



# Distribution, Habitat Use, and Nesting Behavior of the King Cobra (*Ophiophagus hannah*) in the Trashigang Forest Division, Eastern Bhutan

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**Abstract.**—The King Cobra, *Ophiophagus hannah* (Cantor 1836), is the longest venomous snake in the world; it is globally threatened and has been categorized as Vulnerable (VU) on the IUCN Red List. Herein we describe distribution, habitats, and nesting behavior of the King Cobra in Trashigang Forest Division, Bhutan. We recorded a total of 18 King Cobras during the one-year survey period. The elevational distribution was 650–2,057 m but most sightings were at lower elevations. King Cobras did not appear to prefer or avoid any particular habitat type but most records were from areas where human disturbances were at a minimum. We monitored a nest containing 37 eggs that was actively guarded by a female. This study was the first of its kind in Trashigang Forest Division and we hope that the information obtained will help formulate appropriate conservation strategies for this globally threatened species.

The King Cobra, *Ophiophagus hannah* (Cantor 1939), is the world’s largest venomous snake, known to attain a lengths of 4.8–6.0 m (Daniel 1983; Cox 1991; Zug 1993; Whitaker and Captain 2008). The species is globally threatened and has been categorized as Vulnerable on the IUCN Red List of Threatened Species (Stuart et al. 2012) and is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2021). It is widely distributed in southern and southeastern Asia and is known to occur in India, Pakistan, Bangladesh, Myanmar, Bhutan, Nepal, southern China, Macao, Laos, Thailand, Malaysia, Indonesia, Hong Kong, Brunei Darussalam, Cambodia, The Philippines, Singapore, and Vietnam (e.g., Smith 1943; Biswas 1975; Narayan and Rosalind 1989; David and Vogel 1996; Schleich and Kästle 2002; Whitaker and Captain 2004, 2008; Wangyal and Tenzin 2009; Chanhom et al. 2011; Stuart et al. 2012; A. Das et al. 2016; Faiz et al. 2017).

King Cobras are found at elevations of 76–2,566 m in Nepal (Schleich and Kästle 2002; Thapa et al. 2019), 128–2,042 m in Bhutan (Biswas 1975; A. Das et al. 2016), and 161–2,181 m in India (Waltner 1975; Bashir et al. 2010; Hrima et al. 2014), where they inhabit the thick vegetation of evergreen and semi-evergreen forests, estuarine mangrove swamps with heavy rainfall; humid forests, cool swamps,

bamboo patches, Terai grassland, and agricultural land near human habitation (Narayan and Rosalind 1989; David and Vogel 1996; Schleich and Kästle 2002; Leviton et al. 2003; Whitaker and Captain 2004, 2008; Bhattacharyya and Mitra 2005; A. Das et al. 2008). Unique among snakes, female King Cobras build nests of dead leaves and stay with the eggs throughout the 60–90-day incubation period (e.g., Loveridge 1946; Schmidt and Inger 1957; Murthy 1986; Whitaker and Captain 2004, 2008; Hrima et al. 2014; Dolia 2018; Baral et al. 2019).

Previous reports of King Cobras in Bhutan (Biswas 1975, Trashigang District; Narayan and Rosalind 1989, grasslands of the Royal Manas National Park; Wangyal and Tenzin 2009, Trashiyangtse District; A. Das et al. 2016, Sarpang District) were based mainly on opportunistic sightings or as parts of herpetofaunal surveys. Despite its importance as an apex predator and inclusion as a Vulnerable (VU) species in the IUCN Red List (Stuart et al. 2012), essentially no natural history information is available on the species in Bhutan. Herein we present information on habitat preferences, distribution, and the first record of nesting behavior in the country from the Trashigang Forest Division, hoping that these baseline data will assist relevant authorities, conservationists, and the Trashigang Forest Division to develop and implement appropriate conservation strategies by protecting critical habitats.

