

Chapter 26

Diversity and conservation of Algerian amphibian assemblages

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Fourteen amphibian species representing six families inhabit Algeria: Salamandridae (*Pleurodeles nebulosus*, *Pleurodeles poireti*, and *Salamandra algira*), Alytidae (*Alytes maurus*, *Discoglossus pictus*, and *Discoglossus scovazzi*), Bufonidae (*Amietophrynus mauritanicus*, *Amietophrynus xeros*, *Barbarophryne brongersmai*, *Bufo spinosus*, and *Bufoetes boulengeri*), Hylidae (*Hyla meridionalis*), Ranidae (*Pelophylax saharicus*), and Dicroglossidae (*Hoplobatrachus occipitalis*). The presence of some of them, like *A. maurus*, *D. scovazzi*, and *H. occipitalis*, is punctual. Areas of distribution conform to predictable patterns of biogeography; almost all species are present only in the Mediterranean region, while the Sahara Desert relegates a few frog species to isolation in mountain areas and oases with sufficient water. Amphibian community origins are directly related to climatic changes in North Africa throughout the Holocene. Many relict populations can be explained by comparison of the former layout and structure of hydrographic networks with those currently reduced to dry beds and, on occasion, suffering hyper-saline conditions. Relatively close phylogenetic relationships between species in the north of Algeria, portions of the Iberian Peninsula, Moroccan Atlas Mountains, Mediterranean islands and the Italian Peninsula, demonstrate that Algerian amphibian communities have as their origins the same Tertiary geological events that gave rise to today's Mediterranean Sea. In the northern Mediterranean region, human overpopulation of coastal areas is affecting water quality and amphibian species diversity. The relict character of many amphibian populations in the desert regions, along with the rarity of stable water due to a combination of natural climatic changes, over-exploitation of aquifers, and eutrophication or pollution, justifies considering all species to be in danger to one extent or another. Using IUCN-proposed criteria as a guide, we herein suggest a catalogue of threatened amphibian species, provide a preliminary list of areas of interest, and suggest appropriate action necessary for amphibian conservation in Algeria. Of the 14 amphibian species known from Algeria *P. poireti*, a newt found only in the Edough mountains, the Guerbes-Sendhadja wetlands, and the Mekhada marshes, and *A. maurus*, a toad whose only known population in Algeria is in the Tlemcen mountains, must be considered Critically Endangered according to our suggested catalogue. We also consider *P. nebulosus* to be Threatened and *S. algira* to be Vulnerable, each due to continued loss of habitat, rarity, and population fragmentation. Finally, all amphibian populations south of 32°N latitude should be considered Near Threatened.

Key words: Algeria; amphibians; conservation; population decline.

Diversidad y conservación del conjunto de anfibios argelinos. Catorce especies de anfibios de seis familias diferentes viven en Argelia: Salamandridae (*Pleurodeles nebulosus*, *Pleurodeles poireti* y *Salamandra algira*), Alytidae (*Alytes maurus*, *Discoglossus pictus* y *Discoglossus scovazzi*), Bufonidae (*Amietophrynus mauritanicus*, *Amietophrynus xeros*, *Barbarophryne brongersmai*, *Bufo spinosus* y *Bufoetes boulengeri*), Hylidae (*Hyla meridionalis*), Ranidae (*Pelophylax saharicus*) y Dicroglossidae (*Hoplobatrachus occipitalis*). La presencia de algunas de ellas como *A. maurus*, *D. scovazzi* y *H. occipitalis*, es puntual. Las áreas de distribución coinciden con los patrones biogeográficos predecibles; casi todas las especies están presentes únicamente en la región mediterránea, mientras que sólo unas pocas especies aparecen en el desierto del Sáhara quedando aisladas en zonas de montaña y oasis con agua suficiente. Los orígenes de la comu-

nidad de anfibios están relacionados con los cambios climáticos acontecidos en el norte de África durante el Holoceno. La existencia de muchas poblaciones relictas se explica al comparar la disposición y estructura de las antiguas cuencas hidrográficas con las actuales, reducidas a lechos secos y en ocasiones expuestas a condiciones hipersalinas. Las relaciones filogenéticas relativamente estrechas entre las especies del norte de Argelia con las de algunas partes de la península Ibérica, montañas del Atlas marroquí, islas del Mediterráneo y península Itálica, demuestran que las comunidades de anfibios de Argelia tienen el mismo origen Terciario que los eventos geológicos que dieron lugar al actual mar Mediterráneo. En la región mediterránea, al norte, la superpoblación humana en áreas costeras afecta a la calidad del agua y a la diversidad de especies de anfibios. El carácter relicto de muchas poblaciones de anfibios en las regiones desérticas, junto a la escasez de masas estables de agua como resultado de una combinación entre cambios climáticos naturales, sobreexplotación de acuíferos, eutrofización y contaminación, justifica que todas las especies se consideren, en algún grado, amenazadas. Guiándonos en los criterios propuestos por la UICN, sugerimos un catálogo de anfibios amenazados, aportamos una lista preliminar de áreas de interés y sugerimos las acciones necesarias para la conservación de los anfibios de Argelia. De las 14 especies conocidas en Argelia, *P. poireti*, un tritón presente solo en las montañas de Edough, los humedales de Guerbes-Sendhadja y las marismas de Mekhada, así como *A. maurus*, un sapo cuya única población conocida en Argelia está en las montañas de Tlemcen, deben considerarse en peligro crítico según el catálogo que aquí sugerimos. También consideramos a *P. nebulosus* como amenazado y a *S. algira* como vulnerable, en ambos casos como consecuencia de la continua pérdida de hábitat, enrarecimiento y fragmentación de poblaciones. Finalmente, todas las poblaciones de anfibios al sur del paralelo 32°N deberían considerarse como casi amenazadas.

Key words: anfibios; Argelia; conservación; declive de poblaciones.

In spite of its size (2 381 740 km²) Algeria (Fig. 1) has populations of only 14 species of amphibians (SALVADOR, 1996; SCHLEICH *et al.*, 1996) (Table 1). Its species diversity for this group of vertebrates is one of the poorest in Africa. Amphibian assemblages rarely contain more than five species, and more than half of Algeria is territory considered uninhabitable for salamanders, toads, or frogs (SALVADOR, 1996; SCHLEICH *et al.*, 1996; COX *et al.*, 2006). Such limited amphibian diversity has as its origin major climatic changes affecting all of North Africa during the Pleistocene and the Holocene. Historical changes, coupled with today's scarce and unpredictable precipitation in almost the entire country, continue to limit suitable environments for amphibians (FAURE, 1985; PETIT MAIRE, 1985, 1986; DUBIEF, 2001; AUMASSIP & FERHAT, 2002; COX *et al.*, 2006; LE QUELLEC, 2006).

HABITAT

Geology, climate, and vegetation within Algeria allow characterization of two well-differentiated areas (Mediterranean Algeria and Saharan Algeria), each separated geographically from the other by the Sub-Atlasic Fault,



Figure 1: Main regions in Algeria.

a large east-to-west-oriented geological fault near latitude 33°N (ASKRI *et al.*, 1995). This geographic separation has been used to explain floral and faunal differentiation within Algeria (BONS, 1967; WHITE, 1976; QUEZEL, 1978; SCHULZ, 1979; LAMBERT, 1984; WICKENS, 1984; OZENDA, 1991; BOBROV, 2000) and provides a convenient framework for a discussion of amphibian assemblages and the threats they face.

The Mediterranean

Located to the north of the great Sub-Atlasic Fault, the Mediterranean area, also known as Alpine Algeria (ASKRI *et al.*, 1995), has an approximate area of 280 000 km². The geological origin of this region is tied directly to the history of the Mediterranean Sea and to Tertiary folds that gave rise to many of the mountain ranges in southern Europe and northern Africa (MALDONADO, 1985); two of these Tertiary mountain ranges cross contemporary northern Algeria from east to west.

The northern slope of the Tell, or Tellian Atlas (with “Djebel” Lalla Khedidja, at 2308 m, the highest point), coincides almost completely with the Mediterranean coastline and is composed of several individual mountains (Tlemcen, Chr ea and Kabylia) that behave as authentic “interior islands” in that these contain some of the largest concentrations of threatened amphibians in the entire Mediterranean region (COX *et al.*, 2006; STUART *et al.*, 2008). Climatic conditions in the Tell are typically Mediterranean (humid to sub-humid; average annual precipitation > 400 mm, with dry summers and generally moderate temperatures) coinciding with K ppen’s climatic region “Csa” (K PPEN, 1936). This area is the most humid region in Algeria and some meteorological stations, Djurjura, Babor, and El Tarf for example, record total annual precipitation of > 1000 mm (GRIFFITHS & SOLIMAN, 1972).

Vegetation in this area is comprised of sclerophyllous forests and heathlands adapted to hot dry summers. Holm oaks (*Quercus ilex*) accompanied or replaced by Kermes oaks (*Q. coccifera*),

Table 1: Biogeographic characteristics of the amphibian species of Algeria.

