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

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**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 lachrimal 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 & 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. saintigironsi* (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 & 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 & Lee 2004). Earlier studies by Cadle & Gorman (1981), McDowell (1985 & 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 & Minton 1978, Bhaskar 1996; Shine et al., 2003; Heatwole et al. 2005; Cogger and Heatwole, 2006; Brischoux & Bonnet, 2009; Gill & Whitaker 2014; Kabir et al. 2009; Lane et al. 2010; Rasmussen et al. 2014; Park et al., 2017; Vijaykumar & 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 & 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 (Damotharan 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 & 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). Brischoux & 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 & Shine 2001a). Females have short, thin, flattened tails, whereas males have long, pear-shaped, fleshy tails (Shetty & Shine 2002c). Adult males need more terrestrial locomotive capabilities since they hunt in shallower depths and are more terrestrially active during mating (Shetty & 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 (Brischoux & 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 (Brischoux & 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 & 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 & 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 & 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 & Shine 2002b; Shetty & 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 & 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 & Shine 2001). Aside from *Laticauda* species, most sea snake species are less mobile on land (Shetty & Shine 2001). Although there hasbeen 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 & 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 & 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 & 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 & 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 & 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 & 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 & Henderson 1995). As per (Shetty & 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 temperature, 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 & 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 & Bonnet 2009).

In addition, males frequently hunt multiple prey items, whereas females only hunt one item per foraging session (Shetty & Shine 2001; Shetty & 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 & Shine 2002c). After a hunt, yellow-lipped sea kraits return to land to digest their catch (Shetty & 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 & 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 & Shine 2002b). Radio-tracked kraits spent an average of 23 days on land and ocean (Shetty & 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 & 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 (*Haliaetus 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 Phillippines from August to September 1975 (Dunson & 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 & 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 & 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 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 & Powell 1998). , The yellow-lipped sea krait is known to be docile and even tolerant to some degree of human handling (Shetty & 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.

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**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 the shoreline (Saint Girons 1964, Ineich & LaBoute 2002; Lane pers. comm 2010). *Laticuda 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 coral (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.



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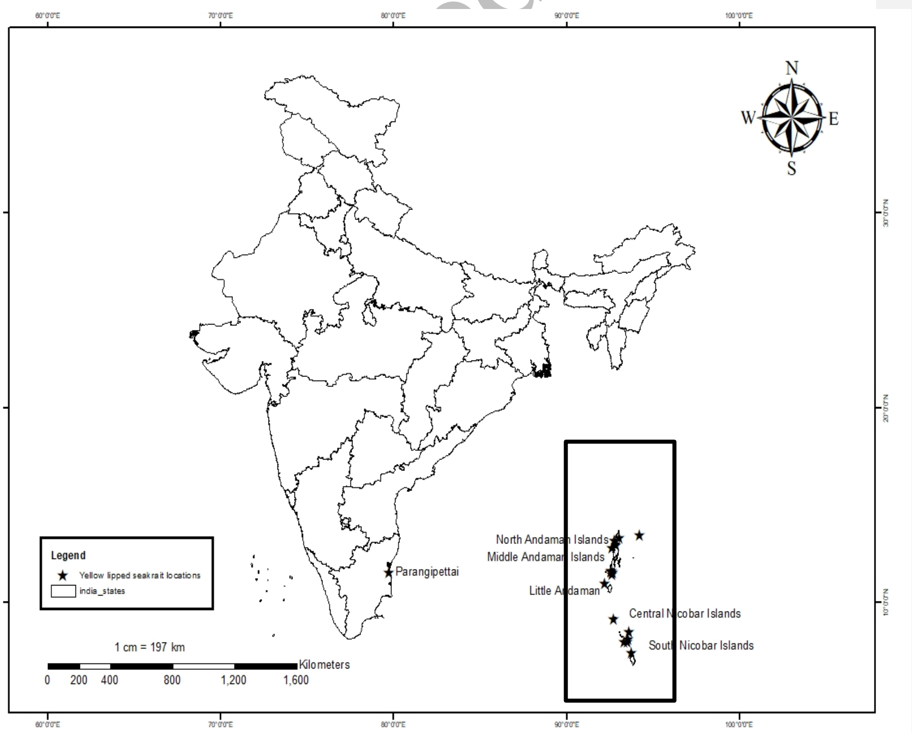
Table 1. Distributional records of *Laticauda colubrina*, Schneider, 1799 in India

