



# The faded stripes of Bengal: a historical perspective on the easternmost distribution of the striped hyena

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## Abstract

The striped hyena (*Hyaena hyaena*) is an understudied large carnivore with no known historic range map. Knowledge of the past and present extent of its easternmost distribution beyond 85° east longitude is dubious. Through a comprehensive review of historical evidence and contemporary records, we investigated striped hyena presence in Bengal, i.e., Bangladesh and the Indian state of West Bengal in South Asia. We found 14 historical records, with the oldest one dating to 1876. Our review establishes Bangladesh as a former striped hyena range country and the striped hyena as one of the first large carnivores to go extinct in Bangladesh. We identified northern Bangladesh as part of its historical range (until ~1965), and south-central Bangladesh as a possible part of its historical range. In West Bengal, India, hyenas were historically present up to the southern tributaries of the Brahmaputra River, but the present range is reduced. The area south of the Damodar River is its last refuge in Bengal. We also found 15 contemporary records (2010–2021) in Bengal, from sites situated on the eastern limit of the Chota Nagpur Plateau. These records noted 25 sightings including 9 deaths due to poaching, train accidents, and retaliatory killings. Our review demonstrates that hyenas are currently present up to 87° east longitude, which extends the currently documented easternmost range for the species by almost 1,000 km. We recommend methods which can be applied to delineate the historical extent of striped hyenas elsewhere as well as for other poorly understood species.

**Keywords** Bangladesh · Carnivore · Extinction · *Hyaena hyaena* · India · Status

## Introduction

The striped hyena (*Hyaena hyaena*), one of the four extant hyena species, is native to 41 countries across North and East Africa, the Middle East, the Caucasus, and Central and South Asia (AbiSaid and Dloniak 2015; Castelló 2020). Despite being widespread across two continents, it is classified as Near Threatened by the IUCN Red List with a declining population of fewer than 10,000 mature individuals, occurring patchily and at low densities throughout

its range (Mills and Hofer 1998; Wagner 2006; AbiSaid and Dloniak 2015). Furthermore, it is an understudied member of the family Hyaenidae (Watts and Holekamp 2007). Many aspects of striped hyena behavioral ecology are yet to be understood (Tichon et al. 2020), though its distribution in multiple range countries has been updated recently (Tichon et al. 2016; Derouiche et al. 2020; Bhandari et al. 2020).

The IUCN Status Survey and Conservation Action Plan: Hyenas (Mills and Hofer 1998) was the first comprehensive effort to gather data on the global distribution of all extant hyena species. The ensuing range maps were drawn by the IUCN Red List mapping unit using the best available methods at the time. Since then, the striped hyena range map has been left unchanged and has not accounted for the far, forgotten reaches of the species' potential distribution. For example, in the most recent IUCN Red List assessment for the species (AbiSaid and Dloniak 2015) – which kept the original 1998 Red List map – the presence of the striped hyena beyond 85° east longitude was not mentioned. In contrast, Menon (2014) considered its extant range up to 87°

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east longitude, which geopolitically falls within the state of West Bengal, India. Recent efforts by the Zoological Survey of India (Nandi 2021) corroborated the description given by Menon (2014). More surprisingly, the historical presence of the species is accounted for even farther eastward. IUCN Bangladesh (2015), Khan (2015), Khan (2018), and Castelló (2020) stated that the striped hyena is extinct in Bangladesh, which lies about 1000 km eastward of the striped hyena distribution from Mills and Hofer (1998) and AbiSaid and Dloniak (2015). Due to the lack of any scientific work discussing hyena occurrence in Bangladesh, the country was not included in the past species status assessments (Mills and Hofer 1998; AbiSaid and Dloniak 2015). However, why, how, or when the striped hyena went extinct from Bangladesh, where it occurred within the country, or whether the species occurred there at all has not been discussed anywhere in the published scientific literature.

Here, we investigated the past and present distribution of striped hyenas in Bengal, a collective regional denomination that includes almost all of Bangladesh and the state of West Bengal, India (Sengupta 2011). By following a structured methodology, we provided empirical evidence to sketch out the pattern of striped hyena historical presence in Bengal. We also accumulated geo-referenced occurrence events in the region between 2010 and 2021 and quantified the amount of loss in the striped hyena range. We discuss the potential of historical distribution records to detect local extinctions and identify range extensions. We also highlight the importance of using historical, verifiable local records to augment range maps and discuss how such findings may inform conservation strategies for hyenas and other species.

## Methods

### Delineation of Bengal

Until the first quarter of the twentieth century, the present-day Indian states of Bihar, Jharkhand, Odisha, and West Bengal, along with most of present-day Bangladesh, were included under the definition of Bengal (Sengupta 2011; Fig. 1). Today, the area lying between 20.5 and 27.9° north latitude and 86.35° and 92.30° east longitude defines the region of Bengal, i.e., present-day West Bengal and part of Bangladesh (Figs. 1 and 2). This delineation, considering part of India and part of Bangladesh, comes with three salient traits: (i) the Bangla language – from which the name has been derived – evolved here, (ii) the region still contains the main nucleus of the Bangla-speaking population, and (iii) the region is situated on the Ganges Delta, the rich alluvial plain formed by some of the largest river tributaries on Earth (Sengupta 2011). To discuss the historical or current presence of hyenas in Bengal, we considered first-level administrative units, or divisions, in both West Bengal

and Bangladesh (Supplementary Fig. 1). Most of these units were defined in the 1800s, corroborate contemporary boundaries, and make it easier to trace and compare with historical regions.

