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RESEARCH ARTICLE

Deadly dormmate: A case study on *Bungarus candidus* living among a student dormitory with implications for human safety

Cameron Wesley Hodges | Curt Hrad Barnes | Porramin Patungtaro | Colin Thomas Strine

School of Biology, Institute of Science, Suranaree University of Technology, Muang, Nakhon Ratchasima, Thailand

Correspondence
Cameron Wesley Hodges, School of Biology, Institute of Science, Suranaree University of Technology, 111 University Avenue, Muang, Nakhon Ratchasima 30000, Thailand.
Email: cameron.wesley.hodges@gmail.com

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Abstract

1. Snakebite, which was reclassified as a neglected tropical disease by the World Health Organization in 2017, afflicts at least 1.8–2.7 million people worldwide each year. Understanding the habits of medically significant snakes can help us better construct preventative measures which reduce snake–human conflicts and snakebite.
2. As a case study, using radio-telemetry, we monitored a single focal *Bungarus candidus* individual for 102 days within a suburban landscape (a university dormitory complex) in Nakhon Ratchasima, Thailand.
3. Daily location checks revealed the telemetered snake sheltered within human settlement habitat 75% of the time it was tracked, where we also documented active foraging, a predation event and interactions with humans.
4. Despite being captured and relocated to an adjacent forest on two occasions, the focal animal promptly returned to the dormitories. Translocation as a management tool requires meaningful discussion at the local level and further study, considering the costs and potential limitations for effectiveness.
5. This case study provides brief insight into the ecology and behaviour of one of Asia's most medically significant snake species and highlights challenges current conflict management practices face locally. Our observations appear to lend credibility to preventative measures such as increasing awareness, encouraging the use of flashlights and carefully maintaining buildings so that snakes cannot enter through crevices or plumbing. Snake–human conflict prevention and mitigation techniques require further evaluation to determine the effectiveness of prescribed management methods.

KEYWORDS
elapid, foraging behaviour, habitat use, human–wildlife conflict, short-distance translocation, snakebite prevention, Thailand, urban ecology

1 | INTRODUCTION

Ecological and behavioural studies can provide valuable information applicable to wildlife conservation and management (Fraser et al., 2018). Such knowledge can reduce and mitigate human–wildlife conflicts (Gunther et al., 2004; Takahata, Nielsen, Takii, & Izumiyama, 2014). Although experimental studies are ideal, information on basic natural history adds to understanding how species live in the wild, even contributing to the disciplines of conservation biology and human health (Dayton, 2003; Greene, 2005; Ramesh & Nehru, 2019; Tewksbury et al., 2014). We must understand target organism behaviour, ecology and natural history to address real-world conservation and wildlife management issues (Fraser et al., 2018; Takahata et al., 2014; Tewksbury et al., 2014).

Despite being directly responsible for snakebite envenomation – a neglected tropical disease (Chippaux, 2017) afflicting at least 1.8–2.7 million people worldwide each year (Chippaux, 1998; Kasturiratne et al., 2008; Suraweera et al., 2020) – behavioural and ecological studies on snakes are relatively few compared to those focusing upon endothermic taxa (Bonnet, Shine, & Lourdais, 2002; Ford, 1995; Pawar, 2003). Investigating medically significant snake ecology will allow us to better construct preventative measures (Pandey, Pandey, Devkota, & Goode, 2016; Ramesh & Nehru, 2019). But, the link between knowledge gained and the direct application of management strategies to reduce snakebite morbidity and mortality remains scarcely addressed by behavioural and ecological studies. Providing information on snake habits to at-risk communities may reduce snake–human conflicts and thus snakebite (Gutiérrez et al., 2017; Suraweera et al., 2020; Warrell, 2010; World Health Organization [WHO], 2016).

Education programmes coupled with conflict mitigation efforts may be important for both snake conservation and snakebite prevention. Frequently people manage conflict events by removing snakes and moving the offending individuals (sometimes hundreds of kilometres) away from the initial capture site (Devan-Song et al., 2016). Long-distance translocation of snakes (moving the animal outside its established home range) results in numerous issues, including poor health, decreased fitness, higher mortality as well as potential disease transmission to receiving areas (Barve et al., 2013; Butler, Malone, & Clemann, 2005; Devan-Song et al., 2016; Massei, Quy, Gurney, & Cowan, 2010; Nowak, Hare, & McNally, 2002; Sullivan, Nowak, & Kwiatkowski, 2015; Wolfe, Fleming, & Bateman, 2018). Short-distance translocations, where the rescuers release the snake near to the initial capture location as possible (within its home range), are generally more ethical and less problematic (Barve et al., 2013; Bauder, Castellano, Jensen, Stevenson, & Jenkins, 2014; Hardy, Greene, Tomberlin, & Webster, 2001). However, translocated animals often return to capture locations or even become a nuisance at new sites (Sullivan et al., 2015). While mitigation translocations can decrease intentional killings of snakes (Balakrishnan, 2010), conflict prevention methods are more sustainable for decreasing the risk of snakebites to people (WHO, 2016).