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


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


N
W
E
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Legend
Yellow lipped seakrait locations
india_states
1 cm = 197 km
Kilometers
0 200 400 800 1,200 1,600
Parangipettai
North Andaman Islands
Middle Andaman Islands
Little Andaman
Central Nicobar Islands
South Nicobar Islands

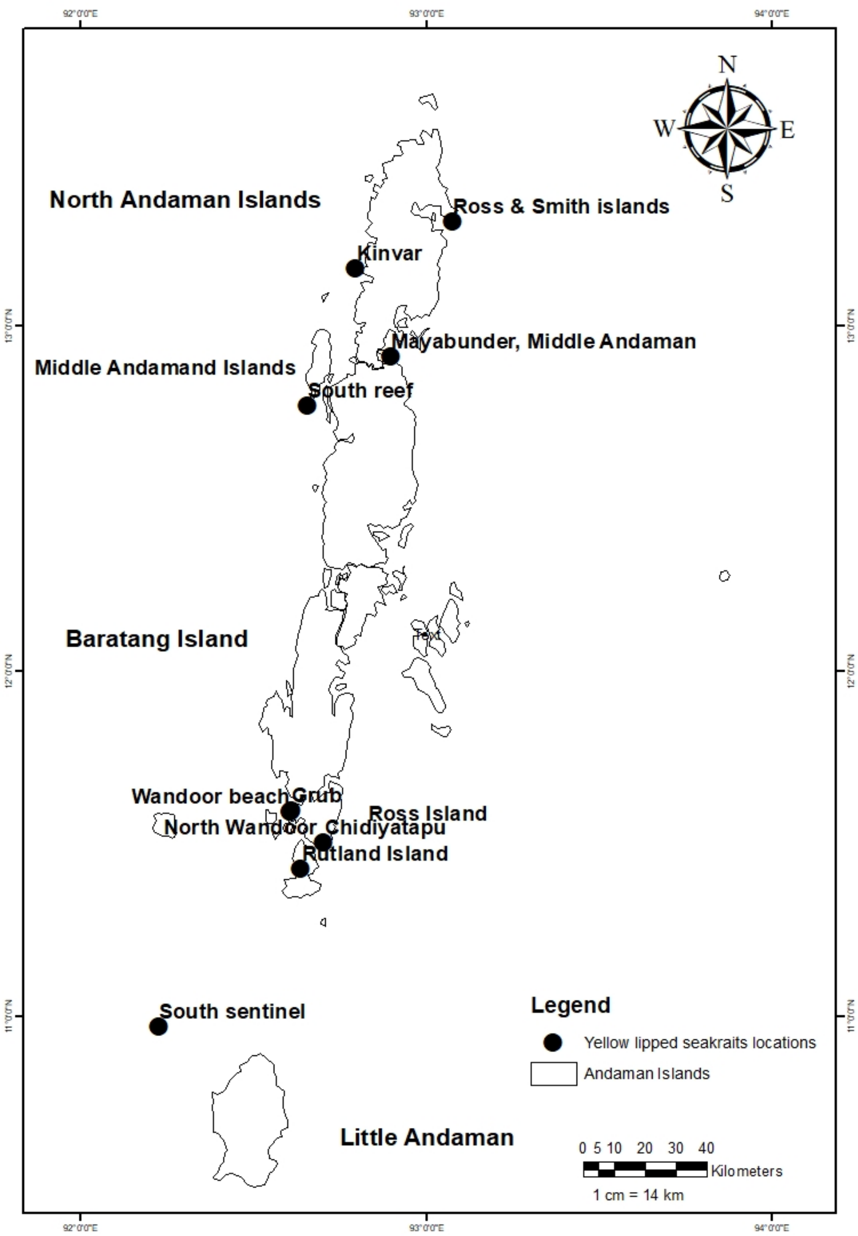


**Figure 3:** Distributional records of yellow-lipped sea kraits in the Andaman Islands

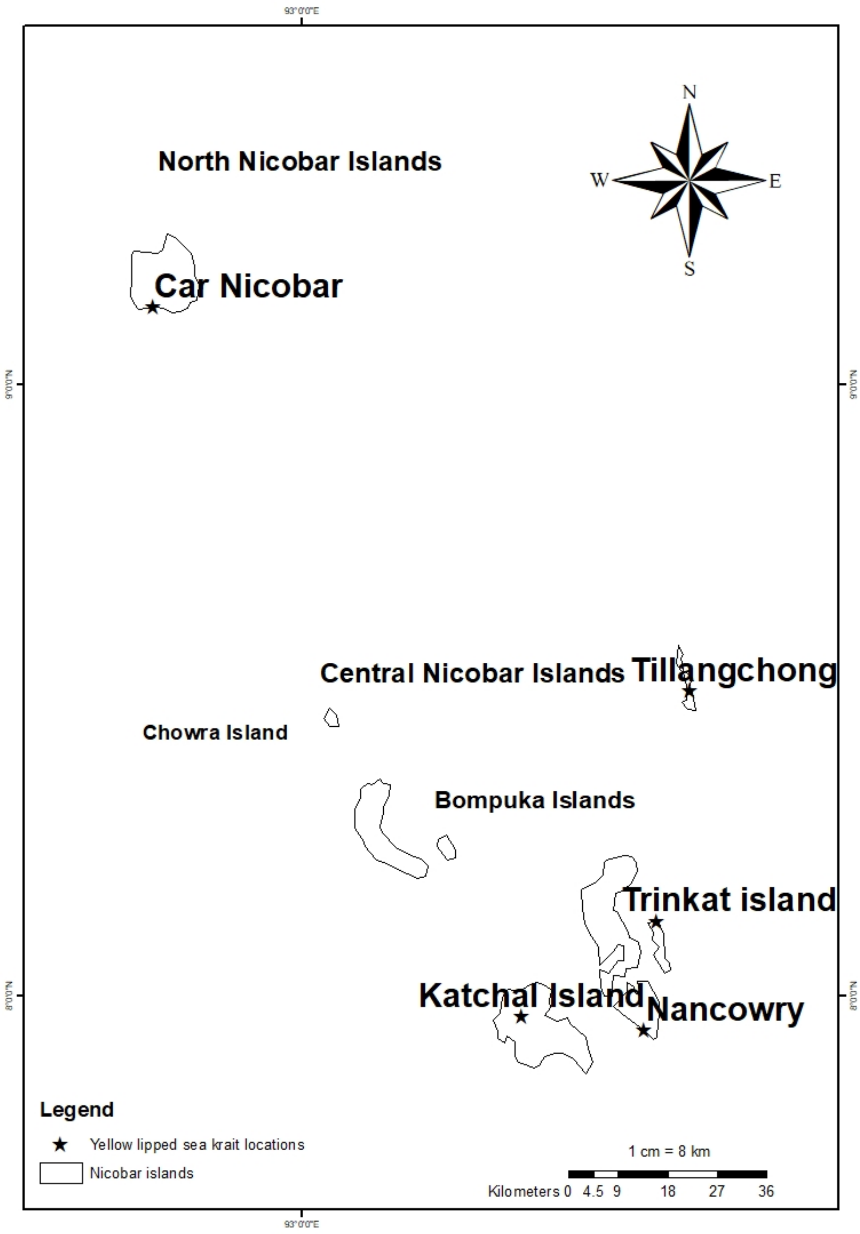


**Figure 4:** Distributional records of yellow-lipped sea kraits in the Nicobar Islands


**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)

**References**


1. Aleksiuk, M., & Gregory, P. T. (1974) Regulation of seasonal mating behavior in *Thamnophis sirtalis parietalis*. *Copeia* 3, 681-–689.
2. Bacolod, P. T. (1983) Reproductive biology of two sea snakes of the genus *Laticauda* from central Philippines. *Philippine Scientist* (Philippines) 21, 155-–163.
