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Morphological characterization and prevalence of ectoparasites in goats in and around Guwahati, Assam, India

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ABSTRACT

A year-long study on the prevalence of various ectoparasites in goats was carried out in and around Guwahati, Assam, India. A total of 716 numbers of goats were screened for different ectoparasites and the highest prevalence of 68.44% was recorded in fleas. This was followed by ticks (67.32%), lice (43.02%) and mites (14.38%). The most common ectoparasites found throughout the year were *Haemaphysalis bispinosa*, *H. hystricis, Rhipicephalus* (*Boophilus*) *microplus*, *Linognathus africanus*, *Damalinia* (*Bovicola*) *caprae*, *Ctenocephalides felis orientis, C. canis, C. felis felis* and *Sarcoptes* scabiei var. *caprae*. The present study also reported *Linognathus africanus* and *Damalinia* (*Bovicola*) *capra* for the first time in goat from Assam. Significantly higher prevalence of tick and flea was found in female goats than the male goats. However, the prevalence of lice and mite were similar for both male and female goats. Age-wise, goats older than 6 months were more likely to have ticks and mites. But younger goats, under 6 months, were more likely to have fleas. Lice were found in goats of all ages and seem not to depend on age. Seasonally, ticks were most common during the pre-monsoon season, which is March, April, and May. On the other hand, lice, fleas, and mites were most common during the winter season, during December, January, and February months. The study revealed that goats of Guwahati, Assam have a considerable high burden of different ectoparasites and needs appropriate preventive measures for controlling them.

Keywords: Assam, Correlation, Ectoparasite, Goat, Prevalence

Goats (*Capra hircus*), popularly known as "poor man's cow", have long been considered extremely valuable animal with a high output value to farmers because of their remarkable capacity to adapt to a wide range of environmental conditions and diets (Webb 2014, Hirst 2019, Ousmane *et al.* 2024). India, with a total of 148.88 million stands second after China in the world ranking of goat population (20th Livestock Census, India). Parasitic diseases, regardless of their ecto or endo parasitic source, are a global concern and a significant hindrance to the wellbeing and productivity of livestock. Ectoparasites such as ticks, mange mites, lice, fleas, etc. cause significant decline in growth and output of animal leading to lower profitability and economic loss to farmers (Milne *et al.* 2008, Hassan 2023, Jote *et al.* 2024). Among different ectoparasites, ticks are regarded as the second most common vector for disease transmission after mosquitoes, and major blood-feeding and obligatory ectoparasites of vertebrates (Soulsby 1982, Kiss *et al.* 2012). Several genera of ticks like *Haemaphysalis*, *Boophilus*, *Hyalomma*, and *Rhipicephalus* are known to spread various tick-borne diseases that affect small ruminants (Gopalakrishnan *et al.* 2017, Muhammad *et al.* 2021, Begam *et al.* 2022). Goat lice infestation is a major constraint in maintenance and rearing of goat flocks all over the world especially during winter or rainy season. Chewing or biting lice (*Damalinia caprae*) and sucking lice (*Linognathus africanus*) are the most frequent parasites on Indian goats (Ajith *et al.* 2017). *Ctenocephalides felis felis* and *C. felis orientis* are the commonest fleas found in Indian goats (Devi 2006, Ajith *et al.* 2017, Soundararajan *et al.* 2018 b). Mange is often termed as a contagious disease caused by *Sarcoptes scabiei* var. *caprae, Psoroptes caprae, Chorioptes caprae* and *Demodex caprae* in goats (Neog *et al.* 1992, Thakuria 2012, Seid *et al.* 2016). It is one of the most important zoonotic diseases from an economic standpoint which spreads among animals either directly through contact with infected sources or indirectly through fomites (Parsani *et al.* 2008). Ectoparasitic infestations in goats have previously been reported by many workers in Assam (Neog *et al.* 1992, Thakuria 2012, Begam 2016). However, there has been no recent systematic investigation undertaken on ectoparasitic infestation in the study area. Therefore, this study was designed to explore the prevalence and morphological characterization of ectoparasites in goats in

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MATERIALS AND METHODS

The study was conducted in Guwahati, Assam over a period of one calendar year, from July 2022 to June 2023. This work was carried out in various organized and unorganized goat farms, VCC of College of Veterinary Science (CVSc), Khanapara, Assam Agricultural University (AAU), in Goat Research Station (GRS), AAU, Burnihat and its adopted villages, private clinics, dispensaries as well as local and village households. Laboratory work was performed at the Department of Veterinary Parasitology, CVSc, Khanapara, AAU, Guwahati. Assam.

