Chapter 27
Conservation status of amphibians in Tunisia

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Received: 10 January 2013; received in revised form: 17 September 2013; accepted: 18 September 2013.

The North African amphibian fauna was once regarded as limited in diversity, but increased field and laboratory research in the region has subsequently revealed considerable endemism and data such as these are necessary for making objective and justifiable recommendations for conservation. Our research, coupled with findings from the literature, allow an up-to-date analysis of distribution, status of populations, and actual and potential threats to the continued survival of all species within Tunisia. The Tunisian batrachofauna currently consists of seven species grouped in seven genera: *Pleurodeles*, *Bufotes*, *Discoglossus*, *Bufo*, *Amietophrynus*, *Pelophylax*, and *Hyla*. Whereas other species are characterized by wider distributions from north to south, *Bufo spinosus* appears restricted to the mountainous northwestern corner where major protected areas occur. *Pleurodeles nebulosus* and *Hyla meridionalis* appear restricted to humid, subhumid, and semi-arid localities in northern Tunisia, in the Khroumirie region, but also within the Mogod region, around Tunis and the Cap Bon Peninsula. Northern localities represent the most humid and temperate portion of the country and support the highest habitat and species diversity. Despite an increasing number of man-made habitats (irrigation canals), southern localities continue to suffer from lack of suitable habitat due to natural and human causes. There are no man-made ponds dedicated to protect amphibian species in Tunisia. Our observations confirmed that Tunisia is affected by amphibian population decline, due especially to loss and fragmentation of habitat. Principal threats to amphibian survival (uncontrolled urban extension, alteration and destruction of habitat, pollution, road kills, and introduction of several predator species) vary slightly from north to south. Implementation of stricter policies coupled with increased public education and awareness is recommended in order to preserve Tunisia's amphibian fauna.

Key words: amphibians; conservation status; Tunisia.

Estado de conservación de los anfibios en Túnez. Tradicionalmente se consideraba a la fauna de anfibios del norte de África poco diversa, pero el aumento de los estudios de campo y laboratorio en esta región ha revelado un grado considerable de endemicidad, haciéndose necesarios más datos para elaborar recomendaciones para la conservación que sean objetivas y justificables. Nuestro trabajo, junto a otros hallazgos recopilados de la literatura, permite un análisis detallado de la distribución, estado de las poblaciones y amenazas reales y potenciales para la supervivencia de todas las especies de Túnez. La batracofauna tunecina consiste actualmente en siete especies en otros tantos géneros: *Pleurodeles*, *Bufotes*, *Discoglossus*, *Bufo*, *Amietophrynus*, *Pelophylax* e *Hyla*. Mientras que algunas especies se encuentran ampliamente distribuidas de norte a sur, *Bufo spinosus* se restringe a la región montañosa noroccidental donde se encuentran las principales áreas protegidas. *Pleurodeles nebulosus* e *Hyla meridionalis* se limitan a las localidades húmedas, subhúmedas y semiáridas del norte, en la región de Khroumirie, además de a la región de Mogod, el entorno de la capital y la península del cabo de Bon. Las localidades septentrionales constituyen la parte más húmeda y templada del país, albergando la mayor diversidad de hábitats y de especies. En las localidades meridionales, pese al incremento en el número de hábitats artificiales (canales de irrigación), existe una falta de hábitats apropiados como consecuencia de factores tanto

This chapter should be cited as: Amor, N., Kalboussi, M. & Said, K. (2013). Conservation status of amphibians in Tunisia. Chapter 27 in Part 2. *Mauritania, Morocco, Algeria, Tunisia, Libya and Egypt* in Vol. 11. *Conservation and Decline of Amphibians: Eastern Hemisphere* of the series *Amphibian Biology. Basic and Applied Herpetology* 27: 85-100. DOI: http://dx.doi.org/10.11160/bah.13006/

naturales como artificiales. No existen en todo Túnez charcas artificiales destinadas a la protección de anfibios. Nuestras observaciones confirman que Túnez no es ajeno al declive de las poblaciones de anfibios, debido fundamentalmente a la pérdida y fragmentación del hábitat. Las principales amenazas para la supervivencia de los anfibios (expansión incontrolada de los núcleos urbanos, alteración y destrucción del hábitat, contaminación, atropellos e introducción de diferentes especies depredadoras) varían ligeramente de norte a sur. Recomendamos implementar políticas más estrictas, junto al incremento de la educación y concienciación social, para preservar la fauna de anfibios de Túnez.