3. Bhaskar, S. (1996) Sea kraits on South Reef Island, Andaman Islands, India. *Hamadryad* Madras 21, 27-–35.
4. Bindoff, N. L., Willebrand, J., Artale, V., Cazenave, A., Gregory, J. M., Gulev, S., Hanawa, K., Le Quere, C., Levitus, S., Nojiri, Y. & Shum, C.K. (2007) *Observations: oceanic climate change and sea level*. Cambridge University Press, U K, pp. 385-–428.
5. Bonnet, X., F. Brischoux, F., D. Pearson D. & P. Rivalan P. (2009) Beach rock as a keystone habitat for amphibious sea snakes. *Environmental Conservation* 36(1), 62–70.
6. Bonnet, X., Ineich, I., & Shine, R. (2005) Terrestrial locomotion in sea snakes: the effects of sex and species on cliff-climbing ability in sea kraits (Serpentes, Elapidae, *Laticauda*). *Biological Journal of the Linnean Society* 85(4), 433–441.
7. Brischoux, F., & Bonnet, X. (2009) Life history of sea kraits in New Caledonia. *Zoologia Neocaledonica*, 7, 37-–51.
8. Brischoux, F., Bonnet, X., & Pinaud, D. (2009) Fine scale site fidelity in sea kraits: implications for conservation. *Biodiversity and Conservation* 18, 2473-–2481.

