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Atlas of the Frogs of Libya

Continental Africa contains more than 800 species of amphibians that correspond to the distinct and largely non-overlapping faunas of North Africa and sub-Saharan Africa (Channing and Rödel 2019; Escoriza and Ben Hassine 2019). The amphibian fauna of North Africa is dominated by salamander and frog species that colonized this region from western Europe in the Late Miocene (e.g., Carranza and Arnold 2004; Escoriza et al. 2006; Busack and Lawson 2008), possibly during the Messinian Salinity Crisis when there was contiguous land between these two regions (Krijgsman et al. 1999; Roveri et al. 2014). In comparison to other countries in North Africa, the amphibian fauna of Libya has received little attention, especially during the past forty years. The meager Libyan amphibian fauna is particularly interesting because the distinct North African and sub-Saharan faunas interdigitate and possibly overlap in Libya. There are many documented populations of frogs

in small, isolated water bodies scattered across the large arid regions of the country. Taken together, these indicate that Libyan amphibians provide a unique opportunity to understand the impact of dramatic climatic changes over the past 10,000 years on the water-dependent faunas in what were once extensive paleolake and paleodrainage systems (Drake and Bristow 2006; Drake et al. 2008, 2011).

With just five species, Libya has the most species-poor amphibian fauna of the 49 countries of continental Africa (Channing and Rödel 2019). Because its reptile fauna is also among the poorest in Africa (only 63 terrestrial species), Libya has received little attention from those interested in the herpetology of North Africa (Bauer et al. 2017; Escoriza and Ben Hassine 2019). Obviously, the lack of amphibian species diversity is not surprising given that the vast majority of Libya's landscape is dominated by the Sahara Desert with few perennial inland water bodies across most of the country. Of the five anuran species recorded in Libya, most records are of two widespread species distributed across northern Africa: *Pelophylax saharicus* and *Bufo boulengeri*. *Pelophylax saharicus* likely represents a colonization event of North Africa via the western Mediterranean (Beerli et al. 1996), but the direction from which *Bufo* colonized this region is more ambiguous (Stöck et al. 2006). The other three species are restricted to southwestern Libya (*Hoplobatrachus occipitalis*, *Ptychadena* sp., *Sclerophrys xeros*) and represent isolated northern extensions of the fauna found in the Sahel along the southern fringes of the Sahara (Channing and Rödel 2019). While salamanders are known from neighboring Tunisia and Algeria, there are no records of salamanders from Libya (Schleich et al. 1996; Escoriza and Ben Hassine 2019).

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The earliest published record of frogs from Libya is that of Günther (1858a) who noted a specimen of what is now *Bufoles boulengeri* collected in Tripoli by Joseph Ritchie (c.1788–1819). The recently published journals of Hugh Clapperton (1788–1827) contain what is likely the earliest written European record of frogs in Libya (May 1822) from the springs near Traghin (“Traghan”) in the Fezzan: “there were a number of frogs hopping in and out and the sides were covered with their spawn” (Bruce-Lockhart and Wright 2000). These records likely correspond to the toad *Bufoles boulengeri*, which remains the only anuran reported from this area (Scortecci 1934, 1936; Ibrahim 2008).

Half of the published research reporting amphibians from Libya comes from a 50-year period extending from the late 19th-century to early 20th-century (1880–1931). Most of these short publications are based on collections of amphibians and reptiles in the mesic regions near the Mediterranean coast (Peters 1880, 1881; Haimann 1886; Rizzardi 1896; Werner 1909; Andreucci 1913; Ghigi 1913, 1920, 1922; Hartert 1913, Boulenger 1914; Zavattari 1922; Calabresi 1923; Vinciguerra 1927; Gestro and Vinciguerra 1931; see Bauer et al. 2017 for a more extensive summary). Scortecci (1936, 1937a) provided the first extensive documentation of frogs from the interior deserts of Libya (i.e., the Fezzan), especially Ghat in extreme southwestern Libya. During the middle and late 20th-century, the reports of Libyan frogs are restricted to the few records from Schnurrenberger (1963) and Sayers (1964) as well as Dumont’s (1982, 1987) reports of several species from Ghat. The most significant works from this period are by Resetar (1981) and Schleich (1987) on the amphibians and reptiles from in or near what is now El-Kouf National Park near the coast in eastern Libya. The last 20 years has seen a slow resurgence of interest in Libyan frogs, including records from new localities in the interior deserts (Frynta et al. 2000; Doria et al. 2001–2002; Ibrahim and Ineich 2005; Stöck et al. 2006; Jdeidi 2008; Essghaier et al. 2015). Both Ibrahim (2013) and the recent book on North African amphibians by Escoriza and Ben Hassine (2019) provide summaries on the biology of several anuran species in Libya.

The availability of standing water in the Sahara changed dramatically during the late Pleistocene. River systems and large paleolakes, such as Megachad and Megafazzan, dominated parts of the central Sahara during 100,000–500,000 years ago (Drake and Bristow 2006; Drake et al. 2008, 2011), likely with repeated expansions and contractions following regional climatic changes. At least some of these water bodies persisted into the early Holocene when human communities living along lake margins fished for Nile perch, catfish, hippos, turtles, and crocodiles (Serenio et al. 2008). Whereas a few relict populations of crocodiles persisted into the 19th or early 20th century (Brito et al. 2011), most large-bodied vertebrates associated with rivers and lakes no longer occur in the central Sahara. Yet many invertebrates, such as dragonflies and snails, and small vertebrates, including fish in the genus *Barbus* and some frogs, persist at isolated oases across the Sahara (Pellegrin 1911, 1919, 1934; Monod 1921; Seurat 1935; Dumont 1978, 1982; Lévêque 1989, 1990). Phylogeographic studies of these species in an explicit paleohydrological context could provide a unique opportunity to understand how the dramatic climatic changes over the past 10,000 years impacted these now-isolated populations.