***Key words*:** anfibios; estado de conservación; Túnez.

Tunisia is the smallest north-African country, with an area of 164 000 km^2. While some forest occurs in the centre of the country, broadly-forested areas are limited to the north; almost one-third of Tunisia's surface area is covered by the Sahara Desert, and a major portion of the rest of the country is dominated by an arid climate characterized by annual and seasonal variation in rainfall (PEEL *et al.*, 2007). The major ecological factor limiting amphibian survival in the country is scarcity of water (AMOR *et al.*, 2010a,b).

Prior studies of the distribution of amphibians in Tunisia (POIRET, 1789; GERVAIS, 1835, 1853; LATASTE, 1881; BOULENGER, 1882, 1891; OLIVIER, 1894, 1896; DOUMERGUE, 1901; DE CHAIGNON, 1904; WOLTERSTORFF, 1901; MAYET, 1903; PELLEGRIN, 1927; GAUTHIER, 1928; MERTENS, 1929; MOSAUER, 1934; BLANC, 1935; GALLIEN, 1948; PASTEUR, 1958; DOMERGUE, 1959; SCHNEIDER, 1974, 1978; HEMMER *et al.*, 1980; BLANC & NOUIRA, 1988; STEINWARZ & SCHNEIDER, 1991; SCHLEICH *et al.*, 1996; MEDDEB & CHENITI, 1998; NOUIRA & LESCURE, 1998; NOUIRA, 2001; ROMDHANE & MISSAOUI, 2001; JOGER, 2003; AZOUZI & TEKAYA, 2004, 2007; BEN HASSINE, 2007, 2011; MEDDEB *et al.*, 2007) understandably were limited in geographical coverage and utilized the morphologically-based taxonomy in use at the time. Updated contributions by AMOR *et al.* (2007, 2009, 2010a,b,c,d,e, 2011), SICILIA *et al.* (2009), BEN HASSINE & NOUIRA (2012a,b), BEN HASSINE *et al.* (2013), and BOGAERTS *et al.* (2013a,b) contribute toward a more complete understanding of the distribution and ecology of Tunisian amphibians.

FAUNAL COMPOSITION AND GENERAL DISTRIBUTION

Pleurodeles nebulosus (Guichenot, 1850), the Algerian ribbed newt, is the only salamander represented in Tunisia (CARRANZA & WADE, 2004; VEITH *et al.*, 2004; SICILIA *et al.*, 2009; BEN HASSINE & NOUIRA, 2012a,b; BEN HASSINE *et al.*, 2013). It has been recorded from north-central Algeria to the Cap Bon Peninsula (SMITH *et al.*, 1998; PASMANS *et al.*, 2002; SICILIA *et al.*, 2009; BEN HASSINE & NOUIRA, 2012b; BEN HASSINE *et al.*, 2013) but currently this Algero-Tunisian endemic appears restricted to the humid, subhumid, and semi-arid localities in northern Tunisia: in the Khroumirie region, and at the Mogod region, around Tunis and the Cap Bon Peninsula (BEN HASSINE, 2012a; BEN HASSINE *et al.*, 2013). In these places it is locally abundant in humid environments close to rivers (Ordha, southwest of Tabarka; the route between Aïn Sobh and the aeroport; near oued El Kebir, Tabarka), small watercourses, and stagnant bodies of water (in the vicinity of Tabarka; Barbra Dam

near the village of Hammam Bourguiba). Individuals tend to congregate in groups of more than ten under the same shelter, probably in response to the lack of suitable shelters, but also they are often found solitary or in small groups. Aestivation during hot and dry periods of the year is accomplished by digging deeply into soil among plant roots. The species' southern limit of distribution in Tunisia seems to be the Cap Bon Peninsula.

