

Life history of a neglected predator of the coral reef ecosystem: amphibious Yellow-lipped Sea Krait *Laticauda colubrina*, Schneider, 1799

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CITATION. Hatkar, P., Datta, S. and Ramesh., C. (2024) Life history of a neglected predator of the coral reef ecosystem: amphibious Yellow-lipped Sea Krait *Laticauda colubrina*, Schneider, 1799. *Hamadryad*. Vol. 41 (1&2), pp. 25–40.

ABSTRACT. The yellow-lipped sea krait (*Laticauda colubrina*), also known as the colubrine sea krait or banded sea krait, is a venomous marine snake belonging to the family Elapidae and is found in the tropical and subtropical coastal waters of the eastern Indian Ocean, Southeast Asia, and the western Pacific Ocean archipelagos. Due to limitations in geographic distribution, there is a dearth of information about its life history. In this study, detailed information on the life history of *L. colubrina* is compiled to assess the thrust areas of research. The yellow-lipped sea krait is designated as a schedule II species under India's Wildlife Protection (Amendment) Act 2022. Furthermore, it is imperative to understand the impacts of climate change on their habitats for vulnerability assessments. Additionally, no bite or casualty reports have been confirmed from India. Hence, habitat assessment must be conducted in distributional locations to understand fine-scale spatial overlap and encounter rates between sea snakes and humans. This paper will review the distribution, ecology, and threats to yellow-lipped sea kraits and highlight potential research gaps related to *L. colubrina* in India.

KEYWORDS. Elapidae, ecology, research gaps, Ophiology, Colubrine sea krait, Coastal and marine habitat

Introduction

Snakes that live entirely or occasionally in marine and estuarine environments account for roughly 90% of all living marine reptile species (Wallach et al. 2014; Uetz & Hosek 2017). Hydrophiine snakes are taxonomically and morphologically the most diverse clade within the venomous family Elapidae, with more than 160 species recognized in approximately 50 genera (Sanders et al. 2008). Multiple habitats, including mangrove forests, coral reefs, lagoons, tidal flats, and estuaries, are home to marine snakes (Voris & Murphy 2012). Four different lineages make up elapids: the sea kraits (Family Elapidae; subfamily Laticaudinae), the mud snakes (Family Colubridae; subfamily Homalopsidae),

the water snakes (Family Colubridae: subfamily Natricinae), and the true sea snakes (Family Elapidae; subfamily Hydrophiidae; Heatwole 1999). All true sea snakes have venomous fixed front fangs and are distinguished by their laterally compressed paddle-like tails. Unlike many land-based snakes, they do not make lightning-fast strikes. Instead, they tend to hang on and chew (Heatwole 1999).

The 'sea kraits' represent a classic intermediate land and sea state. Sea kraits are often encountered in the tropical and subtropical coastal waters of the eastern Indian Ocean, southeast Asia, and the western Pacific Ocean archipelagos (Heatwole et al. 2005). The islets of coral reefs are a major food source for sea kraits

(Heatwole 1999; Ineich & Laboute 2002). They play a vital role in maintaining the functions of coral reef ecosystems (Brischoux et al. 2009). Beaches that are freely reachable from the water and frequently submerged during high tide are known to be used by them as hiding places (Bonnet et al. 2009). Being nocturnal, they feed entirely on aquatic prey, such as eels, diving up to 80 m in depth (Motani 2009). These amphibious snakes have a variety of adaptations to marine life, such as a vertically flattened paddle-like tail for propulsion, dorsally positioned nostrils, each with a valve, salt regulating glands including lacrimal glands that remove salt as tears, and a single lung that extends nearly the entire length of the body (Dunson 1975). All sea snakes have valvular nostrils that can close firmly to keep out water from the top of the snout (Gow 1977). Unlike other genera of marine snakes, sea kraits still practice oviparous reproduction, which means they must travel back to land to lay their eggs (Shetty and Shine 2002b). More significantly, they return to land to breed, feed, and shed their skin. As a result, it appears likely that many sea kraits spend a significant amount of time on land (Greer 1997). Before 2006, *L. saintigironi* (New Caledonian sea krait), *L. guineai*, and *L. frontalis*, a dwarf species restricted to Vanuatu, were all considered subspecies of *L. colubrina* (Heatwole et al. 2005; Cogger and Heatwole 2006).

Only two krait species have been reported from India (Ganesh et al. 2019). The yellow-lipped sea krait (*Laticauda colubrina*, Schneider, 1799), also known as the banded sea krait or colubrine sea krait, has a highly potent neurotoxic venom. *Laticauda colubrina* is one of the most widespread members of the genus *Laticauda* (Heatwole et al. 2005). It is protected under Schedule II of the Wildlife (Protection) Amendment Act of India 2022. In the IUCN Red List, the yellow-lipped sea krait is classified as Least Concerned (Lane et al. 2010).

