frontiers | Frontiers in Amphibian and Reptile Science

TYPE Original Research
PUBLISHED 17 November 2025
DOI 10.3389/famrs.2025.1679679

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OPEN ACCESS

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RECEIVED 05 August 2025
ACCEPTED 20 October 2025
PUBLISHED 17 November 2025

CITATION
Pandey DP and Piya RC (2025) A preliminary snapshot of food contents in the gut of medically important Wall's Krait (*Bungarus walli*): an implication for snakebite prevention and snake conservation.
Front. Amphib. Reptile Sci. 3:1679679.
doi: 10.3389/famrs.2025.1679679

A preliminary snapshot of food contents in the gut of medically important Wall's Krait (*Bungarus walli*): an implication for snakebite prevention and snake conservation

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Introduction: The dietary habit of Wall's Krait (*Bungarus walli*), which causes several fatalities annually in some South Asian countries, is poorly known. Herein we aim to illustrate the food contents in the gut of preserved *B. walli* to determine their most favored prey animals.
Methods: We examined the gut contents of three specimens of *B. walli* preserved in snakebite treatment centers in Jhapa District of Nepal. We identified the contents of their stomachs and intestines. We also collected information on time, date, and geographic locations where people were bitten or encountered these kraits.
Results: Among the three examined specimens (male/female = 1:2) of *B. walli*, two kraits had consumed rodents and one had an empty stomach.
Discussion: This is the first study of foods in the guts of *B. walli* worldwide to our knowledge. The krait specimen having an empty stomach and two specimens with freshly eaten rodents might indicate their access in houses or its outskirts in search of foods. To verify the food stimuli driving them toward human dwellings and the similar feeding but dissimilar distribution patterns of medically important and similar-looking *B. walli* and common kraits (*Bungarus caeruleus*), its movement ecology, sexual cycle, and foraging behavior should be documented, and the diet of additional specimens should be studied. However, this preliminary finding could contribute to understand the feeding ecology of this krait intruding into residential areas and to formulate effective prevention strategies against its bite.

KEYWORDS
Bungarus, diet, kraits, rodents, stomach contents, Wall's Krait

1 Introduction

The composition of animals' diet reflects their feeding behavior, resource use, habitat utilization and preferences, competitive interactions with other sympatric animals, and predatory venom prey specificity (Webb and Shine, 1998; Brown et al., 2014; Kunwar et al., 2016; Michálek et al., 2024). Some snake species have geographic variation in the diet (De Queiroz et al., 2001), some snakes pursue migrated prey animals (Madsen and Shine, 1996), and others have specialized or generalized dietary habits (Webb and Shine, 1998; Brischoux et al., 2009). Overall, snake diets can be dependent to the contexts (such as habitats, urbanization, prey animal diversity and distribution, etc.) (Durso et al., 2013; Wolfe et al., 2017). Foraging behavior even affects the extinction risk of snakes (Baeckens et al., 2023). Therefore, understanding the feeding habit of snakes is necessary to help in the formulation of biodiversity conservation measures.

Deadly venomous kraits (*Bungarus* species) represent 18 species known to be distributed mostly in the Oriental regions of Asia (Abtin et al., 2014; Wallach et al., 2014; Aksornneam et al., 2024). These kraits feed on snakes, fishes, frogs, toads, lizards, and rodents (rats and mice) (Wall, 1921; Mao, 1970; Slowinski, 1994; Kuch, 2001; Pandey et al., 2020a). *B. walli* and *B. caeruleus* are superficially similar but genetically distinct medically highly relevant species. Wall (1907) described *B. walli* to be new to science from among specimens collected from Uttar Pradesh of India. *B. walli* is distributed in Nepal, India, and Bangladesh (Wall, 1907; Khan, 1985; Azam et al., 2011; Pandey, 2015; Deshmukh et al., 2016; Pandey and Thapamagar, 2019; Banik and Ray, 2023) and inhabits perianthropic areas including houses (Pandey, 2015). It (Figures 1C, D, 2B) is morphologically distinguished from *B. caeruleus* (Figures 1A, B, 2A) by 17–19 versus 15 dorsal scales, respectively [Figures 1, 2 are modified from Pandey (2015)].

Although the food spectrum of *B. caeruleus* has been recently described (Slowinski, 1994; Pandey et al., 2020a), the diet of *B. walli* has been inadequately investigated (Banik and Ray, 2023). *B. walli* is a silent killer because it intrudes in houses often at dark hours of the day and cause a painless bite to sleeping people (Pandey, 2015; Ahsan and Rahman, 2017). These snakes have caused several envenomings and deaths in Nepal, India, and Bangladesh (Pandey, 2015; Deshmukh et al., 2016; Ahsan and Rahman, 2017; Pandey and Thapamagar, 2019). Fatal envenomings in residential areas from these snakes are reported from eastern Nepal (Pandey, 2015; Pandey and Thapamagar, 2019) and Noakhali District and vicinity in Bangladesh (Ahsan and Rahman, 2017). *B. walli* was the third most common medically important snake causing envenoming and two deaths in southeastern Nepal (Pandey, 2015). Why these kraits enter residential areas, reach up to beds where people are sleeping, and bite humans is unknown. Therefore, these kraits warrant more study and careful attention where they occur.

The cryptic behaviors, highly secretive, minimal or nocturnal activity patterns, and frequent use of inaccessible (e.g., subterranean) habitats are challenges that prevent the observation and study of their feeding in nature (Parker and Plummer, 1987). Therefore, systematic studies of rarely seen and poorly known snake species must be conducted through dissection of preserved specimens or those killed by locals during human–snake confrontations (Maritz et al., 2021; Pandey, 2023). Unlike *B. caeruleus* (Wall, 1921; Slowinski, 1994) and other krait species (Slowinski, 1994; Kuch and Schneyer, 1996; Kuch, 2001), the dietary preferences of *B. walli* have barely been documented (Wall, 1907; Ahsan and Rahman, 2017; Banik and Ray, 2023). One reason is that *B. walli* has been confused for *B. caeruleus* for a long time due to their similar appearance (Schleich and Kästle, 2002; Sharma et al., 2013a, 2013b; Pandey and Thapamagar, 2019). Wall (1907) mentioned the morphometry of eight specimens of *B. walli* collected from Uttar Pradesh of India, and Ahsan and Rahman (2017) reported its distribution and medical significance in Bangladesh, without information relevant to the diet of *B. walli*. Only Banik and Ray (2023) reported the observation of scavenging on a road-killed Indian bullfrog carcass by this species in Coochbehar, West Bengal, India. Herein, based on observation of food items known during previous similar research (Pandey et al.,