Species	Biogeographic region	Biogeographic affinity	Regional presence in Algeria
<i>Pleurodeles nebulosus</i>	Palaeartic	Mediterranean	Tell
<i>Pleurodeles poireti</i>	Palaeartic	Mediterranean	Eastern Tell (Edough)
<i>Salamandra algira</i>	Palaeartic	Mediterranean	Tell
<i>Alytes maurus</i>	Palaeartic	Mediterranean	Western Tell
<i>Discoglossus pictus</i>	Palaeartic	Mediterranean	Tell
<i>Discoglossus scovazzi</i>	Palaeartic	Mediterranean	Saoura Valley
<i>Hyla meridionalis</i>	Palaeartic	Mediterranean	Tell
<i>Amietophrynus mauritanicus</i>	Palaeartic	Mediterranean	Tell+Hauts Plateaux
<i>Amietophrynus xeros</i>	Ethiopian	Sahelian	Tassili'n'Ajjer and Hoggar
<i>Barbarophryne brongersmai</i>	Palaeartic	Arid Mediterranean	Saharan Atlas
<i>Bufo spinosus</i>	Palaeartic	Eurosiberian	Tell
<i>Bufoes boulengeri</i>	Palaeartic	Arid Mediterranean	All - rare Northeastern extreme
<i>Pelophylax saharicus</i>	Palaeartic	Mediterranean	All
<i>Hoplobatrachus occipitalis</i>	Ethiopian	Soudanian	Tassili'n'Ajjer

Aleppo pines (*Pinus halepensis*), Carob trees (*Ceratonia siliqua*), or Sandarac gum cypress (*Tetraclinis articulata*) in the least humid areas, Cork oaks (*Q. suber*) in areas with soil of low pH, deciduous oaks (*Q. canariensis*, *Q. faginea* and *Q. afares*) in the most humid areas, or firs and cedars (*Abies nummidica* and *Cedrus atlantica*) in the cooler and humid mountains, provide tree cover (SCHULZ, 1979; OZENDA, 1991).

To the south of the Tellian Atlas, and north of the Sub-Atlasic Fault (HERKAT & GUIRAUD, 2006), is the Saharan Atlas, a range of small, isolated mountains rising to 2000 m above sea level. Between the Tellian Atlas and the Saharan Atlas are the Hauts Plateaux and Aïn Regada platform, two plateaus separated by the solid massif of the Aurès.

The Saharan Atlas plateaus have climates that are basically Mediterranean but resemble Saharan climates in that annual precipitation rarely exceeds 200 mm. These areas coincide with the Steppic-Northern African domain defined by QUEZEL (1978) and only a few summits, such as the mountains around Aïn Sefra and “Djebel” Ksel, present a somewhat more humid climate, resembling those characterizing the Tellian Atlas (OZENDA, 1991).

The more humid conditions in the Tellian Atlas and the Aurès support the most complex amphibian assemblages in Algeria (COX *et al.*, 2006). The Hauts Plateaux, Aïn Regada platform, and most of the Saharan Atlas support a less diverse fauna, their geographic ranges being more localized.

The Sahara

South of the Sub-Atlasic Fault, the Saharan platform is larger and more geologically stable than in Alpine Algeria (WILLIAMS, 1984;

ASKRI *et al.*, 1995). This fault line coincides closely with isohyets of 100 mm annual rainfall and, for climatologists and biogeographers alike, this fault line is the northern limit of the Saharan warm desert (Fig. 2) (GRIFFITHS & SOLIMAN, 1972; LAMBERT, 1984, SMITH, 1984; BOBROV, 2000). In addition to variation in volume of rain, different parts of the Sahara also differ in their seasonal pattern of rainfall (GRIFFITHS & SOLIMAN, 1972). Approximately to the south of latitude 23°N precipitation occurs during summer (monsoon), while to the north of latitude 23°N the pattern of rainfall is similar to that of the Mediterranean region (Fig. 2). The variations in patterns of precipitation within the Sahara Desert significantly affect the biogeography of the entire region.

A large portion of the Saharan platform sits directly on the North-African Craton, a Precambrian shield about 1.5 billion years

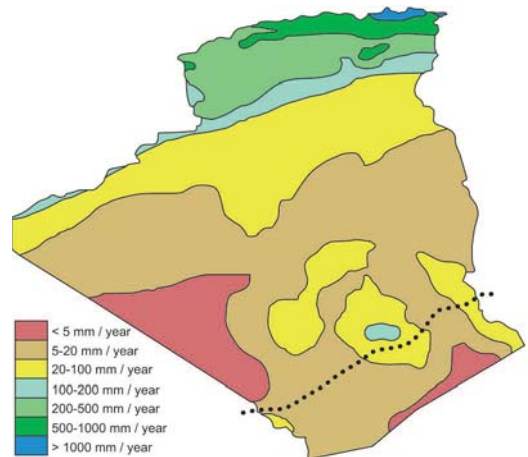


Figure 2: Rainfall pattern in Algeria. Dotted line separates areas with Mediterranean-type precipitation (concentrated in the cool months of the year) from those with monsoon-type precipitation (concentrated during the summer). Modified from GRIFFITHS (1972) and GRIFFITHS & SOLIMAN (1972).

old and partitioned into several large, complex, sedimentary basins (WILLIAMS, 1984; ASKRI *et al.*, 1995). Today, this area presents a monotonous, extremely arid and denuded landscape, for the most part not favourable for amphibian populations (LAMBERT, 1984; BORKIN, 1999). The Sahara Desert however, is not only the “Empty Quarters” of MONOD’s (1958) or EMBERGER *et al.*’s (1962) extensive desert areas, totally free of amphibians, and with an average annual precipitation of 5 mm, e.g., Tanezrouf or Ténéré (Fig. 2) (MONOD, 1958; DUBIEF, 1968); there are also less harsh districts in which some amphibians find favourable microhabitats (GRIFFITHS & SOLIMAN, 1972; LARMUTH, 1984).

In the Algerian Sahara, the monotony of the desert is interrupted by southern mountains and oases. The Targui shield, a socle associated with the Pan-African fold, includes the Hoggar and the plateaus (“tassilis”) surrounding it (WILLIAMS, 1984; ASKRI *et al.*, 1995). These mountains, attaining elevations of up to 3000 m in the Adrar Tahat, receive more precipitation, and are subject to lower rates of evaporation than surrounding areas (Fig. 2) (GRIFFITHS & SOLIMAN, 1972). This moisture regimen, coupled with the existence of deep canyons able to support and maintain stable bodies of water, allows the southern mountains to behave as floral and faunal refuges of the first order (LHOTE, 1972; OZENDA, 1991; BOUMEZBEUR, 2001).

Oases are remnants of a hydrographic network that, fewer than six thousand years ago, supported extensive savannahs with varied faunas (DRAKE & BRISTOW, 2006; LE QUELLEC, 2006). Despite current hyper-arid conditions, the composition and differing thicknesses of silt and the varying elevations of certain areas

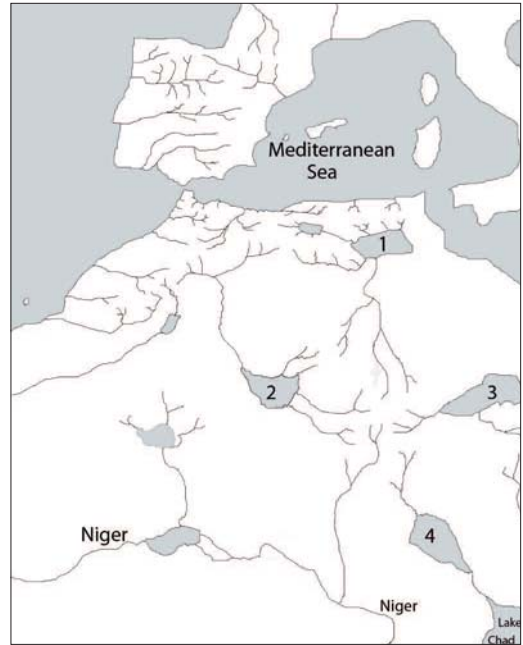


Figure 3: Hydrographic basins of the Central Sahara (main rivers and lakes during the last humid period, about 8000 years ago). 1: Lake of Tidikelt, 2: Melhir / El Djedid mega-lake, 3: Chad mega-lake, 4: Fezzan mega-lake. Modified from DRAKE & BRISTOL (2006).

continue to partition the central Sahara into hydrological basins. These basins, in part, determine the distributions of oases and of amphibian species continuing to inhabit the Algerian Sahara. The most important basins are “wadis” Tafassasset, Tamanrasset and Tin Tarabine, the Tidikelt depression, and the ephemeral water-filled basins in the large “chotts” of the northeast (Fig. 3).

Large northeastern “chotts” (Melhir in Algeria and Djerid in Tunisia) formed Chott-Megalake (a lake of about 30 000 km² that captured waters from the central and eastern Saharan Atlas, the eastern mountains of Nementcha and Tebessa, the subsidiary basins of Hodna and Aurès, and from basins along “wadi” Mya and in the Gassi Touil

Valley, all of which originate north of the Hoggar and the Tademait Plateau) a few thousand years ago (DAMNATI, 2000).

Water for the Tidikelt depression mainly originates from the Moroccan High Atlas, Middle Atlas, and the western Saharan Atlas, supplemented by water from the western side of the Hoggar and the southern slope of the Cretaceous Tademait Plateau (DRAKE & BRISTOW, 2006; FERHAT, 2006). At present, water still flows regularly, reaching Abadla, the valley of the Saoura / Messaoud and continuing to the oases of Touat, resulting in a relatively benign corridor between the Grand "Erg" Occidental and the "Erg" Er Raoui.

The eastern Hoggar, the Tassili'n'Ajjer and, partially, the Air Mountains provide water for the Tafassasset basin and flow on to the Ténéré basin (Niger), a subsidiary basin in turn of the Paleo-Chad. This great inland sea had a surface area the size of France, but at the present time is reduced to little more than 10 000 km².

