

# CONSERVATION BIOLOGY OF FRESHWATER TURTLES AND TORTOISES

A COMPILATION PROJECT OF THE  
IUCN/SSC TORTOISE AND FRESHWATER TURTLE SPECIALIST GROUP

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*Pelomedusa barbata* Petzold, Vargas-Ramírez, Kehlmaier, Vamberger,  
Branch, Du Preez, Hofmeyr, Meyer, Schleicher, Široký, and Fritz 2014 –  
Arabian Helmeted Turtle, Arabian Marsh Turtle, Arabian Mud Turtle

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***Pelomedusa barbata* Petzold, Vargas-Ramírez, Kehlmaier, Vamberger, Branch, Du Preez, Hofmeyr, Meyer, Schleicher, Široký, and Fritz 2014 – Arabian Helmeted Turtle, Arabian Marsh Turtle, Arabian Mud Turtle**

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**SUMMARY.** – The Arabian Helmeted Turtle, *Pelomedusa barbata* (family Pelomedusidae), is a medium-sized, hard-shelled freshwater turtle with a carapace length of up to 216 mm, perhaps 250 mm, and an average adult weight of 800 g. It is characterized by having two small temporal scales on each side of the head and two large barbels located under the chin. The species is endemic to the Arabian Peninsula and occurs in scattered, often isolated populations throughout its range in Saudi Arabia and Yemen. It occupies well-vegetated habitats at elevations from sea level to 1800 m, in basalt- and granite-rock formations that allow the accumulation of surface water within higher rainfall areas as compared to the drier interior of the Arabian Peninsula. Females lay a clutch of 6–11 leathery-shelled eggs that hatch after 50–70 days of incubation. Ontogenetic color changes occur on both the carapace and plastron. The species is threatened by overexploitation of surface water and habitat destruction and is likely to be further impacted by climate change.

**DISTRIBUTION.** – Saudi Arabia and Yemen. Occurs in southwestern Saudi Arabia in the Asir Mountain range in Al-Bahah, Asir, Jizan, and Makkah provinces, and in western and southwestern Yemen within the mountainous regions of Abyan, Adh-Dali, Al-Hudaida, Lahij, Shabwa, and Taiz governorates.

**SYNONYMY.** – *Pelomedusa barbata* Petzold, Vargas-Ramírez, Kehlmaier, Vamberger, Branch, Du Preez, Hofmeyr, Meyer, Schleicher, Široký, and Fritz 2014. Previously considered part of *Pelomedusa subrufa* (Bonnaterre 1789).

**SUBSPECIES.** – No subspecies recognized.

**STATUS.** – IUCN 2021 Red List: Not Evaluated (NE); TFTSG Provisional Red List: Endangered (EN, assessed 2016); CITES: Not listed.

**Taxonomy.** – The African Helmeted Turtle, *Pelomedusa subrufa*, was for a long time considered a pan-African species, distributed across most of sub-Saharan Africa, Madagascar, and the southwestern Arabian Peninsula (Obst and Wranik 1987; Boycott and Bourquin 2007; Fritz and Havaš 2007; Branch 2008). Arillo (1967) first recorded *P. subrufa* from the Arabian Peninsula in Yemen, and Gasperetti et al. (1993) considered *P. subrufa* from Saudi Arabia and Yemen to be part of this monotypic species. However, based on a comprehensive sampling effort across the species' range and analyzing nuclear and mitochondrial DNA (mtDNA) sequences, the Arabian population was found to be genetically deeply divergent (Vargas-Ramírez et al. 2010; Wong et al. 2010;

Fritz et al. 2014). A subsequent taxonomic revision using morphological traits and mtDNA sequences formally split the widespread *P. subrufa* into 10 separate species and described the Arabian Helmeted Turtle as a species new to science, *Pelomedusa barbata* (Petzold et al. 2014), with its type locality at Zinjibar, Abyan, Yemen.

*Pelomedusa barbata* corresponds to *Pelomedusa* mtDNA lineage VII, and based on mitochondrial and nuclear DNA differences, belongs to the northern *Pelomedusa* species group and is most closely related to *P. somalica* (Vargas-Ramírez et al. 2010; Petzold et al. 2014).

The species epithet *barbata* (Latin: bearded) refers to the large barbels beneath the chin, which are present in both males and females (Petzold et al. 2014).