Hyla meridionalis Böttger, 1874, the Mediterranean treefrog, is the country's only arboreal species of amphibian. Recent phylogeographic studies have shown that Tunisian *H. meridionalis* are highly divergent from Iberian and neighbouring populations, suggesting that the Tunisian populations could represent a new species (Recuero *et al.*, 2007; Stöck *et al.*, 2008a), although the interpretation of this divergence could be exaggerated due to absence of samples from Algeria. The Mediterranean treefrog is limited to northern Tunisia, from the Algerian border (El Feija National Park) to Bizerte, south and north of Medjerda (Ben Hassine & Nouira, 2012b), where it has a disjunct distribution and survives mainly around sources of water supporting woody vegetation; when not breeding or moving toward a suitable breeding pond, it usually is found perched on a tree or a bush. The species may be locally abundant in the Khroumirie and Mogod regions during its breeding season, generally from the beginning of February to the end of March (Sicilia *et al.*, 2009; Ben Hassine & Nouira, 2012a). In Tunisia, the species has not been found on coastal dunes (e.g. Bizerte), as is sometimes the case in southern Spain or northern Morocco (Busack, 1986), and its reported occurrence near the city of Tunis and Bardo's gardens (Mayet, 1903) has not been confirmed (Sicilia *et al.*, 2009; Ben Hassine & Nouira, 2012b) .

Discoglossus pictus Otth, 1837, the painted frog, is widely distributed in Tunisia, but its geographic distribution is discontinuous. All eastern Maghrebian populations were formerly known as *D. p. auritus*, but the taxonomic validity of *D. p. auritus* for these populations, and *D. p. pictus* for Mediterranean island populations (Sicily, Malta, and Gozo) does not appear supported by recent genetic and karyological analyses (Fromhage *et al.*, 2004; Zangari *et al.*, 2006; Amor *et al.*, 2007, 2010c,d,e). The painted frog inhabits a wide range of biotopes from montane forests to coastal areas. In northwestern Tunisia it may be found somewhat distant from any water (Amor *et al.*, 2010c,d). In southernmost localities *D. pictus* is confined to areas such as the oases of Gafsa, Chott El Djerid, Kebili, Chinini, and the Oued el Ferd and Kettana both in Gabès (Busack, 2006; Ben Hassine & Nouira, 2009, 2012b; Sicilia *et al.*, 2009; Amor *et al.*, 2010c,d). Higher densities may be found around the multiple dams in the country, especially during breeding seasons. Ben Hassine & Nouira (2012b) considered the painted frog to be absent from all Sahel regions; however, we have recorded the presence of individuals from Gabès to Nabeul (Amor *et al.*, 2010c,d). Surveys within suitable habitats during the breeding season are necessary for verification of this species' presence.

Pelophylax saharicus (Boulenger, 1913), the North African green frog, is the most abundant species in Tunisia (Amor *et al.*, 2007, 2009, 2010a,b). It inhabits oases, ponds (natural and artificial), and irrigation

ditches throughout the country (including northern portions of the Sahara Desert), and population density is often very high (AMOR *et al.*, 2009, 2010a,b). The taxonomy of this species has changed in the recent past (STEINWARZ & SCHNEIDER, 1991; NOUIRA, 2001) from its former names *Rana perezi* (Seoane 1885) and *R. ridibunda* (Pallas 1771). BUCKLEY *et al.* (1994, 1996) and ARANO *et al.* (1998) distinguished between Iberian green frogs (*Pelophylax perezi*) and West African green frogs (*P. saharicus*), and within the latter identified two distinct clades separated by the river Moulaya: *P. saharicus saharicus* in Algeria and *P. s. riodeoroi* in Morocco. A recent morphological study described significant differentiation among Tunisian populations of *P. saharicus* (AMOR *et al.*, 2009). However, using mitochondrial markers, AMOR *et al.* (2010a,b) revealed low genetic variation and the absence of structure within the species in Tunisia.