Scanlon and Lees (2004) combined morphological and molecular results to support the findings that sea kraits (*Laticauda*) and Solomon Islands elapids are basal to the remaining Australian terrestrial elapids and true sea snakes (Hydrophiinae). It implies that the *Laticauda* group is either a basal clade within an elapid subfamily (the Hydrophiinae) or a sister clade

to the Hydrophiinae (Scanlon and Lee 2004). Earlier studies by Cadle and Gorman (1981), McDowell (1985 and 1987), and Greer (1997) provided evidence for variations in this phylogenetic interpretation; the Laticaudinae subfamily was arbitrarily assigned to this clade. Most discussions have concerned the connection between the amphibious *Laticauda* and the true aquatic hydrophiine sea snakes (Rasmussen 1997). *Laticauda* species and the true sea snakes do not form a monophyletic group and most likely represent two distinct invasions of the marine environment, even though it is evident that all the lineages that are referred to as sea snakes are closely related and descended from terrestrial elapid ancestors (Keogh 1998). Out of seven, only two species are reported from India (Ganesh et al. 2019).

Geographical distribution

Laticauda colubrina is found in India, Bangladesh, Myanmar, Malaysia, Indonesia, Cambodia, Vietnam, China, Taiwan, Philippines, Fiji, Vanuatu, Papua New Guinea, Japan, Thailand, New Zealand, Samoa, Palau, Australia, Japan, Tongan archipelago, South Korea, and New Caledonia (Figure 5; Dunson and Minton 1978, Bhaskar 1996; Shine et al. 2003; Heatwole et al. 2005; Cogger and Heatwole, 2006; Brischoux and Bonnet, 2009; Gill and Whitaker 2014; Kabir et al. 2009; Lane et al. 2010; Rasmussen et al. 2014; Park et al. 2017; Vijaykumar and David 2006; Tyabji et al. 2018).

Distribution along the Indian coast

Laticauda colubrina is common in Andaman and Nicobar Islands viz., Wandoor Beach, Trinkat, Nancowry, Narcondam, Ross, Smith, Katchal, Tillangchong, and Menchal Island, along with the only reports from Parangipettai coast of Tamil Nadu, which is the westernmost limit of the range (Shetty and Sivasundar 1997; Das 1999; Heatwole et al. 2005; Damotharan et al. 2010; Figure 1,2,3,4). However, it has rarely been spotted off islands near the Indian mainland (Damotharan et al. 2010, Figure 2). On the South Reef Island of North Andaman, the relative abundance of yellow-lipped sea krait and blue-lipped sea krait (*L. laticauda*) was 200:1 (Bhaskar 1996). The occurrence rate of *L. colubrina* was 20 times greater than that of

L. laticauda in the Andaman Islands (Tyabji et al. 2018).

Habitat

Laticauda colubrina is amphibious in nature. While choosing a habitat, they consider the availability of shelter and clean water (Liu et al. 2012). They are commonly encountered in shallow waters up to a depth of ten meters (Cogger 2007). On land, they live on sandy beaches, coral islands, and in mangrove swamps (Damostraran et al. 2010). It was observed that sea kraits preferred the habitat of fallen trees since it offered them a natural, safe refuge (Tyabji et al. 2018).

Cracks in tree trunks caused by thick bark or rotting sections of the coastal forest trees are likely to be a significant habitat characteristic for sea kraits since these microhabitats have only been found in mature or dying trees (Lowe et al. 2022). An ideal microhabitat for incubating eggs may be found in the cracks of uprooted trees and rocks whose areas are thermally sealed and comparatively warm (Tyabji et al. 2018). They have also been observed congregating on the seashore at night in huge numbers (Chandramouli 2022).

External Morphology

In the Andaman Islands, the total length of males ranged from 74.4–114 cm and 100.5–169.8 cm in females, in a study conducted from 1992 to 1995 (Bhaskar 1996; Chandramouli 2022). Males mature at 70 cm Snout Vent Length (SVL) and females at 90 cm (Guinea 1986), whereas the average SVL in males is around 90 cm and 110 cm in females (Shetty and Shine 2002c). Males weigh only 600 g on average and are 75 to 100 cm long, while females weigh about 1800 g and are about 150 cm long, as reported from the Fiji Islands (Shetty 2000). Brischox and Bonnet (2009) recorded a maximum body size of about 149 cm in total body length (137 cm SVL) on a female in New Caledonia.

Males and females exhibit sexual dimorphism; females are larger than males (Shetty and Shine 2001a). Females have short, thin, flattened tails, whereas males have long, pear-shaped, fleshy tails (Shetty and Shine 2002c). Adult males need more terrestrial locomotive

capabilities since they hunt in shallower depths and are more terrestrially active during mating (Shetty and Shine 2001a).

Scalation

Except for the head, the body is cylindrical, slightly compressed, and nearly uniform in width throughout (Murthy 2007). One preocular and two postoculars, five infralabials in contact with genitals, entire head shield, lateral nostrils, a nasal shield divided by the inter-nasals, seven to eight supralabials, the third and fourth touching the eye, and temporals one and two (Murthy 2007). Ventrals 213–245 and large, half as broad as the body, caudals 37–47 (males), 29–35 (females), scales smooth and overlapping in rows of 21–23, rarely 25 (Murthy 2007).

Colouration

The body is light or dark bluish-grey above and yellowish below, with prominent dark-brown or black bands running across the belly that may often be interrupted in some or all directions (Murthy 2007). The yellow colour of the snout extends backwards on each side of the head, crossing the eye and upper lip (Sharma 2003). The lower jaw has a streak on either side, with an elongated yellow patch in the middle (Murthy 2007). However, the typical colouration is a banded pattern of regularly spaced black rings varying in number from 35 to 55 (Brischox and Bonnet 2009). Ontogenic melanism (progressive darkening of the skin) has been documented in snakes (Lorioux et al. 2008). Also, Lorioux et al. (2008) observed that melanism occurred infrequently in adult kraits from New Caledonia. Several cases of melanism and a relatively high proportion of incomplete or divided black rings were also reported (Brischox and Bonnet 2009).