**Figure 1.** Adult *Pelomedusa barbata*, Taif, Makkah Province, Saudi Arabia. Photo by Johannes Els.

**Description.** — *Pelomedusa barbata* is a medium-sized species, with a known maximum straight-line carapace length (SCL) of 216 mm (Gasperetti et al. 1993). Sexual dimorphism was noted by Gasperetti et al. (1993) in that males are larger than females, with a slightly narrower shell compared to females. The largest male (BMNH 1985.1478) from Yemen measured by Gasperetti et al. (1993) had 216 mm SCL and 152.5 mm straight carapace width (SCW); a female from Jizan, Saudi Arabia, measured 201 mm SCL and 144.9 mm SCW (Gasperetti et al. 1993). Obady (1996) mentioned an even larger specimen of 250 mm SCL from Abyan Governorate in Yemen, but without additional information.

Two small temporal scales (see Fig. 3) are typically located on each side of the head (rarely one large scale) and two (sometimes three) large barbels are present under the chin. The pectoral scutes are triangular and in narrow contact at the midline (Petzold et al. 2014).

Using a 360-bp-long reference alignment of the 12S rRNA gene, Petzold et al. (2014) diagnosed *P. barbata* by the following unique molecular characters: the occurrence of a gap instead of adenine (A), cytosine (C), or thymine (T) at position 122 and by the presence of guanine (G) instead of adenine (A) at position 330 of the alignment. *Pelomedusa barbata* differs in the 12S rRNA gene by sequence divergences of 3.6–10.1% and in the cytochrome *b* gene by divergences of 8.3–16.5% from other *Pelomedusa* species (Petzold et al. 2014).

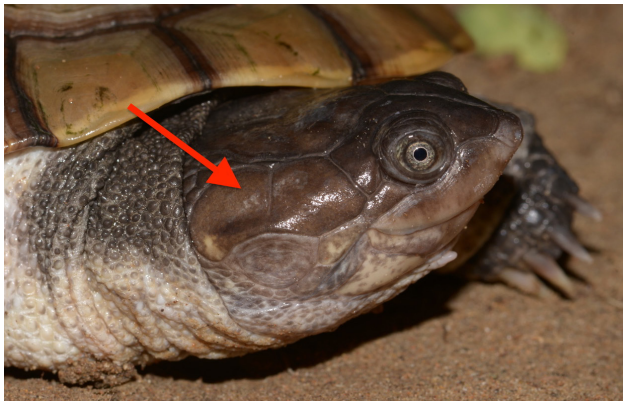
To date, species-specific descriptions of *Pelomedusa* plastron patterns and color variations to aid species identification are limited (Fritz et al. 2015). We here provide a comprehensive description for different life stages ranging from hatchlings to adults.

Hatchlings range from 26–29 mm in SCL and have a body mass of 4–6 g (mean = 5.10 g). The carapace and plastron are black, with white markings on the edges of



**Figure 2.** Adult *Pelomedusa barbata*, Taiz Governorate, Yemen. Photos by Jan Červenka and Lukáš Kratochvíl.



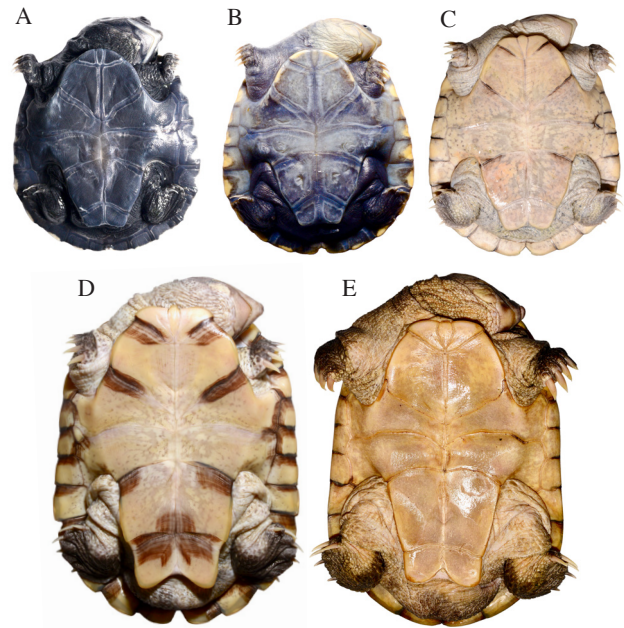


**Figure 3.** Adult *Pelomedusa barbata*, Saudi Arabia. Red arrow indicates the two temporal scales which are typically located on each side of the head. Photo by Johannes Els.

