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A checklist of the amphibians and reptiles of Western Sahara
(Amphibia, Reptilia)

Checkliste der Amphibien und Reptilien von Westsahara
(Amphibia, Reptilia)

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KURZFASSUNG

Die Liste der Amphibien und Reptilien von West Sahara umfaßt 46 definitiv nachgewiesene Arten (4 Amphibien, 42 Reptilien). 13 weitere Arten, die für das Gebiet noch nicht bekannt sind, könnten hier noch gefunden werden. *Tarentola boehmei* wird aus der Faunenliste von West Sahara genommen und die Auswirkungen des Jbel Ouarkziz, einer biogeographischen Grenze, welche die herpetofaunistischen Elemente Marokkos (nördlich des Jbel Ouarkziz) von denen der West Sahara trennt, werden beschrieben. Die Zusammensetzung der Herpetofauna von West Sahara wird wie folgt beurteilt: 10 Arten zeigen mediterrane Affinitäten, 2 nord-saharische, 19 rein saharische und 7 sahelische; 4 sind tropische Relikte und 4 sind auf den ozeanischen Küstenstreifen beschränkt und können als "kontinental-makaronesische Endemiten" bezeichnet werden. Danach ist die Herpetofauna von West Sahara im wesentlichen saharischen Ursprungs, doch stellt das Gebiet trotz der offensichtlich einförmigen Landschaft ein tiergeographisches Grenzgebiet für Amphibien und Reptilien dar. Dies kann auf die große Nord-Süd-Ausdehnung von West Sahara und den Klimakontrast zwischen dem ozeanisch beeinflußten, relativ feuchten und gemäßigten Küstengebiet und dem Landesinneren zurückgeführt werden, das dem trockenen Saharaklima mit seinen starken Temperaturschwankungen ausgesetzt ist.

ABSTRACT

The list of the amphibians and reptiles of Western Sahara includes 46 species (4 amphibians and 42 reptiles), while 13 further species unknown in this area could conceivably be discovered there. Among the important facts, we exclude *Tarentola boehmei* from the fauna of Western Sahara, and report on the effect of the Jbel Ouarkziz which acts as a biogeographical boundary, separating the herpetofaunal elements from Morocco (north of the Jbel Ouarkziz) and from Western Sahara. The herpetofauna of Western Sahara is composed as follows: 10 species can be considered as being of Mediterranean affinities, 2 as North Saharan, 19 as purely Saharan, 7 as being of Sahelian affinities, 4 are tropical relicts and 4 are limited to the oceanic fringe of the Sahara and can be considered as "continental Macaronesian endemics". This confirms that the herpetofauna of Western Sahara is mainly of Saharan origin but that this area is, in spite of its apparently uniform landscape, a biogeographical cross-roads for Amphibians and Reptiles. This can be related to the wide latitudinal amplitude of Western Sahara and by the climate contrast between the oceanic fringe, comparatively humid and temperate, and the remaining of the country, subject to a dry Saharan climate with strongly contrasted temperature.

KEY WORDS

Amphibia, Reptilia, Western Sahara, north-western Africa, checklist, chorology, biogeography

HISTORICAL ACCOUNT ON THE HERPETOLOGICAL INVESTIGATION OF WESTERN SAHARA

Western Sahara, as considered by BONS and GENIEZ (1996), is delimited to the extreme north-east by Algeria (Tindouf area), to the south and east by Mauritania, to the west by the Atlantic and to the north by the 27°30' N parallel. This vast expanse of Sahara (300,000 km^2) thus lies between the 27°30' N and 19°45' N parallels.

The first work concerning the herpetofauna of Western Sahara (then known as Spanish Sahara) was published by GÜNTHER in 1903. This author mentioned the following species from the Dakhla Peninsula: *Geckonia chazaliae*, *Stenodactylus sthenodactylus*, *Tropiocolotes tripolitanus*, *Varanus griseus*, *Acanthodactylus aureus*,

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and *Macroprotodon cucullatus*. Shortly thereafter, ZULUETA (1909) added *Scincus albifasciatus* and *Cerastes vipera* to this list. C. R. BOETTGER (1921) reported on the presence of several new species for the region: "*Eremias guttulata*" (probably *Mesalina olivieri* or *M. pasteuri*), *Cerastes cerastes*, and *Psammophis schokari*. Much later, PARKER (1942) separated the *Tropiocolotes* from southern Western Sahara as a distinct species, *Tropiocolotes occidentalis*, only recognised by LOVERIDGE (1947) as a subspecies of *Tropiocolotes tripolitanus*. MONTEIL (1951) published an annotated list dealing with amphibians and reptiles from Western Sahara, southern Morocco and Mauritania.

The only important book on the vertebrates of Western Sahara was published by VALVERDE in 1957. He drew up the first comprehensive list of amphibians and reptiles from Western Sahara, including 29 species: *Bufo viridis*, *Rana* sp. (cf *saharica*), *Geckonia chazaliae*, *Tropiocolotes tripolitanus*, *Stenodactylus sthenodactylus*, *Stenodactylus petrii*, *Tarentola ephippiata* (according to the author's description, it is *Tarentola annularis*), *Chamaeleo chamaeleon*, *Agama bibronii*, *Trapelus mutabilis*, *Uromastyx acanthinura*, *Varanus griseus*, *Lacerta lepida* (?), *Mesalina rubropunctata*, *Acanthodactylus boskianus*, *Acanthodactylus scutellatus* (in fact *Acanthodactylus aureus*), *Scincus albifasciatus*, *Chalcides* sp. (probably *Sphenops sphenopsiformis*), *Coluber algirus*, *Lamprophis fuliginosus*, *Lytorhynchus diadema*, *Macroprotodon cucullatus*, *Malpolon monspessulanus*, *Malpolon moilensis*, *Psammophis schokari*, *Cerastes cerastes*, *Cerastes vipera*, and *Echis* sp.