**Methods**

The Trashigang Forest Division (27°22'–27°29'N, 91°22'–92°07'E) (Fig. 1), established in 1997, covers an area of 2,447.40 km<sup>2</sup> at elevations of 476–4,382 m asl in Trashigang and Trashiyangtse Districts. About 10,000 households are within the Divisional Forest jurisdiction. Monsoons occur from May to September and annual rainfall is 1,000–2,000 mm; humidity levels are high and relatively stable above 68.6%, reaching 88% during the monsoon (WCSD 2018). The lower-elevation subtropical zone of the Division experiences hot summers and mild winters, whereas the warm temperate and cool temperate zones at higher elevations are characterized by warm summers and cold winters.

About 79 % and 70% of the total areas of Trashigang and Trashiyangtse Districts, respectively, are under forest cover and the corresponding vegetation types across the landscape are characterized by subtropical forests, warm and cool broadleaf forests, mixed conifer, and alpine meadows (FRMD 2017) that harbor a rich biodiversity. The Drangmechuu River, one of the major rivers of Bhutan, flows southwestward through mountainous terrain and enters Mongar District. Providing ideal habitats for various species of snakes are the scrub vegetation, subtropical forest belt, and rocky outcrops that are prominent geophysical features found along the river and its tributaries.

More than 69% of the people in these two districts sustain themselves through agriculture and livestock rearing, and depend heavily on natural resources such as timber, firewood, fodder, and non-wood forest products (NSB 2019).

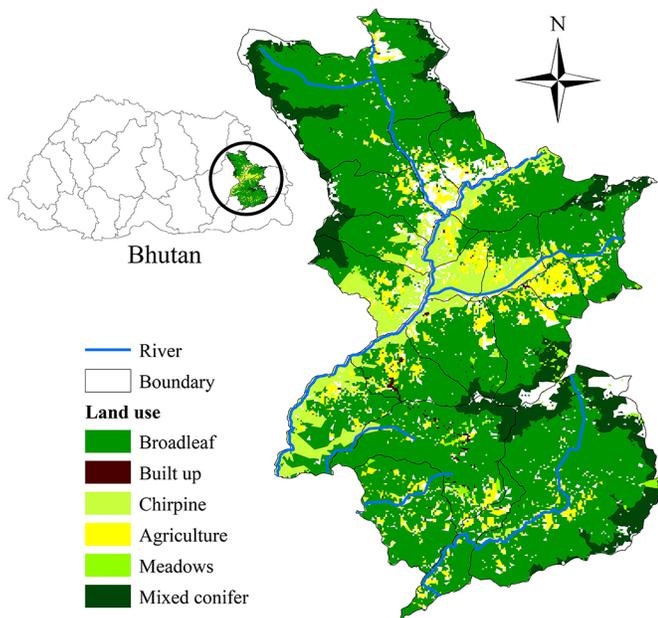
They practice subsistence farming and supplement household income via cottage industries based on natural resources like resin tapping, wood based micro-industries, and lemon-grass distillation.

The virtually intact dense forests, degraded forests, open forests, rural agricultural farm lands, and patches of grassland in the Trashigang Forest Division provide habitat for King Cobras. Both natural and human-modified landscapes appear to be equally important for this species.

We conducted time-constrained visual encounter surveys (Heyer et al. 1994; Doan 2003) from August 2019 to August 2020 that were supplemented by opportunistic visual encounter surveys (Thapa et al. 2019). We searched for King Cobras in all potential habitats. Three observers used 3-hour constrained standard visual encounter surveys in agricultural lands, open forest, grasslands, and along roads and river banks, whereas opportunistic visual encounters were employed in dense forests and areas with rugged terrain. In all cases, we recorded the distance from each individual sighted to the nearest source of water. Because the species is largely diurnal (Bhattacharyya and Mitra 2005), we conducted surveys primarily between 0700 and 1700 h. Although the elevation in the study area ranges from 476–4,382 m asl, we restricted our searches to areas below 2,400 m as most of the literature (e.g., Waltner 1975; David and Vogel 1996; Schleich and Kästle 2002; Bashir et al. 2010; Hrima et al. 2014) indicated that King Cobras usually occur at elevations below 2,200 m.

We recorded precise locality data, elevations, and distances to the nearest source of water for all individuals encountered, live or dead, and documented each sighting, when possible, with digital photographs. We used social media to collect information from staff stationed at remote locations and anecdotal oral histories/testimonies from local residents living near potential King Cobra habitats to better understand the species' distribution. Data with photographic evidence and GPS coordinates were considered confirmed records. We also conducted an extensive literature review of publications dealing with the herpetofauna of Bhutan (Biswas 1975; Bauer and Günther 1992; I. Das and Palden 2000; Wangyal 2011, 2012, 2014; A. Das et al. 2016; Koirala et al. 2016, 2018).