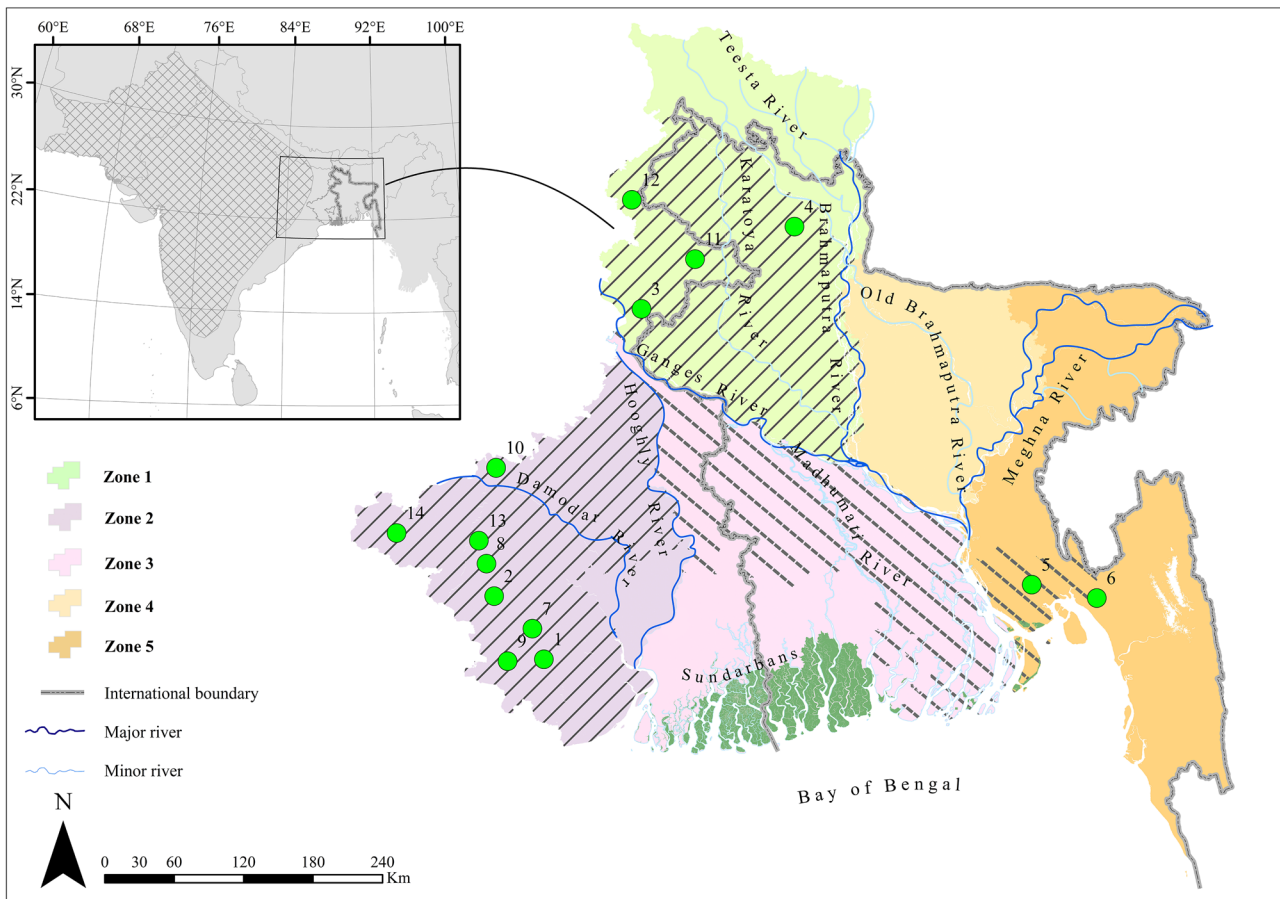
The river systems divide Bengal into separate zones as described in Sengupta (2011) (Fig. 1). We followed this scheme and considered five zones based on the river courses. Zone 1, between the north of the Ganges River and the west of the Brahmaputra River, includes the Barind Tract consisting of the Rajshahi and the Rangpur divisions of Bangladesh (Figs. 1 and 2). Zone 1 also extends further north into the Jalpaiguri division, and westward into the Malda division of West Bengal, with a rise in elevation (Figs. 1 and 2). On the west and the south-west of the Hooghly River, the main southern branch of the Ganges River, Zone 2 includes the Bardhaman and the Midnapore divisions of West Bengal (Figs. 1 and 2). In Zone 3 lies Central Bengal, which comprises the Presidency division of West Bengal, and the Khulna, the Barisal, and most of the Dhaka division of Bangladesh (Sengupta 2011; Figs. 1 and 2). This area is bounded by the Hooghly River to the west, the Ganges River to the north, and the Meghna River to the east (Fig. 1). Central Bengal is the most heavily populated part of Bengal (RGCC 2011; BBS 2011). Between the northeast of the Brahmaputra River and the Ganges River, Zone 4 of Bengal accounts for all of north and northeastern Bangladesh, delimited by the Khasi and the Jaintia Hills (Fig. 1). In the southeast, Zone 5 contains southeastern Bangladesh, delimited by the Chattogram Hill Tracts (Sengupta 2011; Fig. 1).