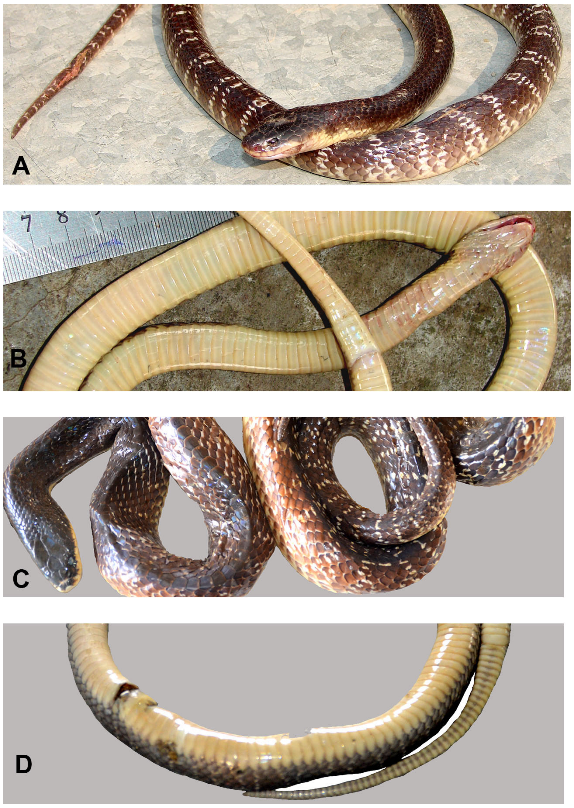

FIGURE 1
Distinguishing *Bungarus walli* from similar-looking *Bungarus caeruleus* with dorsal and ventral coloration. **(A, C)** Dorsal view and **(B, D)** ventral view of *B. caeruleus* and *B. walli*, respectively. **(A, B)** *Bungarus caeruleus* (Saulibas, Baghauda, Chitwan District (27.43598° N, 84.34783° E, 228 m), SVL = 738 mm). **(C)** *Bungarus walli* (Biratnagar town, Morang District, (26.42638° N, 87.26693° E, 70 m asl); SVL = 137 mm, dorsal scale rows at midbody = 17). **(D)** *Bungarus walli* with dark pigmentation on subcaudals. The snake was submitted by the patient or attendants of the patient to Damak snake bite treatment center (26.42364° N, 87.68823° E)] (photographed by Deb P. Pandey).

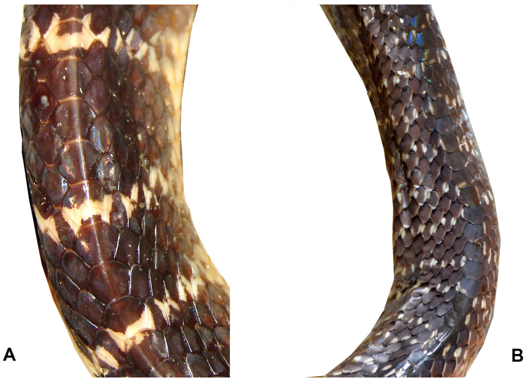

FIGURE 2
Shown are clearly enlarged middorsal scales with white bands in *B. caeruleus* **(A)** and *B. walli* **(B)** (photographed by Deb P. Pandey).

FIGURE 3
Wall's Krait (*B. walli*) from Jhapa District, Nepal, included to examine the contents in their stomachs and intestines. **(A)** Ambadi, Chakchaki 09, Jhapa (26.53147° N, 87.91759° E, 79 m asl). **(B)** Magrumari, Patharia 09, Jhapa District (26.402059° N, 87.99326° E, 62 m asl) (photographed by Deb P. Pandey).

2020a), we document the food contents in the alimentary tracts of dead and preserved individuals of *B. walli* that were involved in snakebite envenoming or intruded indoors and were killed by locals in Nepal. We hypothesize that food stimuli could drive them to human-inhabited areas where they confront with humans (Pandey, 2023), resulting in envenoming or snake killing. Our findings allow us to hypothesize on why *B. walli* enters homes and what would be the food choice of these kraits which have disjoint distribution patterns compared to *B. caeruleus* (Pandey, 2015). Furthermore, our findings can be useful to formulate and implement more effective, widely applicable preventive strategies, lessen the fear of snakes and the subsequent killing of snakes indiscriminately, and support biodiversity conservation.

2 Materials and methods

2.1 Study site

We studied the stomach contents of three (Figures 1C, 3A, B) out of 13 specimens of *B. walli* known to be distributed in southeastern Nepal [Figure 4, modified from Pandey (2015)]. Two dead specimens (involved in snakebite envenoming) were brought by patients or their visitors to Charaali Snakebite Treatment Center (STCs), and the next specimen (not involved in snakebite) was killed by locals in Biratnagar, Morang District and carried to Damak STC in Jhapa District, southeastern Nepal, where those specimens were preserved in 70% ethanol by on-duty health professionals. Among 10 specimens not included in this study, three specimens were damaged (Supplementary Figure S1), and seven were not allowed to be incised for a study of gut contents.

2.2 Sampling design and data collection

The study snakes were opportunistically sampled from STCs in Jhapa District (Figures 3A, B) and a freshly killed snake not involved in snakebite from a community in Biratnagar, Morang District (Figure 1C). These elusive nocturnal snakes are typically encountered by humans in residential areas. Locals sometimes carry killed snakes to STCs to aid in the diagnosis of snakebite envenoming (Bolon et al., 2020). Therefore, there might be locals' or investigators' bias in the sampling of killed snakes.