We monitored a nesting female King Cobra through direct observation by visiting the nesting site on a regular basis from the day of first sighting until the end of the incubation period to assess nesting behavior. Because nesting females are known to attack humans without provocation (Bhattacharyya and Mitra 2005), we observed the snake from elevated ground at a distance of 20–25 m. We recorded all relevant ecological factors at the end of the incubation period.



**Fig. 1.** Map of the Trashigang Forest Division in Trashigang and Trashiyangtse Districts of Bhutan showing vegetation and land-use.

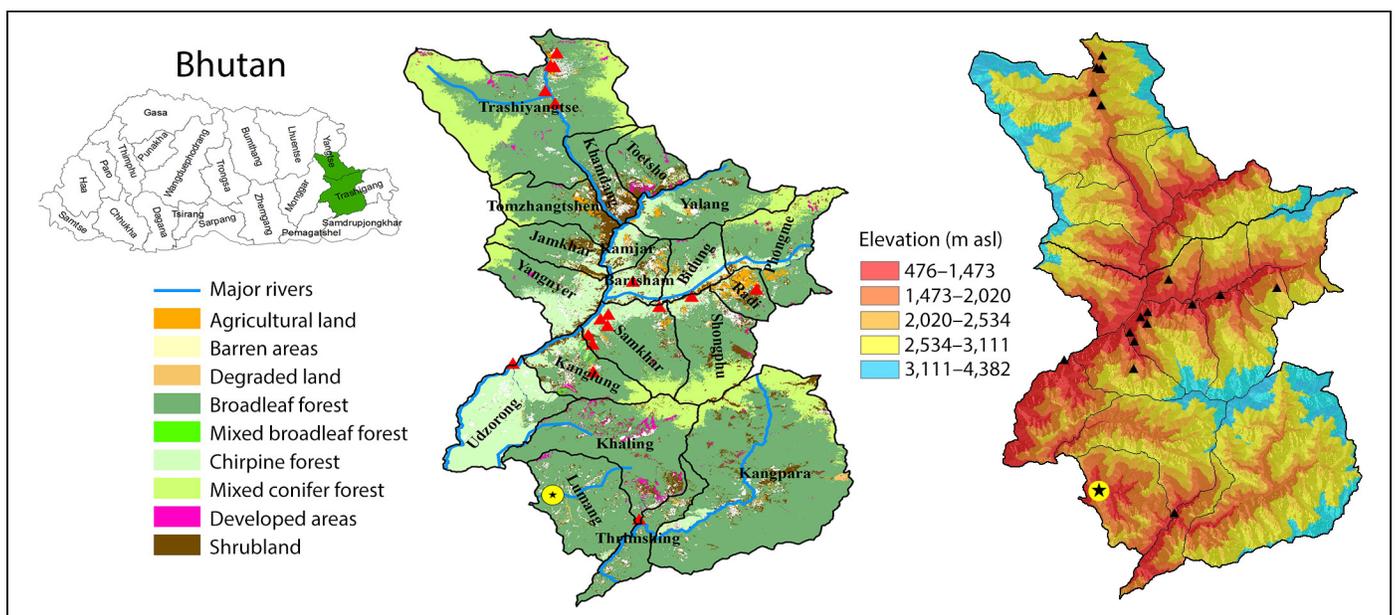
**Results**

In 2019–2020, we recorded a total of 18 King Cobras (*Ophiophagus hannah*) at elevations of 650–2,057 m asl at various locations in the Trashigang Forest Division (Table 1; Figs. 2–4). Thirteen records from Trashigang District were in

eight geogs (= subdistricts) (Samkhar, Kanglung, Bartsham, Lumang, Thrimshing, Udzorong, Shongphu, Radi); all five from Trashiyangtse District were in one geog (Yangtse). Fifteen of the 18 records were sightings during surveys and three were based on photographic evidence with GPS coordinates com-

**Table 1.** Locations where 18 King Cobras (*Ophiophagus hannah*) were encountered in the the Trashigang Forest Division in Trashigang and Trashiyangtse Districts of Bhutan.

