

# Comprehensive Review of the Russell's Viper (*Daboia russelii*): Biology, its Venom, Clinical Significance and Management of Bites

\*Tajkia T<sup>1</sup>, Mia MR<sup>2</sup>

### Abstract

*The Russell's viper (Daboia russelii) is a severely venomous land snake commonly found throughout South Asia and certain areas of Southeast Asia. It contributes to a significant number of snakebite-related injuries and deaths within its habitat due to its common presence, defensive behavior and potent hemotoxic venom. This snake frequently inhabits open terrain, grasslands, farmlands and areas near human settlements, which increases the likelihood of encounters with people. Its venom consists of a sophisticated blend of enzymes and poisons that lead to blood clotting disorders, extensive local tissue injury, kidney failure and widespread systemic effects. While the Russell's viper serves a valuable ecological function by controlling rodent numbers, it remains a major public health issue in numerous rural areas. Ongoing scientific focus on enhancing antivenom efficacy, protecting its habitat and minimizing human-snake interactions remains vital for addressing the dangers posed by this species.*

*PAH Med Col J. Jul 2024; 1 (1): 28-33*

**Keywords:** Bangladesh, Public health, Toxins, Venomous and Venom

### Introduction

Recently, a particular snake species, the Russell's Viper, has become a widely discussed subject across social media platforms in Bangladesh. Conversations about this highly venomous reptile have spread far beyond online forums, becoming a common topic in everyday settings like tea shops and informal chats<sup>1</sup>. Two distinct species of Russell's viper exist globally. *Daboia russelii* is present in Pakistan, India, Nepal, Bhutan, Bangladesh and Sri Lanka, whereas *Daboia siamensis* is found in China, Myanmar, Indonesia, Thailand, Taiwan and Cambodia. The former species is the one located in Bangladesh<sup>2</sup>. The Bangladesh National Guideline for Management of Snakebite notes that the country hosts around 100 snake species, with 37 being venomous. This group includes 16 sea snakes, three cobra species (including the king cobra, *Ophiophagus hannah*), five krait species, two coral snake species, six pit viper species and a single true viper species: the Russell's viper<sup>3</sup>. *Daboia russelii* is a highly venomous snake belonging to the Viperidae family, indigenous to South Asia<sup>4</sup>. The genus name 'Daboia' originates from a Hindi term meaning "the lurker" or that which lies hidden<sup>5</sup>. The snake's common name honors Patrick Russell, a Scottish herpetologist<sup>6</sup>. Locally in Bangladesh, it is often called Chandra Bora or Ulubora and is sometimes mistaken for a young python<sup>1</sup>. This misidentification

has led to the unnecessary killing of non-venomous pythons and Common Wolf Snakes, which can disrupt local ecosystems<sup>7</sup>. Its physical features include large nostrils; each centered in a big nasal scale. The eyes are prominent, often with yellow or gold speckles and are encircled by 10-15 scales. The body is robust with a rounded cross-section and the tail is short, making up roughly 14.0% of its total length, with 41-68 paired scales underneath<sup>8</sup>. Primarily a ground-dwelling snake, the Russell's viper is also capable of water and can swim well. It is generally active at dawn, dusk and night in warmer conditions but may become diurnal during cooler weather<sup>2</sup>. Mature snakes are described as slow-moving and lethargic typically avoiding confrontation unless disturbed; however, they can deliver a strike with exceptional rapidity. Younger individuals are agitated. When feeling endangered, they coil their bodies into a series of S-shaped curves, lift the anterior portion of their body, and generate a distinctive hiss reported to be louder than that of any other snake species<sup>8</sup>. While raising the forebody is a typical defensive posture for many snakes, these vipers are distinguished by their capacity to raise a greater portion of their body from the surface compared to similar species<sup>5</sup>. The forceful hiss of the Russell's viper, along with the rasping sound of

1. \*Dr. Tanzina Tajkia, Associate Professor, Department of Physiology, President Abdul Hamid Medical College.

