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Herpetofauna of Belezma Biosphere Reserve, province of Batna, northeastern Algeria

Saoudi Messaoud^{1, 2*}, Bensaci Mohamed³, Necer Abdeldjabar¹, Baazi Houria⁴, Nemili Zohra⁴, Khelfaoui Farouk⁵

1 Department of Ecology and Environment, Faculty of Natural and Life Sciences, University of Batna 2, 05078 Fesdis, Batna, Algeria

2 Laboratory of Biodiversity, Biotechnology, and Sustainable Development (BBDD), Faculty of Natural and Life Sciences, University of Batna 2, 05078 Fesdis, Batna, Algeria

3 Administration of Belezma National Park, district of Fesdis, 05078 Fesdis, Batna, Algeria

4 Natural Hazards and Territory Planning Laboratory (LRNAT), Institute of Earth Sciences and Universe, University of Batna 2, 05078 Fesdis, Batna, Algeria

5 Department of Biology, Faculty of Sciences, Badji Mokhtar Annaba University, 23005 Sidi Amar, Annaba, Algeria

* Corresponding author contact information:

Address: A Street, Erriadh, 05000 Batna, Algeria

Telephone: +213696001093

Email: m.saoudi@univ-batna2.dz

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Abstract

The present study reports the first herpetological survey in the Belezma Biosphere Reserve in Batna province, Algeria. A total of four amphibian and 19 reptile species belonging to 15 families were recorded during fieldwork carried out from April to September in 2015 and 2016, and again from 2021 to 2024. Among these species, one amphibian, one lizard, and one snake were not previously recorded in the province. A comprehensive checklist of the herpetofauna in the BBR detailing their associated habitats, distribution, and conservation status is provided. This study provides a baseline for future research and management efforts.

Keywords: Amphibians; Reptiles; Checklist; Belezma; Batna; Algeria

Introduction

Research on amphibians and reptiles in Algeria is currently lacking, primarily due to the limited interest of local researchers and the inaccessibility of the terrain for foreign researchers. The Algerian herpetofauna was first recorded in the 19th century by Boulenger (1891). Since then, a few scattered studies have been conducted, including the catalog of the Algerian herpetofauna published by Olivier (1894), the essay of Doumergue (1901) focusing on herpetofauna of the northwestern region of the country, and the review conducted by Seurat (1930) on literature collected from 1830 to 1930. Furthermore, there have been limited studies on the Algerian-Saharan herpetofauna (Gauthier, 1967; Grenot and Vernet, 1972).

Batna province covers a vast area of approximately 12,192 km², encompassing a variety of ecosystems and climates, from desert landscapes to mountain ranges reaching altitudes of up to 2,178 m covered with dense Cedar forests. The amphibians and reptiles of Batna province have been described through generalized species lists based on nationwide distribution maps (e.g. Welch 1982; Schleich et al., 1996; Sindaco and Jeremcenko, 2008 and Sindaco et al., 2013). The only one exception is the study conducted by Chirio and Blanc (1997) on the taxonomy and distribution of reptiles in the Aurès Mountains, which covers mostly the southern part of the province.

The Belezma Biosphere Reserve (BBR) is located in the Belezma Mountains, northeastern Batna province, Algeria. It encompasses the majority of the climatic and habitat variation of the province, with the exception of extreme arid environments, such as the desert. To date, there are a few published studies addressing the geographic distribution and ecological aspects of specific reptile species in the BBR (Bischoff and Bosch, 1991; Bouam et al., 2016 and Saoudi et al., 2017). However, no comprehensive surveys have been conducted, and a complete species list of the herpetofauna of BBR does not yet exist. Surveys on herpetofauna have only been carried out in a few other protected areas of Algeria. A study conducted by Boumaour et al. (2018) revealed the existence of 19 herpetofauna species within the National Park of Gouraya (NPG). Mamou (2016) compiled a list of 15 herpetofauna species in the National Park of Djurdjura (NPD), in the northern part of Algeria. Rouag and Benyacoub (2006) recorded 15 reptile species in the National Park of El Kala (NPK), in the extreme northeast of the country.