9. Brischoux, F., Briand, M. J., Billy, G., & Bonnet, X. (2013) Variations of natremia in sea kraits (*Laticauda* spp.) kept in seawater and fresh water. *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*, 166(2), 333-–337.

10. Cadle, J. E., & Gorman, G. C. (1981) Albumin immunological evidence and the relationships of sea snakes. *Journal of Herpetology* 15(3), 329–334.
11. Chandramouli, S. R. (2022). Snake fauna of the Andaman Islands, Bay of Bengal- — A review of species richness, taxonomy, distribution, natural history and conservation status. *Zootaxa*, 5209(3), 301-–331.
12. Chinnadurai, S. K., Brown, D. L., Van Wettere, A., Tuttle, A. D., Fatzinger, M. H., Linder, K. E., & Harms, C. A. (2008) Mortalities associated with sepsis, parasitism, and disseminated round cell neoplasia in yellow-lipped sea kraits (*Laticauda colubrina*). *Journal of Zoo and Wildlife Medicine* 39(4), 626-–630.'
13. Cogger, H. G., & Heatwole, H. G. (2006) *Laticauda frontalis* (de Vis, 1905) & *Laticauda saintgironsin*. sp. from Vanuatu and New Caledonia (Serpentes: Elapidae: Laticaudinae)- — a A new lineage of sea kraits?. *Records of the Australian Museum* 58, 245-256.
14. Cogger, H.G. (2007) Marine snakes. In: Tzioumis, V. & Keable, S. (Eds), *Description of key species groups in the east marine region*. Australian Museum, nature culture discover, Sydney, pp. 80–94.
15. Dabruzzi, T., Sutton, M. A., Fangue, N. A., & Bennett, W. A. (2016) Evidence for control of cutaneous oxygen uptake in the Yellow-lipped sea krait *Laticauda colubrina* (Schneider, 1799). *Journal of Herpetology* 50(4), 621-–626.
16. Damotharan, P., Arumugam, M., Vijayalakshmi, S., & Balasubramanian, T. (2010) Diversity, biology, and ecology of sea snakes (Hydrophiidae) distributed along the Parangipettai Coast, southeast coast of India. *International Journal of Current Research*, 4, 62-–69.
17. Das, C.S. (2012) Declining snake population - why and how: a case study in the Mangrove Swamps of Sundarban, India. *European Journal of Wildlife Research* 59(2), 227–235.

18. Das, I. (1999) Biogeography of the amphibians and reptiles of the Andaman and Nicobar Islands, in Ota H. (ed.) *Tropical Island Herpetofauna. Origin, Current Diversity, and Conservation*, Elsevier Science B.V., Amsterdam, *Developments in Animal and Veterinary Sciences*, 29, pp. 43 – 77

19.Department of Tourism, Philippines (2023).https://www.visitmyphilippines.com/index_title_ZamboangaSibugay_func_all_pid_469_tbl_0.html Acessed on 10th September 2023

20. Dunson, W. A., & Minton, S. A. (1978) Diversity, distribution, and ecology of Philippine marine snakes (Reptilia, Serpentes). *Journal of Herpetology*, 12(3), 281-–286.

21. Dunson, W.A. (1975) Adaptation of sea snakes. In: Dunson, W.A. (ed.) *The Biology of Sea Snakes*. University Park Press, Baltimore, pp. 3-–19.

22. Ganesh, S. R., Nandhini, T., Samuel, V. D., Sreeraj, C. R., Abhilash, K. R., Purvaja, R., & Ramesh, R. (2019) Marine snakes of Indian coasts: historical resume, systematic checklist, toxinology, status, and identification key. *Journal of Threatened Taxa* 11(1), 13132-–13150.

23. Gill, B. J., & Whitaker, A. H. (2014) Records of sea-kraits (Serpentes: Laticaudidae: *Laticauda*) in New Zealand. *Records of the Auckland Museum* 39-–42.

24. Glodek, G. S., & Voris, H. K. (1982) Marine snake diets: prey Prey composition, diversity and overlap. *Copeia* 3, 661-–666.