Bufo spinosus Daudin, 1803, the common toad, is confined to mountainous regions of northwestern Tunisia. A recent phylogeographic study, covering the entire distribution of the species complex, suggested the use of *B. bufo* ssp. for the African population and that this population might include two different subspecies, one in the Western Maghreb and another in the Eastern Maghreb (GARCIA-PORTA *et al.*, 2012). However, further studies have discovered that populations from northern Africa, as well as those from the Iberian Peninsula and southern France constitute a different species, *B. spinosus* (RECUERO *et al.* 2012; ARNTZEN *et al.*, 2013). *Bufo spinosus* inhabits forested areas between Tabarka and Ouchtata and can sometimes be found near cities (Jendouba) and archaeological sites in Bulla Regia, both of which may constitute local refuges for many amphibian and reptilian species, but it generally avoids proximity to humans. SICILIA *et al.* (2009) and BOGAERTS *et al.* (2013a) reported this species near Aïn Draham in an oak forest near the reservoir of Beni M'tir; BEN HASSINE & NOUIRA (2012a,b) also mention Beni Mtir, Ghardimou, and El Feija. Population densities were very low. In addition to localities specified by previous authors, we add maritime pine forests west of Melloula, mixed oak (zeen and cork oak) forests east of Tabarka, and oak forests south of Nefza (Bellif forests).

Amietophrynus mauritanicus (Schlegel, 1841), the Mauritanian toad, is an endemic species of the Maghreb. During our fieldwork we observed this species to be present in low densities throughout Tunisia where it inhabits rocky areas, meadows, bushes, cultivated fields, and some urban environments (Gafsa). In the south it is confined to the oases of Gafsa, Chott El Djerid, Tozeur, Kebili, and Ben Gardane (BOULENGER, 1891; JOGER, 2003; AMOR *et al.*, 2007; SICILIA *et al.*, 2009).

Bufotes boulengeri (Lataste, 1879), Boulenger's toad, has recently become better understood in a phylogenetic context. Previously considered a member of the Palearctic green toad complex as *Bufo viridis*, recently it has been reassigned independent species status based on mitochondrial DNA data (see STÖCK *et al.*, 2006, 2008b and BEUKEMA *et al.*, 2013 for details). It is widely distributed throughout Tunisia and inhabits forest, meadow, and steppe environments (AMOR *et al.*, 2011). Resistant both to

drought and saline conditions, it prefers open terrain near water courses but in arid areas it lives close to irrigation ditches, springs, and oases (Amor *et al.*, 2011). According to Sicilia *et al.* (2009), the southernmost breeding site is a temporary stream in the rocky desert (Hamada) near Tataouine. The species seems to be quite common on the Tunisian islands of Kerkennah and Djerba (Stöck *et al.*, 2006; Ben Hassine & Nouira, 2012b). Recent morphometric study of Tunisian Boulenger's toad reported clinal variation in body size and weight that might result from phenotypic plasticity correlated with local environmental factors (Amor *et al.*, 2011).

The North African Fire Salamander, *Salamandra algira* (Bedriaga, 1883), occurs in isolated populations throughout the northern mountain ranges of north-western Africa (Schleich *et al.*, 1996). Blanc (1935) mentioned that *S. algira* might occur in Tunisia, as its type locality is found nearby in Algeria. Despite the fact that Blanc (1935) encouraged searches for *S. algira* in the Khroumirie region, no subsequent records were provided. Recently, after field trips conducted in northeastern Tunisia, Bogaerts *et al.* (2013b) found no indications for the presence of *S. algira* in Tunisia. Additionally, phenotypic and morphological examinations of "Tunisian" *S. algira* museum specimens originating from the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK), Germany, were carried out. The ZFMK specimens of *S. algira* turned out to be most likely middle or eastern European *Salamandra salamandra*. These results do not support earlier statements on the presence of the species in Tunisia.