For these snakes, we collected information on time, date, and geographic location where the people were bitten or where human–snake confrontation occurred (without snakebite, but resulting in the killing of the involved snake). Habitat consisted of residential areas including houses and their outskirts. We studied their diets during July 2016–October 2018 while investigating the food spectrum of *B. caeruleus* (Pandey et al., 2020a), but these specimens were collected and preserved in 70% ethanol during a hospital-based epidemiological study of snakebites in 2013.

Based on observation of food items known during previous similar research (Pandey et al., 2020a), we documented the food contents in the alimentary tracts of dead individuals of *B. walli* that were involved in snakebite envenoming in two occasions and the next specimen which was not involved in snakebite but which the locals confronted in the kitchen of a house in Biratnagar of Morang District in southeastern Nepal.

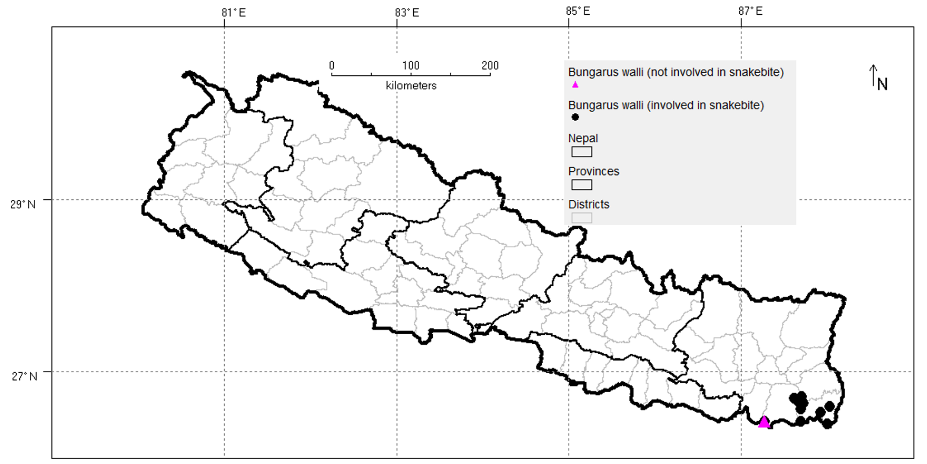

FIGURE 4
Distribution of Wall's Kraits (*B. walli*) known with localities and specific places where they encountered with humans or were involved in snakebites to locals in southeastern Nepal. The details on the voucher specimens and co-ordinates of displayed snake localities on this map are listed in Appendix 2 by Pandey (2015) as 26.42364° N, 87.68823° E, 73 m; 26.57245° N, 87.69182° E, 102 m; 26.69752° N, 87.61655° E, 143 m; 26.60065° N, 88.02698° E, 110 m; 26.67586° N, 87.66519° E, 133 m; 26.66417° N, 87.65444° E, 128 m; 26.62639° N, 87.69725° E, 100 m; 26.63428° N, 87.72141° E, 116 m; 26.71724° N, 87.69970° E, 171 m; 26.42638° N, 87.26693° E, 70 m; 26.65659° N, 87.70363° E, 130 m; 26.40206° N, 87.99326° E, 62 m; 26.53147° N, 87.91759° E, 79 m.

2.3 Gut content analysis

To characterize the diet of *B. walli*, we dissected dead specimens as described earlier (Pandey et al., 2020a). We incised the ventral body longitudinally (Figure 5A) and examined the food contents in the digestive tracts (fore-, mid-, and hind-gut) thoroughly (Figure 5B). The foregut (esophagus) would have remains of prey animals if the snake was killed while feeding or immediately after feeding, the mid-gut (stomach) would contain undigested or partly digested prey animals if the snake fed recently, and the hindgut (small and large intestine) may contain the indigestible parts of a prey (e.g., bones, hairs, feathers, claws, scales, etc.) (Pandey et al., 2020a).

We identified and counted the intact or partly digested prey animals or undigested prey remains of the study snakes as accurately as possible by comparing the anatomy and morphology of the prey items described in published sources available elsewhere by examining the gut contents as described in our previous similar work (Pandey et al., 2020a). We identified the prey items to the lowest possible taxonomic group.

2.4 Body length and sex

We determined sex by dissection of the gonads (testes—Figure 6A and ovaries—Figure 6B). As described about the sexual maturity of *B. caeruleus* (Wall, 1921; Pandey et al., 2020a), we assumed the sexual maturity of *B. walli* included in this study if they attained a whole body size of at least 890 mm. We measured the snout–vent length (SVL), total length, and cloaca to tail tip length (CTL) using a measuring tape. Because of the small sample size of the snake specimens, we did not perform any statistical testing. Data were managed using MS Excel.

3 Observations

We examined three preserved specimens of *B. walli*—two female (Figures 3A, B, 5B) and one male (Figures 1C, 6A)—to identify the prey that they consumed (Figure 7). All *B. walli* specimens were collected during the rainy season, two in July and one in September. The rainy season in eastern Nepal lasts from June to September and is characterized by frequent rainfall and high humidity.

Two female snakes were both involved in snakebites. One snakebite occurred on the head and trunk at 0700 h on July 11, 2013 of a 35-year-old man (a tea garden supervisor) while he was carrying straw (a type of fodder) piled at the outskirt of his own brick–wood–cement house with galvanized tin roofs to feed his cattle in Magrumari, Patharia 09, Jhapa District (Figure 3B). The other occurred on the head and truck at night (2230 h) on September 22, 2013 of a 7-year-old female student while she was sleeping on the floor-bed of a wattle and daub (wood, bamboo) house with galvanized tin roofs located in Ambadi, Chakchaki 09, Jhapa District of Nepal (Figure 3A). The male snake (Figure 1C) intruded into the kitchen of a house located at Sikai Tole, Nayabasti, Biratnagar Municipality 16, Morang District of Nepal at night on July 2013 but did not cause a snakebite.

The maximum total length (TL) of *B. walli* in this study was 1,566 mm, with the second longest specimen being 700 mm and the smallest specimen being 453 mm (mean = 906 mm). The average SVL of the study snakes was 783 mm. The male snake (Figure 1C)

FIGURE 5
Wall's Krait (*B. walli*) from Chakhaki of Jhapa District, Nepal, incised longitudinally to examine the contents in the stomach and intestine. Co-author (RCP) incising **(A)** a female *B. walli* specimen with empty stomach **(B)** (photographed by Deb P. Pandey).

