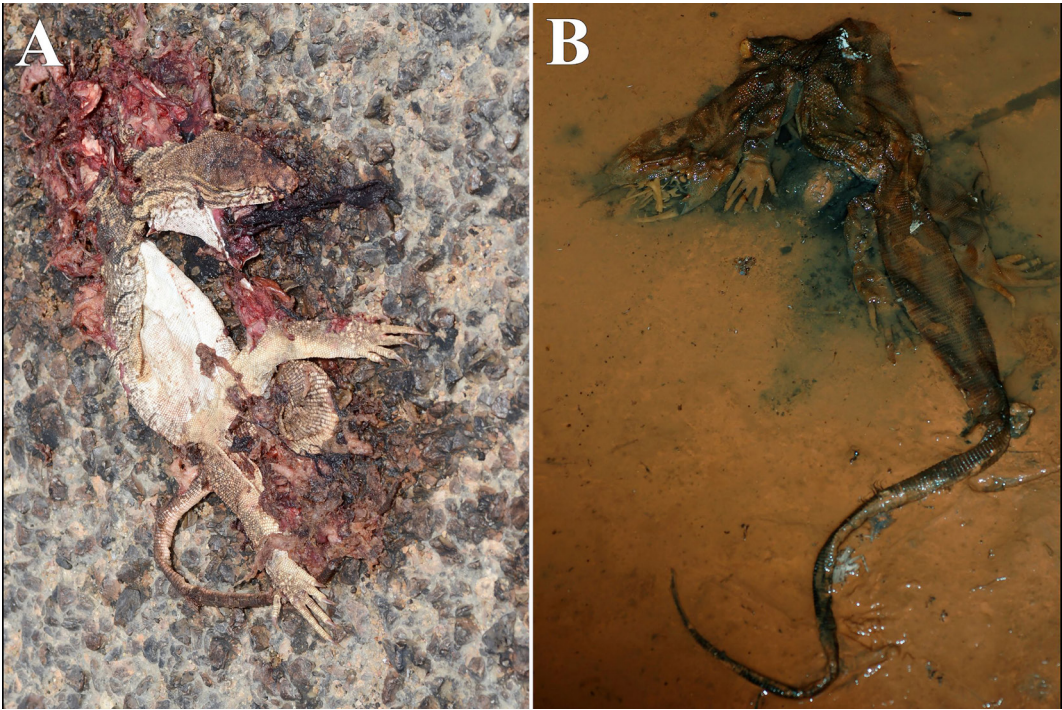


Figure 3. (A) Adult *Varanus griseus* found dead on a road near Smara (Atlantic Sahara). (B) a dead specimen in a *matfia* in Assa, southern Morocco. Photos by Gabriel Martínez del Mármol.

Table 1. Observations of *Laramus griseus* in Morocco listed in chronological order, including record number, date of observation, life stage with the number of individuals if more than one (adult – AD; subadult – SB; juvenile – JV; unidentifiable – U), life status (dead – D; alive – A), type of threat (cistern-big-hole *maffia* – CBH; cistern-small-hole *maffia* – CSH; cube *maffia* – CUB; roadkill – RK; hunted – HUN; plastic-lined reservoir – RES), and locality.