Though evidence is generally lacking, snake–human conflicts can theoretically largely be prevented. In an attempt to discourage snake presence and their prey among human settlements, managers commonly suggest clearing understory vegetation, keeping food properly contained and moving brush piles, grain stores and other clutter away from houses (Parkhurst, 2009; WHO, 2016). While working outdoors, wearing boots and using a flashlight and walking-stick during the night can prevent snakebite (WHO, 2016). Sealing gaps in structures where snakes may be able to enter households and sleeping under bed-nets similarly help prevent snakebites from occurring inside homes by limiting access (Chappuis, Sharma, Jha, Loutan, & Bovier, 2007). This may protect people from kraits (*Bungarus* species), which are medically significant snakes from South and Southeast Asia that commonly enter homes and bite (Kularatne, 2002; Tongpoo et al., 2018; Warrell, 2010; Warrell et al., 1983).

Malayan kraits (*B. candidus*) are highly venomous nocturnal elapids, ranging throughout Southeast Asia. *B. candidus* commonly occur in human-modified habitats, such as agriculture, rural settlements and even suburban settlements, near forested areas (Chanhome, Cox, Vasaruchapong, Chaiyabutr, & Sitprija, 2011; Hodges, D'souza, & Jintapirom, 2020b; Knierim et al., 2018), where researchers have observed them entering occupied buildings in search of prey (Hodges et al., 2020b; Prasarnpun, Walsh, Awad, & Harris, 2005). In fact, many bite incidences occur while the victim is sleeping on the ground in rural settlements (Prasarnpun et al., 2005; Warrell, 2010). As a result of this species' potent neurotoxic venom and behaviour, *B. candidus* is responsible for a considerable proportion of snakebite deaths in Thailand (Buranasin, 1993; Looareesuwan, Viravan, & Warrell, 1988; Tongpoo et al., 2018; Viravan et al., 1992; Table 1).

We present details on the space use and foraging ecology of a single radio-tracked male *B. candidus* as a case study in northeast Thailand, and subsequently discuss ecological insight gained and subsequent implications for human safety. While this study is limited by the number of individuals examined ($n = 1$), the study period (102 days, corresponding to the wet season and early cold season), sampling regime (fixes ca. every 21 h, with a total of 117 fixes) and the study site (one university campus in NE Thailand), we provide a detailed account of the movements, foraging behaviour, habitat use and general natural history of a focal individual of a medically significant and rarely studied species living at close proximity to humans. We also provide discussion regarding short-distance translocation, which was utilized as a public safety mitigation measure twice. Lastly, we attempt to provide direct and clear recommendations and bite-prevention solutions derived from our focal animal, which could be applied to other individuals, species and areas.

2 | MATERIALS AND METHODS

2.1 | Study site

The observations and movement data detailed are one component of a larger study on *B. candidus* on Suranaree University of Technology (SUT) campus, in Nakhon Ratchasima province, Thailand. The campus of SUT is a matrix of human-modified land-use types with numerous buildings interspersed with small patches of mixed deciduous forest.

TABLE 1 Summary of the published data on bite occurrences by *B. candidus*, with mortality percentages and regional hotspots of documented bite incidents in Thailand

Reference	Study area	Total number of bites	Number of krait bites	Number of fatal bites by *B. candidus*	Regional hotspots
Warrell et al. (1983)	Chanthaburi, Thailand and Kedah, Malaysia	5	5 (*B. candidus*)	1 (20% all, 33% of envenomed)	3 of 5 in E Thailand
Looareesuwan et al. (1988)	Thailand	46 (all fatal)	14 (13 *B. candidus*, 1 *B. fasciatus*)	13 of 46 fatal bites (28.26% of fatal bites)	10 of 13 in NE Thailand (76.9%)
Viravan et al. (1992)	Thailand	1145	15 (13 *B. candidus*, 2 *B. fasciatus*)	Unknown	6 of 13 in NE Thailand (46.2%)
Buranasin (1993)	Nakhon Ratchasima, Thailand	199	4 (either *B. candidus* or *B. fasciatus*)	1-2 of 7 fatal bites (14.29–28.57% of fatal bites)	NA
Tongpoo et al. (2018)	Thailand	78	78 (68 *B. candidus*, 9 *B. fasciatus*, 1 *B. flaviceps*)	5 out of 68 bites (7.35% of *B. candidus* bites)	55 of 78 krait bites in NE Thailand (70.5%)