FIGURE 6
Gonads of Wall's Kraits of Nepal. **(A)** A male specimen from Biratnagar of Morang District. **(B)** A female specimen from Chakchaki of Jhapa District (photographed by Deb P. Pandey).

had greater length than the female snakes (Table 1, Figures 3A, B). Only one of the three snakes, the male, was sexually mature.

For the three killed specimens of *B. walli*, all digestive tracts contained partially digested vertebrate prey animals or their body fragments. The foregut contained no food items in all three specimens. One of the specimens had an empty stomach, and the stomachs of the rest of the two snakes contained rodents [a partially digested identifiable rodent (i.e., *Rattus* sp.) in the snake that entered a house and bit a sleeping child (Figures 7A, B) and freshly eaten juvenile rodents in the Morang specimen (Figure 8)]. The specimen that was in a pile of straw and carried by a farmer along with the straw to feed his cattle had an empty stomach.

Two specimens' hindguts contained the body fragments of vertebrate prey animals. The Biratnagar specimen contained snake-scale-like items, and the Jhapa specimen, which also contained a rodent in the stomach, contained mammal fur. The snake-scale-like items could not be identified to any lower taxon because key morphological features were lost; however, these could be from a snake prey of *B. walli*. Traces of mammalian fur in the *B. walli* containing the partly digested rodent (Figure 7) could be the fur of a second rodent. The third snake's hindgut contained finely digested contents that we could not identify (Table 1).

4 Discussion

The study provides the first empirical data on the gut contents of *B. walli*, which is the first evidence-based preliminary snapshot of prey composition of dead non-captive *B. walli* worldwide to our knowledge. We examined the stomach and intestinal contents comprehensively, accurately, and in greater detail than past studies, which mostly did not report the dietary details of *B. walli* (Wall, 1907; Ahsan and Rahman, 2017). Banik and Ray (2023) recently observed a *B. walli* in Coochbehar, West Bengal, India, scavenging a road-killed Indian bullfrog (*Hoplobatrachus tigerinus*) carcass. The evidence of rodent predation shows the potential link between prey (rodents) and human–snake conflict. This study finding can have a valuable and logical implication for public health and snake conservation.

4.1 Diet of Wall's Krait

Our new data on the diet of opportunistically obtained *B. walli* in southeastern Nepal (Figure 4) provides initial data that contributes to understanding the feeding ecology of this species. Because of developing prey-specific toxicity effects in some viperid and elapid snakes (Sanz et al., 2006; Gibbs and Mackessy, 2009; Modahl et al., 2016), our report on the prey animals of Wall's Kraits may help to understand their toxicity effects in the future. There is a further need of conducting similar multi-center studies and studying the movement ecology of these kraits to prepare a more comprehensive list of confirmed species of the prey animals that attracted these kraits to residential areas. This list can be used to implement more practicable and effective prevention strategies and to minimize the unnecessary killing of snakes that locals encounter,

FIGURE 7
Non-snake prey animal in the stomach of Wall's Krait involved in human envenoming in Magrumari, Patharia 09, Jhapa District, Nepal. A partially digested rodent prey **(A, B)** in its stomach would be a recently eaten rodent by this snake (photographed by Deb P. Pandey).

eventually contributing to biodiversity conservation. Although there are challenges in studying the diet of this elusive and nocturnal snake species (Maritz et al., 2021), our findings can maximize later utility to a range of inquiries by biodiversity conservationists or public health policy makers to implement effective prevention strategies against its bites to humans (and domestic animals).

The hindguts of the *B. walli* specimens examined in this study were either empty or contained unidentifiable finely digested contents. Among the identified contents in the digestive tract of a *B. walli* in Nepal, it can be concluded that two snakes had consumed rodents (Figures 7A, B, 8). Our finding of a partly digested and freshly eaten juvenile of rodents and traces of furs in its hindgut shows that *B. walli* preys on small, warm-blooded prey animals like *B. caeruleus* known from Nepal (Pandey et al., 2020a). This shows that *B. walli* and *B. caeruleus* might have similar needs and food choices. Like the stomachs of the majority of *B. caeruleus* known nationwide (Pandey et al., 2020a), *B. walli*, which entered a house, had an empty stomach. An empty stomach could be interpreted as a snake searching for food, not necessarily one that found food in a human dwelling. We provided supplementary evidence on why these krait species entered homes where they encountered sleeping people resulting in envenoming. Rodent prey (Figures 7A, B) and empty stomach could be the stimuli attracting these snakes in the residential areas of Nepal and other countries where they are distributed. Our findings of mainly empty stomachs of snakes that encountered with locals particularly at night and a partly digested rodent in the stomach of a snake killed in residential areas (Figures 7A, B) and the availability of these prey animals in residential areas and houses in Nepal and India (Pandey, 2015; Krishnakumar et al., 2023) support that food stimuli could be the reason why these Wall's Kraits entered residential areas including indoor beds and kitchens. Similar reasons for the entry of *B. caeruleus* likewise into residential areas were reported earlier (Pandey et al., 2020a). Although similar-looking *B. caeruleus* that were not collected from Nepal (Wall, 1921; Slowinski, 1994) and those collected from Nepal (Pandey et al., 2018, 2020) consumed snakes and the closely related *B. sindanus* frequently ate *Echis* species (i.e., viperid snakes) (Boulenger, 1897; Wall, 1921), the ophiophagy of *B. walli* that we examined during this study is speculative (without morphological or genetic information of snake-scale-like contents in the hindgut in the Biratnagar specimen of Wall's Krait).

Interestingly, *B. walli* and *B. caeruleus* had disjoint distribution (Pandey, 2015). *B. walli* are found mainly in eastern Nepal and *B. caeruleus* in central and western Nepal (Pandey, 2015). Wall (1921) frequently observed in nature and captivity that *B. walli* was eaten by *B. caeruleus*. Whether the ophiophagy of both species having comparable dietary compositions disjointed these similar-looking (Figures 1, 2) *B. walli* and *B. caeruleus* in Nepal is a future research question. Their similar food choices but distinct distributions raise questions about their potential competition, which warrants further study on foraging, sexual cycle, and movement ecology of these similar-looking species.