Habitat diversity and current status

Northern localities

Habitat diversity is highest between the Medjerda Mountains in the west and Cap Bon Peninsula in the east. Northwestern Tunisia (Khroumirie and Mogod regions) has the highest rainfall (650-1500 mm / year) (Omrani & Ouessar, 2008) and is the most humid and temperate portion of the country, dominated by forests of natural cork (*Quercus suber*) and zeen (*Quercus canariensis*) (Le Floc'h *et al.*, 2010). The northwest, with two national parks and four natural reserves, provides appropriate habitats for populations of all Tunisian amphibian species. Best known are the national parks, from which six species are reported (Karem, 2003; Sicilia *et al.*, 2009; Ben Hassine & Nouira, 2012a,b; Ben Hassine *et al.*, 2013) but species commonly found in other parts of North Africa, such as *B. spinosus* and *H. meridionalis*, have not been found in either northern park or in the south of Tunisia.

Northern Tunisia is continuing to experience increasing rural populations with high human densities of 173-256 inhabitants / km^2) (Coelho *et al.*, 1999; Gafsi *et al.*, 2008). Intense human activity and population growth over the past century have led to deforestation for agriculture and industry, overgrazing, forest fires, and pollution, resulting in significant loss of amphibian habitat (Boussaïd *et al.*, 1999). The plain of Tunis suffers fragmentation of habitat resulting from urbanization, industrial pollution, and waste management. Many artificial lakes and dams have been created in the west in the

past twenty years; while the water is used primarily for agriculture and some artificial wetlands may dry in summer, these artificial sites provide refuges and breeding areas for amphibians in a country where water is an important variable influencing amphibian survival. Natural habitats, however, often are damaged during construction because of alteration of the courses of rivers and streams. Introduction of several species of fish (*Mugil cephalus*, *Liza ramada*, *Rutilus rubilio*, *Scardinius erythrophtalmus*, *Gambusia affinis*) into new dams may also lead to predation, mostly on eggs and larvae (GHRAB & BOUATTOUR, 1999; AMOR *et al.*, 2009; BEN HASSINE & NOUIRA, 2012a). The impact of these lakes on local amphibian populations is yet to be studied.

Severe drought in 1987-1988 and 1988-1989 exacerbated habitat degradation in the wetlands on Cap Bon Peninsula (SMART & HOLLIS, 1989). At one site, Azmour, we found several *P. saharicus* specimens displaying morphological abnormalities (missing digits), probably stemming from intensive agricultural activity. In the same region, BEN HASSINE *et al.* (2011) reported high rates of malformation in populations of *P. saharicus* and *D. pictus* inhabiting an artificial dam ("lebna").

Central localities

Habitat destruction in this region is also increasing as a result of urban and industrial development. We observed high mortality of amphibians and reptiles on roadways throughout all visited localities; concentration of the textile industry in the Sahel region (Moknine, Monastir, Ksarhlel, and Sousse) has likely contributed to declines in species abundance that we noted during field trips (2004-2013). In fact, disposal of large amounts of industrial waste at breeding sites caused massive pollution (CAR / PAP, 2005).

Southern localities

The scarcity of suitable habitat for amphibians in southern Tunisia (AMOR *et al.*, 2009, 2010a,b,c, 2011) is due both to natural and human causes: an increase in temperature, a decrease in annual rainfall (ALOUI, 2010) and, thus, an increase in the intensity of drought on the one hand, and the expansion of human activity on the other. Elevated temperatures can lead to early desiccation of breeding ponds and subsequent mortality of eggs and tadpoles and may also result in mortality of adults due to the increased rate of water loss associated with dry conditions (BLAUSTEIN *et al.*, 2010). However, in southern agricultural regions where natural wetlands are scarce, irrigation channels may represent important breeding habitats for amphibians. In fact, we observed that all amphibian species were breeding in these man-made habitats.

