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Prevalence and Distribution of Hard Ticks (Acari: Ixodidae) in Domestic Animals from Solapur District, Maharashtra, India

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Abstract: In the present study, species diversity, prevalence and distribution of hard ticks was conducted along six substations; Barshi city, Gadegaon, Khandavi, Soundare, Ridhore and Wadshinge from Barshi and Madha Taluka of Solapur District, Maharashtra, India. Hard ticks were collected from domestic animals (canines, cattle and cats) monthly from January 2021 to December 2021. A total of 450 domestic animals were inspected, of which 233 animals comprising 103 canine, 108 cattle and 22 cats were infested with ticks. 2 species of hard ticks (*Rhipicephalus sanguineus* and *Rhipicephalus microplus*) were recorded from the study area. Recorded ticks revealed higher density and a serious infestation in studied domestic animals. In dogs, maximum density of ticks was recorded in and around ear and the neck, compared to appendages, abdomen, back and perianal region. While in cattle, abundance of ticks was found around the neck region (crest and dewlap), ear, and from the tail, head to the udder region. Cats revealed higher density of tick infestation to the ear only. This could be attributed to the abiotic factors like hot and arid climate of the study area for which the ticks show highest adaptation. Regular monitoring of the health, vaccination against bacterial and viral pathogens and to maintain health and hygiene of the domestic animals is recommended. Plant-based acaricidal compounds should be used for prevention and control of hard ticks. Study suggests practice of integrated approaches to manage the hard ticks in a sustainable manner.

Keywords: Domestic animals, Ectoparasite, Epidemiology, Hard ticks, Ixodidae, Prevalence, Tick-borne diseases

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Introduction

Arthropods (insects, lice, mites, ticks, etc.) are important group of external or ectoparasites because of the direct effect associated with heavy infestations on health and food production. Injurious ectoparasite infestations impair the productivity of domestic animals and, in extreme cases, result in mortality (Adalberto *et al*., 2020). Infestation by ectoparasites (ticks, mites, lice, etc.) is a serious veterinary problem with adverse effects on health of human livestock and cause heavy economic losses. Among ectoparasites, infestation by tick causes severe irritation, allergy,

toxicosis, lowered productivity, mortality and transmission of diseases (babesiosis, theileriosis, anaplasmosis etc.).

Changbunjong *et al*. (2009) reported that arthropod ectoparasites live, feed and shelter on or just beneath the surface of their host's epidermis, hair or feathers. Due to this, skin and other subcutaneous tissues reveal symptoms such as irritation, hypersensitivity, dermatoses and alopecia. Feeding activity of the ectoparasites, also result in blood loss, secondary infestations, pruritus, excoriation and premature death. They may also cause behavioural disturbances, such as increased frequency of rubbing or scratching, leading to reduced time in feeding (Colebrook and Wall, 2004). Petney *et al*. (2007) documented that some ectoparasites also act as vectors of viruses, rickettsia, bacteria, protozoa, cestodes and nematodes, including vectors of zoonotic diseases in humans.

Ticks are blood-sucking ectoparasites and belong to the Phylum Arthropoda, Class Arachnida, Sub-class Acari (ticks and mites), Superorder Parasitiformes, Order Ixodida, Family Ixodidae and Genus Rhipicephalus. They share the Superorder Parasitiformes with the suborders Holothyrida, Mesostigmata (mites) and Opilioacarida (Brites-Neto *et al*., 2015). Ticks belong to the family Ixodidae (hard ticks), and the family Argasidae (soft ticks). Ixodid tick species affect cattle health and production around the world. Depending on the species, ixodid ticks will parasitize one, two or three hosts to complete the larval, nymphal, and adult stages. Mated adult females drop off the host to lay their eggs on the ground. Compared with ixodid ticks, argasid ticks are faster feeders and nidicolous, living in or near shelters used by their hosts (Adalberto *et al*., 2020).

Generally, the activity of ticks is highly seasonal for different stages of development. Female of the hard ticks can increase their weight up to 120 times as they engorge with blood prior to egg laying. When fully engorged, a female tick can measure up to one centimetre in length and resembles a small bean (Sahu *et al*., 2013). Life cycle of the tick may be completed in either one-, two-, or three-host ticks, i.e. each life cycle stage feeds once on a new host individual after actively seeking for their hosts by climbing, on to the leaves of small plants such as blades of grass (ESCCAP, 2022).