Two out of three *B. walli* collected from residential areas with fatal human–snake interactions corresponded with the report of similar human confrontations with *B. caeruleus* in residential areas of Nepal (Pandey et al., 2020a) and elsewhere (Bawaskar and Bawaskar, 2004; Ariaratnam et al., 2008). *Bungarus walli* is found in Nepal, India, and Bangladesh (Wall, 1907; Khan, 1985; Azam et al., 2011; Pandey, 2015; Pandey and Thapamagar, 2019) where they usually inhabit crop fields, grassy plains, and residential areas. Because food stimuli can drive *B. walli* to the residential areas, all prey animals of this snake should be removed or kept away from residential areas to prevent fatal interactions of people with this and other nocturnal venomous snakes. Therefore, while designing prevention and control strategies, *B. walli* should also be considered together with *B. caeruleus*. This study finding may also be a basis for knowing the feeding ecology of *B. walli* and the development of strategies for biodiversity conservation and prevention of nocturnal krait bites. Our analysis of food contents in the gut of dead kraits is a cost-effective approach for understanding feeding ecology because documenting feeding ecology even using radiotelemetry of these nocturnal and highly elusive Wall's Kraits is challenging. Therefore, these study findings have great implications to minimize the incidence of envenoming, fear of snake, and ruthless killing of snakes and to maximize biodiversity conservation efforts.

Krait envenoming causes great socio-economic (Pandey, 2015; Pandey and Thapamagar, 2019; Pandey et al., 2025) and socio-

TABLE 1 Length measurements (mm) for study snake specimens of *Bungarus walli* by sex.

Sex	Snout–vent length (SVL, mm)	Total length (TL, mm)	Cloaca to tail tip length (CTL, mm)	Habitats and places where the snake was originally collected		Date the snake collected	Involved in snakebite[a]	Prey in the		References
				Habitat	Place			Stomach	Hindgut	
This study										
Male	1,371	1,566	195	Kitchen of a house	Sikai Tole, Nayabasti, Biratnagar Municipality 16, Morang District, Nepal	DD July 2013	No	Rodent	Scale-like contents	
Female	590	700	110	Indoor (floor-bed)	Ambadi, Chakchaki 9, Jhapa, District	22 September 2013	Yes	Empty	Fine contents	
Female	387	453	66	Pile of fodder near a house	Magrumari, Patharia 09, Jhapa District	11 July 2013	Yes	Rodent	Furs	
Mean	489 (female), 783 (all)	577 (female), 906 (all)	88 (female), 124 (all)							
Other study										
Female	–	484.2	–	Underneath the soil (exposed after disturbance)	Oudh, Fyzabad, Uttar Pradesh State of India	06 August 2015	NA	NA	NA	Wall, 1907, p. 609
Female	–	452.4	–	Underneath the soil (exposed after disturbance)	Oudh, Fyzabad, Uttar Pradesh State of India	06 August 2015	NA	NA	NA	
Female	–	380	–	Underneath the soil (exposed after disturbance)	Oudh, Fyzabad, Uttar Pradesh State of India	06 August 2015	NA	NA	NA	
Male	–	1,301.6	–	Underneath the soil (exposed after disturbance)	Oudh, Fyzabad, Uttar Pradesh State of India	06 August 2015	NA	NA	NA	
Male	–	803.2	–	Underneath the soil (exposed after disturbance)	Oudh, Fyzabad, Uttar Pradesh State of India	06 August 2015	NA	NA	NA	
Male	–	1,046.1	–	Tree	Oudh, Fyzabad, Uttar Pradesh State of India	06 August 2015	NA	NA	NA	
Male	–	1,498.5	–	Underneath the soil (exposed after disturbance)	Oudh, Fyzabad, Uttar Pradesh State of India	06 August 2015	NA	NA	NA	
Male	–	496.5	–	Underneath the soil (exposed after disturbance)	Oudh, Fyzabad, Uttar Pradesh State of India	06 August 2015	NA	NA	NA	

(Continued)

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TABLE 1 Continued

Sex	Snout–vent length (SVL, mm)	Total length (TL, mm)	Cloaca to tail tip length (CTL, mm)	Habitats and places where the snake was originally collected		Date the snake collected	Involved in snakebite[a]	Prey in the		References
				Habitat	Place			Stomach	Hindgut	
Other study										
Female	908	1,054	146	Abandoned well	Jalalkheda a little town in Narkhedtahsil of Nagpur District, India	01 August 2015	No	NA	NA	Deshmukh et al. (2016)

mm, millimeter. [a]Yes, involved in snakebite; No, not involved in snakebite; NA, data on involvement in snakebite was not available.

psychological impact or extreme fear of snakes elsewhere (Williams et al., 2011; Wijesinghe et al., 2015; Pandey et al., 2016, 2020; Pandey, 2023). This induces unnecessary conflicts between snakes and humans (Pandey, 2023), leading many people to kill all snakes that they encounter, which results in biodiversity loss (Pandey et al., 2016, 2020; Pandey, 2023) and potentially enhances snakebite risk (Morandi and Williams, 1997) and local, regional, or global extinction of particular snake species.

4.2 Risks of envenoming

Two of three specimens of *B. walli* confronted with humans indoors at night in Nepal and its report as being found from an abandoned well at daytime in Nagpur District of India (Deshmukh et al., 2016) (Table 1) indicated the risk of envenoming due to *B. walli* bite at night and day times in residential areas. Like *B. caeruleus* (Pandey et al., 2020a), these *B. walli* also used to enter homes where they confronted with locals at night as well as in the morning in rainy months, i.e., July to September, and caused envenoming to even a sleeping person. Overall, the peak of fatal interactions among *B. walli*, *B. caeruleus*, and humans occurred during the rainy season at dark and light hours of the day (Deshmukh et al., 2016; Pandey et al., 2020a). This may correspond to a disturbance by heavy rain water or flooding in holes and burrows of the prey animals of these kraits (i.e., rodents, snakes, etc.) or treading of exposed snake hiding underneath the soil after a disturbance (e.g., by digging or ploughing) as listed in Table 1. From the disturbed hiding places, the prey animals might move to homes looking for shelter and food. Like the pursuit of pythons for food (Madsen and Shine, 1996), Wall's Kraits might pursue their prey animals and eventually enter human residential areas, resulting in human–snake confrontations, snakebites, and snake killings. Although the dietary patterns of Wall's Kraits and common kraits (Pandey et al., 2020a) correspond to the distribution and abundance of respective prey animals in the lowlands of Nepal (Pandey, 2015), there is a need to survey areas in and around houses versus natural areas in order to observe any differences in the dietary patterns of these kraits during rainy seasons and flooding periods in those areas. Unless more sophisticated survey results are available, it is essential to minimize the abundance of the prey animals of *B. walli* and *B. caeruleus* in and around houses in order to avoid envenoming of humans and domesticated animals due to krait bites across their distribution ranges in Asia.