Based on our complete survey of the literature, we provide a gazetteer of localities with frogs from 76 sites in Libya. In addition, surveys of data from museum records provide a small handful of additional records from localities that are otherwise

not represented in the literature. Significant to the conservation of frogs at isolated water bodies across Libya, we note that there are at least 30 localities for which there are no published records in more than 50 years. We intend for this gazetteer of Libyan frogs to complement the recent work on North African amphibians by Padial et al. (2004, 2013), Baha El Din (2006), Mateo et al. (2013), Beukema et al. (2013), Bouazza et al. (2021), and the excellent recent summary by Escoriza and Ben Hassine (2019). We hope that our work inspires a new generation of Libyan scientists eager to study frogs.

METHODS

Data were primarily gathered from published sources and built on the work of Bauer et al. (2017). Literature records were extracted from 30 publications from 1858–2019 that explicitly mention anuran species with localities in Libya. As a general reflection of the lack of recent relevant research in Libya, it is worth noting that only 11 of these publications are from the past 50 years. This resulted in a list of 60 localities, including 69 unique taxon-locality combinations. We did not extract localities that only appear as points on maps without any further details as to locality names or the sources of information (e.g., the distribution maps of Salvador [1996] and Escoriza and Ben Hassine [2019]). When the same locality was present in Bauer et al. (2017), we used the geocoded coordinates from that gazetteer though in some cases we have updated the name or current spelling. We followed the methods of Bauer et al. (2017) to assign geocoded coordinates for new localities, including following recommendations from Guralnick et al. (2006) and Chapman and Wicczorek (2020) in using tools such as BioGeomancer, Google Earth, and Fuzzy Gazetteer. In a few cases, we used the coordinates already assigned to specimens associated with these localities, such as those at the Field Museum of Natural History from Resetar (1981). All localities are listed in Appendix 1 along with the locality number of Bauer et al. (2017), if relevant, or with a new number if unique to this gazetteer. We refer readers interested in the physiography, climate, and vegetation of Libya, as well as the history of study of Libyan amphibians and reptiles, to the thorough summary provided by Bauer et al. (2017).

In addition to surveys of the literature, we compiled data for museum records and from field surveys by one of us from 2006–2020 (TBJ). We queried the Global Biodiversity Information Facility (GBIF) for any records for country=Libya and taxonkey=Anura, resulting in 75 records from 10 published datasets (<https://doi.org/10.15468/dl.z7mjjw5>). Based on data from GBIF, we added three unique localities (including geocoded coordinates) for *Bufoles boulengeri* from the United States National Museum of Natural History (USNM; Smithsonian Institution) collected during work presented by Ranck (1968). We also added three unique locality records based on our knowledge of the scientific collections from Museo di Storia Naturale dell’Università di Firenze (MZUF), for which the data are not published to aggregators such as GBIF. We do not list museum specimens or data from recent field surveys if the same locality is already represented in the literature.

For each species, we provide the common names in English and Arabic and a chresonymy for publications of Libyan records of this species. For consistency, we have updated the spelling of the English transliterations given by previous authors. Following a general summary of the distribution, we provide a list of all of the known localities organized by the traditional geographic divisions

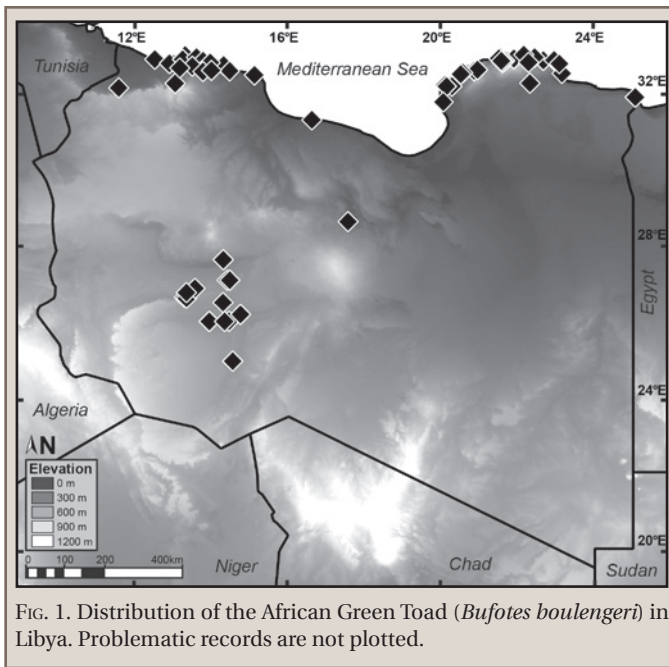


FIG. 1. Distribution of the African Green Toad (*Bufoles boulengeri*) in Libya. Problematic records are not plotted.

of Libya (Tripolitania, Fezzan, and Cyrenaica), followed by the current administrative divisions (*Baladiyat*; singular *Baladiyah*). For each locality, we have provided the relevant literature citations followed by the locality number from Bauer et al. (2017). For those localities not in that publication, a new locality number was assigned that adds to those of Bauer et al. (2017) to create an extended numbered list of localities of Libya's amphibians and reptiles (Appendix 1). If relevant, we list records that are problematic as well as comments relevant to the distribution or taxonomy. We provide a brief summary of ecological data as per publications associated with these Libyan records as well as the current IUCN (2021) threat category. For further and more detailed summaries about these species from across their distributions in North Africa, see Escoriza and Ben Hassine (2019).