Ticks can be found all over the body of the host, but the preferred sites should be non-hairy and thin-skinned areas (face, ears, axillae, interdigital, inguinal and perianal regions). Removal of blood, in heavy infestations, may lead to anaemia. The wound of a tick bite may become infected and develop as a reaction to the mouthparts if the tick is forcibly removed and the mouthparts remain embedded in the skin (Shobana *et al.*, 2013).

Ticks acts as potential vector along with reservoirs of infectious agents (*Pasteurella multocida*, *Brucella abortus* and *Salmonella typhimurium*) in animals and man (Rony *et al*., 2010). Bandaranayaka *et al.* (2022) reported that tick infestations and tick-borne diseases have become a major emerging health concern of dogs in Sri Lanka. Ticks infest mostly all types of domestic animals and acts as vectors for the transmission of tick-borne infections in human and animal population worldwide (de la Fuentem *et al*., 2017; Iqbal *et al*., 2022). According to Brites-Neto *et al*. (2015), ticks are responsible as reservoirs at the transmission of pathogenic fungi, protozoa, viruses, rickets and others bacteria during their feeding process on the hosts.

Keyyu *et al.* (2003) reported that, farmers in developing countries face the prevalence of ticks and tick-borne diseases in the wet seasons, which limit the productivity of their animals. Diseases transferred by ticks can be severely debilitating or fatal to livestock, humans and companion animals (Adenubi *et al*., 2016). Jongejan and Uilenberg (2004) described that in Africa, Asia and Latin America, tick-borne protozoan diseases (theilerioses and babesiosis) and rickettsial diseases (anaplasmoses and cowdriosis) are the most common diseases of small and large

ruminants affecting the livelihoods of farming communities.

World Organization for Animal Health (WAHO) (2019) stated that tick-borne pathogens cause transboundary cattle diseases (bovine babesiosis, anaplasmosis, theileriosis, and heartwater) which pose threat to health of domestic animals and human. ESCCAP (2022) noted that ectoparasites may cause cutaneous lesions, induce immuno-pathological responses, transmit pathogens, zoonotic or transmit zoonotic infections and may interfere with the human–animal bond.

Ticks are effective vectors because of their some distinctive features such as, secure attachment to the host and easy transfer to new host; ingestion of large number of pathogens due to lengthy feeding period; allows easy transfer of pathogen from host to host due to feeding on different hosts; long lived; females lay large number of eggs; survive for lengthy period without feeding and ingested pathogen may be passed transtadially or transovarially (Li *et al*., 2018). Ticks have seasonal distribution and preferable host selection. Also, tick infestation in buffalo poses a serious damage to the livestock industry in Iraq (Sabeeh and Hatem, 2018).

Species diversity is a useful parameter to know the state of succession and stability in the community. Species richness, or the number of species, is currently the most widely used diversity measure (Olawusi-Peters and Ajibare, 2014). Studies of tick distribution and diversity are important in building up knowledge about tick borne disease (Shobana *et al*., 2013). Literature review reveals that worldwide plenty of scientific data is generated on the hard ticks with reference to taxonomy, morphological identification, dragging protocol, species diversity, prevalence, impact on livestock and human health, epidemiology, tick-borne infections, management, and guidelines for the control.

Further, it was noticed that, worldwide many investigators have studied various aspects of hard ticks. Work of these investigators is worth to mention: Byford *et al.* (1992), Keyyu *et al.* (2003), Colebrook and Wall (2004), Jongejan and Uilenberg (2004), Petney *et al.* (2007), Stafford (2007), Changbunjong *et al.* (2009), Rony *et al.* (2010), Tongjura *et al.* (2012), IPCM (2013), Neagu *et al.* (2013), COWS (2014), Olawusi-Peters and Ajibare (2014), Sofizadeh *et al.* (2014), Brites-Neto *et al.* (2015), Adenubi *et al.* (2016), de la Fuentem *et al.* (2017), Ernieenor *et al.* (2017), Karim *et al.* (2017), Li *et al.* (2018), Musa *et al.* (2018), Sabeeh and Hatem (2018), Al-Husseini (2019), Ali *et al.* (2019), Ramzan *et al.* (2019), WAHO (2019), Adalberto *et al.* (2020), Agu *et al.* (2020), El-Alfy *et al.* (2022), ESCCAP (2022), Iqbal *et al.* (2022), Shahid *et al.* (2022) and Tawana *et al.* (2022).

