Seasnakes and their bites

Anslem de Silva and Malik Fernando

Introduction


Jayaindra Fernando - watercolour

Seasnakes have evolved to spend their entire lives in the sea, including coastal estuaries and brackish lagoons. Members of one genus (*Laticauda*, sea kraits) come ashore to lay eggs, but the majority never leave the water, giving birth to live young. They were previously grouped in their own family Hydrophiidae (or in the subfamily Hydrophiinae of the family Elapidae) but are now included in the family Elapidae together with the cobras, coral snakes and kraits (Somaweera & Somaweera, 2009). They are all highly venomous, but mostly non-aggressive, biting usually under provocation. Currently 15 species of true sea snakes (in two genera) are recognised in Sri Lankan waters (de Silva & Ukuwela, 2017).

Biology

Sea snakes reported from Sri Lanka

Hydrophis bituberculatus	Peter's sea snake
Hydrophis curtus	Shaw's sea snake
Hydrophis cyanocinctus	Annulated sea snake
Hydrophis fasciatus	Striped sea snake
Hydrophis jerdonii	Jerdon's sea snake
Hydrophis lapemoides	Persian Gulf sea snake
Hydrophis mammilaris	Bombay Gulf sea snake
Hydrophis ornatus	Gray's sea snake
Hydrophis schistosus	Hook-nosed sea snake
Hydrophis spiralis	Narrow-banded sea snake
Hydrophis stokesii	Stoke's sea snake
Hydrophis stricticollis	Guenther's sea snake
Hydrophis platurus	Yellow-belly sea snake
Hydrophis viperinus	Viperine sea snake
Microcephalophis gracilis	John's sea snake

- after de Silva and Ukuwela, 2017

Identification

The head is often small in comparison to the body, with a slender neck and fore body. The midbody is large, deep and laterally compressed; the belly V-shaped and belly scales reduced except in *Hydrophis viperinus* which has fairly distinct ventral scales in the anterior half of the body. Tail short, laterally compressed, paddle-shaped, with a rounded tip. Most sea snakes are silvery in colour with dark bands, the back darker than the belly. The notable exception is the yellow-belly sea snake (*Hydrophis platurus*) that is chocolate brown or black on the back with a bright yellow belly; the tail is patterned in the same colours [heading image].

Sea snakes may be confused with fresh water-dwelling water snakes that are occasionally washed out to sea from rivers. These snakes have rounded bellies, the belly scales being wide (except in the file snake *Acrochordus granulatus*). The tail is cylindrical, tapering to a point and not paddle-

shaped. They are non-venomous and variously coloured, none silvery with black bands. The file snake or cloth snake (*A. granulatus*) of the family Acrochordidae is sometimes found in shallow sea waters and the dog-faced water snake (*Cerberus rynchops*) and the glossy marsh snake (*Gerarda prevostiana*) of the family Homalopsidae live in the intertidal zones of Sri Lankan coastal waters (Somaweera & Somaweera, 2009).

A sea snake washed up on the beach at Mount Lavinia. The head is to the right. Circa 2 m long.

Photo Naqueeb Hussain

Marine eels may also be mistaken for sea snakes, some being silvery with black bands. They are types of fish, with two pairs of nostrils, one pair being tubular, and a gill opening on each side of the neck. Most have paired pectoral fins. Some have a dorsal fin and an anal fin confluent with the caudal (tail) fin, the tail itself ending in a point. They have no scales. (Images of sea snakes and eels may be found on the Guidelines2017 page:-*More on identification of venomous snakes / Pictures of medically important snakes / family Elapidae* subfamily *Hydrophiinae*.)