4.3 Snake size, sex, and maturity

Our findings of greater snout–vent length of a male snake correspond to similar findings of *B. caeruleus* in earlier studies (Wall, 1921; Pandey et al., 2020a). Our male *B. walli* was larger than the largest male *B. walli* (total length = 1,499 mm) that was examined by Wall in India (Wall, 1907) (Table 1) and the largest male *B. caeruleus* (total length = 1,322 mm) known in Nepal

FIGURE 8
Juvenile rodents in the stomach of Wall's krait not involved in snakebite in Biratnagar town, Morang District, Nepal. A partially digested rodent prey **(A, B)** in its stomach would be a recently eaten rodent by this snake (photographed by Deb P. Pandey).

(Pandey et al., 2020a). The female *B. walli* were relatively smaller than *B. caeruleus* specimens, with SVL ranging 460–936 mm (Pandey et al., 2020a). Only a male *B. walli* (Figure 1C) was sexually mature, which intruded into the kitchen of a house. Approximately 35% sexually matured *B. caeruleus* (Pandey et al., 2020a) entered residential areas, mainly indoors. The maturity and intrusion of these krait species into residential areas suggest that the reproductive cycle and reproductive activities of snakes might orient them to look for mates or warm and secure shelters. To determine whether the reproductive cycle (to know the stages for maturity of gonads) and reproductive activities contribute to prompt them to homes, it is essential to carry out a radiotelemetric study of mature kraits.

4.4 Constraints of the study

We could not identify species of prey animals or their body fragments based on DNA analysis because of the resource constraints. This species dietary composition may not be extrapolated to its population in its natural habitats such as forests, grasslands, etc., because our non-probability samples with a small sample size of killed snakes in residential areas may introduce potential sample biases. These snakes may also feed on other prey animals that are not listed in our study. Our extrapolation of threshold for sexual maturity of *B. walli* from the threshold for *B. caeruleus* can be the next potential limitation of this study because we assumed the criteria for sexual maturity (SVL ≥ 890 mm) that was cited from studies on *B. caeruleus*.

5 Conclusion

The preliminary insight of *Bungarus walli*'s diet has implication to understand its ecology and interface with humans. This dietary information is useful in understanding their role in controlling small mammal population sizes in human activity areas (because very little is known about food preference (i.e., feeding ecology) of this elusive, deadly, and medically highly important snake). This helps to mitigate potential human–snake conflicts, which, in turn, contributes to snakebite prevention and snake conservation efforts because it intrudes into anthropic and perianthropic areas in Nepal. However, further studies on the movement patterns of this species distributed in forested and residential areas, agricultural lands, and other natural ecosystems are necessary to know more precise and comprehensive information on the diet of *B. walli* and to understand about the factors attracting them toward residential areas in order to formulate and implement more effective prevention strategies against their bites as well as to minimize human–snake conflicts.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material. Further inquiries can be directed to the corresponding author.

Ethics statement

The animal study was approved by Nepal Health Research Council and Department of Forestry, Ministry of Nepal. The study was conducted in accordance with the local legislation and institutional requirements. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

DPP: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. RCP: Investigation, Project administration, Resources, Writing – review & editing.

Funding

The author(s) declare financial support was received for the research and/or publication of this article. The PI was financially supported by the Senckenberg Biodiversity and Climate Research Centre, Senckenberg Research Institute and Natural History Museum, Frankfurt am Main, Germany by a DAAD scholarship to accomplish his PhD dissertation between 2011 and 2015.

Acknowledgments

We are thankful to Damak and Charaali STCs, Jhapa District, and all staffs involved for the preservation of specimens brought by patients or their visitors. We are especially thankful to Prem Bista (a snake rescuer in Biratnagar) who provided detailed information on killed specimen of Wall's Krait that was not involved in snakebite. We are grateful to Apex Academy for providing us a biology laboratory to examine the food contents and deposit the study specimens. We are grateful to A. Durso, Florida Gulf Coast University, USA, for his review comments.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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SUPPLEMENTARY FIGURE 1
Damaged specimens of *Bungarus walli* [upper: MVEM.BW4, 26.66417° N, 87.65444° E, 128 m; middle: MVEM.BW5, 26.62639° N, 87.69725° E, 100 m; bottom: MVEM.BW3, 26.67586° N, 87.66519° E, 133 m] involved in snakebite that were excluded for gut food content analysis (Photographed by Deb P. Pandey). The cases MVEM.BW4 and MVEM.BW5 were interviewed at the site of snakebite to interpret the eco-epidemiology of their bites. The case MVEM.BW4 was a 21-year-old female farmer who was bitten by this snake on the hand while cutting grasses in an agricultural field in the morning (00700–0759 h) on July 16, 2013. After washing the bite wound with water, she was carried on a motorcycle to a snakebite treatment center run by Nepal Red Cross Society based on Damak of Jhapa District. The case MVEM.BW5 was a 43-year-old male farmer who was bitten by this snake on the hand while attempting to kill the snake indoor of her own house (house type: brick/block–bamboo–cement house with galvanized tin roofs) in the night (2000–2059 h) of July 30, 2013. After using a single tourniquet, he was also carried on a motorcycle to a snakebite treatment center run by Nepal Red Cross Society based on Damak of Jhapa District. MVEM.BW3 was a 56-year-old male farmer.