With reference to India, comparatively meagre data is available on the hard ticks. Work of these investigators is worth to mention: Anish *et al.* (2000), Sahu *et al.* (2013), Shobana *et al.* (2013), Chhillar *et al.* (2014), Krishna murthy *et al.* (2017), Apurba *et al.* (2018), Jadhao *et al.* (2018), Paikade and Chavan (2019), Nataraj *et al.* (2021), Ranganathan *et al.* (2021) and Bandaranayaka *et al.* (2022).

In Maharashtra, species diversity and role of ticks in zoonotic disease transmission is not well described, partly, due to limited available information on tick diversity. Further, no scientific studies have been carried out on the species diversity of hard ticks of Solapur District, Maharashtra, India; hence, the present study was undertaken. Objective of the study was to evaluate the species composition of hard ticks with respect to prevalence and distribution.

Materials and Methods

Study Area:

Geographically, Solapur District (Lat. 17° 39' 35.7120''N and Long. 75° 54' 22.9932''E) with the population of 4,317,756 is located entirely in the Bhima and Seena basins (Fig. 1). It is sharing border with Ahmednagar District to the North, Osmanabad District to the North, Pune District to

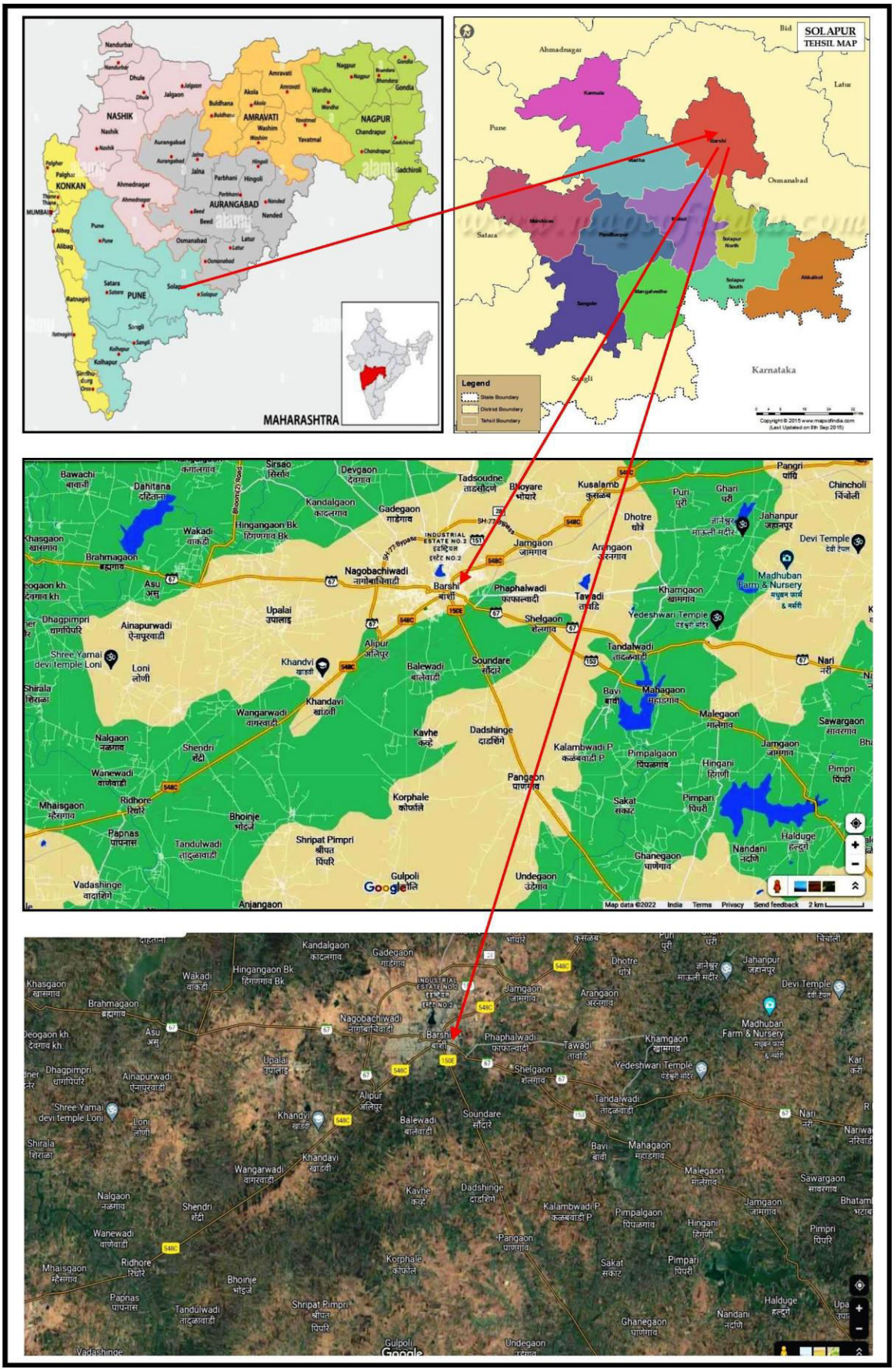

Fig. 1: Map and Satellite image of the study area (Source: Google map).

the west, and Sangli District to the west. Solapur District occupies an area of approximately 14845 square kilometres and is in the 552 meters to 457 meters elevation range.

For administrative purposes, Solapur district is subdivided into eleven talukas, such as Akkalkot, Barshi, Karmala, Madha, Malshiras, Mangalwedha, Mohol, North Solapur, Pandharpur, Sangola, and South Solapur. Annual average temperature of the district is about 29.27ºC and it receives about 103.15 millimetres as annual precipitation.

Barshi Taluka (Lat. 18° 13' 51.513"N and Long. 75° 41' 40.2468"E) with the population of 372,711 (Census of India, 2021), has average annual precipitation of about 103.15 mm and temperature range is 23.32-32.1 ºC. Month of May is the warmest month of the year and has maximum temperature up to 39.38ºC.

Sampling strategy:

The present study was carried out for a period of one year, from January 2021 to December 2021. For present investigation, two Talukas namely, Barshi and Madha were selected as primary study sites and among them, six sub-sites were selected on the basis of geographical locations. From Barshi Taluka, four sub-sites (Barshi city, Gadegaon, Khandavi and Soundare) and from Madha Taluka, two sub-sites (Ridhore and Wadshinge) were selected for the studies on species composition, prevalence and distribution of hard ticks.

Geographical positions of the selected sub-sites were as follows: Barshi City (Lat. 18° 13' 51.513" N and Long. 75° 41' 40.2468" E), Gadegaon (Lat. 17° 39' 28.317" N and Long. 75° 14' 38.9256" E), Khandavi (Lat. 18° 11' 39.3966" N and Long. 75° 38' 12.5304" E), Soundare (Lat. 18° 11' 52.278" N and Long. 75° 42' 54.6798" E), Ridhore (Lat. 18° 8' 10.4892" N and Long. 75° 32' 1.377" E) and Wadshinge (Lat. 18° 4' 31.2918" N and Long. 75° 30' 9.5646" E).

The study sub-sites were surveyed monthly and at each site, tick-infested domestic animals such as cows, buffaloes, cats and dogs were studied. Of each animal, five specimens were studied for the prevalence and distribution of hard ticks. During the study, twice a month, Government Veterinary Hospitals were also visited to assess the species diversity, abundance and symptoms of hard ticks among the tick-infested animals under treatment. At study sites, cattle were examined by visiting the livestock area of the farmers. Dogs were studied by visiting the dog breeding centres, pet shops, pet owners, and veterinary hospitals, and also the stray dogs. Cats were examined by visiting the pet shops, pet owners and veterinary hospitals.

Collection and Identification of hard ticks:

For collection of hard ticks, various equipments and tools such as sampling bottles, gloves, forceps, gas lighter, macro lens, Cannon EOS1100D digital camera etc. were used. The selected canine, cattle and dogs were thoroughly investigated by close inspection, parting the hairs against their natural direction for the detection of ticks. Ticks were collected from their preferred site of attachment i.e. ear, anal and peri-anal, abdomen, tail, etc.