25. Gorman, G. C., Licht, P., & McCollum, F. (1981) Annual reproductive patterns in three species of marine snakes from the central Phillippines. *Journal of Herpetology* 15(3), 335-–354.

26. Gow, G. F. (1977) *Snakes of the Darwin Area*. Museum and Art Galleries board of the Northern Territory, NT, Australia. , pp. 29 pp.

27. Greer, A. E. (1997) *The biology and evolution of Australian snakes*. Surrey Beatty and Sons, Sydney, New South Wales, Australia. , pp. 358 pp.

28. Guinea, M. L. (1986) Aspects of the biology of the common Fijian Sea Snake *Laticauda colubrina* (Schneider). Doctoral dissertation. The University of the South Pacific Suva, Fiji, pp. 106.i106 pp.

29. Guinea, M. L. (1994) Sea snakes of Fiji and Niue. In: Gopalakrishnakone, Ponnampalam (ed.) *Sea Snake Toxicology*. Singapore University Press, pp. 212–233.

30. Heatwole, H., & Powell, J. (1998) Resistance of eels (*Gymnothorax*) to the venom of sea kraits (*Laticauda colubrina*): a test of coevolution. *Toxicon* 36(4), 619-–625.

31. Heatwole, H., Busack, S., & Cogger, H. (2005) Geographic \ variation in sea kraits of the *Laticauda colubrina* complex (Serpentes: Elapidae: Hydrophiinae: Laticaudini). *Herpetological Monographs* 19(1), 1-–136.

32. Hoegh-Guldberg, O. (1999) Climate change, coral bleaching and the future of the world's coral reefs. *Marine and freshwater research* 50(8), 839-–866.

33. Hoover D.B. Carbachol (2015). , Reference Module in Biomedical Sciences,
In Meyler's Side Effects of Drugs The International Encyclopedia of Adverse Drug Reactions and Interactions (Sixte enth Edition), Elsevier,80pp.https://doi.org/10.1016/B978-0-444-53717-1.00448-0

34. Ineich, I., & Laboute, P. (2002) Sea snakes of New Caledonia. *IRD et Muséum national d'Histoire naturelle Editions, Collection Faune et flore tropicales,* Paris, 304 pppp. 304.

35. Kabir, S.M.H., M. Ahmed, M., A.T.A. Ahmed, A.T.A., A.K.A. Rahman, A.K.A., Z.U. Ahmed, Z.U., Z.N.T. Begum, Z.N.T., M.A. Hassan, M.A., & M. Khondker, M. (Eds.) (2009) *Encyclopedia of Flora and Fauna of Bangladesh: Amphibians and Reptiles 25*. Asiatic Society of Bangladesh, Dhaka, Bangladesh,. pp. 204 pp.

