A PRECIPITOUS DECLINE OF THE ALGERIAN NEWT *PLEURODELES POIRETI* GERVAIS, 1835 AND OTHER CHANGES IN THE STATUS OF AMPHIBIANS OF NUMIDIA, NORTH-EASTERN ALGERIA

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RÉSUMÉ. — *Déclin précipité du Triton de Poiret* Pleurodeles poireti *Gervais, 1835 et autres changements du statut des amphibiens de Numidie, Algérie du Nord-Est.* — La crise aiguë que traverse la biodiversité à l'échelle planétaire n'a pas épargné les amphibiens qui figurent parmi les taxons les plus touchés, illustrés par le déclin prononcé ou la disparition de plusieurs espèces. Notre connaissance du statut et de l'écologie des amphibiens d'Algérie reste limitée alors que les milieux naturels locaux subissent une pression anthropique intense qui ne fait que s'accroître et qui risque de s'exacerber sous l'effet du réchauffement climatique. Dans le but d'inventorier et d'évaluer le statut du peuplement d'amphibiens du complexe de zones humides de la Numidie, «point chaud» pour de nombreux taxons aquatiques et poche relictuelle afrotropicale, nous avons échantillonné 82 sites entre 1996 et 2010. Un total de neuf espèces dont trois Urodèles (*Pleurodeles poireti* Gervais, 1835, *Pleurodeles nebulosus* (Guichenot, 1850) et *Salamandra algira* Bedriaga, 1883) et six Anoures (*Bufo bufo spinosus*, *Bufo mauritanicus* Schlegel, 1841, *Bufo viridis* Laurenti, 1768, *Discoglossus pictus* Otth, 1837, *Hyla meridionalis* Boettger, 1874 et *Pelophylax saharicus* Boulanger *in* Hartert, 1913) ont été inventoriées. Un fait marquant est le déclin net, rapide et inexpliqué du Triton de Poiret *Pleurodeles poireti,* espèce endémique à une région limitée au Djebel Edough et ses environs, au cours des dernières années. Le statut de trois espèces (*S. algira*, *P. nebulosus* and *B. bufo spinosus*) semble préoccupant au vu des pressions anthropogéniques qui s'exercent sur la Numidie qui abrite 82% des amphibiens d'Algérie.

SUMMARY. — The worldwide erosion of biological diversity has not spared amphibians which are amongst the most affected taxa with numerous extinct or near-extinct species. Our knowledge of the status and ecology of amphibians of Algeria is still limited whereas local natural habitats are fast disappearing under a strong anthropogenic pressure. Eighty two localities were sampled between 1996 and 2010, to survey the amphibian community within Numidia, North-Eastern Algeria. Nine species, three Urodeles (*Pleurodeles poireti*, *Pleurodeles nebulosus* and *Salamandra algira* and six Anurans (*Bufo bufo spinosus*, *Bufo mauritanicus*, *Bufo viridis*, *Discoglossus pictus*, *Hyla meridionalis* and *Pelophylax saharicus*) were found within the region. Results suggest a marked, rapid and unexplained crash of the Algerian Newt *Pleurodeles poireti*, a species endemic to a small area in and around Djebel Edough (Annaba). Information on the status (abundance and distribution) of each recorded taxon is provided and conservation measures are discussed in the light of an apparent local decline of Anurans and the vulnerability of three species (*S. algira*, *P. nebulosus* and *B. bufo spinosus*).

Reports over the last two decades of worldwide amphibians decline has been causing much concern (Blaustein & Wake, 1990; Wake, 1991; Pechmann & Wake, 1997; Heyer & Halliday

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1999) and in the face of widespread wetlands degradation, discerning local from global causes has been a major undertaking and a crucial task to gather knowledge that may enable managers to react proactively (Stuart *et al*., 2004; Beebee & Griffiths, 2005). North-Eastern Algeria houses an important wetlands complex, internationally known as an important wintering and breeding quarter for waterbirds (Samraoui & Samraoui, 2008). Recently, an increasing number of its habitats have become vulnerable to anthropogenic pressures (Samraoui *et al*., 2011) and, in this context, knowledge of the status of local amphibians, some of them endemics, and the characterization of their breeding habitats are urgently needed if sound conservation measures are to be taken.

Starting with the explorations of Poiret (1789 *in* Seurat, 1930), and with a few exceptions (Pellegrin, 1927; Schleich *et al*., 1996), the amphibians of Algeria are mainly known to us through surveys conducted in the nineteenth century (Lataste, 1879, 1880-81 *in* Seurat, 1930; Boulenger, 1891; Olivier, 1894; Doumergue, 1901). In contrast to Morocco where herpetological studies are much more advanced (Pasteur & Bons, 1959; Bons, 1967, 1972, 1973; Busack, 1986; Mellado & Dakki, 1988; Bons & Geniez, 1996; Schleich *et al*., 1996), the status and ecology of local populations are hardly known to us despite the interest of such knowledge.