Reproduction

Males reach sexual maturity at about one and a half years, and females are sexually mature at one and a half to two years (Heatwole et al. 2005). The male identifies the female through the vomeronasal organ, the snake's main olfactory apparatus, to detect sexual and conspecific scents (Aleksiuk and Gregory 1974). As per observations of their mating habits, it facilitates pheromonally mediated mate choice (Bhaskar

1996; Shine 2003). Males gather in groups around gently sloping areas at high tide every year during the warmer months of September through December. Males prefer larger females because they produce larger and more offspring (Shetty and Shine 2002b). Sivapushanam et al. (2023) observed a congregation of yellow-lipped sea kraits inside the cavity of a dead Andaman Bullet-Wood tree (*Manilkara littoralis*) about 1.5 m above the ground. A study of mating groups on a small Fijian island found that they spend an average of two hours mating after courtship (Shetty and Shine 2002b). A male snake pursues a female and starts mating when he spots her, then entangles itself around a single female. Then the male snakes rhythmically contact after aligning their bodies with the females; the resulting mass of snakes can remain almost motionless for several days (Shetty and Shine 2002b; Shetty and Shine 2002d).

Oviparous females lay up to 10 eggs per clutch, which they deposit on land and lay in small gaps until they hatch (Guinea 1994). Females choose caves and cracks in rocks land for roosting and egg laying. However, the nesting habits of *L. colubrina* are unknown because only two instances of egg-laying in the wild have been documented (Guinea 1986). Therefore, it can be said that their reproductive habits are very elusive (Lane et al. 2010).

Adaptations

The snake's tail has been modified to swim by taking the form of a paddle (Shetty and Shine 2002b). Due to the differences in motion between crawling and swimming, these adaptations are also present in more distantly related 'true' or ovo-viviparous sea snakes (Hydrophiinae; Shetty and Shine 2001). Aside from *Laticauda* species, most sea snake species are less mobile on land (Shetty and Shine 2001). Although there has been no data on movements in the ocean, adult female *L. colubrina* eats large (deep-water) eels, whereas males and juveniles eat small (shallow-water) eels (Pernetta, 1977). Thus, females may be under more intense selection for effective aquatic locomotion (Shetty and Shine 2001). Larger snakes have been observed to move more quickly than smaller ones, but on land, they are slower. Particularly on land, male sea kraits move more quickly than females.

Both on land and in the water, prey items in the gut decrease locomotor speed (Shetty and Shine 2001).

When the level of pulmonary oxygen saturation changes, *L. colubrina* can alter cutaneous uptake. Yellow-lipped sea kraits spent more time outside but breathed less frequently when subjected to 20% stepwise reductions in the aerial oxygen saturation from 100% to 40%. Between 100% and 60% saturation, there was a notable graded increase in cutaneous uptake, most likely caused by the recruitment of subcutaneous capillaries (Dabruzzi et al. 2016). Reducing subcutaneous perfusion optimizes swimming performance during foraging, whereas redirecting blood to skin surfaces maximizes dive times when subduing prey or avoiding aerial predators (Dabruzzi et al. 2016). *Laticauda colubrina* twist their tail around their length axis so that the tail tip's lateral aspect corresponds to the dorsal view of the head. In doing so, colouration and pattern, in combination with tail movement and posture, make the tail appear very similar to the head; this behaviour helps them to avoid becoming prey (Rasmussen and Elmberg 2009). A locomotor performance study by Wang et al. (2013) found that *L. colubrina* was the most terrestrial species in habits and moved significantly faster than the other sea krait species during terrestrial locomotion.

Behavioural Ecology

Preliminary studies on the behaviour of sea kraits were conducted in the late 1990s at South Reef Island, Andaman Islands (Bhaskar 1996; Shetty and Devi Prasad 1996). The current studies show that sea kraits restrict their terrestrial activities between 1800 and 0400 hours (Tyabji et al. 2018). Sea kraits seek refuge during the day in the cool microclimates of the cracks in living and dead trees (Shetty and Devi Prasad 1996). Adult females hunt for larger conger eels in deeper water, and males prefer to hunt for smaller moray eels in shallower water (Shetty and Shine 2001a). Despite being venomous, it is non-aggressive underwater (Desai pers. comm. 2023). It does not pose a significant threat to humans as it is generally docile and avoids human contact (Desai pers. comm. 2023). However, caution should still be exercised when encountering this species. They displayed aggressive

behaviour and signs of disturbance when tourists photographed them using a flash (Tyabji et al. 2018).

They display philopatric behaviour (Lawrence and Henderson 1995). As per (Shetty and Shine 2002a), yellow-lipped sea kraits in Australia have moved from the Fijian Islands to other islands five kilometres away, returning to their home islands, as all recaptured individuals were found on their home islands in an average of 31 days. When rapid locomotion was possible (i.e., in the case of juveniles rather than adults, and in the water rather than on land), kraits were more likely to escape into the water than remain stationary (Shine et al. 2003). Additionally, nighttime is more difficult for predators to pursue them than daytime. These trends imply snakes modify their antipredator strategies to survive (Shine et al. 2003).