A total of 450 domestic animals comprising 150 each of canine, cattle and cats were examined for ticks using forceps and brush. The collected adult ticks were preserved in 70% alcohol in sampling bottles, labelled with details of location, host, and date. Ticks were photographed by Cannon EOS1100D digital camera. In the laboratory, ticks were observed under a stereo-zoom microscope and identification of the ticks were done by following the available literature, standard taxonomic keys and reference books of Wall and Shearer (1997), Geevargheseet *et al.* (1997), Walker *et al.* (2003) and Estrada-Pena *et al.* (2004).

Results and Discussion

Two species of hard tick belonging to one order, one superfamily, one family and one genus were recorded. A preliminary checklist of ticks recorded from study area is presented in Table 1. Two species of ticks *Rhipicephalus sanguineus* (Latreille, 1806) and *R. microplus* (Canestrini,

Table 1: Checklist of hard ticks from Barshi and Madha Taluka, Solapur, Maharaashtra

S. No.	Order	Superfamily	Family	Species	Common name
1	Ixodida	Ixodoidea	Ixodidae	*Rhipicephalus sanguineus* (Latreille, 1806)	Kennel tick, Pan-tropical dog tick, Brown dog tick
2	Ixodida	Ixodoidea	Ixodidae	*Rhipicephalus microplus* (Canestrini, 1888)	Cattle tick

1888) (Fig. 2) revealed higher density and cause infestation among domestic animals.

Of the total 450 domestic animals inspected, 233 animals comprising 103 canine, 108 cattle and 22 cats were infested with ticks (Tables 2 to 5). It was observed that, in dogs, maximum density of ticks were recorded at in and around the ear and the neck region, compared to appendages, abdomen, back and perianal region (Fig. 3). Further, in cattle, more abundance of ticks was observed around the neck region (crest and dewlap), the ear, and from the tail, head to the udder region. In case of cats, higher frequency of tick infestation was recorded in the ear only. Results recorded on total prevalence and prevalence in canines, cattle and cat are represented in Table 2 to 5.

Anish *et al*. (2000) identified 8 species of ticks in cattle, buffaloes, sheep, goats, and dogs from Andhra Pradesh, India. Shobana *et al*. (2013) reported 14 species of ticks from 5 genera in domestic animals (cats, dogs, goats and buffalo) of Villupuram District, South India. Chhillar *et al*. (2014) recorded 4 species of hard ticks in domestic buffalo and cattle from Haryana, India. Krishna Murthy *et al*. (2017) reported fleas, ticks, lice etc. as ectoparasites in stray and pet dogs of Shimoga, Karnataka. Ranganathan *et al*. (2021) recorded 14 species of ticks from 5 genera in house-hold animals (cows, dogs, goats, cats and fowl) in Tamil Nadu, South India.

With reference to Indian context, plenty of data is published worldwide on hard ticks on species composition, epidemiology, distribution, prevalence and health impacts on domestic animals and human. Sabeeh and Hatem (2018) have identified six species of ticks (five species of hard ticks and one species of soft tick) in buffalo from Basrah Province, Iraq. Fatemian *et al*. (2018) reported 12 species of Ixodidae ticks from livestock fauna (sheep, goat, and cattle) in Boyer-Ahmad and Dena cities of Kohgiluyeh and Boyer-Ahmad Province, Southwest of Iran. Kebbi *et al.* (2019) noted the infestation by 4 species of ticks in domestic dogs in Bejaia province, Northern Algeria. Also, the prevalence of infestation by ticks in young animals (≤ 1 year of age) was higher than that in adult animals (> 1 year of age). Lotfi *et al*. (2021) have identified seven species of hard ticks in the cattle of in Jijel Province (northeastern Algeria). Bandaranayaka *et al*. (2022) have reported eight species of brown dog ticks belonging to five genera and noted that the species diversity of brown dog ticks varies in different climatic regions of Sri Lanka.

