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Short Communication

Living With Snakes in India: The Intensifying Health Crisis over Snakebites- Challenges and Way Ahead

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ABSTRACT

Snakes form an integral component of ecological systems. However, human population's explosion and associated acceleration of habitat destruction and degradation, have led to a rapid increase in human-snake encounters. This article describes the status of human-snakes conflict and gives possible mitigation to reduce the negative interaction with snakes. Recognizing the severity of the problem, the World Health Organization has declared snakebite as a "Neglected tropical diseases". Meanwhile, snake venom is a potential source of medicine, anticancer drugs, and pain-killers. Collection of venom from different regions of the country to produce Anti-venom and other medical purpose is essential to obtain snakebite treatment for robust results. Translocation of "nuisance" snakes is a common practice in India, which affects the snake's life history and may cause more human-snake negative interaction. Lack of basic natural history information for even the widespread snakes is a major constraint in framing policies to manage human-snake conflict. Hence, future studies shall plan to frame appropriate guidelines for snake translocation and sustainable venom collection. Necessary changes required in the existing policies for the sustainable venom collection across the distributional range of snakes; such policies would help to create a win-win situation, as it would conserve the snakes as well as save the human lives.

Key words: Snakebite mitigation, Snake-venom extraction, Anti-venom, Health-Education, Human-Wildlife Conflict

INTRODUCTION

Human-snake conflict has evolved as a challenging aspect of conservation and wildlife management. Especially with an increase in human population coupled with habitat loss and habitat degradation, the frequencies of humans and wildlife interactions also increased rapidly (Dickman, 2010). These interactions often result in the loss of lives on both sides. Recently, human-wildlife conflict has momentum in the tropics with a launch of a number of conservation efforts to mitigate and manage such negative interactions (Agarwal *et al*., 2016; GIZ, 2018). However, the human-snake conflict, which claims the highest number of human lives due to wildlife, is yet, only provided a little attention.

Indian subcontinent covers an area of ~4.4 million square kilometers. Located at the crossroads of two distinctive biogeographic realms–the Palaearctic and the Oriental, the region is known for its rich biodiversity with a high level of endemism. Its known to harbor around 700 species of reptiles of which 52% are snakes (Das & Das, 2017), which consists of 98 genera and 361 species belonging to 18 families. A total of 73 species are venomous, belonging to families Elapidae and Viperidae (40 and 33 species, respectively). This number of venomous species is much higher than earlier reports; this is mainly due to recent systematic classification where Sea snakes (21 species) are treated as a subfamily Hydrophiinae under the family Elapidae (Das & Das, 2017).

Besides its bewildering biodiversity, South Asia, particularly India is the most densely populated region in the world and has the highest incidence and mortality rates due to snakebite (Alirol *et al*., 2010). It is a growing public-health crisis and most neglected public health issues in poor rural communities living in India. According to a community-based survey titled "the million death study" published in 2011, every year India alone loses between 40 and 50 thousand human lives to venomous snakebite (Mohapatra *et al.,* 2011). The four widely distributed and relatively abundant venomous snakes *viz,* Indian cobra (*Naja naja*), Russell's viper (*Daboia russelli*), Saw-scaled viper (*Echis carinatus*) and Common krait (*Bungarus caeruleus*) commonly known as the "big four" contribute to a major proportion of the snakebite incidences and fatalities (Mohapatra *et al*., 2011). The presence of abundant prey species (*i.e.,* rodents, amphibians, and poultry species) around the human habitations and agricultural fields attracts these snakes and makes human-snake

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encounters inevitable. Snakebite affects more people than many other Neglected Tropical Diseases and often causes death, disability or disfigurement. Recognizing the severity of the problem, the World Health Organization has declared snakebite as a "*Neglected tropical diseases*" (Chippaux, 2017). The major limitations in managing snakebite related human health hazard includes i) Lack of understanding on snake biology, ii) Lack of proper snakebite treatment protocol and scarcity of anti-venom iii) Geographical variation in venom of a single species across different regions (Saikumari *et al*., 2015) iv) Misconception and lack of awareness among public.