Physiology

Studies have suggested that rainfall and the accessibility of surface water may be contributing factors as they drink fresh water or very diluted seawater to regulate their water balance and compensate for dehydration on land and in the ocean (Lillywhite et al. 2008). Consequently, drought and global warming may impact the population demographics of some *Laticauda* species (Lillywhite 2008). In sea kraits that had been first transferred to fresh water and then to seawater, Brischoux et al. (2013) looked at patterns of salt regulation, specifically variations in natremia (plasma sodium) and body mass (net water flow). Brischoux et al. (2013) found that sea kraits that were allowed to roam freely exhibited hypernatremia (up to 205 mmo. l-1).

The number of encounters with *L. colubrina* correlated significantly with abiotic factors like atmospheric humidity, temperature, sand temperature, and humidity; however, these relationships were not biologically substantial (Tyabji et al. 2018). The number of encounters was unaffected by lunar or tidal phases (Tyabji et al. 2018). They are typically not categorized as strictly nocturnal animals despite the reality that most of their interactions happen at night or dusk, frequently gathering in small clusters during the daytime in search of cover under beach debris, tree roots, and rock crevices (Heatwole et al. 2005). To regulate their body tempera-

ture, they typically alternate between periods of shade and sunlight (Heatwole et al. 2005). Also, they have been observed resting in the tree shadows (Lowe et al. 2022).

Old-growth coastal forests have created considerable environmental heterogeneity, which appears essential for *L. colubrina* to maintain healthy populations. This suggests that they rely on healthy coral reef systems for hunting and specific environmental conditions in their terrestrial habitats, underscoring the importance of conserving both habitats for *L. colubrina* and other sea krait species (Lowe et al. 2022).

Therefore, *L. colubrina* may make a suitable flagship species for promoting effective land-sea management, given its need for balanced coastal areas (Lowe et al. 2022).

Food and Feeding pattern

Their diet consists almost entirely of eels from the order Anguilliformes and families Congridae, Muraenidae, and Ophichthidae (Glodek and Voris 1982). Although often described as strictly eel-eaters, examples of other types of bony fish of Synodontidae and Pomacentridae have been recorded from the stomachs of some sea kraits (Gorman et al. 1981). Also, the striped eel catfish *Plotosus lineatus* and dartfish of *Ptereleotris* sp. were reported from New Caledonia (Brischoux and Bonnet 2009).

In addition, males frequently hunt multiple prey items, whereas females only hunt one item per foraging session (Shetty and Shine 2001; Shetty and Shine 2002c). Despite preying on eels, one eel species, the banded snake eel *Myrichthys colubrinus*, might be crucial for their survival (McCoy 1980). In terms of appearance and behaviour, this species of Indo-Pacific eel is very similar to the yellow-lipped sea krait. The eel may use this advantage by projecting a threatening and venomous aura to potential attackers (McCoy 1980). In the Fiji Islands, adult males feed upon smaller moray eels and frequently hunt multiple prey items (Shetty and Shine 2008). Prey size increases with body size in both males and females, but the sexes follow different trajectories in this respect (Shetty and Shine 2008). Female sea kraits consume larger eels relative to predator head size and body length than males; hence, the larger head size of female sea kraits is interpreted as an adaptation

to consuming more oversized prey items (Shetty and Shine 2002c). After a hunt, yellow-lipped sea kraits return to land to digest their catch (Shetty and Shine 2002a). However, adult females spend less time on land during mating and hunt in deeper waters, necessitating a greater capacity for aquatic locomotion (Shetty and Shine 2001). In captivity, they are exposed to a damp environment, leading to respiratory issues due to unstable temperatures in the tank.

Movement ecology

Radio transmitters were surgically implanted into kraits and were monitored for 80 days between November 1998 and January 1999 in the Fiji Islands (Shetty and Shine 2002b). Radio-tracked kraits spent an average of 23 days on land and ocean (Shetty and Shine 2002b). The average time spent by males in one habitat before returning to the other was 11 days and ten days in the case of females (Shetty and Shine 2002b). The studies indicate that yellow-lipped sea kraits are truly amphibious animals. The radio-tracked snakes spent approximately equal amounts of time in the ocean as on land (Shetty & Shine 2002b). *Laticauda colubrina* is heavier-bodied and stronger in body mass compared to *L. laticaudata*, as per a study conducted in New Caledonia (Bonnet et al. 2005). Thus, the ability of different species and sexes of sea kraits to climb cliffs correlates with their body shape, even though these primarily aquatic animals rarely use cliff edges and steep surfaces.

Predators

Although specific predators of *L. colubrina* have not received much attention, the white-breasted sea eagle (*Haliaeetus leucogaster*) is a known predator of this species (Lading et al. 1991). Remains of *L. colubrina* have also been found in the stomach contents of wild captured elasmobranchs and tiger sharks (*Galeocerda cuvieri*) (Masunaga et al. 2008).

Bycatch

A total of 55 kraits were caught by night lighting at the Gigante Island in the Phillipines from August to September 1975 (Dunson and Minton, 1978). No bycatch incidences have been reported from India yet.