	Location (coordinates) and elevation (m asl)	Age
1	Thrimshing, Trashigang (27°06'39.68"N, 91°35'24.59"E) 1,200 m	Adult
2	Barsam, Trashigang (27°22'23.47"N, 91°35'12.25"E) 1,872 m	Adult
3	Radi, Trashigang (27°21'45.59"N, 91°43'21.89"E) 2,057 m	Adult
4	Rangsikhar, Trashigang (27°18'15.13"N, 91°32'30.63"E) 890 m	Adult
5	Rongthung, Trashigang (27°16'26.30"N, 91°32'26.84"E) 1,800 m	Adult
6	Trashigang Dzong area (27°19'54.60"N, 91°33'02.09"E) 1,000 m	Juvenile
7	Trashigang (27°20'13.92"N, 91°33'32.79"E) 1,000 m	Juvenile
8	Lungtenza, Trashigang (27°20'42.10"N, 91°36'56.63"E) 820 m	Juvenile
9	Buna, Trashigang (27°21'20.48"N, 91°39'04.48"E) 720 m	Juvenile
10	Rolong, Trashigang (27°17'03.31"N, 91°27'12.63"E) 650 m	Adult
11	Pam, Trashigang (27°18'51.58"N, 91°32'12.27"E) 809 m	Adult
12	Melphey, Trashigang (27°19'28.46"N, 91°33'30.53"E) 1,050 m	Adult
13	Yangtse, Trashiyangtse (27°35'02.55"N, 91°29'36.22"E) 1,810 m	Adult
14	Rigney, Trashiyangtse (27°36'37.81"N, 91°30'12.94"E) 1,811 m	Adult
15	Lumang, Trashigang (27°08'18.58"N, 91°29'42.91"E) 1,030 m	Adult
16	Yangte, Trashiyangtse (27°36'42.69"N, 91°29'57.53"E) 1,800 m	Adult
17	Langla, Trashiyangtse (27°34'11.38"N, 91°30'14.30"E) 1,829 m	Adult
18	Bayling, Trashiyangtse (27°37'31.49"N, 91°30'24.07"E) 2,032 m	Adult



**Fig. 2.** Observations of King Cobras (*Ophiophagus hannah*) in 2019–2020 in various habitat types (marked by red triangles) (left) and at various elevations (marked by black triangles) (right) in the Trashigang Forest Division, Bhutan. The stars mark the site of a nesting King Cobra.



**Fig. 3.** An adult King Cobra (*Ophiophagus hannah*) encountered at an elevation of 2,057 m asl near the Tokshingmang Primary School, Radi Geog, Trashigang District, Bhutan. Photograph © B.K. Koirala.



**Fig. 4.** An adult King Cobra (*Ophiophagus hannah*) encountered at an elevation of 650 m asl in Rolong, Trashigang District, Bhutan. Photograph © B.K. Koirala.

municated through social media. One was an actively guarded nest in the Lumang Forest area in Trashigang District.