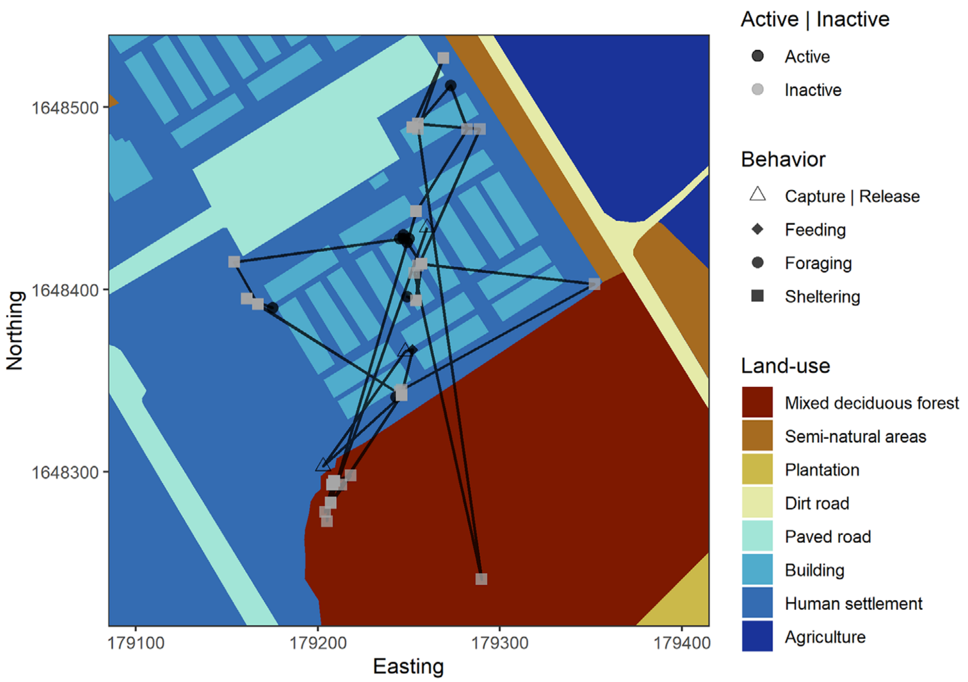

FIGURE 1 A map of land-use illustrating how the telemetered *B. candidus* predominately used human settlements among S-15 dormitory buildings and the edge of adjacent mixed deciduous forest. Circles = foraging, triangles = capture/release points, squares = sheltering; black = active, light gray = inactive

The landscape surrounding the university is dominated by upland monoculture agricultural plots and human residential areas. Mean yearly temperature is about 28°C (high of 30.2°C, low of 23.7°C) and average rainfall is about 90 mm (Paiboon, Aroon, Thanee, Jitpukdee, & Tantipanatip, 2018). People rarely encounter Malayan kraits on SUT campus. We have only documented 29 live individuals between 15 May 2018 and 15 May 2020 (26 among human settlements from residents contacting investigators for snake removal services).

Here we devote attention to one particular on-campus student dormitory, Suranivet 15 (S-15), on the north-eastern border of SUT campus. The dormitory has two sides, separated by a large covered flattop area for motor vehicle parking. Each side has 18 single-story rectangular buildings (measuring 40 m × 8 m). We focus primarily on the southern half (Figure 1), where 466 students resided during the time of this study. Among the dormitory buildings is manicured grass lawn and sparse tree cover. There are various other land-use features surrounding the dormitory premises, including a two-lane road just west of the dormitory complex, a 3.9-ha mixed deciduous forest (followed by a 2.6-ha mature eucalyptus plantation forest) to the dormitory's immediate south and agriculture bordering the campus to the east.

The agricultural land is mostly monoculture plots of cassava, maize and sugarcane.

2.2 | Materials and methods

University security personnel captured the focal individual *B. candidus* (ID = BUCA28) on 3 July 2019 after a student encountered the snake moving across a sidewalk adjacent to a dormitory building at 22:10

(UTM 48N 0179260, 1648429). Soon after, we transferred the snake to our laboratory, and then processed it for morphological measurements. We then housed the individual in a plastic box with provided shelter and water for 5 days, awaiting surgical transmitter implantation by the veterinarian at the Korat Zoo. The *B. candidus* had a mass of 91.2 g, and measured 77.2 cm snout-to-vent length (SVL) and 11.4 cm tail length (TL). On 8 July 2019, we surgically implanted a 1.8-g Holohil BD-2 radio-transmitter within the coelomic cavity of the snake, as described by Reinert and Cundall (1982), while the snake was anaesthetized. In order to minimize stress to the snake and to allow it to thermoregulate in the wild, we released the snake that night at the edge of the forest patch immediately behind the student dormitory, 150 m from the location where the snake was captured.

Upon releasing the snake, we began to determine the individual's location daily, through VHF radio telemetry. We recorded the snake's location with a Garmin 64S GPS device, which had an average GPS accuracy of near 5 m. While at each site, we recorded the straight-line distance between the current and previous location (distance moved), habitat type (forest, human-settlement, semi-natural area or agriculture) and attempted to identify shelter type. We then calculated mean values for movement distance, daily displacement, time between location checks (lag-time), number of consecutive days the snake relocated shelters and consecutive days of inactivity, using $\pm$ to denote standard error and SD to indicate standard deviation where means are reported.

In addition to determining the snake's diurnal location daily, we occasionally tracked the snake at nighttime in an attempt to document active behaviours. However, these nocturnal tracks were relatively infrequent and not randomly selected. All night tracks took place between 18:00 and 00:20; we selected nights sometimes arbitrarily and sometimes based on when we perceived the snake to be most likely to be active (based on recent movement history and environmental conditions), and when weather conditions allowed for tracking (i.e. we did not track the snake during heavy rains to protect our telemetry equipment). Whenever we encountered the telemetered *B. candidus* while active we dimmed our torchlight, minimized movements and limited flash photography, while also attempting to maintain a distance of > 5 m from the snake, as we aimed to observe and document the snake's natural behaviour without disrupting it.