Diseases

The yellow-lipped sea krait is a host to parasites, including the sea snake tick *Amblyomma nitidum*, *Paraheterotyphlum ophiophagos*, *Kalicephalus laticaudae*, and chigger mites *Vatacarus ipoides* of the family Trombiculidae (Nadchatram 2006; Toriba, 2011; Kwak et al. 2020). One study reported multiple mortalities due to multicentric lymphoid neoplasia (abnormal tissue growth), and secondary sepsis potentially leading to the malfunctioning of various organs, shock, and death were observed in captive *L. colubrina* (Chinnadurai et al. 2008). A case of lymphoid leukaemia was also documented in an adult yellow-lipped sea krait found dead in an aquarium at the National Aquarium in Baltimore (Walker 2022).

Lifespan

The yellow-lipped sea krait has specific problems that restrict its life expectancy in captivity, and as a result, the species is rarely kept in captivity (Chinnadurai et al. 2008).

Venom toxicity

The yellow-lipped sea krait has a highly potent neurotoxic venom, with an LD50 of 0.45 mg/kg of mice, and 95% of the expected observation falls from 0.34 to 0.60 mg/kg (Levey 1969). The venom attacks post-synaptic membranes of muscle tissues and inhibits acetylcholine and carbochol (Levey 1969). Acetylcholine is an excitatory mediator that regulates cardiac contractions and blood pressure, and Carbachol acts primarily by stimulating muscarinic receptors (Hoover 2015; Sam and Bordoni, 2023). Victims of envenomation die rapidly due to respiratory arrest and subsequent cardiovascular collapse due to diaphragm and heart muscle failures (Levey 1969; Sato et al. 1969; Takasaki 1988). Sublethal doses cause paralysis and may still lead to death over an extended period of two to five hours (Levey 1969). The molecular size of the toxin of yellow-lipped sea krait is very similar to the erabutoxins a and b isolated by Tamiya and Arai (1966) and Sato et al. 1969 from *Laticauda semifasciata*. *Laticauda colubrina* specifically targets *Gymnothorax* eels from the Pacific ocean, and eels have been shown to withstand high doses of venom without suffering any negative effects. Research has shown

Table 1. Distributional records of *Laticauda colubrina*, Schneider, 1799 in India

SN	Species	Latitude	Longitude	Place of Sighting	References
1	<i>Laticauda colubrina</i>	11.42950562	92.63738515	Rutland Island	Sivapushanam 2023
2	<i>Laticauda colubrina</i>	12.9137927	92.8969574	Mayabunder, Middle Andaman	Chandramouli 2022
3	<i>Laticauda colubrina</i>	11.5962399	92.6080082	North Wandoor	Chandramouli 2022
4	<i>Laticauda colubrina</i>	11.5071032	92.7018082	Chidiyatapu	Chandramouli 2022
5	<i>Laticauda colubrina</i>	11.594623	92.607428	Wandoor beach	Tyabji et al. 2018
6	<i>Laticauda colubrina</i>	11.600382	92.608973	Grub	Tyabji et al. 2018
7	<i>Laticauda colubrina</i>	9.126684	92.756352	Car Nicobar	Heatwole et al. 2005
8	<i>Laticauda colubrina</i>	8.123491	93.578133	Trinkat island	Heatwole et al. 2005
9	<i>Laticauda colubrina</i>	7.944241	93.558071	Nancowry	Heatwole et al. 2005
10	<i>Laticauda colubrina</i>	10.974	92.224564	South Sentinel	Heatwole et al. 2005
11	<i>Laticauda colubrina</i>	13.431481	94.257579	Narcondam	Heatwole et al. 2005
12	<i>Laticauda colubrina</i>	12.771147	92.655222	South Reef	Heatwole et al. 2005
13	<i>Laticauda colubrina</i>	13.168292	92.796973	Kinvar	Heatwole et al. 2005
14	<i>Laticauda colubrina</i>	13.302883	93.075297	Ross & Smith islands	Heatwole et al. 2005
15	<i>Laticauda colubrina</i>	11.522104	79.768587	Parangipettai coast	Damotharan et al. 2010
16	<i>Laticauda colubrina</i>	7.96726665	93.3576929	Katchal Island	Vijaykumar and David 2006
17	<i>Laticauda colubrina</i>	8.49927174	93.6332406	Tillangchong	Vijaykumar and David 2006
18	<i>Laticauda colubrina</i>	7.40059776	93.765682	Menchal Island	Vijaykumar and David 2006

that the Caribbean spotted moray *Gymnothorax moringa* is sensitive to the venom of the sea krait at doses as low as 0.01 mg dry weight of venom/kg wet weight of eel and proving lethal at 0.1 mg/kg. These findings imply that the resistance of Pacific *Gymnothorax* to sea krait's venom results from the coevolution of predator and prey (Heatwole and Powell 1998). The yellow-lipped sea krait is known to be docile and even tolerant to some degree of human handling (Shetty and Shine 2002b, Desai Per. Comm.). Not all bites result in venom injection (Takasaki et al. 1988). This sea krait's bite may go unnoticed as the bites are relatively painless or produce minimal pain (Purohit 2019). Symptoms and signs can vary across individuals and occur within hours, including bite marks or teeth marks on an arm or leg. There may be no slight pain or swelling at the bite site. The patient experiences nausea, vomiting, diarrhoea, abdominal pain, headache, unconsciousness, poor reflexes, fatigue, muscle weakness, enlarged lymph nodes, blurred vision, difficulty breathing, dizziness, convulsions, and bluish skin caused by poisoning in case of sea krait bite casualty (Purohit 2019). Currently, specific anti-venoms are unavailable

for sea krait bites, and their venoms are poorly researched in India.