HOOGMOED (1974) mentioned *Saurodactylus* (*mauritanicus*) *brosseti* from around Boujdour. He also suggested (1972) that the toads pictured in VALVERDE (1957) may be *Bufo brongersmai*, but later examination of these animals confirmed that they were *Bufo viridis*. In 1975 SALVADOR and PERIS published a new list of the amphibians and reptiles from Western Sahara. They described a new subspecies of frog (*Rana ridibunda riodeoroi*), confirmed the occurrence there of *Tarentola ephippiata* and *Saurodactylus* (*mauritanicus*) *brosseti* and added four species to those already known: *Acanthodactylus pardalis* (in fact a species endemic to south-western Morocco and Western Sahara, *Acanthodactylus busacki*, e.g., SALVADOR 1982), *Mesalina guttulata*, *Mesalina olivieri simoni* (possibly intending *Mesalina pasteuri*), and *Sphenops delislei*. SALVADOR (1982) recognised in his systematic revision of the genus *Acanthodactylus* four species from Western Sahara: *Acanthodactylus boskianus*, *A. busacki*, *A. aureus* and *A. dumerili*. Recently, VALVERDE (1989), in his systematic study of *Naja haje*, described a new subspecies, *Naja haje legionis*, restricted to north-western Africa. According to him, this form inhabits the northern half of Western Sahara. In an oral communication of 1992 the same author announced the occurrence of several snake species that are rare in north-western Africa: *Spalerosophis diadema*, *Dasypeltis scabra*, *Telescopus obtusus*, and *Bitis arietans*. GARCIA-PARIS and LÓPEZ-JURADO (1990) added new localities to the distribution of *Bufo viridis* in Western Sahara.

Two recent notes dealt with the herpetofauna of Western Sahara. The first one (GENIEZ et al. 1992) brought new localities for several species already known from the area. The second one (GENIEZ & GENIEZ 1993) reported two new species for Western Sahara: *Tarentola boehmei* and *Mesalina pasteuri*. BONS and GENIEZ (1996) set the list of amphibians and reptiles from Western Sahara to 42 species, including only one species new to the area: *Tarentola mauritanica*, occurring in Dakhla and already mentioned from this place by SALVADOR and PERIS (1975) as *Tarentola mauritanica deserti*. The same year, SALVADOR (1996) mentioned only two species from Western Sahara in his work on amphibians of Northwest Africa: *Bufo viridis* and *Rana saharica*. Lastly, MATEO et al. (1997) discovered a new amphibian species for Western Sahara (*Bufo xeros*), and MATEO et al. (1998) described a new *Uromastyx* species, *U. occidentalis*, the only reptile species considered as endemic to Western Sahara. This present study increases the number of species in this list by the discovery of *Dicroglossus occipitalis* in 1999. The total number of amphibian and reptile species known to occur in Western Sahara now reaches 46.

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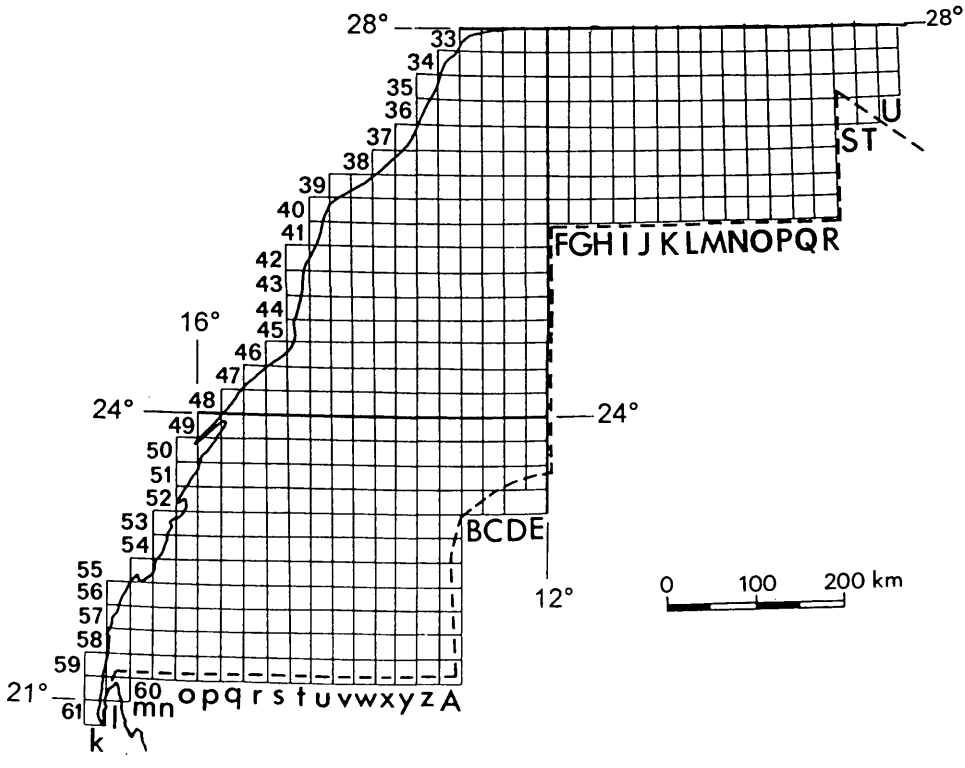

Fig. 1: Map of Western Sahara with the 1/50,000 IGN maps (about 20 km x 25 km) used to reference the localities mentioned in the text.

Abb. 1: Karte von West Sahara mit Koordinaten und dem Netz der 1:50.000 IGN Kartenblätter (zu je etwa 20 km x 25 km), die als Lagebezug für die im Text zwischen eckigen Klammern angegebenen Fundorte dienen können.

CHECKLIST OF AMPHIBIANS AND REPTILES OF WESTERN SAHARA

The following list of the amphibian and reptile species known from Western Sahara provides information on their geographical range within this area. The position of locations followed by co-ordinates between brackets can be found in figure 1. E. B. Doñana = Estación Biologíca de Doñana (Sevilla).

Bufo viridis viridis LAURENTI, 1768

The occurrence of this species is restricted to the few temporary or permanent water points along the coast: Sekhiat al Hamra, from Laâyoune-Plage [z36] (VALVERDE 1957; M. THÉVENOT pers. com.; GARCIA-PARIS & LÓPEZ-JURADO 1990) to 55 km east of Laâyoune (GARCIA-PARIS & LÓPEZ-JURADO 1990); Dakhla [p49, p50] (M. THÉVENOT pers. com.); El Argoub and 7 km north of El Argoub [p50] (GENIEZ et al. 1992). The latter three localities constitute part of the southern edge of the species' distribution.

Bufo xeros TANDY, TANDY, KEITH & DUFF-MCKAY, 1976

This subsaharan species reaches the southern Sahara (SALVADOR 1996) along the southward oriented valleys (wadis). In Western Sahara, the only definite locality

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is Auadi [A57], in the upper part of Wadi Aïn-Ascaf, which runs from north-east to south-west and opens toward the Azeffâl in Mauritania (MATEO et al. 1997). This species should be looked for in the Adrar Souttouf, where toads of the genus *Bufo* have been reported (E. MAHÉ pers. com.).