Biodiversity inventories are crucial for developing informed management and conservation policies. They also serve as the basis for selecting priority areas for conservation efforts (Leynaud and Bucher, 1999). Herpetological inventories play an important role in land-use planning and conservation, while also serving as a foundation for future research on specific species (Raven and Wilson, 1992 and Silva and Sites, 1995). Field surveys are essential for accurately identifying and recording the biodiversity of an area, providing the necessary data to improve management plans.

The greatest threat to amphibian and reptile populations and diversity in the BBR is habitat loss due to anthropogenic influence. The main factors impacting the habitat of these species with the BBR are climate change, human-induced fires, and overgrazing by cattle. Herein, this study presents the results of the first extensive herpetological surveys conducted in the BBR. Based on the results, recommended conservation and management actions are provided for the protection of this area.

Materials and Methods

Study site

The Belezma Biosphere Reserve (BBR), established in June 2015 by UNESCO, is situated between coordinates 35°36'N–35°41'N and 05°54'E–06°19'E in Batna province, northeastern Algeria (Figure 1). The reserve covers an area of about 26,250 ha, of which around 5,315 ha are dominated by Atlas cedar (*Cedrus atlantica*), a symbolic tree species of the region. This represents almost one-third of the cedar forests of Algeria. The BBR has a diverse topography, with elevations ranging from 915 to 2,136 m above sea level. It includes a variety of habitats, such as Mediterranean forests and shrublands, cliffs, and watercourses (oueds).

The BBR has a typical Mediterranean montane climate: dry and hot in summer, cold and wet in winter, ranging from cool sub-humid to inferior semi-arid conditions. Climatic data recorded by a local meteorological station from 1993 to 2022 show that July was the warmest month with average temperatures ranging from 24.8°C to 37.5°C, depending on altitude. While January was the coldest month, with average temperatures ranging from -2.8°C to 2.2°C, also varying with

elevation. Rainfall is irregular and fluctuates yearly, with an annual average ranging from 774 mm at the highest elevation and 278 mm at the lowest elevation (Benchouala et al., 2023).

Data collection

Sampling was conducted via visual encounter surveys (VES). VES occurred on unsystematic transects while visually searching for amphibian and reptile species in the open and under stones, bushes, or other natural cover. Once a specimen was encountered, it was either visually identified, or captured and photographed for subsequent identification, then released in the same location where it was captured. Both diurnal (9–16h) and nocturnal VES (18–23h) were conducted throughout the BBR and some of its surrounding areas, from April to September in 2015 and 2016, and again from 2021 to 2024. Surveys were conducted by all or some of the authors in three seasons (i.e. spring, summer, and autumn) susceptible of being the period of activity for all the amphibian and reptile species of BBR. In total, an estimated minimum of 500 man-hours was dedicated to the sampling effort. During this period, 28 localities representing all of the major habitat types of the BBR were surveyed, including forests, maquis, open areas, rocky areas, and watercourses (mainly oueds—seasonally dry valleys) (Figure 1, Table 1). Additional information resulted from opportunistic observations of any species in surveys of other taxonomic groups.

The forest habitats were classified into two categories: Cedar forest, primarily composed of *Cedrus atlantica* trees, with the occurrence of sharp cedar (*Juniperus oxycedrus*) and green holm oak (*Quercus ilex*) occasionally (Figure 2.A); and Pine forest, primarily consisting of Aleppo pine (*Pinus halepensis*) accompanied by *Juniperus phoenicea*, *Rosmarinus officinalis*, *Genista microcephala*, *Genista cinerea*, *Cistus salviifolius*, and *Cistus monspeliensis* (Figure 2.B). The maquis, which are typical Mediterranean shrublands, are usually composed of oak trees (*Quercus ilex*), olive trees (*Olea europaea*), and short evergreen shrubs, usually dominated by mastic (*Pistacia lentiscus*), and Phoenician juniper (*Juniperus phoenicea*) (Figure 2.C, D). Additionally, another type of maquis exists in the region, which is dominated by Phoenician juniper. However, for the purpose of this study, the two types of maquis have been combined into one category.