2. Dr. Md. Rajibe Mia, Associate Professor, Department of Endocrinology, President Abdul Hamid Medical College.

**Article History: Received:** 13-06-2023

**Revised:** 18-08-2023

**Accepted:** 07-09-2023

Address of Correspondence: Dr. Tanzina Tajkia, Associate Professor, Department of Physiology, President Abdul Hamid Medical College. E-mail: drtanzinatajkia@gmail.com; Cell Number: 01911919783.

the saw-scaled viper, serves as both a warning signal and an identifiable acoustic trait<sup>9</sup>. The Russell's viper possesses one of the most sophisticated venom delivery systems among snakes. Similar to other vipers, it has long, hinged fangs at the front of its upper jaw that function like hypodermic needles. Although lifting the front part of the body is a common defensive stance for numerous snakes, this viper species is notable for being able to elevate a larger segment of its body off the ground than related snakes<sup>5</sup>. The powerful hiss of the Russell's viper, combined with the distinctive grating noise made by the saw-scaled viper, acts as an auditory warning and a



Figure 2: Open-mouth view of a venomous snake showing exposed fangs and oral cavity

This viper has one of the most evolved mechanisms for injecting venom in the serpent world. Like all vipers, its upper jaw contains

lengthy, hinged fangs at the front that operate similarly to syringe needles. This allows the snake to deliver venom effectively through a rapid stab, rather than needing to hold onto its target. This efficient mechanism also lets it confront larger prey with less danger<sup>10</sup>. The Russell's viper is ovoviviparous<sup>11</sup> and a highly fertile species. Broods typically consist of 20 to 40 young<sup>8</sup>, though smaller litters, sometimes just a single offspring, are possible<sup>12</sup>. The largest recorded litter size is 75 young<sup>13</sup>. These snakes reach reproductive maturity between two and three years of age. Females bear live young, with litter sizes ranging from 6 to 63, primarily from May to November. The peak birthing season is June and July, following a gestation period longer than six months<sup>2</sup>.

### Discussion

The 2021 Mongabay article "Tracking Russell's viper in rural Karnataka unravels their behaviour" noted that during the research, Glaudas had numerous close interactions with these vipers without being bitten, as they typically remain concealed in vegetation. The snakes usually stayed still and only occasionally moved further into cover or pulled their heads back to hide. Researcher Xavier Glaudas emphasized that, contrary to common perception, vipers are not aggressive. He defined an unprovoked strike as aggressive behavior and explained, "Snakes bite in defense because they are frightened of us; one can think of it as them fighting for their life when faced with a large, moving creature"<sup>6</sup>. Zohra Mila, a wildlife and biodiversity conservation officer with the Bangladesh Forest Department, stated: "The Russell's Viper does not strike at people unless it feels threatened. This snake does not even enter homes, as it prefers to avoid human contact." She advised, "To avoid snake bites, one should make noise or use a flashlight before venom in the serpent world. Like all vipers, its upper jaw contains lengthy, hinged fangs at the front that operate similarly to syringe needles. This allows the snake to deliver venom effectively through a rapid stab, rather than needing to hold onto its target. This efficient mechanism also lets it confront larger prey with less danger<sup>10</sup>. The Russell's viper is ovoviviparous<sup>11</sup>, and a highly fertile species. Broods typically consist of 20 to 40 young<sup>8</sup>, though smaller litters, sometimes just a

single offspring, are possible<sup>12</sup>. The largest recorded litter size is 75 young<sup>13</sup>. These snakes reach reproductive maturity between two and three years of age. Females bear live young, with litter sizes ranging from 6 to 63, primarily from May to November. The peak birthing season is June and July, following a gestation period longer than six months<sup>2</sup>. entering a paddy field<sup>7</sup>. In professions with a high risk of snakebite, such as rice cultivation and aquaculture, employers could be considered responsible for supplying protective gear like boots<sup>9</sup>. This year, at least ten individuals, primarily agricultural and fishing workers, have died from bites by this viper. Reports indicate the snake is now found in at least 25 districts across Bangladesh<sup>6</sup>. Information from Rajshahi Medical College shows that between 2013 and 2023, 202 patients were admitted after being bitten by Russell's Vipers, with a mortality rate of 30.0%<sup>7</sup>. Recent reports confirm its presence in nine districts, while older records document it in eleven others, totaling seventeen out of sixty-four districts in Bangladesh. The most affected areas are Chapai Nawabganj and Rajshahi, where twenty fatalities occurred from 2013 to 2016<sup>2</sup>. A separate five-year study of 336 snakebite cases at Mymensingh Medical College Hospital found that 70.0% of victims were aged 11-30 years and 75.0% were male (Bhuiyan, WHO, New Delhi, 1981, unpublished).

