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Review

Soft-shelled turtles of the family Trionychidae in South Asia: A review of studies on their biogeography, diversity, and conservation

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Abstract

There are 30 species of soft-shelled turtles belonging to the family Trionychidae worldwide. Nine species and five genera of this family are native to South Asia. All soft-shelled freshwater turtle species of this family in South Asian countries are listed in the IUCN Red List. The authors review the existing literature, discuss the findings, and suggest integrating ecological and bio-molecular concepts to understand soft-shelled turtles in South Asia. These turtles play a vital role in the health of aquatic ecosystems because they are both scavengers and omnivores, providing a mechanism for dispersing plants, purifying water by removing carrion, and contributing to the overall health of these ecosystems. These turtles are a source of food and ingredients in Chinese medicine and Oriental pharmacopeia. Their populations are declining due to the large-scale usage of these turtles for various purposes and habitat degradation.

Keywords: Biogeography; Conservation; Diversity; Soft-shelled turtles; South Asia

1 | Introduction

Turtles have a nearly global distribution outside the polar regions (Ahmed et al. 2024). Representatives of this group occur in most habitats, from deserts to rainforests to coral reefs (Ihlow et al. 2012). This group performs essential ecosystem services (Falcón & Hansen, 2018; Ahmed et al. 2024). These have shells around their body, and their anatomical structures differentiate them from other groups of reptiles (Zug 2022). A total of 357 species and 14 recognized families of turtles, which also include sea turtles, are recorded in various habitats worldwide (Tikedar & Sharma 1985; Safi & Khan 2014; Rhodin et al. 2021). However, the specific expression used for a particular turtle may vary depending on the environment where it is found. For example, "turtle" refers to testudines living in or near water (Salleh et al. 2022), tortoise is commonly used to refer to chelonians that spend their time on land, have no web between the digits, and depend on bushes, grass, and fruit as food (Buhlmann et al. 2008; Branch 2012), while turtles or freshwater turtles live in freshwater or estuaries (Jualaong et al. 2019). The family Trionychidae includes soft-shelled turtles of the Cryptodira with 15 genera and around 30 species that live exclusively in freshwater, some in brackish water in North America, Africa, and South and East Asia (Safi et al. 2024a). The carapace is bony-shelled and reduced except for a central part in the carapace and dermal bones on the belly that are not fused to skeleton, instead of the horny scutes, it is covered by a thick skin that extends over the body, especially in the rear part (Smith 1931; Pritchard 1993; Karl 1997). South Asia is home to 33 freshwater turtle and tortoise species (Safi et al. 2024a & b). Trionychidae is exclusive to the Old World, with 30 species worldwide, including 9 species and 5 genera in South Asia. These species inhabit the three major riverine systems of the Indian subcontinent (Indus, Ganges, and Brahmaputra) and some southern Indian small riverine systems (Safi et al. 2014a). All these systems contain numerous canals, channels, lakes, agricultural reserves, and small ponds. All tributaries of these rivers provide rich habitats for turtles. The main threats to these species are illegal hunting and habitat destruction (Khan et al. 2016a & b). Soft-shell turtles are a source of traditional Chinese medicine, and their shells are considered highly effective for purifying blood and curing many diseases (Khan et al. 2016b). Most of the turtles of South Asia are threatened; many are already endangered or critically endangered (Safi and Khan 2014; Khan et al. 2016a & b). Turtles face threats from human activities and also from natural climate change. Many factors contribute to their conservation today. Sand mining, river dams, degradation of wetlands, and intensive fishing are all parts of the long-term human impact on turtles and their environment (Khan et al. 2015; Safi et al. 2024b). In addition to the demand for meat, there is also a market for eggs. Although the trade in turtles' meat and eggs is illegal in these countries, unfortunately, the practice and trade still exist. For centuries, chelonians, including softshell turtles, have been exploited for their meat, shells, and eggs (Pritchard, 1979; IUCN/TFTSG and ATTWG-IUCN/SSC, 2000; Purkayastha et al. 2015; Rhodin et al. 2021).

The Indus, Ganges, and Brahmaputra basins cover the northern, western, and northeastern parts of South Asia; this region is home to many species that help maintain the ecological balance and

Table 1. Country-wise checklist of freshwater soft-shelled turtles of South Asia (Safi et al. 2024a).

Country	Soft-shelled turtle species of the family Trionychidae	Total Species
Afghanistan	*Nilssonia gangetica, Lissemys punctata*	2
Pakistan	*Chitra indica, Nilssonia gangetica, Nilssonia hurum, Lissemys punctata*	4
India	*Chitra indica,* *Nilssonia gangetica, Nilssonia hurum, Nilssonia nigricans,* *Lissemys leithii, Lissemys punctata, Pelochelys cantorii, Amyda cartilaginea*	8
Nepal	*Chitra indica, Nilssonia gangetia, Nilssonia hurum, Nilssonia nigricans, Lissemys punctata*	5
Bhutan	-	0
Bangladesh	*Chitra indica, Nilssonia gangetica, Nilssonia hurum, Nilssonia nigricans, Lissemys punctata, Pelochelys cantorii, Amyda cartilaginea*	7
Sri Lanka	*Lissemys ceylonensis*	1
Maldives	-	0

benefit human progress. This “turtle hotspot” is home to 22 out of 33 species of freshwater turtles in South Asia. More than 85% of the species of soft-shell turtles in the region need protection (Safi et al. 2024a). Human-induced threats, especially bycatch and mortality due to entanglement in fishing nets, are significant problems for the turtles (Khan et al. 2016). Furthermore, the lack of reliable scientific data on turtle diversity and their habitat usage hinders the conservation measures for their long-term survival. Failure to protect turtle habitats leads to population decline and extinction of these vulnerable species (Safi et al. 2024a).

The checklist of turtles in South Asia was presented previously (Safi et al. 2024a), but the current conservation status needs to be updated. In this paper, the soft-shelled turtle species checklist, current status, distribution, reasons for population decline, and research trends on turtles are reviewed. In doing so, we make a list of common threats and describe the research that needs to be performed to ensure the long-term survival of the turtles. This article aims to assist in the systematics, biogeography, status, and conservation of the turtles of the family Trionychidae in South Asia.

Biogeography of soft-shelled turtles

Biogeography and conservation are closely linked through the relationships between habitats, primary productivity, world history, and species richness. The genetic linkage is very strong in South Asian turtles with rich taxa covering an area of approximately 5.2 million square kilometers, located at the intersection of three biogeographic realms: The Palearctic, the Ethiopian, and the Oriental (Rao 2016). The region also has some of the mildest climates, including the highest mountain ranges such as the Karakoram, the Hindu Kush, and the Himalayas, as well as some of the world's wettest regions such as the Mawsynram, located in the Meghalaya's East Khasi Hills district of India, which is the wettest place in the world, this region receives a lot of rain, with an average annual rainfall of up to 11,871 mm (*www.britannica.com/place-/South-Asia)*. South Asia includes eight countries: Afghanistan, Pakistan, India, the Maldives, Sri Lanka, Bhutan, Nepal, and Bangladesh (Figure 1). Its major features include the Hindu Kush, Karakoram, and Himalaya Mountains; the Indus, Ganges, and Brahmaputra Rivers; and the Thar desert (Safi et al. 2024a). Three major aquatic systems, including the major "Hotspots" of biodiversity, are sustainable for freshwater biota (Ramakrishna et al. 2014). Some of the main geographical and physical characteristics of this region are shown in Figure 1 (Das 1996).