Results and Discussion

Systematic Inventory

A total of 23 herpetofauna species belonging to 15 families were recorded in the Belezma Biosphere Reserve (BBR) (Table 2; Figures 3–5). The four amphibian species recorded are all anurans, distributed across three families. The most species-rich family was Bufonidae, with two species (50% of amphibian species richness). The remaining amphibian families, Alytidae and Ranidae, are represented by a single species. Among reptiles, turtles are represented by two species distributed across two families. Lizards comprise 12 species from seven families, with the Lacertidae family being the most species-rich, which include six species (50% of lizard species richness). The other six Saurian families are represented by one species each. Snakes are represented by five species distributed across three families. The recorded snake diversity is dominated by the family Colubridae, which includes three species (60% of snake species richness), followed by Psammophiidae and Viperidae, each represented by one species.

The amphibian community of the BBR (4 species) represents 29% of the total of amphibian species recorded in Algeria (14 species), which rarely contains more than five species in a single assemblage (Mateo et al., 2013). The reptile species recorded in BBR (19 species) represent approximately 46% of the 41 species registered to the Aurès region, which includes localities within the provinces of Biskra, Khenchela, and the southern part of Batna (Chirio and Blanc, 1997). Despite the small size of the BBR, it contains approximately 18% of the total reptile species recorded in Algeria (104 species; Rouag et al. (2024)).

The herpetofauna recorded in the BBR exceeds that of the National Park of Gouraya (NPG), which hosts 19 species (Boumaour et al., 2018). The amphibian species richness in the BBR (four species) surpasses that of National Park of Djurdjura (NPD), which includes three species (Mamou, 2016). Additionally, the study area demonstrates higher reptile species richness (with 19 species) compared to the National Park of El Kala (NPK) and the NPD, which host 15 and 12 species, respectively (Rouag and Benyacoub, 2006 and Mamou, 2016). The greater diversity of ecosystems in the BBR than in the NPD might explain its higher species diversity. However, the difference in species richness between the BBR and both the NPK and NPG may be explained by the lack of extensive surveys in these national parks. Given that the NPK and the NPG present a wide range of ecosystems not found in the BBR, such as lakes, and coastal and marine habitats;

more comprehensive surveys in these parks could result in a higher number of amphibian and reptile species.

Protected areas in Morocco, such as Souss-Massa National Park (SMNP), host 23 reptile species (Elbahi et al., 2022), while Al Hoceima National Park (AHNP) and Khnifiss National Park (KNP) include 18-20 and 20 reptile species, respectively (Median et al., 2015 and Qninba, 2013). Similarly, Banc d'Arguin National Park in Mauritania hosts 21 species (Sow et al. 2014). These areas show higher reptile diversity compared to the BBR. The coastal-nature of these national parks likely explains the difference in species richness. However, it is important to note that our study did not record *Psammodromus blanci*, which was previously documented by Chirio and Blanc (1997) within the BBR. If included, this could narrow the difference in species diversity between these regions.

On a Mediterranean scale, the BBR presents higher reptile species richness than Circeo National Park in Italy, which hosts 16 species of reptiles, and Port-Cros National Park in France, hosting 17 species (Vignoli et al., 2017 and Marchand et al., 2019). This comparison shows that the BBR is an important biodiversity hotspot for reptile species in the Mediterranean Region.

Species distribution and Habitat preferences

In the present study, one amphibian species, *Bufo boulengeri*, was recorded as a new addition to the herpetofauna of both the BBR and Batna province. Additionally, one reptile, *Hemidactylus turcicus*, and one snake, *Macropododon cucullatus*, have not yet been documented in either the BBR or Batna province.