Habitat fragmentation in extensive areas is also a significant negative factor influencing amphibian survival (BLAUSTEIN *et al.*, 1994; FISHER & SHAFFER, 1996; GILLESPIE & HOLLIS, 1996; HECNAR & M'CLOSKEY, 1996). Plantations established on weakened soils in Gafsa are fragmenting the land and many natural water sources have run dry because of agricultural activities. An important problem facing amphibians in this area, however, is pollution of remaining freshwater and terrestrial habitats by mineral mining and wastewater (commonly known as

"margine") from olive mills. Tailings from phosphate mining have polluted the Bay of Gafsa (Gafsa, Mitlaoui, Moularayes, Redaief, and Lala), thereby threatening coastal and fishing waters (Gabès and Sfax) and underground aquifers. The average volume of "margine" produced annually, at Sfax, during extraction of olive oil is estimated at 700 000 m^3 (0.7 m^3 / ton of fresh olives). Although its effects on the environment through pollution, corrosion, and blocking of sewage pipes have not been thoroughly documented, we have observed large quantities of "margine" and other kinds of waste being released into natural habitats (Fig. 1). Other sources of pollution are cement plants, chemical (M'dilla, Guetar, and Ksar-Gafsa) and steel manufacturing plants and petroleum refineries (HAMZA-CHAFFAI, 1993; HAMZA-CHAFFAI *et al.*, 1997; SERBAJI, 2000; SMAOUI-DAMAK *et al.*, 2003).

Figure 1: "Margine" waste generated during the process of olive (*Olea europaea*) oil extraction. (a) Ain Essoltan. (b) Gafsa (Oasis Nord).

Discoglossus pictus has been found in the Oued el Ferd, Nefta (BOULENGER, 1891) and in the oases of the Chott El Djerid (MAYET, 1903). The southernmost sites where the species occurred were irrigation canals in Chott El Djerid and also in Chinini oasis near Gabés; in the same area from which it was recorded by Busack in March, 1972 (BUSACK, 2006), and by SICILIA *et al.* (2009). *Discoglossus pictus* was reported to occur in Gafsa, Kebili, and Kettana (BEN HASSINE & NOUIRA, 2009, 2012b; AMOR *et al.*, 2010c,d). SCHNEIDER (1978) reported the occurrence of *A. mauritanicus* on the northern border of the Sahara Desert. Recent studies reveal that this species is confined to oases, especially Tozeur and Gafsa (JOGER, 2003; AMOR *et al.*, 2007; SICILIA *et al.*, 2009; BEN HASSINE & NOUIRA, 2012b). *Bufotes boulengeri* and *P. saharicus* appear remarkably adapted to extreme conditions in the southern part of Tunisia, occurring in irrigation channels and agricultural reservoirs in spite of high temperatures and elevated salinity (Tozeur, Ras El Ain). Plasticity in the annual reproductive cycle of *P. saharicus* (ESTEBAN *et al.*, 1999), coupled with predation on tadpoles and juveniles of *B. boulengeri*, contribute to this species being the dominant amphibian in the south (MEDDEB & CHENITI, 1998).

THREATS TO SURVIVAL

In general, Tunisians do not like amphibians and avoid any contact with them. Toads are particularly disdained because of their large size and rough skin. Few people exhibit fear of these animals and amphibians are not deliberately killed unless found in close proximity to gardens and houses. No Tunisian species are objects of local trade or exploitation except, perhaps, frogs (*P. saharicus* mostly) used as model animals in the educational system.