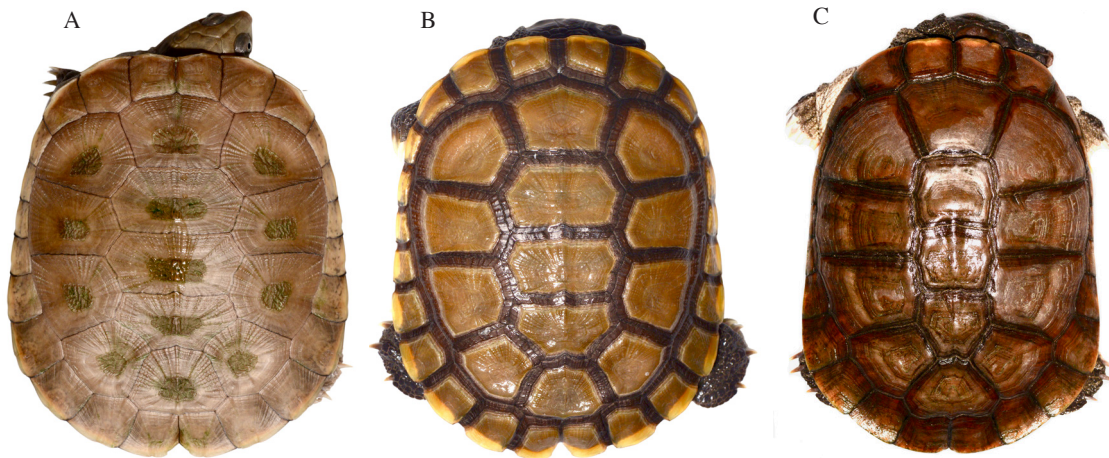
the carapacial marginal scutes, the jaws, and two distinct barbels on the chin. Skin coloration of both the anterior and posterior limbs is black. Juvenile coloration changes when a SCL of 37–46 mm is reached. The markings on the marginal scutes change from white to a yellowish color, as they do on the anterior ventral scutes. The dorsal and ventral surface of the head is then white to yellowish and the color extends beyond the temporal scales onto the neck, but does not extend further down towards the body. The carapace and plastron colors are grayish-white, and the barbels on the chin remain white.

Larger juveniles have a significant color transformation around a SCL of 69–76 mm. The carapace turns light brown with darker markings along the scute seams, with the plastron base color cream to yellowish with mottled gray to light-brown markings. Scutes on both the carapace and plastron may have black to darker brown radial markings, particularly on the anterior and posterior portion of the plastron. Skin coloration on all limbs and tail is gray to cream with gray-mottled markings. The skin on the posterior limbs bordering the claws is dark gray.

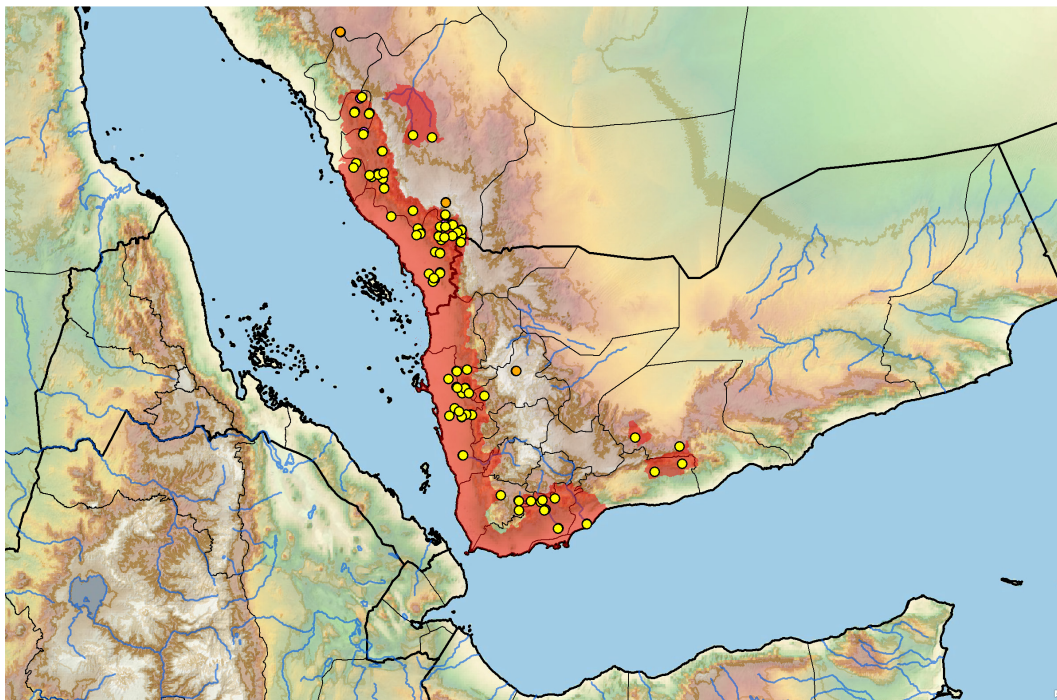
At a SCL of 100–120 mm, the carapace is light- to dark-brown and the plastron yellowish, with or without darker mottling. The carapace and plastron have dark brown linear markings along the margins of the scutes. Skin coloration is gray from head to the tail tip. Sexually mature adults at a SCL of 150–216 mm have a brown or dark-olive gray carapace with the plastron entirely yellowish. The skin color varies from a lighter shade of gray-brown to dark brown on the dorsum of the head. Males with a SCL  $\geq 70$  mm are distinguishable by a longer and thicker tail compared to females. The plastron in mature males is concave.