### Geographic distribution and public health

Impact Bangladesh is among the region's most severely impacted by snakebites, owing to its geographic setting, tropical climate, dense population, farming activities and frequent human-wildlife encounters<sup>14</sup>. In 2002, the International Union for Conservation of Nature (IUCN) listed the Russell's Viper as extinct within Bangladesh. Although the species traditionally favors dry zones like the Barind region, experts and officials now report its spread to at least 35 districts, including several coastal areas<sup>1</sup>. Snakebite incidence is higher in males than in females, except in sectors where the labor force is mainly female, such as tea and coffee harvesting. Children and young adults represent the most commonly bitten age groups, with some data suggesting the highest fatality rates occur in young children and the elderly. For pregnant individuals, snakebite poses clear- though not fully quantified- risks to both mother and fetus, primarily from hemorrhage and potential

miscarriage. Most bites affect the lower legs and feet of agricultural workers<sup>9</sup>. If encountering a snake, avoid trying to kill it, as this can be hazardous. Also, never handle a snake, even a severed head, with bare hands, as it can still deliver a bite<sup>9</sup>. The viper's population has grown as farming practices intensified to two or three annual harvests, ensuring a constant crop presence. This continuous food supply attracts rats, the snake's primary prey, providing ample nourishment that supports rapid reproduction<sup>6</sup>. Outbreaks of snakebite can follow major floods, as documented in India, Bangladesh and Myanmar, or when large workforces enter snake habitats for projects like road construction, logging, or irrigation schemes- such as Sri Lanka's Mahaweli project- which alter local ecology and attract both snakes and farmers. In Myanmar, no immediate surge in bites followed Cyclone Nargis, but an increase was noted 9-12 months later<sup>9</sup>.

*Vipera russelli* (Shaw), or Russell's viper, has an irregular distribution across ten South Asian nations and is a major cause of lethal envenomation in Pakistan, India, Bangladesh, Sri Lanka, Myanmar and Thailand, ranking as the fifth leading cause of death in Myanmar<sup>15</sup>. The World Health Organization classifies snakebite as a neglected tropical disease and has prioritized its management<sup>16</sup>. A core issue across much of the Asia-Pacific region is that snakebite care often falls to traditional, herbal, or Ayurvedic healers, meaning most victims are never treated or recorded in formal medical facilities. For instance, one traditional herapist in Thailand treated between 72 and 393 bite cases annually from 1985 to 2002<sup>9</sup>. Syeda Anannya Faria, a compliance and development officer at the Deep Ecology and Snake Conservation Foundation (DESCF), noted: "Fatalities often result from delayed hospital admission after a bite. In Bangladesh, many patients still consult traditional healers first." She added, "There are instances where hospitalized patients were taken by relatives to shamans, only to return in worse condition"<sup>7</sup>.

### Venom and clinical manifestation of envenomation

The volume of venom an individual *D. russelii* can deliver is substantial. Reported yields from adult snakes range from 130-250 mg, 150-250 mg and 21-268 mg<sup>8</sup>. Since a lethal dose for most humans is estimated at 40-70 mg, a single bite can easily inject a fatal amount. The overall venom potency