### Search protocol

We adopted the approach of Pullin and Stewart (2006) to construct our literature search protocol. Based on Jacobson et al. (2016), Lozano et al. (2019), and Akash et al. (2021a), preset keywords were chosen. “Scientific or common name of the species,” i.e., “hyena” or “striped hyena” or “Indian hyena” or “Hyaena hyaena” AND “region name,” i.e., “Bangladesh” or “West Bengal” or “Bengal” were included in combination in every search carried out in three search engines (Google, Archive.org, and Google Scholar). For “common name of the species,” we also applied the British variant of the spelling, i.e., “hyaena.” We considered both English and Bangla language literature. In the case of the latter, we applied our keyword string, i.e., “common name of the species” AND “region name” in Bangla. We also searched for anecdotes written about game animals with the preset search protocols.

### Consideration of literature and timeline

We classified three clusters of literature: (i) peer-reviewed scientific studies and books/book chapters, (ii) gray literature



**Fig. 1** Historical evidence on the presence of the striped hyena in Bengal. Geographic position of Bengal in the Indian Subcontinent is shown in the inset. Black cross-hatched area denotes the current hyena range in the Indian Subcontinent (from AbiSaid and Dloniak

2015). Green circles denote the historical hyena sighting locations. Numbers beside the circles are site codes and correspond to the observational briefs given in Table 1

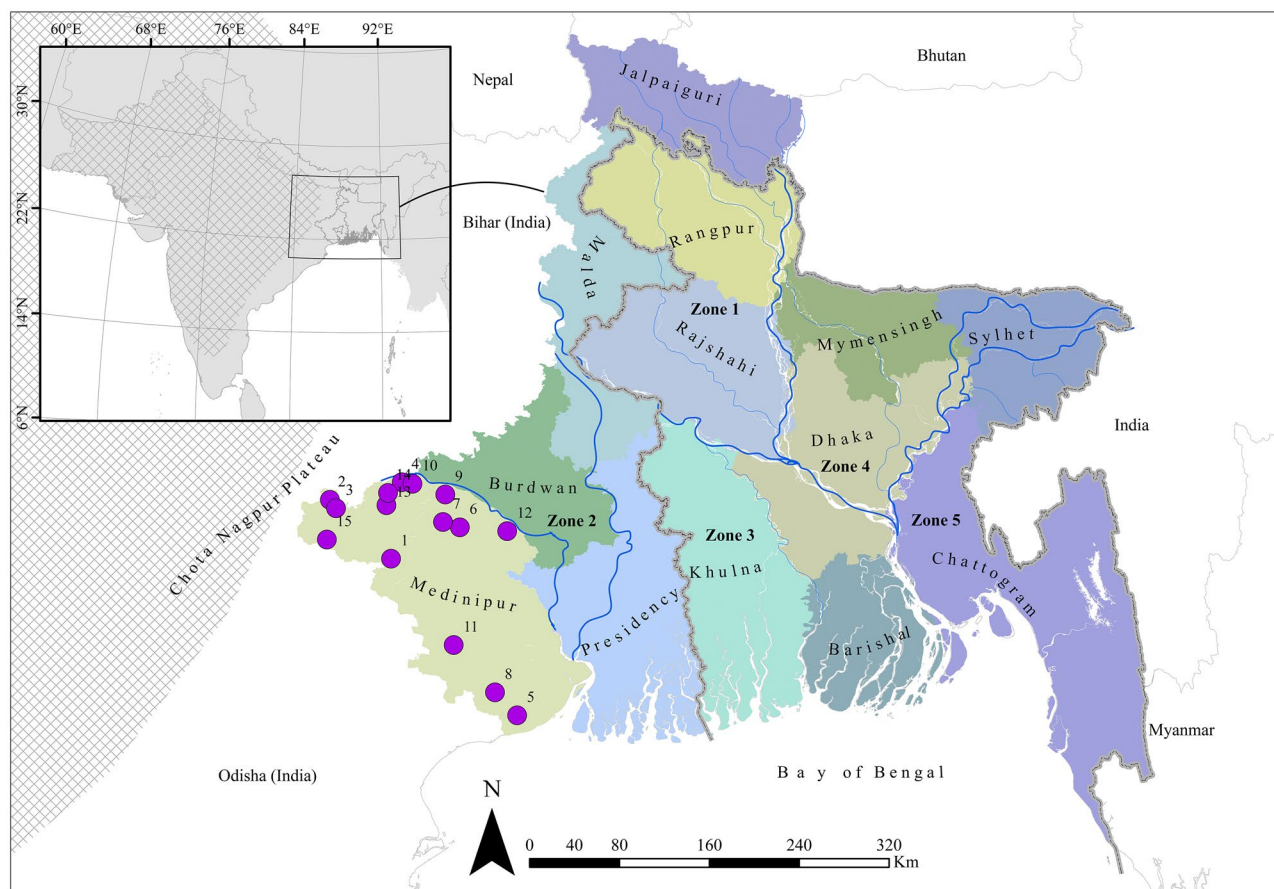
(e.g., project reports) and media reports, and (iii) historical evidence. We had no timeline for limiting peer-reviewed scientific studies or book chapters and used the search protocol identified above. For historical evidence, we searched for works published between 1870 and 1990. For current records, we looked at print media between January 2010 and April 2021. The selected sources have initiated database indexing around 2010, which led us to select this period and it matches with ongoing research investigating hyena distribution.