Behaviour

Sea snakes generally have a placid disposition, biting only under provocation, a character first reported many years ago (Reid, 1956, Reid and Lim, 1957). They are seen by scuba divers unconcernedly inspecting holes and crevices in shallow reefs, searching for the fish and eels that they prey on. They take no notice of divers around them (personal observations by MF). The hook-nosed seasnake however, (*Hydrophis schistosus,* previously *Enhydrina schistosa*) is known to be a particularly dangerous animal (Kularatne et al, 2014). Sea snakes are to be found all around Sri Lanka, but are particularly common in certain areas, such as the Gulf of Mannar and around Jaffna in the north. During an island wide survey conducted by one of us (AdeS), we were able to collect specimens of 12 species of sea snakes. Some were confined to specific localities like coastal brackish lagoons (*Hydrophis schistosus*), while others were widely distributed (*Hydrophis curtus* and *Hydrophis spiralis*). The yellow-belly seasnake *Hydrophis platurus* was collected from many localities around the island; it is known to be the most widely distributed snake species in the world. The aggressive, highly venomous viperine seasnake *Hydrophis viperinus* was observed only around the coasts of northern Sri Lanka. As mentioned earlier, it is the only seasnake found in Sri Lanka whose ventral scales are large and distinct, species of the genus *Aipysurus* also sharing this character.

Hydrophis viperinus, the distinct anterior ventral scales arrowed - photo Anslem de Silva

Many sea snakes are caught in fishing nets laid from boats, and when hauled aboard have to be disentangled and thrown overboard (de Bruin, 1983 pers. comm. in Fernando and Gooneratne, 1983). Fishermen are exposed to bites on their fingers and hands during this process (Karunaratne and

Panabokke, 1972) and may be bitten on their feet if accidently stepped on (Kularatne et al, 2014). However, such bites are rare, as most species appear to be reluctant to bite, and dry bites are common. The snakes are picked up by the tail and thrown overboard. They are unable to reach up when held by the tail, unlike a terrestrial snake, because of their weak musculature developed for side-to-side undulations in water only. At present fishermen around Kalpitiya use a heavy stick they carry in their boats to kill sea snakes promptly if inadvertently hauled into the boat in the net (personal observations, AdeS).

Toxinology

Sea snake venoms are a mixture of various toxic polypeptides, proteins and other substances. Common toxins in venoms are short-chain neurotoxins (60-62 amino acid residues), long-chain neurotoxins (66-74 amino acid residues) and phospholipases. These are either neurotoxins or myotoxins. The former block nerve conduction at the neuromuscular junction, either pre-synaptically or post-synaptically, and may lead to paralysis and death through asphyxiation caused by failure of the nerve supply to the diaphragm.

The myotoxins cause breakdown of muscle tissue releasing myoglobin and creatine kinase in the process. Myoglobin is excreted by the kidneys but if present in large quantities precipitates as plugs in the tubules and causes extensive necrosis and kidney damage. Some toxins have multiple effects and act both as neurotoxins and myotoxins (Tamiya et al, 1983). This study was based on the venoms of two sea snakes viz. *Hydrophis ornatus* and *Hydrophis lapemoides*. A more recent publication is a systematic review of references to the toxins of *Hydrophis schistosus*, *Hydrophis cyanocinctus*, *Hydrophis lapemoides*, *Hydrophis spiralis*, and *Lapemis curtus* (Mohebi et al, 2016). The authors concluded thus: "There is scant variability in the venom composition in the same and different species of sea snakes. Our study revealed that there is a rather simple venom profile with an affinity towards a lethal mixture of high abundance of neurotoxins and PLA2s, and lower amounts of toxins such as CRISP, SVMP and LAAO[1]".

Epidemiology

Seasnake-human conflict occurs predominantly in estuaries and lagoons, particularly with the dangerous hook-nosed sea snake. The victims are usually fishermen but bathers and swimmers in estuaries and river mouths may also be bitten (Reid & Lim, 1957). Sea snake bites are encountered infrequently in Sri Lanka, with non-envenoming 'dry bites' being frequent (Somaweera and Somaweera, 2009). Kularatne et al (2014) in their paper had this to say: "The first victim was bitten on a finger but despite a bleeding injury he continued to work because 'his fellow fishermen reassured him that sea snakes of this sort are abundant in the area, are frequently trapped in nets and bite people with no untoward effects'. Almost all of the bites were said to be asymptomatic with few, if any, needing hospital treatment."