The majority of the observed amphibians and reptiles exhibit wide distributions within the Aurès region and Batna province (Boulenger, 1891; Schleich et al., 1996 and Chirio and Blanc, 1997). However, several species had not been previously recorded in the BBR, including *Pelophylax saharicus*, *Discoglossus pictus*, *Mauremys leprosa*, *Testudo graeca*, *Chamaeleo chamaeleon*, *Acanthodactylus erythrurus*, *Mesalina olivieri*, *Tarentola mauritanica*, *Hemorrhois hippocrepis*, and *Natrix maura*.

Most of amphibian and reptile species recorded in the study area are ubiquitous, being observed in more than one type of habitat. However, some species were found exclusively in specific habitats, such as oueds (e.g. *Discoglossus pictus*, *Pelophylax saharicus* and *Mauremys leprosa*), or rocky areas (e.g. *Tarentola mauritanica*). Additionally, species like *Mesalina* were recorded only once, in an open, flat terrain dominated by rocks and *Artemisia herba-alba* shrubs, while *Hemidactylus* was found in an abandoned house located in what used to be an orchard. *Testudo graeca*, *Trogonophis wiegmanni* and *Hemorrhois hippocrepis* were found only in the maquis habitat. (Table 2).

Amphibians are expected to be dependent on aquatic resources due to their complex life history traits, such as aquatic larval stages). *Pelophylax saharicus* is strictly aquatic, found only in oueds (Schleich et al., 1996). Other amphibians, like the two Bufonidae species, occupied a variety of habitats, ranging from maquis and cedar forests to rocky areas.

Most of the reptile species, such as *Podarcis vaucheri* and *Macroprotodon cucullatus*, showed a preference for maquis and cedar forests, which are the dominant habitat types within the BBR. Some species, like *Chamaeleo chamaeleon* and *Daboia mauritanica*, were recorded in both maquis and open areas.

Conservation IUCN Status

The majority of herpetofauna recorded in the BBR (86.9%) are classified as Least Concern according to the International Union for Conservation of Nature (IUCN) (Cox et al., 2006) (Table 2). *Testudo graeca* is the only species listed as Vulnerable (4.4%) (Cox et al., 2006). Approximately 9% of the total species, specifically *Mauremys leprosa* and *Daboia mauritanica*, are categorized as Near Threatened (Cox et al., 2006). These species face ongoing population declines, primarily due to anthropogenic factors.

Testudo graeca is particularly vulnerable due to its collection for the local and national pet trade. *Mauremys leprosa* is threatened by habitat degradation, with only one permanent watercourse (Oued Bouïlef) remaining in the BBR, which is subject to water pumping, flow interruption, or rerouting for irrigation purposes. Finally, *Daboia mauritanica* is at risk due to habitat loss and human threats, including intentional killings. Moreover, the pressures on the habitats of these

endangered species are intensified by human-caused fires and cattle overgrazing. These threats underscore the importance of targeted conservation efforts within the BBR to protect the declining populations of these species.

Although most amphibian and reptile species documented in this study, including *Discoglossus pictus*, *Bufo boulengeri*, *Pelophylax saharicus*, and various reptile species, are listed as Least Concern by the IUCN (Cox et al., 2006), these species could still face future pressures, particularly from habitat loss, climate change, wildfires, and grazing. Therefore, precautionary conservation measures are essential to protect not only the vulnerable and near-threatened species but also the currently classified as stable.