results from a synergistic mix of at least five distinct components, each of which is less toxic in isolation. Both the toxicity and the clinical symptoms following a bite can vary among different geographic populations and over time<sup>8</sup>. Contrary to widespread opinion, the Russell's Viper is not the most venomous snake in Bangladesh. Its median lethal dose (a measure of venom strength) is lower than that of the Cobra. In fact, the Common Krait is responsible for the greatest number of snakebite fatalities in the country<sup>7</sup>. A study from 1988-1989 documented 764 bites with 168 deaths (a 22.0% fatality rate); among these, 34.0% were cobra bites, which carried a 40.0% mortality rate<sup>9</sup>. The venom is a complex mixture, primarily targeting the blood and tissues, causing rapid internal hemorrhage. It also contains various cytotoxins that destroy cells, leading to tissue death and significant damage in larger victims<sup>10</sup>. Symptoms of envenomation start with immediate pain and swelling at the bite site. Bleeding- often from the gums, in the urine, or in sputum- can begin within 20 minutes. Blood pressure and heart rate drop. Blistering appears near the bite and can spread along the limb in serious cases. Tissue necrosis is typically superficial but can be extensive. Vomiting and facial swelling occur in roughly a third of patients<sup>8</sup>. In a clinical series, 55 patients had confirmed Russell's viper bites, while 154 were suspected cases. Common complications included blood clotting disorders (76.1%), kidney impairment (18.7%), neuromuscular paralysis (69.9%) and local tissue damage (91.9%), appearing in various combinations. Abdominal pain was present in 79.5% of these patients, starting 5 minutes to 4 hours post-bite<sup>17</sup>. Acute kidney injury develops in about 25.0-30.0% of untreated bites. Severe cases may also involve disseminated intravascular coagulation. Prompt medical care and antivenom administration are critical to preventing these life-threatening complications. Intense pain can persist for 2-4 weeks and swelling often peaks within 48-72 hours, sometimes spreading to the trunk. Trunk involvement within 1-2 hours indicate severe envenomation. Discoloration from leaked blood cells and plasma may appear throughout the swollen area<sup>18</sup>. Death can result from sepsis, or kidney, respiratory, or cardiac failure, occurring 1 to 14 days post-bite or later<sup>18</sup>. Neuromuscular weakness is a frequent symptom, caused by toxins that either block nerve signals or directly damage muscle fibers<sup>19</sup>. The venom contains multiple procoagulant

enzymes that activate clotting factors, potentially triggering disseminated intravascular coagulation within 30 minutes. A metalloproteinase damages blood vessels and other components impair platelet function, leading to clotting, hemorrhage, edema and shock. Acute kidney failure is the most common fatal complication. Hemorrhage and micro-clots in the pituitary gland can cause pituitary infarction, resulting in acute or chronic pituitary hormone deficiency (hypopituitarism) in long-term survivors, a condition rarely seen with other snakespecies<sup>20</sup>. A study in *The Lancet* found that 29% of survivors suffered significant pituitary damage leading to hypopituitarism<sup>21</sup>. a finding supported by other research<sup>4</sup>. Thrombotic strokes, confirmed by imaging, have also been rarely reported following envenomation, particularly in Sri Lanka<sup>9</sup>.

Table I: The percentages of patients with each symptom, in a study in Myanmar<sup>22</sup>.

Symptom	Percentage
Death	09
Kidney failure	29
Blood incoagulability	59
Local Swelling at the site of the bite	73

The most severe consequences of the venom involve its disruption of the blood's clotting system, which critically impacts kidney performance. Within a cohort of 45 patients who required dialysis, 14 succumbed. Research will be conducted to simulate the venom's biochemical effects, aiming to establish optimal criteria for initiating dialysis and determining the required duration of treatment<sup>22</sup>.

### Treatment approaches

Recommended first-aid methods<sup>9</sup>

1. Calm the individual, as they may be experiencing significant distress.
2. Keep the patient completely still by having them lie down in a secure and relaxed posture. Specifically, prevent movement of the affected limb using a splint or sling. Physical activity or muscle contraction speeds up the absorption of venom into the circulatory and lymphatic systems.
3. If resources and training permit, apply pressure-immobilization or a pressure pad, unless a bite from an elapid snake (e.g., cobra, krait) has been

definitively ruled out. In Myanmar, the pressure pad technique has shown effectiveness for Russell's viper envenomation.

4. Refrain from any manipulation of the bite site- such as cutting, scrubbing, aggressive washing, massaging, or applying traditional or chemical substances- as this can lead to infection, enhance venom uptake and worsen local hemorrhage.