On some occasions, we stationed field cameras (Bushnell Trophy Cam HD Essential E2) outside occupied shelter sites in an attempt to record interesting behaviours and gain information about the snake's activity patterns. We carefully positioned cameras outside shelter entrances with small tripods and configured each camera to a time-lapse setting, taking one photograph every minute. Note that we typically refrained from placing cameras on shelter sites which were directly visible from the dormitory sidewalks, as we did not wish to reveal the snake's location to the residents.

We deposited all data in online repositories to facilitate open and transparent analysis following recommendations from Marshall and Strine (2021) regarding openness and transparency in herpetology.

3 | RESULTS

3.1 | Movements

We tracked the *B. candidus* for a total of 102 days (8 July 2019 to 18 October 2019) and located the individual a total of 117 times, with 31 relocations (moves > 5 m) during the study. Mean movement distance between locations was 62.07 $\pm$ 10.54 m (8-251 m) and mean daily displacement was 18.62 $\pm$ 4.23 m (movement distance summaries exclude the focal animal's 85 m move back to the dormitory post translocation to the forest). Mean lag-time between tracks was 20.99 (*SD* = 7.69 h), and there were only 2 days where we were unable to locate snake due to heavy and prolonged rainfall. Of the 100 days, we located the snake during sheltering, a total of 75 fixes were within human settlements, while only 25 were within mixed deciduous forest, with all but one of which being within 15 m of the forest's hard edge.

In total, we located the snake 96 times during daylight (from between 06:00 to 18:00) and on 17 different occasions at night (from between 18:00 to 06:00; excluding four additional points taken while following the snake's movements on 13 August 2019). We found that the individual cycled through periods of consecutive days of movements (mean = 2 days, max = 5, min = 1, SD = 1.3 days), followed by longer periods of inactivity (mean = 5 days, max = 18, min = 1, SD = 4.7 days). Movement data are available on Zenodo (https://doi.org/10.5281/zenodo.4309113; Hodges, Barnes, Patungtaro, & Strine, 2020a) and Movebank (ID: 1396626072; Hodges, Barnes, Patungtaro, & Strine, 2021).

3.2 | Noteworthy observations

During nocturnal tracking, we visually observed the snake on three separate occasions. The snake was also detected by students residing at the dormitories and subsequently captured by trained security staff workers before being handed over to us and released on one occasion in addition to the instance that led to the snake's initial capture. Here we detail a predation event and foraging behaviour by the telemetered *B. candidus* living in close proximity to a student dormitory.

3.3 | Disturbed predation event

On 2 August 2019 at 00:23, a student encountered the focal animal during a predation attempt on a juvenile banded kukri snake, *Oligodon fasciolatus*, within a shallow concrete drainage gutter which runs along

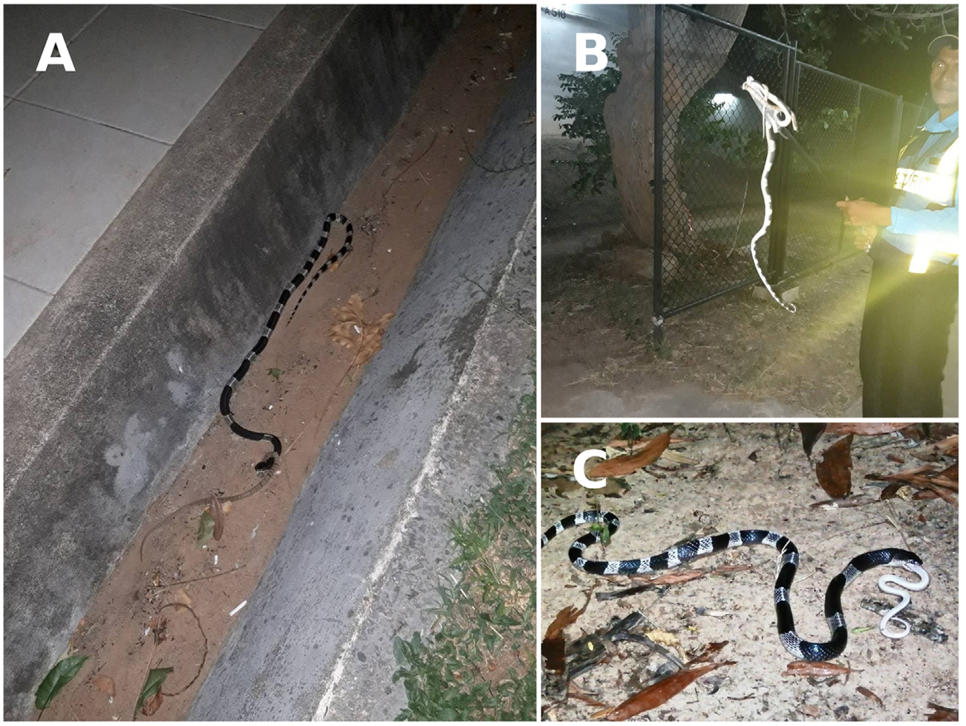

FIGURE 2 (a) Telemetered *B. candidus* was discovered by an SUT student during the predation of a young *O. fasciolatus* among the student dormitories. (b) University security staff promptly captured the *B. candidus* so that it could be relocated away from the dormitories. (c) The *B. candidus* was released at the edge of a nearby forest patch and presented with the now dead prey item. The *B. candidus* immediately resumed feeding on the *O. fasciolatus*