**Figure 4.** Plastron color and pattern variations from neonate to adult in *Pelomedusa barbata* arranged according to straightline carapace length (SCL): (A) 28.9 mm, (B) 42.4 mm, (C) 71.6 mm, (D) 110.7 mm, (E) 190.5 mm. Photos by Johannes Els.



**Figure 5.** Carapace color variations from juvenile to adult in *Pelomedusa barbata*, arranged according to straightline carapace length (SCL): (A) 71.6 mm, (B) 110.7 mm, (C) 190.5 mm. Photos by Johannes Els.



**Figure 6.** Distribution of *Pelomedusa barbata* on the Arabian Peninsula in southwestern Saudi Arabia and Yemen. Yellow dots = museum and literature occurrence records of native populations based on Iverson (1992), Gasperetti et al. (1993), Alqahtani (2017), other literature sources, and authors' data; orange dots = possible trade or inaccurately reported specimens. Distribution based on GIS-defined level 12 HUCs (hydrologic unit compartments) constructed around verified localities and then adding HUCs that connect known point localities in the same watershed or physiographic region, and similar habitats and elevations as verified HUCs (Buhlmann et al. 2009; TTWG 2021), and adjusted based on data from authors' and other sources.

**Distribution.** — *Pelomedusa barbata* is restricted to the southwestern Arabian Peninsula and is the only endemic chelonian species in the region (Vargas-Ramírez et al. 2016; Aloufi et al. 2019; TTWG 2021). The distribution range extends along southwestern Saudi Arabia and western and southwestern Yemen (Vargas-Ramírez et al. 2010; Wong et al. 2010; Alqahtani 2017) at elevations from sea level to 1800 m asl. Its distribution range is largely restricted to areas with higher rainfall with available surface water, as compared to the drier interior Arabian Peninsula.

In Saudi Arabia, *P. barbata* is known from the Asir Mountain range from its interior foothills in the east and its coastal slopes in the west, within the provinces of Al-Bahah, Asir, Jizan, and Makkah, and is most frequently encountered at elevations of 150 to 1300 m (Alqahtani 2017). Populations from the eastern (interior) and western (coastal) watersheds within Saudi Arabia are disjunct from each other.

In Yemen, it has been recorded within mountainous areas with streams and dams in the wadis of Abyan, Adh-Dali, Al-Hudaida, Lahij, Shabwa, and Taiz governorates (Arillo 1967; Obst and Wranik 1987; Gasperetti et al. 1993; Showler 1995; Obady 1996). It has also been recorded in the wadis of Al-Rabwa and Bgear in Sh'ab Ad-Diwan, at the dam of Saba in Lahij Governorate, in Koor Al-Awaliq, Shabwa Governorate (A. Al Hindi and F. Al Saaw, pers.

obs.), and in Wadi Surdood in the Tihamah region (Al-Safadi and El-Shimy 1993).