Use and trade

Three meat samples in Phuket showed adulteration with traces of yellow-lipped sea krait meat, raising serious consumer concerns (Suntrarachun et al. 2018). While there is no verified evidence, residents in the Andaman Islands claim that Karen migrants from Myanmar have killed this species for food (Gatus pers. comm. 2010).

Threats

Anthropogenic factors like habitat loss and coastal development may be the primary threats to this species. This includes the damage of coastal habitats necessary for egg laying and prey digestion. Since this species is drawn to light, coastal lighting makes them highly vulnerable to anthropogenic activities (Bhaskar 1996). Anecdotal evidence suggests that the number of *L. colubrina* populations on some Fijian islands may have declined due to tourism projects (Marsh et al. 1993).

Sea kraits primarily use the intertidal zone and need appropriate cover, such as beach rocks, between one and four meters from



Figure 1. *Laticauda colubrina*, Schneider, 1799 from the Andaman Islands (Photo credits Digant Desai)

the shoreline (Saint Girons 1964, Ineich and LaBoute 2002; Lane pers. comm 2010). *Laticauda colubrina* is harvested for use as smoked sea snake and exported to Japan (Gatus pers. comm. 2010). Despite not being consumed as food in India, numerous threats to this species exist, such as anthropogenic activities and habitat destruction (Das 2012; Sarker 2013; Cao Van et al. 2014). Suitable amphibious habitats in the inter-tidal region are lost due to rising sea levels associated with climate change. This is expected to constitute a direct future threat (Meehl et al. 2005; Bindoff et al. 2007).

Furthermore, *Laticauda* species have specific oviposition requirements, which have rarely been recorded (Bacolod 1983; Guinea pers. Comm, 2010). In the published literature, egg laying was observed in rocky inter-tidal caves, accessible to kraits only at certain tides. If sea level changes prevent access to suitable egg-laying sites or render these sites unusable, this would also directly threaten the persistence of sea kraits

(Lane et al. 2010). Because they switch between land and water, they usually hunt and swim in coral reefs. The indirect threat is due to the degradation of their ecosystems, like coral reefs, and the destruction of mangrove forest habitats (Lane et al. 2010). Mass coral bleaching is associated with elevated sea surface temperature episodes, resulting in significant loss of live cor-