Recent studies have shown that what was previously known as the North African *Pleurodeles poireti* comprises two distinct lineages (Veith *et al*., 2004), now recognized as *P. poireti* endemic to the Edough Mountain and environs (close to the town of Annaba), and *P. nebulosus*, endemic to other parts of Algeria and Tunisia (Carranza & Wade, 2004). Numidian populations are thus made up of a mixture of endemics, relics and Palearctic species whose populations face, at the southern end of their geographical distribution, a hot and dry summer, a characteristic feature of the Mediterranean climate. The present paper is concerned with changes of the status (distribution and abundance), and conservation of Numidian populations.

METHODS AND LIST OF LOCALITIES

A total of 82 sites were sampled between May 1996 and July 2009 (Fig. 1). The sites listed below are all located within Numidia, North-Eastern Algeria. Position recorded as decimals of minutes were determined with a Global Positioning System (Garmin 45; Garmin/Europe Ltd, Romsey, U.K.) having a resolution o about 120 m. Other positions were taken from maps. In locality designations, the words 'Garaet' or 'Garaa' (lake/large pond), 'Mare' (small pond, pool) and 'Oued' (wadi) are abbreviated to 'G', 'M' and 'O' respectively.

List of localities

Eastern Numidia; prefix 'E': The Annaba/El Kala wetlands complex (Samraoui & de Bélair, 1998):

1. Lac Tonga (36°52'N, 8°31'E): a shallow freshwater lake of 2400 ha with *Scirpus lacustris*, *Phragmites australis*, *Typha angustifolia*, *Iris pseudo-acorus* and *Nymphaea alba*.
2. Lac Oubeïra (36°50'N, 8°23'E): a shallow freashwater lake of 2200 ha dominated by *Trapa natans*, *Myriophyllum spicatum*, *Scirpus lacustris*, *Typha angustifolia*.
3. Lac Bleu (36°54.701'N, 8°20'E): a permanent dunary pond of 2 ha with *Nymphaea alba*, *Phragmites australis*, *Osmunda regalis* and *Carex elata.*
4. M. Lac Bleu: a man made pool adjacent to Lac Bleu, dominated by *Ludwigia palustris* and *Wolffia arrhiza*.
5. Saulaie: (36°54.701'N, 8°20.291'E): a seasonal dunary slack with *Scirpus lacustris*, *Callitriche obtusangula* and mainly covered by *Salix atrocinerea*.
6. Fedjoudj (36°51.652'N, 8°15.065'E): a seasonal pool located in a quarry with *Typha angustifolia* and *Callitriche obtusangula*.
7. Gérard (36.50.594'N, 8°09.587'E): a seasonal pool with *Ranunculus baudotii*, *R. ophioglossifolius*, *Glyceria fluitans* and *Ludwigia palustris*.
8. Lac Okréa (36°50.832'N, 8°10.792'E): a seasonal pond with *Typha angustifolia*, *Scirpus lacustris*, *Juncus effusus*, *Paspalidium obtusifolium* and *Utricularia exoleta*.
9. M. Isoetes (36°50.663'N, 8°08.888'E): a seasonal pool with *Ranunculus baudotii*, *R. ophioglossifolius*, *Isoetes velata* and *I. histrix*.
10. G. El Khobzi (36°51.65'N, 8°08.95'E): a seasonal pond with *Nymphaea alba*.
11. Berrihane Ecole (36°50.469'N, 8°08.089'E): a seasonal pool with *Glyceria fluitans*, *Ranunculus baudotii* and *R. ophioglossifolius*.
12. Berrihane Sud (36°50.067'N, 8°06.680'E): a seasonal pool with *Glyceria fluitans*, *Alisma plantago-aquatica* and *Chara* sp.
13. El Hrib (36°50.110'N, 8°06.680'E): a dunary pond with *Ranunculus baudotii*, *Callitriche obtusangula* and *Scirpus maritimus*.