The whole study period was split into four seasons: Pre-Monsoon (March, April, and May), Monsoon (June, July, August, and September), Post-Monsoon (October and November), and Winter (December, January, and February), according to the Regional Meteorological Centre at Lokpriya Gopinath Bordoloi International Airport in Guwahati, Assam.

Collection and identification of ticks, lice and flea: Ticks, lice and flea were collected by thorough examination and palpation of different body parts of goat such as ear, head, neck, back, abdominal regions, areas surrounding the eye and genitalia, inter-digital space and tail. These areas were known to be common places where external parasites like ticks, lice, and fleas usually settle (Ajith *et al.* 2017, Gopalakrishnan *et al.* 2017). The hair separation and combing methods were used to visualize lice and fleas (Lewis *et al.* 1967) and collected with a fine brush dipped in 70% alcohol (Giri *et al.* 2013). Preservation of the samples was done in 70% alcohol labelled vials with collection details.

Ticks were punctured behind their spiracle with a 24-G needle and gently pressed dorsally to remove internal contents. The liquidified tissue was then evenly removed by applying light pressure (Ajith *et al.* 2020), followed by treatment with 10% potassium hydroxide for 24 hours for better visibility. Lice underwent a similar treatment, while fleas were boiled in 10% potassium hydroxide for 5-10 min. All ectoparasites were kept in successive solutions of ethanol (70%, 80%, 95%, and 100%) for 30 minutes each. The collected parasites were identified microscopically based on their morphological character by preparing permanent mounts following the procedure outlined by Cable (1963).

Identification of ticks was done by microscopic observation (10X, 40X) under binocular microscope as per the taxonomic keys of Yamaguti *et al.* (1971), Sen and Fletcher (1962), Soulsby (1982), Geevarghese and Mishra (2011). Lice were identified by following the keys and guidelines of Sen and Fletcher (1962), Soulsby (1982), Sebei *et al.* (2004) and Alsaqabi (2019). Fleas were identified with the help of the keys and guidelines provided by Sen and Fletcher (1962), Lewis (1967), Joseph (1981), Soulsby (1982), Lawrence *et al.* (2014), Hii *et al.* (2015).

Collection and identification of mite: For the identification of mite, skin scrapings from suspected lesions were collected using the method of Sloss and Kemp (1978). The samples were preserved in separate vials with 70% alcohol. For processing, the scrapings were boiled in 10% KOH for 1-2 min and centrifuged at 1500 rpm for 3 min. After discarding the supernatant, the sediment was placed on a clean slide and examined under a binocular microscope (4X, 10X, 40X) for mites. Identification was done using keys from Sen and Fletcher (1962) and Soulsby (1982).

Statistical analysis: Baseline information was expressed as Mean±Standard Error (SE). Pearson's Chi-square statistical analysis was used to compare the data obtained from various ectoparasitic prevalence based on age, season and sex. Correlation between different ectoparasites encountered in this study with the climatic conditions such as average temperature, relative humidity and rainfall (as per the meteorological data from July 2022 to June 2023) is shown through a heat map.

RESULTS AND DISCUSSIONS

Out of 716 goats screened for different ectoparasites in and around Guwahati, Assam, infestation of fleas was the most common, affecting 68.44% of the goats, followed by ticks at 67.32%, lice at 43.02%, and mites at 14.38% (Table 1). The finding goes in tandem with the findings of Seyoum *et al.* (2015) and Nataraj *et al.* (2021). The high prevalence of fleas may be because goats often graze and share areas with other animals that also have fleas. The high prevalence of ticks in this study agrees with the findings of Soundararajan *et al.* (2018a) and Anish *et al.* (2020). However, Begum (2016) found a lower prevalence rate of ticks in goats from Assam. The difference in these results could be because of how the goats are managed and the growing resistance to treatments that kill ticks. Prevalence per cent of lice was almost similar to the findings of Giri *et al.* (2013). Prevalence of mite (14.38%) in the present study found similar with the findings of Kapoor (2016) but less than the findings of Neog (1985) and Thakuria (2012) in Assam, where they reported 25.08 and 28.61 per cent prevalence, respectively. Possible reasons of less prevalence of mites in this study may be because of climate change, different housing system and awareness among people regarding this devastating disease in the present study areas.