the dormitory sidewalk (Figure 2(a)). At the time of discovery, the *B. candidus* was still struggling with the live *O. fasciolatus*; however, by the time SUT security officers arrived the krait had already ingested about 1/3 of the *O. fasciolatus*. The security officers then proceeded to capture the snakes using snake tongs, causing the *B. candidus* to regurgitate the *O. fasciolatus* (Figure 2(b)).

We arrived at the dormitory at 00:35 and confirmed that the captured *B. candidus* was in fact our resident telemetered individual. At 01:05, we released the *B. candidus* about 75 m southwest of the capture point, near a shelter site the individual was known to have used previously at the edge of the adjacent forest patch. As we gently released the snake, we carefully placed the dead *O. fasciolatus* (which we quickly measured after initial capture of the krait, and just before we released it: SVL = 284 mm, TL = 55 mm) near its head, to which the *B. candidus* responded by immediately rapidly flicking its tongue twice before biting the prey item on the head. The krait then began to move away from us while dragging the dead *O. fasciolatus*. He carried the snake with him for approximately 30 s, only moving a couple of metres, before stopping and beginning to ingest the prey item head-first (Figure 2(c)). Total prey handling time took just under 5 min. After swallowing the *O. Fasciolatus*, the *B. candidus* cautiously moved into nearby tall grass.

The following morning, we returned to determine the diurnal shelter location of the *B. candidus*. We were surprised to find that the individual had returned to the dormitories and was sheltering within the same burrow leading underneath a dormitory building in which the snake had spent the previous 2 days (ca. 85 m from the release location).

3.4 | Active foraging

On 13 August 2019 at 20:40, we witnessed the telemetered individual actively foraging during a nocturnal track. The krait had already moved 15 m away from the shelter where it had been located, in the centre of the dormitory complex, earlier that day. The snake appeared to be actively foraging along a heavily trafficked sidewalk. After locating the snake, we moved several metres away from the snake and began observing its behaviour. I was able to watch the snake for a total of 130 min. During this time, the snake was flicking its tongue frequently and rapidly, as it moved slowly through the grass adjacent to the sidewalk. The snake crossed over the sidewalk a total of four times while being observed. Also, the snake explored numerous nooks and crannies and even went completely inside holes in the ground and under the sidewalk and other anthropogenic structures a total of seven times, spending roughly 1–8 min within each refuge before re-emerging. The snake revisited one particular hole underneath the sidewalk on three different occasions and a hole at the base of a shrub on two separate occasions.

The sidewalk where the snake spent approximately 2 h meandering around was concealed in shadows, as the nearby over-head lamps did not shine over this part of the walkway, which was between two dormitory complex buildings (Figure 3). Numerous students (at least 12) attempted to pass by on the sidewalk before being alerted to the snake's presence by us, and consequently opting to take a longer alternate route to their rooms. The majority of these students were wearing