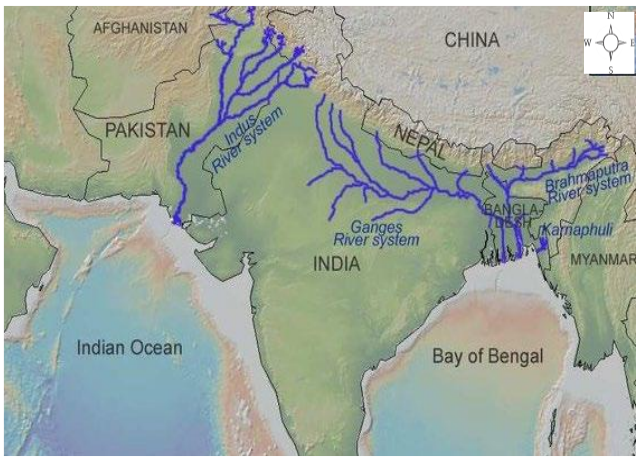

Figure 1. South Asia's geography and major river systems (Courtesy: Braulik, 2012).

Diversity of soft-shelled turtles

Soft-shelled Turtles (Trionychidae): There are currently 30 extant species of soft-shelled turtles belong to the family Trionychidae globally, of which 9 species of 5 genera are found in South Asia of this sole family of soft shelled freshwater turtles (Afghanistan [2 species], Bangladesh [6 species], India [8], Nepal [5], Pakistan [4], Sri Lanka [1]) while Bhutan and Maldives have no soft-shelled turtles (Rao, 1987; Vyas and Patel 1990; Iverson, 1992; Samah et al. 2015; Safi et al. 2024b) (Table 1).

Softshell turtles lack hard, keratinized scutes and instead possess a leathery and pliable carapace. Therefore, they are flatter and less domed, making it easier for them to burrow into mud or silty substrates and remain submerged. Their long necks and noses allow them to stay out of water and breathe.

3.1 Diversity of freshwater soft-shelled turtles in South Asia

i. India: India has eight out of the nine soft-shelled turtle species in the region (Rao 1987, 2001, 2010; Choudhury et al. 2000; Das 1991, 2008a & b; Das and Sangupta 2010; Ramakrishna et al. 2014; Purkayastha et al. 2015; Badola et al. 2019; Yadav et al. 2021; Safi et al. 2024a & b).

ii. Bangladesh: Bangladesh is smaller in area than Pakistan and Afghanistan, but it is the second most turtle species-rich country with seven species of soft-shelled freshwater turtles. The reason is that Bangladesh is a riverine country. A total of 58 international rivers flow through Bangladesh, 55 from India and 3 from Myanmar (Das 1990; Rashid & Khan 2000; Rashid & Rehman 2014; Safi et al. 2024a).

iii. Nepal: This is the third soft-shelled turtle-rich country in this region and has five turtle species (Praschag et al. 2022). It is a hilly country located in the center of the Himalayan range, placing the country in the transitional zone between the eastern and western Himalayas. Nepal’s rich biodiversity is a

reflection of this unique geographic position as well as its altitudinal and climatic variations (Aryal et al. 2010; Pun et al. 2023).

iv. Pakistan: Pakistan is the second largest country in South Asia, having 4 species of soft-shelled freshwater turtles found in the Indus River system (Safi & Khan 2014; Khan 2015; Khan et al. 2015, 2016a & b; Safi et al.2015, 2021, 2022, 2024a & b).

v. Bhutan: Bhutan has no species of soft-shelled turtle (Wangyal et al. 2012, 2020; Phuntsho et al. 2022; Safi et al. 2024b).

vi. Afghanistan: Only two species of soft-shell turtles (*Nilssonia gangetica* and *Lissemys punctata)* are found in the wetlands in the country's east, especially in the River Kabul (Safi et al. 2024a & b).

vii. Sri Lanka: Sri Lanka has no land connection with any other country. It has one species of soft-shelled turtle, *Lissemys cylonensis*, which is an endemic species to Sri Lanka (Dilrukshi et al. 2019; Safi et al. 2024b).

viii. Maldives: This small archipelagic country does not have soft-shelled turtles (Safi et al. 2024a).

4. Biogeography, and conservation status of soft-shelled turtles of family Trionychidae in South Asia

4.1 *Lissemys punctata* (Bonnaterre, 1789) (Fig. 2)

Common Name(s): Indian flap-shell turtle, Indus flap-shelled turtle, spotted flap-shell turtle, and Indus-mud turtle.

Synonym(s): *Emyda granosa,* Schoepff 1801; *Testudo granulosa,* Suckow 1798; *Testudo punctata,* Lacépède 1788; *Testudo punctata,* Bonnaterre 1789; *Testudo sonnerati,* Meyer 1790; *Testudo granulata,* Daudin 1801; *Trionyx coromandelicus,* Geoffroy Saint-Hilaire 1809; *Emyda dura,* Anderson 1876 (Bhupathy et al. 2014).

Distribution: The Indian Flap-shelled turtle is found in India, Bangladesh, Myanmar, Nepal, Afghanistan, and Pakistan. (Fig. 3).

Sub-species: Currently, three sub-species are recognized:

i. *Lissemys punctata punctata* Bonnaterre, 1789 (Southern Indian Flap-shell turtle, distributed in the Southern Indian Peninsula (Kerala, Tamil Nadu).

ii. *Lissemys punctata andersoni* Webb, 1980 (Distributed in Bangladesh, Northern India, Myanmar, Nepal, Afghanistan, and Pakistan).

iii. *Lissemys punctata vittata* Peters, 1854 (Synonymy: *Emyda vittata* Peters 1854) (Distributed in Central India) (TFTSG 2007; Bhupathy et al. 2014).

Figure 2. *Lissemys punctata* (Photo by Amtyaz Safi).

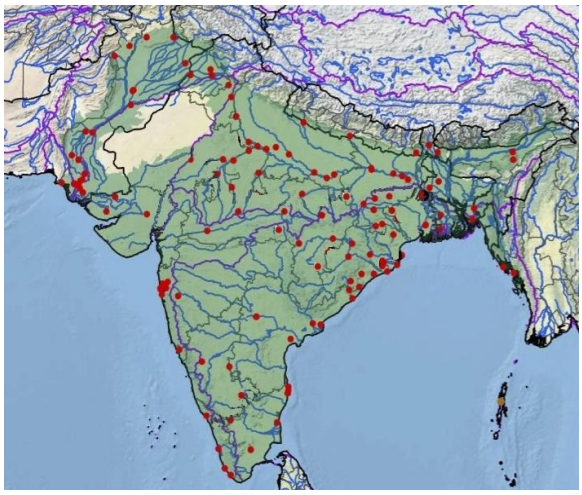

Figure 3. Distribution of *Lissemys punctata* in South Asia (Courtesy: IUCN-TFTSG 2007; Bhupathy et al. 2014).

Threats: Trading for meat, pets, traditional medicine, wetland loss, habitat destruction due to human activities like development and agriculture, pollution, climate change, and accidental capture in fishing nets (Rahman et al. 2021).

Conservation status: This species is listed in Appendix II of CITES and categorized as Vulnerable (VU) in the IUCN Red List of Threatened Species (Rahman et al. 2021).

4.2 Lissemys ceylonensis (Gray, 1856) (Fig. 4)

Common names: Commonly known as the Sri Lankan flap-shell turtle.

Synonym: *Emyda ceylonensis*, Gray 1856; *Emyda granosa*, Boulenger 1889; *Emyda granosa ceylonensis*, Annandale 1912; *Lissemys punctata granosa*, Smith, 1931; *Lissemys ceylonensis*, Praschag *et al.* 2011; *Lissemys ceylonensis*, Karunarathna & Amarasinghe 2011; *Lissemys ceylonensis*, TTWG 2014; *Lissemys ceylonensis*, TTWG 2021.