For books, we examined the following field guides: Ahmed et al. (2009), Menon (2014), Khan (2015), Khan (2018), Hunter and Barrett (2018), and Castelló (2020). Additionally, we reviewed Mills and Hofer (1998), and IUCN Bangladesh (2000, 2015).

To glean data from print media, we selected web-based archives of one Bangla newspaper (Anandabazar Patrika), four English newspapers (The Statesman, The Hindustan Times, The Times of India, and The Telegraph), and online

news portals (Supplementary Fig. 1). We did not find any media source from Bangladesh as the striped hyena has been extinct there for decades. The sources were chosen based on the highest circulation rates (Hary 2021). In secondary data skimming, readership can be a trait of selection (Akash et al. 2021a; Athreya et al. 2015).

For the third cluster, historical evidence of the striped hyena in the region, we sought out several series of gazetteers: (i) A Statistical Account of Bengal (comprised 20 volumes; compiled by Sir William Wilson Hunter between 1869 and 1877), (ii) The Imperial Gazetteer of India (a 26-volume gazetteer of the then British Indian Empire; published between 1881 and 1887, revised editions until the 1930s), (iii) Bengal District Gazetteers (came out in multiple volumes; each described the then administrative units which represent the present-day divisions; published until the first quarter of the twentieth century), (iv) West Bengal District Gazetteer (a state-wide initiative by the Government of India to update the previous gazetteers;



**Fig. 2** Contemporary records of the striped hyena in Bengal with the delineation of divisions of West Bengal, India, and Bangladesh. The geographic position of Bengal in the Indian Subcontinent is shown in the inset. Black cross-hatched area denotes the current hyena range

in the Indian Subcontinent (from AbiSaid and Dloniak 2015). Purple circles denote the contemporary hyena sighting locations. Numbers beside the circles are site codes and correspond to the observational briefs given in Table 2

published in multiple volumes between 1958 and 1990), and (v) Bangladesh District Gazetteer (an initiative by the Government of Bangladesh; published in multiple volumes between 1971 and 1990). Chronology and details of these compilations were obtained from Burton (1966), Scholberg (1970), and [www.archive.org](http://www.archive.org), and [www.biodiversitylibrary.org](http://www.biodiversitylibrary.org). Gazetteers are considered to be comprehensive and reliable sources to trace past accounts (Laurini 2015; Acheson et al. 2017). Finally, we checked two journals that were operational since the eighteenth century: (i) The Journal of the Bombay Natural History Society (109 volumes; published between 1886 and 2012) and (ii) Journal of the Asiatic Society of Bengal (75 volumes; published between 1832 and 1936).

### Verification of occurrence records

To verify any hyena-related event featured in the media and to avoid repeated entries, we followed a two-step approach. We considered a result pertinent only if the

location was within the present-day geopolitical boundary of West Bengal, India, or Bangladesh. Each report was used only if it had been published with an identifiable image of a hyena (dead or alive) or hyena spoor and/or included expert statements confirming species identification (e.g., from the West Bengal Forest Department personnel). All else was excluded from our analysis. For example, we did not consider the report of Sengupta (2020) as the identification of the conflict animal was uncertain. Similarly, we did not consider Mallick (2019) because it mentioned the presence of the striped hyena in West Bengal but did not specify any locality. We also excluded Maiti (2021) as, from the video provided with the report, we identified the animal as an Indian wolf (*Canis lupus pallipes*).

The data collected between 2010 and 2021 were classified under four themes: type, place, time, and source. Each theme was further classified under different considerations. Regarding the type of occurrence, the data were grouped into two categories: (i) human-hyena conflict and (ii)

encounters in the wild. Human-hyena conflict corresponds to the retaliatory events induced by hyenas and/or by hyena attacks on humans or livestock as well as vehicle collisions. Any instance of hyena sightings in a wildlife survey or as an opportunistic event was defined as an encounter in the wild. The number of hyenas that appeared on each occasion, and damage, if any, caused by hyenas were also noted. We adopted definitions for these categorizations from Balme et al. (2014) and Akash et al. (2021a). The source, time (year, month, and date), and place (i.e., the type of habitat: forest, urban/peri-urban, or rural/agricultural; adopted from Acharya et al. 2016) of each event were also noted. When considering contemporary (2010–2021) occurrence events, we observed topographic traits of the occurrence location from Google Earth Imagery and noted pertinent district statistics compiled by RGCC (2011) and BBS (2011).

We have updated the historic and current easternmost distribution of the striped hyena to include the Bengal region. We procured the international boundary of India and Bangladesh from GADM.org. To refer to the status of forests of West Bengal, we consulted ISFR (2017); for Bangladesh, we followed IUCN Bangladesh (2015) and Khan (2018).