The Tamanrhasset and Tin Tarabine rivers occasionally receive water from the southern and western slopes of the Hoggar, water generally lost to the deserts of northern Mali and Niger. In the recent past, however, these rivers, tributaries of the Niger, facilitated migration of numerous sub-Saharan water-associated species to the north. Mega-Fezzan, a lake exceeding 100 000 km², located in southwestern Libya, continues to receive much of its water from the eastern slopes of the Tassili'n'Ajjer (DRAKE & BRISTOW, 2006).

Amphibian Fauna

Estimates of the number of amphibian species in Algeria historically have been limited to between eight and ten (LAMBERT, 1984;

SALVADOR, 1996; SCHLEICH *et al.*, 1996; BORKIN, 1999) but recent molecular investigations have led to discovery of species previously unnoticed (COX *et al.*, 2006). DNA analysis has demonstrated that newts of the Edough are well-differentiated from those in the rest of the country and should be considered different species (*Pleurodeles poireti* and *P. nebulosus*) (CARRANZA & ARNOLD, 2004; CARRANZA & WADE, 2004) and that painted frogs from most of Algeria are representative of a complex containing two species, *Discoglossus pictus* and *D. scovazzi* (PABIJAN *et al.*, 2012; BEUKEMA *et al.*, 2013), although the presence of *D. scovazzi* appears to be restricted to isolated populations in the Saoura Valley (HUGHES & HUGHES, 1992).

Populations of two species previously unknown in Algeria have also been discovered. The African Midwife Toad (*Alytes maurus*), the nearest viable population of which was only known from several hundred kilometres to the west in Morocco, has been recently found in the mountains of Tlemcen (first specimens caught by J. Peña in 1990; confirmed 2009). *Barbarophryne brongersmai*, previously known from Figuig, Morocco, a few kilometres from the border with Algeria (BONS & GENIEZ, 1996), recently has been found in four towns in the Saharan Atlas of northwestern Algeria (first specimens caught by Jesús Peña in 1990, and J.A. Mateo, personal observation).

Nomenclature for Algeria's amphibians (Table 1) follows that proposed by CARRANZA & WADE (2004) for caudate species, and BEUKEMA *et al.* (2013) for anuran species. Of the 14 species of Algerian amphibians, three are caudates (Fig. 4) in the family Salamandridae (two species of *Pleurodeles* [one endemic] and one species of *Salamandra*) and 11 are anurans (Figs. 5-8) in the families Alytidae (one species

Table 2: Species-complexes, species, and subspecies of amphibians occurring in the Messinian biogeographic regions.

South of the Iberian Peninsula	Rif + Moroccan Atlas	Tellian Atlas	Sicily + Calabria
<i>Salamandra salamandra longirostris</i>	<i>S. algira tingitana</i> and others	<i>S. algira algira</i>	<i>S. salamandra</i>
<i>Pleurodeles waltl</i>	<i>P. waltl</i>	<i>P. nebulosus</i>	-
		<i>P. poireti</i>	
<i>Alytes dickhillenii</i>	<i>A. maurus</i>	<i>A. maurus</i>	-
<i>Discoglossus jeannae</i>	<i>D. scovazzi</i>	<i>D. pictus auritus</i>	<i>D. pictus pictus</i>
<i>D. galganoi</i>			
<i>Hyla meridionalis</i>	<i>H. meridionalis</i>	<i>H. meridionalis</i>	<i>H. intermedia</i>
<i>H. arborea</i>			
<i>Bufo spinosus</i>	<i>B. spinosus</i>	<i>B. spinosus</i>	<i>B. bufo</i>
<i>Pelophylax perezi</i>	<i>P. saharicus riodeoroi</i>	<i>P. saharicus saharicus</i>	<i>P. esculentus</i>

of *Alytes*, two species of *Discoglossus*), Bufonidae (two species of *Amietophrynus* and one species each of *Barbarophryne*, *Bufo*, and *Bufotes*), Hylidae (one species of *Hyla*), Ranidae (one species of *Pelophylax*), and Dicroglossidae (one species of *Hoplobatrachus*).

Two species reported in the literature (*Amietophrynus regularis* and *Ptychadena* sp.) (LE BERRE, 1989; SALVADOR, 1996; SCHLEICH *et al.*, 1996) have not been found in recent years and are no longer considered members of the Algerian fauna. Both species, reported from southern Algeria, were very likely confused with *Amietophrynus xeros* and *Hoplobatrachus occipitalis*, two species present in the mountains of the Tassili and the Hoggar (COX *et al.*, 2006).

FAMILY SALAMANDRIDAE: NEWTS AND “TRUE” SALAMANDERS

This Palearctic family is represented by two genera (*Pleurodeles* and *Salamandra*), and three species (*P. nebulosus*, *P. poireti*, and *S. algira*).

Pleurodeles nebulosus (Guichenot, 1850): Algerian Newt (Fig. 4). This species is endemic

to the Maghreb of Algeria and northern Tunisia. In Algeria this species is present in humid, sub-humid, and semi-arid Mediterranean areas in the north, but absent from the northwest, with Sig (“Wilaya” of Mascara) being its westernmost known locality (KOLAR, 1955; LE BERRE, 1989; SCHLEICH *et al.*, 1996; CARRANZA & WADE, 2004; VEITH *et al.*, 2004). This newt prefers stagnant waters.

Pleurodeles poireti (Gervais, 1835): Edough’s Newt (Fig. 4). This species is an Algerian endemic (SAMRAOUI & DE BÉLAIR, 1997; CARRANZA & WADE, 2004), smaller (up to 129 mm total length) but otherwise very similar in external appearance to *P. nebulosus*. In addition to genetic differences, it differs from *P. nebulosus* in external morphometric characters and in the configuration of the vomerine teeth (PASTEUR, 1958; CARRANZA & WADE, 2004). Edough’s Newt has a very restricted distribution, being found only in the coastal massif of Edough, the Guerbes-Sendhadja wetlands and the Mekhada marsh (“Wilayas” of Annaba and Skikda) (SAMRAOUI *et al.*, 2012).

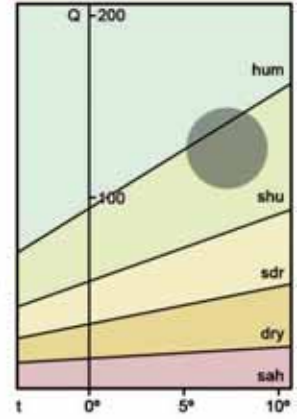
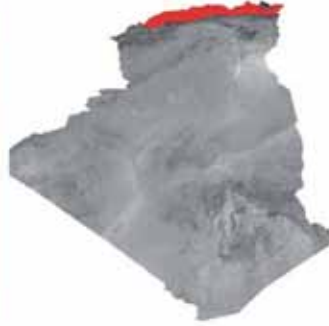
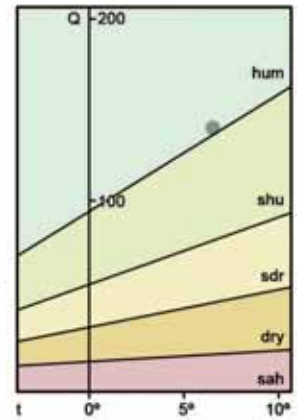
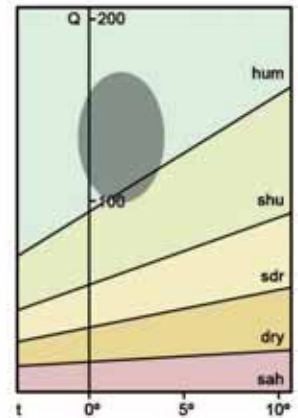
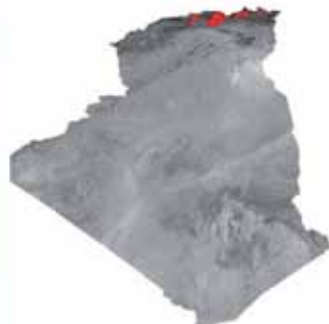
*Pleurodeles nebulosus**Pleurodeles poreti**Salamandra algira*

Figure 4: Distributional ranges and bi-dimensional approximation to bioclimatic range for species of Caudata. Bioclimatic approximation utilizes Emberger's ombroclimatic index ($Q = 2000 P / M^2 - t^2$), an indicator of degree of Mediterranean feel in temperate climates (OZENDA, 1964), where P is annual rainfall in mm, M is the average maximum temperature of the hottest month and t is the average minimum temperature during the coldest month (see DAGET, 1977). hum: humid; shu: sub-humid; sdr: sub-dry; sah: Saharan.

Salamandra algira Bedriaga, 1883: Algerian Salamander (Fig. 4). In Algeria this species is restricted to very humid places in the northern mountains (SCHLEICH *et al.*, 1996; MARTÍNEZ-MEDINA *et al.*, 1997; DONAIRE & BOGAERTS, 2003; MATEO *et al.*, 2003). DOUMERGUE (1901) documented a population at Rhar-el-Maden (near Remchi) in Oran and this population is the westernmost known from Algeria (BONS & GENIEZ, 1996). There are confirmed records from the mountains of Constantine, Edough, Medjerda, Traras, Tlemcen, and the Blidah Atlas; the majority of literature citations are from the Grande and Petite Kabylia regions (JOGER & STEINFARTZ, 1995; ESCORIZA *et al.*, 2006).

Larvae may occur in puddles and in creeks with slow moving currents and clear, clean water but adults frequent very humid and rocky areas and are associated with deciduous forests. *Salamandra a. algira* is the subspecies found in Algeria (DONAIRE & BOGAERTS, 2003) and it is probable that the extreme fragmentation to which the species is subjected masks genetic differentiation exceeding the species-subspecies threshold.