Distribution: This is endemic to Sri Lanka (Fig. 5).

Subspecies: No subspecies is recognized.

Threats: The primary threats to *Lissemys ceylonensis* (Sri Lankan flapshell turtle) include habitat loss and degradation, water pollution, and overexploitation for meat and egg consumption, pets, and medicinal purposes.

Conservation status: This species is listed in Appendix II of CITES, while the status is vulnerable (VU) in the IUCN Red List of Threatened Species.

Figure 4. *Lissemys ceylonensis* (Photo by Herbert Becker, Inaturalist).

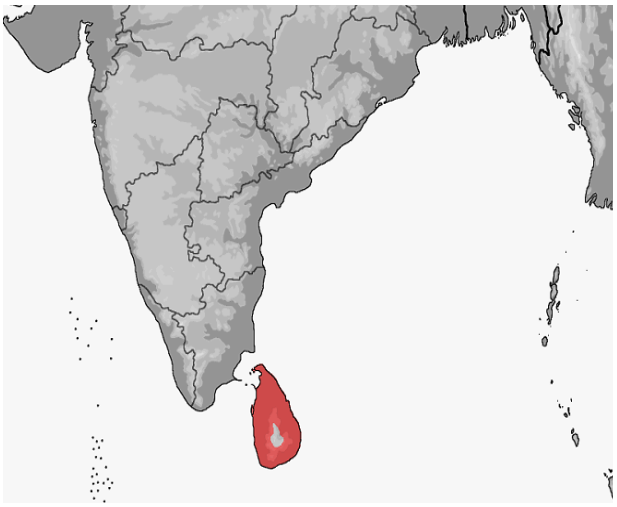

Figure 5. Distribution of *Lissemys ceylonensis* in South Asia, endemic in Sri Lanka (Courtesy: RepFocus).

4.3 Nilssonia gangetica (Cuvier, 1825) (Fig. 6)

Common Names(s): Indian soft-shell turtle, Ganges soft-shell turtle.

Figure 6. *Nilssonia gangetica* (Photo by Amtyaz Safi).

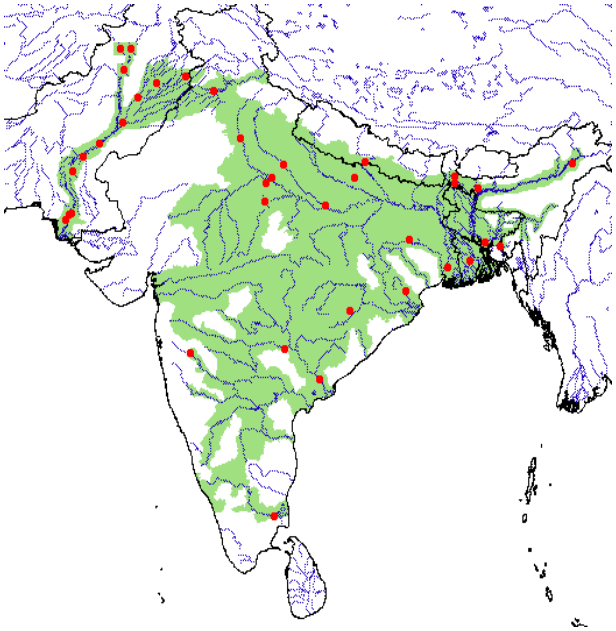

Figure 7. Distribution map of *Nilssonia gangetica*

Synonym(s): *Aspideretes gangetica* Cuvier, 1825; *Trionyx gangeticus* Cuvier, 1825; *Nilssonia gangetica* Cuvier, 1825; *Aspideretes gangeticus* Ernst, 1989; *Aspilus gataghol* Gray, 1872; *Isola gangeticus* Baur, 1893; *Nilssonia gangetica* Praschag, 2007.

Distribution: This species is found in India, Bangladesh, Nepal, Afghanistan, and Pakistan. It is found throughout the Indus, Ganges, and Brahmaputra floodplains and associated canals and marshes of South Asia (Fig. 7).

Subspecies: No subspecies are recognized.

Threats: The species is locally exploited for consumption of their meat, egg. Some other major threats are medicines, riverine development projects, aquatic pollution, sand mining, construction of hydroelectric projects, poaching, and exploitation of eggs (Das & Sengupta 2010).

Conservation status: This species is included in Appendix I of CITES, and the status is Endangered (EN) in the IUCN Red List of Threatened Species.

4.4 *Nilssonia hurum* (Gray, 1831) (Fig. 8)

Common Names(s): Indian Peacock soft-shell turtle.

Figure 8. A juvenile of *Nilssonia hurum* (Photo by Khan et al. 2016a)

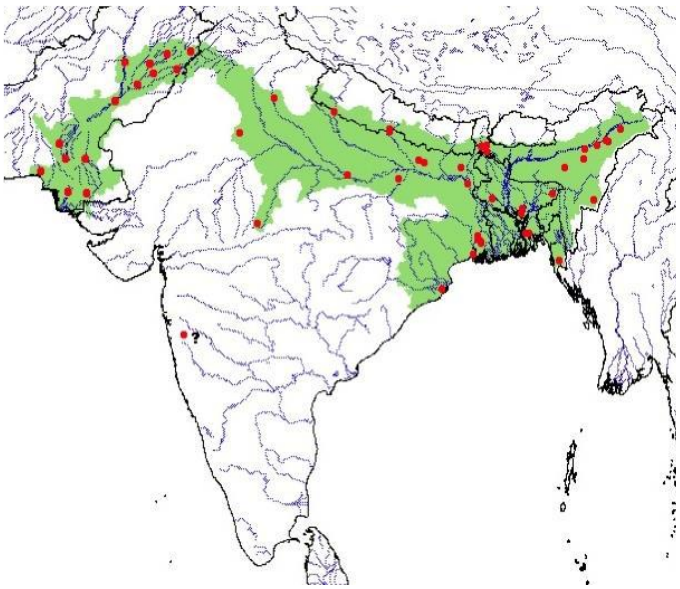

Figure 9. Distribution map of *Nilssonia hurum* in South Asia (Courtesy: IUCN-TFTS 2007; Das et al. 2010).

Synonymy(s): *Trionyx occellatus* Gray 1830a, *Trionyx ocellatus, Gymnopus ocellatus, Trionyx hurum* Gray 1830b, *Gymnopus duvaucelii* Duméril and Bibron 1835, *Trionyx sewaare* Gray 1872, *Trionyx bellii* Gray 1872, *Trionyx buchanani* Theobald 1874, *Isola hurum, Aspideretes hurum, Tyrse hurum, Amyda hurum* (IUCN-TFTS 2007; Das et al. 2010).

Distribution: Bangladesh, India, Nepal, and Pakistan (Fig. 9) (Das et al. 2010).

Subspecies: No subspecies are recognized.

Threats: The species is exploited for meat. Other major threats are riverine development projects, aquatic pollution, sand mining, construction of hydroelectric projects, poaching, and exploitation of eggs (Das & Sengupta 2010).

Conservation Status: This species is included in Appendix I of CITES, while its status is Endangered (EN) in the "IUCN Red List of Threatened Species" (Khan et al. 2016a).

4.5 *Nilssonia nigricans* (Anderson, 1875) (Fig. 10)

Common Names(s): Black soft-shell turtle and lack peacock softshell turtle.

Synonym/s: *Aspideretes nigricans* Anderson, 1875; *Trionyx nigricans* Anderson, 1875

Distribution: Nepal, Bangladesh, and India (Baruah et al. 2010; Praschag et al. 2022) (Fig. 11).

Subspecies: No subspecies are recognized.

