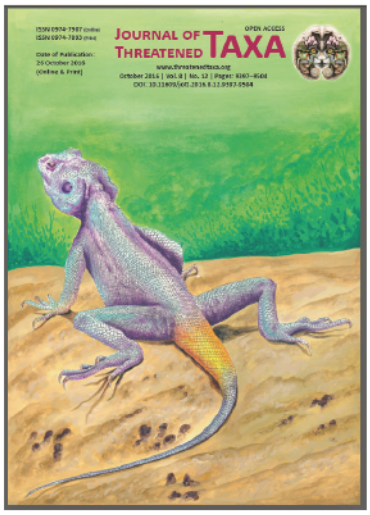

Journal of Threatened Taxa

The international journal of conservation and taxonomy

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

SHORT COMMUNICATION

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26 October 2016 | Vol. 8 | No. 12 | Pp. 9454–9460
10.11609/jott.2373.8.12.9454-9460

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 October 2016 | 8(12): 9454–9460

An inventory of herpetofauna from Wadi Sayq, Dhofar, Oman

ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

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OPEN ACCESS

Abstract: Two research expeditions surveyed the herpetofauna within the monsoon-influenced zone of Wadi Sayq, a coastal wadi system 31.5km in length, situated in the southwestern Jabal Qamar mountain range, Dhofar, Oman. Surveys were undertaken from 02 to 29 February 2012, and from 06 February to 07 March 2013. Ninety-three individuals belonging to 15 species were recorded. Morphological data was collected for 10 species. An elevation gradient in habitat preference is observed for the genus *Hemidactylus*, and the discovery of four *Coluber thomasi* individuals significantly increases the total global records for this species.

Keywords: *Coluber thomasi*, Dhofar, Hemidactylus, herpetofauna, Oman, reptiles, Wadi Sayq.

One-hundred-and-seventy-two non-marine reptile species and nine amphibian species are currently recognised for the Arabian Peninsula. Eighty-nine of these reptile species and six amphibian species are Arabian endemics (Cox et al. 2012). The herpetofauna species richness is greatest around the edge of the peninsula, which experiences higher levels of precipitation. Only six of the Arabian reptile species are assessed as globally threatened by the IUCN in addition to 10 considered regionally threatened. This is encouraging and suggests that the Arabian Peninsula may be experiencing lower levels of habitat degradation than on other continents (Cox et al. 2012).

The south-western mountains in Saudi Arabia and the southern mountains of Yemen and Dhofar are hotspots for diversity and endemism (Gardner 2013). Oman boasts seventy-four native and two introduced non-marine reptile species. Four are classified as vulnerable, one as near threatened and six as data deficient by the IUCN (Cox et al. 2012). The herpetofauna of Dhofar in southern Oman, like much of the biodiversity in the region, shows zoogeographical affinities with African taxa (Smid 2010).

The herpetofauna of Dhofar has received increasing attention since the 1977/78 Oman Flora & Fauna Survey was published as a special report in Journal of Oman Studies (Reade et al. 1980). Within this special report Arnold (1980) addressed some 500 individual records and described five new species as well as reviewing the taxonomy for several others. Influential works that followed included Gasperetti (1988), Gardner (1999) and Egan (2007), and more recently genetic analysis has seen systematic reviews of the *Hemidactylus* (Carranza & Arnold 2012; Smid et al. 2013), *Ptyodactylus* (Nazarov

DOI: http://dx.doi.org/10.11609/jott.2373.8.12.9454-9460 | **ZooBank:** urn:lsid:zoobank.org:pub:14A38C2F-E737-4644-AFFF-67CBE94B348A

Editor: Pritpal S. Soorae, Environment Agency, Abu Dhabi, UAE. **Date of publication:** 26 October 2016 (online & print)

Manuscript details: Ms # 2373 | Received 11 April 2016 | Final received 24 September 2016 | Finally accepted 27 September 2016

Citation: Ball, L.D. & J.S. Borrell (2016). An inventory of herpetofauna from Wadi Sayq, Dhofar, Oman. *Journal of Threatened Taxa* 8(12): 9454-9460; http://dx.doi.org/10.11609/jott.2373.8.12.9454-9460

Funding: Anglo-Omani Society; Shell Development Oman LLC; and the Sandy and Zorica Glen Charitable Settlement.

Conflict of Interest: The authors declare no competing interests.

Acknowledgements: The authors wish to gratefully acknowledge the support of the British Exploring Society (BES) and the Office for Conservation of the Environment (OCE), Diwan of Royal Court, Oman in undertaking this study. Furthermore, we thank Terry Fones, Soo Redshaw and Andrew Stokes-Rees for supporting the logistics of this research in the field. Finally, the authors wish to thank all the members of the expeditions. This work was supported by the Anglo-Omani Society; Shell Development Oman LLC; and the Sandy and Zorica Glen Charitable Settlement.

et al. 2013) and *Pristurus* (Badiane et al. 2014) genera, and a new species of *Pseudotrapelus* has been described from Dhofar (Melnikov & Pierson 2012). Most recently, Gardner (2013) published a comprehensive account of the herpetofauna of Oman and the UAE, providing updated and robust reference material for current research to build upon.