*Removing tight bands or tourniquets:* These should ideally remain in place until the patient has reached a medical facility with resuscitation equipment and has begun receiving antivenom therapy<sup>9</sup>. Antivenom is the sole specific antidote for snake venom. It is a critical component for treating systemic envenomation, though it may not alone guarantee survival. This treatment was pioneered by Albert Calmette at the Institut Pasteur in Saigon during the 1890s<sup>23</sup>. Antivenom consists of purified immunoglobulin derived from the blood plasma of horses, mules, donkeys, or sheep that have been immunized with venom from one or more snake species<sup>9</sup>. In India, the Haffkine Institute produces a polyvalent antivenom effective against bites from this species. In late 2016, a new antivenom developed by Costa Rica's Clodomiro Picado Institute entered clinical trials in Sri Lanka<sup>4</sup>. A common misunderstanding is that no effective antivenom exists for Russell's Viper<sup>24</sup>. In fact, the government supplies it free of charge at district (Sadar) hospitals and upazila health centers. The private pharmaceutical company Incepta also markets antivenom for Russell's Viper, Cobra, Common Krait and Saw-scaled Viper<sup>7</sup>.

Antivenom must never be administered intramuscularly if intravenous delivery is possible. Injection into the gluteal region should be avoided due to slow, unreliable absorption and the risk of sciatic nerve injury, especially when given by untrained personnel. Since snakes inject the same venom quantity into children and adults, pediatric patients require a full adult dose of antivenom<sup>9</sup>. According to Aniruddha Ghose, principal investigator at the government-funded Venom Research Centre Bangladesh, diagnosing envenomation is challenging due to the absence of a serological test to detect venom in patient samples. Diagnosis often relies on victim or witness accounts or identification of the snake by a clinician. The current national protocol recommends antivenom administration when the clinical presentation meets defined criteria<sup>3</sup>.

Indications for administering an additional dose of antivenom beyond the initial one<sup>9</sup>.

1. Continued or returning inability of the blood to clot six hours after treatment, or ongoing bleeding one to two hours post-treatment.
2. Worsening neurological symptoms (such as paralysis) or cardiovascular instability (such as low blood pressure) one to two hours after the first dose.

Research from the Venom Research Centre at Chittagong Medical College indicates these antivenoms are close to 100% effective against the venom. The Bangladeshi government is implementing steps to improve antivenom availability, prioritizing high-incidence areas and guaranteeing access in distant locations<sup>5</sup>. Epinephrine (adrenaline) must always be prepared in advance to address any immediate severe allergic reaction to the antivenom. For neurotoxic envenomation causing throat muscle and respiratory failure, antivenom alone may not prevent fatal suffocation; mechanical ventilation becomes critical in these situations. Supportive care, including dialysis when necessary, is an effective approach for managing acute kidney injury resulting from bites by Russell's vipers, hump-nosed vipers and sea snakes. When antivenom is unavailable, careful and attentive conservative treatment can often sustain the patient's life<sup>9</sup>. It is now crucial to conduct widespread public education to dispel the common misconceptions about Russell's viper<sup>5</sup>.

### Future research

This analysis, which relies on information from news articles, social media platforms and published academic papers, may be subject to biases in how incidents are reported and how the species' range is mapped. To verify data on habitat utilization and movement behaviors, future studies should integrate direct field observations, radio-tracking methods and interviews with local communities. Furthermore, examining the genetic variation within *D. russelii* populations could help elucidate their ability to persist and their level of connectedness across divided habitats.

### References

1. Russell's Viper: How did it get its name? Dhaka Tribune News, Tribune Desk, Publish: 22 Jun 2024, 02:00 PM Update: 24 Jun 2024,