RESULTS

Anura

Family Bufonidae Gray 1825

Bufoles boulengeri (Lataste 1879)

Common Names.—African Green Toad (English; Channing and Rödel 2019); *ضفدعة خضراء*, *dhufda'a khadra'* (Arabic; Baha El Din 2006); *علجوم*, *oljourn* (Arabic; Escoriza and Ben Hassine 2019); *علجوم أخضر مغاربي*, *oljourn akhdar magharebi* (Arabic; Bouazza et al. 2021); *الضفدع الأخضر*, *al-oljourn al-akhdar*; *ضفدع الطين*, *dhufda'a al teen*.

Bufo viridis: Günther 1858a; Haimann 1886; Werner 1909; Andreucci 1913; Ghigi 1913; Hartert 1913; Boulenger 1914; Ghigi 1920; Ghigi 1922; Zavattari 1922; Calabresi 1923; Vinciguerra 1927; Gestro and Vinciguerra 1931; Scortecci 1936; Schnurrenberger 1963; Sayers 1964; Resetar 1981; Dumont 1987; Schleich 1987; Salvador 1996; Frynta et al. 2000; Doria et al. 2001–2002; Ibrahim and Ineich 2005; Ibrahim 2008; Essghaier et al. 2015.

Bufo variabilis: von Martens 1883; König 1888.

Bufo pantherinus: Haimann 1886; Ghigi 1913.

Bufo boulengeri: Stöck et al. 2006.

Bufoles boulengeri: Nicolas et al. 2018; Dufresnes et al. 2019.

Distribution.—*Bufoles boulengeri* is the most widespread North African amphibian species, extending from Morocco to Egypt and with populations in Sicily and several other Italian islands (Salvador 1996; Schleich et al. 1996; Baha El Din 2006; Ibrahim 2013a; Channing and Rödel 2019; Escoriza and Ben Hassine 2019; Dufresnes et al. 2019). Populations on Sicily and associated islands were recently recognized as a distinct taxon, *Bufoles boulengeri siculus* (Stöck et al. 2008; Dufresnes et al. 2019; Nicolas et al. 2018). There are isolated populations of *B. boulengeri* in the oases of Algeria, Libya, and Egypt (Pellegrin 1927, 1934; Marx 1963; Baha El Din 2006; Nicolas et al. 2017; Dufresnes et al. 2019). In Libya, *B. boulengeri* is widespread along the coast, though with few records along the Gulf of Sidra (also known as the Gulf of Sirte), and common at sites in the Fezzan from near Sabh and Murzuq.

Libyan Records (Fig. 1).—**Tripolitania:** **Jabal Nafusah:** Gharyan (Werner 1909; 154), Rabta (this study; 596); **Mergeb:** Al Khums (Andreucci 1913; 68), Msalatah, 5 km W of ("Al Qusbat", USNM:Amphibians and Reptiles:146807–09; 597), Wadi Caam (Scortecci 1936; 70); **Misratah:** Alnagazah (this study; 599), Ghanima (this study; 600), Misrata (Boulenger 1914; Doria et al. 2001–2002; 80); **Nalut:** Badr (Ibrahim and Ineich 2005; 105); **Sirte:** Sirte (Scortecci 1936; 175); **Tarhuna:** Ain Sharshara (this study; 59); **Tripoli:** Garbuli (this study; 14), Janzur (this study; 602), Mellaha (Scortecci 1936; 43), Tajura (this study; 44); Tripoli (Günther 1858a; König 1888; Werner 1909; Andreucci 1913; Ghigi 1913; Scortecci 1936; Sayers 1964; Doria et al. 2001–2002; 45); **AlZawiyah:** Al-Zahra (Werner 1909; Andreucci 1913; Ghigi 1913; 16), Sabratah (Frynta et al. 2000; 11), Sorman (this study; 603). **Fezzan:** **Jiffra:** Zillah (Scortecci 1936; 221); **Murzuq:** Al Quatrun (Scortecci 1936; 325), Duesa (Scortecci 1936; 606), Murzuq (Scortecci 1936; Ibrahim 2008; Essghaier et al. 2015; 298), Traghin ("Taraghin", Scortecci 1934, 1936; Ibrahim 2008; 303), Umm AlAranib (Ibrahim 2008; 310); **Sabha:** Ghadduwah (Scortecci 1936; 281), Sabh (Scortecci 1936; Essghaier et al. 2015; 286), Sabh (5 km W) (Schnurrenberger 1963; 283); **Wadi al Hayaa:** Al Biraq (Scortecci 1936; Schnurrenberger 1963; 210), Al'Fjayj (Frynta et al. 2000; Stöck et al. 2006; 274), Gaberoun (Frynta et al. 2000; Stöck et al. 2006; 277), Mandara Lake (Dumont 1987; 607), Tekerkiba ("Techertiba", Scortecci 1937a; 272). **Cyrenaica:** **Al-Gubba:** Ain Mara (this study; 608); **Benghazi:** Abiar Garig es-Snaba (Ghigi 1920; Calabresi 1923; 617), Benghazi (von Martens 1883; Werner 1909; Andreucci 1913; Ghigi 1913, 1920; Zavattari 1922; Calabresi 1923; 357), Fwayhat (Ghigi 1920; Calabresi 1923; 358), Gharrdah (Hartert 1913; 609), Gioh (Haimann 1886; Ghigi 1913; 350), Qaminis (Calabresi 1923; 367), Tocra, 8 km W of (USNM:Amphibians and Reptiles:146802–804; 610); **Butnan:** Wadi Raheb (Porto Bardia; Vinciguerra 1927; Gestro and Vinciguerra 1931; Doria et al. 2001–2002; 503); **Derna:** Bombah (Doria et al. 2001–2002; 474), Derna (Haimann 1886; Werner 1909; Andreucci 1913; Ghigi 1913, 1920, 1922; Zavattari 1922; Calabresi 1923; Schleich 1987; 466), Wadi Alhamsa (this study; 612), Wadi Alkhabta (this study; 613), Zawiyat al Mukhaylá (Calabresi 1923; 484); **Jabal al Akhdar:** Ain Dabusia (this study; 614), Ain Zarga (Resetar 1981; 615), Cyrene ruins (Resetar 1981; 419), eastern border of Kouf National Park (Resetar 1981; 440), Haniyah Beach Dunes, SW Kouf National Park (Resetar 1981; 414), Kouf National Park climatological station (Resetar 1981; 616), Kufanta, 1.5 km W (Resetar 1981; 444), Massah (Resetar 1981; Schleich 1987; 431), Shahhat (Ghigi 1920; Calabresi 1923; Doria et al. 2001–2002; Frynta et al. 2000; Stöck et al. 2006; 421), Susah Apollonia, 27 km E (USNM:Amphibians and Reptiles:146790–2; 611), Wadi Sudan (Resetar 1981; 434), Zawiyat al Mukhaylá (Calabresi 1923; 484);