No.	Date	Stage	Status	Threat	Locality
1	24 Aug 2009	AD	D	CBH	Assa
2	23 Jun 2011	AD	D	CSH	Assa
3	19 Aug 2012	AD	D	CBH	Smara
4	22 Aug 2013	AD	A	CBH	Assa
5	14 Apr 2017	JV	D	CUB	Merzouga
6	28 Apr 2019	2SB	A	CSH	Draa Valley
7	5 Nov 2019	SB	D	CUB	Smara
8	5 Nov 2019	SB	D	CUB	Smara
9	5 Nov 2019	SB	D	CUB	Smara
10	5 Nov 2019	2AD	D	CUB	Smara
11	1 Nov 2021	AD, JV	A	CBH	Smara
12	3 Sep 2021	AD	D	CSH	Smara
13	3 Sep 2021	AD	A	CSH	Smara
14	5 Sep 2021	AD	A	CSH	Assa
15	15 May 2022	AD	D	CBH	Smara
16	1 Jun 2022	AD	A	CSH	Smara
17	10 Sep 2022	SB	D	CSH	Assa
18	20 Sep 2022	AD	A	CBH	Smara
19	6 Dec 2022	JV	D	CUB	Smara
20	8 Jun 2023	AD	A	CBH	Smara
21	2 Aug 2023	SB	A	CBH	Smara
22	1 Sep 2023	U	D	CBH	Tantan
23	1 Sep 2023	SB	D	CUB	Goulmima
24	1 Oct 2023	SB	D	CUB	Goulmima
25	4 May 2024	JV	A	CSH	Assa
26	30 May 2024	2JV	D	CUB	Smara
27	5 Jun 2024	AD	A	CSH	Assa
28	5 Jun 2024	JV	D	CSH	Assa
29	27 Jul 2024	AD	A	CUB	Smara

No.	Date	Stage	Status	Threat	Locality
30	27 Jul 2024	AD	A	CBH	Smara
31	31 Aug 2024	SB	D	CSH	Assa
32	31 Aug 2024	SB	D	CSH	Assa
33	31 Aug 2024	JV, SB	D/A	CSH	Assa
34	1 Sep 2024	JV	D	CUB	Smara
35	3 Sep 2024	SB	A	CSH	Smara
36	22 Sep 2024	2AD	A	CUB	Smara
37	22 Sep 2024	AD	A	CUB	Smara
38	Nov 2024	U	D	CUB	Merzouga
39	Nov 2024	U	D	CUB	Draa-Tafilalet
40	Nov 2024	U	D	CUB	Draa-Tafilalet
41	U	AD	D	CBH	Smara
42	U	AD	D	CBH	Smara
43	2 Aug 2013	AD	D	RK	Smara
44	16 Aug 2013	AD	D	RK	Smara
45	20 Aug 2017	SB	D	RK	Tinghir Alnif
46	15 Jun 2020	AD	D	RK	Tinghir Alnif
47	9 May 2021	AD	D	RK	Errachidia
48	22 May 2021	AD	D	RK	Agdz
49	15 May 2022	AD	D	RK	Smara
50	24 Jul 2022	SB	D	RK	100 km E Laayoune
51	14 Apr 2022	AD	D	RK	Zagora
52	14 Oct 2024	SB	D	RK	Errachidia
53	10 Jun 2014	SB	A	HUN	Zagora
54	19 Jun 2023	SB	A	HUN	Figuig
55	18 Apr 2024	3AD	D	RES	Zagora
56	1 Oct 2024	2AD	A/D	RES	Essmevra
57	Nov 2024	U	D	RES	Merzouga
58	Nov 2024	U	D	RES	Draa-Tafilalet

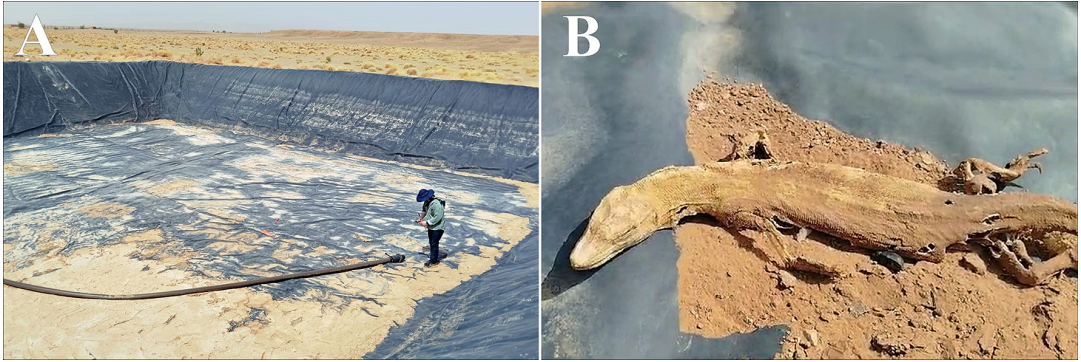


Figure 4. (A) A plastic-lined reservoir used in watermelon cultivation; (B) an adult *Varanus griseus* found dead in a tank in Zagora (southeastern Morocco). Photos by Abdellah Bouazza.