References

Abtin, E., Nilson, G., Mobaraki, A., Hosseini, A. A., and Dehgannejhad, M. (2014). A new species of Krait, *Bungarus* (Reptilia, Elapidae, Bungarinae) and the first record of that genus in Iran. *Russian J. Herpetology* 21, 243–250.

Ahsan, M. F., and Rahman, M. M. (2017). Status, distribution and threats of kraits (Squamata: Elapidae: Bungarus) in Bangladesh. *J. Threatened Taxa* 9, 9903–9910. doi: 10.11609/jott.2929.9.3.9903-9910

Aksornneam, A., Rujirawan, A., Yodthong, S., Sung, Y.-H., and Aowphol, A. (2024). A new species of krait of the genus *Bungarus* (Squamata, Elapidae) from Ratchaburi Province, western Thailand. *Zoosystematics Evol.* 100, 141–154. doi: 10.3897/zse.100.116601

Ariaratnam, C. A., Sheriff, M. H. R., Theakston, R. D. G., and Warrell, D. A. (2008). Distinctive epidemiologic and clinical features of Common Krait (*Bungarus caeruleus*) bites in Sri Lanka. *Am. J. Trop. Med. Hygiene* 79, 458–462. doi: 10.4269/ajtmh.2008.79.458

Azam, M. S., Alam, S. S., and Shah, M. R. (2011). "Country report of Bangladesh on CITES Asian Snake Trade Workshop," in *CITES Asian Snake Trade Workshop*, Guangzhou, China: CITES 1–12.

Baeckens, S., Meiri, S., and Shine, R. (2023). Foraging mode affects extinction risk of snakes and lizards, but in different ways. *Conserv. Lett.* 16, e12977. doi: 10.1111/conl.12977

Banik, A., and Ray, P. (2023). *Bungarus walli* (Wall's krait). Scavenging. *Herpetological Rev.* 54, 308.

Bawaskar, H. S., and Bawaskar, P. H. (2004). Envenoming by the Common Krait (*Bungarus caeruleus*) and Asian Cobra (*Naja naja*): clinical manifestations and their management in a rural setting. *Wilderness Environ. Med.* 15, 257–266. doi: 10.1580/1080-6032(2004)015[0257:EBTCKB]2.0.CO;2

Bolon, I., Durso, A. M., Botero Mesa, S., Ray, N., Alcoba, G., Chappuis, F., et al. (2020). Identifying the snake: first scoping review on practices of communities and healthcare providers confronted with snakebite across the world. *PloS One* 15, e0229989. doi: 10.1371/journal.pone.0229989

Boulenger, G. A. (1897). A new krait from Sind (*Bungarus sindanus*). *J. Bombay Natural History Soc.* 11, 73–74.

Brischoux, F., Bonnet, X., and Shine, R. (2009). Determinants of dietary specialization: a comparison of two sympatric species of sea snakes. *Oikos* 118, 145–151. doi: 10.1111/j.1600-0706.2008.17011.x

Brown, D. S., Burger, R., Cole, N., Vencatasamy, D., Clare, E., Montazam, A., et al. (2014). Dietary competition between the alien Asian Musk Shrew (*Suncus murinus*) and a re-introduced population of Telfair's Skink (*Leiolopisma telfairii*). *Mol. Ecol.* 23, 3695–3705. doi: 10.1111/mec.12445

De Queiroz, A., Henke, C., and Smith, H. M. (2001). Geographic variation and ontogenetic change in the diet of the Mexican Pacific lowlands garter snake, *Thamnophis validus*. *Copeia* 2001, 1034–1042. doi: 10.1643/0045-8511(2001)001[1034:GVAOCI]2.0.CO;2

Deshmukh, R. V., Deshmukh, S. A., and Badhekar, S. A. (2016). First records of *Oligodon taeniolatus* and *Bungarus sindnus walli* from Nagpur District, Maharashtra, India. *Reptile Rap* 18, 40–42.

Durso, A., Willson, J., and Winne, C. (2013). Habitat influences diet overlap in aquatic snake assemblages. *J. Zoology* 291, 185–193. doi: 10.1111/jzo.12061

Gibbs, H. L., and Mackessy, S. P. (2009). Functional basis of a molecular adaptation: prey-specific toxic effects of venom from *Sistrurus rattlesnakes*. *Toxicon* 53, 672–679. doi: 10.1016/j.toxicon.2009.01.034

Khan, M. S. (1985). Taxonomic notes on *Bungarus caeruleus* (Schneider) and *Bungarus sindanus* Boulenger. *Snake* 17, 71–78.

Krishnakumar, B., Guptha, B., Ramanujam, E., and Ganesh, S. (2023). Rodent Surveys reveal good insights into the snake fauna in an agro-pastoral ecosystem in southern India. *J. Biol. Stud.* 6, 230–240. doi: 10.62400/jbs.v6i2.7905

Kuch, U. (2001). Notes on the diet of the Malayan Krait, *Bungarus candidus* (Linnaeus 1758). *Herpetological Bull.* 75, 10–14.

Kuch, U., and Schneyer, W. (1996). Erfahrungen mit der terrarienhaltung von vier arten nahrungsspezialisierter giftnattern der gattung *Bungarus* Daudin 1803. Teil IV: *Bungarus flaviceps* (Reinhardt, 1843). *Sauria* 18, 3–16.

Kunwar, A., Gaire, R., Pokharel, K. P., Baral, S., and Thapa, T. B. (2016). Diet of the four-horned antelope *tetracerus quadricornis* (De blainville 1816) in the churia hills of Nepal. *J. Threatened Taxa* 8, 8745–8755. doi: 10.11609/jott.1818.8.5.8745-8755

Madsen, T., and Shine, R. (1996). Seasonal migration of predators and prey: a study of pythons and rats in tropical Australia. *Ecology* 77, 149–156. doi: 10.2307/2265663

Mao, S. (1970). Food of the common venomous snakes of Taiwan. *Herpetologica* 26, 45–48.

Maritz, B., Hofmann, E. P., Maritz, R. A., Greene, H. W., Grundler, M. C., and Durso, A. M. (2021). Challenges and opportunities in the study of snake diets. *Herpetological Rev.* 52, 769–773.