- 04:21 PM, Available at: <https://www.dhakatribune.com/bangladesh/349914/russell-s-viper-how-did-it-get-its-name>.
2. Eddleston M. Patterns and problems of deliberate self-poisoning in the developing world. *QJM-Mon J Assoc Physicians*. 2000; 93(11):715-31.
  3. Ahsan MF, Saeed MA. Russell's viper (*Daboia russelii*) in Bangladesh: Its boom and threat to human life. *Journal of the Asiatic Society of Bangladesh Science*. 2018;44(1):15-22. Available at: <https://www.researchgate.net/publication/340533783>
  4. Siddique, A, 'Resurgence of deadly Russell's viper prompts Bangladesh to develop antivenom' *Mongabay news*, on 26 April 2023, Available at: <https://news.mongabay.com/2023/04/resurgence-of-deadly-russells-viper-prompts-bangladesh-to-develop-antivenom/>
  5. Wikipedia: Wikimedia Foundation, Russell's viper. 8th July 2024, Available at: [https://en.wikipedia.org/wiki/Russell%27s\\_viper#cite\\_ref-1](https://en.wikipedia.org/wiki/Russell%27s_viper#cite_ref-1)
  6. 'Russell's Viper: Myths, facts and everything you need to know. *Daily Sun*, e-paper, Publish: Thursday, 27 June 2024, 11:26, Available at: <https://www.daily-sun.com/post/754877>.
  7. 'Debunking tales of the Russell's viper', *Daily Star*, e-paper, Thursday, July 11, 2024, Available at: <https://www.thedailystar.net/opinion/views/news/debunking-tales-the-russells-viper-3639596>
  8. Mojid MI. Russell's Viper: Panic, misinformation and the reality. *Dhaka tribune news*, Published: 29 Jun 2024; 04:43 PM, Updated: 29 Jun 2024, 04:43 PM, Available at: <https://www.dhakatribune.com/bangladesh/350520/russell-s-viper-panic-misinformation-and-the>.
  9. Mallow D, Ludwig D, Nilson G.. *True Vipers: Natural History and Toxinology of Old-World Vipers*. Malabar, Florida: Krieger Publishing Company. 2003. p.359. ISBN 0-89464-877-2.
  10. David A Warrell, Guidelines for the management of snake-bites. *Southeast Asian Journal of Tropical Medicine and Public Health* in 1999, WHO Regional Office for South-East Asia. p.41, 63.
  11. 'Russell's Vipers: Predators of the Undergrowth. *Round glass sustains*. Available at: <https://roundglassustains.com/species/russells-vipers>.
  12. Noman ZA, Anika TT, Sikder, Rafiq K. A Review on the Potential of Antivenom Industry in Bangladesh. *European Journal of Veterinary Medicine*. January 2024;4(1):1-4.
  13. David A. Warrell, 'Snake venoms in science and clinical medicine 1. Russell's viper: biology, venom and treatment of bites. *Transactions of The Royal Society of Tropical Medicine and Hygiene*. 1989;83(6):732-40.
  14. Ethirajan A. Bangladesh reels from surge in snake bites. *BBC News*, 22 June 2024, BBC World Service South Asia regional editor. Available at: <https://www.bbc.com/news/articles/ck55keekpljo>
  15. Stidworthy J. *Snakes of the World (Revised ed.)*. New York: Grosset & Dunlap Inc. 1974. ISBN 0-448-11856-4.
  16. Daniel JC. *Russell's viper. The Book of Indian Reptiles and Amphibians*. Oxford, USA: Oxford University Press. 2002. p.148-51.
  17. Russell's Viper delivers 75 snakelets". *Bangalore Mirror*. Archived from the original on 2020-07-11.
  18. Kularatne SAM, Silva A, Weerakoon K, Maduwage K, Walathara C, Paranagama R, Mendis S. Revisiting Russell's Viper (*Daboia russelii*) Bite in Sri Lanka: Is Abdominal Pain an Early Feature of Systemic Envenoming? *PLoS One*. 2014; 9(2):e90198.
  19. United States Navy (1991). 'Poisonous Snakes of the World'. New York: United States Government/Dover Publications Inc. 203 pp. ISBN 0-486-26629-X.
  20. Harris J.B., 'Snake venoms in science and clinical medicine 3. Neuropharmacological aspects of the activity of snake venoms, *Transactions of The Royal Society of Tropical Medicine and Hygiene*. 1989;83(6): 745-7.
  21. Fleseriu M. *The Pituitary (Fourth Edition)*, 2017, Chapter 11-Pituitary Dysfunction in Systemic Disorders. 2017. p.365-81.
  22. The deadly Russell Viper: How the snake's venom affects humans. May 4, 2015. Archived from the original on December 13, 2020. Retrieved November 29, 2020.
  23. Warrell et al. Bites by Russell's Viper in Burma: Haemostatic, Vascular and Renal Disturbances and Response to Treatment. *The Lancet*. 1985. p.1259-64.
  24. Bon C, Goyffon M. 'Envenomings and their treatments'. Lyon: Éditions Fondation Marcel Mérieux, 1996.