Rana saharica riodeoroi
SALVADOR & PERIS, 1975

In Western Sahara, Green frogs are only known from the irrigated area around Foum El-Oued, about 15 km north-west of Laâyoune [A36] (BONS & GENIEZ 1996). They should be looked for in the Zemmour mountains, where ranid tadpoles have been seen (HASI et al. 1997).

Dicroglossus occipitalis
(GÜNTHER, 1858)

This Sahelian ranid has been reported from the southern edge of the Sahara, in peculiar from south-western Libya, Adrar des Iforas (Mali), Air mountains (Niger) (SALVADOR 1996), and Adrar (Mauritania) (SALVADOR 1996; R. MARQUEZ, pers. com.). Several animals of this species previously unknown in Western Sahara were found recently (1999) at Gleib Ledjir [21° 23' N / 13°05' W], in the south-eastern margin of Western Sahara (M. HASI pers. com.), a relatively wet area, with puddles resulting from recent rain.

Tarentola (*Tarentola*) *mauritanica*
(LINNAEUS, 1758)

GENIEZ et al. (1991) have wrongly mentioned the presence of *Tarentola boehmei* JOGER, 1984 in northern Western Sahara, especially around the Khnifiss lagoon [E32 and D33], around Laâyoune [A36] and at Dchira [A37]. Having recently re-examined these animals, we realized that, although their general habitus was similar to the habitus of *T. boehmei* (general coloration translucent pink or yellowish, weak dorsal tubercules), their scalation was strongly reminiscent of *T. mauritanica*. They have carinated tubercles in the vertebral area, the tubercles from the upper flanks are encircled by a row of secondary tubercles, and they have a reduced number of subdigital lamellae (17 or 18) and gular scales. All these characters are in agreement with the diagnosis of *T. mauritanica* in JOGER (1984). But several features distinguish these animals form all other populations of *T. mauritanica*. They were described as a new subspecies - *Tarentola mauritanica pallida* GENIEZ, ESCATLLAR, CROCHET, MATEO & BONS, 1999 (GENIEZ et al 1999). Furthermore, the form *Tarentola mauritanica juliae* JOGER, 1984, that has a Mediterranean distribution and reaches the surroundings of Tan-Tan toward the south-west (GENIEZ et al. 1999), was found in only one locality in Western Sahara: the cemetery of Dakhla [p50]. Given the natural range of this form, the species is likely introduced there. SALVADOR & PERIS (1975) had already mentioned some *Tarentola* in this place, under the name "*Tarentola mauritanica deserti*".

Tarentola (*Sahelogecko*)
annularis annularis
(GEOFFROY SAINT-HILAIRE, 1809)

This big *Tarentola* of Sahelian affinity is thinly distributed over the whole area (mainly in rocky places) except for a 50 to 100 km wide coastal stripe (BONS & GENIEZ 1996).

Tarentola (*Sahelogecko*)
ephippiata hoggarensis
WERNER, 1937

This *Tarentola* is spread over the whole area, but is restricted to acacia trees (*Acacia raddiana* and *A. ehrenbergiana*) (J. A. VALVERDE pers. com.; BONS & GENIEZ 1996).

Hemidactylus brooki angulatus
HALLOWELL, 1852

The subspecies *angulatus* is the African form of *H. brooki* (LOVERIDGE 1947; WELCH 1982). It has an intertropical distribution, reaching north up to Nouakchott along the Mauritanian coast (INEICH 1997). Only one locality - where it may not be native - is known in Western Sahara: 24 km north of Lagwera (Cap-Blanc peninsula) [k60] (HASI et al. 1997).

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Geckonia chazaliae
MOCQUARD, 1895

This remarkable endemic of the Atlantic fringe of the Sahara, inhabits the whole coastal range of Western Sahara. It usually lives close to the littoral zone, except in the Sekhiat al Hamra where it reaches as far as 115 km from the ocean [C38] (HASI et al. 1997).

Stenodactylus sthenodactylus
(LICHTENSTEIN, 1823)

This Saharan gecko is widespread over the whole area, including the coasts, mainly in less sandy places (BONS & GENIEZ 1996).

Stenodactylus petrii
ANDERSON, 1896

Considered as the most psammophilous Saharan gecko, this species is limited to the large dune areas where it tends to replace *S. sthenodactylus*: from Laâyoune [A36] to A'Raryd [J40]; Dakhla peninsula [p49]; Imililik [p51] (BONS & GENIEZ 1996). Its presence should be investigated in all sandy areas, especially around Boujdour.

Saurodactylus brosseti
BONS & PASTEUR, 1957

This North-west African endemic is found along the Western Saharan coast as far south as wadi Assag [u42] (HOOGMOED 1974). It is also known from Mahbes-Eskaikima [Q35] (HASI et al. 1997), and Guelta Zemmour [D44] (SALVADOR & PERIS 1975). In the latter locality, its presence can be related to the occurrence of several other species of Mediterranean or North Saharan affinities: *Mesalina guttulata*, *Acanthodactylus busacki*, *Chalcides ocellatus*, and *Telescopus obtusus*.

Tropiocolotes tripolitanus
PETERS, 1880

Two parapatric forms inhabit Western Sahara, including the coasts. The form *algericus* LOVERIDGE, 1947 is the most widespread, reaching as far south as the Cap Blanc peninsula (INEICH 1997). In Western Sahara, the form *occidentalis* PARKER, 1942 seems restricted to the southern third except the littoral areas (BONS & GENIEZ 1996).

Chamaeleo chamaeleon chamaeleon
(LINNAEUS, 1758)

This species seems to be rare in Western Sahara, along the Atlantic coast: Tarfaya [B33], Laâyoune [A36], and 87 km beyond Boujdour toward Dakhla [t43] (GENIEZ & GENIEZ 1993).

Agama impalearis BOETTGER, 1874
[*Agama bibroni*
DUMÉRIL & DUMÉRIL, 1851]

The most common Moroccan reptile is much rarer in Western Sahara. It is thinly distributed over the Atlantic coast, south to Dakhla [p50] and extends inland in the Sekhiat Al Hamra, east to Smara [G38] (BONS & GENIEZ 1996). It should be looked for in the Zemmour moutains, where the rocky substrates should constitute a favourable habitat.

Trapelus mutabilis
(MERREM, 1820)

One of the most common reptiles in Western Sahara, widespread over the whole area, including the coasts (GENIEZ & GENIEZ 1993). Nevertheless, it seems to be absent from the roughest grounds, like some parts of the Adrar Souttouf.