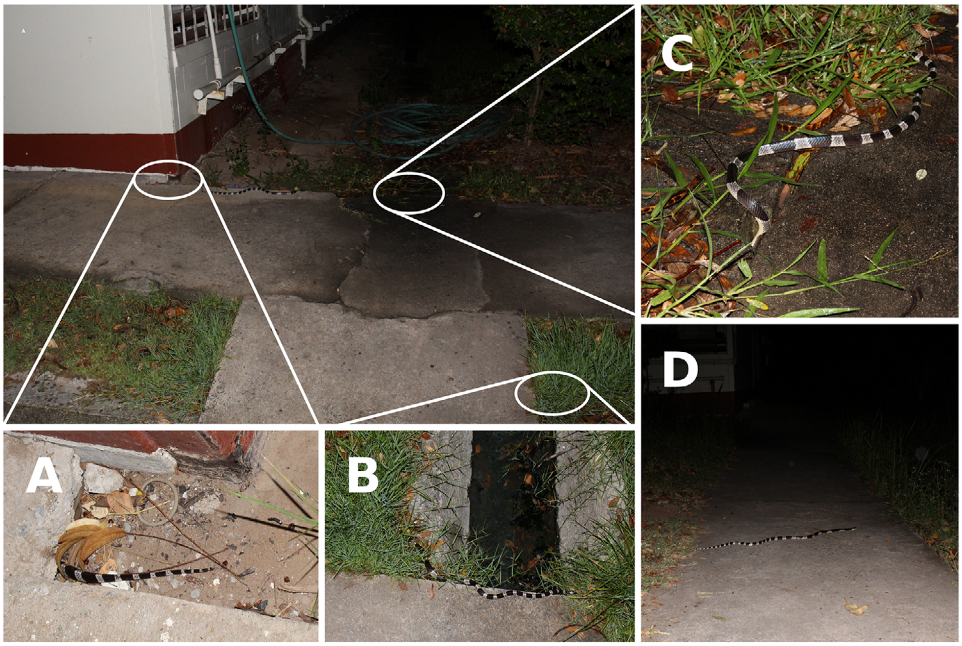

FIGURE 3 The telemetered *B. candidus* meandered around a high-traffic sidewalk at the centre of a university student dormitory complex as it actively foraged for prey. (a) The individual re-visited this particular hole underneath the pavement, moving fully within the cavity and re-emerging a total of three times. (b) The *B. candidus* moved slowly and spent most of its time searching for prey along anthropogenic structures, investigating crevices and potential prey refugia. (c) The *B. candidus* probed its head into burrows and crevices which may harbor prey species. (d) The *B. candidus* crossed over the sidewalk a total of four times during a 2-h period

flip-flop shoes and shorts, and many of the students were walking along the dark sidewalk while looking at their illuminated phone screen, paying no attention to their surroundings. Several of these students came within a few metres of the snake before being stopped by us. None of the students were using hand-held flashlights, despite most, if not all, possessing cellphone devices which have flashlight features installed in them.

At 22:50, the snake approached a snake hook which we had left leaning against one of the dorm building walls before the snake began moving that direction. We watched as the snake smelled the hook and then quickly responded by rapidly turning 180° and fleeing down one of the nearby holes which the snake had previously entered during our observations.

3.5 | Camera trapping

We placed camera traps on shelter sites (holes near buildings) and gathered a total of 12,122 photographs through time-lapse photography spanning nine different days; however, the *B. candidus* individual was only visible in a total of 16 of these photographs, from three different nights. The snake left and did not return to the same shelter site on two of the occasions (i.e. the snake was located within a different shelter the next morning).

While generally we only had photographs of the snake peering out from the refuge entrance, emerging and subsequently leaving the shelter, during one of the occasions the snake was seen to exit the shelter at 19:06, and subsequently return to the shelter two more times, passing by once (19:23), and even re-entering the shelter (19:26) and then exiting it again (19:32; Figure 4). Based on radio-telemetry findings, the next day, we determined the *B. candidus* ultimately returned to this same shelter; however, the snake must have re-entered relatively quickly or through an additional entrance out of frame, as we did not capture a photograph of the snake as it returned.

4 | DISCUSSION

While limited to a single individual, our case study provides novel insight into the behaviour and ecology of *B. candidus* living among human settlements, demonstrating how resilient at least some individuals of the species are to human disturbances and providing brief insight into their foraging ecology. Through radio-telemetry, we demonstrated that short-distance translocation of snakes in a suburban landscape does not necessarily solve the problem in long term, as our telemetered individual quickly returned to sheltering and foraging among the student dormitories after being captured and relocated to an adjacent forest on two occasions. These observations also reveal a high potential for krait–human conflicts to occur, highlighting a need for more awareness and education programmes among the local public. Potential prevention measures derived from our observations mirror previous suggestions, which largely lacked direct evidence.

As observed in another local active foraging elapid (king cobra, *Ophiophagus hannah*; Marshall et al., 2020), the focal *B. candidus* fluctuated between extended periods of inactivity followed by brief periods of activity (i.e. moving). This is largely governed by the snake's