Here we report on the results of herpetofauna surveys conducted over two multidisciplinary research expeditions to Wadi Sayq in the Jabal Qamar mountain range. Wadi Sayq is a deep seasonal river valley (wadi) measuring approximately 31.5km in length from its source near the Yemen border, to its mouth at Khor Kharfot (16^{0}43'48"N & 53^{0}20'11"E). From June-September the Jabal Qamar mountain range becomes influenced by the summer monsoon (Khareef), during which low cloud and mist form against the south-facing slopes, depositing moisture, and rapidly regenerating the vegetation. At Wadi Sayq, dense scrub and woodland predominates on the slopes and gullies of the main valley and its tributaries, consisting largely of *Acacia*, *Commiphora* and the near-endemic *Anogeissus dhofarica*. Freshwater marsh, salt marsh and tidal lagoons support a peak in biodiversity at the estuary. Whilst transhumance management of livestock has resulted in overgrazing throughout the more accessible parts of the wadi, it is still considered one of the greenest valleys in the Dhofar Mountains (Ball et al. 2015) and is likely to be of considerable importance for research and conservation of Dhofarian herpetofauna.

Materials and Methods

Herpetofaunal surveys of Wadi Sayq were undertaken from 02 to 29 February 2012, and from 06 February to 07 March 2013 by one or both authors and trained volunteers. The surveys focused on the lower 15km section of the wadi, between the beach at Khor Kharfot and the edge of the monsoon-influenced zone above the main road that intercepts the wadi.

A range of opportunistic-capture methods were employed throughout the research periods. Whilst a conventional pitfall trapping approach was piloted, this was found to be unfeasible due to the hard substrate of the wadi system, thus all individuals were captured by hand, with nets or using nooses (Image 1). Surveys were undertaken during the day and at night to ensure both diurnal and nocturnal species were represented. Intensive herpetofauna surveys took place in each of the lower, middle and upper stretches of the monsoon-influenced zone of the wadi system in accordance with the position of the expedition satellite camps.

Morphological data was obtained for collected individuals to aid positive identification. Additional measures of microhabitat, temperature and humidity were collected for approximately two-thirds of the individuals and can be found in the supplementary raw data set (Supplementary_file). Hazardous venomous species were not handled. Individuals that were positively identified by sight, and not captured, were also recorded.

Results

Ninety-three individuals belonging to fifteen species were recorded (Table 1). Fourteen of these species were reptiles and one was the amphibian *Duttaphrynus dhufarensis*. *Pristurus rupestris* and the newly described *Ptyodactylus dhofarensis* (Nazarov et al. 2013) (previously referred to as *P. hasselquistii*) were found in abundance.

The spatial distribution of the recorded individuals is shown in Image 2. *Echis khosatzkii* and *Bitis arietans* were recorded to the east along the coastal path, which leads to the neighbouring town of Rakhyut.

Discussion

Hemidactylus alkiyumii was newly described in 2012. It is a southern Arabian endemic confined to the monsoon-influenced mountain slopes of Yemen and Dhofar (Caranza & Arnold 2012). Two individuals were recorded in the middle section of Wadi Sayq during this research. Many specimens have been recorded by Caranza & Arnold (2012) at nearby Dhalkut. *Hemidactylus alkiyumii* was differentiated from other *Hemidactylus* species from Dhofar, namely *H. flaviviridis, H. minutes*, *H. lemurinus* and *H. robustus*, by the comparatively larger tubercles covering the majority of the body and tail. However, distinguishing this species from *H. festivus* is challenging and thus further confirmation was sought from other researchers knowledgeable on the region (Salvador Carranza pers. comm. 07 December 2013). Carranza & Arnold (2012) provides a valuable dichotomous reference for species belonging to the genus *Hemidactylus*.

Hemidactylus lemurinus is endemic to the southern Dhofar and Yemen Mountains (Carranza & Arnold 2012). It appears to be limited to isolated subpopulations which occupy a very narrow, discontinuously distributed ecological niche. Wadi Sayq can be added to the short list of localities for this species, which includes Mughsayl in Dhofar, and Sayhut and Wadi Hajr in Yemen (Schatti & Desvoignes 1999). Due to the scarcity of records, this species is listed as Data Deficient by the

Table 1. Herpetofauna species recorded within Wadi Sayq showing morphological measurements.