## Results and discussion

In this first scientific report examining the easternmost distribution of the striped hyena, we have updated knowledge of the historic extent of the species and adjusted the current range map, pushing the distribution limit over 1000 km eastward from the current IUCN Red List range map (Fig. 1a, b and Tables 1 and 2; AbiSaid and Dloniak 2015). We have established West Bengal as being within the current range of the striped hyena in India. In addition, we present evidence that Bangladesh is a historical range country for the species. Asmat (2001), published in Bangla, is the only other known work that discussed hyena extinction in Bangladesh (Akash and Zakir 2020).

Our literature review compiled 14 historical works that noted striped hyena presence in Bengal (i.e., West Bengal, India, and Bangladesh; Table 1 and Fig. 1). The earliest of these anecdotes was in 1876 (Hunter 1876a–d). We also collated 15 contemporary records of the species that were verifiable, geographically explicit, and occurred in West Bengal between 2010 and 2021 (Table 2, Fig. 2, and Supplementary Fig. 1). From our work, it also appears that major rivers played a crucial role in both the expansion and extinction of hyena in Bengal (Fig. 1); the region lies on the largest delta in the world (IUCN Bangladesh 2015; ISRF 2017).

### Hyena in Bangladesh

Within the historical evidence, we found four works (Hunter 1876c, d; Thomas 1885; Baker 1886) in which hyenas were

reported to be present in areas that are now present-day Bangladesh (Site Code 4,5,6; Table 1; Fig. 1). The written accounts of the topographic features of these areas (Hunter 1876c, d; Thomas 1885; Baker 1886; Nishat et al. 2002; ISFR 2017; IUCN Bangladesh 2015) are comparable to the known habitat preferences of the striped hyena.

According to our zonal classification, two disconnected zones in Bangladesh (Zone 1 and Zone 5) were noted to have the species (Fig. 1). Zone 1 is characteristically drier, composed of grey terrace soils and open undulating knolls, and holds some of the oldest land formations from the Pleistocene era (Nishat et al. 2002; Figs. 1 and 2). Zone 1 once had a swath of wet deciduous forests covering almost half of the entire northern Bangladesh (Nishat et al. 2002; IUCN Bangladesh 2015). The historical topographic features of Zone 1 are similar to the habitat characteristics of the Chota Nagpur plateau, a neighboring region that currently has striped hyenas (Menon 2014). The Chota Nagpur plateau is drier, composed of red laterite soils, open scrublands, and dry deciduous forests (Kala and Dubey 2012). The eastern limit of the plateau abuts with the western boundary of historical Bengal. From Zone 1 of Bangladesh, the plateau is less than 100 km west in the shortest linear distance (Fig. 1). The southwestern part of Zone 5 contains coastal Bangladesh which, in the past, had stretches of grasslands along the coast (Hunter 1876d; Thomas 1885; Baker 1886; Nishat et al. 2002; IUCN Bangladesh 2015).

We reviewed the historical large mammal community that lived in Zones 1 and 5. Both of the zones had a similar assemblage that is known to prefer open forest systems, savanna, and grasslands (IUCN Bangladesh 2015; Khan 2018). For example, one of the last Asiatic cheetahs of Bengal (*Acinonyx jubatus venaticus*) was killed in Zone 1 in 1874 (Raoul 1893). Historically, the Indian wolf was extant in both zones at the same time (Akash et al. 2021b; Hunter 1876c, d; O'Malley 1914, 1923). Wolves disappeared from Bangladesh in the 1960s but still occur sympatrically with the striped hyena in the Chota Nagpur plateau (Kala and Dubey 2012; Sharma et al. 2019; Mukherjee et al. 2021).

The easternmost extent of the striped hyena in Bangladesh does not appear to have exceeded the Brahmaputra River (Fig. 1). However, in the south (Zone 5), the species likely crossed the Ganges–Brahmaputra–Meghna confluence based on three historical records of the striped hyena from coastal Bangladesh (Hunter 1876d; Thomas 1885; Baker 1886) (Site codes 5 and 6; Fig. 1 and Table 1). We consider these records authentic because of the abundance of scrubland-grassland mosaics during that period (suitable habitat for the species), the mentions of Indian wolves in a simultaneous manner (a large carnivore that shares several common habitat requirements and is sympatric with the striped hyena; Mukherjee et al. 2021), and the fact that the authors were experienced game hunters. The sighting from

**Table 1** Historical evidence collated on the presence of the striped hyena *Hyaena hyaena* in Bengal. Site code corresponds to the number provided in Fig. 1 and Supplementary Fig. 1