Marj: Abiar Garig es-Snaba (Ghigi 1920; 617); al-Marj (Zavattari 1922; Calabresi 1923; 385).

Problematic Records.—Fezzan: **Ghat:** Al-Awaynat (Essghaier et al. 2015; 235), Ghat (Giardini di Mustafa; Dumont 1987; Essghaier et al. 2015; 249).

Comments.—Although, *B. boulengeri* is the most widespread and frequently recorded anuran in Libya, there remain many localities for which there have been no published records in many years. Both the record of “*Bufo* sp.” from Fwayhat by Scortecci (1937a) and “*Anura* sp.” from Mandara Lake by Dumont (1987) likely correspond to *B. boulengeri* since this is the only species documented from Fwayhat or from Gaberoun (nearby Mandara). Photographs shared by Khaled Etayeb indicate that the records of *B. boulengeri* from Ghat and Al-Awaynat by Essghaier et al. (2015) correspond to *Sclerophrys xeros*. Because there are no other verified records of *B. boulengeri* from Ghat, the report of this species from Ghat by Dumont (1987) likely corresponds to *S. xeros*. In their geographic distribution map for *B. boulengeri*, Escoriza and Ben Hassine (2019) considered records from Zillah and Al Quatrun to be “unconfirmed” though provide no further information to indicate why the records in Scortecci (1936) should be considered questionable. These same authors also include a point near Ghadames as an “unconfirmed” record; to our knowledge, the only other published record of *B. boulengeri* in this region is the map for this species provided by Salvador (1996), though the basis for that record is unclear. Schleich et al. (1996) detailed variation in both body size and color patterns across populations in southern Libya. How this variation might relate to population divergences recovered by Dufresnes et al. (2019) is unclear.

Ecology in Libya.—*Bufoes boulengeri* is widespread in coastal areas near water, as well as in saline depressions that fill with water following rains (also known as a *sebkhah*; Schleich et al. 1996). At sites in the Fezzan, it has been recorded from permanent lakes in Idehan Ubari, including Gaberoun. Adults have been observed from March–November (Werner 1909; Andreucci 1913; Ghigi 1913, 1920; Hartert 1913; Zavattari 1922; Calabresi 1923; Vinciguerra 1927; Scortecci 1936; Sayers 1964; Resetar 1981; Schleich 1987; Frynta et al. 2000; Ibrahim and Ineich 2005; Ibrahim 2008), with records of tadpoles in Cyrenaica during April to July (Calabresi 1923; Schleich 1987) and in the Fezzan during both March and August (Scortecci 1936).

IUCN Threat Status—Least Concern (IUCN 2021).

Sclerophrys xeros (Tandy, Tandy, Keith,
and Duff-MacKay 1976)

Common Names.—Sub-Saharan Toad, Desert Toad (English; Channing and Rödel 2019); Savannah Toad (English; Bouazza et al. 2021); **علجوم**, *oljoum* (Arabic; Escoriza and Ben Hassine 2019); **علجوم السافانا**, *oljoum as-safana* (Arabic; Bouazza et al. 2021); **علجوم الصحراء**, *oljoum al-sahraa*.

Bufo regularis: Scortecci 1934, 1936, 1937a; Dumont 1982, 1987.

Bufo xeros: Ibrahim 2008 [part].

Amietophrynus xeros: Essghaier et al. 2015.

Distribution.—*Sclerophrys xeros* is widespread across the Sahel of sub-Saharan Africa (Channing and Rödel 2019), extending from Western Sahara, Mauritania, and Senegal in the west to Ethiopia, Kenya, Somalia, and Tanzania in the east (Tandy et al. 1976; Mateo et al. 1997; Froufe et al. 2009; Padial and De la Riva 2004). There are isolated Saharan records from the Adrar plateau of Mauritania

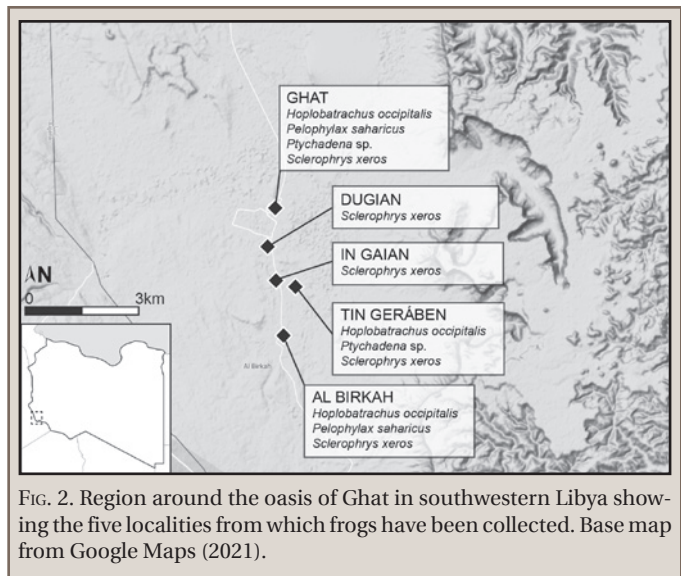


FIG. 2. Region around the oasis of Ghat in southwestern Libya showing the five localities from which frogs have been collected. Base map from Google Maps (2021).