Within Abyan Governorate *P. barbata* is absent in the interior and occurs in isolated pools bordering Shabwa Governorate at higher elevations and Lahij Governorate at lower elevations. Wadis in the interior of Abyan Governorate are ephemeral and the absence of *P. barbata* and the several species of freshwater fish from the central portion of Yemen east of Aden show similar disjunct distribution patterns (Freyhof et al. 2020; F. Krupp, pers. comm.). The populations in the inland and coastal drainages of Shabwa Governorate also appear to be disjunct from each other. The species has not yet been recorded from the Hadhramaut region of far eastern Yemen, although climatic modeling has suggested that it might possibly be present there (Vargas-Ramírez et al. 2016).

The species does not apparently occur at the higher-altitude area around the Yemeni capital, Sana'a. Although two of the *P. barbata* syntypes, NHMUK (BMNH) 1985.1478–1479, were recorded by Petzold et al. (2014) as coming from "Amanat Al Asimah, Sana'a Area, Yemen," their collection history does not support this locality. The NHMUK catalogue records these two specimens as donated by M. Al-Safadi and obtained in the "Sana'a region, Yemen," but with a later communication from Al-Safadi (*in litt.*, 1988) noting that one of the specimens was collected at "Wadi Warazan (Taiz area)," and the other





**Figure 7.** Habitats of *Pelomedusa barbata* in southwestern Saudi Arabia and Yemen. (A) Lahij Governorate, Yemen. Photo by Fatehi Al Saaw. (B) Taiz Governorate, Yemen. Photo by Lukáš Kratochvíl and Jan Červenka. (C) Wadi in southern Tihamah region, Saudi Arabia. Photo by Abdulaziz Alqahtani. (D) Wadi Jizan, Saudi Arabia. Photo by Abdulaziz Alqahtani. (E) Wadi Amood dam, Saudi Arabia. Photo by Abdulaziz Alqahtani. (F) Wadi Al-Jinah dam, Saudi Arabia. Photo by Abdulaziz Alqahtani.

at “Wadi Surdood (Tihamah region).” Gasperetti et al. (1993) recorded the locality for these two specimens as “Sana’a (in error),” and Al-Safadi and El-Shimy (1993) provided specific geographic coordinates for the corrected localities, and they are located in lower-altitude areas far from Sana’a.

**Habitat and Ecology.** — The habitat of *P. barbata* is characterized as semi-arid, with more rainfall than the drier interior of the Arabian Peninsula. The species occupies areas with available surface water that typically accumulates in basalt- and granite-rock formations as well as in hot coastal areas with high temperatures and elevated relative humidity (Alqahtani 2017). The species is found in natural and anthropogenic habitats such as streams, wadi pools, ponds and dams, especially well-vegetated slow flowing streams.

*Pelomedusa barbata* is mainly a diurnal species, often preferring deep freshwater bodies and is frequently

observed basking during early morning hours (Obady 1996; Alqahtani 2017). It estivates during the dry season (May–August) in mud or surrounding soils if surface water is absent until the next seasonal rain. Males are territorial and will defend territories aggressively against intruding males by biting the neck or other body parts. Reproductive behavior occurs only underwater and appears to be frequent during late summer (August–November). Mating behavior is similar to that observed in other *Pelomedusa* species (Spawls et al. 2004; Largen and Spawls 2010). Copulation observed in captive *P. barbata* in the United Arab Emirates occurred in the water with the male grasping the female carapace with his feet and shaking his head laterally above the female’s head. Females in captivity have been observed to lay clutches of 6–11 (mean = 8) leathery-shelled eggs during late summer (September–November) approximately 200 mm deep in sandy soils. The production of multiple annual clutches is unknown





**Figure 8.** *Pelomedusa barbata* neonate hatching from leathery-shelled egg. Photo by Johannes Els.

and has not been observed in captive specimens. Eggs are 29–31 mm long (mean = 30.36 mm), 19–21 mm wide (mean = 20.48 mm), and have a mass of 6–8 g (mean = 7.17 g). The shell thickness of two eggs from one clutch was measured as 0.18 mm and 0.22 mm. Incubation in the wild may vary from 50–70 days, with hatchlings emerging during the first seasonal rains. Further observations of wild populations are required to establish if this reproductive cycle is of regular occurrence.

*Pelomedusa barbata* is an opportunistic carnivore, feeding mostly on invertebrates as hatchlings and small juveniles, progressing as larger juveniles and adults to larger prey such as frogs, fish, small reptiles, birds and other small terrestrial vertebrates at or near the water edge (Gasperetti et al. 1993; Shobrak, pers. obs.). Carrion is also scavenged and consumed, but no observations of the species have revealed it to feed on plant material in the wild or captivity, although herbivory has been documented for other *Pelomedusa* species (Spawls et al. 2004; Bour 2008; Branch 2008).