Uromastyx flavifasciata
MERTENS, 1962

This taxon has recently been given full species rank by MATEO et al. (1998). Distributed over the whole area except a littoral fringe about 100 km wide. Seems to be less abundant in the mountain ranges. *U. flavifasciata* is represented by two subspecies present in the area (MATEO et al. 1998): *U. f. flavifasciata*, characterized by a yellow colour stripped of black and lives in the northern two thirds of Western Sahara as far as Tindouf area (Algeria); *U. f. obscura* MATEO, GENIEZ, LÓPEZ-JURADO & BONS, 1998, characterised by a uniformly black colour lives in the southern third of

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Western Sahara, as far as Awserd in the north.

Uromastyx occidentalis
MATEO, GENIEZ, LÓPEZ-JURADO & BONS, 1998

Only known from the western rim of the Adrar Souttouf, at Aagtel Agmumuit [q57] (between Yeloua and Mades) (MATEO et al. 1998). At the time of writing, it is the only reptile species considered as endemic to Western Sahara.

Uromastyx cf. *maliensis*
JOGER & LAMBERT, 1996

A picture taken by E. MAHÉ of a specimen from the north of the Adrar Souttouf suggests a strong similarity of this specimen to *U. maliensis*, but the occurrence of this species in the mountain areas of southern Western Sahara needs confirmation. *Uromastyx maliensis* is known from northern Mali and southernmost Algeria. Several specimens from the Mauritanian Adrar examined by us closely match the description given for this species by JOGER & LAMBERT (1996).

Varanus griseus griseus
DAUDIN, 1803

Thinly distributed over the whole Western Sahara, mainly in sandy areas (BONS & GENIEZ 1996). Rare (or extinct) in the littoral area, where it is only known by two old records: Dakhla peninsula [p49] (GÜNTHER 1903) and Cap Blanc peninsula [k61] (BOETTGER 1921).

Mesalina olivieri
(AUDOUIN, 1829)

Known from the coastal fringe from Tarfaya [B33] to 68 km south of Boujdour toward Tarfaya [u42] (GENIEZ & GENIEZ 1993). Records of this species in the southern half of Western Sahara could be of *Mesalina pasteuri*.

Mesalina guttulata
(LICHTENSTEIN, 1823)

Scattered over the rocky areas of the northern half of Western Sahara: Edcherer [D36] (BONS & GENIEZ 1996); wadi Sloguia, 50 km south of Mahbes [S36] (BONS & GENIEZ 1996); Agalmin Mellas [E43] (SALVADOR & PERIS 1975). Absent from the littoral.

Mesalina pasteuri
(BONS, 1960)

This small lizard is sparsely distributed in areas where sand is limited: Foucht [r51] (GENIEZ & GENIEZ 1993); Auhaifrit [u52] (BONS & GENIEZ 1996); 58 km beyond Smara toward Laâyoune [E38] (BONS & GENIEZ 1996); Wadi Aïn Ascaf, Auadi [A57] (HASI et al. 1997).

Mesalina rubropunctata
(LICHTENSTEIN, 1823)

This species can be found in the regs of Western Sahara, where it is easily overlooked. Probably lacking along the coast (BONS & GENIEZ 1996).

Acanthodactylus busacki
SALVADOR, 1982

This North-west African endemic inhabits the northern third of Western Sahara where it is especially widespread on the littoral, south to the surroundings of Boujdour [v40]. Enters inland through the Sekhiat al Hamra, reaching Mahbes Eskaikima [Q35] (coll. E. B. Doñana; BONS & GENIEZ 1996).

Acanthodactylus boskianus
(DAUDIN, 1802)

The most widespread fringe-toed lizard in Western Sahara. Inhabits most of the country, especially abundant in the beds of fossil wadis. Reaches the coastal area near Laâyoune [z36 and z37] (VALVERDE 1957; SALVADOR 1982; coll. E. B. Doñana) via the Sekhiat al Hamra, and near Dakhla [p50] (SALVADOR 1982).

Acanthodactylus dumerili dumerili
(MILNES EDWARDS, 1829)

According to SALVADOR (1982), western Saharan populations of *A. dumerili* are intermediate between *A. d. dumerili* and *A.*

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d. exiguus LATASTE, 1885. Only found in continental sand dunes and sand banks. Parapatric with *A. aureus* (SALVADOR 1982; pers. obs.).

Acanthodactylus aureus
GÜNTHER, 1903

The most abundant lacertid along the coast. Reaches inland as far as around Smara via the Sekhiat al Hamra (BONS & GENIEZ, 1996).

Chalcides ocellatus ocellatus
(FORSKÅL, 1775)

This only species of the genus known from Western Sahara has been found only in one locality: Ichargan [D46], in the Zemmour mountains (HASI et al. 1997). This locality is roughly halfway between the southernmost localities in Morocco (cf. MATEO et al. 1995) and the Adrar Atar in Mauritania (DEKEYSER & VILLIERS 1956).

Sphenops sphenopsiformis
(DUMÉRIL, 1856)

This species, which has a distribution similar to *Acanthodactylus aureus*, is the most abundant scincid lizard in Western Sahara. Restricted to dunes and sand beds, it reaches inland as far as 250 km from the coast. In our region, the three species of *Sphenops* (included Morocco with *Sphenops boulengeri*) have a parapatric distribution (BONS & GENIEZ 1996).

Sphenops delislii
(LATASTE, 1876)

This fossorial scincid species is known from only five localities in Western Sahara, all situated in continental sand beds in the southern third of the country (SALVADOR & PERIS 1975; GENIEZ & GENIEZ 1993; specimens seen by the authors in the collections of the E. B. Doñana). It avoids the coastal fringe where it is replaced by *S. sphenopsiformis*.

Scincus albifasciatus albifasciatus
BOULENGER, 1890

Strictly restricted to the large eolian dunes (ergs) where it is thinly distributed. Reaches the coast near Laâyoune [z36] (ARNOLD & LEVITON 1977; pers. obs.) and Dakhla [p49] (ZULUETA 1909).

Coluber algirus intermedius
WERNER, 1929

This snake can be found all along the coast of Western Sahara. It has also been mentioned at a few inland localities: Adrar Souttouf [s56]; Zemmour mountains, at Aïn Timellousa [E44] and Bir Moghrein in Mauritania [G43]; Fderik, in Mauritania close to the border with Western Sahara [C54] (BONS 1962; HASI et al. 1997).

