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Tick Infestation on Wild Snakes in Northern Part of Western Ghats of India

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ABSTRACT In total, 167 individuals of 30 species of snakes belonging to 22 genera and five families were examined for tick infestation from November 2008 to March 2010. Only two species of snakes, *Ptyas mucosa* (L., 1758) (Indian rat snake) and *Naja naja* (L., 1758) (spectacled cobra), were found infested by ticks. All ticks collected were identified to be *Amblyomma gervaisi* [previously *Aponomma gervaisi* (Lucas, 1847)]. The average prevalence of these ticks on Indian rat snakes ($n = 48$) was 29.16%, with abundance of 7.02 ticks per individual; on spectacled cobras ($n = 20$), average prevalence was 30.00%, with abundance of 6.9 ticks per individual. The nymphs and males were predominant. All the ticks were found on the dorsal aspect of the body of the snake, and no ticks were recorded on the head, tail, or ventral body. The rate of tick infestation was highest in scrubland and was lowest in evergreen forests. Female Indian rat snakes showed higher tick infestation rates than male Indian rat snakes. Using Mann–Whitney *U* test, we found that longer snakes of both species had significantly higher rate of tick infestation in both the species of snakes.

KEY WORDS *Amblyomma*, *Aponomma*, Indian rat snake, spectacled cobra

Hard ticks are hematophagus parasites that are important vectors of many viral, bacterial, rickettsial, and protozoal diseases of humans and domestic animals. They are known to parasitize a variety of vertebrate hosts, including wild animals. Hard ticks belong to subfamily Ixodoidea, order Acarina, class Arachnida (Sharif 1928). Although there are numerous articles on the infestation of ticks on different hosts, both domestic and wild animals, information on tick infestation on reptiles is rare or scanty in India. Ticks found on reptiles generally belong to genus *Amblyomma* (formerly *Aponomma*). The Life cycle of *Aponomma lucasi* Warburton has been studied under laboratory conditions (Bhat and Nikam 1986). In the previous reports from India by Geevarghese and Dhanda (1995) and Ghosh et al. (2007), *Aponomma gervaisi* (Lucas, 1847), *Aponomma leave* Neumann, *Aponomma lucasi* Warburton, and *Aponomma pattoni* (Neumann) have been recorded on reptile hosts. Some of these species are either synonyms or invalid as per the recent classification (Horak et al. 2002, Klompen et al. 2002, Barker and Murrell 2004). Human pathogens such as *Coxiella burneti* and *Rickettsia honei* are known to be transmitted by *Aponomma* ticks (now *Amblyomma*); these ticks are known to infest humans accidentally in India (Tenderio 1953, Stephen and Rao 1979, Prakashan and Ramani 2003, Stenos et al. 2003). *Aponomma* ticks are known to cause tick paralysis in the *Coluber constrictor priapus* (southern black racer) (Hanson et al. 2007). *Aponomma* ticks are vectors of *Aeromonas hydrophilia* that causes bacterial stomatitis and pneumonia in snakes (Marcus 1981). The aim of the current study is to record the prevalence of infestation of tick on different species of wild snakes found in western Maharashtra and Karnataka, India.

Materials and Methods

Study Area. The study was conducted in the northern part of western Ghats area from November 2008 to March 2010, covering different seasons, i.e., winter, summer, and monsoon. The study localities included Pune (18° 31′6.34″ N, 73° 51′24.14″ E), Saswad (18° 20′34.60″ N, 74° 1′47.52″ E), Lonavala (18° 44′53.00″ N, 73° 24′26.00″ E), Jejuri (18° 16′35.85″ N, 74° 9′43.79″ E), Tahmini (18° 26′48.85″ N 73° 25′49.96″ E), Shirwal (18° 9′9.24″ N, 73° 58′46.94″ E), Amboli (15° 57′52.98″ N, 74° 0′12.86″ E), Bhimashankar (19° 4′21.11″ N, 73° 32′9.81″ E), Badalapur (19° 9′0.00″ N, 73° 16′0.00″ E), Kas (17° 41′60.00″ N, 73° 49′60.00″ E) in Maharashtra state and Agumbe (13° 30′25.76″ N, 75° 5′40.89″ E) in Karnataka state of India. In brief, the study area covered different habitats, including evergreen forest, semi-evergreen forest, dry deciduous forest, scrubland, and agricultural and human habitations.