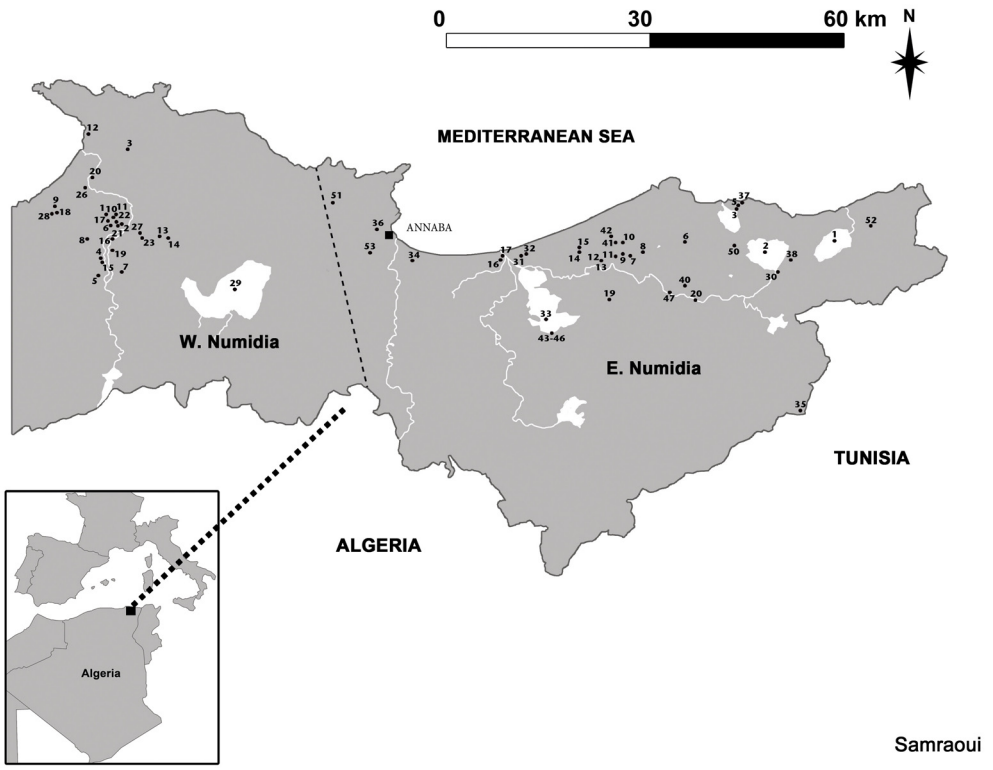

Figure 1: The location of the surveyed sites across western (W.) and eastern (E.) Numidia.

14. Carrière (36°50.875'N, 8°04.477'E): a sand quarry with *Glyceria fluitans* and *Typha angustifolia*.
15. Tamaris (36°51.149'N, 8°04.603'E): a semi-permanent pool with *Ranunculus baudotii, Lythrum hydropiper, Sparganium erectum* and *Callitriche obtusangula*.
16. M. aux Sangliers (36°50.248'N, 7°56.754'E): a brackish pond with *Typha angustifolia*, *Juncus acutus* and *Tamarix gallica*.
17. Mafragh (36°50.440'N, 7°56.875'E): a brackish pond with *Typha angustifolia*, *Juncus acutus* and *Chara* sp.
18. Khoud El Barouk, a dunary slack north of Loc. 32. Vegetation includes *Typha angustifolia* and *Carex elata*.
19. Lac des Oiseaux (36°46'N, 8°07'E): a shallow lake with *Typha angustifolia*, *Scirpus lacustris*, *Scirpus maritimus*, *Polygonum senegalense* and *Nymphaea alba*.
20. M. aux Frênes (36°46.761'N, 8°16.066'E): a seasonal pool situated within an Ash (*Fraxinus angustifolia*) plantation.
21. Gauthier I (36°50.243'N, 8°26.611'E): a seasonal pool dominated by *Myriophyllum verticillatum*, *Glyceria fluitans*, *Ranunculus baudotii* and *Scirpus inclinatus*.
22. Gauthier II (36°50.243'N, 8°26.611'E): a seasonal pool with *Glyceria fluitans*, *Ranunculus baudotii* and *Myriophyllum verticillatum*.
23. Gauthier III (36°50.243'N, 8°26.611'E): the plant assemblage of this pool is similar to that of Gauthier II.
24. Gauthier IV (36°50.243'N, 8°26.611'E): the plant assemblage of this pool is similar to that of Gauthier II.
25. Gauthier V (36°50.243'N, 8°26.611'E): a seasonal pool with *Glyceria fluitans*, *Ranunculus baudotii* and *Juncus acutus*.
26. Gauthier VI (36°50.243'N, 8°26.611'E): the plant assemblage of this pool is similar to that of Gauthier V.
27. Gauthier VII (36°50.243'N, 8°26.611'E): an ephemeral pool close to Gauthier VI.
28. Gauthier VIII (36°50.243'N, 8°26.611'E): an ephemeral pool close to Gauthier VII.
29. Gauthier Puit (36°50.243'N, 8°26.611'E): a recent man-made pool, initially devoid of vegetation.
30. M. Messida (36°48.769'N, 8°26.611'E): a seasonal pool with *Glyceria fluitans*, *Alisma plantago-aquatica* and *Scirpus lacustris*.
31. G. Estah (36°50.556'N, 7°58.939'E): a dunary pond with *Nymphaea alba*, *Salvinia natans*, *Typha angustifolia*, *Scirpus lacustris* and *Salix atrocinerea*.
32. G. Dakhla (36°50.674'N, 7°59.077'E): a dunary pond with *Typha angustifolia*, *Typha latifolia*, *Salix atrocinerea*, *Cladium mariscus*, *Carex elata* and *Nymphaea alba*.