Spalerosophis diadema cliffordi
(SCHLEGEL, 1837)

From Western Sahara only known from the coast between Tarfaya and Laâyoune (SCHOUTEN & THÉVENOT 1988) and from the Sekhiat El Hamra, eastward to Smara [G38] (BONS & GENIEZ 1996).

Macroprotodon cucullatus cucullatus
(GEOFFROY SAINT-HILAIRE, 1827)

Reaches the limit of its range in Western Sahara. It is sporadic on the coast where it has only been found in the following localities: Dakhla [p50] (GÜNTHER 1903; VALVERDE 1957) and Dakhla airport [p49] (GENIEZ et al. 1992); 6 km, 8.5 km and 11.5 km south-west of Lemsid [x39] (GENIEZ et al. 1992; GENIEZ & GENIEZ 1993).

Telescopus obtusus
(REUSS, 1834)

Mentioned only twice for Western Sahara: Laâyoune [A36] (VALVERDE 1992) and Ichargan [D46] in the Zemmour mountains (HASI et al. 1997).

Lytorhynchus diadema diadema
(DUMÉRIL, BIBRON & DUMÉRIL, 1854)

This species may have a disjunctive range in the area, inhabiting the sandy areas in the north of Western Sahara and having been reported from El Aioudj [m60] (PELLEGRIN 1910) and at the north of Tirersioum (MAHÉ 1985) [o61], in Mauritania, very close to the border to Western Sahara. It should consequently be looked for

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in all sandy habitats of the region, including on the coastal fringe.

Lamprophis fuliginosus fuliginosus
(BOIE, 1827)

There is only one mention for Western Sahara: Laâyoune [A36] (VALVERDE 1992). This is the southernmost of the relict populations isolated north of the Sahara.

Dasypeltis scabra scabra
(LINNAEUS, 1758)

Only one locality in Western Sahara: Ahel Brahimat (=Adaro) [B39] (coll. E. B. Doñana). As for *L. fuliginosus*, it is the southernmost locality north of the Sahara.

Malpolon monspessulanus monspessulanus
(HERMANN, 1804)

This Mediterranean species reaches Western Sahara along the coast, south to the Dakhla peninsula [p49 and p50] (VALVERDE 1957; pers. obs.), which constitutes the southern limit of its range.

Scutophis moilensis
(REUSS, 1834)

Widespread all over the country, also in the coastal areas (BONS & GENIEZ 1996).

Psammophis schokari
(FORSKÅL, 1775)

This most conspicuous snake of Western Sahara is widespread all over the country, including the coasts (BONS & GENIEZ 1996).

Naja haje legionis
VALVERDE, 1989

Known from the northern third of Western Sahara, south to wadi Assag [u44] (VALVERDE 1989). It has also been found in the Zemmour at Aïn Timellousa [E44] (HASI et al. 1997).

Cerastes cerastes (LINNAEUS, 1758)

This most common viper in Western Sahara is widespread all over the country, although the only mention from the coast was many years ago: Cap Blanc peninsula (BOETTGER 1921). Furthermore, there is a specimen from Laâyoune in the collections of the E. B. Doñana, but we think that the origin of this specimen is doubtful.

Cerastes vipera (LINNAEUS, 1758)

Like *Scincus albifasciatus* this small viper is restricted to the large eolian sand dunes: coastal dunes, from Tarfaya to 41 km after Boujdour toward Dakhla [u42] (M. GENIEZ pers. com.); Bou Kra [B39] and 12 km south of Bou Kra [C41] (coll. E. B. Doñana); Auhaifrit [u52] (VALVERDE 1957); Aghoueinit [A56] (coll. E. B. Doñana); Cap Blanc peninsula in Mauritania [160] (INEICH 1997).

Bitis arietans arietans (MERREM, 1802)

This large tropical species has a disjunctive distribution, with isolated populations north of the Sahara in South-west Morocco and in Western Sahara where it is distributed along the coast from Tarfaya [B33] to the Cap Boujdour [v39] (VALVERDE 1992).

SPECIES WHICH HAVE NOT YET BEEN RECORDED IN WESTERN SAHARA BUT MAY BE EXPECTED TO OCCUR THERE

Bufo brongersmai
HOOGMOED, 1972

This small toad is endemic in Southern Morocco. The southernmost localities lie around the Khnifiss lagoon (SCHOUTEN & THÉVENOT 1988), i.e. 35 km from the 27°30'N parallel which we designated as the northern border of Western Sahara. In the Sekhiat El Hamra, the species has never been found despite thorough research (L. F. LOPEZ-JURADO, pers. com.; pers. obs.). It should nevertheless been looked for in the Zemmour mountains which, as the Anti-Atlas, contains apparently favourable habitats.

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Bufo mauritanicus
SCHLEGEL, 1841

Like the preceding species, *B. mauritanicus* has been recorded as far south as the Khnifiss lagoon (SCHOUTEN & THÉVENOT 1988). It could thus be found in the same areas as *B. brongersmai*. It could also be worth investigating the temporary pools situated in the wadi Kara, about 95 km north of Smara.

Tarentola boehmei
JOGER, 1984

This species is endemic to south-western Morocco (JOGER 1984; BONS & GENIEZ 1996). It has erroneously been reported for Western Sahara, in the surroundings of Laâyoune and south to Dchira [A37] (GENIEZ et al. 1991) (see under *T. mauritanica*), in ruins and around buildings. Its presence remains nevertheless a possibility in the rocky parts of the Zemmour massif.

Quedenfeldtia moerens
(CHABANAUD, 1916)

This Moroccan endemic is restricted to the dry mountains in the south of this country, inhabiting small rocky cordilleras of Saharan climate in the southern part of its range. The southernmost localities lie near Abatteh (BONS & GIROT 1974), 40 km north of the 27°30' N parallel. It should be searched for in the small mountains in the north of Western Sahara, especially in the cuestas between Smara and Laâyoune, as well as in the Zemmour mountains.

Ptyodactylus oudrii
LATASTE, 1880

This gecko inhabits dry rocky mountains in southern Morocco, north-central Algeria and western Tunisia (HEIMES 1987). The southernmost localities in Morocco are situated on the north side of the wadi Drâa, south of Tiglite and Aouïnet Torkoz (BONS & GIROT 1974), i.e. 85 km north of the 27°30' N parallel. It should thus be looked for in similar habitats in Western Sahara, especially in the Zemmour mountains.