Site code	Zone	Region/Country	Name of the area in historic mentions	Present-day division comprising the area	Source	Quote verbatim/Remarks
1	2	West Bengal	Midnapore	Medinipur	Hunter (1876a)	“Tigers, leopards, hyaenas, bears, buffaloes...frequent the jungle tracts along the western boundary of the district.”
2	2	West Bengal	Bankura	Medinipur	Hunter (1876b)	“Tigers, leopards, small but fierce bears, hyaenas, wolves, deer, and buffaloes... frequent the jungle tracts along the western boundary of the district, bears and hyaenas being especially numerous.”
3	1	West Bengal	Maldah	Malda	Hunter (1876c)	“The following is a list of the more important wild animals: Tiger, leopard, tiger cat, civet cat, mongoose, hyaena (very rare), wolf (rare), jackal, and occasionally, rhino (very rare), wild hog, wild buffalo, large swamp deer, hog deer, and spotted deer. “
4	1	Bangladesh	Rangpur	Rangpur	Hunter (1876c)	“Foxes and jackals are numerous in every part of Rangpur district, and hyaenas are sometimes met with.”
5	5	Bangladesh	Noakhali	Chattogram	Hunter (1876d)	“The following list of mammals found in the district of Noakhali has been furnished by collect (Mr R Porch, CS). The scientific names are taken from Dr Jerdon's Mammals of India: ... (12) striped hyaena ( <i>Hyaena striata</i> )..., (15) Indian wolf ( <i>Canis pallipes</i> )...”
6	5	Bangladesh	Sitakundo	Chattogram	Thomas (1885)	“Across the valley to the right rose an almost perpendicular hill, its whole side one tangle of long creepers and dense undergrowth, save just at the centre, and here a gap showed a pathway which led across the face of the cliff. As I gazed at this, a striped hyaena passed slowly along a faintly-outlined track, quite unconscious that he was observed. “
-	-	Both Bangladesh and West Bengal	-	-	Baker (1886)	Baker (1886) mentioned the presence of hyenas in Bengal multiple times, however, did not specify the exact localities
7	2	West Bengal	Midnapore	Medinipur	Sclater (1891)	One stuffed specimen and a skull were included in the catalogue of the collection of the then Indian Museum, Kolkata. These were procured from the site mentioned
8	2	West Bengal	Bankura	Medinipur	O'Malley (1908)	“Among other carnivorous animals the following are fairly common: hyaenas, jackals, fox, civet cats, wild cats of several species, as well as the ubiquitous mongoose.”
9	2	West Bengal	Bardhaman	Burdwan	Peterson (1910)	“Wolves have been known to carry off children. Hyenas do not commit much mischief as they content themselves with carrion but they occasionally carry off goats and sheep.”
10	2	West Bengal	Midnapore	Medinipur	O'Malley (1911)	“Hyaenas are found in the jungles bordering villages.”

**Table 1** (continued)

Site code	Zone	Region/Country	Name of the area in historic mentions	Present-day division comprising the area	Source	Quote verbatim/Remarks
11	1	West Bengal	Dinajpur	Malda	Strong (1912)	“Hyaenas are nowhere mentioned as indigenous to the district, but in May 1909 an unmistakable hyena was seen in the Bansihari thana (present-day Dakshin Dinajpur).”
12	1	West Bengal	West Dinajpur	Malda	Sengupta (1965)	“Jackal, foxes, mongooses and hyaenas are also found (present-day Paschim Dinajpur).”
13	2	West Bengal	Bankura	Medinipur	Banerji (1972)	“The carrion-and-bone-eater striped hyena is also found in the district but is strictly nocturnal.”
14	2	West Bengal	Purulia	Medinipur	Bhattacharya et al (1985)	“Hyenas are sometimes found in the dry forests. It is a scavenger by nature, and may carry away dogs and goats from villages occasionally.”

Thomas (1885) came from a hilly, semi-evergreen, stream-fed forest-savanna mosaic (Zone 5; Site code 6; Figs. 1 and 2 and Table 1). The species is reported from similar habitats of East Africa (Castelló 2020). Similar instances have been noted for other species of hyenas. For example, the spotted hyena (*Crocuta crocuta*) has been observed in the tropical forests of Gabon by Bout et al. (2010). Immediately north of the possible historic range of the species in Zone 5 (Fig. 1) lie several settlements that predate the timeline of the British Indian Empire by thousands of years (Hunter 1876d; Thomas 1885; Baker 1886). Further east or south, the zone gains elevation and had dense mixed-evergreen forests in the nineteenth century (Baker 1886). Although Zone 5 may have offered habitats for the striped hyena in those periods, we did not come across any such suggestions.

If areas of Zone 5 were occupied by the striped hyena in historical times as we suggest, the presence of hyenas in Zone 3 (Central Bengal) can be deduced although no records were found. Immediately below the Ganges, in the 1900s, Zone 3 possessed three distinctive habitats: (i) complex grassland-sandbar mosaic near the banks of the Ganges and its tributaries, (ii) grassland-marshland mosaics (O'Malley 1914; 1923), and (iii) numerous estuarine rivers flowing through the southern tip of Zone 3 before emptying into the Bay of Bengal and forming the Sundarbans, the largest mangrove forest in the world (Khan 2018). However, hyenas never populated the mangroves, and the historic extent of the mangroves was more extensive. The grassland-sandbar mosaics, known to contain a rich wildlife including tiger (*Panthera tigris*), leopard (*Panthera pardus*), and buffalo (*Bubalus arnee*), is a possible historic dispersal route for striped hyenas to get into Zone 5.

Similarly, we did not find any historic record of the species in Zone 4. This region contains some of the oldest

human settlements in Bengal; however, until the first half of the twentieth century, also held swaths of wet deciduous forests encompassing central Bangladesh and was rich in large vertebrates. These habitats may have been inhabited by hyenas. However, we consider that it would have been before the fifteenth century, if not prehistoric, which, in turn, is beyond the scope of this study. Combined with its secretive nature, and a less-coveted game species, the striped hyena was possibly overlooked in historic anecdotes that featured Zone 4. In addition, the historic presence of hyenas in this region was certain to be influenced by an extreme nature event: the 1762 Arakan Earthquake impacted Bengal with an epicenter in Zone 5 and triggered a change in the main course of the Brahmaputra River (Fig. 1; Steckler et al. 2008). The course prior to the earthquake is known as the Old Brahmaputra River (Fig. 1; Sengupta 2011).