33. Mekhada (36°48'N, 8°00'E): a brackish marsh of 14 000 ha dominated by *Scirpus maritimus*, *Typha angustifolia*, *Scirpus triqueter* and *Phragmites australis*.
34. Salines (36°49'N, 7°48'E): a shallow saline basin.
35. Ghora (36°37'N, 8°26'E): a high altitude pool with *Ranunculus baudotii*.
36. Boukhadra (36°52.807'N, 7°44.382'E): a brackish pond with *Typha angustifolia*, *Juncus acutus* and *Ranunculus baudotii*.
37. Ruppia (36°55.03'N, 8°20.62'E): a brackish dunary pond with *Ruppia maritima*, *Phragmites australis* and *Ranunculus baudotii*.
38. El Frine (36°50.18'N, 8°25.56'E): a shallow, ephemeral pool with sandy substrate on the shore of Lake Oubeïra.
39. G. Butomes (36°50.07'N, 8°06.01'E): a freshwater marsh with *Scirpus maritimus*, *Typha angustifolia*, *Ranunculus baudotii* and *Butomus umbellatus*.
40. Bou Redim (36°45'N, 8°15'E): a marsh dominated by *Alnus glutinosa*, *Salix atrocinerea*, *Carex elata*, *Scirpus lacustris*, *Iris pseudo-acorus* and *Typha angustifolia*.
41. M. Khobzi (36°51.65'N, 8°0895'E): a dunary pond with *Ranunculus baudotii* and *Nymphaea alba*.
42. Medjez Ezzitoun (36°52'N, 8°08'E): a seasonal marsh.
43. El Feid I (36°43.970'N, 8°01.739'E): a small pool with *Callitriche obtusangula*, *Ranunculus baudotii* and *Alisma plantago-aquatiqua*.
44. El Feid II (36°43.970'N, 8°01.739'E): with similar vegetation to EL Feid I.
45. El Feid III (36°43.970'N, 8°01.739'E): with similar vegetation to El Feid I.
46. El Feid IV (36°43.970'N, 8°01.739'E): with similar vegetation to El Feid I.
47. M. Eleocharis (36°47.36'N, 8°13.54'E): a seasonal pool dominated by *Eleocharis palustris*.
48. G. Batikha (36°51'N, 8°08'E): a seasonal dunary slack.
49. Lac Blanc (36°51.652', 8°15.065'E): a pool located in a quarry.
50. M. Brabtia (36°51'N, 8°20.80'E): a seasonal pool fed by wadi Bouarroug.
51. Seraïdi (36°55'N, 7°40'E): a residual pool in a seasonal stream.
52. Carrière Oum Teboul (36°55.03'N, 8°20.62'E): a seasonal pool located in a quarry.
53. Boussedra (36° 51.26'N, 7°43.82'E): a freshwater pond of 10 ha with *Typha angustifolia*, *Scirpus maritimus* and *Scirpus lacustris*.