Taxon	IUCN Red List status	No. of individuals recorded	Avg. (max) snout-vent length (mm)	Max tail length (mm)	Avg. (max) weight (g)
Amphibians					
Bufonidae					
Duttaphrynus dhufarensis Parker, 1931	LC	3			26.5
Reptiles					
Agamidae					
Acanthocercus adramitanus Anderson, 1896	LC	7	86 (max 143)	280	30.8 (max 104)
Chameleonidae					
Chamaeleo arabicus Matschie, 1893		1	178	170	39
Gekkonidae					
Hemidactylus alkiyumii Carranza & Arnold, 2012	NE	2	52	69	10
Hemidactylus minutus Vasconcelos & Carranza, 2014	LC	5	29.8 (max 34)	36	1.3 (max 2)
Hemidactylus lemurinus Arnold, 1980	DD	6	44 (max 63)	57	4 (max 7)
Hemidactylus robustus Heyden, 1827	LC	4	52 (max 60)	61	4.1 (max 5.3)
Phyllodactylidae					
Ptyodactylus dhofarensis Nazarov, Melnikov & Melnikova, 2013	LC	29	79 (max 91)	86	16.3 (max 45)
Sphaerodactylidae					
Pristurus rupestris Blanford, 1874	LC	26	22 (max 31.5)	39	0.6 (max 0.7)
Scincidae					
Trachylepis tessellata Anderson, 1895	LC	2	50.5 (max 65)	129	8.2
Colubridae					
Coluber thomasi Parker, 1931	DD	4	350	116.5	15
Platyceps rhodorachis Jan, 1865	LC	1			
Elapidae					
Naja arabica Scortecci, 1932	LC	1			
Viperidae					
Echis khosatzkii Cherlin, 1990	LC	1			
Bitis arietans Merrem, 1820	LC	1			

IUCN. Three of the individuals collected in Wadi Sayq were recorded on large water-smoothed white marble boulders in the upper stretches of the wadi system alongside *Ptyodactylus dhofarensis*, which is consistent with observations by Arnold (1980) and Caranza & Arnold (2012). *Hemidactylus lemurinus* was easily distinguished from other possible *Hemidactylus* species by its relatively large size and head, slender limbs and absence of tubercles, and by its pallid colouration (Caranza & Arnold 2012).

Hemidactylus robustus is a widespread species in Arabia (Carranza & Arnold 2012). All four individuals were recorded less than 1.5km from the coast which conforms to reports by Arnold (1980) who suggested this is a mainly coastal species. Narrow adhesive pads, small tubercles and a distinctive dark eye-stripe distinguish this species from other local *Hemidactylus* species.

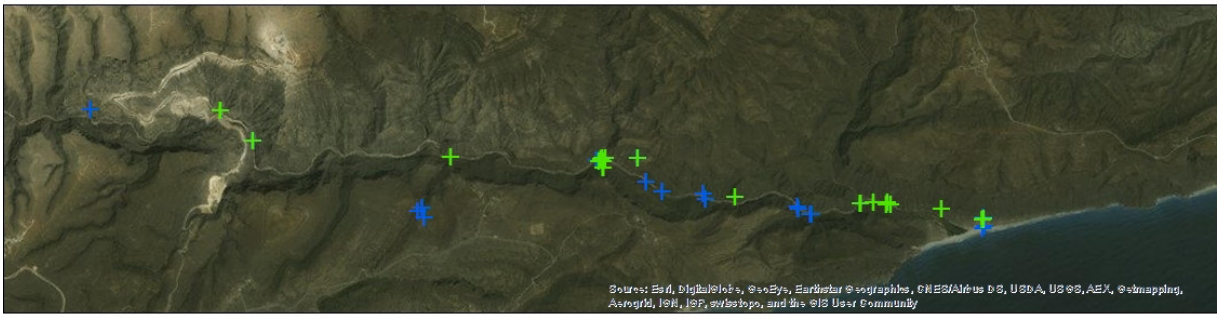
Although our sample size is small, species of the genus *Hemidactylus* appear to be distributed along an elevation gradient with each species occupying specific stretches of the valley. The size, shape, texture and quantity of rocks and boulders changes substantially along the length of Wadi Sayq, thus creating a range of niches related to the energy, transport and deposition characteristics of the intermittent river at different points. *Hemidactylus* species may have adapted to specialise in these ecological niches as a result (Arnold 1980; Carranza & Arnold 2012). An exception is our

Image 1. Photographic evidence of the recorded species.
A - *Duttaphrynus dhufarensis*; B - *Acanthocercus adramitanus;* C - *Hemidactylus alkiyumii*; D - *Hemidactylus minutus*; E - *Hemidactylus lemurinus*; F - *Ptyodactylus dhofarensis;* G - *Pristurus rupestris*; H - *Trachylepis tessellata;* I - *Coluber thomasi;* J - *Echis khosatzkii*. (Photos by various expedition team members).