FAMILY ALYTIDAE: PAINTED FROGS

With a Mediterranean distribution, this anuran family is comprised of two genera and 11 species (SAN MAURO *et al.*, 2005). There are three species in Algeria: *Alytes maurus*, *Discoglossus pictus*, and *D. scovazzi* (HUGHES & HUGHES, 1992; PABIJAN *et al.*, 2012).

Alytes maurus Pasteur and Bons, 1962: African Midwife Toad (Fig. 5). Holocene fossil remains found near Oran suggest that the African Midwife Toad had a considerably

wider distribution a few thousand years ago (MATEO *et al.*, 2003), and the presence of this species in northwestern Algeria was considered likely according to models of potential distributions (POUL *et al.*, 2013).

In 1990 two adults of this species were captured in an artificial reservoir in the Hafir Forest (1170 m, 34°46'12" N / 1°27'23" W) by Jesús Peña and colleagues. Because these specimens had been incorrectly identified and labeled in the collection of the Asociación de Amigos de Doñana they went unnoticed until 2006 when they were re-identified by José A. Mateo. A visit to the Hafir Forest area by Mateo in May, 2009, allowed for detection of *Alytes* larvae. Numbers, however, were low and some individuals presented deteriorated horny beaks, an unequivocal sign they were infected by the fungus *Batrachomyxium dendrobatidis* (ALFORD *et al.*, 2007). Chytridiomycosis, whose presence in North Africa has been confirmed (EL MOUDEN *et al.*, 2011), is considered a prime cause for extinction of numerous amphibian species and it virulently affects adults and larvae of *Alytes* (BOSCH *et al.*, 2013). A visit to the area during summer, 2013, provided no evidence of *Alytes* in the original artificial reservoir or vicinity.

Adults of *A. maurus* are not very aquatic, and the species is restricted to regions of humid Mediterranean climate.

Discoglossus pictus Otth, 1837: Algerian Painted Frog (Fig. 5). This species is relatively terrestrial and generally found in well-watered, highly humid areas. It is present in all relatively humid Mediterranean regions of northern Tunisia, Algeria and north-eastern Morocco, Sicily, Malta, the Galita islands, and in French Roussillon and Spanish Catalonia (as an introduced species with an

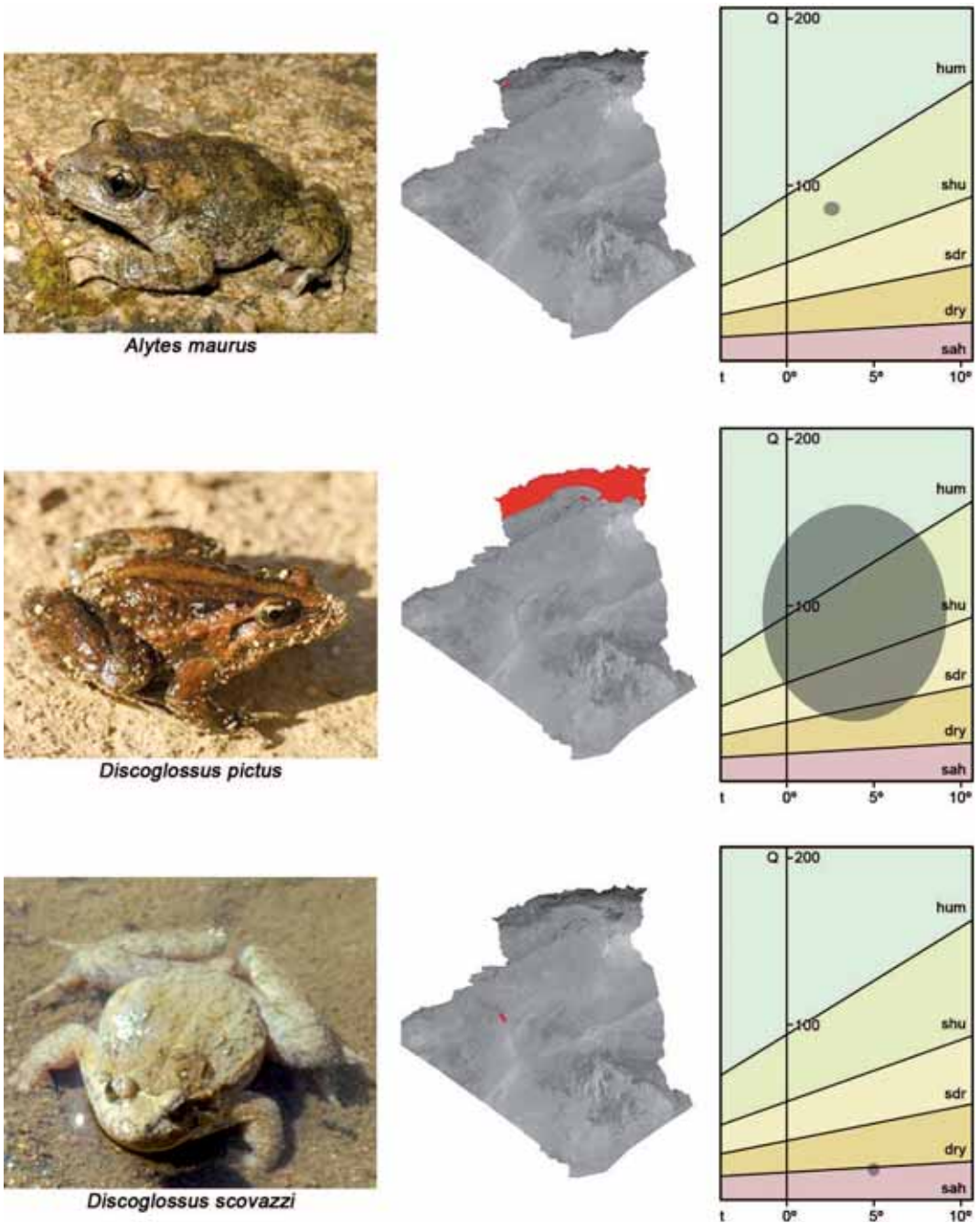
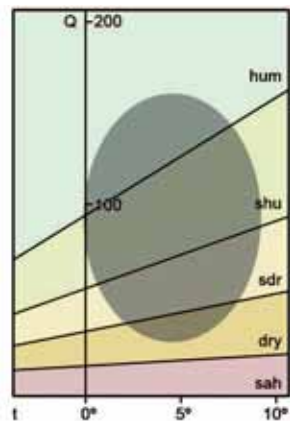


Figure 5: Distributional ranges and bi-dimensional approximation to bioclimatic range for species of Alytidae. See Fig. 4 legend for details.



Amietophrynus mauritanicus



Amietophrynus xeros

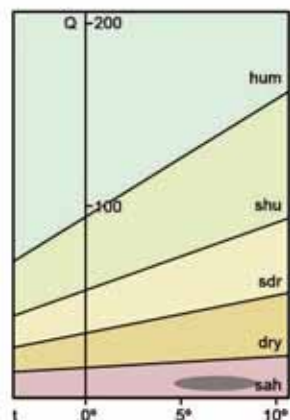
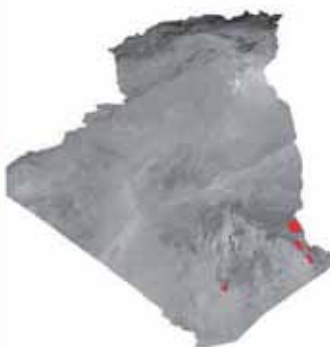


Figure 6: Distributional ranges and bi-dimensional approximation to bioclimatic range for species of *Amietophrynus*. See Fig. 4 legend for details.

expanding distribution) (LANZA & BRUZZONE, 1960; VEITH & MARTENS, 1997; PLEGUEZUELOS, 2002; FRANCH *et al.*, 2007; BEUKEMA *et al.*, 2013).

In Algeria, populations have been documented from the entire Tell, and from the vicinity of Oran to the border with Tunisia. It is relatively common in the Hauts Plateaux and has been found in the oasis of Zibans and in the Saharan Atlas (KOLAR, 1955; SURA, 1983; SALVADOR, 1996). VEITH & MARTENS (1997) assigned Algerian populations to the subspecies *D. p. auritus* Héron-Royer, 1888.

Discoglossus scovazzi (Camerano, 1878): Moroccan Painted Frog (Fig. 5). This species, found in humid and sub-humid areas, is represented by a relict population in the Saoura Valley (HUGHES & HUGHES, 1992). The Saoura Valley is formed from the confluence of some intermittent rivers originating in the Moroccan Atlas Mountains, where *D. scovazzi* is common (authors' personal observation).

FAMILY BUFONIDAE: “TRUE” TOADS

Five species (*Amietophrynus mauritanicus*, *A. xeros*, *Barbarophryne brongersmai*, *Bufo*

spinus, and *Bufotes boulengeri*) from this family are known in Algeria (SALVADOR, 1996; SCHLEICH *et al.*, 1996; COX *et al.*, 2006).

Amietophrynus mauritanicus (Schlegel, 1841): Berber Toad (Fig. 6). Exclusive to the Maghreb, the Berber toad is quite common in humid, sub-humid, and semi-arid areas with a Mediterranean climate in the north and north-west of Algeria (SALVADOR, 1996; SCHLEICH *et al.*, 1996). It is found along the entire coastal area, in the Tellian Atlas, the Hauts Plateaux, region of Zibans, the Saharan Atlas near the river Guir, and the Drâa (KOLAR, 1955; BALOZET, 1957; SIBOULET, 1968; ALTES & SIBOULET, 1977; SURA, 1983; LE BERRE, 1989; SALVADOR, 1996; SCHLEICH *et al.*, 1996). References to *A. mauritanicus* in the south of Algeria (Hoggar and Tassili'n'Ajjer) (ANGEL & LHOTE, 1938; LE BERRE, 1989) are erroneous; the species found there is *A. xeros*. *Amietophrynus mauritanicus* lives in close proximity to temporary or permanent bodies of water that generally are deeper than those used by other Algerian bufonids.