Western Numidia; prefix'W': Lac Fetzara and the Guerbes-Senhadja wetlands complex (Samraoui & de Bélair, 1997):
1. Sidi Fritis (36°53.975'N, 7°17.437'E): a dunary lake of 40 ha with *Ranunculus baudotii*, *Nymphaea alba*, *Lythrum hydropiper*, *Potamogeton nodosus* and *Cyperus flavescens*.
2. G. Ouajaa (36°53.192'N, 7°18.963'E): a freshwater marsh of 20 ha with *Salix alba*,, *Typha angustifolia*, *Eleocharis palustris* and *Veronica anagallis-aquatica*.
3. G. Azla (36°59.477'N, 7°19.541'E): a seasonal pond with *Ranunculus baudotii*, *Iris pseudo-acorus*, *Glyceria fluitans* and *Scirpus maritimus*.
4. Aïn Magroun (36°50.225'N, 7°16.943'E): a seasonal marsh with *Alisma plantago-aquatica*, *Scirpus lacustris*, *Sparganium erectum* and *Typha angustifolia*.
5. Aïn Nechma (36°48.837'N, 7°16.728'E): a marsh in the alluvial plain of wadi Maboun dominated by *Scirpus lacustris*, *Scirpus maritimus*, *Polygonum amphibium*, *Alisma plantago-aquatica* and *Juncus acutus*.
6. Bechna (36°53.082'N, 7°17.802'E): a dunary pond of 2 ha with *Echinodorus ranunculoides*, *Ranunculus ophioglossifolius*, *Isoetes velata* and *Lythrum hydropiper*.
7. M. Boumaïza (36°49.155'N, 7°18.975'E): a seasonal marsh with *Alisma plantago-aquatica*, *Scirpus lacustris*, *Sparganium demersum*, *Ceratophyllum demersum, Lemna minor, Potamogeton nodosus, Alima plantago-aquatica, Scirpus maritimus* and *Typha angustifolia*.
8. G. Hadj Tahar (36°51.774'N, 7°15.957'E): a freshwater marsh of 75 ha with *Scirpus lacustris*, *Scirpus maritimus*, *Typha angustifolia*, *Sparganium erectum*, *Iris pseudo-acorus* and *Nymphaea alba*.
9. G. Sidi Lakhdar (36°54.80'N, 7°12.55'E): a freshwater pond of 25 ha with *Cyperus longus*, *Juncus conglomeratus*, *Typha angustifolia* and *Lythrum junceum*.
10. G. Chichaya (36°53.791'N, 7°18.230'E): a freshwater marsh of 50 ha with *Sparganium erectum*, *Scirpus lacustris*, *Typha angustifolia*, *Iris pseudo-acorus* and *Potamogeton lucens*.
11. G. Sidi Makhlouf (36°53.94'N, 7°18.248'E): a freshwater marsh of 50 ha with *Alnus glutinosa*, *Osmunda regalis*, *Scirpus lacustris*, *Sparganium erectum*, *Iris pseudo-acorus*, *Rorripa amphibia* and *Nymphaea alba*.
12. Lac Marsadelle (37°00.815'N, 7°15.637'E): A dunary slack of 10 ha with *Scirpus lacustris*, *Ceratophyllum demersum*, *Nymphaea alba* and *Ranunculus baudotii*.
13. Bordj du Cantonnier (36°52.168'N, 7°22.760'E): a shallow freshwater pond of 2 ha with *Ranunculus baudotii*, *Potamogeton nodosus*, and *Myriophyllum verticillatum*.
14. G. Tacha (36°51.979'N, 7°23.587'E): a small, narrow marshy area of 0.5 ha dominated by *Scirpus lacustris*, *Scirpus maritimus*, *Sparganium erectum* and *Oenanthe fistulosa*.
15. G. Loughat (36°50'N, 7°17'E): a freshwater marsh of 38 ha with *Ranunculus baudotii*, *Apium nodiflorum*, *Eleocharis palustris*, *Glyceria fluitans* and *Scirpus lacustris*.
16. G. aux Linaires (36°52'N, 7°18'E): a small dunary pond of 0.5 ha with *Eleocharis palustris*, *Nymphaea alba*, *Echinodorus ranunculoides* and *Isoetes velata*.
17. G. Bouina (36°53.490'N, 7°17.574'E): a dunary marsh of 25 ha with *Nymphaea alba*, *Cladium mariscus*, *Scirpus lacustris*, *Typha angustifolia* and *Cyperus longus*.

18. G. Nouar Ezzouaoua (36°54.188'N, 7°12.463'E): a marshy area of 13 ha with *Ranunculus baudotii*, *Alisma plantago-aquatica*, *Glyceria fluitans* and *Oenanthe fistulosa*.
19. G. aux Oliviers (36°51'N, 7°18'E): a marsh of 2 ha with *Ranunculus baudotii*, *Apium nodiflorum*, *Glyceria fluitans* and *Rorripia amphibia*.
20. G. Beni Mhamed (36°57'N, 7°16'E): a brackish marsh stretching across 380 ha dominated by *Juncus acutus*.
21. G. El Guelb (36°53.206'N, 7°18.538'E): a freshwater marsh of 15 ha with *Scirpus lacustris*, *Scirpus maritimus*, *Alisma plantago-aquatica*, *Eleocharis palustris* and *Rorripia amphibia*.
22. Canal Sidi Makhlouf (36°53.295'N, 7°18.478'E): a man-made canal with *Scirpus lacustris*, *Ranunculus baudotii*, *Glyceria fluitans* and *Rorripia amphibia*.
23. G. Khemissa (36°52'N, 7°21'E): a dunary pond with *Ranunculus baudotii*.
24. G. Grand Bleu, a sand quarry adjacent to Loc. 11.
25. M. Nord Fetzara, a seasonal pond north of Loc. 29.
26. Demnat Ataoua (36°56.132'N, 7°14.780'E): An alder carr which forms a unit of 280 ha with the adjacent Messaoussa marsh. Vegetation includes *Alnus glutinosa*, *Athyrium filix-femina*, *Salix pedicellata*, *Typha angustifolia*, *Sparganium erectum*, *Ludwigia palustris*, *Phragmites australis* and *Alisma plantago-aquatica*.
27. G. Khedidja (36°52.08'N, 7°20.94'E): a dunary pond with *Ranunculus baudotii*.
28. M. Emifor (36°54'N, 7°12'E): a seasonal pool with *Glyceria fluitans*.
29. Lac Fetzara (36°48'N, 7°30'E): a marsh of 24 000 ha covered with *Scirpus maritimus*, *Typha angustifolia*, *Phragmites australis* and *Scirpus triqueter*.