+ *Bitis arietans* + *Echis khosatzkii* + *Platyceps rhodorachis*
+ *Coluber thomasi* + *Naja arabica*

+ *Acanthocercus adramitanus* + *Duttaphrynus dhufarensis*
+ *Chamaeleo arabicus* + *Trachylepis tessellata*

+ *Hemidactylus alkiyumii* × *Hemidactylus minutus*
+ *Hemidactylus lemurinus* + *Hemidactylus robustus*



+ *Pristurus rupestris*
+ *Ptyodactylus dhofarensis*

0 2 4 6 8 Km

N

Image 2. Maps showing the distribution of recorded individuals within Wadi Sayq.

record of the newly described *H. minutus* (Vasconcelos & Carranza 2014) (previously referred to as *H. homeoelepis*) which was recorded in both the upper and lower valley. However, this is unsurprising as this species is amongst the most abundant in Dhofar (Arnold 1980) indicating a generalist life strategy, and is sympatric with *H. lemurinus* at other sites. *Hemidactylus minutes* may be differentiated in the field by its lack of tubercles and small size, with a maximum snout-vent length of 34mm (Carranza & Arnold 2012).

Pristurus rupestris is common throughout northeast Africa and the Arabian Peninsula (Cox et al. 2012). Very recently, genetic studies have uncovered two clades. The eastern clade occupies the Hajar Mountains in northern Oman and the western clade, to which our records belong, occupies the Dhofar, Yemen and Saudi Arabia mountain ranges. It is believed that more than one subspecies was recorded in Wadi Sayq, as several morphological variations were noticed, consistent with the findings of Badiane et al. (2014). However, because subspecies have not yet been defined and named, records from this study were defined generically as *P. rupestris*. Badiane et al. (2014) explain this species occupies a variety of microhabitats and variation is common between neighbouring local populations. This adaptability may explain its abundance in all rocky realms within Wadi Sayq, both within the valley and on surrounding hillsides. This sheer abundance helped to confirm its identification, however, its more slender build, and longer and flattened tail differentiate it from *Pristurus carteri*. Some individuals were too large and the distinctive colourations were lacking to be considered as *P. minimus*. It should also be noted that the eye pupil of *P. rupestris* is rounded in its entirety unlike *P. carteri* and *P. minimus* (Firouz 2005).

Coluber thomasi is listed as data deficient by the IUCN as the species has previously been known from only 10 specimens. Endemic to the Dhofar Mountains, its ecology and vulnerability is poorly known and requires further study (Cox et al. 2012). This species was collected on one occasion and three additional sightings were made during this research. As snake sightings were generally infrequent on the expedition it is postulated that this species could be fairly abundant within Wadi Sayq. This was later confirmed by a group of frequently visiting archaeologists who stated regularly observing this species in Wadi Sayq (Chad Aston pers. comm. April 2013). Deliberate killing of this species by humans is reported to occur (Khalid Al Hikmani (OCE) pers. comm. 14 February 2013), as it is believed to be deadly and bring bad luck. In fact, as a member of the Platyceps genus the bite of this conspicuously patterned species is likely to be harmless (Scrimgeour et al. 2001). Killing of this species may be a key contributor to its scarcity. It is notable that Wadi Sayq has relatively low levels of human disturbance, thus it may be an important location for the conservation of this species.

Platyceps rhodorachis is abundant throughout the Arabian Peninsula (Cox et al. 2012). It was recorded on one occasion in Wadi Sayq, though a number of unconfirmed sightings of racer-type snakes were made by the expedition team and can likely be attributed to this species.

A number of species that might be expected in the area were not recorded during this research. These include species of the genera *Uromastyx*, *Bunopus*, *Pristurus* and *Acanthodactylus*. Whilst additional survey time may reveal their presence, it is also plausible that they are less common, or absent, from this area.

Hemidactylus alkiyumii, Hemidactylus lemurinus and *Coluber thomasi* are not yet classified by the IUCN and records are sporadic throughout the eastern Yemen and Dhofar Mountains (Cox et al. 2012). Their presence in Wadi Sayq is therefore notable, and it is hoped that the preceding observations will contribute to the limited ecological knowledge of these species.

In summary, the multidisciplinary surveys undertaken by the expeditions, of which this study was a component, revealed high diversity across all taxonomic groups (Ball 2014; Ball et al. 2015). When compared to adjacent areas, the monsoon influenced zones of Wadi Sayq have been subject to comparatively low disturbance, likely due to remoteness and inaccessibility. As such, it constitutes an important refuge for Arabian herpetofauna, worthy of protection.

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Journal of Threatened Taxa

OPEN ACCESS

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

October 2016 | Vol. 8 | No. 12 | Pages: 9397–9504
Date of Publication: 26 October 2016 (Online & Print)
DOI: 10.11609/jott.2016.8.12.9397-9504
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