The freshwater leech, *Placobdelloides multistriatus*, has been recorded as an epibiont on *P. barbata* in several waterbodies in Yemen (Al-Safadi and El-Shimy 1993).

**Population Status.** — The population size of *P. barbata* appears to have decreased dramatically during the last decade based on observations from known localities, although there are few quantified data or systematic status surveys. The number of observed specimens in Saudi Arabia varied during an investigation in 2016 depending on the size and depth of the water body during different seasons (Alqahtani 2017). At Rwam (ca. 0.39 ha) and Amood (ca. 0.21 ha) dams, which contain a larger volume of water throughout the year, 11–12 adult specimens were observed in each. Areas with less water harbored far fewer specimens. These results may be attributed to the combination of the elusive nature of *Pelomedusa* species in arid regions (Vamberger et al. 2019) and limited survey efforts, although it is also noted that the availability of surface water within the

species' distribution range is limited and often restricted to only a few smaller localities. This may imply that the population size is limited by competition for resources within an otherwise harsh environment, which is subjected to extreme climatic conditions. From observations of captive specimens, reproduction may be delayed for long periods until environmental parameters are more suitable to increase the potential survival rate of hatchlings.

**Threats to Survival.** — Habitat degradation, water extraction, and climate change are the main threats to the species within Saudi Arabia (Alqahtani 2017; Aloufi et al. 2019). Annual rainfall in the region has significantly decreased (47.8 mm per decade), with a relatively high inter-annual variability, while temperatures (maximum, mean, and minimum) have increased significantly at rates of 0.71, 0.60, and 0.48°C per decade, respectively, since 1979–2009 (Almazroui et al. 2012). Although the species is adapted to drought periods, the negative impact of extended droughts becomes especially severe when populations have already been compromised by other environmental threats such as water extraction.

Fisher (1997) noted that a dieback of *Juniperus procera* (African pencil-cedar tree) forests in the Raydah Reserve of southwestern Saudi Arabia was attributed to climate change and the scarcity of rainfall. Climate change combined with water extraction due to intensive farming has led to a dramatic decrease in natural vegetation cover and the drying of natural water bodies (Aloufi et al. 2019). The first nationally determined contribution report in 2021 to UNFCCC (United Nations Climate Change 2021) noted that Saudi Arabia is particularly vulnerable to climate change as an arid country with limited surface water resources that are overutilized for domestic, agricultural, and industrial purposes, causing desertification and serious consequences for freshwater ecosystems. Alqahtani (2017) noted that *P. barbata* populations in southwestern Saudi Arabia are drastically declining in recent years due to these factors, and that anthropogenic habitats such as dams may provide a refuge for some populations. Also in parts of Yemen water extraction is a major threat. However, for this country, there are no current assessments dealing with water and biodiversity.

The species occurs in trade (Alqahtani 2017), but there are insufficient data to conclude the quantity of animals being collected for the trade. It appears to be mainly collected for the local pet trade and no reports of consumption as a food source are known. The species has been collected for the local pet trade in Yemen, but this is rare in recent years (Busais, pers. comm.). Additionally, the species may be threatened by hybridization in the future, if not already, through intentional or accidental release of imported *Pelomedusa* species from Africa for the pet

trade. Boland and Burwell (2021) listed *P. barbata* as one of 97 terrestrial vertebrate species of high conservation priority within Saudi Arabia. Apart from water extraction and habitat loss, impoundment, introduced species, and stream pollution were also identified as threats to the species in Saudi Arabia (Boland and Burwell 2021).

**Conservation Measures Taken.** — The conservation status of *P. barbata* has not yet been formally evaluated for the IUCN Red List, although the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group in 2016 provisionally assessed its conservation status as Endangered (Rhodin et al. 2018, TWTG 2021). A formal IUCN Red List assessment of the global conservation status for the species is a priority.

*Pelomedusa barbata* is not listed on CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora). The species has recently become protected under the broader national wildlife laws of Saudi Arabia, which prohibit collecting or hunting of wild animals. There are no laws or regulations within Yemen providing protection for the species. In Saudi Arabia and Yemen, the species has not been confirmed in any of the several protected areas within its distribution range. The possible occurrence of *P. barbata* within Asir National Park, Saudi Arabia, requires confirmation.