Uromastyx acanthinura werneri
L. MÜLLER, 1922

This species is abundant in all the Moroccan areas lying south and east of the High Atlas, except in the Souss valley and the oceanic fringe. The southern limit of its range is constituted by the Jbel Ouarkziz, which is crossed along the wadi Saac (= Souak). Further south this agamid is replaced by the vicariant *U. flavifasciata*. An interspecific competition between these two taxa could thus exclude *U. acanthinura* form Western Sahara.

Lacerta sp.

VALVERDE (1957) reports on the existence of a large lacertid species, supposed to be "*Lacerta lepida*", in the Sekhiat al Hamra area: Laâyoune [A36], seen several times on the rocks of the northern side of the Sekhiat El Hamra; Messied [J32], one individual hiding among *Rhus* sp. in open scrubland; Edchera [A36] (= Dchira), two records on the rocks along the Sekhiat; doubtfully seen in the "graras" south-east of Laâyoune. The author adds that these animals are rare in all cited locations, and seem restricted to rocks and densely vegetated areas with a rich biocenose. No observation of large lacertids has been done since that in Western Sahara, despite extensive searching in the localities mentioned by VALVERDE (M. GENIEZ & L. F. LOPEZ-JURADO pers. com.; SCHLEICH et al. 1996).

Acanthodactylus taghitensis
GENIEZ & FOUCART, 1995

This lizard is presently known from only three localities, two near Taghit (Béni-Abbès area, Algeria) and one at Fort-Gouraud (= Fderik) in Mauritania, some 40 km from the border to Western Sahara (HASI et al. 1997). This species should thus be searched for in the sandy areas of the south-eastern margins of Western Sahara.

Chalcides polylepis
BOULENGER, 1890

This Moroccan endemic is widespread west of the Atlas mountains. The most south-western observation has been

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made near the Atlantic coast, 5 km west of Hassi oued Ouma Fatma [G31] (BONS & GIROT 1974), 60 km north of the 27°30' N parallel. Similar habitats occur further south, in the region of Laâyoune. The species might thus be found in the extreme north-western Western Sahara. MATEO et al. (1995) mentioned the existence of *Ch. polylepis* in Laâyoune, quoting VALVERDE (1957), a quotation also repeated by GENIEZ & BONS (1996). In fact, VALVERDE never mentioned this species for Western Sahara. The record from Laâyoune must thus be considered as erroneous.

Sphenops boulengeri (ANDERSON, 1896)

This species occupies the sandy areas and the ergs of the western half of the Sahara (SCHLEICH et al. 1996). In Morocco, it is widespread in sandy zones situated south of the Atlas mountains and subject to a Saharan climate with temperate winters (BONS & GENIEZ 1996). Along the Drâa valley it reaches as far west as 71 km beyond Aouïnet Torkoz toward Messied [L31]. Further west, it is replaced by a western vicariant species, *S. sphenopsiformis* (DUMÉRIL, 1856). It seems likely that competition with this species takes place in Western Sahara, but *S. boulengeri* should nevertheless be looked for in the region between Amgala and Tindouf, where no *Sphenops* has been recorded up to now.

Leptotyphlops macrorhynchus (JAN, 1861)

This Saharo-Sindian element known from 11 Moroccan localities is regularly spread over the Saharan margins of the country (BONS & GENIEZ 1996). The southernmost Moroccan locality is Hassi Amott [M32] (BONS 1973) in the Jbel Ouarkziz, about 70 km north of the border to Western Sahara. The species is also mentioned in the Adrar of Mauritania, not far from the south-eastern edge of Western Sahara (DEKEYSER & VILLIERS 1956). Being very small and difficult to detect, this snake probably also occurs in Western Sahara.

Spalerosophis dolichospilus (WERNER, 1923)

In Morocco this snake, which is considered as a Maghreban endemic by PASTEUR (1967), occurs in the arid eastern and southern parts of the country. BONS & GENIEZ (1996) consider that the lower Drâa valley constitutes the southern limit of its range, and that it is replaced further south (Khnifiss lagoon and Sekhiat al Hamra) by the closely-related *S. diadema* (SCHLEGEL, 1837). In spite of this, J. GARZONI and J. M. PILLET (pers. com.) discovered one specimen of this species at Sidi Lemsid [E32], near the Khnifiss lagoon, where only *S. diadema cliffordi* (SCHLEGEL, 1837) was hitherto known (SCHOUTEN & THÉVENOT 1988). This constitutes the first case of sympatric occurrence of these two taxa in Morocco, and illustrates the possibility that *S. dolichospilus* could reach the region of the Sekhiat al Hamra.

Macrovipera mauritanica
(DUMÉRIL & BIBRON in GUICHENOT, 1848)

This big viper is another endemic of the Maghreb. The southernmost locality where it has been found is situated 55 km after El Aïoun-du-Drâa toward Aouïnet Torkoz [M31] (BONS 1957), i.e. 85 km north of the northern boundary of Western Sahara. It should be looked for in the small rocky cuestas bordering the Sekhiat al Hamra and in the most rocky parts of the Zemmour mountains.

Echis leucogaster
ROMAN, 1972

This small viper seems to be extremely rare in southern Morocco, where it is only known by three specimens from two localities (MARAN & GENIEZ 1999). In addition, REYMOND (1956) mentions the observation of a viper which could be an *Echis* in the Zemmour in Mauritania, precisely at Kreyma el Maïjat, between the hills of Delooa and Houmat el Ham, only a few kilometres from the border to Western Sahara. Lastly, VALVERDE (1957) reports on the existence of a viper specimen in the zoological collection of Laâyoune, bearing no indication of date or locality. According to him, it should be a member of the genus *Echis*. These indications suggests that *E. leucogaster* should be looked for in the rocky wadis of Western Sahara, especially in the Zemmour.

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DISCUSSION

The herpetofauna of Western Sahara comprises at least 46 species, 4 amphibians and 42 reptiles. Partially based on the map of BRIGNON & SAUVAGE (1962-63) in BONS & GENIEZ (1996: 13), the elements of this faunistic assemblage can be assigned to six biogeographical categories:

Mediterranean elements

This category is here understood to include the species that are widespread in the Mediterranean bioclimatic region of the Maghreb and enter Western Sahara through the Atlantic littoral and/or some mountain massifs. They include *Bufo viridis*, *Rana saharica*, *Tarentola mauritanica*, *Saurodactylus brosseti*, *Chamaeleo chamaeleon*, *Agama impalearis*, *Mesalina olivieri*, *Chalcides ocellatus*, *Macroprotodon cucullatus*, and *Malpolon monspessulanus*. Among these species, *B. viridis* and *C. ocellatus* are somehow particular because they both have a large distribution and could be regarded as "Mediterraneo-Sindian", *B. viridis* even going beyond these regions since it occurs in Central Europe and Western Asia, in peculiar in areas subject to continental climate with strong thermal variations. Besides, *Tarentola mauritanica* is apparently the only Mediterranean species that occurs in Western Sahara as a differentiated form proper to this area. Among the species that might be later discovered in Western Sahara, *Bufo mauritanicus*, *Quedenfeldtia moerens*, *Chalcides polylepis* and *Macrovipera mauritanica* are elements of this biogeographic category.