Snakes form an integral component of ecological systems. They are among the most dominant predator in some ecosystems (Sperry *et al*., 2008) while also serving as an important prey in other ecosystems (Moreno-Rueda & Pizzaro, 2007). These characteristics have led to the evolution of interaction patterns between snakes and other prey species. For example, predation pressure by snakes has influenced behaviour, habitat usage, foraging, and other activities of a number of prey species (Bouskila, 1995). Snakes have attracted humans' curiosity for centuries and mentioned in several mythologies and cultures (Whitaker & Andrew, 1999). Venomous species can be of keen interest from a human health perspective, as mortality rate due to snakebite are high in some regions (Chippaux, 2017). In addition, the anti-venom and drugs produced from snake venom is a potential source for anticancer drugs and painkillers (Burton, 1991). In spite of human's deep curiosity about snakes, they yet remain one of the least known components of our natural world owing to their secretive mode of life and a communication system, which is largely chemical based (Mason & Parker, 2010). Even the basic natural history information on some of the most widespread species are lacking (Mullin & Seigel, 2009). Snakebite management in India is still in the rudimentary stage and requires collaborative efforts from herpetologists, researchers, wildlife managers, anti-venom manufacturers, policymakers, medical practitioners and funding agencies. In this review, we focus on the current knowledge base in snake research, and necessary improvements required addressing the conflict.

STATUS OF SNAKE ECOLOGICAL RESEARCH

Scientific research on the ecology of snakes had attracted many researchers around the world in recent decades (Seigel & Collins, 1993). Basic ecological parameters are relatively well understood only in few snake populations (Rajendran, 1996; Rao, 2011; Sawant, 2011; Ramesh, 2012) Further, the geographic and phylogenetic basis for studies has expanded enormously, and a majority of research on snakes conducted on species from temperate regions (Fitch, 1999). However, similar studies on the snakes from South Asia or other tropical regions are limited.

Most of the literature on snakes from India is pertaining to their status, distribution, and taxonomy (Murthy, 1990; Das, 2003; Mohapatra, 2009; Das, 2010). The few literatures available on Uropeltid snakes (Rajendran, 1985) biology of Pit-vipers (Rajendran, 1996; Sawant, 2011) and, the ecology of King cobra (Rao, 2011) Snakes are believed to play a vital role in forest and agroecosystem, as an important predator, especially on rodents. However, no attempt has been made to assess the same. Understanding the species biology can be critical for effective human-snake conflict management and conservation. For instance, species biology in the case of Indian python (Ramesh & Bhupathy, 2010; Ramesh & Bhupathy, 2013; Bhupathy, 2014) have provided better insights for the conservation of the species. Ecology and evolution of major lineages of venomous snakes remain scanty. Although species of the genus Naja (the Cobras) are abundant over much of Asia and Africa and are significant both for human welfare (as common causes of snakebite) and for economic issues (via commercial exploitation (Jenkins & Broad, 1994; Boeadi *et al*., 1998) Nevertheless, the operational difficulties are immense for the field-based studies on snakes throughout the world; moreover, these animals rarely occur in high densities and therefore remain poorly studied.

CHALLENGES IN MANAGING VENOMOUS SNAKES

Understanding the ways in which an animal utilizes its space is important to address questions related to ecology, behavior, and conservation. This is especially true for snakes, where movement pattern and spatio-temporal use of habitat is related to life history parameters (Bronikowski, 2000; Luiselli, 2006). This is crucial for studying snakes that often come in confrontation with humans. The snakes rescued by "wildlife rescuers" around human habitation are often released away from their home range to avoid the recurrence of human-snake interaction. The adaptability and survival status of these trans-located snakes are poorly understood (Barve *et al*., 2013), the relocated snakes may become stranded and disoriented overtime (Seock *et al*., 2017). The relocated King Cobra has traveled three times more distance than the non-translocated snakes and maintained a nearly four times larger home range than the non-translocated snakes (Barve *et al*., 2013). Such a random movement of the translocated snakes with an unusually larger home range has a potential to aggravate the human-snake conflict. Therefore, a clear understanding of snake ecology and behavior required to formulate predictive models to minimize health hazard *vis-à-vis* snake conservation. One of the best techniques to study snake behavior can be radio-telemetry (Whitaker *et al*., 2010). India's only radio-telemetry snake study was conducted by the Agumbe Rainforest Research Station on King cobra (Whitaker *et al*., 2010; Barve *et al*., 2013). Recently, Indian rock python telemetry study initiated in the Moyar River Valley, Tamilnadu by the Wildlife Institute of India that would provide more insight in to snakes biology in the country. Thus, an effort to understand the venomous snake's will be useful in understanding the ecological concepts and in updating management guidelines for reducing snakebite related human fatalities.