The last survey to confirm the species at several localities within Saudi Arabia was conducted in 2016 (Alqahtani 2017). Yemen is in need of detailed surveys to reveal the extent of occurrence within the country. There are no known captive breeding programs in the countries of origin, but a breeding group exists at the Breeding Centre for Endangered Arabian Wildlife in Sharjah, United Arab Emirates.

**Conservation Measures Proposed.** — Surveys are required to establish the presence or absence of the species in protected areas. The inclusion of known populations of *P. barbata* within protected areas or the expansion of existing areas to include the species' occurrence is strongly recommended as a general measure for the conservation of freshwater turtles (van Dijk 2000). As an endemic to the Arabian Peninsula, *P. barbata* should be considered during the planning of all Key Biodiversity Areas within Saudi Arabia and Yemen. In Saudi Arabia, the Asir Mountains are of high conservation priority (Boland and Burwell 2021), as they include nearly 50% of the species' known distribution range.

We regard it important to promote short- to long-term biological studies, including annual surveys to confirm whether *P. barbata* still occurs at known localities, along with the assessment of population parameters

**Table 1.** Biochemistry values for *Pelomedusa barbata*. AST = aspartate aminotransferase, LDH = lactate dehydrogenase.

Parameters	Adult (n = 2)		Juvenile (n = 7)	
	Mean ± SD	Range	Mean ± SD	Range
Total Protein (g/L)	45.55 ± 2.76	43.60–47.50	30.59 ± 10.16	23.50–47.90
Albumin (g/L)	26.34 ± 0.54	25.95–26.72	17.91 ± 4.50	14.81–26.79
Globulin (g/L)	19.22 ± 3.30	16.88–21.55	12.68 ± 5.88	5.09–21.11
Uric Acid (umol/L)	143.77 ± 46.27	111.05–176.49	161.46 ± 38.00	103.63–199.95
Cholesterol (mmol/L)	3.12 ± 0.28	2.92–3.32	4.03 ± 1.33	2.31–5.70
Creatine Kinase (U/L)	858.10 ± 854.47	253.9–1462.3	980.84 ± 434.87	520.1–1607.5
AST (U/L)	75.85 ± 20.58	61.30–90.40	72.06 ± 31.60	41.80–137.3
LDH (U/L)	278.30 ± 81.88	220.4–336.2	433.41 ± 206.24	217.8–721.2
Calcium (mmol/L)	2.36 ± 0.12	2.27–2.44	1.99 ± 0.15	1.73–2.18
Phosphorus (mmol/L)	1.20 ± 0.41	0.91–1.49	1.14 ± 0.30	0.80–1.66

**Table 2.** Hematology values for *Pelomedusa barbata*.

Parameters	Adult (n = 2)		Juvenile (n = 7)	
	Mean ± SD	Range	Mean ± SD	Range
Hemoglobin (g/L)	75.00 ± 12.73	66.00–84.00	51.00 ± 20.77	15.00–72.00
Packed Cell Volume (%)	0.26 ± 0.04	0.23–0.28	0.17 ± 0.07	0.04–0.23
Red Blood Cells (x 10 <sup>12</sup> /L)	0.44 ± 0.02	0.42–0.45	0.30 ± 0.14	0.09–0.51
White Blood Cells (x 10 <sup>9</sup> /L)	9.38 ± 0.11	9.30–9.45	15.01 ± 9.82	5.80–33.60
Heterophils (%)	18.50 ± 6.36	14.00–23.00	62.86 ± 20.24	23.00–88.00
Heterophils (x 10 <sup>9</sup> /L)	1.73 ± 0.58	1.32–2.14	9.95 ± 7.28	1.93–19.82
Lymphocytes (%)	71.50 ± 0.71	71.00–72.00	33.00 ± 21.14	9.00–75.00
Lymphocytes (x 10 <sup>9</sup> /L)	6.70 ± 0.14	6.60–6.80	4.36 ± 3.58	1.97–11.76
Monocytes/Azuropils (%)	3.00 ± 2.83	1.00–5.00	1.86 ± 2.85	0.00–8.00
Monocytes/Azuropils (x 10 <sup>9</sup> /L)	0.28 ± 0.27	0.09–0.47	0.26 ± 0.34	0.00–0.91
Eosinophils (%)	2.00 ± 1.41	1.00–3.00	0.86 ± 1.21	0.00–3.00
Eosinophils (x 10 <sup>9</sup> /L)	0.19 ± 0.13	0.09–0.28	0.20 ± 0.37	0.00–1.01
Basophils (%)	5.00 ± 4.24	2.00–8.00	1.43 ± 0.53	1.00–2.00
Basophils (x 10 <sup>9</sup> /L)	0.48 ± 0.40	0.19–0.76	0.24 ± 0.21	0.06–0.67