Michálek, O., King, G. F., and Pekár, S. (2024). Prey specificity of predatory venoms. *Biol. Rev.* 99, 2253–2273. doi: 10.1111/brv.13120

Modahl, C. M., Mukherjee, A. K., and Mackessy, S. P. (2016). An analysis of venom ontogeny and prey-specific toxicity in the Monocled Cobra (*Naja kaouthia*). *Toxicon* 119, 8e20. doi: 10.1016/j.toxicon.2016.04.049

Morandi, N., and Williams, J. (1997). Snakebite injuries: contributing factors and intentionality of exposure. *Wilderness Environ. Med.* 8, 152–155. doi: 10.1580/1080-6032(1997)008[0152:SICFAI]2.3.CO;2

Pandey, D. P. (2015). Venomous snakes of medical relevance in Nepal: study on species, epidemiology of snake bite and assessment of risk factors of envenoming and death (Frankfurt: Goethe University). Available online at: http://publikationen.ub.uni-frankfurt.de/frontdoor/index/index/docId/38272 (Accessed July 26, 2025).

Pandey, D. P. (2023). "Global perspectives on human-snake interactions," in *Snakes: Morphology, Function, and Ecology*. Ed. D. Penning (Nova Science Publishers, Inc, New York, USA), 547–596.

Pandey, D. P., Adhikari, B., Pandey, P., Sapkota, K., Bhusal, M., Kandel, P., et al. (2025). Cost of snakebite and its impact on household economy in southern Nepal. *Am. J. Trop. Med. Hygiene* 112, 431–440. doi: 10.4269/ajtmh.24-0399

Pandey, D. P., Bhattarai, P., and Piya, R. C. (2020a). Food spectrum of Common Kraits (*Bungarus caeruleus*): An implication for snakebite prevention and snake conservation. *J. Herpetology* 54, 87–96. doi: 10.1670/18-054

Pandey, D. P., Chaudhary, B., Subedi Pandey, G., Piya, R. C., and Devkota, N. R. (2020b). School students' perceptions on snakes, their uses, and snakebite in Nepal: implications for snake conservation and snakebite prevention. *Adv. Clin. Toxicol.* 5, 000180. doi: 10.23880/act-16000180

Pandey, D. P., Jelic, D., Sapkota, S., Lama, H. M., Lama, B., Pokharel, K., et al. (2018). New records of snakes from Chitwan National Park and vicinity, Central Nepal. *Herpetology Notes* 11, 679–696.

Pandey, D. P., Subedi Pandey, G., Devkota, K., and Goode, M. (2016). Public perceptions of snakes and snakebite management: implications for conservation and human health in southern Nepal. *J. Ethnobiology Ethnomedicine* 12, 22. doi: 10.1186/s13002-016-0092-0

Pandey, D. P., and Thapamagar, C. (2019). *Medically Important Snakes and Snakebite Management in Nepal. Nepali edition* (Bharatpur, Nepal: Bishnu Kumari Pandey).

Parker, W. S., and Plummer, M. V. (1987). "Population ecology," in *Snakes: ecology and evolutionary biology*. Eds. R. A. Seigel, J. T. Collins and S. S. Novak (MacMillan Publ. Co, New York, USA), 253–301.

Sanz, L., Gibbs, H. L., Mackessy, S. P., and Calvete, J. J. (2006). Venom proteomes of closely related *Sistrurus rattlesnakes* with divergent diets. *J. Proteome Res.* 5, 2098–2112. doi: 10.1021/pr0602500

H. H. Schleich and W. Kästle (Eds.) (2002). *Amphibians and Reptiles of Nepal: Biology, Systematics, Field Guide* (Ruggell, Germany: A.R.G. Gantner Verlag Kommanditgesellschaft).

Sharma, S. K., Pandey, D. P., Shah, K. B., Tillack, F., Chappuis, F., Thapa, C. L., et al. (2013a). *Venomous Snakes of Nepal: A Photographic Guide. Nepali edition* (Lalitpur, Nepal: B. P. Koirala Institute of Health Sciences, Dharan, Nepal).

Sharma, S. K., Pandey, D. P., Shah, K. B., Tillack, F., Chappuis, F., Thapa, C. L., et al. (2013b). *Venomous Snakes of Nepal: A Photographic Guide. English edition* (Lalitpur, Nepal: B. P. Koirala Institute of Health Sciences, Dharan, Nepal).

Slowinski, J. B. (1994). The diet of kraits (Elapidae: *Bungarus*). *Herpetological Rev.* 25, 51–53.

Wall, F. (1907). A new krait from Oudh (*Bungarus walli*). *J. Bombay Natural History Soc.* 17, 608–611.

Wall, F. (1921). *Ophidia Taprobanica or the snakes of Ceylon* (Colombo: The Government Press).

Wallach, V., Williams, K. L., and Boundy, J. (2014). *Snakes of the World: A Catalogue of Living and Extinct Species* (New York: CRC Press).

Webb, J. K., and Shine, R. (1998). Ecological characteristics of a threatened snake species, *Hoplocephalus bungaroides* (Serpentes, Elapidae). *Anim. Conserv.* 1, 185–193. doi: 10.1111/j.1469-1795.1998.tb00028.x

Wijesinghe, C. A., Williams, S. S., Kasturiratne, A., Dolawaththa, N., Wimalaratne, P., Wijewickrema, B., et al. (2015). A randomized controlled trial of a brief intervention for delayed psychological effects in snakebite victims. *PloS Negl. Trop. Dis.* 9, e0003989. doi: 10.1371/journal.pntd.0003989

Williams, S. S., Wijesinghe, C. A., Jayamanne, S. F., Buckley, N. A., Dawson, A. H., Lalloo, D. G., et al. (2011). Delayed psychological morbidity associated with snakebite envenoming. *PloS Negl. Trop. Dis.* 5, e1255. doi: 10.1371/journal.pntd.0001255

Wolfe, A. K., Bateman, P. W., and Fleming, P. A. (2017). Does urbanization influence the diet of a large snake? *Curr. Zoology* 64, 311–318. doi: 10.1093/cz/zox039