While our study focused on *V. griseus* in Morocco, similar observations have been made in the Middle East, where Desert Monitors are commonly found trapped in wells, with many dying as a consequence (Aviad Bar and Guy Haimovitch, pers. comm.). Similarly, the Nile Monitor, *Varanus niloticus* (Linnaeus, 1766), is often found trapped in wells located in Diawling National Park, Mauritania, and Toubakouta, Senegal (Martínez del Mármol et al., 2024). In Indonesia, particularly around the capital city of Jakarta on Java Island, Two-striped Water Monitors, *Varanus salvator bivittatus* (Kuhl, 1820), face similar threats (Kevin Geraldhy, pers. comm.).

Conservation action. Addressing this issue requires urgent action. Our study reveals a high mortality rate (58%) among monitors trapped in *maffias* in Morocco and, clearly, those we were able to rescue would not have survived if left behind. This alarming statistic underscores the severity of the threat and the immediate need for intervention. We urge conservationists to prioritize this issue. Observations such as these, can broaden the scope of our understanding of the threats posed to these monitor lizards. Implementing measures to protect varanids and mitigate their threats is vital for maintaining biodiversity and preserving the health of natural habitats (Miranda, 2017; Doody et al., 2021; Jameson et al., 2024). One potential solution could involve public awareness campaigns and workshops focused on wildlife conservation, such as those proposed by Bhattacharya et al. (2019). These initiatives aim to highlight the importance of protecting these animals to maintain ecosystem balance and biodiversity. They also address the need for education concerning local beliefs and superstitions (Bhattacharya and Koch, 2018).

Acknowledgements. We would like to thank Khaffou Abdelaziz, Ahmed Agdz, Ignazio Avella, Aviad Bar, Laurent Barthe, Pablo Bernalte Tébar, Brahim, Rodrigo Bustos Gil, Marco Caetano, Álvaro Camina Vega, Alex Carreras, Antoine Coquis, Nicolas Denize-Proust, Bilal El Khoutabi, Noordine Elmrbabet, Miguel Eraso, Eduardo Fernández Meléndez, Dionisio Manuel Fernández Muñoz, Thomas Friedrich, Mélodie Gaglio, Kevin Geraldhy (and his team), Alberto González, Aurélien Grimaud, Guy Haimovitch, Fernando Iglesias, Ander Izagirre, Raul León, Fernando Martínez-Freiria, Khaffou Mhamed, Benjamin Miles, Killian Mille, Bryan Minne, Ahmed Mouaamou, Selim Nait, Doru Painatescu, Marion Petit, Jordi Ribó, Baudilio Rebollo Fernández, Iván Ruiz, Marco Sassoe, Francisco Silva, and Rafael Vázquez Graña, for sharing their observations with us or participating in our work when some of the lizards were found. Special thanks to Nicolas Dubos, Paul Freed, and Karol Wałach, whose valuable help we can always count on, and to Hinrich Kaiser and Philippe Geniez for helpful suggestions to improve this manuscript.

References

- Auliya, M., Koch, A. (2020): Visual Identification Guide to the Monitor Lizard Species of the World (Genus *Varanus*). Guidance for the Identification of Monitor Lizards with Current Distribution Data as well as Short Explanations on Reproductive Characteristics and Captive Breeding to Support CITES Authorities. Bonn, Germany, Bundesamt für Naturschutz.
- Ayob, N., Mustapha, M.A., Senawi, J., Ahmad, N. (2020): Herpetofauna roadkills on Langkawi Island, Peninsular Malaysia: the influence of landscape and season on mortality distribution. *Sains Malaysiana* **49**(10): 2373–2382.
- Bennett, D. (1998): Monitor Lizards: Natural History, Biology, Husbandry. Frankfurt am Main, Germany, Edition Chimaira.
- Bhattacharya, S., Koch, A. (2018): Hatha Jodi: an illegal trade of misused scientific facts or blindfolded myths and beliefs? *Biawak* **12**(2): 97–99.
- Bhattacharya, S., Zia, S.Z., Mahato, S., Gangwar, R.K., Singh, N., Auliya, M., Koch, A. (2019): Report on the awareness