Seasnake bites are painless with no local inflammation.
Puncture marks with rapid onset of pain and inflammation would be due to a fish or sea urchin sting

[1]PLA = phospholipase A2, CRISP = cysteine-rich secretory protein, SVMP = snake venom Zn^{2+}-metalloproteinase , LAAO = L-amino acid oxidase

Sea snake bites are characteristically painless with no inflammation unlike stings by venomous fish that are very painful with inflammation. Sea urchin stings are also painful, the spine remnants being often visible in the puncture holes. Although sea snake bites are reportedly painless, this may not always be true as shown in the first reported case of sea snake bite reported from Sri Lanka (Amarasekera et al, 1994). This case was notable in that the authors commented as follows "… unusual features observed in our patient were the occurrence of pain at the site of the bite, regional lymph node enlargement and absence of muscle pain and tenderness."

Reports of sea snake bites in Sri Lanka are few. The literature has been summarised by Somaweera & Somaweera, 2009 with an additional report by Kularatne et al in 2014 (see Annex I).

Clinical manifestations

Early investigations of sea snake envenoming were by H. A. Reid and his co-workers in Malaysia and the surrounding area in the nineteen-fifties. Their findings have been summarised in the 1983 CMJ publication on snakebite (Fernando & Gooneratne, 1983). Kularatne et al, 2014 point out that recent studies have shown that there are two distinct types of sea snake envenoming: myotoxic envenoming and dominant flaccid paralytic envenoming, "the latter mediated by the neurotoxins that are found in abundance in the venom of many species of sea snakes (White, 1995; Komori et al, 2009; Takasani, 1998; Tamiya et al, 1983)".

There are seven published reports of sea snake bite in Sri Lanka that describe signs and symptoms and the outcome. (See ANNEX I for a summary of published reports.) The spectrum of clinical effects seen have been varied, including both myotoxic and neurotoxic effects, as well as no signs of envenoming.

Many bites do not cause envenoming. Symptoms can be mild with spontaneous resolution in a few days while others would result in systemic envenoming that needs aggressive management. Symptoms are usually seen between 30 and 60 minutes. If no symptoms are seen 2 hours after the bite, serious envenoming can be ruled out. Symptoms start as aching, stiffness, slight or moderate muscle movement pains involving the neck, trunk and limbs. Patients will be reluctant to move because of pain as a result of rhabdomyolysis. Hyaline necrosis involves the muscle fibres only, leaving the sarcolemmal sheaths unaffected. With resolution the muscle fibres re-grow within the original sarcolemmal sheaths with minimal scarring and therefore there are no long-term effects attributable to muscle involvement (Marsden & Reid, 1961).

True paresis can also occur initiated by the neurotoxins. This will be usually flaccid, with diminished or absent tendon reflexes. Trismus, dysphagia and dysarthria may occur, as well as ptosis, ophthalmoplegia and respiratory muscle paralysis. Hypertension and renal failure can be seen.

The summary of symptoms and signs described above are taken from the publications of Reid and his co-workers. Many of these features have been seen in the cases described by Sri Lankan workers. They are shown in tabular form, together with laboratory findings in Box A. The sequence of appearance of the symptoms and signs and the laboratory findings give an indication of the expected clinical progress and the possible need for aggressive therapies.

BOX A

Summary of symptoms, signs and investigations in seasnake envenoming

Based on the work of H. A. Reid

Trivial envenoming: About 10% of bite victims; No treatment needed, will resolve within 3 days without specific seasnake antivenom.

Aching, stiffness, slight or moderate muscle movement pains involving neck, trunk, limbs.	No leucocytosis, raised AST, proteinuria.

Serious envenoming: About 20% of bite victims; Treatment needed, preferably with seasnake antivenom.