We found no works that discuss the extinction timeline of the striped hyena in Bangladesh. Hyenas in present-day Bangladesh were not mentioned in any work after the 1950s. The last anecdotes on wolves in the country were from the same period (Mitra 1957). Hyenas were likely extinct from the area south of the Ganges (Zones 3 and 5) first (before the 1920s), because these areas were subject to heavy land conversion and urbanization (Sengupta 2011). Currently, both zones hold some of the densest settlements in West Bengal and Bangladesh (RGCC 2011; BBS 2011). In Zone 1, hyenas had disappeared at least a decade later than their timeline of possible extinction in Zone 3 or 5. For example, the latest mention is from Sengupta (1965), who stated the occasional presence of hyenas from northern West Bengal, India (Site code 12; Fig. 1), an area only 40 km away. We found one report, in Bangla, that considered the extinction of the striped hyena in Bangladesh (Asmat 2001), and it also compiled a few of the anecdotes presented here (for

**Table 2** Contemporary records collated on the presence of the striped hyena *Hyaena hyaena* in Bengal. Site code corresponds to the number provided on Fig. 1c and Supplementary Fig. 1c. Record sources correspond to those presented in Supplementary Fig. 2

Site code	Zone	Place of occurrence (Division)	Place of occurrence (District)	Year	Month	Type of occurrence	Hyena killed?(y/n)	Hyena rescued?	Remarks
1	2	Medinipur	Purulia	2013	December	human-hyena conflict	y	n	One individual was killed by poachers
2	2	Medinipur	Purulia	2014	-	human-hyena conflict	n	y	One individual was ventured into locality
3	2	Medinipur	Purulia	2015	September	human-hyena conflict	y	n	One individual was crushed by train. The report also mentioned about five more train accidents that involved hyena death and occurred between 2014–2015
4	2	Medinipur	Purulia	2015	September	human-hyena conflict	y	n	One individual was crushed by train
5	2	Medinipur	Purba Medinipur	2016	February	human-hyena conflict	y	n	One individual was ventured into locality, killed by villagers
6	2	Medinipur	Bankura	2016	November	human-hyena conflict	y	n	One individual was found dead nearby locality
7	2	Medinipur	Bankura	2016	December	human-hyena conflict	y	n	One individual was found dead nearby locality
8	2	Medinipur	Paschim Medinipur	2018	November	human-hyena conflict	n	y	One individual was ventured into locality, rescued by villagers
9	2	Medinipur	Bankura	2018	May	human-hyena conflict	y	n	One individual was found dead nearby locality
10	2	Medinipur	Purulia	2018	-	encounter in the wild	n	n	Only peer-reviewed study that stated presence of the species in West Bengal. Exact date/month of the sighting event could not be retrieved According to Chattopahyay et al. (2018), “Striped Hyaena was observed only once during the present study but reports by local villagers suggest that they were spotted at least five times during the present study duration (two years).”
11	2	Medinipur	Jhargram	2019	March	human-hyena conflict	n	n	One individual attacked a goat and injured the owner of the goat
12	2	Medinipur	Bankura	2019	July	human-hyena conflict	y	n	One individual found dead nearby locality
13	2	Medinipur	Purulia	2020	July	human-hyena conflict	y	n	One individual was killed, allegedly by poachers
14	2	Medinipur	Purulia	2020	December	human-hyena conflict	n	y	One individual rescued from paddy field
15	2	Medinipur	Purulia	2021	January	encounter in the wild	n	n	One individual was sighted from car. It is very likely the first live footage in the region



example, Hunter 1876c, d ). Our observations corroborate with Asmat (2001) and ongoing research by the Hyaena Distribution Mapping Project (authors' unpublished data).

Based on the historical records and the similarity of the historical topographic and ecological features of Bengal and its large mammal community, we conjecture that the striped hyena was once present across northern Bangladesh, and possibly also in riverine and coastal grasslands of south-central Bangladesh. The species likely went extinct in the country in the 1960s and was one of the first large carnivores to go extinct from the country.

## Hyena in West Bengal, India

Zone 1 and Zone 2 of Bengal, i.e., present-day West Bengal nearly in its entirety, had the striped hyena in historical times. We collated 12 historical accounts that described the presence of hyenas from what is now West Bengal (Table 1 and Fig. 1). In northern West Bengal (Zone 1), the Teesta tributaries of the Brahmaputra River marked the northernmost extent of the historical hyena presence. No description beyond this geographic barrier mentioned hyenas in any period. West Bengal lost hyenas in the northern part, i.e., north of the Ganges, first. After Sengupta (1965), we found no mentions of hyenas beyond this limit. We did not consider the northern half of Zone 1 as a historic range of hyenas. This half of Zone 1, in the time of the British Indian Empire, was primarily forest but was extensively cleared to make room for tea-gardens. It still contains some of the oldest tea-gardens in the subcontinent. The region was also impacted by the 1762 Arakan Earthquake. In 1787, a massive and prolonged flooding period changed the tributaries of the Teesta River and pushed them eastward (Fig. 1; Rahman et al. 2011). Our deduction on this region is based on these considerations, which ought to be unfavorable for the hyenas.