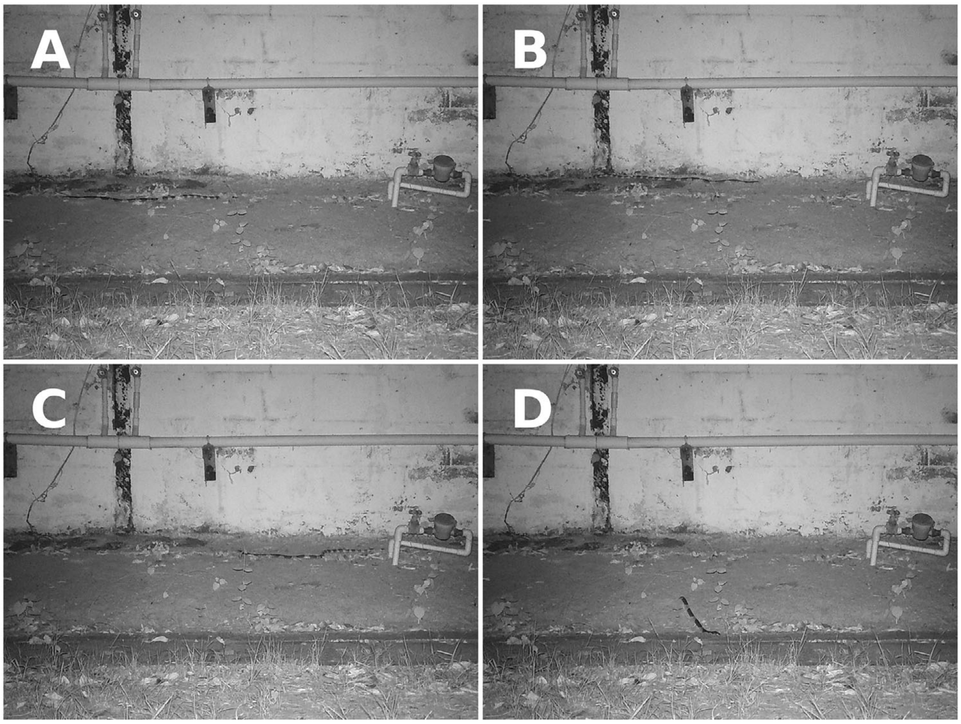

FIGURE 4 Time-lapse photographs taken with a camera trap positioned proximal to the opening of the telemetered *B. candidus* shelter under a student dormitory on SUT campus. (a) The *B. candidus* first emerges from the shelter at 19:06 and moves out of frame to the photograph's left. (b) Just 17 min later (19:23) the snake passes above the shelter towards the right. (c) At 19:26, the *B. candidus* returns to the shelter, re-entering through the same hole. (d) After spending 6 min within the shelter, the *B. candidus* re-emerges from a different burrow opening (19:32) and proceeds to move out of frame to the right before ultimately returning to the same shelter at an unknown time later that night

need to actively forage for food, followed by periods allocated for digestion and ecdysis (Dodd & Barichivich, 2007; Siers, Yackel, & Reed, 2018). We found that the telemetered *B. candidus* exhibited relatively strong site fidelity, as it frequently re-used some shelter sites and even occasionally left a shelter to forage before eventually returning to that same refuge. This may suggest the importance of maintenance of these sites if population viability is of primary concern, or alternatively, elimination of such sites if deterrence of these snakes is desired.

Through daily shelter location checks, we found the telemetered snake sheltered within human settlements 75% of the time it was tracked, while spending the remaining time sheltering within forest habitat. Increased rodent densities are commonly attributed as the primary factor driving snakes to live among human settlements and agriculture (Ramesh & Nehru, 2019; Shankar, Ganesh, Whitaker, & Prashanth, 2013); however, studies on drivers have yet to be adequately undertaken. Despite being used to a smaller degree by this focal animal, less-disturbed vegetated areas are often vital to sustaining wildlife among otherwise inhospitable and high-risk areas within human-modified landscapes (Hughes, 2017; Marshall et al., 2020). Agriculture may mimic natural habitat more closely than dormitories, but in northeast Thailand crops experience a relatively short rotation which can result in direct mortality due to associated machinery (Knierim, Barnes, & Hodges, 2017). Although our focal individual did not use the agriculture land during the time we tracked it, other telemetered *B. candidus* have used such habitats (Knierim et al., 2018). Since we were limited to only tracking the movements of this animal within the wet season and early cold season, we cannot exclude the possibility that the focal individual may use habitats differently in other seasons.

Though our observations were limited, the telemetered *B. candidus* commonly foraged along the edges of anthropogenic structures, such as building walls, concrete drainage gutters and sidewalks, probing its head into potential prey refugia, and meandering around while continuously flicking its tongue. We also observed this individual to seemingly search for prey fossorially, by fully entering burrow systems, holes and spaces underneath anthropogenic structures, before re-emerging and continuing to search for prey above ground on multiple occasions. The snake appeared to be following scent trails left by potential prey items, covering a small area thoroughly (even re-checking some areas a second or third time) similar to scent trailing chemosensory responses described in other snakes during foraging (Cooper, 2008; O'Connell, Greenlee, Bacon, Smith, & Chiszar, 1985). Additionally, our findings reveal that the telemetered snake commonly foraged near shelter locations (within 20 m), suggesting that prey availability might influence shelter selection, which has been observed with other snake species (Whitaker & Shine, 2003).

Short-distance translocation is frequently seen as one of the most ethical methods to address human–snake conflict, but our focal study highlights aspects within this method which may influence the effectiveness of this solution. As has been observed in other snakes among suburban and rural communities (Butler et al., 2005; Hardy et al., 2001), we found that our individual promptly returned to capture locations among residential areas after being translocated. We have been fortunate to train more than 200 people, like the security guards in this communication, who do not receive compensation for short-distance translocations. Also worth consideration for snake handlers and rescuers is the presence of scents from previously handled snakes on gear, as this krait clearly avoided the snake hook. This could easily be remedied by sanitizing gear after each use and could also have the further benefit of reduction of disease spread (Lorch et al., 2016), a topic which has not been well investigated within the context of human–snake conflict.

Short-distance translocations in reality may not address the direct problem (Sullivan et al., 2015) due to high shelter and foraging site fidelity of *B. candidus*; therefore, we suggest more effort be made to look into snake–human conflict prevention rather than mitigation efforts. Long-distance translocation of snakes from urban and rural environments to less-disturbed areas generally provides people with a good moral feeling (compared to the negative stigma associated with killing the snake); however, it often results in poor snake health and survival (Barve et al., 2013; Butler et al., 2005; Devan-Song et al., 2016). Furthermore, snakes are more likely to elevate defensive behaviours and bite when experiencing higher baseline stress levels (Herr, Graham, & Langkilde, 2017), which requires further study within the context of snakebite management and conflict. Snakes translocated to natural areas outside of their home ranges still sometimes move into surrounding human settlements (Butler et al., 2005), which also requires further investigation as to whether that represents an increase in risk for potential snakebite and conflict within human populated areas near to the receiving natural areas. In Thailand, many snake rescuers do employ long-distance translocation of snakes, but snake health, disease spread and survivorship as well as the potential for increased risk of snakebite to and conflict with humans near release sites are topics which require study for these translocations.