Amietophrynus xeros (Tandy, Tandy, Keith and Duff-MacKay, 1976): Savannah Toad (Fig. 6). Typically a Sahelian species of arid savannahs, dry "wadies", oases, and similar areas, the Savannah Toad is restricted to the Hoggar and Tassili'n'Ajjer mountains (ANGEL & LHOTE, 1938; CEI, 1973; JOGER, 1981; SALVADOR, 1996; SCHLEICH *et al.*, 1996; RÖDEL, 2000) of southern Algeria.

Barbarophryne brongersmai Hoogmoed, 1972: Brongersma's Toad (Fig. 7). GENIEZ *et al.* (2004) suggested that Brongersma's toad was a possible species to be found in north-

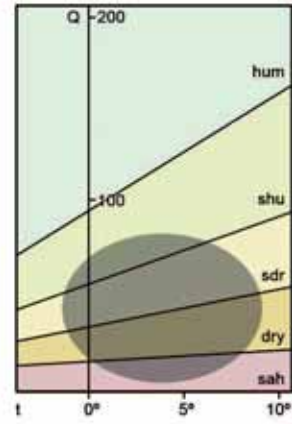
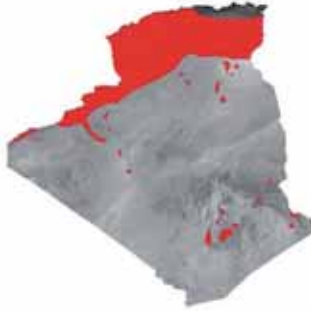
western Algeria and, recently, it has been discovered in four towns in the Saharan Atlas within Algeria (Jesús Peña and José A. Mateo, unpublished). The species also may actually occur in other areas of this mountain range where it could have been confused with *B. boulengeri*. It is not a very aquatic toad, and lives near humid areas (e.g., "wadies", ditches, oases, orchards, gardens) in arid areas of Mediterranean climate.

Bufo spinosus Daudin, 1803: Common Toad (Fig. 7). The common toad is not very abundant in Algeria and its distribution is fragmented. It is found only in humid and sub-humid areas of Mediterranean climate in the north; it is well-documented from the Tellian Atlas (SALVADOR, 1996; SCHLEICH *et al.*, 1996; AGASYAN *et al.*, 2008). According to GARCIA-PORTA *et al.* (2012) common toads of North Africa should be considered a non-described subspecies.

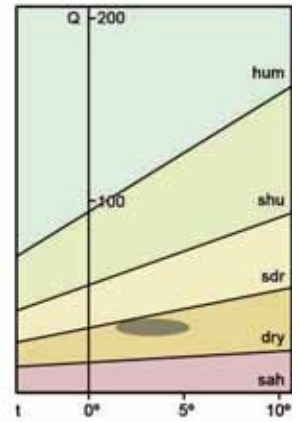
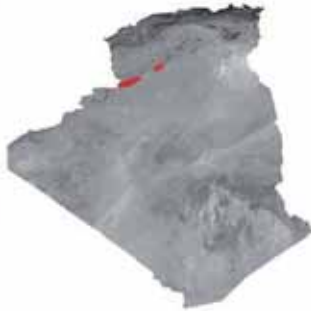
Bufotes boulengeri (Lataste, 1879): North-African Green Toad (Fig. 7). This species is relatively common in the north, but rare in the more humid areas there (SALVADOR, 1996; SCHLEICH *et al.*, 1996). It is present in varying densities in the oases and relatively humid areas of central and southern Algeria. It is absent from the Kabylia mountains but relatively common in the Hauts Plateaux, other semi-arid and arid regions of the Saharan Atlas, and the southern slope of the Aurès and Tebessa Mountains (SEURAT, 1930; SALVADOR, 1996). SAMRAOUI *et al.* (2012) have found some isolated populations of this species in Numidia (northwestern Algeria), where it is rare. In the central Sahara, North-African Green Toads are associated with oases (SCHLEICH *et al.*, 1996) or with temporary



Bufotes boulengeri



Barbarophryne brongersmai



Bufo spinosus

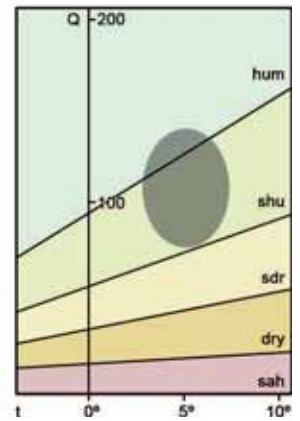
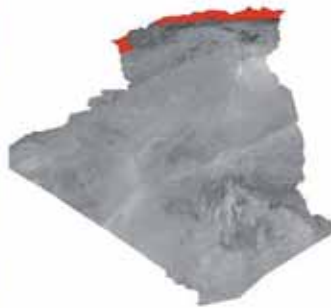


Figure 7: Distributional ranges and bi-dimensional approximation to bioclimatic range for *Bufotes boulengeri*, *Barbarophryne brongersmai* (Moroccan individual), and *Bufo spinosus*. See Fig. 4 legend for details.

watercourses (BONS & GENIEZ, 1996). In the south, this species is probably the most common amphibian and is known from the Mouydir Mountains and the massifs of the Hoggar and Tassili'n'Ajjer (SCHLEICH *et al.*, 1996).

This toad is associated with seasonal ponds of shallow depth in areas of very arid climates but in other geographical areas their preferences can vary.

FAMILY HYLIDAE: TREEFROGS

RECUERO *et al.* (2007) and STÖCK *et al.* (2008) demonstrated that tree frogs in Tunisia and northeastern Algeria are genetically different from those in Morocco and northern and northwestern Algeria but no taxonomic changes have yet been introduced.

Hyla meridionalis Boettger, 1874: Stripeless Treefrog (Fig. 8). This anuran is associated with bodies of water with dense vegetation in humid regions with a Mediterranean climate along the entire Algerian coast, in the Tell, along the Cheliff Valley, and in the northern half of the Aurès (LLABADOR, 1947; SURA, 1983; BONS & GENIEZ, 1996; SALVADOR, 1996; SCHLEICH *et al.*, 1996).

FAMILY RANIDAE: "TRUE" FROGS

True frogs are represented in Algeria only by *Pelophylax saharicus*.

Pelophylax saharicus (Boulenger, 1913): North-African Green Frog (Fig. 8). By far the most common and widely distributed anuran throughout North Africa (BONS & GENIEZ, 1996; SCHLEICH *et al.*, 1996; GENIEZ *et al.*, 2004; BAHA EL DIN, 2006; DONAIRE-BARROSO

et al., 2008), two subspecies of the North-African Green Frog, *P. s. saharicus* (BOULENGER, 1891) and *P. s. riodeoroi* (SALVADOR & PERIS, 1975), are currently recognized. *Pelophylax s. riodeoroi* can be found in the northwest around Tlemcen and Aïn Sefra, in western "hamadas" along the Oueds Guir, Saoura and Zousfana, in the Touat Oasis up to Timimoun, and in the valley of the Drâa. *Pelophylax s. saharicus* is present in the Tellian Atlas, central and eastern Sahara, Hauts Plateaux, Kabylia, Aurès, the region of Tebessa, along the Ghardaia-El Golea corridor, on the Tademaït Plateau, and in oases (ARANO *et al.*, 1998).

In the north its distribution is continuous and this aquatic species inhabits creeks and ponds from the Mediterranean coast down to the Saharan Atlas (HEMMER *et al.*, 1980; LE BERRE, 1989; SALVADOR, 1996; SCHLEICH *et al.*, 1996). More to the south, and in the centre and east of the country, it is restricted to dayas and oases (BOULENGER, 1891; ANGEL & LHOTE, 1938; COX *et al.*, 2006). In the massifs of Hoggar and Tassili'n'Ajjer it is relatively common in deep gorges and close to bodies of relatively stable water (ANGEL & LHOTE, 1938).

FAMILY DICROGLOSSIDAE: FORKED TONGUED FROGS

Recent separation of this group from the family Ranidae is based on molecular evidence and no anatomical characterization is yet available (FROST *et al.*, 2006). The only African representative of this newly-formulated family is *Hoplobatrachus occipitalis*.