Collection of Ticks. Snakes were randomly sampled for tick infestation as and when they were rescued with the help of local snake rescuers from different

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Table 1. Snake species collected, habitat-wise, with prevalence of tick infestation

Habitat	No. snake specimens	Snake species[a]	Prevalence of *A. gervaisi* (%)
Dry deciduous forest	9	IRS, BR, CTS, RV, SK	11.111
Evergreen forest	53	BCS, MPV, CVS, BPV, CKS, BTS, FCS, LSNS, MS, PS, UB, SC, YSWS	0
Human settlement	54	CKS, BR, LSS, SK, CTS, CWS, DBS, GK, RIS, RV, SC, RKS, SSV	9.260
Scrubland	40	BR, BCS, CKr, CSB, IRS, RSB, SSV, SC, SK	27.5
Semi-evergreen forest	11	BPV, BK, BTS, GK, IRS, MTS, SC	27.272

[a] CSB, common sand boa (*Gongylophis conicus*); RSB, red sand boa (*Eryx johnii*); CKS, common kukri snake (*Oligodon arnensis*); BR, banded racer (*Argyrogena fasciolata*); BCS, Beddome's cat snake (*Boiga beddomei*); BK, Beddome's keelback (*Amhiesma beddomei*); BTS, common bronzeback tree snake (*Dendrelapis tristis*); SK, Striped keelback (*Amphiesma stolatum*); CKS, cheackered keelback (*Xenochrophis piscator*); FCS, Forsten's cat snake (*Bioiga forsteni*); CTS, common trinket snake (*Coelognathus helena helena*); CVS, common vine snake (*Ahaetulla nasuta*); CWS, common wolf snake (*Lycodon aulicus*); DBS, Dumeril's black-headed snake (*Sibynophis subpunctatus*); GK, green keelback (*Macropisthodon plumbicolor*); IRS, Indian rat snake (*Ptyas mucosa*); LSNS, lesser striped necked snake (*Liopeltis calameria*); MTS, montane trinket snake (*Coelognathus helena monticollaris*); RKS, Russell's kukri snake (*Oligodon taeniolatus*); YSWS, yellow-spotted wolf snake (*Lycodon flavomaculatus*); CKr, common krait (*Bungarus caeruleus*); SC, Spectacled cobra (*Naja naja*); LSS, large-scaled shieldtail (*Uropeltis macrolepis macrolepis*); MS, mahabaleshwar shiledtail (*Uropeltis macrolepis mahabaleshwarlensis*); PS, Phipson's shieldtail (*Uropeltis pepsonii*); UB, shieldtail snake (*Uropeltis bicatinata*); BPV, bamboo pit viper (*Trimeresurus gramineus*); MPV, Malabar pit viper (*Trimeresurus malabaricus*); RV, Russell's viper (*Daboia russelii*); SSV, saw-scaled viper (*Echis carinatus*).

localities. Description of various habitats from where the snakes were examined and other details were recorded in a field book. Snake species were identified with the help of field guides (Whitaker and Captain 2004) and from prior experience. The length, sex, and body parts where ticks were collected, and certified snake rescuer's names were recorded. Overall body condition, including emaciation, wounds, and status of molt of the snake, also was noted. Emaciated snake was easily identified by palpating the whole body for muscle thickness. Snakes during molt were reexamined for tick infestation before and after the molting.