36. Keogh, J. S. (1998) Molecular phylogeny of elapid snakes and a consideration of their biogeographic history. *Biological journal of the Linnean Society* 63(2), 177-–203.
37. Kwak, M. L., Kuo, C. C., & Chu, H. T. (2020) First record of the sea snake tick *Amblyomma nitidum* Hirst and Hirst, 1910 (Acari: Ixodidae) from Taiwan. *Ticks and tick-borne diseases* 11(3), 101383.
38. Lading, E. A., Stuebing, R. B., & Voris, H. K. (1991) A population size estimate of the yellow-lipped sea krait, *Laticauda colubrina*, on Kalampunian Damit Island, Sabah, Malaysia. *Copeia* 4, 1139-–1142.
39. Lane, A., Guinea, M., Gatus, J. & Lobo, A. (2010) *Laticauda colubrina*. The IUCN Red List of Threatened Species 2010: e.T176750A7296975. Available from: http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T176750A7296975.en (11 December, 2022).
40. Lawrence, E. & Henderson, I.F. (1995) *Henderson's Dictionary of Biological Terms (11th ed.)*. New York, NY: J. Wiley & Sons, Inc. New York, pp. 432 pp.
41. Levey, H. A. (1969) Toxicity of the venom of the sea-snake, *Laticauda colubrina*, with observations on a Malay' folk cure'. *Toxicon 6*(4), 269-–276.
42. Lillywhite, H. (2008) *A long drink of water*. Natural History. Available from: A Long Drink of Water | Natural History Magazine (accessed 03 January, 2023)
43. Lillywhite, H. B., Babonis, L. S., Sheehy III, C. M., & Tu III, M. C. (2008) Sea snakes (*Laticauda* spp.) require fresh drinking water: implication for the distribution and persistence of populations. *Physiological and Biochemical Zoology* 81(6), 785-–796.
44. Liu, Y L., Y.H. Chen, Y.H., H.B. Lillywhite, H.B. & M.C. Tu, M.C. (2012) Habitat selection by Sea Kraits (*Laticauda* spp.) at coastal sites of Orchid Island, Taiwan. *Integrative and Comparative Biology* 52(2), 274–280.
45. Lorioux, S., Bonnet, X., Brischoux, F., & De Crignis, M. (2008). Is melanism adaptive in sea kraits?. *Amphibia-Reptilia*, 29(1), 1-–5.
46. Lowe, C., Keppel, G., Waqa, K., Peters, S., Fisher, R. N., Scanlon, A., Osborne-Naikatini, T. & Thomas-Moko, N. (2022) Fijian sea krait behavior relates to fine-scale environmental heterogeneity in old-growth coastal forest: The importance of integrated land–sea management for protecting amphibious animals. *Ecology and Evolution* 12(4), e8817.
47. Marsh, H., Corkeron, P.J., Limpus, C.J., Shaughnessy, P.D. & Ward, T.M. (1993) Conserving marine mammals and reptiles in Australia and Oceania. In: C. Moritz and J. Kikkawa (eds), *Conservation Biology in Australia and Oceania*, Surrey, Beatty & Sons, Chipping Norton pp. 225-–244.
48. Masunaga, G., Kosuge, T., Asai, N., & Ota, H. (2008) Shark predation of sea snakes (Reptilia: Elapidae) in the shallow waters around the Yaeyama Islands of the southern Ryukyus, Japan. *Marine Biodiversity Records* 1, 96.
49. McCoy, M. (1980) *Reptiles of the Solomon Islands*. Hong Kong: Sheck Wah Tong Printing Press Limited, Hong Kong, pp pp. 69-–70.
50. McDowell, S. B. (1985) The terrestrial Australian elapids: general summary. *The Biology of Australasian Frogs and Reptiles*, pp pp. 261-–264.
51. McDowell, S.B. (1987) Systematics. In: Snakes: R.A. Seigel, J.T.C. Collins and S.S. Novak (Eds). *Ecology and Evolutionary Biology*, (ed.) Macmillan, New York, pp. 1–50.
52. Meehl, G.A., Washington, W.M., Collines, W.D., Arblaster, J.M., Hu, A.X., Buja, L.E., Strand, W.G. & Teng, H.Y. (2005) How much more global warming and sea level rise?. *Science* 307(5716), 1769-–1772.
53. Motani, R. (2009). The evolution of marine reptiles. *Evolution: Education and Outreach*, 2, 224-–235.

54. Murthy, T. S. N. (2007) Pictorial Handbook on Marine Reptiles of India. *Zoological*
55. Nadchatram, M. (2006) A review of endoparasitic acarines of Malaysia with special reference to novel endoparasitism of mites in amphibious sea snakes and supplementary notes on ecology of chiggers. *Tropical biomedicine* 23(1), 1-–22.

56. Park, J., Koo, K. S., Kim, I. H., Choi, W. J., & Park, D. (2017) First record of the blue-banded sea krait (*Laticauda laticaudata*, Reptilia: Squamata: Elapidae: Laticaudinae) on Jeju Island, South Korea. *Asian Herpetolgical Research*, *8*: 131-–136.
57. Pernetta, J.C. (1977) Observations on the habits and morphology of the sea snake *Laticauda colubrina* (Schneider) in Fiji. *Canadian Journal of Zoology*Can. J. Zool, 55: 1612-–1619.