(Dekeyser and Villiers 1956), southern Algeria in the mountains of Tassili N’Ajjer and Hoggar (Scortecci 1937b; Salvador 1996; Mateo et al. 2013), northern Mali in Adrar des Iforhas (Angel and Lhote 1938; Joger and Lambert 1996), northern Niger from near Agadez and in the Air Mountains (Angel and Lhote 1938; Guibé 1950; Joger 1981; Dumont 1982, 1987), and from northern Chad at Lake Yoa near Ounianga Kébir (Trape 2013). In Libya, *S. xeros* is known only from sites in southwestern Libya near Ghat.

Libyan Records (Fig. 2).—Fezzan: **Ghat:** Al Birkah (Scortecci 1934, 1936, 1937a; Ibrahim 2008; 253), Dugian (Scortecci 1936; 604), Ghat (Giardini di Mustafa, Tunin; Scortecci 1934, 1936, 1937a; Dumont 1982, 1987; Essghaier et al. 2015; 249), In Gaian (Scortecci 1936; 605), Tin Geráben (Scortecci 1934, 1936, 1937a; 252).

Problematic Records.—Fezzan: **Sabha:** Sabh (Essghaier et al. 2015; 286).

Comments.—Records from Libya attributed to *Sclerophrys regularis* have long been recognized as likely corresponding to *S. xeros* (Tandy et al. 1976; Schleich et al. 1996). Because there are no other records from Sabh—and *B. boulengeri* is well documented in that region—the record of *S. xeros* from Sabh by Essghaier et al. (2015) is probably incorrect and should be referred to *B. boulengeri*. *Sclerophrys xeros* is possibly the only anuran of the sub-Saharan amphibian fauna that is still present in Libya; it was observed most recently by Ibrahim (2008) at Al Birkah and Tunin, both near or in Ghat.

Ecology in Libya.—*Sclerophrys xeros* is known from wells and springs near Ghat in southwestern Libya (Scortecci 1937a), with records from February, March, July, September, and October (Scortecci 1936).

IUCN Threat Status—Least Concern (IUCN 2021).

Dicroglossidae Anderson 1871

Hoplobatrachus occipitalis (Günther 1858b)

Common Names.—African Tiger Frog, African Crowned Bullfrog (English; Channing and Rödel 2019); **ضفدع**, *dhufda’a* (Arabic; Escoriza and Ben Hassine 2019); **ضفدع أدرار**, *dhufda’a adrar* (Arabic; Bouazza et al. 2021); **ضفدع النمر الإفريقي**, *dhufda’a al-nemr al-afriqi*.

Rana occipitalis: Scortecci 1934, 1936, 1937a.

Ptychadena tigrina occipitalis: Dumont 1982.

Distribution.—*Hoplobatrachus occipitalis* is a widespread species in savannas throughout sub-Saharan Africa, extending from Western Sahara and Mauritania (Geniez et al. 2004; Padial et al. 2013; Reques et al. 2013) to Ethiopia, Kenya, and Tanzania in the east (Rödel 2000; Channing and Rödel 2019). There are isolated Saharan records from Mauritania on the Adrar plateau (Dekeyser and Villiers 1956; Padial et al. 2013), from northern Mali in Adrar des Iforhas (Joger and Lambert 1996), southern Algeria in the Tassili N'Ajjer (Mateo et al. 2013), northern Niger from the Air Mountains (Dumont 1982, 1987; Joger 1981) and the isolated oasis of Bilma (Angel and Lhote 1938; Böhme 1978), and Fata in northern Chad (Wake and Kluge 1961).

Libyan Records (Fig. 2).—**Fezzan:** **Ghat:** Al Birkah (Scortecci 1937a; 253), Ghat (Giardini di Mustafa, Tunin; Scortecci 1934, 1936, 1937a; Dumont 1982; 249), Tin Gerâben (Scortecci 1937a; 252).

Comments.—The last reported record of *H. occipitalis* in Libya is from Dumont (1982). Schleich et al. (1996) stated that this species "...may have been artificially introduced here to control mosquitoes." This seems unlikely since it implies that this species was introduced to this remote site prior to Giuseppe Scortecci's survey in 1934 (Scortecci 1936, 1937a). Ibrahim (2013b) considered the records in Libya as "questionable" as there have been no recent records. Because of the changing availability of surface water due to changes in irrigation and wells, this species is likely no longer found in this region. Mateo et al. (2013) noted that this species has disappeared from some water bodies in the Tassili N'Ajjer where it was formerly abundant.

Ecology in Libya.—*Hoplobatrachus occipitalis* was observed in wells and pools near Ghat during February, March, September, and October, with juveniles observed in all of these months and tadpoles in February (Scortecci 1936). Elsewhere in Africa, tadpoles of *H. occipitalis* are known to survive water temperatures of 40°C (Rödel 2000).

IUCN Threat Status.—Least Concern (IUCN 2021).

Ptychadenidae Dubois 1987

Ptychadena sp. Boulenger 1917

Common Names.—Grass or Ridged Frogs (Channing and Rödel 2019); **ضفدع العشب**, *dhufda'a al-ashep*.