Aggravated and rapidly increasing aching, stiffness. Severe muscle movement pains. Paresis - usually flaccid with diminished or absent tendon reflexes. Trismus, dysphagia, dysarthria. Ptosis, ophthalmoplegia, respiratory muscle paralysis. Hypertension. Renal failure.	Leucocytosis, raised ALT, AST, hyperkalaemia, proteinuria, microscopic haematuria, myoglobinuria, ECG changes.

*After Fernando & Gooneratne, 1983, CMJ **28/3** p. 137*

Management

Management of a sea snake bite victim is conservative as there is no effective antivenom available in Sri Lanka. The locally available polyvalent antivenom should not be administered. Specific sea snake antivenom is manufactured in Australia by the Commonwealth Serum Laboratories (CSL) that is reported to be effective against the venom of a number of sea snake species found in Sri Lankan waters. (Details in the on-line CSL Antivenom Handbook on their website; see Bibliography for URL.)

Observe the victim for the development of any of the following, in the meantime ensuring good hydration with adequate urine flow.

Myoglobinuria — Myoglobinuria is associated with necrosis of striated muscle that presents as stiffness and pain on attempted movement, particularly involving the jaw and neck muscles. It turns the urine red-brown to black in colour, the depth of colour being proportionate to the amount of myoglobin being excreted. This is confirmed spectroscopically. Resolution of the condition will be indicated by a progressive lightening of the colour in serial samples of urine. Prolonged and high levels of myoglobinuria lead to myoglobin casts in the tubules with distal tubular necrosis and acute renal failure (Marsden & Reid, 1961; Sitprija et al, 1971). More recently it has been postulated that the

mechanisms that lead to kidney injury are direct venom effects as well as indirect effects such as myoglobinuria (Pickwell, 1994; Kularatne et al, 2014). Kularatne et al (2014) point out that Sitprija et al (1971) had reported two cases of severe myonecrosis and acute renal failure successfully managed with early use of haemodialysis. This is an option that should be borne in mind. Hyperkalaemia and cardiovascular collapse secondary to severe venom-induced rhabdomyolysis is well known and anticipation of such cardiovascular collapse is important (Kularatne et al, 2014). The blood chemistry and the ECG should be closely monitored. Hyperkalaemia can be treated with calcium gluconate, dextrose with insulin, salbutamol or sodium bicarbonate. Haemodialysis is also effective but may not always be practical.

Paresis— Paresis should be distinguished from the reluctance to use voluntary muscles due to the pain of myonecrosis, described by Reid as "muscle movement pain". Paresis is usually flaccid with diminished or absent tendon reflexes. If involving respiratory muscles mechanical ventilation is indicated.

Laboratory investigations— Laboratory investigations that are useful in a case of sea snake envenoming are set out in the table in Box A, which is based on Reid's publications. One that is not in that list is creatine kinase (CK). Raised CK levels will be seen when there is rhabdomyolysis. Congestion and centrilobular necrosis of the liver was a common finding reported by Marsden & Reid, 1961 and Karunaratne & Panabokke, 1972 (Kularatne et al, 2014), accounting for raised liver enzymes ALT and AST. A rise in AST alone indicates muscle necrosis and will be seen in the milder form of envenoming.

ECG changes—Reid has reported two possible changes in the ECG: where there is hyperkalaemia the characteristic T-wave changes will be seen (such as prolongation of the PR interval and development of peaked T-waves) and in others, changes indicative of right ventricular dominance (a dominant R wave in chest lead V4R[2]). The serum potassium level at which ECG changes occur is said to be variable and interpretation of the recording can be difficult, so these changes should not be relied on to detect hyperkalaemia.

Anslem de Silva MSc, DSc (Honoris Causa)
University of Peradeniya

Herpetologist
Regional Chairman IUCN Crocodile
Specialist Group for South Asia and Iran,
Co-Chair IUCN Amphibian Specialist Group
for Sri Lanka

Malik Fernando MBChB (Bristol), MIOB (SL)
Retired Physician

Past President
Sri Lanka Medical Association

April 2018

Acknowledgements: We wish to thank Dr. Kanishka Ukuwela and Prof. S. A. M. Kularatne for reviewing the text and making helpful comments.