Hoplobatrachus occipitalis (Günther, 1859): African Bullfrog (Fig. 8). Algerian populations

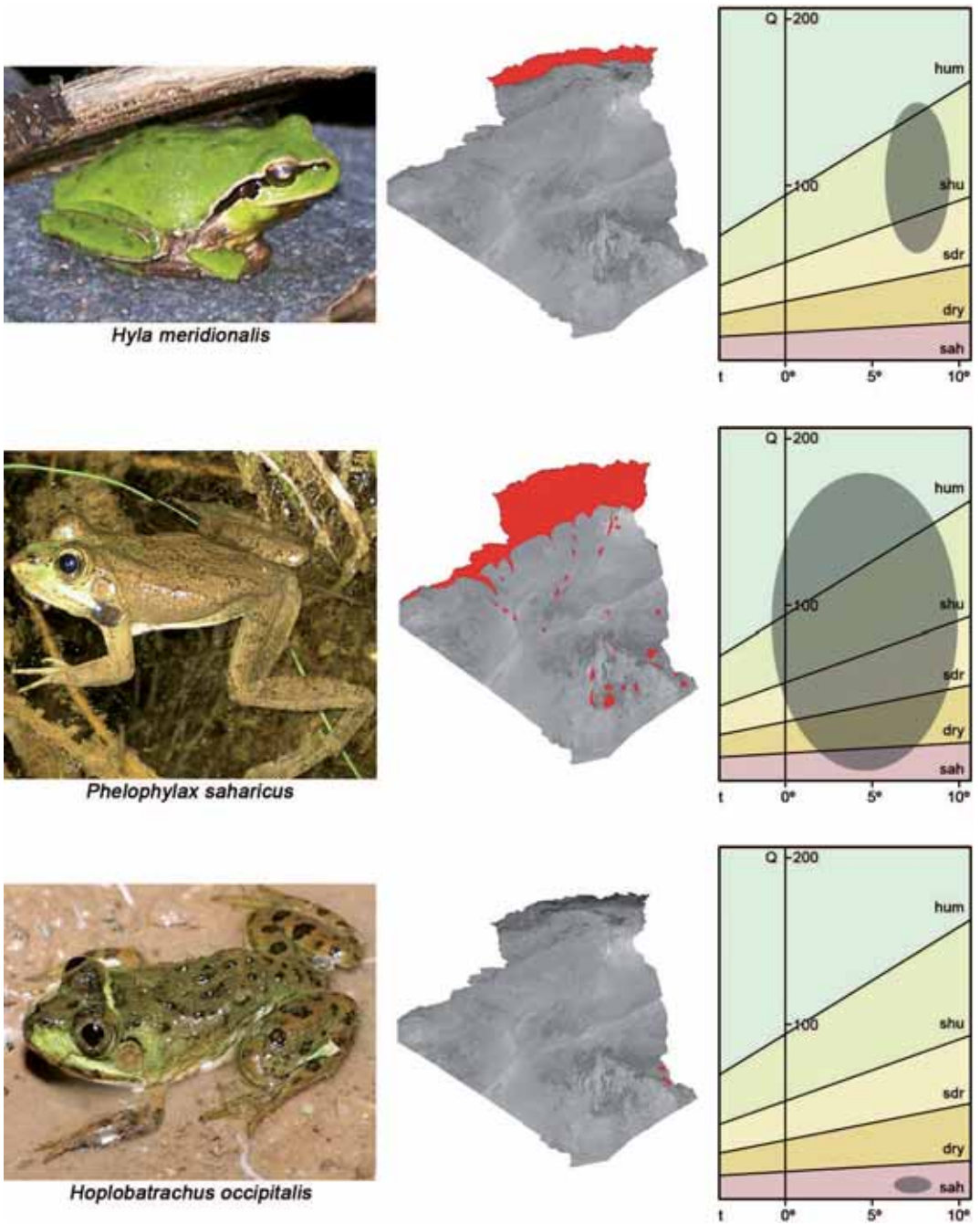


Figure 8: Distributional ranges and bi-dimensional approximation to bioclimatic range for *Hyla meridionalis*, *Pelophylax saharicus*, and *Hoplobatrachus occipitalis*. See Fig. 4 legend for details.

of this widely-distributed bullfrog are restricted to Tassili'n'Ajjer, where several populations have been found in the vicinity of Iherir (25°24' N, 8°44' E), Zaouatallaz (24°52' N, 8°26' E), in aguelman of Ifedil (24°33' N, 9°31' E), and at the head of the "wadi" Iddo (25°13' N, 9°44' E) (SEURAT, 1930; SCORTECCI, 1937; ANGEL & LHOTE, 1938; RÖDEL *et al.*, 2006).

African Bullfrogs are very aquatic and inhabit rivers and temporary ponds of sub-Saharan savannahs; in the Tassili'n'Ajjer they can be found only near stable sources of water and have suffered significant decreases in recent decades. In 1990 they had disappeared from some "gueltates" in which they were formerly abundant (Isidro Corea, personal communication).

BIOGEOGRAPHY

Geology and bioclimatic conditions partition Algeria into three regions of biogeographic importance for amphibians: the Mediterranean Tell (with humid or sub-humid conditions), a transition zone between Mediterranean Tell and the Sahara Desert (with arid or semi-arid conditions), and the Sahara Desert (Fig. 2).

The Tell

Coincidence of distribution for several species or species-complexes in the Tellian region with those of the Moroccan Atlas, the north of Tunisia, the Iberian Peninsula, or the south of Italy suggests that amphibian distribution in these areas sharing a Mediterranean climate can be partially explained by the "Messinian Model" (Table 2) (BUSACK, 1986; MATEO *et al.*, 2003; BUSACK & LAWSON, 2008). This biogeographical model, initially

proposed by BOCQUET *et al.* (1978) to explain floristic coincidences, relates distributional patterns to intercontinental connections during desiccation and rehydration of the Mediterranean Sea during the Messinian (Upper Miocene) "Salinity Crisis". The co-occurrence of several species is related to disappearance and re-appearance of a marine barrier resulting from fragmentation of Pangaea. Conformation of current regional amphibian assemblages with circumstances initiated by this series of events has been broadly explained in the works of BUSACK (1986), ARANO *et al.* (1998), MATEO *et al.* (2003), CARRANZA & ARNOLD (2004), FROMHAGE *et al.* (2004), RECUERO *et al.* (2007), and BUSACK & LAWSON (2008).

Research demonstrates that genetic diversity in various complexes (Table 2) is explained by the closure and re-opening of the Strait of Gibraltar. BUSACK (1986), for example, demonstrated significant differences in genetic distances between some species considered vicariant from one side to the other of the Strait of Gibraltar. Other workers (ARANO *et al.*, 1998; CARRANZA & WADE, 2004; FROMHAGE *et al.*, 2004; MARTÍNEZ-SOLANO *et al.*, 2004; VEITH *et al.*, 2004) have also discovered genetic discontinuities of the same order of magnitude. BARBADILLO *et al.* (1997), and later CARRANZA & WADE (2004) and PAULO *et al.* (2008), presented very convincing hypotheses based on fragmentation of basal populations, before and during the Messinian Crisis, to explain discontinuities. These authors suggested that the area now comprising the coast of northwestern Africa and the southern Iberian Peninsula once belonged to a series of islands belonging to a geologic complex named Alkapeca (MICHARD

et al., 2002). Each of these islands could, over a long period of time, harbour isolated populations of amphibians currently represented in the region by allopatric species. ARANO *et al.* (1998), CARRANZA & ARNOLD (2004), FROMHAGE *et al.* (2004), MARTÍNEZ-SOLANO *et al.* (2004), and RECUERO *et al.* (2007) have described genetic discontinuity considered appropriate for supporting taxonomic changes among North-African amphibians in the genera *Pelophylax*, *Alytes*, *Discoglossus*, *Pleurodeles*, and *Hyla*. Mountainous massifs of Edough, connected for a few thousand years to the mainland, remained totally isolated over a period of several millions of years and represent the last of the islands of the Alkapecca complex; the newt from Edough represents one additional example of allopatric speciation (CARRANZA & ARNOLD, 2004; CARRANZA & WADE, 2004).

In addition to faunal distributions attributable, in part, to Messinian events the Tell region also has contemporary differences in climate. Eastern and western areas along the Mediterranean Sea have areas of varying humidity and, while northwestern Algeria is relatively arid, the Kabilya area (GRIFFITHS, 1972) and some areas to the east of Alger, in the mountains of the Tell, are humid. Some northwestern slopes (Tlemcen Mountains, Aricha Plateau) drain into the Moulouya. The valley through which this river flows provides a gradual northern corridor of desert and provides a pathway through which some species with clear Saharan affinities can approach to within less than 20 km of the Mediterranean Sea (BONS & GENIEZ, 1996).

Two endemic species of the genus *Pleurodeles*, along with two species with Eurosiberian affinity (*B. spinosus* and *S. algira*),

are more common in these more humid regions. *Bufoles boulengeri* is, however, almost absent from this region.

On occasion, north-south and east-west humidity gradients (described above) are interrupted by elevations or depressions. The relative aridity of northwestern Algeria is partially ameliorated in the mountains behind Tlemcen, thereby creating a haven for Mediterranean sub-humid vegetation and sheltering several faunal relics that appear again only in the Middle Atlas, Rif, or Kabilya Mountains (SCHLEICH *et al.*, 1996). *Alytes maurus* is one such faunal vestige that merits a mention.

The Transition Zone

While maintaining a strong climatic affinity with the Mediterranean, the transition zone has continental thermal conditions and a mean annual rainfall of 100-250 mm; this produces an aridity that reduces amphibian species richness. Included in this zone are the entire Hauts Plateaux, the Aïn Regada platform, the Saharan Atlas, and the southern slopes of the Aurès and Tebessa Mountains.

The batrachian fauna of the transition zone is characteristically Mediterranean; creeks, ponds, "dayas", and humid steppes in the area provide shelter for some of the more common anurans of the Tell. *Discoglossus pictus*, *A. mauritanicus*, *B. boulengeri*, and *P. saharicus* are species that can be found in the area (SALVADOR, 1996; SCHLEICH *et al.*, 1996; BRUNET *et al.*, 2009).

Also in the transition zone, but very near the desert in the Saharan Atlas, some summits (including, among others, Morhad at 2137 m, Makter at 2063 m, Aissa at 2236 m, and Ksel at 2009 m) serve as relatively humid havens surrounded by arid steppes.