Figure 10. A juvenile of *Nilssonia nigricans*, Anderson, 1875 (Photo by Sadanand Bhuti).

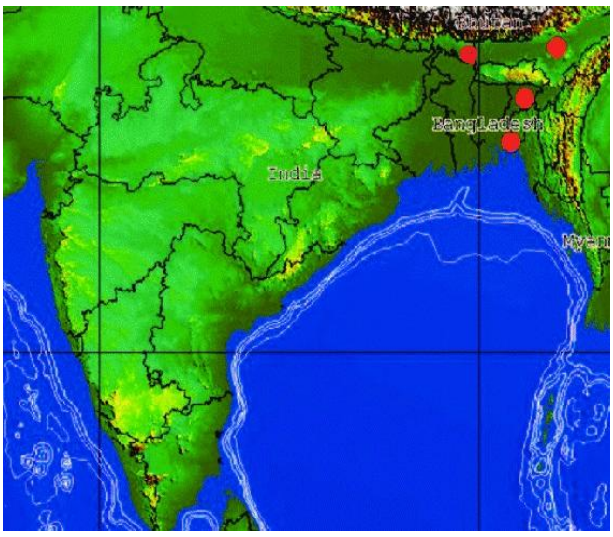

Figure 11. Distribution map of *Nilssonia nigricans* in South Asia (Courtesy: Baruah et al. 2010).

Threats: The species is locally exploited for meat, egg, and traditional medicines. Some other threats are riverine development projects, aquatic pollution, sand mining, construction of hydroelectric projects, poaching, and exploitation of eggs (Das & Sengupta 2010).

Conservation Status: This species is included in Appendix I of CITES, while its status is Critically Endangered (CR) in the "IUCN Red List of Threatened Species". Previously thought to be extinct in the wild, but was later rediscovered in the wild in 2015 (Kundu et al. 2015). This species needs immediate conservation attention (Praschag et al. 2007, 2021, 2022).

4.6 *Nilssonia leithii* (Gray, 1872) (Fig. 12)

Common Names: Leith's softshell turtle.

Synonymy: *Testudo gotaghol*, Gray 1831, *Trionyx leithii,* Gray 1872, *Isola leithii, Aspideretes leithii, Amyda leithii, Nilssonia leithii, Aspilus gataghol,* Gray 1872; *Trionyx sulcifrons,* Annandale 1915.

Distribution: Endemic to India, especially in the southern peninsular of India (Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, and Tamil Nadu) (Das et al. 2014) (Fig. 13).

Subspecies: No subspecies are recognized.

Threats: The species is locally exploited throughout peninsular India. Other major threats are riverine development projects, aquatic pollution, sand mining, construction of hydroelectric projects, poaching, and exploitation of eggs (Das et al. 2014; Dharwadkar & Sneha 2020).

Figure 12. A juvenile of *Nilssonia leithii* (Photo by Anagha Devi, 2019).

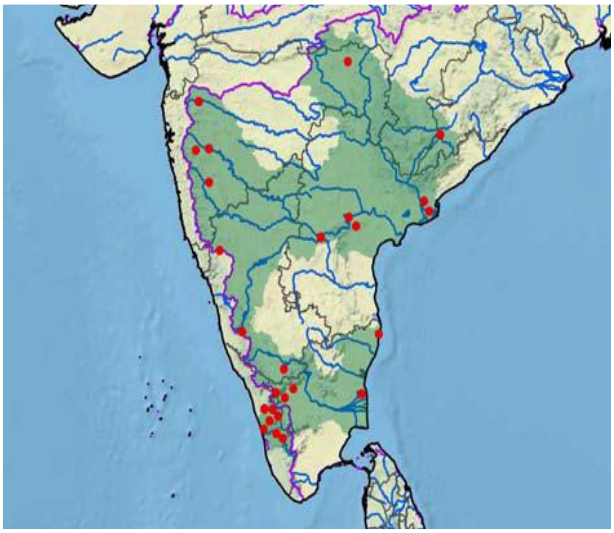

Figure 13. Distribution of *Nilssonia leithii* in India, South Asia (Courtesy: Das et al. 2014; Buhlmann et al. 2008).

Conservation Status: This species is included in Appendix I of CITES, while its status is Critically Endangered (CR) in the "IUCN Red List of Threatened Species

4.7 *Chitra indica* (Gray, 1830) (Fig. 14)

Common name: Narrow-headed soft-shell turtle.

Synonym(s): *Trionyx indicus* Gray, 1830; *Gymnopus lineatus,* Dumeril & Bibron, 1835.

Distribution: Occurs in the Indus, Ganges, and Brahmaputra flood plains to western Malaysia (Fig. 15).

Subspecies: No subspecies are recognized.

Threats: The turtles are often caught by humans, both as bycatch and for consumption, as turtle meat and eggs are considered a delicacy (Das & Singh 2009).

Conservation status: This species is included in CITES Appendix II, while the status of this species is Endangered (EN) in the "IUCN Red List of Threatened Species".

Figure 14. *Chitra indica* (Photo by Shekar Dattatri)

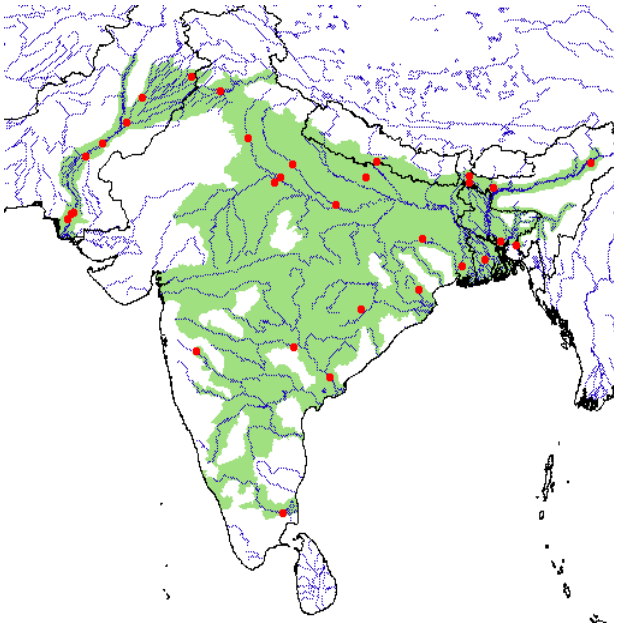

Figure 15. *Chitra indica* distribution in South Asia (Courtesy: IUCN/TFTS, 2007; Das & Singh, 2009).

4.8 *Amyda cartilaginea* (Boddaert 1770) (Fig.16)

Common name: The Asiatic soft-shell turtle and black-rayed soft-shell turtle.

Synonymy: *Testudo cartilaginea,* Boddaert 1770a; *Gymnopus cartilaginea, Trionyx cartilagineus, Aspidonectes cartilagineus, Potamochelys cartilagineus, Amyda cartilaginea, Amyda cartilaginea cartilaginea, Testudo membranacea,* Blumenbach 1779, *Testudo boddaerti,* Schneider 1787; *Trionyx boddaerti, Testudo striata,* Suckow 1798; *Amyda javanica,* Geoffroy Saint-Hilaire 1809; *Trionyx javanicus, Tyrse javanica, Aspidonectes javanicus, Trionyx stellatus javanica, Aspilus javanicus, Potamochelys javanicus, Trionyx stellatus,* Geoffroy Saint-Hilaire 1809; *Potamochelys stellatus, Trionyx cariniferus,* Gray 1856; *Aspilus cariniferus, Trionyx carinifera, Trionyx ornatu,* Gray 1861; *Aspilus ornatus, Ida ornata, Amyda ornata, Amyda ornata ornata, Aspilus punctulatus* Gray 1864; *Trionyx phayrei* Theobald 1868; *Aspidonectes phayrei, Trionyx jeudi* Gray 1869; *Trionyx ephippium* Theobald 1875; *Trionyx phayrii* Boulenger 1889; *Amyda phayrii, Trionyx trinilensis* Jaekel 1911; *Trionyx nakornsrithammarajensis* Nutaphand 1979; *Amyda nakornsrithammarajensis, Trionyx cartilageneus* nakorn Nutaphand 1990 (nomen novum), *Trionyx cartilagineus*, *Amyda cartilaginea maculosa* Fritz, Gemel, Kehlmaier, Vamberger, and Praschag 2014 (Auliya et al. 2016; Rhodin et al. 2016; Karl, Safi & Philippen 2019).