58. Pratchett, M.S., Munday, P.L., Wilson, S.K., Graham, N.A.J., Cinner, J.E., Bellwood, D.R., Jones, G.P., Polunin, N.V.C. & McClanahan, T.R. (2008) Effects of climate-induced coral bleaching on coral reef fishes - Ecological and economic consequences. In: Gibson, R. N., Atkinson, R. J. A. & Gordon, J. D. M. (Eds) *Oceanography and Marine Biology: An Annual Review*, C.R.C. Press pp. 251- –296.
59. Purohit, M.P. (2019) Common Yellow Lipped Sea Krait Bite. https://www.dovemed.com/diseases-conditions/common-yellow-lipped-sea-krait-bite/ Accessed on 17th May 2023.
60. Rasmussen, A. R. (1997) Systematics of sea snakes (a critical review). *Proceedings of the Zoological Society of London* 70, pp. 15-–30.
61. Rasmussen, A. R., & Elmberg, J. (2009) Head for my tail: a new hypothesis to explain how venomous sea snakes avoid becoming prey. *Marine Ecology* 30(4), 385-–390.
62. Rasmussen, A. R., Sanders, K. L., Guinea, M. L., & Amey, A. P. (2014) Sea snakes in Australian waters (Serpentes: subfamilies Hydrophiinae and Laticaudinae) — a review with an updated identification key. *Zootaxa*, 3869(4), 351-–371.
63. Saint Girons, H. (1964) Notes on the ecology and population structure of laticaudinae (Snakes, Hydrophidae) in New Caledonia. *Revue d'Ecologie, Terre et Vie* (2), 185-–214.
64. Sam C. and, Bordoni, B. (2023) Physiology, Acetylcholine.In StatPearls [Internet]. Treasure Island (F.L.): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK557825/
65. Sanders, K. L., Lee, M. S., Leys, R., Foster, R., & Scott K., J. (2008) Molecular phylogeny and divergence dates for Australasian elapids and sea snakes (Hydrophiinae): evidence from seven genes for rapid evolutionary radiations. *Journal of evolutionary biology*, 21(3), 682-–695.
66. Sarker, M.S.U. (2013) Threatened herpetofauna of Bangladesh: present and past status and conservation issues. *Bulletn de la Société Herpétologique de France* (145–146), 29–48.
67. Sato, S., Yoshida, H., Abe, H., & Tamiya, N. (1969) Properties and biosynthesis of a neurotoxic protein of the venoms of sea snakes *Laticauda laticaudata* and *Laticauda colubrina*. *Biochemical Journal* 115(1), 85-–90.
68. Scanlon, J.D., & Lee, M.S.Y. (2004) Phylogeny of Australasian venomous snakes (Colubroidea, Elapidae, Hydrophiinae) based on phenotypic and molecular evidence. *Zoologica Scripta* 33(4), 335–363.

69. Sharma, R.C. (2003) *Handbook-Indian snakes* (Published -Director, Zoological survey of India, Kolkata) pp. 292pp.

70. Shetty, S. & Devi Prasad, K.V.P. (1996) Studies on the terrestrial behavior of Laticauda colubrina in the Andaman Islands, India. *Hamadryad* 21, 23–26.