[2]Chest lead V4R is a lead placed on the right side of the chest in the same anatomical location as the left-sided lead V4 in the standard 12-lead ECG.

Bibliography

Amarasekera N, Jayawardena A, Ariaratnam A, Hewage UC, de Silva A (1994). Bite of a sea snake (Hydrophis spiralis): a case report from Sri Lanka. *J Trop Med & Hyg*, 97(4):195-198]

CSL Sea Snake Antivenom:
http://www.toxinology.com/generic_static_files/cslavh_antivenom_seasnake.html

Das I, de Silva Anslem (2011). *A Photographic Guide to Snakes and other Reptiles of Sri Lanka*. New Holland, UK, 144 pp.

de Silva A, Kanishka Ukuwela, (2017). *Reptiles of Sri Lanka*, Sri Lanka Edition, 176 pp, Vijitha Yapa, Colombo.

de Silva Anslem (1994). An account of the sea snakes (Serpentes: Hydrophiidae) of Sri Lanka. IN: *Sea Snake Toxinology*, (Editor) P. Gopalakrishnakone, National University of Singapore, pp. 234-249.

de Silva Anslem (2011). Sea snake survey of Sri Lanka. *Sea Snake Specialist Group Newsletter,* 1: 1-2.

de Silva Anslem, Ukuwela Kanishka, Sivaruban Abyerami, Sanders Kate L (2011). Preliminary observations on the reproductive biology of six species of Sri Lankan sea snakes (Elapidae: Hydrophiinae). *Salamandra,* **47**(4) 193–198.

de Silva Anslem, Sivaruban A, Ukuwela Kanishka, Rasmussen Arne R, Sanders Kate L (2011). First record of a sea snake (*Lapemis curtus*) feeding on a Gastropod. *Herpetology Notes*, volume 4: 373-375 (published online on 2 November 2011).

Fernando Malik, Gooneratne Walter (1983). Sea-snake Envenoming, *CMJ*, **28**, 131-143.

Jahubar M, Subramanium A, James RF (1984). An analysis of snake bite in Base Hospital Mannar. *2nd Annual Sessions of the Jaffna Medical Association*: 9.

Karunaratne KEdeS, Panabokke RG (1972). Sea-snake poisoning - Case Report, *J Trop Med & Hyg*, **75** (5), 91.

Marsden ATH, Reid HA (1961). Pathology of Sea-snake Poisoning.*Br Med J*1, 1290-1293.

Komori Y, Nagamizu M, Uchiya K, Nikai T, Tu Anthony (2009). Comparison of sea snake (Hydrophiidae) neurotoxin to cobra (Naja) neurotoxin. *Toxins* 1, 151–161.

Kularatne SAM, R. Hettiarachchi, J. Dalpathadu, ASV Mendis, PDSAN Appuhamy, HDJ Zoysa, K Maduwage, VS Weerasinghe, A de Silva (2014). Enhydrina schistosa (Elapidae: Hydrophiinae) the most dangerous sea snake in Sri Lanka: Three case studies of severe envenoming, *Toxicon***77,** 78–86.

Mohebbi G, Seyedian R, Nabipour I (2016). The toxinology of sea snakes: A systematic review. *Iran South Med J*, **19**(4), 662-703.

Pickwell VG (1994). A review of contemporary sea snake toxinology: chemistry, pharmacology, immunology and clinico-pathological aspects. In: Gopalakrishnakone, P. (Ed.), *Sea Snake Toxinology*. Singapore University Press, Singapore Read, pp. 93–166.

Reid HA (1956). Sea-snake bite research, *Trans R Soc Trop Med & Hyg*, **50**, 517.

Reid HA, Lim KJ (1957). Sea-snake bite, a survey of fishing hazards in N. W. Malaya, *Br Med J*, 2, 1266.