Distribution: Bangladesh and India (Auliya et al. 2016) (Fig. 17).

Subspecies: No subspecies are recognized.

Threats: The major threats are riverine development projects, aquatic pollution, sand mining, construction of hydroelectric projects, poaching, and over exploitation for meat and eggs (Auliya et al. 2016; Badola et al. 2019).

Figure 16. *Amyda cartilaginea* (Photo by David Emmett).

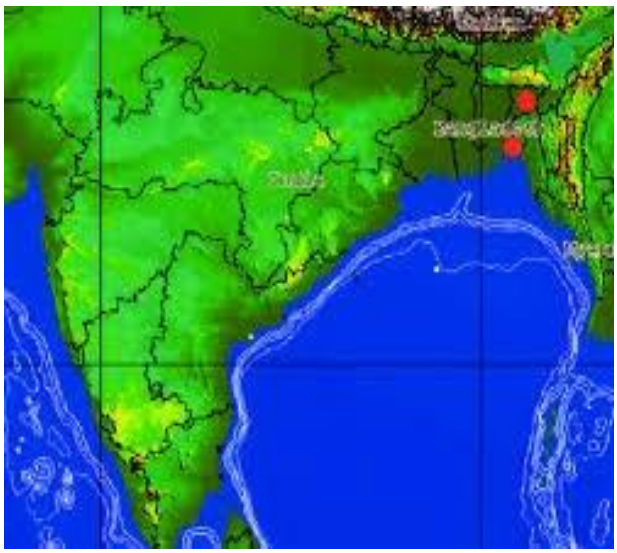

Figure 17. Distribution of *Amyda cartilaginea* in South Asia (Courtesy: Buhlmann et al. 2009; TTWG 2014; Auliya et al. 2016).

Conservation Status: This species is included in Appendix II of CITES, while its status is Vulnerable (VU) in the "IUCN Red List of Threatened Species.

4.9 *Pelochelys cantorii* (Gray, 1864) (Fig. 18)

Common name: Asian giant soft-shell turtle, Cantor's giant soft-shell turtle, and the Frog-faced soft-shell turtle.

Synonymy: *Pelochelys cantorii,* Gray 1864; *Pelochelys cantoris*, *Pelochelys cumingii,* Gray 1864; *Pelochelys poljakowii,* Strauch 1890.

Distribution: Bangladesh and India (Das 2008b) (Fig. 19).

Subspecies: None recognized.

Threats: This species is illegally hunted for local and international consumption for their meat and eggs. Climate change and anthropogenic activities are also some major causes of their threat (Das 2008).

Conservation Status: This species is included in Appendix II of CITES, while its status is Critically Endangered (CR) in the "IUCN Red List of Threatened Species.

Figure 18. *Pelochelys cantorii* (Photo by Annette Olsson).

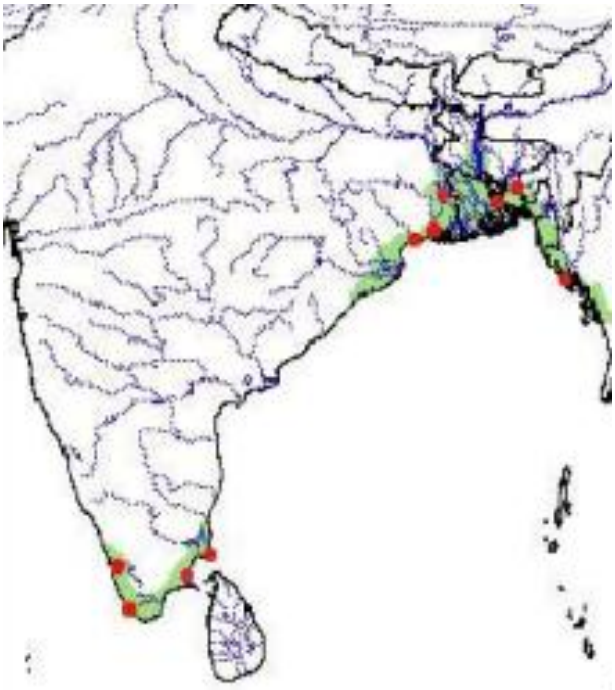

Figure 19. *Pelochelys cantorii* distribution in South Asia. Source (Courtesy: IUCN-TFTS 2007; Das 2008).

5 | Current conservation status

5.1 | The Status of the IUCN Red List

The IUCN Red List classifies species into nine groups based on information on population size, rate of decline, geographical distribution, isolation, and population hierarchy. Table 2 shows that there are 9 turtle species belonging to 5 genera of soft-shelled turtles of the family Trionychidae in South Asia, and all these nine species are threatened. Source: IUCN Red List, June 2024; Rao, 1991. Tables 2-4 and Figure 21. Three species (*Pelochelys cantorii, Nilssonia nigricans,* and *N. leithii*) are in Critically Endangered (CR) status among soft-shelled turtles; three species (*Nilssonia hurum, N. gangetica,* and *Chitra indica*) are declared as Endangered (EN) species, which means a very high risk of extinction in the wild (Rao 2016; Safi et al. 2024a). The remaining three species of soft-shelled freshwater turtles (*Lissemys punctata, Lissemys ceylonensis*, and *Amyda cartilagine*a) are declared as Vulnerable (VU).

South Asia hosts about 10% of the world's freshwater turtles and tortoises.

The CITES has included all four species of the genus *Nilssonia* in Appendix I. The remaining 5 species of soft-shelled turtles are included in Appendix II (Fig. 20; Tab. 2).

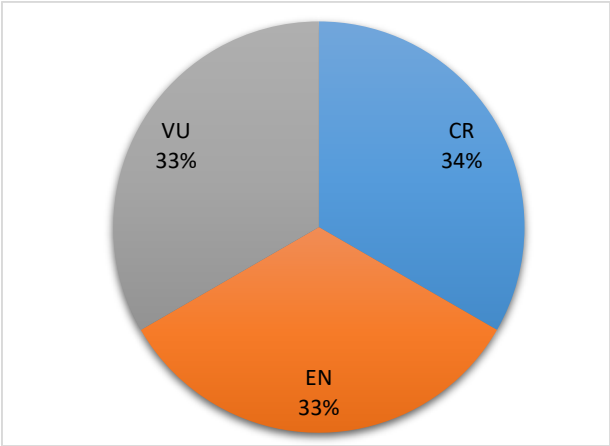

Figure 20. IUCN Red List status (April 2025) of the 9 species of soft-shelled freshwater turtles in South Asia.

5.2 Threat factors for the decline of Soft-shell turtles

South Asia is one of the most populous regions in the world. Most of the people of this region are poor, and poverty is one of the main reasons for the trade in turtles. People hunt these soft-shelled turtles for food, medicine, and decoration (Rao, 1982; Rao and Shaad, 1985; Barhadiya and Singh, 2020). The Indus, Ganges, and Brahmaputra River basins and their tributaries, such as streams, lakes, rivers, creeks, marshes, swamps, etc, provide food and breeding grounds for these turtles. The population trends for all VU, EN, and CR turtle populations are decreasing (Safi et al. 2024a).