Rana mascareniensis: Scortecci 1936.

Distribution.—Populations at Ghat in southwestern Libya and at Ifédil in the Tassili N'Ajjer in southeastern Algeria have been previously identified as *Ptychadena mascareniensis* (Scortecci 1937a,b; Angel and Lhote 1938; Dumont 1982). However, taxonomic confusion and recent revisions of the genus leave it unclear whether these populations represent the widespread species *P. mascareniensis*, *P. nilotica* (recently recognized for populations extending into the Nile; Dehling and Sinsch 2013), or yet some other species.

Libyan Records (Fig. 2).—**Fezzan:** **Ghat:** Ghat (Giardini di Mustafa; Scortecci 1936); Tin Gerâben (MCSN Am 461–465; 252).

Comments.—Scortecci (1936) notes that this species occurs in Tassili N'Ajjer and Ghat, though it is his only publication to note this taxon in Libya. Examination of specimens collected from Tin Gerâben by Scortecci in the Museo Civico di Storia Naturale in Milan confirms that these specimens (MCSN Am 461–465) represent *Ptychadena*, though it is unclear which species; these likely represent Scortecci's (1936) record from "Ghat." Some of

the "*Rana* sp." from Scortecci (1937a) may also correspond to *Ptychadena*. Mateo et al. (2013) considered records from Tassili N'Ajjer and Hoggar in southern Algeria to be *Hoplobatrachus occipitalis*, but at least those from Tassili N'Ajjer likely correspond to the *Ptychadena* of earlier authors such as Pellegrin (1911a,b, 1913). There have been no further reports of *Ptychadena* from in and around Ghat since Scortecci (1936).

Ecology in Libya.—No ecological details are provided by Scortecci (1937a) for the individuals of *Ptychadena* that he encountered at Ghat.

IUCN Threat Status.—Least Concern (IUCN 2021).

Ranidae Fitzinger 1843

Pelophylax saharicus (Boulenger in Hartert 1913)

Common Names.—Sahara Green Frog (English; Channing and Rödel 2019); **جزاع صحراوي**, *jaza' sahraawi* (Arabic; Baha El Din 2006); **الضفدعة الخضراء**, *al-dhufda'a al-khadra'a* (Arabic; Escoriza and Ben Hassine 2019); **ضفدع أخضر مغاربي**, *dhufda'a akhdar maghrebi* (Arabic; Bouazza et al. 2021); **ضفدع الماء**, *dhufda'a al-maa*; **ضفدع الاخضر**, *dhufda'a al-akhdar*.

Rana esculenta: Peters 1880, 1881.

Rana ridibunda: Werner 1909; Ghigi 1913, 1920; Zavattari 1922; Calabresi 1923; Scortecci 1934, 1936; Resetar 1981; Schleich 1987.

Rana esculenta saharica: Hartert 1913.

Rana zavattari: Scortecci 1936, 1937a.

Rana ridibunda perezii: Dumont 1987.

Rana saharica: Frynta et al. 2000; Doria et al. 2001–2002; Ibrahim and Ineich 2005; Jdeidi 2007a,b, 2008.

Distribution.—*Pelophylax saharicus* is widespread across North Africa ranging from Morocco and Western Sahara through Algeria and Libya to the Siwa Oasis in western Egypt (Geniez et al. 2004; Baha El Din 2006; Channing and Rödel 2019). It occurs in isolated locations throughout southern Algeria (Angel and Lhote 1938) and, at least historically, was represented by an isolated population in and near Ghat in southwestern Libya (Scortecci 1936, 1937a).

Libyan Records (Fig. 3).—**Tripolitania:** **Gharyan:** Wadi Zaret (this study; 595); **Jabal Nafusah:** Ain Rumia (Scortecci 1936; 140), Rabta (Jdeidi 2007b, 2009; 596), Shakshuk (Scortecci 1936; 597); **Misratah:** Misrata (Rizzardi 1896; Ghigi 1913; 90), Tawergha (Scortecci 1936; 83); **Mergeb:** Sharshara (Peters 1880, 1881; Ghigi 1913; 59); **Nalut:** Ain Al-Khenjari (Ibrahim and Ineich 2005; 601), Dirj (Scortecci 1936; 113), Gabr Saleh (Hartert 1913; 110); **Tripoli:** Garabuli (Jdeidi 2007b, 2009; 56), Wadi sidi Bennur (MZUF 284, MZUF 18770; 53); **Al Zawiyah:** Al-Zahra (Werner 1909; Ghigi 1913; 16). **Fezzan:** **Ghat:** Al Birkah (Scortecci 1934, 1936, 1937a; 253), Ghat (Giardini di Mustafa; Dumont 1987; 249). **Cyrenaica:** **Al-Gubba:** Ain Mara (this study; 608); **Al Wahat:** Jalu (MZUF 16401–03; 564); **Derna:** Derna (Werner 1909; Ghigi 1913, 1920; Zavattari 1922; Calabresi 1923; Schleich 1987; 466), Msalatah (this study; 598), Wadi Alkhabta (this study; 613); **Jabal al Akhdar:** Ain Zarga (Resetar 1981; Jdeidi and Elhosk 2009; 615), Cyrene ruins (Schleich 1987; 419), Shahhat (Calabresi 1923; Frynta et al. 2000; Doria et al. 2001–2002; 421), Susah (Zavattari 1922; Calabresi 1923; 417), Wadi El-Kouf (Jdeidi 2007a, 2008, 2009; 430).