DEVELOPMENTS IN SNAKE-VENOM RESEARCH AND STATUS OF SNAKE VENOM COLLECTION

The biochemical components in snake venom are used in basic physiology, biochemistry research, a variety of medications, diagnostic tests, and anti-venom preparation (Koh *et al*., 2006; Powell *et al*., 2006). Scientists from Tezpur University in India and University of Northern Colorado in USA have discovered that the venom of Russel's Viper contains a chemical component that has therapeutic potential to act as a "clot-busting drug" for heart patients (Kalyan, 2013). Similarly, a mix of highly venomous chemicals called alpha-neurotoxins found in Cobra venom with the fluorescent nanoparticles of cadmium selenide known as quantum dots had effectively marked the boundaries of cancer growths (Kalyan, 2013). Snake venom is also used in anti-cancer drugs and painkillers (Yang *et al*., 2005; Koh *et al*., 2006). A large number of snakes would be required each year for venom extraction for the research and pharmaceutical industry. Therefore, catching snakes in the wild can be country's interest because rearing them in captivity for the purpose of obtaining venom has proved to be not only costly but also challenging (Burton, 1991; Whitaker & Andrews, 1996). Guidelines needed to prevent over-exploitation of wild snakes for the purpose of venom extraction and protocols need to be framed for rescue, rehabilitation and release of snakes. Seven laboratories across India produces snake anti-venom, but several other producers also exist whose legal status is uncertain. During 2011–2012 for venom extraction, a total of 8,060 Cobras were used by Haffkine Institute and Bharat Serums & Vaccines (Whitaker, 2012). Countrywide requirement of snakes for venom extraction is high; therefore, the demand for snakes in many public and private sectors involved in anti-venom production is tremendous. After venom extraction, venom replenishment does not occur rapidly, and the survival status of the venom-extracted snakes is unknown. Hence, a knowledge base needs to develop through proper scientific studies for the better management of snakes in the anti-venom industry.

LEGAL CONSTRAINTS FOR SNAKE-VENOM COLLECTION

An obstacle in the venom collection can be a geographical variation of the same species and sub-species, which makes it difficult to use the anti-venom of one region in another region (Wuster & Thorpe, 1991; Saikumari *et al*., 2015). Hence, there is a need for more registered venom collection units to cover the geographical variation in the venom of widespread species for the medicinal and research purposes. The focus should be on improving antivenom production, price and use is important. In India, snakes are protected under the Wildlife Protection Act, 1972; hence, permission to capture snakes for venom extraction or research purposes is a contentious issue.

CONCLUSION

The behaviour and adaptability of the released snakes after various stages of the venom extraction is unknown. Only if the authorization provided, it will be possible to investigate and gather information on relocated snakes. Such information shall be useful to frame relevant policies and guidelines by the government to meet the anticipated demand of venom requirements in the country. A thorough understanding of a species is a basic element to reduce human-snake conflict. Therefore, the existing knowledge gap on various aspects of snake ecology is first needed to find solutions for this complex issue. Such a knowledge about snakes will help the managers to prepare effective management protocols for rescue operations and to mitigate human-snake conflicts. This information can immensely contribute to creating awareness among the public in avoiding snakebite and will help farmers to understand ways in which the snakes can be kept away from their living spaces. There are several challenges persist that prevent appropriate management of snakebite victims in India. For example, not all hospitals and clinics can afford the antivenom. Antivenom often have a limited self-life and require continuous refrigeration, which is a problem in remote places without electricity. Further, poor access of inadequately equipped and staffed medical centres in rural places, high cost of treatment, and inadequate use of antivenoms are other major concerns. Importantly not all medical doctors are trained to treat snakebite victims in the country, these issues need to be addressed.

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