Figures

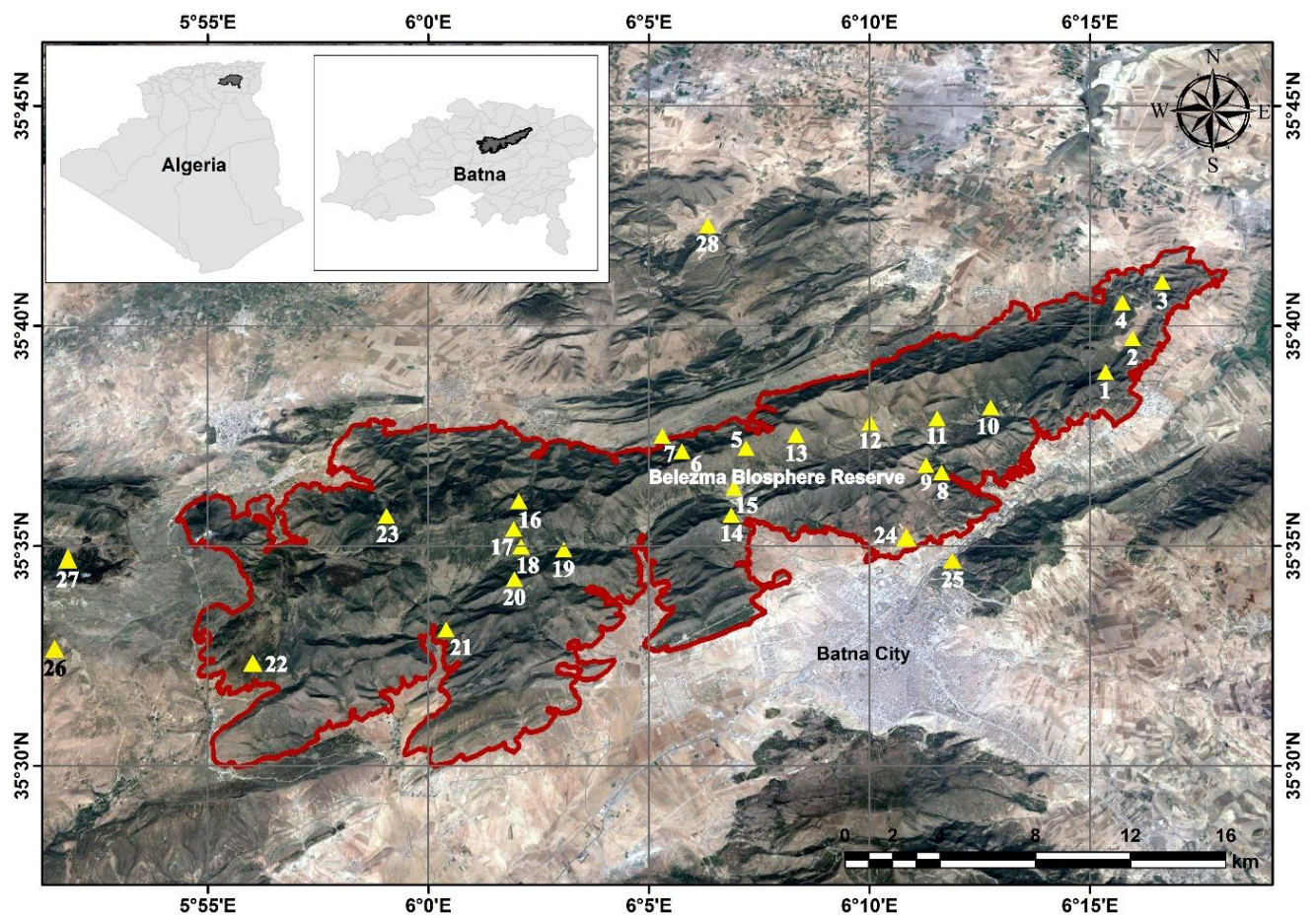


Figure 1. Location of the Belezma Biosphere Reserve. Sampling localities (▲) within and outside the BBR are also indicated.





Figure 2. Representative habitat types of the Belezma Biosphere Reserve. **A)** Cedar forest; **B)** Pine forest; **C)** and **D)** Maquis-type vegetation. Photos by SM.