The present study revealed that most of the goats had a mix of different external parasites, and the most common type was a mix of other parasites with lice, which occurred in 87.36% of the cases (Table 1). This may be attributed to the grazing practice and also association of goats with pet or other domestic animals in the village areas which may increase the likelihood of exposure to multiple parasites in their environment. Mixed associations of ectoparasites were also reported by Ajith *et al.* (2020) in the Western Himalayas, Insyari'ati *et al.* (2024) in Indonesia and Leul *et al.* (2024) in Ethiopia.

Based on the morphological characterization, the

occurence of different ectoparasites were presented in Table 1. Three species of ticks belonging to two genera namely *Haemaphysalis bispinosa* (95.23%), *H. hystricis* (7.26%) and *Rhipicephalus* (*Boophilus*) *microplus* (0.83%) were recorded in the present study (Supplementary Fig. 1,2,3). Prevalence of similar species of ticks was also encountered by Shruthi *et al.* (2017) and Anish *et al.* (2020). In case of lice, although several workers have reported different species of lice in goat such as *Bovicola caprae*, *Linognathus africanus*, *L. stenopsis*, *L. vituli* Giri *et al.* 2013, Ajith *et al.* 2017, Rashmi and Saxena 2017) in various parts of the world but no such work has been carried out on the prevalence of lice in goat in Assam. Our study revealed that two different species of lice namely, *Linognathus africanus* (72.40%) and *Damalinia* (*Bovicola*) *caprae* (31.49%) were encountered for the first time in Assam (Supplementary Fig. 4,5). In case of flea, three species i.e *Ctenocephalides* i.e *Ctenocephalides felis orientis* (74.29%)*, C. canis* (17.76%) and *C. felis felis* (7.96%) were also recorded in the present study (Supplementary Fig. 6,7,8). Similar species of flea in goat were also reported by Muraleedharan and Sahadev (2012) and Ashwini *et al.* (2016) in Karnataka. Notably, Devi (2006) documented a higher prevalence of *C. canis* (55.55%) and *C. felis felis* (22.22 %) and a lower prevalence of *C. felis orientis* (22.22 %) in goats in Assam. Only one species of mite i.e., *Sarcoptes scabiei* var. *caprae* was recorded in goats during the present study (Supplementary Fig. 9). Many workers like Neog (1985) and Thakuria (2012) in Assam recorded different species of mites in goat. Non-occurrence of other mite species in the present investigation is suggestive of an extensive survey including a larger population of goat over a longer period of time.

A significant association was found between the prevalence of ticks and fleas and the gender of the goats examined (Supplementary Table 1). Higher prevalence of ticks and fleas was observed in female goats (ticks: 72.62%; fleas: 71.03%) than the male goats (ticks: 54.72%; fleas: 62.26%). This might be due to the hormonal influence and weaker immune status of females during pregnancy or lactation. Females have higher prolactin and progesterone hormone levels which make them more susceptible to any kind of infection (Borba *et al.* 2018). Other studies by Begam (2016) and Jariko *et al.* (2020) have also found similar results. No significant association was found between the prevalence of mite and lice with the gender of the goats examined. These findings goes in parallel with the reports of Sheferaw *et al.* (2010), Iqbal *et al.* (2014), Degu *et al.* (2015), and Rashmi and Saxena (2017).

Significantly higher prevalence of ticks (76.41%) and mite (15.79%) was observed in goats aged more than 6 months (Supplementary Table 1). Contrary to the goats of more than 6 months of age, the younger goats were less likely exposed to ectoparasite infested pasture and were kept in close proximity to households (Kusiluka *et al.* 1995). Moreover, the worn-out immune system of older goats increases the possibility of more infestation of ticks and mites (Sarkar *et al.* 2010, Shuvo *et al.* 2021). Similar findings were observed by Seyoum *et al.* (2015). Present study revealed significantly higher flea infestation was found in the age group less than 6 months. Young animals may exhibit poor grooming habits, which could explain why this condition is more common in them. Similar findings were found by Ashwini *et al.* (2016). Another possible reason of higher flea infestation in young animals might be because of shorter hair and thinner skin of young goats that make it easier for fleas to access and penetrate their skin, contributing to the higher incidence in this age group (Dawit *et al.* 2012).