Simply killing the kraits would likely not provide the most desirable alternative due to ethical and ecological concerns, as snakes do play an important role in ecosystems as both meso-predators, with *B. candidus* potentially helping control both rodent and snake populations (Hodges, 2020; Kuch, 2001) and prey for larger predators. Previous studies in the United States have also suggested one of the major causes of snakebite in that region is to attempted killing of snakes (Ruha et al., 2017; Wasko & Bullard, 2016). Support for killing kraits in the region also carries the unintended consequence of killing of sympatric nonvenomous snakes of the genus *Lycodon*, which are Batesian mimics (Karraker, Strine, Crane, & Devan-Song, 2015). Several species of snakes on the university campus (*Coelognathus radiata*, *Malayopython reticulatus*, *Ptyas korros*, *P. mucosa*, *Python bivittatus*, *Xenopeltis unicolor*) are listed as protected by Thai law under the Wildlife Conservation and Protection Act, 2019 (Ministerial Regulations, 2003) and would likely also benefit from snake–human conflict prevention measures. Worth consideration is that while *B. candidus* are not listed as protected under Thai law and have the designation of least concern by the IUCN (Wogan, Vogel, Grismer, Chan-Ard, & Nguyen, 2012); no comprehensive population study or viability analysis records exist.

The behavioural tendencies of the case study individual to go into small crevices under anthropogenic structures during foraging highlights a need to seal gaps and crevices large enough for snakes to enter though under housing walls and doors. Also, this brings attention to the need for grating covers over water drain pipelines, which empty to the outside of the house. Other *B. candidus* individuals, as well as other dangerous species, such as *Naja siamensis*, have been known to use PVC pipelines and water drainage systems in order to move under and inside buildings, often entering homes through improperly covered bathroom floor drains (Hodges, pers. obs.). It may also be worth attempting to eliminate gaps under concrete sidewalks and building foundations to help prevent creating shelters for snakes and their prey.

Our findings also highlight the need for awareness programmes which encourage people to use flashlights. Kraits are relatively large and conspicuous serpents, so the decision not to use a flashlight and appropriate protective footwear attire compounded with lack of situational awareness in light of such an obvious snake is disturbing. There are other venomous snake species present and regularly encountered by students at SUT, arguably none of which are as clearly marked as kraits. Indeed, within our study area at SUT, there were four snakebites which occurred to students walking outdoors proximal to their dormitory rooms at night with uncovered footwear (i.e. flip-flops) and no flashlight in the year of 2019 (two of which occurred within the S-15 student dormitory; snakebite data supplementary file available on Zenodo: https://doi.org/10.5281/zenodo.4309113; Hodges et a., 2020a). We believe awareness programmes to be imperative, as even with proper ambient lighting, the vast majority of people are simply not aware of the potential for snakebites to occur, and thus do not pay enough attention to where they are placing their feet.

Our inferences and management solutions are derived from a single individual which was radio-tracked for only 102 days, which potentially limits the ability to make generalizations, but provides important insight into a focal individual of a rarely studied and medically significant species. Visual observations resulted from nocturnal location checks which occurred non-randomly. Furthermore, this communication does not attempt to claim that all *B. candidus* behave in this way, but rather it provides a detailed look into how at least some wild *B. candidus* behave when closely sharing space with humans and highlights the potential opportunities for snakebites and conflict to occur. For example, since the initial submission of this manuscript we observed another *B. candidus* individual depredating on the same species of snake (*O. fasciolatus*) within the same concrete drainage gutter system at the same dormitory complex as our focal individual (photographs/data also available on Zenodo; Hodges et al., 2020a). Snakebite is a significant medical concern in Thailand and many other tropical countries (Buranasin, 1993; Warrell, 2010), causing debilitating injury and mortality, but natural history study and subsequent management solutions of this topic are severely lacking. Study of venomous snake ecology and natural history over the course of multiple seasons and individuals directly investigating those topics within the context of human–venomous snake conflict is required. Furthermore, solutions derived from such research need to be investigated and further evaluated as well as communicated at the local level.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTIONS

CWH, CHB and CTS conceived the ideas and designed methodology; CWH and PP collected the data; CWH analysed the data; CWH and CHB led the writing of the manuscript; PP wrote the Thai abstract. CWH, CHB and CTS edited the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

Movement data, behavioural camera trap/observation photographic evidence and snakebite incident data available from Zenodo https://doi.org/10.5281/zenodo.4309113 (Hodges et al., 2020a). Movement data are also available on Movebank, ID: 1396626072 (Hodges et al., 2021).

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ORCID

Cameron Wesley Hodges https://orcid.org/0000-0003-2101-6792

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