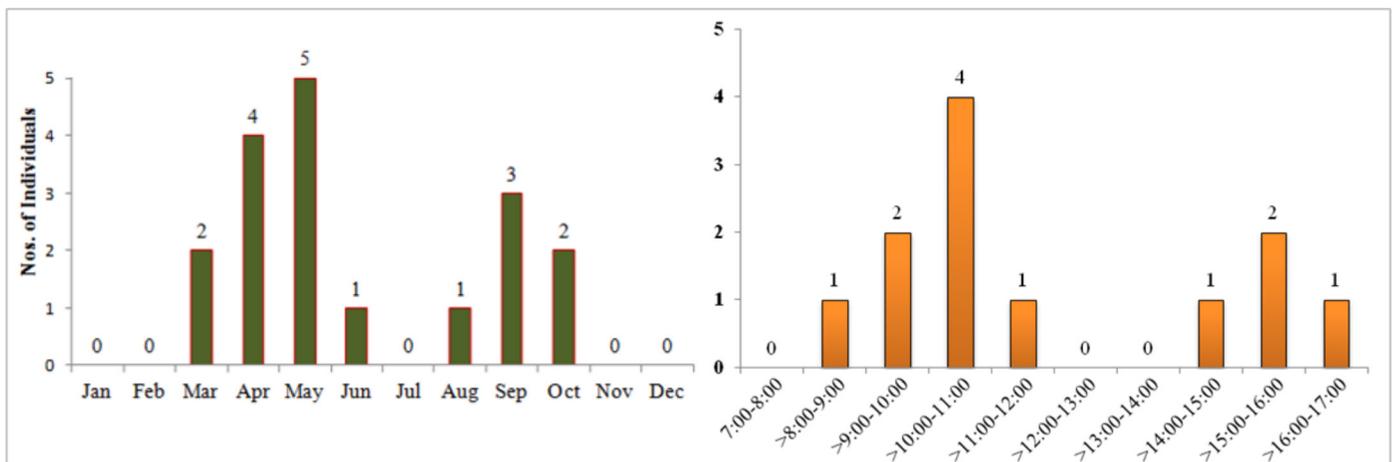
Most King Cobras were encountered along river valleys at elevations of 650–1,400 m asl, where recorded summer temperatures ranged from 21 °C to 32 °C. Eleven of the 18 King Cobra sightings were recorded during the early monsoon, fewer in late summer, and none during the winter when these snake brumate (Fig. 5). All twelve of the observations for which we have time-of-day occurred during the day (Fig. 5). Two incidents of King Cobras feeding on Indochinese Ratsnakes (*Ptyas korros*) occurred during the hours 1000–1100 h and 1400–1500 h.

We encountered King Cobras in various habitats that included dense forest (n = 4), open (degraded) forest (n = 5; Fig. 6), forest edges (n = 3), agricultural land (n = 4; Fig. 6), scrubland (n = 2), and in close proximity to or in human settlements (n = 4). No clear pattern was evident but most sightings were in or in close proximity to forests and an even

larger number (15) were within 500 m of a permanent water source (e.g., perennial stream or major river).

On 16 May 2020, we observed a gravid female King Cobra building a nest along the ancient forest trail connecting Wamrong to Pemagatshel District via Lumang. The nesting materials consisted primarily of dried oak (*Quercus lanata*) mixed with pine needles (*Pinus roxburghii*), other oak (*Quercus griffithii*) leaves, fern (*Drynaria propinqua*), and tick-trefoil (*Desmodium* sp.) gathered within a periphery of 2–4 m. The nest was built precisely on a flat surface of the forest trail on a well-drained forested south-facing 75.35° slope approximately 300 m from the Damree River. The source of most nesting materials, the *Quercus lanata* (trunk diameter 34 cm) was 7.6 m from the nesting site with branches providing about 90% canopy cover. The nest was 82.7 cm in height with a base diameter of 125 cm.

The snake was guarding its eggs by curling on top of the nest from 17 May until the end of the incubation period



**Fig. 5.** Monthly observations (left) and observations at various times of day (right) of King Cobras (*Ophiophagus hannah*) in 2019–2020 in the Trashigang Forest Division, Bhutan.



**Fig. 6.** Habitats of King Cobras (*Ophiophagus hannah*) the Trashigang Forest Division of Bhutan: Open forest in the Drangmeechu River Valley (left) and agricultural farmland in the Gamreechu River Valley(right). Photographs © B.K. Koirala.

(Figs. 7–8). On 19 July, we found the nest partially dismantled and with no sign of the female. A close examination of the nest revealed shells from 34 hatchlings and three apparently non-viable eggs (mean size 7.02 x 10.2 cm). The condi-

tion of the eggshells and shed hatchling skins indicated that eggs probably hatched 2–3 days earlier. Local cattle-herders told us that they had seen a hatchling near the nesting site at 1608 h on 15 July 2020. Eggs hatching on 15–18 July 2020 would reflect an incubation period of 60–64 days at this location.



**Fig. 7.** A female King Cobra (*Ophiophagus hannah*) guarding its nest at Lumang, Trashigang District, Bhutan. Photograph © Dawa Tshering.