71. Shetty, S. & Shine, R. (2002a) Philopatry and Homing Behavior of Sea Snakes (*Laticauda colubrina*) from Two Adjacent Islands in Fiji. *Conservation Biology* 16 (5), 1422–1426
72. Shetty, S. & Shine, R. (2002b) Activity Patterns of Yellow-Lipped Sea Kraits (*Laticauda colubrina*) on a Fijian Island. *Copeia* 1, 77–85.
73. Shetty, S. & Shine, R. (2002c) Sexual divergence in diets and morphology in Fijian sea snakes *Laticauda colubrina* (Laticaudinae). *Australian Ecology* 27 (1), 77–84.
74. Shetty, S. & Shine, R. (2002d) The Mating System of Yellow-Lipped Sea Kraits (*Laticauda colubrina*: Laticaudidae). *Herpetologica* 58 (2), 170-–180.
75. Shetty, S. & Shine, R. (2008). Sexual divergence in diets and morphology in Fijian sea snakes *Laticauda colubrina (*Laticaudinae). *Austral Ecology* 27(1), 77-–84.
76. Shetty, S. & Sivasundar A. (1997). Preliminary studies on the ecology of the Yellow-lipped Sea Krait (*Laticauda colubrina*) in the Andaman Islands, India. Report submitted to Centre for Herpetology – Madras Crocodile Bank Trust.
77. Shetty, S. & Sivasundar, A. (1998) Using passive integrated transponders to study the ecology of *Laticauda colubrina. Hamadryad* 23(1), 71– 76.
78. Shetty, S. (2000) Behavioural ecology of the yellow-lipped sea krait, *Laticauda colubrina*, in the Fiji Islands. School of Biological Sciences, Faculty of Science, University of Sydney.
79. Shine, R. (2003) Reproductive strategies in snakes. *Proceedings of the Royal Society of London Series B: Biological Sciences* 270(1519), 995–1004.
80. Shine, R., & Shetty, S. (2001) Moving in two worlds: aquatic and terrestrial locomotion in sea snakes (*Laticauda colubrina*, Laticaudidae). *Journal of Evolutionary Biology* 14(2), 338-–346.
81. Shine, R., Bonnet, X., & Cogger, H. G. (2003). Antipredator tactics of amphibious sea-snakes (Serpentes, Laticaudidae). *Ethology*, 109(6), 533-–542.
82. Shine, R., Cogger, H.G., Reed, R.N., Shetty, S. & Bonnet, X. (2003) Aquatic and terrestrial locomotor speeds of amphibious sea-snakes (Serpentes, Laticaudidae). *Journal of Zoology* 259(3), 261-–268.
83. Sivapushanam, K., Vedagiri, T., Fulmali, M., & Prabakaran, N. 2023. A mating congregation of Yellow-Lipped Sea Kraits, *Laticauda colubrina* (Schneider 1799), from the Andaman Islands, India. *Reptiles & Amphibians*, 30(1), e18979-–e18979.
84. Slowinski, J. B., Knight, A., & Rooney, A. P. (1997) Inferring species trees from gene trees: a phylogenetic analysis of the Elapidae (Serpentes) based on the amino acid sequences of venom proteins. *Molecular phylogenetics and evolution* 8(3), 349-–362.
85. Suntrarachun, S., Chanhome, L., & Sumontha, M. (2018) Identification of sea snake meat adulteration in meat products using PCR-RFLP of mitochondrial D.N.A. *Food Science and Human Wellness*, 7(2), 170-–174.
*Survey of India*, pp pp. 48-–49.
86. Takasaki, C., Kimura, S., Kokubun, Y. & Tamiya, N. (1988) Isolation, properties and amino acid sequences of a phospholipase A2 and its homologue without activity from the venom of a sea snake, *Laticauda colubrina*, from the Solomon Islands. *Biochemical Journal* 253, 869-–875.
87. Tamiya, N., & Arai, H. (1966) Studies on sea-snake venoms. Crystallization of erabutoxins a and b from *Laticauda semifasciata* venom. *Biochemical Journal* 99(3), 624.
88. Toriba, M. (2011) Annotated checklist of the parasitic nematodes of the snakes of Japan. *Current herpetology* 30(2), 163-–171.
89. Tyabji, Z., Mohanty, N. P., Young, E., & Khan, T. (2018) The terrestrial life of sea kraits: insights from a long-term study on two *Laticauda* species (Reptilia: Squamata: Elapidae) in the Andaman Islands, India. *Journal of Threatened Taxa* 10, 12443–12450.

90. Uetz, P. & Hosek, G. (2017) *The EMBL Reptile Database*. Last accessed on 4th May, 2023.
91. Uetz, P., Freed, P. & Hošek, J. (eds.) (2022) The Reptile Database. Available from: http://www.reptile-database.org (December 11, 2022)
92. Van Cao, N., Thien Tao, N., Moore, A., Montoya, A., Redsted Rasmussen, A., Broad, K., Voris, H. K., & Takacs, Z. Cao Van, N., Thien Tao, N. G. U. Y. E. N., Moore, A., Montoya, A., Redsted R. A., Broad, K., Voris, H.K. & Takacs, Z. (2014) Sea snake harvest in the gulf of Thailand. *Conservation Biology* 28(6), 1677-–1687.
93. Vijayakumar, S. P., & David, P. (2006) Taxonomy, natural history, and distribution of the snakes of the Nicobar Islands (India), based on new materials and with an emphasis on endemic species. *Russian Journal of Herpetology* 13(1). 11–-40.
94. Voris, H.K. & Murphy, J.C. (2012) *Sampling marine and estuarial reptiles. Reptile biodiversity, standard methods for inventory and monitoring*. University of California Press, Berkeley, 192–196 pp.
95. Walker, I. D. (eds.)(2022) Lymphoid Leukemia in a Yellow Lipped Sea Krait, *Laticauda colubrina*: Diagnosis and Potential Etiology IAAAM 1999. Available from: Lymphoid Leukemia in a Yellow Lipped Sea Krait, *Laticauda colubrina*: Diagnosis and Potential Etiology - IAAAM1999 - VIN (January 16, 2023)
96. Wallach, V., Kenneth L.W. & Boundy J. (2014) *Snakes of the World: A Catalogue of Living and Extinct Species*. Taylor and Francis, C.R.C. Press, Boca Raton, pp. 1237 pp.
97. Wang, S., Lillywhite, H. B., & Tu, M. C. (2013). Locomotor performance of three sympatric species of sea kraits (*Laticauda* spp.) from Orchid Island, Taiwan. *Zoological Studies*, 52, 1-–7.