Sampling

Sampling was carried out during two distinct phases, phase 1: 1996-2001 and phase 2: 2006-2010. As part of a long term project, twenty six seasonal ponds all located in eastern Numidia (locs: 4, 6-7, 9, 11-17, 20-24, 30, 34, 36-39, 43-46) were sampled monthly for the whole length of their annual hydroperiods. Ten sweeps of a dip net were carried out across all types of microhabitats. Adults were simply recorded but larvae were preserved in 5 % formaldehyde and identified in the laboratory. A separate sample of *Pleurodeles* larvae were preserved in ethanol for DNA studies (Veith *et al*., 2004). Other sites were studied based on three sampling campaigns in autumn and winter 1998 and in spring 1999. Alarmed by the absence of *P. poireti* during the second sampling phase of the seasonal ponds, a new sampling campaign of the other sites was initiated in the winter of 2009.

RESULTS

A total of 25 sites had 4 or more species with 9 sites having a maximum of 5 species. Only 3 sites (3.6 %) had no records of amphibians.

The information is presented as follows: (1) Account of the amphibian of Numidia and their status in this region (1996-2010). (2) Their biogeographical origin. (3) Brief description of biotopes. (4) Observations. Localities where the species were located are presented in Table 1.

Table I

Check-list of amphibians of Numidia with their IUCN Red List status. Numbers in italics refer to sites where Pleurodeles poireti *seems to have disappeared in the last years.*

Species	IUCN Red List category	Localities
Salamandra algira	VU	E51
Pleurodeles nebulosus	VU	E: 6-8, 11-15, 20-29, 35, 47-50, 52
Pleurodeles poireti	EN	E: *36, 43-46*, *51*, 53; W: *2, 4-7, 12, 14, 15, 18-25, 27, 29*
Discoglossus pictus	LC	E: 4-9, 11-18, 20, 21, 23, 24-28, 30-32, 34-36, 40, 42-47, 51; W: 1, 2, 6, 7, 10, 14, 16-19, 21-23, 25, 27-29
Bufo bufo spinosus	LC	E:35
Bufo mauritanicus	LC	E: 1-3, 5-8, 13-17, 19, 21-24, 30-32, 34, 36-38, 53; W: 6, 9, 12, 24, 26
Bufo viridis	LC	W: 24, 29
Hyla meridionalis	LC	E: 1, 4-9, 11-15, 17, 18, 20-24, 30-32, 35, 37, 38, 40-48; W: 2-9, 12, 15-23, 25, 27
Pelophylax saharicus	LC	E: 1-9, 11-17, 19, 21-24, 30-33, 35-37, 39; W: 1-3, 9, 12, 16-18, 21, 23, 28

CAUDATA

Salamandridae

Salamandra algira Bedriaga, 1883

(1) Very rare and known from only one site. (2) Endemic to Algeria and Morocco. (3) Cork and Zeen Oak forests (500-800 m). (4) Not much is known of its ecology. Only one specimen was recorde as investigations in forests were hampered for security reasons.

Pleurodeles nebulosus (Guichenot, 1850) (Fig. 2, top)

(1) Locally abundant and fairly widespread. (2) Endemic to eastern Algeria and Tunisia. (3) Seasonal pools and ponds (0-600 m, possibly higher). (4) Found also at Souk Ahras (South of Numidia). Vulnerable like *P. poireti* to fish predation (they both seem to avoid large ponds and lakes) and to early drying of habitats.

Pleurodeles poireti Gervais, 1835 (Fig. 2, bottom)

(1) Rare and (previously) locally abundant. (2) Endemic to Djebel Edough and environs (Annaba). (3) Seasonal pools and ponds (0-600 m, possibly higher). (4) Over the last five years, this species has virtually disappeared from its former breeding sites (Edough, Lake Fetzara and the Guerbes Senhadja wetlands). All our own records are anterior to 2008 and no records were noted during the second sampling phase. In 2011, two adults were recorded at Boussedra and the dunes of the Mafragh (Youcefi, pers. com.).