- workshops “Perceptions of wildlife conservation of today’s youth in West Bengal, India, with a focus on Monitor Lizards”. *Biauwak* **13**(2): 94–100.
- Bons, J., Geniez, P. (1996): Amphibiens et Reptiles du Maroc (Sahara Occidental Compris). Atlas Biogéographique. Barcelona, Spain, Asociación Herpetológica Española.
- Bouazza, A., Rihane, A., El Mouden, E.H. (2021): Checklist of amphibians and reptiles of Morocco: a taxonomic update and standard Arabic names. *Herpetology Notes* **14**: 1–14.
- Böhme, W., Ahmed, S.H., Al-Sheikhly, O.F., Ararat, K., Auer, M., Khudur, F.A., Langner, C. (2023): Desert monitor lizards (Squamata: Varanidae: *Varanus*: *Psammosaurus*) from the Middle East: further records of Nesterov’s Desert Monitor, *Varanus* (*P.*) *nesterovi* Böhme, Ehrlich, Milto, Orlov et Scholz, 2015, from Iraq, and adjacent localities of *Varanus* (*P.*) *g. griseus* (Daudin, 1803) and *Varanus* (*P.*) *g. caspius* (Eichwald, 1831), with comments on biogeography and taxonomy. *Russian Journal of Herpetology* **30**(6): 518–528.
- Carreras Barranco, A., Martínez del Mármol, G. (2021): The 101 Snakes Trip. Available at: www.moroccoherps.com/en/the-101-snakes-trip-september-2021. Accessed on 13 December 2023.
- Chirikova, M.A., Zima, Y.A., Pestov, M.V., Gubin, B.M., Kovalenko, A.V. (2019): Investigations on distribution, occurrence and threats of *Varanus griseus caspius* (Eichwald, 1831) at the north-eastern periphery of its geographical range (Kazakhstan). *Russian Journal of Herpetology* **26**(4): 185–200.
- Doody, J.S., Soennichsen, K.F., James, H., McHenry C., Clulow S. (2021): Ecosystem engineering in deep-nesting monitor lizards. *Ecology* **102**(4): e03271.
- Escoriza, D., Ferrer, J., Amat, F., Tarragó, A. (2011): Nova cita i aspectes ecològics del varà del desert *Varanus griseus* (Sauria: Varanidae) al Sàhara Occidental. *Butlletí de la Societat Catalana d’Herpetologia* **19**: 70–74.
- García-Cardenete, L., Pleguezuelos, J.M., Brito, J.C., Jiménez-Cazalla, F., Pérez-García, M.T., Santos, X. (2014): Water cisterns as death traps for amphibians and reptiles in arid environments. *Environmental Conservation* **41**(4): 341–349.
- Hinckley, A., Rodríguez Rodríguez, E.J., Liedtke, H.C., García Tardío, M.I., Flores-Stols, M.V., García-Cardenete, L. (2020): On the distribution of *Felis margarita* and *Felis lybica* in SW Morocco. *Galemys* **32**: 80–84.
- Jameson, T.J.M., Johnston, G.R., Barr, M., Sandow, D., Head, J.J., Turner, E.C. (2024): Squamate scavenging services: heath goannas (*Varanus rosenbergi*) support carcass removal and may suppress agriculturally damaging blowflies. *Ecology and Evolution* **14**: e11535.
- Jones, A.R., Jessop, T.S., Ariefiandy, A., Brook, B.W., Brown, S.C., Ciofi, C., et al. (2020): Identifying island safe havens to prevent the extinction of the world’s largest lizard from global warming. *Ecology and Evolution* **10**(19): 10492–10507.
- Koch, A., Ziegler, T., Böhme, W., Arida, E., Auliya, M. (2013): Distribution, threats, and conservation status of the monitor lizards (Varanidae: *Varanus* spp.) of southern Asia and the Indo-Australian archipelago. *Herpetological Conservation and Biology* **8**(3): 1–62.