Comments.—Based on differences in the male advertisement call between populations in northeastern and northwestern coastal Libya, Jdeidi (2007a, b, 2008, 2009) suggested that *P. saharicus* comprises several populations that might deserve

recognition as distinct subspecies. The population reported as *Rana zavattari* from in and near Ghat by Scortecci (1936, 1937a) represents the most extreme southern record of *P. saharicus* in Libya (for brief summary of taxonomy, see Blackburn and Scali 2014). There have been no reports of this species from Ghat in at least thirty years, but potentially much longer if Dumont (1987) was simply repeating records by Scortecci (1936) instead of reporting his own record. Specimens in the Museo Civico di Storia Naturale in Milan corresponding to *Rana zavattari* are not lost as reported by Dubois and Ohler (1994). Escoriza and Ben Hassine (2019) include two confirmed reports near Benghazi but the basis for these records was not reported.

Ecology in Libya.—In coastal Libya, *Pelophylax saharicus* occurs near springs, wells, and *sebkhas* (Schleich et al. 1996). Adults have been observed nearly year-round, from January–November (Peters 1880, 1881; Werner 1909; Ghigi 1913, 1920; Hartert 1913; Zavattari 1922; Scortecci 1936; Resetar 1981; Frynta et al. 2000; Ibrahim and Ineich 2005), and males can be found calling much of the year from February through September (Jdeidi 2007a).

IUCN Threat Status.—Least Concern (IUCN 2021).

ERRONEOUS OR UNCONFIRMED RECORDS FROM LIBYA

Bufonidae Gray 1825 *Bufo pantherinus* Smith 1828

Reported from Gihon by both Haimann (1886) and Ghigi (1913). Werner (1909) doubted this record and referred it to *Bufo viridis* (now *Bufo boulengeri*). *Sclerophrys pantherina* is restricted to South Africa (Channing and Rödel 2019).

Alytidae Fitzinger 1843 *Discoglossus pictus* Otth 1837

Reported from Misratah by Rizzardi (1896) and by Ghigi (1913) based on specimens collected by Brichetti. Werner (1909) doubted this record and referred it to *Rana ridibunda* (now *P. saharicus*). *Discoglossus pictus* is known from Morocco, Algeria, and Tunisia, as well as the islands of Sicily and Malta, but there are no records from Libya (Escoriza and Ben Hassine 2019).

Pyxicephalidae Bonaparte 1850 *Tomopterna cryptotis* (Boulenger 1907)

Reported from Ghat by Dumont (1987). *Tomopterna cryptotis* is known to occur in isolated areas including the Adrar plateau of Mauritania (Dekeyser and Villiers 1956) and the Air Mountains of northern Niger (as “*Pyxicephalus delalandii*” by Guibé 1950; as “*Arthroleptis agadezi*” by Angel and Lhote 1938; Dumont 1982). Dumont’s (1987) record from Libya remains unverifiable as no details, images, or specimens are known. Channing and Rödel (2019) indicate that their “*Tomopterna cf. milletihorsini*” may occur in an isolated region of southeastern Algeria and southwestern Libya, though it is unclear what this record was based on (M.-O. Rödel, pers. comm.).

DISCUSSION

Libya has the fewest amphibian species of any country in continental Africa. Even so, this amphibian fauna remains of interest to the study of biogeography because it represents the

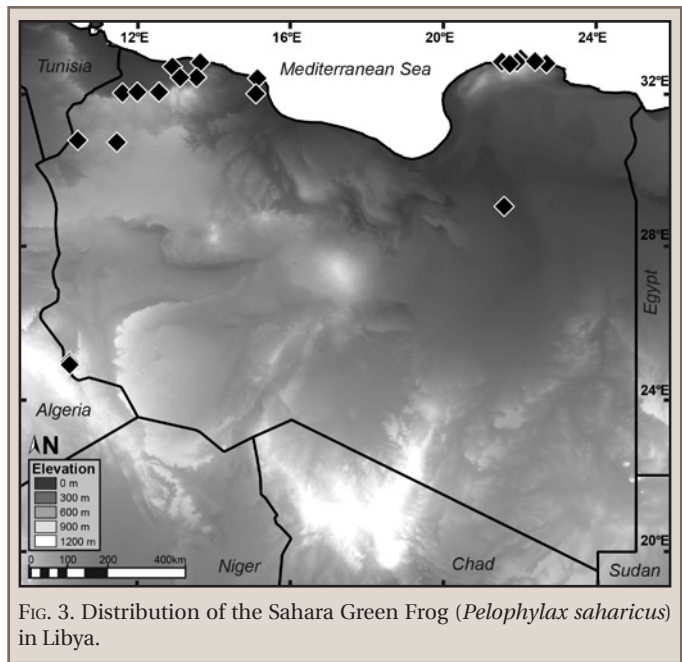


FIG. 3. Distribution of the Sahara Green Frog (*Pelophylax saharicus*) in Libya.

boundary between both the Mediterranean and sub-Saharan faunas and the faunas of western and eastern North Africa. In this atlas, five species of anurans are confirmed for Libya, including two bufonids (*Bufo boulengeri*, *Sclerophrys xeros*), one microglossid (*Hoplobatrachus occipitalis*), one ranid (*Pelophylax saharicus*), and one pythadenid (*Ptychadena* sp.). It is likely that two of these species (*Hoplobatrachus occipitalis* and *Ptychadena* sp.) no longer occur in Libya. Based on >150 years of published literature, this atlas summarizes 76 localities with records of anurans in Libya. Twenty-nine of these localities have only one published record, fourteen localities have five or more records, and only three localities (Derna, Ghat, Al Bikrah) have ten or more records. Several additional localities are reported based on fieldwork by one of us (TBJ) or specimens preserved in the Museo Zoologico “La Specola” at the Università di Firenze or the Smithsonian Institution’s National Museum of Natural History. For approximately half of the known localities, there have not been published records of frogs for at least 70 years. The isolated oasis of Ghat once contained the richest amphibian fauna in Libya with four species (Fig. 2), but it seems that only one species remains, *Sclerophrys xeros*. There have been no records of *Hoplobatrachus occipitalis* from in and around Ghat since 1982, none of *Pelophylax saharicus* since 1987, and none of *Ptychadena* since 1936. In general, there have been few records from any region in Libya during the past 20 years. At southern Libyan sites, the local extinction of species is likely driven by a loss of wetland breeding sites related to changes in water use practices. These changes include mechanized wells for accessing aquifers and the Great Man Made River that transports millions of cubic meters of water per day from Saharan aquifers to communities along the Mediterranean (White et al. 2003; Ibrahim 2008; Abdelrahman et al. 2013).