Heavy infestation of domestic animals by hard ticks reported in present study, could be attributed to the hot climatic condition of the study area. Similar results on adaptation of hard ticks to hot and humid environment were reported by Tadesse *et al*. (2012) and Carolyn (2015). Fatemian *et al.* (2018) and Kebbi *et al.* (2019) reported that environmental conditions like heavy rainfall and heat, show significant effect on the activity of ticks. Also, biological activity of the ticks is dependent on ambient temperature. Al-Husseini (2019) noted that the abundance of the cattle tick infestation in sheep in Alnnajaf province, Iraq is started during March to May and then declined in June to July but in September, the abundance raised at top, may be due to variations in temperature and humidity of province. This

Rhipicephalus sanguineus

Rhipicephalus microplus

Hard ticks attached to the ear

Infestation by adult ticks

Ticks in between the digits of paw

Tick attached to the ear of dog

Fur of Pomeranian dog after infection of tick

Fig. 2: Hard ticks recorded from the study area.

Table 2: Total Prevalence recorded from canine, cattle and cat

Animal category	**No. of observed animals**	**No. of infested animals**	**Rate of prevalence (%)**
Canine	150	103	68.66
Cattle	150	108	72
Cat	150	22	14.66
Total	450	233	51.78

Table 3: Total Prevalence recorded from canine

Age of Animal	No. of observed animals	No. of infested animals	Rate of prevalence (%)
< 2 years	25	11	44.0
2 to 8 years	92	71	77.17
> 5 years	33	21	63.63
Total	150	103	68.66

Table 4: Total Prevalence recorded from cattle

Age of Animal	No. of observed animals	No. of infested animals	Rate of prevalence (%)
< 2 years	39	16	41.02
2 to 8 years	65	59	75.38
> 5 years	46	33	71.73
Total	150	108	72.00

Table 5: Total Prevalence recorded from cat

Age of Animal	No. of observed animals	No. of infested animals	Rate of prevalence (%)
< 2 years	43	00	00
2 to 8 years	38	12	31
> 5 years	69	10	14.49
Total	150	22	14.66

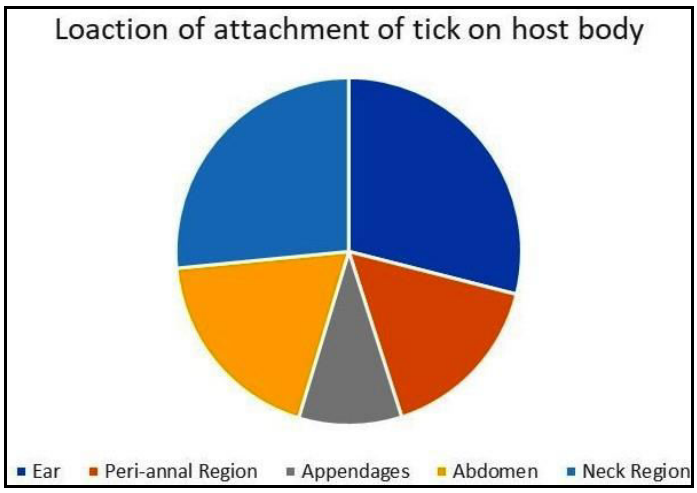

Fig. 3: Site wise preference of attachment of hard ticks.

suggests that, hard ticks were well adapted to the hot and arid weather conditions.

Results of present study indicated that presence of heavy infestation of hard ticks in livestock fauna, increases the health risk of transmission of bacterial and viral pathogens to human. Also, such infestation pose a serious health risk to the domestic animals and also cause the financial losses to the owners. This study recommends, regular monitoring of the health of domestic animals, vaccination against bacterial and viral pathogens and to maintain health and hygienic condition of domestic animals. Also, use of plant-based acaricidal compounds for the prevention and control of hard ticks is suggested. Instead of repelling the ticks, it is recommended to

kill the hard ticks to avoid health risk to domestic animals and human. Integrated approaches to manage the ectoparasites in a sustainable manner should be practised.

Conclusion

Years of use and overuse of available chemical acaricides have resulted in the large scale development of resistance in ticks with negative environmental impacts. Implementation of new alternative, environmentally friendly parasite control policies with minimum possibility of development of resistance should be effective to control ticks. Use of plant-based compounds (extracts) may be a good source for preparations of new acaricidal compounds. Also, instead of repellent activities, killing of ticks is recommended for effective control of ticks.

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