In summary, major threats to amphibian survival in Tunisia currently include:

- Deforestation and destruction of natural vegetation close to watercourses and ponds. The decrease in natural vegetation is continuing, and large portions of natural forests are degraded. *Hyla meridionalis*, in particular, is negatively affected by such practices, and many local populations have declined or disappeared in the past few years because of habitat loss.

- Desiccation of wetlands, ponds, and meadows (El Mnagaa) due to agricultural activity and urban extension, especially in southern Tunisia (Ain Essoltan) (BEN AMOR, 2010).

- Transformation, fragmentation, and destruction of suitable natural habitat due to grazing, farming, and urbanization. Ecosystems have been changed dramatically during the past century, and the phenomenon is not likely to end in the near future. Plowing may constitute destruction of the habitat of *P. nebulosus* because this species aestivates in the soil during summer. In regions where intensive agricultural activity occurs, newts are restricted to the margins of cultivated land where soil is not turned over.

- Pollution derived from industry, such as mining (Gafsa), petroleum (Sfax), and textile production (Monastir), or agriculture (Cap Bon) pose risks to freshwater and to the equilibrium of the ecosystem.

- Road kills: large numbers of amphibians, mainly toads, are killed on roads during the breeding season and after rains. Amphibians are constrained to move within their home ranges and must often cross roads, exposing them to vehicular traffic. There is no system of tunnels allowing safe movement from one place to another along the Tunisian national network of routes and highways.

CURRENT STATUS

The network of protected areas in Tunisia is comprised of 17 national parks and 27 natural reserves, four faunal reserves, and 38 humid areas (Ramsar). During the past two years, many of these protected areas have been subjected to numerous degradations (e.g. cutting trees, fires, poaching) that have many consequences for the fauna inhabiting them. Prior studies by SICILIA *et al.* (2009) and BEN HASSINE & NOUIRA (2012b) evaluated the conservation status of Tunisian amphibians. In addition, we carried out recent fieldwork in more than 30 localities including different aquatic and terrestrial habitats (Table 1) and covering the entire species' ranges (AMOR *et al.*, 2007, 2009, 2010a,b,c,d,e, 2011). On the basis of these surveys, we noted that *D. pictus*, *P. saharicus*, *B. boulengeri*, and *A. mauritanicus* are common and do not appear threatened, which, with the exception of *D. pictus*, accords with the observations made by BEN HASSINE & NOUIRA (2012b). On the other hand, species like *B. spinosus*, *H. meridionalis*, and *P. nebulosus* were believed to be represented only at a few scattered localities, although

recent intensive surveys like those by SICILIA *et al.* (2009) and BEN HASSINE & NOUIRA (2012a,b) have confirmed their presence in some new localities, revealing a more continuous distribution. In the network of protected areas, no status report concerning amphibian populations has been completed, and available data are not sufficient to provide an accurate status report for all species. *Salamandra algira*, however, has been determined not to occur within Tunisia's borders (BOGAERTS *et al.*, 2013b).

Table 1: Geographic information and species detected in the localities recently surveyed. Pn: *Pleurodeles nebulosus*, Dp: *Discoglossus pictus*, Am: *Amietophrynus mauritanicus*, Bsp: *Bufo spinosus*, Bbo: *Bufotes boulengeri*, Hm: *Hyla meridionalis*, Ps: *Pelophylax saharicus*.