Assemblages of up to four different amphibian taxa can be found in these areas, including species otherwise occurring much further to the north (DOUMERGUE, 1901; SCHLEICH *et al.*, 1996). These populations, now in danger of extirpation, are relicts from a not too distant time when precipitation was more abundant (PETIT-MAIRE, 1985; AUMASSIP, 2004; LE QUELLEC, 2006).

The only amphibian characteristic of the transition zone is *B. brongersmai* whose distribution in Algeria is believed to extend into desert regions of the western Hauts Plateaux and western steppe of the Saharan Atlas.

The Sahara

Strictly Saharan amphibians do not exist (BONS, 1973; BORKIN, 1999). Of the six species of frogs and toads occurring south of 33°N, four have Mediterranean, and therefore Palearctic, affinities (*D. scovazzi*, *B. boulengeri*, *A. mauritanicus*, and *P. saharicus*), while the other two (*H. occipitalis* and *A. xeros*) are Ethiopian. Unlike reptiles or mammals, amphibians in the Sahara Desert face a hostile environment and an almost impassable biogeographic barrier. Requiring surface water, most frogs and toads have physiological and ecological requirements that preclude their survival over more than 99% of this great desert's surface area (COX *et al.*, 2006). Locations providing humid microclimates, regardless of size, serve to explain species' distributions (LARMUTH, 1984); only where water exists on the surface, or seasonally, as in some mountain "gueltates" and "dayas" in the region of Laghouat, and some wells and oases, are amphibians found.

Hydrographic basins, almost always dry, may be used as basic geographic units

(PALOMO & ANTÚNEZ, 1992); their distribution and extent can offer interesting insight into the origin and affinity of the amphibian populations for which they provide refuge (see summary by DRAKE & BRISTOW, 2006). Isolation of *D. scovazzi*, *A. mauritanicus*, and *P. saharicus* in different tracts of the Saoura Valley (BONS & GENIEZ, 1996) likely began 6000 years ago as water from Saharan slopes of the Great Atlas and Middle Atlas drained into the basin of Tidikelt, of which the Saoura forms a part (HUGHES & HUGHES, 1992; DRAKE & BRISTOW, 2006).

The presence of *A. xeros* and *H. occipitalis* on the southern slopes of Tassili'n'Ajjer and, to a lesser extent, the Hoggar, is understandable because these slopes are associated with the Niger River and the Lake Chad basins, areas where both species are still abundant (LE BERRE, 1989; SALVADOR, 1996; RÖDEL, 2000). Today's Saharan batrachofauna is a pale memory of what it would have been only a few thousand years ago when the region was dotted by lakes and interior deltas, and traversed by large rivers. During that time Paleolithic artists of the Tassili, Drâa Valley, and the Eglabs region found inspiration in the hippopotamus, crocodile, and other vertebrates associated with water, in places where even dromedary camels find it difficult to survive today (VERNET, 1995; AUMASSIP, 2004; LE QUELLEC, 2006).

CONSERVATION PROBLEMS

The same skin that allows an exchange of gases and ions with the environment makes amphibians extraordinarily susceptible to chemical contaminants, ultraviolet radiation, and infection. Increasing levels of various

kinds of pollutants (HEATWOLE & WILKINSON, 2009) and UV-radiation (MARCO *et al.*, 2009) have been registered in recent decades, and there has been a globalization of pathogenic viruses, bacteria, and fungi (BERGER *et al.*, 2009; HEMINGWAY *et al.*, 2009) that in the past were limited to resistant and geographically-restricted species (STUART *et al.*, 2004; ALFORD *et al.*, 2007). Amphibians may serve as an “early-warning” taxon for potential threats to other species, including humans, and they deserve programmed and continuous monitoring (COX *et al.*, 2006; DODD *et al.*, 2012).

The monitoring carried out during the past three decades by the University of Annaba has revealed significant reduction in numbers of *P. poireti* in recent years, and determined that this newt can be found only in Algeria. This species has come to be regarded as one of the most threatened amphibians in the Mediterranean region (SAMRAOUI *et al.*, 2012). Unfortunately, monitoring programs of Algerian amphibian populations were restricted to localized areas (SAMRAOUI & DE BÉLAIR, 1997; ROUAG, 2006; ROUAG & BENYACOUB, 2006) and the effects that acid rain, contaminated aquifers, or illnesses transmitted by ranaviruses or chytrid fungi (*Batrachochytrium*) may be having on amphibians in Algeria is only beginning to be understood.

The presence of chytrid fungi in North Africa had been predicted by earlier models (RON, 2005), and now has been confirmed in Morocco (EL MOUDEN *et al.*, 2011). Chytrid fungus had gone completely unnoticed in Algeria, but evidence of infection found in midwife toad larvae in the region of Tlemcen suggests that chytridiomycosis is affecting some amphibian popula-

tions in this country. The recently discovered Algerian population of *A. maurus* is already in extreme danger of extirpation.

Shortage and unpredictability of precipitation make most of Algeria a territory in which permanent and semi-permanent bodies of water are rare. In the north, the only region in which rainfall is relatively plentiful, water quality is often compromised by high human population density and the enormous volume of waste that industry and urbanization generate (MIMOUNI & CHIBANE, 1989). In the arid Sahara to the south, human presence occasionally has fostered survival of some amphibian species, thanks to construction of channels and “fogharas” and to the maintenance of palm groves (e.g., the Ramsar reserve at the Ouled Saïd Oasis). It is possible that small populations of *D. scovazzi* detected in the Saoura Valley (HUGHES & HUGHES, 1992) survive precisely because of this contribution of water.

In other cases, however, presence of humans has resulted in eutrophication of “gueltates” and wells, and extirpation of fragile amphibian populations. Regardless of location, being it the north, central, or south of Algeria, amphibians continue to lose suitable areas in which to live.

COX *et al.* (2006) published conclusions regarding distributions and state of conservation for Mediterranean amphibians as expressed by experts from 18 countries. Three of the 12 batrachian species then known from Algeria were listed as threatened under criteria established by the International Union for the Conservation of Nature (IUCN, 2010) (Table 3). While the evaluation summarized by COX *et al.* (2006) was global, application of the same IUCN criteria then used has been applied at the regional

Table 3: Conservation status of Algerian amphibian species. R%: percentage of the species' worldwide distribution corresponding to Algeria (ASTUDILLO & ARANO, 1995); IUCN Med: estimated level of threat, according to IUCN criteria, in countries bordering the Mediterranean Sea (COX *et al.*, 2006); IUCN Algeria: level of threat proposed after the present updated review for Algerian populations, including species newly-recorded for the country; Criteria according to IUCN (2010) for species catalogued in Algeria as VU, EN or CR. LC: Least Concern; NT: Near threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered. No Algerian species is included in category DD: Deficient Data.

Species	R %	IUCN Med	IUCN Algeria	Criteria
<i>Pleurodeles nebulosus</i>	68	VU	VU	B 1ab (ii) + 2 ab (iii)
<i>Pleurodeles poireti</i>	100	EN	CR	B 2ab (iii)
<i>Salamandra algira</i>	42	VU	VU	B 1ab (ii) + 2 ab (iii)
<i>Alytes maurus</i>	4	NT	CR	B 1ab + D 2
<i>Discoglossus pictus</i>	57	LC	LC	
<i>Discoglossus scovazzi</i>	1	LC	NT	
<i>Hyla meridionalis</i>	47	LC	LC	
<i>Amietophrymus mauritanicus</i>	48	LC	LC	
<i>Amietophrymus xeros</i>	1	LC	NT	
<i>Barbarophryne brongersmai</i>	37	LC	LC	
<i>Bufo spinosus</i>	6	LC	VU	B 1ab (v)
<i>Bufoes boulengeri</i>	5	LC	LC / NT*	-
<i>Pelophylax saharicus</i>	42	LC	LC / NT*	-
<i>Hoplobatrachus occipitalis</i>	1	LC	NT	-

*Saharan populations south of 32°N latitude

level (GAERDENFORS *et al.*, 2001; IUCN, 2010) to the 14 species currently known to occur in Algeria (Table 3) and this assessment allows completion of the Algerian catalog of threatened species, and provides a basis for making recommendations to appropriate governmental authorities (see PLEGUEZUELOS *et al.*, 2010). Reference to the protection of autochthonous fauna, and the necessity of legislation dedicated specifically for that purpose, is published in Algeria's Constitution, but none of the lists of threatened Algerian fauna published since Algeria's independence has included amphibians (DUPUY, 1966; WORLD LAW GUIDE, 2010).

Table 3 provides information about the level of threat to each of the 14 amphibian species known to occur in Algeria.

THREATENED AMPHIBIANS

Pleurodeles poireti. Because of its small geographic range (restricted to the Massif of Edough, the Guerbes-Sendhadja wetlands, and the Mekhada wetlands; SAMRAOUI & DE BÉLAIR, 1997; CARRANZA & WADE, 2004; SAMRAOUI *et al.*, 2012), and the proven regression of this species (SAMRAOUI *et al.*, 2012), Edough's Newt is considered the most threatened amphibian in Algeria. Because the species is an endemic, Algeria's responsibility for its conservation is a high priority.

These newts are threatened by water pollution, overgrazing, and drying out of habitat due to agricultural and sanitary development (COX *et al.*, 2006). A wetland area at Guerbes-Senhadja, including almost all the lagoons and

swamps near Annaba, and encompassing more than half of the known distribution of this species, has been declared a Ramsar reserve, which, at least in theory, provides a territorial base for which a recovery plan can be developed. This plan should include procedures based on the species' biology and basic requirements as a means of formulating management measures (SAMRAOUI *et al.*, 2012).