North Saharan elements

In this category we have classified those species the habitats of which - at present - are primarily situated at the northern margin of the Sahara. Some of these species do also occur much further south in mountainous massifs in Central and Southern Sahara, where they show a relictary distribution. *Mesalina guttulata* and *Telescopus obtusus* (the latter as far as Mali, Burkina Faso, and Niger) constitute these elements. The distribution of *Bufo viridis* and *Chalcides ocellatus*, placed in the preceding category, extends into the Sahara as well. Among the species of possible occurrence, *Bufo brongersmai*, *Tarentola boehmei*, *Ptyodactylus oudrii*, *Uromastyx acanthinura*, and *Spalerosophis dolichospilus* would have to be included in this category.

Saharan elements

As a consequence of the geological and bioclimatic situation, this category includes most of the reptile species inhabiting Western Sahara. More than half of these (22 species exactly) have strong Saharan affinities, even if some of them, like *Stenodactylus sthenodactylus*, *Trapelus mutabilis* or *Acanthodactylus boskianus*, marginally reach out of the Sahara. The Saharan elements are *Stenodactylus sthenodactylus*, *Stenodactylus petrii*, *Tropiocolotes tripolitanus*, *Trapelus mutabilis*, *Uromastyx flavifasciata*, *Uromastyx occidentalis*, *Varanus griseus*, *Mesalina pasteuri*, *Mesalina rubropunctata*, *Acanthodactylus boskianus*, *Acanthodactylus dumerili*, *Scincus albifasciatus*, *Coluber algirus*, *Spalerosophis diadema*, *Lytorhynchus diadema*, *Scutophis moilensis*, *Psammophis schokari*, *Cerastes cerastes*, and *Cerastes vipera*. Among the species the occurrence of which may be expected, *Acanthodactylus taghitensis*, *Sphenops boulengeri*, and *Leptotyphlops macrorhynchus* are also typical Saharan elements.

Sahelian elements

Sahelian species as we understand them are species that mainly inhabit the southern margins of the Sahara subject to seasonal tropical rain. Several of these species enter the central Sahara through mountainous massifs (for example the Hoggar mountains, Tassili-n-Ajjer (Algeria) or Mauritanian Adrar) or wooded steppes with *Acacia* sp. Several of these species occur in Western Sahara: *Bufo xeros*, *Dicroglossus occipitalis*, *Tarentola annularis*, *Tarentola ephippiata*, *Hemidactylus brooki*, *Uromastyx* cf. *maliensis* and *Sphenops delislii*. Among them, *Hemidactylus brooki* has probably been introduced in Western Sahara by man.

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Tropical relicts

They are represented by *Lamprophis fuliginosus*, *Dasypeltis scabra*, *Naja haje* and *Bitis arietans*. These snakes are widespread in most of tropical Africa and were probably continuously distributed over the major parts of North Africa as far as to the Atlas mountains until desertification of the area had begun (around 8,000 years ago, cf. LE HOUÉROU 1992). Except for *Naja haje*, which inhabits the northern margins of the Sahara from Morocco to Egypt, these species of tropical origin are now confined, north of the Sahara, to south-western Morocco, the Sekhiat al Hamra and the Atlantic seaboard south to around Boujdour.

Macaronesian endemics

The littoral fringe of Western Sahara is subjected to a "Saharan climate with hot winter". Frequently fogs occur as a result of the intense evaporation of the Atlantic ocean at these latitudes, which considerably lowers the thermal variation. As a consequence, vegetation cover is more extensive than in the interior of the country. The main plant species are *Euphorbia* (*E. regis-jubae*, *E. balsamifera* and *E. echinus*), *Senecio anteuphorbium*, *Mesembryanthemum cristallinum*, *M. nodiflorum*, *Opophytum theurkauffii*, *Aizoon canariense*, and *Limonium* spp. Several of these species show close phylogenetic relationships with representatives of the flora of the Macaronesian islands (OZENDA 1991; BRAMWELL & BRAMWELL 1994), which is also true for several insect genera (GARCÍA BECERRA et al. 1992). These facts, together with its geographical proximity with the Macaronesian islands and a similar climate, explain why the Western Sahara coastal area has been sometimes designed as "the continental Macaronesia" (e. g., BONS & GENIEZ 1996). However, the herpetofaunas of this area and of the Western Atlantic Islands have only few closely related elements in common: *Tarentola boehmei*, *T. mauritanica*, and *Chalcides polylepis* are closely related to the Canarian *Tarentola angustimentalis* and *Chalcides simonyi* respectively (cf. JOGER 1984; PASTEUR 1981), which inhabits the easternmost islands that lie closest to the African coast (Lanzarote, Fuerteventura and the surroundings islets). The continental "Macaronesian" fringe is nevertheless interesting because of its remarkable endemic elements. *Acanthodactylus busacki*, *A. aureus* and *Sphenops sphenopsiformis* are geographical vicariant species closely related to *A. pardalis* s.l., *A. scutellatus* s.l. and *Sphenops boulengeri* respectively, but *Geckonia chazaliae* is one of the most remarkable Saharan endemics, with no living close relative.

The Jbel Ouarkziz boundary

The Jbel Ouarkziz is a low mountain chain (maximal altitude: 770 m) 300 km long with an east-west orientation, running from Messeied to Foum Alguim, right south of Tata. Several passes (called "foum" in Arabic) run through it, from west to east Tisgui-Remz, Oum el Achar and Kheneg Tafagount. It is bordered to the north by the wadi Drâa which, in this area, is only constituted of scattered permanent pools ("guelta"). The southern slope is dominated by a hamada devoid of permanent water courses. In spite of its moderate altitude, the Jbel Ouarkziz constitutes an impassable barrier for several reptile species. Although it lies outside the area considered in this paper (south of the 27° 30' N parallel), a comparison of the herpetofauna inhabiting south and north of this mountain range demonstrates that it constitutes in fact the boundary between the herpetofaunal communities of Western Sahara and Morocco.