Senanayake M P, Ariaratnam CA, Abeywickrema S, Belligaswatte A (2005). Two Sri Lankan cases of identified sea snake bites, without envenoming. *Toxicon*, 45: 861-863.

Sitprija V, Sribhibhadh R, Benyajati C (1971). Haemodialysis in poisoning by sea snake venom. *Br Med J* 3, 218–219.

Somaweera Ruchira, Somaweera Nilusha (2009). An overview of Sri Lankan sea snakes with an annotated checklist and a field key, *Taprobanica*, **1**/1, 43-54, 3 pls.

Takasani C (1998). The Toxinology of sea snake venom. *J. Toxicol -Toxin Rev* 17, 361–372.

Tamiya N, Maeda N, Cogger HG (1983). Neurotoxins from the venoms of the sea snakes Hydrophis ornatus and Hydrophis lapemoides. *Biochem J* **312**, 31–38.

Thanabalasundrum RS, Vidyasagara NW (1969). Snake bites and its treatment. *CMJ* **14** (4): 188-191.

Ukuwela, Kanishka, de Silva Anslem, Mumpuni, Fry BG, Lee MSY, Sanders Kate L (2013). Molecular evidence that the deadliest sea snake *Enhydrina schistosa* (Elapidae: Hydrophiinae) consists of two convergent species. *Molecular Phylogenetics and Evolution* 66: 262–269.

Ukuwela, KDB, De Silva A, Mumpuni, Fry BG, Sanders KL (2014). Multi-locus phylogeography of the sea snake *Hydrophis curtus* reveals historical vicariance and cryptic speciation. *Zoologica Scripta.* Royal Swedish Academy of Sciences, 43, 5, pp 472–484.

Ukuwela, KDB, de Silva A, Lee MSY, Sanders KL (2016). Diversity, systematics and conservation of the marine snakes of Sri Lanka. *Proceedings of the annual Session – Wildlanka Symposium.* (Abstracts). 23 & 24 August, 2016: p 44-45.

Vithanage KK, Thirumavalavan K (2012). A case of a sea snake bite resulting in fatal envenoming, *CMJ* **57**: 174-175.

White J (1995). Clinical toxicology of sea snakebites. In: Meier J, White J (Eds.), *Handbook of Clinical Toxicology of Animal Venoms and Poisons*. CRC Press, Boca Raton (FL), pp. 159–170.

ANNEX I - Summary of reported seasnake bites in Sri Lanka

Jahubar *et al*, 1984 & Subramaniam & James, 1985; Reports of three bites in fishermen at Mannar during a period of five months.

Amarasekera *et al*, 1994; *Hydrophis spiralis*; Pain at the bite site, regional lymph node enlargement and absence of muscle pain and tenderness.

Karunaratne & Panabokke, 1972; Un-identified, *Pelamis platurus* ?; Adult fisherman; Ptosis, difficulty in talking, swallowing but no heart or respiratory difficulties. Later developed severe pains, renal failure, hyperkalaemia which lasted for 24 days, and the patient died.

Senanayake *et al*, 2005; *Pelamis platurus*; 7-year-old boy; No local or systemic effects recorded other than a 2.5cm linear scratch mark. Hospitalised for one and a half days.

Senanayake et al, 2005; *Enhydrina schistosa*; 39-year-old male; Mild redness around two bite marks but no pain or local/ systemic effects. Only prescribed tetanus toxoid.

After Somaweera & Somaweera, 2009

Kularatne et al, 2014; *Enhydrina schistosa*; Three lagoon fishermen: a 26-year-old fisherman, severe myalgia with very high creatine kinase (CK) levels lasting longer than 7 days, a 32-year-old fisherman, gross myoglobinuria, high CK levels and hyperkalaemia, both recovering; a 41-year-old man who trod on a sea snake in a river mouth, severe myalgia seven hours later, severe rhabdomyolysis, died three days later due to cardiovascular collapse.

Kularatne et al, 2014