The major cause of the decline is human activities, especially consuming eggs and meat (Rao, 1986, 1991). Calipee is the cartilaginous part of the turtle plastron and is considered the most essential source of the turtle's body, which is used in soups and other dishes in China and Thailand. Since they are neighboring countries, it is easy for traders to export all turtles or their products to these countries. Environmental and climate change, and natural disasters are also causes for the decline of these turtles. Pollution due to industrial, agricultural, or domestic waste, pesticides, fertilizers, and water pollution poses threats to turtles. Urban development,

Table 2. Checklist of Soft-shelled Turtle Species of the family Trionychidae of South Asia and their global status (Safi et al. 2024b).

S.N.	Scientific name	Common name	IUCN Red List Status	CITES Appendix I	CITES Appendix II
1	*Chitra indica*	Indian narrow-headed soft-shell turtle	EN		+
2	*Nilssonia gangetica*	Indian soft-shell turtle	EN	+	
3	*Nilssonia hurum*	Indian Peacock Soft-Shell Turtle	EN	+	
4	*Nilssonia nigricans*	Black soft-shell turtle	CR	+	
5	*Nilssonia leithi*	Leith's soft-shell turtle	CR	+	
6	*Lissemys punctata*	Indian flap-shell turtle	VU		+
7	*Lissemys ceylonensis*	Sri Lankan flap-shell turtle	VU		+
8	*Amyda cartilaginea*	Asiatic soft-shell turtle	VU		+
9	*Pelochelys cantorii*	Asian giant soft-shell turtle	CR		+

infrastructure, dams, and road construction are also causes of their population decline (Taigor and Rao, 2008; Khan et al. 2016).

Figure 21. The first author (AS) collecting information about soft-shelled turtle.

5 | Conclusions

We are facing a crisis for many turtle species, and if we do not intervene, many species will disappear in the next few decades. It is necessary to review all the current data/information and conservation decisions. Conservation status is often based on IUCN and CITES assessments, including some factors such as population size, diversity, and data availability. Many countries, including South Asians, have limited resources and funding for turtle conservation (Rao, 2016). Our research on reviewing the available information on turtles can help identify what government and NGO projects and activities need to be undertaken. The importance of this work is also to help researchers and students identify the areas that have not yet been studied and, more importantly, to help make recommendations for protecting high-risk animals and providing awareness to the public and funding (Figure 21). The laws and rules should be enforced more effectively to control poaching and other anthropogenic activities. It is also important to encourage short- and medium-term studies of ecology, molecular systematics, and medium- and long-term studies of conditions that can lead to monitoring and management. We must bring together many experts, such as taxonomists, ecologists, and molecular biologists, to produce scientific results and to raise public awareness of the sustainability and conservation of the turtles. Some of the future research outlined in this review may help scientists work together to save these turtle species and prepare for the future with new ideas and conservation strategies.

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Conflicts of interest

The authors declare no conflict of interest.

References

Ahmed, K., Tapley, B., and Michaels, C.J. 2024. Global and regional patterns in distribution and threat status of zoo collections of turtles and tortoises. The Herpetological Journal. 34:1–10. https://doi.org/10.33256/34.1.110

Aryal, P.C., Dhamala, M.K., Bhurtel, B.P., Suwal, M.K., and Rijal, B. 2010. Turtles of Nepal: A Field Guide for Species Accounts and Distribution. Environmental Graduates in Himalaya (EGH), Resources Himalaya Foundation, and Companions for Amphibians and Reptiles of Nepal (CARON). Kathmandu, Nepal.

Auliya, M., van Dijk, P.P., Moll, E.O., and Meylan, P.A. 2016. *Amyda cartilaginea* (Boddaert 1770) – Asiatic Softshell Turtle, Southeast Asian Softshell Turtle. In: Rhodin, A.G.J., Pritchard, P.C.H., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A., Iverson, J.B., and Mittermeier, R.A. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs 5(9):092.1–17. https://doi.org/10.3854/crm.5.092.cartilaginea.v1.2016

Badola, S., Choudhary, A.N. and Chhabra, D.B. 2019. Tortoises and Freshwater Turtles in illegal trade in India (2019). TRAFFIC Study (Fact sheet). Accessed from https://www.traffic.org/publications/reports/illegal-testudine-trade-in-india/ (Accessed on 07 June 2025).

Barhadiya, G. and Singh, S. 2020. Cultural use of turtle shells, an underrated threat in Turtle conservation: A case study in Assam, India. IRCF Reptiles and Amphibians, 27(2):213–215.

Baruah, C., Sharma, D.K. and Ali Reza, A.H.M. 2010. Le *Trionyx noiratre,* la Tortue de *Bostami Nilssonianigricans* (Anderson 1875). Cheloniens 18:33–38.

Braulik, G.T., Smith, B.D. and Chaudhry, A.A. 2012. *Platanista gangetica* ssp. minor. IUCN Red List of Threatened Species (Version 2014.3). http://www.iucnredlist.org

Bhupathy, S., Webb, R.G, and Praschag, P. 2014. *Lissemys punctata* (Bonnaterre 1789) – Indian Flapshell Turtle. In: Rhodin, A.G.J., Pritchard, P.C.H., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A., Iverson, J.B., and Mittermeier, R.A. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 076.1–12. https://doi.org/10.3854/crm.5.076.punctata.v1.2014

Branch B. 2012. Tortoises, Turtles & Turtles of Africa. Penguin Random House South Africa; Cape Town, South Africa: 2012.

Buhlmann K., Tuberville T., Gibbons J.W. 2008. Turtles of the Southeast. University of Georgia Press; Athens, GA, USA: 2008.