Each rescued snake was carefully restrained physically by experience rescuers, and head, body, and tail (ventral and dorsal sides) were carefully examined for ticks or any other ectoparasitic fauna, such as other acarines or insects, lodged in between the scales within 24 h of rescue. All the ticks present on the body of the snakes were collected and preserved in 70% ethanol for later identification of species and life stage. Photographic documentation was done to examine the lodging habits of ticks. All snakes were released by rescuers.

Statistical Analysis. Tick prevalence was determined according to the equation [(no. of parasitized snakes)/(total no. of snakes] $\times$ 100, and tick abundance was determined according to the equation [(no. of ticks)/(no. of snakes)] (Margolis et al. 1982). Differences in the prevalence of *Ptyas mucosa* (L., 1758) (Indian rat snake) and *Naja naja* (L., 1758) (spectacled cobra) infestation, prevalence in males and females of Indian rat snake, and prevalence of infestations in different habitats with the overall prevalence observed were compared using Fisher exact test. Lengths of Indian rat snakes and spectacled cobras were correlated with presence of tick infestation using Mann–Whitney *U* test. Statistical analyses were carried out using the XLSTAT statistical package and the results were considered significant at $P < 0.05$.

Results

Representativeness of Samples and Prevalence. We examined 167 snakes of 30 species belonging to 22 genera and five families (Uropeltidae, Boidae, Colubridae, Elapidae, and Viperidae) for tick infestation. Habitat, number of snakes and species sampled, and number of ticks collected from all the localities are depicted in Table 1.

Only two species, Indian rat snake and spectacled cobra, were found to be positive for tick infestation in this study. No other ectoparasitic infestations were found. All ticks collected from snakes were identified as *A. gervaisi* (Fig. 1a and b). The prevalence and abundance of tick infestation for Indian rat snake was 29.16% and 7.02 (n = 48), whereas for spectacled

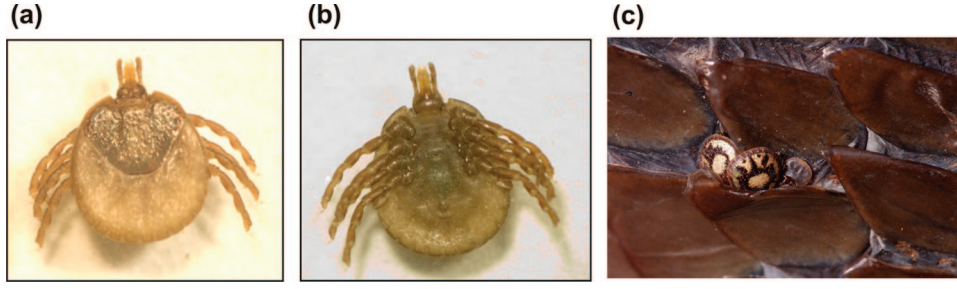

Fig. 1. Photos of *A. gervaisi*. (a) *A. gervaisi* female dorsal view. (b) *A. gervaisi* female ventral view. (c) *A. gervaisi* lodged in between scales of Indian rat snake. (Photo credit: Rohan Pandit; online figure in color.)

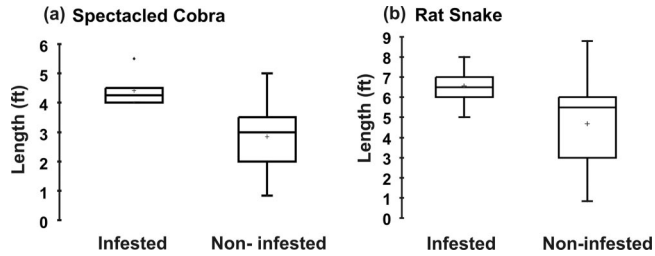

Fig. 2. (a) Box plot showing lengths in meters of infested and noninfested Indian rat snake. (b) Box plot showing lengths in meters of infested and noninfested spectacled cobra.