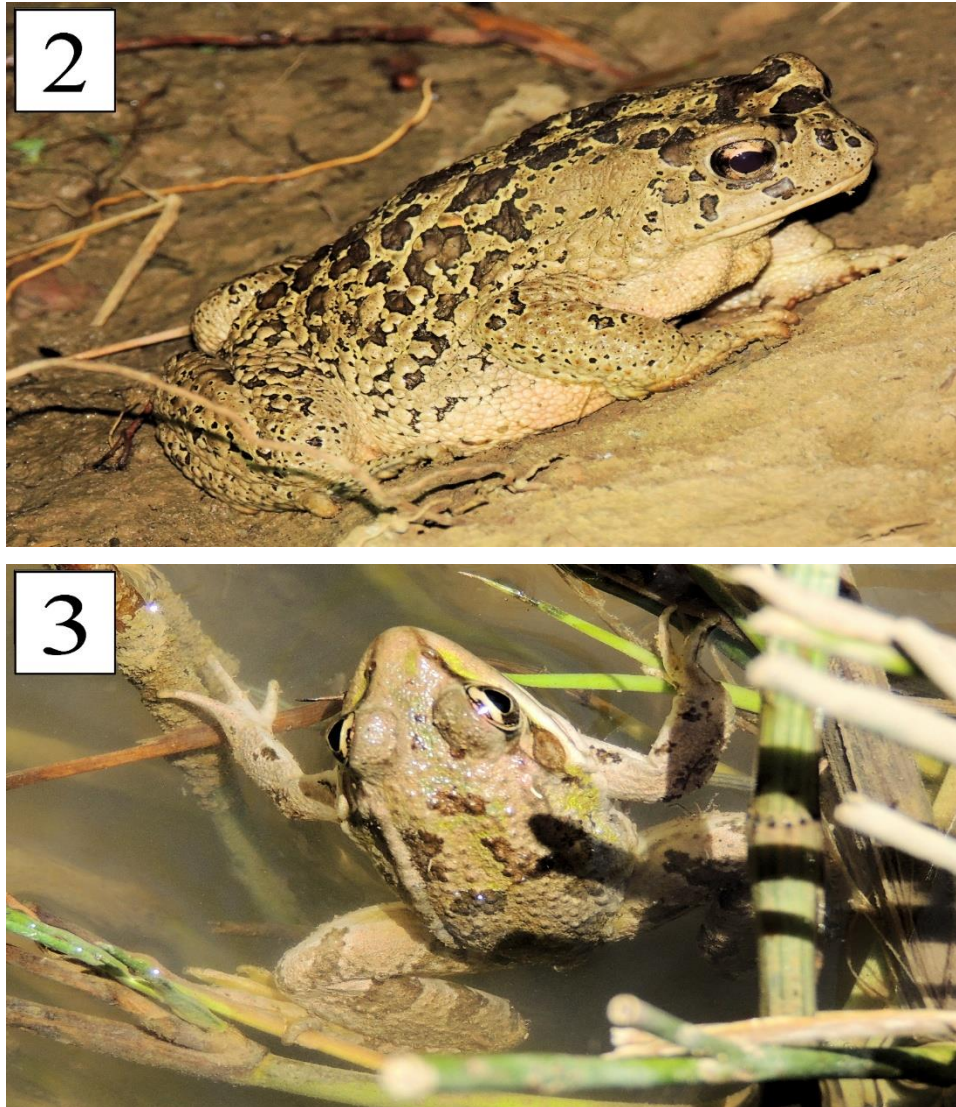


Figure 3. Some amphibian species recorded during the survey in the Belezma Biosphere Reserve. 1) *Bufotes boulengeri*; 2) *Sclerophrys mauritanica*; 3) *Pelophylax saharicus*. Photos by SM.