Chan E.H. 2013. A report on the first 16 years of a long-term marine turtle conservation project in Malaysia. Asian Journal of Conservation Biology, 2:129–135.
Choudhury, B. C., Bhupathy, S. and Hanfee, F. (2000). Status information on the tortoises and freshwater turtles of India. Chelonian Research Monographs, 2, 86–94.
Das, I. 1990. Color Guide to the Turtles and Tortoises of the Indian Subcontinent S. R. & A. Publishing Limited, Portishead, 133 pp.
Das, I. 1996. Biogeography of the reptiles of South Asia. Krieger Publishing Company, Malabar, Florida, 32950.
Das, I. 2008. A Photographic Guide to Snakes and Other Reptiles of India. Om Books International, New Delhi, India.
Das, I. 2008. *Pelochelys cantorii* Gray 1864 – Asian giant softshell turtle. In: Rhodin, A.G.J., Pritchard, P.C.H., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A., and Iverson, J.B. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 011.1-011.6. https://doi.org/10.3854/crm.5.011.cantorii.v1.2008
Das, I. and Singh, S. 2009. *Chitra indica.* Conservation Biology of Freshwater Turtles and Tortoises, Chelonian Research Monographs 5.
Das, I. and Sengupta, S. 2010. Morenia petersi Anderson 1879 –Indian eyed turtle. In: Rhodin,A.G.J., Pritchard, P.C.H., van Dijk,P.P., Saumure, R.A., Buhlmann, K.A., Iverson, J.B., and Mitter-meier, R.A. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 045.1–045.5. https://doi.org/10.3854/crm.5.045.petersi.v1.2010
Das, I., Sirsi, S., Vasudevan, K., and Murthy, B.H.C.K. 2014. *Nilssonia leithii* (Gray 1872) – Leith's Softshell Turtle. In: Rhodin, A.G.J., Pritchard, P.C.H., van Dijk, P.P., Saumure, R.A., Buhlmann, K.A., Iverson, J.B., and Mittermeier, R.A. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs No. 5, pp. 075.1–5. https://doi.org/10.3854/crm.5.075.leithii.v1.2014
Dharwadkar, Sneha 2020. *Nilssonia leithii* (Gray, 1872). India Biodiversity Portal. Accessed on 12 June 2025.
Dilrukshi H.N., Jayasooriya, A.P. and Prathapasinghe, G.A. 2019. Morphological Observations on the Shell of Fresh Water Turtles and Tortoises Found in Sri Lanka. Integrative Journal of Veterinary Biosciences, 3(1):1–13.
Falcón, W. and Hansen, D.M. 2018. Island rewilding with giant tortoises in an era of climate change. Philosophical Transactions of the Royal Society B: Biological Sciences, 373, 20170442.
Ihlow, F., Dambach, J., Engler, J.O., Flecks, M., Hartmann, T., Nekum, S., Rajaei, H. and Rödder, D. 2012. On the brink of extinction? How climate change may affect global chelonian species richness and distribution. Global Change Biology, 18:1520–1530.
International Union for Conservation of Nature. IUCN Red List Categories and Criteria. IUCN; Cambridge, UK: 2001. p. 30. Species Survival Commission.
IUCN TFTSG and ATTWG (IUCN/SSC Tortoise and Freshwater Turtle Specialist Group and Asian Turtle Trade Working Group). 2000. Recommended changes to 1996 IUCN Red List Status of Asian turtle species. In: P.P. van Dijk, B.L. Stuart and A.G.J. Rhodin (eds), Asian Turtle Trade: Proceedings of a Workshop on Conservation and Trade of Freshwater Turtles and Tortoises in Asia. Chelonian Research Monographs, Number 2, pp. 156–164. Chelonian Research Foundation, Lunenburg, MA, USA.
IUCN Red List Categories and Criteria Version 3.1 (2nd edition). International Union for Conservation of Nature and Natural Resources. (2012). Available online: *http://www.iucnredlist.org/documents/redlist_cats_crit_en.Pdf* (Accessed on 12 June 2025)
IUCN The IUCN Red List of Threatened Species. Version 2020-3. 2020. Available online: https://www.iucnredlist.org (Accessed on 12 June 2025).
Iverson, J.B. 1992. A Revised Checklist with Distribution Maps of the Turtles of the World. Richmond, IN: Privately printed, 363 pp
Jualaong S., Songnui A., Thongprajukaew K., Ninwat S., Khwanmaung S., Hahor W., Khunsaeng P., Kanghae H. 2019. Optimal salinity for head-starting Northern river turtles (*Batagur baska* Gray, 1831). 9:855. https://doi.org/10.3390/ani9110855
Kar, S., Pegu, K., Basistha, M. and Singh, S. 2024. Diversity, abundance, and habitat assessment for aquatic reptiles along the lower Brahmaputra in Assam. Technical Report by TSA Foundation India, submitted to Assam Forest Department. 26 pp.
Karl, H.-V. 1997. Zur Taxonomie und Morphologie einiger tertiärer Weichschildkröten unter besonderer Berücksichtigung von Trionychinae Zentraleuropas (Testudines: Trionychidae). - 202 S., 32 Abb., 3 Kart., 1 Tab., 3 Klad., 32 Taf., Univ. Diss., Univ. Salzburg.
Karl, H.-V., Safi, A. and Philippen, H.D. 2019. Evidence of Chelonophagy by early hominid (Homo erectus) during the middle of Pleistocene from beds of Trinil´s layers in Central Java (Indonesia), with an updated list of Trinil's testudines, and a redescription of *Duboisemys isoclina* (Dubois, 1908). International Journal of Zoology Sciences, 4(6):73–84.
Karl, H-V., Safi, A. and Paust, E. 2021. Re-examination and illustration of shells of interspecific hybrid tortoises of *Testudo horsfieldii* (Gray, 1844) and Testudo *h. hermanni* (Gmelin, 1789) (Testudines: Testudinidae) from the collection of Walter Kirsche in the Dahme Heideseen Nature Park, Prieros, Germany. SPC Journal of Environmental Sciences, 3(2):65-68.
Khan, M.S. 2015. Status and Distribution of Freshwater Turtles in Pakistan. Bulletin of the Chicago Herpetological Society, 50(4):51–53.
Khan, M.Z., Safi, A., Fatima, F., Ghalib, S.A., Hashmi, M.U.A., Khan, I.S., Siddiqui, S., Zehra, A., and Hussain, B. 2015. An Evaluation of Distribution, Status, and Abundance of Freshwater Turtles in Selected Areas of Sindh and Khyber Pakhtunkhwa Provinces of Pakistan. Canadian Journal of Pure and Applied Sciences, 9(1):3201–3219.
Khan M.Z., Safi A, Ghalib SA and Kanwal R. 2016a. Population status, distribution, and conservation of freshwater turtles of Peshawar Valley, Khyber Pakhtunkhwa, Pakistan. Canadian Journal of Pure and Applied Sciences. 10 (1):3732 – 3750.
Khan M.Z., Kanwal R., Ghalib S.A., Fatima F., Zehra A., Siddiqui S, Yasmeen G., Safi A., Hashmi M.U.A., Hussain B., Iqbal MA., Manzoor U., and Ubaid Ullah. 2016b. A review of the distribution, threats, conservation, and status of freshwater turtles in Sindh. Canadian Journal of Pure and Applied Sciences, 10(3):3997–4009.
Knight A.T., Bode M., Fuller R.A., Grantham H.S., Possingham H.P., Watson J.E., Wilson K.A. 2010. Barometer of life: More action, not more data. Science. 329:141. https://doi.org/10.1126/science.329.5988.141-a
Nijman V., Shepherd C.R. 2007. Trade in non-native, CITES-listed wildlife in Asia, as exemplified by the trade in freshwater turtles and tortoises (Chelonidae) in Thailand. Contrib. Zool. 76:207 - 211. https://doi.org/10.1163/18759866-07603007
Phuntsho T., Koirala R.K., Tschering Y. and Tshomo K. 2022. Diversity and Distribution of Tortoises and Turtles in the Phibsoo Wildlife Sanctuary and Adjoining Areas in Southern Bhutan. Reptiles and Amphibians, 29:439–44.
Praschag, P., Hundsdörfer, A.K., Reza, A.H.M.A. and Fritz, U. 2007. Genetic evidence for wild-living *Aspideretes nigricans* and molecular phylogeny of South Asian softshell turtles (Reptilia: Trionychidae: *Aspideretes*, *Nilssonia*). Zoologica Scripta, 36:301–310.
Praschag, P., Ahmed, M.F. and Singh, S. 2021. *Nilssonia nigricans*. The IUCN Red List of Threatened Species. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T2173A2778172.
Praschag, P., Rai, T.P. and Schleic, H. 2022. First record of the critically endangered Black softshell turtle, Nilssonia nigricans (ANDERSON, 1875) for Nepal. ARCO Veröffentlichungen – Arco-Nepal Newsletter 24, October 2022. 15–22.
Pritchard, P.C.H. 1979. Encyclopedia of Turtles. T.F.H. Publications, Inc. Ltd. 1–895
Pritchard P.C.H. 1993. Carapacial pankinesis in the Malayan softshell turtle, *Dogania subplana*. Chelonian Conserv. Biol. 1:31–36.
Purkayastha, J. Das, I. and Sangupta, S. 2015. Freshwater turtles and tortoises of South Asia. Published by Bhabani Books. Bhbani Pvt. Ltd., Assam. India.
Pun, SK.,,Craig B. Stanford, CB and Khadka, BB. (2023). Distribution records and conservation status of turtles in Chitwan, Nepal. Journal of Institute of Science and Technology, 28(1), 25–30.
Rahman, S.C., Ahmed, M.F., Choudhury, B.C., Praschag, P. and Singh, S. 2021. *Lissemys punctata*. The IUCN Red List of Threatened Species 2021: e.T123802477A3008930. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T123802477A3008930.en. Accessed on 12 June 2025.
Ramakrishna, S. Jayashankar, M., Alexander, R. and Avinash K. 2014. Testudines of India: a review on diversity, threats and conservation initiatives. Int. J. Pharm Life Sci.ence, 5 (2) (2014), pp. 3297–3304.