The southern half of West Bengal (Zone 2) had the striped hyena in most of its areas (Site codes 1, 2, 7, 8, 9, 10, 12, and 14; Fig. 1). Sclater (1891) noted stuffed specimens and skulls of hyenas in the Indian Museum, which were sourced from Zone 2. However, the eastern part, the Presidency Division, had no mentions about the striped hyena as it holds the Sundarbans (never inhabited by the hyena) and the areas that had been transformed heavily since the 1900s (Sengupta 2011). The western part of Zone 2 is the eastern extremities of the Chota Nagpur plateau, which has open savanna systems, formed on dry, lateritic, and red soil highlands (RGCC 2011); further west, the zone continues into the Indian states of Odisha and Jharkhand (Fig. 2).

We noted 15 contemporary records of the striped hyena from West Bengal that occurred between 2010 and 2021 (Table 2, Fig. 2, and Supplementary Fig. 1). All but two surfaced as media records. The two non-media records were also the only reported wild encounters with hyenas in West

Bengal. The remaining 13 were outcomes of human-hyena conflict. On six occasions, single individuals were found dead in the vicinity of nearby villages. These incidents were allegedly due to poachers (Site codes 1, 6, 7, 9, 12, and 13; Table 2, Fig. 2, and Supplementary Fig. 1). On two reported occasions, hyenas were killed by trains (Site codes 3 and 4; Table 2, Fig. 2, and Supplementary Fig. 1). Death of hyenas by train in the state was reported as a common phenomenon (Site code 3; Table 2, Fig. 2, and Supplementary Fig. 1). On another four occasions, one individual on each occasion strayed into villages (Site codes 2, 5, 8, and 14; Table 2, Fig. 2, and Supplementary Fig. 1). All were rescued except on one occasion where the animal was killed. One incident reported an attempted hunt on a domestic goat. Chattopadhyay et al. (2018) is the only peer-reviewed work we found that noted the species' presence in West Bengal. In total, these reports between 2010 and 2021 noted about 25 hyena sightings including 9 deaths. All of these incidents occurred south of the Damodar River (Fig. 2). From our review, we found that the western part of West Bengal (Midnapore Division) is the only area in Bengal that still has the striped hyena. Although the recent records may suggest an increase of range of the striped hyena by approximately 1,000 km<sup>2</sup> eastward (Fig. 2), they are plausibly relict sub-populations of striped hyenas that were not included by Mills and Hofer (1998), likely because data were not received during their survey process and therefore not included in the map. The region lying south of the Damodar River is also the last refuge of the Indian wolf in Bengal (Sharma et al. 2019).

## Conclusion

Our findings contribute new knowledge about the striped hyena's current and historical distribution and to its conservation. Given the habitat and topographic features of Bengal, the natural disasters that occurred there, and the historical evidence we found, the extent of hyenas included present-day Bangladesh. It would therefore be prudent to conduct a study from a paleontological perspective. Since historic times, the striped hyena has been a species of human neglect. According to Thomas (1885) and Baker (1886), the species was the least prized (even less so than wolves) among hunters. Hyenas were thus absent in most of the famous historical anecdotes on pig-sticking practices and the game mammals of the Indian subcontinent. The striped hyena population receded gradually, likely through a combination of persecution, habitat loss, and prey loss exacerbated by game hunting, facing a silent extinction throughout Bangladesh and most of West Bengal. We found no studies on hyenas in Bengal in either of the primary natural history journals we considered. Hyenas are still facing the same treatment and lack of

attention. This situation has only changed in the past year, as according to Nandi (2021), the Zoological Survey of India recently initiated a systematic survey on the striped hyena in West Bengal.

Our work also suggests additional methods which can be applied to delineate the historical extent of the striped hyena and to similar lesser-known species. For instance, the extent of the striped hyena in the remaining part of its Asian range could be further elucidated using similar methods (in particular in Turkey and Central Asia). Without an accurate understanding of a species' historical distribution and the ecological conditions in which it was found, scientific interpretation of fundamental and realized niches, the application of appropriate management measures, and analysis of factors affecting fitness can be biased. For example, according to Han et al. (2019), a previous lack of historical context for the giant panda's (*Ailuropoda melanoleuca*) distribution and behavior was suggested to have hamstrung conservation efforts until recently due to a poor understanding of what the species needs to persist. Similarly, a review on the European bison (*Bison bonasus*) historical population dynamics helped to identify major threats that benefitted the current management of the species (Samojlik et al. 2019). Thus, studies such as ours which identify and interpret local extinctions and historical distributions can inform present-day management and conservation. We contend that it is crucial to examine historical and local knowledge to gain a complete understanding of basic species ecology and to implement evidence-based conservation policies, planning, and actions. Importantly, without this review, we would have assumed that the recent records in West Bengal would have implied a range extension of nearly 1,000 km east of the existing distribution limits, as opposed to recognizing it as a relict population deserving of conservation attention.

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## Declarations

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