Figure 4. Some reptile species recorded during the survey in the Belezma Biosphere Reserve. **1)** *Mauremys leprosa* (photo taken from another locality in Batna province); **2)** *Testudo graeca*; **3)** *Agama impalearis*; **4)** *Chamaeleo chamaeleon*; **5)** *Hemidactylus turcicus* (photo taken from another locality in Batna province); **6)** *Acanthodactylus erythrurus*; **7)** *Ophisops occidentalis*; **8)** *Podarcis vaucheri*; **9)** *Psammodromus algirus*; **10)** *Timon pater* (photo taken from another locality in Batna province); **11)** *Tarentola mauritanica*; **12)** *Chalcides ocellatus*. Photos 1, 3, 7, 8, 9, 10 and 11 by SM. Photos 2, 4, 5, 6 and 12 by BM.





Figure 5. Some snake species recorded during the survey in the Belezma Biosphere Reserve. **1)** *Hemorrhois hippocrepis*; **2)** *Macroprotodon cucullatus*; **3)** *Natrix maura*; **4)** *Daboia mauritanica*. Photo 1, 2 and 4 by BM. Photo 3 by SM.

Tables

Table 1. Sampling localities in the Belezma Biosphere Reserve and its surroundings, Batna (northeastern Algeria).

Locality	Geographic coordinates	Altitude	Type of habitat
1	35°38'57" N, 6°15'21" E	1048	Maquis
2	35°39'43" N, 6°15'58" E	1057	Open area
3	35°40'60" N, 6°16'38" E	1016	Rocky area
4	35°40'32" N, 6°15'44" E	1037	Pine forest
5	35°37'13" N, 6°7'12" E	1664	Cedar forest
6	35°36'59" N, 6°5'51" E	1578	Cedar forest
7	35°37'30" N, 6°5'18" E	1405	Open area
8	35°36'32" N, 6°11'39" E	1039	Maquis
9	35°37'6.11" N, 6°11'13.45" E	1088	Oued
10	35°38'9" N, 6°12'45" E	1106	Maquis
11	35°37'54" N, 6°11'32" E	1248	Rocky area
12	35°37'48" N, 6°10'1" E	1282	Open area
13	35°37'31" N, 6°8'20" E	1468	Maquis
14	35°35'42" N, 6°6'52" E	1261	Maquis
15	35°36'10.52" N, 6°6'33.81" E	1369	Open area
16	35°36'1" N, 6°2'3" E	1401	Oued
17	35°35'23" N, 6°1'56" E	1731	Cedar forest
18	35°34'59" N, 6°2'6" E	1681	Maquis
19	35°34'55" N, 6°3'4" E	1438	Maquis

20	35°34'15" N, 6°1'57" E	1611	Cedar forest
21	35°33'6" N, 6°0'24" E	1285	Oued
22	35°32'46" N, 5°56'55" E	1788	Cedar forest
23	35°35'41" N, 5°59'3" E	1619	Maquis
24	35°35'7.90" N, 6°10'38.88" E	1079	Open area
25	35°34'55.51" N, 6°11'55.66" E	1012	Open area
26	35°32'35.38" N, 5°51'29.83" E	1699	Cedar forest
27	35°35'41.58" N, 5°52'51.16" E	1579	Maquis
28	35°42'17" N, 6°6'20" E	1062	Rocky area

Table 2. Amphibians and reptiles recorded in the study area, including their habitats and IUCN conservation status. Habitats: Cedar forest (CF), Pine forest (PF), maquis (M), open areas (OA), Oued (O), and rocky areas (RA). The systematic order follows Frost (2024) for amphibians, and Uetz and Hošek (2024) for reptiles. Conservation status is based on IUCN Red List (Cox et al., 2006).