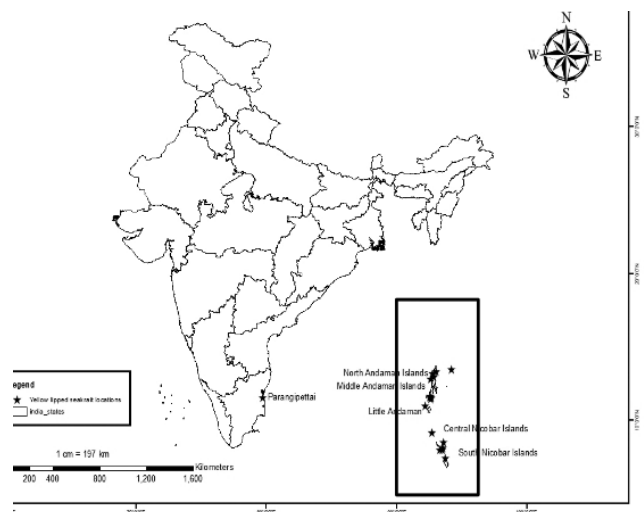


Figure 2. Distribution map of *Laticauda colubrina* in India, Schneider, 1799

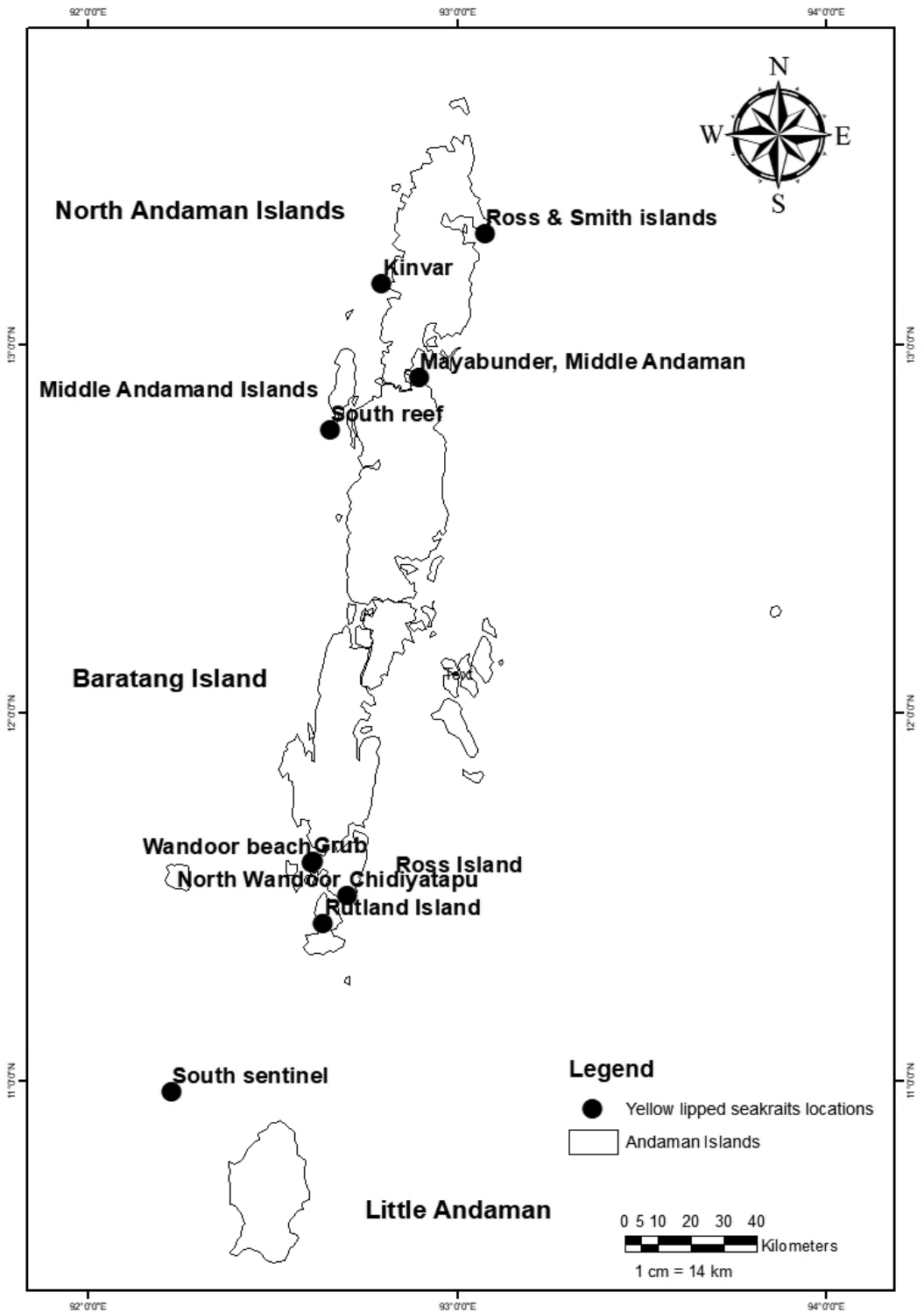


Figure 3. Distributional records of yellow-lipped sea kraits in the Andaman Islands