and monitoring of possible threats at these locations. Using treated wastewater for agricultural and urban landscapes would aid to reduce the overexploitation of natural freshwater resources. The possibility to use treated wastewater to supplement ponds and pools of significant populations during extended periods of drought could be beneficial in particular for the survival of juvenile turtles. Although existing dams may provide a refuge for some populations of *P. barbata*, building additional dams is not recommended due to the potential negative impact on natural freshwater systems by disrupting run-off beyond the dams, leaving no surface water for many other freshwater organisms and thus compromising the survival of other species adapted to live in small pools or puddles.

The long-term effects of climate change on the species' reproduction needs to be monitored to determine its possible impact. Radio telemetry studies will help to understand the movement of individuals during different seasons and the effects of water level fluctuations. Core body temperature loggers can provide information on heat tolerance, in both the absence and presence of water. Determining reproductive frequencies, clutch sizes, and generation time, and how these are influenced under different climatic conditions will aid in providing baseline information to improve conservation planning. Combined with *in situ* projects, a regional breeding program will benefit the species to ensure genetic diversity for future reintroduction or for supplemental release programs. The development of a regional action plan for the species is needed, along with increasing captive assurance populations with the aim for future reintroductions.

**Captive Husbandry.** — The husbandry requirements for *P. barbata* are similar to other *Pelomedusa* species. Adult pairs are best kept in a pond of at least two square meters with a minimum depth of one meter sloping gradually up to a land area, which should be at least one square meter. Within their natural range, outdoor breeding facilities of this size are sufficient to allow thermoregulation. Adults will require a two- to three-month cooling period in line with natural temperature declines throughout their range.

At the Breeding Centre for Endangered Arabian Wildlife in Sharjah, eggs are collected after nesting and incubated at 29–30°C, with humidity ranging between 70–80%. Incubation at these temperatures takes 56–63 days until hatching. Hatchlings are preferably reared in groups indoors for the first year in fiberglass tanks of one square meter with a water depth of 150 mm. Water temperature is maintained with a heater between 25–27°C, which is connected to the external water filtration of the holding tank. Both UV-B and halogen heating lights are provided for basking, under which the temperature ranges

between 40–45°C. Basking areas above water level are provided with a PVC frame structure covered with PVC mesh, which angles 40° below the water surface.

Water lettuce (*Pistia stratiotes*) is provided for cover and the long roots of the plant provide shelter within the water. Hatchlings are fed a diet consisting mainly of invertebrates (crickets, locusts, cockroaches, mealworms, earthworms), which are gut-loaded prior to feeding with Metazoa cricket gut-loader. As small juveniles progress in size, small whole fish and rodents are offered occasionally with a longer interval between feeds. Adults are fed a combination of the above diet. Different plant-based foods were routinely offered, but were not consumed. Diet and feeding intervals need to be monitored to prevent obesity. The terrapins are assessed routinely to monitor their body conditions using Rawski and Józefiak (2014) as a reference for body condition scoring.

Records from the Breeding Centre for Endangered Arabian Wildlife suggest that captive specimens may reach sexual maturity at 10 yrs of age. The longevity of captive *P. barbata* as of November 2021 is 31 yrs and still reproductively active.

In an attempt to provide some baseline information to assist future research projects, both *in situ* and *ex situ*, we established reference ranges for the species' biochemistry and hematology (see Tables 1 and 2). Reference ranges are important to help assess causes of disease and develop appropriate management for wild and captive individuals (Oliveira-Júnior et al. 2009). Only healthy animals with no signs of illness or lesions on the plastron or carapace were included. Individuals with a SCL of 170 to 190 mm with a mean weight of 820 g were categorized as adults, and those with a SCL ranging from 90 to 120 mm with a mean weight of 196 g, as juveniles.

**Current Research.** — There is an ongoing study by researchers at King Saud University investigating gene flow among populations in the Sarawat Mountains, Saudi Arabia, as populations from the eastern and western drainages are isolated from each other.

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