cobra, the values were 30.00% and 6.9, respectively ($n = 20$). The prevalence in female Indian rat snakes (50.0%; $n = 22$) was found to be significantly higher than that of male Indian rat snakes (11.76%; $n = 17$) ($P = 0.0183$). Lengths of the Indian rat snakes and spectacled cobras showed significant differences when correlated with presence of infestation by using the Mann–Whitney *U* test (Indian rat snake $U = 366.0$, $P = 0.004$; spectacled cobra $U = 73.50$, $P = 0.007$) (Fig. 2a and b). An Indian rat snake that was about to molt and was heavily infested with ticks was kept at a proper place for its molting; 187 ticks were recorded before molting. After molting, the snake retained all ticks.

Tick Population Structure and Lodging Habits. Of 475 *A. gervaisi* ticks, 40.69% were males, 16.86% were females, 34.01% were nymphs, and 8.43% were larvae. Ticks were lodged between the scales, with the capitulum safely hiding below a scale. When present, one to four ticks were observed per scale (Fig. 1c). Under one scale, either only males, only females, or both or mixed stages of adults, nymphs, and larvae were recorded. All ticks were found on the dorsal aspect of the body of the snake. Two ticks were present on the hood of a spectacled cobra. No tick was found on the tail or ventral aspect of any snake.

Relationship Between Habitat and Prevalence. The prevalence of infestation in different habitats (Table 1), such as dry deciduous forest (11.11%; $n = 9$) ($P = 1.00$), semi-evergreen forest (27.27%; $n = 11$) ($P = 0.15$), and human habitations (9.25%; $n = 54$) ($P = 0.80$), was found to be almost similar with that of prevalence observed irrespective of habitat (11.97%; $n = 167$). However, prevalence in evergreen forest (0.0%; $n = 53$) ($P = 0.004$) was significantly less, and prevalence in scrubland (27.5%; $n = 40$) ($P = 0.024$) was significantly higher than the overall observed prevalence (11.97%; $n = 167$).

Discussion

The study was intended to generate a baseline data of tick infestation on snakes found in northern part of western Ghats of India. Previous studies on tick infestation on reptiles are from monitor lizard (*Varanus bengalensis*) and Indian rat snake (Harakare et al. 2007a,b). This is the first time that such kind of extensive surveillance has been carried out in India. Of the 30 different species of snakes surveyed, only two species, Indian rat snake and spectacled cobra, were found to be infested by ticks. It is not still clear whether other species of snakes are refractory or susceptible. Ticks adapted to specific habitat type encounter only those vertebrates adapted to the same habitat (Mullen and Durden 2002). Thus, it might be possible that there might be ecological reasons behind host specificity of *A. gervaisi* to Indian rat snake and spectacled cobra, but the other reasons such as evolutionary history and ability of ticks to avoid host rejection must be studied in detail. In terms of ecology, the maximal parasitism was recorded on the snakes collected in scrublands ($P = 0.024$) because Indian rat snake and spectacled cobra were scarcely sampled from evergreen ($P = 0.004$) and semi-evergreen forests ($P = 0.15$) during the study. Snakes collected from urban areas also were infested.

The difference in the prevalence of males and females of Indian rat snake might be because of their breeding behavior where females are supposed to get more exposure to infestation. Other infestation studies conducted on ball python (*Python regius*) (Aubret et al. 2005) and on western fence lizard (*Sceloporus occidentalis*) (Eisen and Eisen 1999) have indicated higher tick burden on males than females. In our study, snakes having longer length were found to be more to be infested in both Indian rat snake and spectacled cobra. This difference might be because of the age where older snakes are more likely to be exposed to infestation than the younger snakes. Degenhardt and Degenhardt (1965), while studying the tick infestation on snake *Elaphe subocularis*, observed that juveniles and younger snakes are less likely to be found infested with tick infestation. Our study has shown that the molting habit of snakes does not affect tick parasitism because the number of ticks recorded before and after the molting remained the same.

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