**Discussion**

In Bhutan, the King Cobra’s known elevational distribution ranges from 128 m in the tropical plains of the southern foothills (A. Das et al. 2016) to 2,042 m in the mid-elevation temperate forests of eastern Bhutan (Biswas 1975). Data accumulated during this study suggest that the species is widely distributed in the Trashigang Forest Division, where we found snakes in sub-tropical forests (elev. 650 m) to temperate broad-leaf forests (2,057 m). The wide elevational distribution agrees with prior findings in which King Cobras have been recorded



**Fig. 8.** A female King Cobra (*Ophiophagus hannah*) on her nest (left) and shells of hatched eggs (right) at Lumang, Trashignag District, Bhutan. Note the three inviable eggs at the left of the image. Photograph © Dawa Tshering.

at elevations of 150–2,181 m (Waltner 1975; David and Vogel 1996; Schleich and Kästle 2002) and suggests that the species has the ability to withstand varied climatic conditions. However, the greater number of snakes at lower elevations and during warmer seasons (NCMH 2018) implies that the species prefers warmer areas. Hofer et al. (1999) noted that terrestrial reptiles respond strongly to temperature, which likely limits seasonal abundance (Fitzgerald et al. 2002) and elevational distributions of species (Fu et al. 2007). Alternatively, the number of sightings near permanent sources of water agrees with observations by Hrima et al. (2014) and Bhattacharyya and Mitra (2005) of King Cobras living and building their nests near water. Some combination of suitable temperature and access to water appears to be critical.

Our observations of King Cobras exploiting a diversity of habitats were essentially similar to those of David and Vogel (1996), Leviton et al. (2003), Stuart et al. (2012), and Rao et al. (2013). This likely is predicated by the availability of preferred prey. Mitra (2009) and Mitra et al. (2012) recorded 16 species of snakes in the study area, which would appear to be an ample prey base for ophiophagous King Cobras (Bhaisare et al. 2010; Barve et al. 2013; Rao et al. 2013; Dolia 2018).

Our sightings of King Cobras during daylight hours suggest that the species is diurnal. Rao et al. (2013) recorded 87% of activity from 1000 to 1800 h. Our anecdotal observation of King Cobras feeding on Indochinese Ratsnakes during late morning and afternoon might reflect a bimodal activity period, such as that seen in snakes in the tropical forests of the Western Ghats (Rao et al. 2013).

Studies in eastern Asia noted that King Cobra nests have been sighted exclusively in June (Dolia 2018; Baral et al. 2019) or that 82% of nesting females were sighted in June–July (Hrima et al. 2014). However, the observed nesting period (i.e., from April to July) in the Trashigang Forest Division more closely coincided with the previously recorded nesting season by Whitaker et al. (2013). Also, our observation of the female constructing a nest with dry vegetative material under a thick canopy is similar to information in Baral et al. (2019).

Female King Cobras have been recorded guarding eggs by lying coiled on a nest for an entire incubation period of 60–90 days (Murthy 1968), although a range of 2–77 days was cited by Whitaker et al. (2013) and Dolia (2018). Variable durations of the nest-guarding period in different locations likely reflects varied microclimatic conditions and other site-specific environmental parameters. Our observed incubation period (60–64 days) is congruent with a report of a 65-day incubation period by Baral et al. (2019).

The clutch size recorded in this study (37) exceeds recorded ranges of 14–35 (Hrima et al. 2014), 14–25 (Baral et al. 2019), and 21–33 (Wall 1925), but falls within those of 20–43 and 20–40 reported by I. Das (2012) and Murthy

(1986), respectively. Our observation that 34 of 37 (92%) eggs hatched successfully is greater than the average success rate (78%) in two clutches from Uttarakhand (Dolia 2018) but is similar to the 90% success rate in 14 nests recorded by Whitaker et al. (2013) and the 96% hatching success rate in two Nepalese nests reported by Baral et al. (2019).

### Conclusion

Until now, only a few studies have addressed the distribution of the King Cobra in Bhutan and none have recorded nesting behavior. We present these data as important baseline information, hoping that they will contribute to our understanding of how distribution patterns, habitat use, and ecology of King Cobras vary geographically throughout the species' range and lend insight into the species' ability to cope with ongoing climatic change and the expanding presence of humans in Bhutan and elsewhere.

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