Taxon	Locality	Habitat	IUCN Status
CLASS AMPHIBIA			
Order Anura			
Family Alytidae			
<i>Discoglossus pictus</i> (Otth, 1837)	9, 16, 21	O	Least concern
Family Bufonidae			
<i>Bufotes boulengeri</i> (Lataste, 1879)	6, 10, 13, 22	CF, M	Least concern
<i>Sclerophrys mauritanica</i> (Schlegel, 1841)	1, 9, 10, 11, 13	M, RA, O	Least concern
Family Ranidae			
<i>Pelophylax saharicus</i> (Boulenger, 1913)	9, 16, 21	O	Least concern
CLASS REPTILIA			
Order Testudines			
Family Geoemydidae			
<i>Mauremys leprosa</i> (Schweigger, 1812)	9	O	Near threatened
Family Testudinidae			
<i>Testudo graeca</i> (Linnaeus, 1758)	1	M	Vulnerable
Order Squamata			
Suborder Sauria			

Family Agamidae			
<i>Agama bibronii</i> (Duméril, 1851)	3, 11	M, RA	Least concern
Family Chamaeleonidae			
<i>Chamaeleo chamaeleon</i> (Linnaeus, 1758)	1, 8, 12	M, OA	Least concern
Family Gekkonidae			
<i>Hemidactylus turcicus</i> (Linnaeus, 1758)	15	OA (abandoned house in an open area)	Least concern
Family Lacertidae			
<i>Acanthodactylus erythrurus</i> (Schinz, 1833)	4, 25, 26, 27	PF, OA, CF, M	Least concern
<i>Mesalina olivieri</i> (Audouin, 1829)	24	OA	Least concern
<i>Ophisops occidentalis</i> (Boulenger, 1887)	2, 3, 4, 8, 11, 18, 19, 24, 27	M, PF, RA, OA	Least concern
<i>Podarcis vaucheri</i> (Boulenger, 1905)	5, 6, 17, 18, 19, 26	CF, M	Least concern
<i>Psammodromus algirus</i> (Linnaeus, 1758)	4, 5, 6, 7, 8, 10, 11, 17, 20, 26, 27, 28	PF, CF, OA, M, RA	Least concern
<i>Timon pater</i> (Lataste, 1880)	6, 7, 13, 17, 20	CF, M, OA	Least concern
Family Phyllodactylidae			
<i>Tarentola mauritanica</i> (Linnaeus, 1758)	3, 28	RA	Least concern
Family Scincidae			
<i>Chalcides ocellatus</i> (Forskål, 1775)	5, 15, 18	CF, OA, M	Least concern

Family Trogonophidae			
<i>Trogonophis wiegmanni</i> (Kaup, 1830)	14	M	Least concern
Suborder Serpentes			
Family Colubridae			
<i>Hemorrhois hippocrepis</i> (Linnaeus, 1758)	10, 13	M	Least concern
<i>Macroprotodon cucullatus</i> (Geoffroy Saint-Hilaire, 1827)	6, 14	CF, M	Least concern
<i>Natrix maura</i> (Linnaeus, 1758)	9, 21, 23	M, O	Least concern
Family Psammophiidae			
<i>Malpolon monspessulanus</i> (Hermann, 1804)	6, 12, 25	CF, OA	Least concern
Family Viperidae			
<i>Daboia mauritanica</i> (Gray, 1849)	2, 14, 23	M, OA	Near threatened

Conclusions

The results of this study suggest that, despite the impact of climate change, human-induced fires, and cattle overgrazing on the general landscape of the BBR in recent years (i.e. the suppression and fragmentation of vegetation cover), the remaining original structure continues to support diverse amphibian and reptile species. Based on these findings, primary management actions are recommended for implementation within the BBR. Emphasis should be applied to the restoration of the Atlas cedar and alpine forests, as well as the maquis of green oak, to prevent population declines. Additionally, the recorded species in the BBR, with priority for those dependent on cedar and alpine forests, and maquis, should be used as indicators in order to accurately evaluate the success of the management actions.

Furthermore, it is essential that attention is focused on the management of areas outside the borders of the BBR, as habitat loss pressure is also increasing in these unprotected regions across Algeria.

This checklist of herpetofauna provides baseline knowledge on the BBR biodiversity, which is fundamental for its sustainable management. Nonetheless, it is recommended that this inventory should be supported with additional sampling efforts to assess population densities in different habitats and conduct genetic analyses, which will be necessary for the development of informed conservation strategies.

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