North of the Jbel Ouarkziz, in the Drâa valley, 39 species of amphibians and reptiles have been recorded whereas only 26 have been reported in the southern area from the Sekhiat al Hamra to the southern slopes of the Jbel Ouarkziz.

The 18 species common to both areas are *Bufo viridis*, *Tarentola ephippiata*, *Quedenfeldtia moerens*, *Stenodactylus sthenodactylus*, *Tropiocolotes tripolitanus*, *Chamaeleo chamaeleon*, *Agama bibronii*, *Trapelus mutabilis*, *Varanus griseus*, *Mesalina guttulata*, *Mesalina pasteuri*, *Acanthodactylus busacki*, *Acanthodactylus boskianus*, *Lytorhynchus diadema*, *Scutophis moilensis*, *Psammophis schokari*, *Naja haje* and *Cerastes cerastes*.

19 species reach their southern limit in this area at the northern foothills of the

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Jbel Ouarkziz or reach further south only along the Atlantic seaboard: *Bufo mauritanicus*, *B. brongersmai*, *Rana saharica*, *Tarentola mauritanica*, *T. boehmei*, *Ptyodactylus oudrii*, *Saurodactylus brosseti*, *Uromastyx acanthinura*, *Acanthodactylus dumerili*, *Chalcides ocellatus*, *Sphenops sphenopsiformis*, *Eumeces algeriensis*, *Coluber hippocrepis*, *Spalerosophis dolichospilus*, *Natrix maura*, *Malpolon monspessulanus*, *Macrovipera mauritanica*, *Bitis arietans*, and *Crocodylus niloticus* (extinct). *Leptotyphlops macrorhynchus* and *Echis leucogaster* have not yet been found in the area south of Jbel Ouarkziz, but these desert dwelling species are extremely difficult to find in North-west Africa and could have easily been overlooked; they probably occur also south of the Jbel Ouarkziz.

Inversely, the Jbel Ouarkziz seems to mark the north-western limit of the range of several southern species, some of which reach further north but along the Atlantic coast only. These are *Tarentola annularis*, *Stenodactylus petrii*, *Uromastyx flavifasciata*, *Mesalina rubropunctata*, *Acanthodactylus aureus*, *Sphenops sphenopsiformis*, and *Spalerosophis diadema*.

The most interesting distribution pattern that can be detected around the Jbel Ouarkziz is the tendency for the Saharan species from continental Morocco to come closer to the coast along the Drâa valley, whereas several reptiles confined to the sandy Atlantic seaboard enter the Sekhiat al Hamra, east to Smara at least. The best examples are the *Acanthodactylus scutellatus* group (*A. dumerili*, coming from the east, goes along the northern side of the Jbel Ouarkziz, whereas *A. aureus*, coming from the west, extends along its southern side), *Sphenops* (*S. boulengeri* to the north, *S. sphenopsiformis* to the south) and *Uromastyx* (*U. acanthinura* to the north, *U. flavifasciata* to the south). As a consequence, these vicariant species cannot meet in the area. The barrier that is created by the Jbel Ouarkziz thus plays an important part in shaping the distribution of the herpetofauna in the north and west of the Sahara, in a way similar to the High-Atlas that splits Morocco in two distinct biogeographical zones (cf. BONS & GENIEZ 1996).

CONCLUSIONS

The following points can be identified in this overview of the amphibian and reptile fauna of Western Sahara:

* the inclusion of this area into the Saharan region, since more than half of the reptiles that inhabit Western Sahara are of clearly Saharan affinity.

* the uniqueness of this area (including south-western Morocco), stemming from the southward extension of several Mediterranean and North-Saharan species along the Atlantic coast, the persistence of tropical species north of the Sahara thanks to a mild climate, and the existence of several endemic species.

* the important part played by the Zemmour mountains which, although not very high, have been acting as a refugium in the heart of the Sahara for several Palearctic and North-Saharan species.

* the importance of the Adrar Souttouf, an equally low massif, that segregates the three species of *Uromastyx* (*U. flavifasciata* in the reg, *U.* cf. *maliensis* in the rocky parts of the massif, and *U. occidentalis* at the western edge of the massif).

* the rather high proportion of taxa of southern (Sahelian) origin in the southern third of Western Sahara (*Bufo xeros*, *Dicroglossus occipitalis*, *Hemidactylus brooki*, *Tropiocolotes tripolitanus occidentalis*, *Uromastyx* cf. *maliensis* and *Sphenops delislii*).

* lastly, the biogeographical barrier represented by the Jbel Ouarkziz which clearly separates the herpetofaunas of Morocco from that of Western Sahara.

Western Sahara, seemingly extremely uniform, is in fact a true biogeographical "cross-roads" for reptiles, with species of Mediterranean, North-Saharan, Saharan, Sahelian, tropical and Macaronesian affinities meeting there. Nevertheless, distribution patterns discussed here will have to be refined and confirmed by field research. Indeed, big gaps remain in our knowledge of the species distribution in this area.

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RÉSUMÉ

Liste commentée les Amphibiens et des Reptiles du Sahara Occidental.—La liste des amphibiens et des reptiles du Sahara Occidental compte 46 espèces (4 Amphibiens et 42 Reptiles) alors que 13 espèces, inconnues de cette région, sont suceptibles d'y être découvertes. Parmi les faits marquants, signalons l'absence de *Tarentola boehmei* du Sahara Occidental, ainsi que la mise en évidence d'une barrière biogéographique importante: le Jbel Ouarkziz, qui sépare nettement le cortège herpétofaunique du Maroc (au nord de l'Ouarkziz) de celui du Sahara Occidental. La composition de l'herpétofaune du Sahara Occidental se répartit comme suit: 10 espèces peuvent être qualifiées comme étant d'affinités méditerranéennes, 2 comme nord-sahariennes, 19 comme franchement sahariennes, 7 présentent des affinités sahéliennes, 4 sont des relictes tropicales et 4 sont des taxons propres à la façade atlantique du Sahara et peuvent être considérés comme des «endémiques macaronésiens continentaux». Cette partition confirme que l'herpétofaune du Sahara Occidental est majoritairement saharienne mais que la région constitue, malgré son apparente monotomie paysagère, un carrefour biogéographique intéressant en ce qui concerne les amphibiens et les reptiles. Ceci peut être expliqué par la grande amplitude latitudinale du Sahara Occidental, et par la façade océanique relativement humide et particulièrement tempérée qui s'oppose fortement au reste du pays, soumis à un climat saharien sec et à des températures contrastées.

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