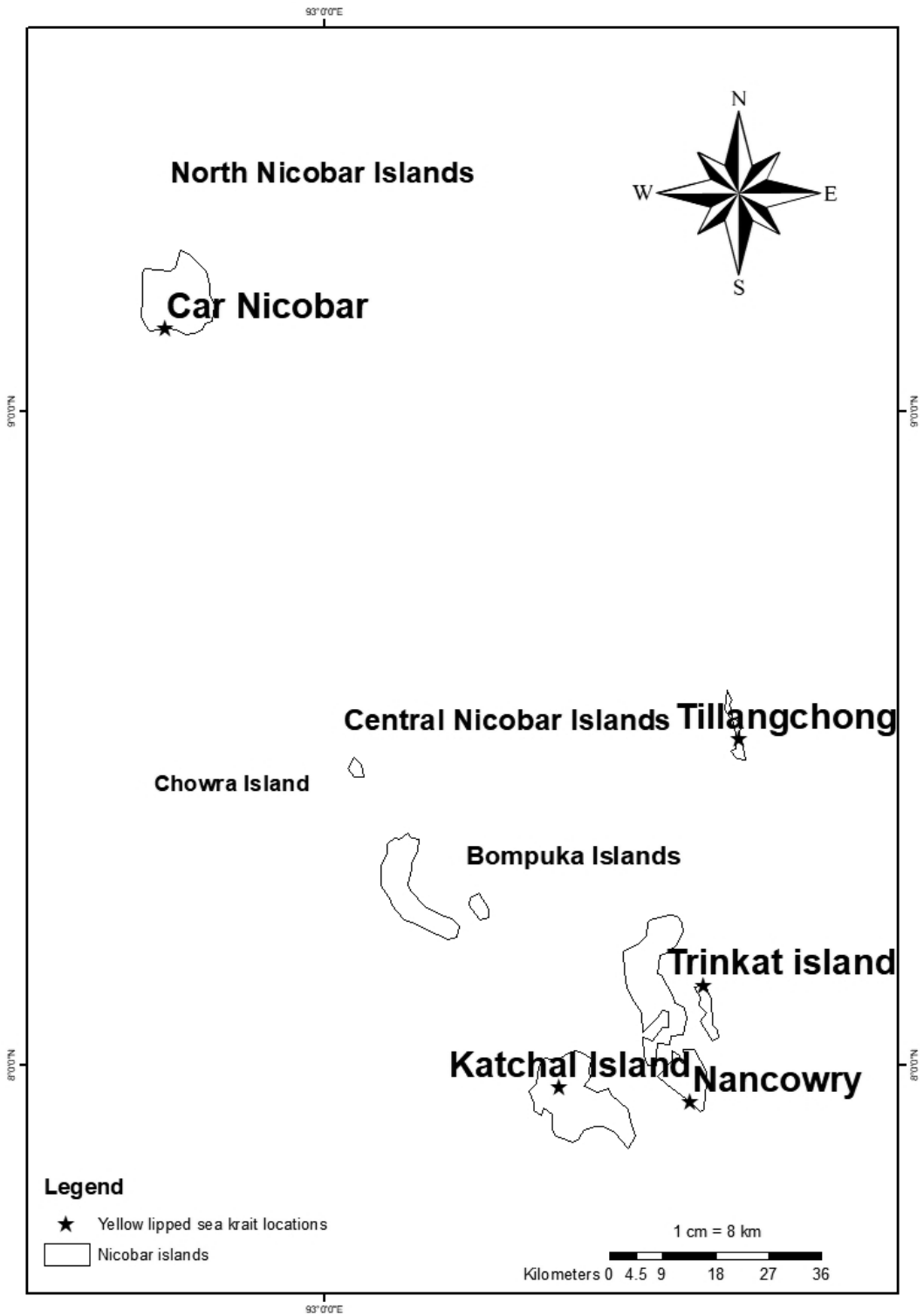


Figure 4. Distributional records of yellow-lipped sea kraits in the Nicobar Islands

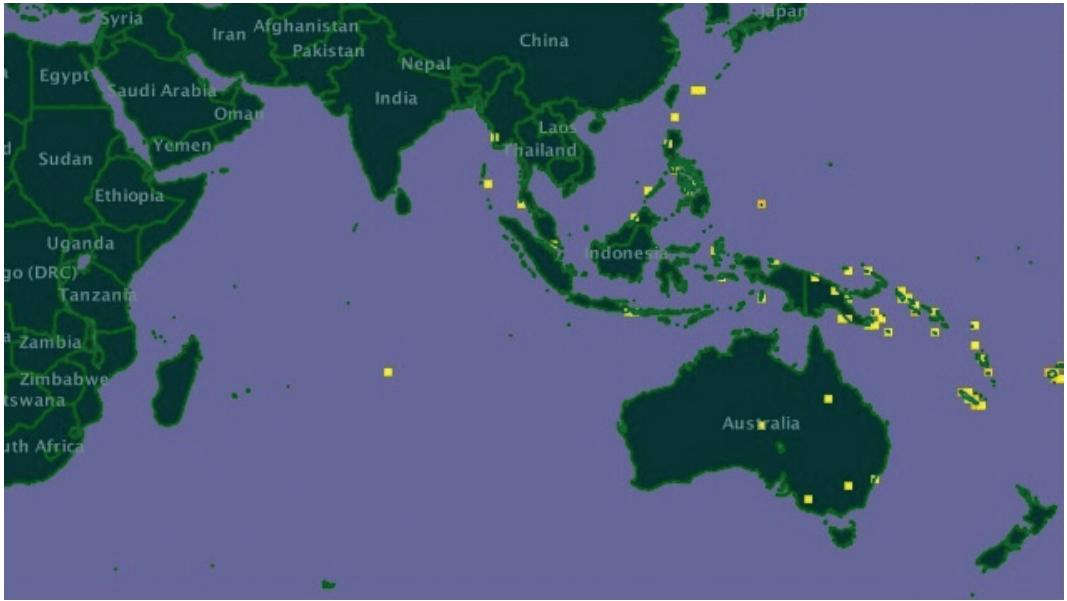


Figure 5. Biodiversity occurrence data published by Global Biodiversity Information Facility Open Geospatial Consortium services (Accessed through GBIF Data Portal, data.gbif.org, 2023-12-08)

al (Hoegh-Guldberg 1999). This reduces habitat complexity, with a consequent decrease in prey abundance (Pratchett et al. 2008) and the loss of refuge sites. Two sea snake sanctuaries have been declared in the Philippines, Gato Island, Cebu, and Pulo Laum, Zamboanga (Department of Tourism, Philippines, 2023).

Conclusion

Yellow-lipped sea kraits only consume eels and aid in regulating eel populations in coral reef ecosystems where they live (McCoy 1980). Although they are designated as a scheduled species in India, it is necessary to understand the impacts of climate change on sea krait's distribution and ecology to prevent exploitation. Human-induced threats to this species are not documented clearly, as they have been sporadically sighted and not adequately documented by researchers in India. A better understanding of the population dynamics, bycatch composition, breeding and nesting habits, and medicinal uses of this species will fill the knowledge gaps currently in India. Detailed research needs to be carried out on factors influencing their distribution and the effect of climate change on their distribution in the future.

Acknowledgement

The authors would like to acknowledge the Director and Dean of the Wildlife Institute of India, Dehradun, for their encouragement and support. We sincerely appreciate Digant Desai for allowing us to use his image of a Yellow-lipped sea krait taken on the Andaman Islands. Additionally, we thank Anushka Banerjee and Taslima Hazarika for proofreading the manuscript. This study was supported by the Science and Engineering Research Board (F.No.: C.R.G./2021/005095), Department of Science and Technology, Govt. of India. Comments and suggestions by Karthik Shankar and anonymous reviewers helped us improve the quality of this paper.

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Date submitted 27/05/2023

Date accepted 21/03/2024

Available online