ANURA

Discoglossidae

Discoglossus pictus Otth, 1837

(1) Abundant and widespread. (2) Mediterranean. (3) Seasonal pools and astatic ponds (0-1000 m). (4) This species aestivates under stones until the first autumnal rains.

Bufonidae

Bufo bufo spinosus Daudin 1803

(1) Rare with a localized distribution. (2) Widespread in South-Western France, Iberian Peninsula and fresh parts of North-Africa. (3) Seasonal ponds (~900-1200 m). (4) Adults aestivate within Cork and Zeen Oak forests.

Bufo mauritanicus Schlegel, 1841

(1) Abundant and fairly widespread. (2) North African endemic. (3) Seasonal and permanent lowland ponds and lakes. (4) Outside Numidia, found at Timerganine in the North-Eastern Hauts Plateaux where it is less abundant than *Bufo viridis* and apparently confined to freshwater sites. May coexist with fish albeit at low numbers. Precocious drying of habitats prevents it from breeding. Adults are preyed upon by a wide range of birds (Black Kite *Milvus migrans*, Purple Heron *Ardea purpurea*, Glossy Ibis *Plegadis falcinellus*).

Figure 2: Top : *Pleurodeles nebulosus* (Mare Messida). Bottom : *Pleurodeles poireti* (Mare El Feid). Pictures by B. Samraoui.

Bufo viridis Laurenti, 1768

(1) Not abundant and uncommon. (2) Palearctic and saharo-sindian. (3) Quarries and seasonal marshes in Numidia. Elsewhere found in wadi, salt and freshwater lakes as well as gueltas. (4) Recorded also in the Sahara: Mzab and the Ahaggar (gueltas: Mtajer and Tamekrest, the southernmost record of the species' range). Widespread within the salt lakes complex of the North-Eastern Hauts Plateaux where massive irruptions of newly hatched juveniles have been recorded. Adults were recorded to fall prey to Cattle Egret, *Ardea ibis*.

HYLIDAE

Hyla meridionalis Boettger, 1874

(1) Abundant and widespread. (2) West Mediterranean. (3) Seasonal ponds and pools (0-1000 m). (4) Highly vulnerable to fish predation.

RANIDAE

Pelophylax saharicus (Boulenger in Hartert, 1913)

(1) Abundant and widespread. (2) North African. (3) Seasonal and permanent ponds and lakes (0-1000 m). (4) Widely distributed within the country (Hauts Plateaux and Sahara). May coexist with fish.

DISCUSSION

The amphibian community of Numidia is made up of 9 species: 3 Urodeles (*Pleurodeles nebulosus*, *Pleurodeles poireti* and *Salamandra algira*) and 6 Anurans (*Discoglossus pictus*, *Bufo bufo*, *Bufo mauritanicus*, *Bufo viridis*, *Hyla meridionalis* and *Pelophylax saharicus*). This number represents 75 % of the amphibians recorded in Algeria (Schleich *et al*., 1996) but it could be as high as 90 % of the known Algerian species as only *Amietophrynus regularis* (Reuss, 1833), and *Amietophrynus xeros* Tandy, Tandy, Keith & Duff-Mackay, 1976, all confined to the Central Sahara (Schleich *et al*., 1996), are absent from Numidia. However, *A. regularis* has probably been confused with *A. xeros* (P. Geniez pers. com.) and the presence of the Afrotropical *Ptychadena mascareniensis* (Duméril & Bibron, 1841) is considered as dubious and is thus in need of confirmation (Schleich *et al*., 1996).

Of serious concern is the status of *Pleurodeles poireti*, fairly well distributed within its range during the first phase of the sampling program and virtually absent during the second period. Although a systematic sampling of all the wetlands in and around Djebel Edough (Annaba) is needed to confirm the recorded disappearance from the monitored ponds and other breeding sites, this precipitous decline should stimulate more studies and prompt action to reverse the trend before the extinction of the Algerian Newt. A recent global assessment of the amphibians of the Mediterranean region has designated *P. poireti* as "Endangered" (Cox *et al*., 2006). We believe the status should be upgraded to "Critically Endangered". Similarly, climate change may affect negatively the North African relict *Bufo bufo*, rare in Numidia and confined to high altitude. Its regional status differs markedly from the global one and there is a need to closely monitor its populations.