Rao, R.J. 1982. Studies on neuroanatomy, cytology, and histochemistry of the reproductive system of the freshwater turtle, *Trionyx gangeticus* (Cuvier), with special reference to seasonal cyclicity, PhD thesis, Bhopal University, Bhopal, India.
Rao, R.J. 1986. Freshwater turtle conservation in the National Chambal Sanctuary. Tigerpaper, 13(3):28–29.
Rao, R.J. 1987. Ecological studies of Indian turtles, Tigerpaper, 14(3):21-25.
Rao, R.J. 1991. Conservation management of freshwater turtles in the National Chambal Sanctuary. Journal of Ecological Society, 4:43–53.
Rao, R.J. 2001. Biological resources of the Ganga River, India. Hydrobiologia 458: 159-168.
Rao, R.J. 2010. The diversity, ecology, and conservation management of freshwater turtles in the Ganges River System. www.wii.gov.in/envis/chapter 15.
Rao, R.J. 2016. Conservation strategies of Indian Freshwater turtles. Bionature, 36(2):71-79.
Rao, R.J. and Shaad, F.U. 1985. The freshwater turtle trade in Madhya Pradesh. Hamadryad, 10(1&2):17-18, 1985.
Rashid, S.M.A. and Khan, S.M.M.H. 2000. Trade and conservation status of turtles and tortoises in Bangladesh, In: Van Dijk, P.P., Stuart, B.L., and Rhodin, A.G.J.(Eds.). Asian Turtle Trade: Proceedings of a Workshop on Conservation and Trade of Freshwater Turtles and Tortoises in Asia. Chelonian Research Monographs 2:77–85.
Rashid, S.M.A. and Rahman, M.M. 2014. Domestic turtle trade: a barrier for freshwater turtle conservation. In: Khan, M.A.R., Ali, M.S., Feeroz, M.M., and Naser, M.N. (Eds.). The Festschrift on the 50th Anniversary of the IUCN Red List of Threatened Species. Bangladesh: IUCN, pp. 136–143. Phuntsho T, Koirala RK, Tschering Y, and Tshomo K. (2022). Diversity and Distribution of Tortoises and Turtles in the Phibsoo Wildlife Sanctuary and Adjoining Areas in Southern Bhutan. Reptiles and Amphibians, 29:439–44.
Rhodin, A.G.J., Iverson, J.B., Bour, R., Fritz, U., Georges, A., Shaffer, H.B., and van Dijk, P.P. 2021. Turtle Taxonomy Working Group [. Turtles of the World: Annotated Checklist and Atlas of Taxonomy, Synonymy, Distribution, and Conservation Status (9th Ed.). In: Rhodin, A.G.J., Iverson, J.B., van Dijk, P.P., Stanford, C.B., Goode, E.V., Buhlmann, K.A., and Mittermeier, R.A. (Eds.). Conservation Biology of Freshwater Turtles and Tortoises: A Compilation Project of the IUCN/SSC Tortoise and Freshwater Turtle Specialist Group. Chelonian Research Monographs, 8:1–472. https://doi.org/10.3854/crm.8.checklist.atlas.v9.2021
Safi, A. and Khan, M.Z. 2014. Distribution and current population of freshwater turtles of District Charsadda of Khyber Pakhtunkhwa, Pakistan. The Journal of Zoology Studies, 1(4):31–38.
Safi, A., Khan M.Z, Hashmi, M.U.A., Kanwal, R., Karl, H.V. 2020. Some aspects of morphometry, systematics, and biogeography of the freshwater turtles, *Pangshura* (Testudines: Geoemydidae) of Pakistan. SPC Journal of Environmental Sciences, 2 (1):26–35.
Safi, A., Khan, M.Z., Kanwal, R., Karl, H.V. 2021. Population Status, Threats and Conservation of the Spotted Pond Turtle; *Geoclemys Hamiltonii* (Gray, 1830) (Geoemydidae) of Pakistan. Journal of Zoological Research, 3(1):29–37.
Safi, A., Volker, K. and Tichy, G. 2024a. A review of the biogeography, diversity, and current conservation status of turtles and tortoises of the Indian subcontinent. Sustainability and Biodiversity Conservation, 3(2): 66–85.
Safi, A., Hashmi, M.U.A., Yousufzai, S. and Volker K. 2024b. A review analysis of the poaching and illegal trade of tortoises and freshwater turtles (TFTs) in Pakistan. SPC journal of Environmental Sciences, 6(1):13–18.
Samah B.K, Maqsood A., Muhammad A., Hussain, I. and Tariq M.. 2015. Morphometric studies of the freshwater turtles from Rawalpindi Islamabad Region of Pakistan, Journal of Biodiversity and Environmental Sciences, 6(5):228–233
Salleh, M.H.M., Esa, Y., Salleh, M., and Sah, S.A. 2022. Turtles in Malaysia: A Review of Conservation Status and a Call for Research, Animals (Basel), 12(17):2184.
Smith, M.A. (1931). The Fauna of British India, including Ceylon and Burma. Vol. I. Loricata, Testudines. London: Taylor and Francis, 185 pp.
Smith M.J., Benítez-Díaz H., Clemente-Muñoz M.Á., Donaldson J., Hutton J.M., McGough H.N., Medellin R.A., Morgan D.H., O'Criodain C., Oldfield T.E. 2011. Assessing the impacts of international trade on CITES-listed species: Current practices and opportunities for scientific research. Biol. Conserv. 144:82-91.
Taigor, S.R., and Rao, R.J. (2008). Sand mining practices on the Chambal River banks and their impact on the aquatic animal biodiversity. Journal of Environmental Research and Development, 2(4):644–650
Tikedar, B.K. and Sharma, R.C. 1985. Handbook: Indian testudines. Zoological Survey of India, Calcutta.
Vyas, R. and Patel, B.H. 1990. A survey of freshwater turtles of Gujarat. Journal of the Bombay Natural History Society, 87(1):152–155.
Wangyal, J.T., Wangchuk, D. and Das, I. 2012. First Report of Turtles from the Himalayan Kingdom of Bhutan. Chelonian Conservation and Biology, 11:268–272. https://doi.org/10.2744/CCB-0995.1.
Wangyal, J.T., Bower, D.S., Tshewang, S.S., Wangdi, D., Rinchen, K. Phuntsho, S., …… Dorji, T. and Das, I. 2020. New herpetofaunal records from the Kingdom of Bhutan were obtained through citizen science. Herpetological Review, 51:790–798.
Yadav P., Kumar A., Sahoo, S., Yadav, N., Hussain S.A. and Gupta, S.K. 2010. Identification of Gangetic turtles based on species-specific variations on mitochondrial cyt b and nuclear Cmos genes. Forensic Science International: Animals and Environments, 1:100035.
Zug G.R. Turtle. Encyclopædia Britannica. Available online: https://www.britannica.com/animal/turtle-reptile (accessed on 20 March 2025).
Online resources:
https://www.iucnredlist.org/species/39618/2930943
https://www.britannica.com/place/South-Asia