Region	Locality	Latitude (N)	Longitude (E)	Elevation (m)	Observed species
North	Azmour	36°55'05.32"	11°00'22.20"	95	Dp, Am, Bbo, Ps
	Beja	36°43'58.48"	9°11'00.69"	249	Dp, Am, Bbo, Ps
	Ghar Dimaou	36°26'59.37"	8°25'43.60"	449	Pn, Dp, Am, Bsp, Bbo
	Grombalia	36°36'10.95"	10°29'38.41"	45	Dp, Am, Bbo, Ps
	Hammamet	36°22'36.76"	10°32'20.36"	3	Dp, Am, Bbo, Ps
	Kelibia	36°50'58.75"	11°06'49.49"	4	Dp, Am, Bbo, Ps
	Korba	36°33'53.84"	10°51'36.28"	0	Dp, Am, Bbo, Ps
	Lebna (1)	36°44'27.08"	10°55'20.03"	13	Dp, Am, Bbo, Hm, Ps
	Lebna (2)	36°44'26.83"	10°55'19.70"	12	Pn, Dp, Am, Bbo, Ps
	Nabeul	36°27'32.37"	10°44'07.44"	39	Dp, Am, Bbo, Ps
	Oued El Maleh Beja	36°41'19.81"	9°14'19.64"	154	Dp, Am, Bbo, Ps
	Bizert	37°19'45.31"	9°48'50.87"	29	Dp, Am, Bbo, Hm, Ps
	Barbra dam	36°44'02.00"	8°32'08.00"	176	Pn, Dp, Am, Bbo, Ps
	Oued Ezzarga	36°38'34.22"	9°12'59.33"	302	Dp, Am, Bbo, Ps
	Tunis	36°52'20.21"	10°10'32.54"	30	Dp, Am, Bbo, Ps
Centre	Kairouan (1)	35°40'13.00"	10°5'57.72"	62	Dp, Am, Bbo, Ps
	Kairouan (2)	35°43'22.02"	10°5'55.12"	65	Dp, Am, Bbo, Ps
	Kasserine	35°10'25.93"	8°49'36.37"	726	Dp, Am, Bbo, Ps
	Kasserine el Arich	35°12'00.61"	8°49'13.30"	633	Dp, Am, Bbo, Ps
	Monastir 1	35°45'33.04"	10°48'49.35"	24	Dp, Am, Bbo, Ps
	Monastir 2	35°42'03.04"	10°46'00.12"	22	Dp, Am, Bbo, Ps
South	Ain Essoltan	34°23'15.16"	8°49'42.13"	278	Dp, Am, Bbo, Ps
	Ben Garden	36°22'36.76"	10°32'20.36"	3	Dp, Am, Bbo, Ps
	Gabès (Chenini)	33°52'33.59"	10°04'39.68"	44	Dp, Am, Bbo, Ps
	Gafsa	34°23'43.41"	8°46'51.35"	270	Dp, Am, Bbo, Ps
	Gafsa (Oasis Nord)	34°23'12.21"	8°46'12.15"	271	Dp, Am, Bbo, Ps
	Gafsa (Oasis Sud)	34°23'21.18"	8°47'00.50"	283	Dp, Am, Bbo, Ps
	Djerba	33°49'40.70"	11°01'04.83"	0	Dp, Am, Bbo, Ps
	Kebili	33°41'22.06"	8°58'17.82"	38	Dp, Am, Bbo, Ps
	Nefta	36°50'58.75"	11°06'49.49"	4	Dp, Am, Bbo, Ps
	Oued El Maleh Gafsa	34°23'09.02"	8°49'11.40"	270	Dp, Am, Bbo, Ps
	Tamerza Oasis 1 gk	34°23'04.68"	7°56'24.36"	291	Dp, Am, Bbo, Ps
	Tamerza Oasis 2 pk	34°23'06.66"	7°55'19.23"	270	Dp, Am, Bbo, Ps
	Tozeur Ras El Ain	33°55'20.59"	8°07'58.93"	92	Dp, Am, Bbo, Ps

All aspects of the biology and life history of amphibians in Tunisia require additional study and protection-oriented action. Priority should be given to localized populations and species with restricted ranges for implementation of conservation measures in the near future. In addition, implementation of stricter policies, especially for industrial and agricultural activities, is necessary to preserve the Tunisian amphibian fauna. Finally, there is a need to increase civic awareness and participation among the citizens of Tunisia with regard to the importance of protecting and preserving our natural heritage in order to reduce the rate at which the ecosystem is degrading.

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