There are many amphibian species in adjacent countries that have never been recorded in Libya. Few amphibian taxa that are endemic to northwestern Africa are found in Libya: there are no salamanders, nor are the anuran genera *Alytes* and *Discoglossus* present, nor are species such as *Bufo spinosus*. There are no records to suggest that the eastern Mediterranean species *Pelophylax bedriagae* extends west into Libya, though there may be introduced populations of the Balkan *P. kurtmuelleri*

near Tripoli (Blackburn and Jdeidi, unpublished data). There are several sub-Saharan anuran species that are unknown from Libya but documented in the northern desert regions of adjacent Niger and Chad. *Sclerophrys pentoni* is known from northern Niger in Agadez and the Air Mountains (Angel and Lhote 1938; Guibé 1950; Joger 1981; Dumont 1982) as well as from northern Mali (Dumont 1982; Joger and Lambert 1996). Sereno et al. (2008) identified a bufonid from the Holocene archaeological site Gobero in northern Niger, but whether this corresponds to *S. pentoni*, *S. xeros*, or another species remains uncertain. *Tomopterna cryptotis* is also documented from northern Niger (Angel and Lhote 1938; Guibé 1950; Dumont 1982). Though reported from Ghat by Dumont (1987), the lack of any supporting evidence—or of records by any other authors in this region—leads to us to consider this as a likely misidentification; this record might correspond to the bufonid *S. xeros*. Another sub-Saharan taxon found in northern Niger but not in southwestern Libya is *Pyxicephalus*, though the only known record from the Air Mountains was a partial, desiccated specimen (Blackburn 2008). Last, there are no recent records of the genus *Xenopus* from southern Libya, though *X. fischbergi* is known from the Ennedi of northern Chad (Evans et al. 2015; originally reported as *Xenopus muelleri* by Monod 1968; Dumont 1982, 1987). *Xenopus* is documented from the Oligocene of Libya (Špinar 1980), though Báez (1996) argued that these should be referred to a different genus. *Xenopus* persisted elsewhere in North Africa into the Miocene (Vergnaud-Grazzini 1966).

It is unlikely that new field research will reveal additional species of frogs in Libya. However, there remain opportunities for sampling of populations across Libya, including resurveying sites that have not been visited in many years. New surveys along the coast and at more isolated seasonal or permanent water bodies could help to determine whether populations of these five anuran species still persist following decades of dramatic water use changes. New genetic resources from field surveys would also facilitate phylogeographic studies of populations at remote sites. Such studies could provide new insights into how the changing history of waterways in the Sahara impacted the distributions and patterns of gene flow in these relictual anurans. Given both climate change and the many changes to how people use and access water across the Sahara, it is important to study these populations soon before they disappear.

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APPENDIX 1. Gazetteer of additional localities not present in Bauer et al. (2017). Alternative names are presented in brackets.

Locality #	Latitude °N	Longitude °E	Locality name
TRIPOLITANIA			
GHARYAN			
595	32.1056	12.8015	Wadi Zaret
JABAL NAFUSAH			
596	32.7506	13.6850	Rabta
597	32.0177	11.9553	Shakshuk [Scec Sciuc]
MERGEB			
598	32.5769	13.9889	Msalatah [Al Qusbat, Cussabat], 5 km W of
MISRATAH			
599	32.6646	14.1566	Alnagazah
600	32.7156	14.0789	Ghanima
NALUT			
601	31.9936	11.5633	Ain Al-Khenjari
TARHUNA			
602	32.8389	13.0569	Janzur
AL ZAWIYAH			
603	32.4661	13.6169	Sorman
FEZZAN			
GHAT			
604	24.9396	10.1763	Dugian
605	24.9199	10.1819	In Gaian
MURZUQ			
606	25.9334	14.3093	Duesa [Disa]
WADI AL HAYAA			
607	26.6919	13.3134	Mandara Lake
CYRENAICA			
AL-GUBBA			
608	32.7528	22.3786	Ain Mara
BENGHAZI			
609	32.4333	20.5333	Gharrdah [Ghardaïa]
610	32.4927	20.4954	Tocra [Tukrah], 8 km W of
DERNA			
611	32.8750	22.2125	Susah Apollonia [Apollonia], 27 km E of
612	32.6497	22.9983	Wadi Alhamsa
613	32.6636	22.9236	Wadi Alkhabta
JABAL AL AKHDAR			
614	32.8333	22.2803	Ain Dabusia
615	32.8097	21.4772	Ain Zarga [K. N. P. [Kouf National Park], Ain Zarga; K. N. P., 6 m E of Ain Zarga; Sebkah Ayn Shagigah; K. N. P., 55 m S and W of Ain Shagigah] K. N. P., climatological station E of office
616	32.7052	21.5623	
MARJ			
617	32.5147	20.9166	Abiar Garig es-Snaba ["Lago di El Garig"]