- Martínez del Mármol, G., Harris, D.J., Geniez, P., de Pous, P., Salvi, D. (2019): Amphibians and Reptiles of Morocco. Frankfurt, Germany, Edition Chimaira.
- Martínez del Mármol, G., Izagirre-Egaña, A., Frahm, S., Sassoè, M. (2024): Herpetofauna of Mauritania: results of a field survey. *Boletín de la Asociación Herpetológica Española* **34**: 73–86.
- Mendoza-Roldan, J.A., Louzada-Flores, V.N., Lekouch, N., Khouchfi, I., Annoscia, G., Zatelli, A., et al. (2023): Snakes and souks: zoonotic pathogens associated to reptiles in the Marrakech markets, Morocco. *PLoS Neglected Tropical Diseases* **17**(7): e0011431.
- Miranda, E.B.P. (2017): The plight of reptiles as ecological actors in the tropics. *Frontiers in Ecology and Evolution* **5**(159): 1–15.
- Nijman, V., Bergin, D. (2017): Reptiles traded in markets for medicinal purposes in contemporary Morocco. *Contributions to Zoology* **86**(1): 39–50.
- Pasteur, G., Bons, J. (1960): Catalogue des Reptiles Actuels du Maroc: Révision de Formes d’Afrique, d’Europe et d’Asie. Rabat, Morocco, Travaux de l’Institut Scientifique Chérifien.
- Pleguezuelos, J.M., Brito, J.C., Fahd, S., Feriche, M., Mateo, J.A., Moreno-Rueda, G., et al. (2010): Setting conservation priorities for the Moroccan herpetofauna: the utility of regional red lists. *Oryx* **44**(4): 501–508.
- Pleguezuelos, J.M., García-Cardenete, L., Caro, J., Feriche, M., Pérez-García, M.T., Santos, X., et al. (2017): Barriers for conservation: mitigating the impact on amphibians and reptiles by water cisterns in arid environments. *Amphibia-Reptilia* **38**(1): 113–118.
- Shadlo, S., Mahmoodi, S., Hosseinzadeh, M.S., Kazemi, S.M. (2021): Prediction of habitat suitability for the desert monitor (*Varanus griseus caspius*) under the influence of future climate change. *Journal of Arid Environments* **186**: 104416.
- Soorae, P., Eid, E.K.A., Behbehani, S.J.Y., Al Johany, A.M.H., Amr, Z.S.S., Egan, D.M., et al. (2021): *Varanus griseus*. The IUCN Red List of Threatened Species 2021: e.T62252A3110663.
- Species Plus (2023): *Varanus griseus* (Daudin, 1803). Available at https://www.speciesplus.net/species#/taxon_concepts/9436/legal. Accessed on 13 December 2023.
- Uetz, P., Freed, P., Aguilar, R., Reyes, F., Hošek, J. (2024): The Reptile Database. Available at <http://www.reptile-database.org>. Accessed on 13 April 2024.
- Zdunek, P., Kolenda, K. (2022): The threat of discarded food and drinks containers to monitor lizards. *Herpetological Bulletin* **161**: 28–30.
- Zdunek, P., Stenger, P.-L. (2023): A dragon in a trap! A record of using an aquatic trap to collect the Southeast Asian Water Monitor, *Varanus salvator macromaculatus* (Deraniyagala, 1944), in Indonesia (Squamata: Varanidae). *Herpetology Notes* **16**: 937–940.
- Zima, Y.A., Fedorenko, V.A. (2024): The range of the Desert Monitor *Varanus griseus caspius* (Eichwald, 1831) in Central Asia. *Frontiers of Biogeography* **17**: e138199.