What regulates the distribution and abundance of species (Begon *et al*., 2005) and how aquatic communities are structured remains an area of active research in community ecology (Wellborn *et al*., 1996; McPeek & Brown, 2000). However, concern about the worldwide decline of amphibians has stimulated increased interest into mechanisms underlying their distribution (Skelly, 2001; Werner *et al*., 2007). Amphibian community patterns are believed to be structured by predation and stochastic variations in the environment and not by availability of resources (Beebee, 1995). However, both intra and interspecific competition have been shown to exist. Interspecific competition among local anurans is mainly lessened by a tempo-

ral segregation as has been found in southern Spain (Diaz-Paniagua, 1988, 1992) but spatial partionning in Numidia is also exhibited. The two *Pleurodeles* species are parapatric and there is almost no overlap in the range of *Bufo* species within Numidia and a spatial displacement between *Bufo mauritanicus* and *Bufo bufo*, resulting in altitudinal stratification, is apparently present. *Bufo viridis,* a common species in The Hauts Plateaux and the Sahara, is relatively uncommon in Numidia and its breeding is more precocious than that of *B. mauritanicus*. It is not clear whether the recent record of the species within western Numidia suggests that it is expanding its range northwards.

Variation in abiotic factors among ponds has a major influence on the distribution pattern of amphibians. Furthermore, changes in abiotic factors can alter the outcome of biotic interactions (Warner *et al*., 1993). Another important factor is the hydroperiod which is crucial to larval survival. Seasonal ponds, a characteristic feature of the Numidian landscape, are a habitat of choice (Collinson *et al*., 1995; Pearman, 1995; Griffiths, 1997; Semlitsch, 2003; Wells, 2007) which provides unique opportunities for local amphibians. Seasonal ponds are very productive due to the regular mineralisation of nutrients and their shallowness allows them to rapidly warm in spring thus promoting growth of species with high thermal coefficients. Due to their small size and their seasonality, they are also largely devoid of vertebrate and invertebrate predators (Williams, 2006). However, subjected to natural fluctuation in rainfall and evaporation, they are prone to desiccation and they undergo a speedy change in water quality. During dry years when desiccation precociously occurs, species with extended larval development (*P. nebulosus* and *P. poireti)* and late breeding species like *B. mauritanicus* suffer heavy mortality or fail to breed, respectively.

Typically, permanent habitats seem to be avoided by a number of local anurans (*P. poireti*, *H. meridionalis* and *D. pictus*); The reasons lay, in parts, with the presence of predatory fish represented locally by two allochtonous species, the Mosquitofish *Gambusia holbrooki*, introduced in Algeria and in many parts of the world to help control malarial vectors but which have been shown to adversely impact amphibians (Brönmark & Edenhamn, 1994; Goodsell & Kats, 1999) and the omnivorous Common Carp *Cyprinus carpio* which escaped from Lake Oubeïra where pisciculture was attempted in the late 80's and early 90's.

Despite the lack of baseline data for the study area, there is no doubt that local amphibians have undergone a serious decline in numbers and the reasons are manifold. Freshwater has always been a scarce resource in North Africa and human encroachment has resulted in drainage and alteration of many wetlands (Bélair & Samraoui, 1994; Samraoui & Bélair, 1998). Draining of local wetlands will probably go unabated in the near future and this challenging state of affairs is likely to be exacerbated by impending global warming (Hulme *et al*., 2001). Destruction, alteration and fragmentation of habitats can negatively affect amphibian populations (Cushman, 2006). Recent road building (like the CW109 and the East-to-West Highway) cuts right into the Numidian wetland complex. Heavy casualties, mainly on the RN44 and the new CW109 which both border the Mekhada marsh, are caused by road traffic. The Mekhada marsh has also been negatively impacted by the damming of Oued Kebir and one indication of a marked reduction of anurans in the region is the absence, in the last decade, of the spectacular autumnal dispersion between aestivating refuges and breeding sites (like the Mekhada marsh) after the first heavy rainfall of the season. During the last decade, repeated large scale forest fires have probably had an important adverse impact on population dynamics, knowing that species like *D. pictus*, *B. bufo spinosus* and *S. algira* aestivate or breed in woodlands. Over the last decades, exotic fish has been widely introduced in all types of local wetlands. Predation by fish may eliminate amphibians either directly or indirectly (Bradford *et al*., 1993; Smith *et al*., 1999) but may also have indirect positive effects on some species (Werner & McPeek, 1994). Both *Gambusia holbrooki* and *Cyprinus carpio* have recently expanded their range (unpublished) and, of more concern to amphibians, are able to invade seasonal ponds and marshes (Poizat & Crivelli, 1997, unpublished data). Both species, in laboratory conditions predate eggs of *D. pictus* (unpublished).

The endemic *P. poireti* deserves special attention in the face of imminent extinction. The reasons of its precipitous decline, in the last ten years, comparatively to its congener *P. nebu-*

losus, are unclear as both species of newts face similar anthropogenic pressures. Two other species (*S. algira* and *B. bufo*) deserve monitoring as these have reduced populations and a restricted range limited to highland sites. Further investigations are needed to estimate current populations and get a better knowledge of their ecological requirements and take into account the context-dependently dynamics of ecological systems (Blaustein & Kiesecker, 2002).

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