Pleurodeles nebulosus. The Algerian Newt has a much less limited distribution than Edough's Newt. Lagoons and other bodies of fresh water in its distributional range, however, have suffered direct human impact, from draining of land for sanitary reasons, loss of land to cultivation, contamination of land by agriculture or industry, and decrease in residual water volume associated with growth of Algeria's human population over the past three centuries.

Concern for wetlands has increased in the past few decades and that concern has been translated into numerous Ramsar reserves. These reserves, especially the complex of lagoons (Lac des Oiseaux and Lake Fetzara) that are part of El Kala National Park, have helped this species. As with Edough's Newt, more information about this species' biology and of the actions required to guarantee its conservation, is urgently needed (SAMRAOUI *et al.*, 2012).

Salamandra algira. The range of the Algerian Salamander is discontinuous in mountains with significant rainfall and high water quality, and studies of the genetic variability of North African populations should be undertaken (BOGAERTS & DONAIRE-BARROSO, 2003). Loss of habitat due to deforestation

and cultivation, as well as loss from overgrazing and water contamination, are considered serious areas of concern within Algeria (IUCN, 2005, unpublished report). Some habitats of the Algerian Salamander already possess some level of protection (Chr ea, Djurdjura, and El Kala National Parks; Babor Natural Reserve), yet many areas in the Grande and Petite Kabilya and in the Constantine Mountains should also be considered areas of interest for conservation.

Alytes maurus. The only well-known haven for the African Midwife Toad is in the Tlemcen Mountains, a good part of which is at present included in Tlemcen National Park (LOUKKAS, 2006). Loss of habitat associated with deforestation, contamination of water, and emergent illness are among the main threats. Algeria has limited responsibility for conservation of this species because Tlemcen populations represent only the eastern edge of a wider distribution in Morocco. Application of some basic and inexpensive conservation measures in Tlemcen National Park could guarantee its survival. If, as seems to be happening, chytridiomycosis is affecting the population of Midwife Toads from Tlemcen, urgent measures need be taken to preserve this species in Algeria.

Bufo spinosus. The Common Toad is a widespread species not considered globally threatened (COX *et al.*, 2006) but that, in Algeria, has a highly fragmented distribution associated with mountainous areas (SAMRAOUI *et al.*, 2012). This pattern of distribution and progressive deterioration of populations support the conclusion that the species is Vulnerable.

Table 4: Areas of special interest for amphibians in Algeria.

Area	Coordinates	Area (km ²)	Climate	Type of Habitat
Lake Béni Belaïd	36°53' N 6°05' E	6	Mediterranean subhumid	Freshwater lake, adjacent humid areas and coastal dunes
Edough	36°51' N 7°19' E	700	Mediterranean subhumid	Mediterranean mountains and forest
Guerbes-Senhadja	36°56' N 7°20' E	42	Mediterranean subhumid	Coastal wetlands
Mekhada marshes	36°47' N 8°07' E	9	Mediterranean humid	Marshes
Lake Fetzara	36°47' N 7°31' E	90	Mediterranean humid	Stable coastal lagoons, areas of seasonal flooding
Lac des Oiseaux	36°45' N 8°01' E	1.2	Mediterranean humid	Freshwater lagoon
El Kala National Park	36°51' N 8°23' E	764	Mediterranean subhumid and humid	Humid area, coastal swamps and subhumid Mediterranean forest
Tlemcen Mountains	34°36' N 1°27' W	82	Mediterranean semi-arid and subhumid	Mediterranean mountains with cork, pine, and oak forest
Chr�ea	36°26' N 2°53' E	266	Mediterranean subhumid	Mediterranean mountains with oak and cedar forests
Djurdjura	36°19' N 3°34' E	185	Mediterranean semi-arid and subhumid	Mediterranean mountains with cork forests, cedar and pine
Djebel Babor	36°30' N 5°30' E	17	Mediterranean humid	Mediterranean forests of Holm oak, cedar, and fir
Ksour Mountains and Djebel Ksel	33°54' N 0°09' E	2550	Mediterranean Saharan	Arid Mediterranean areas
Oases of Wadi Igharghar	33°37' N 6°04' E	204	Saharan, precipitation in colder months	Oases, dunes, and "hamadas"
Guir / Saoura	29°54' N 1°54' W	11 000	Saharan, precipitation in colder months	Alignment of Oases, between "ergs" and "hamadas"
Dr�aa Valley	29°31' N 7°01' W	4200	Saharan, precipitation in colder months	Temporary "wadies", isolated "gueltates", and abandoned irrigation ditches
Tassili n'Ajjer National Park	24°35' N 09°31' E (Djanet)	72 000	Saharan, precipitation in warmest months	Hyperarid plateaus and hills
Hoggar National Park	22°47' N 5°31' E (Tamanrasset)	380 000	Saharan, precipitation in warmest months	Mountainous Desert

*BR: Biosphere Reserve; NP: National Park; NR: Natural Reserve.

Wilaya	Protection*	N° Species	Threatened and Near-Threatened species	References
Jijel	NR Ramsar site 1303	5	<i>P. nebulosus</i>	Rouag, 1997 in Boumezbeur & Naziha 2003; Boumezbeur & Naziha, 2002
Annaba	NR, Ramsar	7	<i>P. poireti</i> <i>S. algira</i>	Samraoui & de Bélair, 1997; Carranza & Wade, 2004
Skikda	Ramsar site 1056	5	<i>P. poireti</i>	Samraoui <i>et al.</i> , 2012
El Tarf	Ramsar	5	<i>P. poireti</i>	Samraoui <i>et al.</i> , 2012
Annaba	Ramsar site 1299	6	<i>P. nebulosus</i>	Boumezbeur, 2003
El Tarf	NR Ramsar site 975	5	<i>P. nebulosus</i>	Boumezbeur & Naziha, 2003
El Tarf	NP, Ramsar sites 280, 281, 1293, 1301, 1305 and 1424	6	<i>P. nebulosus</i> <i>B. spinosus</i>	Rouag, 2006; Rouag & Benyacoub, 2006
Tlemcen	NP	7	<i>A. maurus</i> <i>B. spinosus</i>	Doumergue, 1901; Loukkas, 2006
Blida	NP, BR	6	<i>S. algira</i> <i>B. spinosus</i>	Loukkas, 2006
Bouira Tizi Ouzou	NP	6	<i>S. algira</i> <i>B. spinosus</i>	Loukkas, 2006
Sétif	NR	6	<i>S. algira</i> <i>B. spinosus</i>	-
Naama Bayadh	NP, Ramsar	5	<i>B. brongersmai</i>	-
El Oued	None	3	<i>P. saharicus</i> <i>A. mauritanicus</i> <i>B. boulengeri</i>	-
Bechar Adrar	None	4	<i>P. saharicus</i> <i>A. mauritanicus</i> <i>B. boulengeri</i>	Gauthier, 1967; Hughes & Hughes, 1992
Tindouf	None	4	<i>D. scovazzi</i> <i>B. boulengeri</i> <i>P. saharicus</i> <i>B. brongersmai?</i>	Bons & Geniez, 1996
Illizi	NP	4	<i>A. xeros</i> <i>B. boulengeri</i> <i>H. occipitalis</i> <i>P. saharicus</i>	Le Berre, 1989; Hughes & Hughes, 1992; UNEP / WCMW, 2008
Tamanrhas-set	NP	3	<i>P. saharicus</i> <i>A. xeros</i> <i>B. boulengeri</i>	Hughes & Hughes, 1992; Boumezbeur, 2001

NEAR-THREATENED SPECIES

Three species, considered of Least Concern (LC) at the global level, have restricted and severely fragmented distributions in Algeria and are considered Near Threatened (NT) at the local level. *Barbarophryne brongersmai* is relatively common in semi-arid regions in portions of the Saharan Atlas, and both *A. xeros* and *H. occipitalis* have wide distributions in sub-Saharan Africa but are restricted to some areas of the Hoggar and the Tassili in Algeria. As with the previous species, water quality and loss of habitat are the main causes of their precarious state.

Pelophylax saharicus and *B. boulengeri* are not considered threatened at the global level (COX *et al.*, 2006) and are relatively common in northern Algeria but isolated populations in the Saharan region are, on occasion, very threatened. For this reason, populations south of latitude 32°N in Algeria can appropriately be considered as Near Threatened (NT).

AREAS OF SPECIAL INTEREST FOR AMPHIBIANS

Reports published in 2003 by Earth Trends identify 5.1% of Algeria's surface as within limits of reserves, national parks, national monuments, or otherwise protected landscape. Although amphibians are repeatedly considered excellent indicators of the ecological health of an area, they have rarely been considered when site mapping for these protected areas (BUTCHART *et al.*, 2006). In addition to sites important for historical and landscape reasons, Algerian parks and reserves have targeted mainly the conservation of birds and large mammals (LOUKKAS, 2006). The protective measures adopted have, however, indirectly

benefitted some amphibian species. The most obvious examples of this are wetland areas protected by the Ramsar convention, areas originally mapped for ornithological reasons but that also serve as amphibian refuges. As noted above, protection of wetlands in the north of Algeria benefits species such as *P. poireti* and *P. nebulosus*; similarly, protection of mountainous areas, such as those of the Djurdjura, Tlemcen, or the Hoggar, serve as refuges for some threatened species and protect relict fauna like *S. algira* and *A. maurus*.

Not all areas important for amphibian conservation are found within the boundaries of a national park or reserve, however, but all deserve to be preserved, especially all Saharan water points whose amphibian communities are, by definition, threatened. We conclude this chapter with a preliminary listing of areas of importance to amphibians, including information on location, area, climate, habitat characteristics, and Threatened and Near Threatened species that can be found in these areas (Table 4).

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