A highly significant association ($p<0.01$) was found between ectoparasites and the four different seasons (Supplementary Table 2). Prevalence of tick peaked in the pre-monsoon season (March, April and May) and was lowest in winter (December, January and February). This pattern may be attributed to the favourable hot climate and dense vegetation during the pre-monsoon with rainfall and high relative humidity, which enhances tick propagation and increases their attachment to hosts while grazing (Anish *et al.* 2020). This indicates a strong positive correlation, moderate positive and a mild positive correlation between the prevalence of ticks with rainfall, temperature and humidity, respectively (Supplementary Fig. 10). Almost similar findings were observed by Ajith

Table 1. Prevalence of various genera and species of ectoparasites in goat in and around Guwahati.

Ectoparasite		No. of goats examined in the study	No. of goats found positive (%)	Mixed infestation (%)	No. of goats found positive for different species (%)
Ticks	Haemaphysalis bispinosa	716	482 (67.32%)	409 (84.85%)	459 (95.23%)
	H. hystricis				35 (7.26%)
	Rhipicephalus (*Boophilus*) *microplus*				4 (0.83%)
Lice	Linognathus africanus		308 (43.02%)	269 (87.36%)	223 (72.40%)
	Damalinia (*Bovicola*)*caprae*				97 (31.49%)
Fleas	Ctenocephalides felis orientis		490 (68.44%)	404 (82.45%)	364 (74.29%)
	C. canis				87 (17.76%)
	C. felis felis				39 (7.96%)
Mites	*Sarcoptes scabiei* var. *caprae*		103 (14.38%)	26 (25.42%)	103 (100.00%)

et al. (2020) and Anish *et al.* (2020). On the contrary, an earlier report of Begam (2016) in Assam showed the highest prevalence of ticks in the monsoon season. This variation may be attributed to the climate change observed globally. In contrast, lice, fleas, and mites showed higher prevalence in winter and lower during the monsoon (June, July, August and September). This might be due to the huddling of the animals during the winter season. The micro-environment generated by the hair coat of goats is a significant factor in the survival and development of the host-specific lice population. Also, lice cannot withstand hot and humid climate (Alilio 2019). This is indicative of strong negative, moderate and weak negative correlation between the prevalence of lice with temperature, humidity and rainfall, respectively which correlates with the findings of Rashmi and Saxena (2017), Meguini *et al.* (2018) and Ajith *et al.* (2020).

Higher prevalence of flea in the winter may probably attributed to huddling of animals and less grooming. This finding goes in parallel with the reports of Yakhchali and Hosseine (2006) and Iqbal *et al.* (2014). Grazing goats go through nutritional deficiencies and poor health status in the winter season due to lesser growth of vegetation during this season. This might trigger mite infestation and as it is highly contagious there might be inter-host transmission which has led to its higher prevalence in the winter season. This indicates strong negative correlation of prevalence of mite with temperature and rainfall and mild negative correlation with humidity. Probably the low humidity increases the rate of feeding of mites in winter, thereby producing distinct skin lesions, yet, its presence throughout the study period suggests that during pre-monsoon, monsoon and post-monsoon season, the mites became dormant (Wharton and Cross 1957). Earlier, Neog (1985), Thakuria (2012) and Lashari *et al.* (2016) also recorded highest prevalence of mange mite in winter season. Another interesting conclusion that can be drawn out from observing the correlation values is that, lice, flea and mites have strong correlation values between each other, implying that the climatic conditions needed for lice, flea, and mite infestations are similar, but there is a negative relationship between tick presence and the occurrence of lice, flea, and mite. Therefore, climate and weather are the crucial factors in determining the prevalence and diversity of an organism and these factors generally have varied effects on the hosts and parasites, resulting in significant variations of the organisms from time to time.

Our study revealed widespread occurrence of different ectoparasites in goats in Guwahati, Assam which has impacted the economic losses per year to the farmers. Three species of tick (*Haemaphysalis bispinosa*, *H. hystricis* and *Rhipicephalus* (*Boophilus*) *microplus*), two genera of lice (*Linognathus africanus* and *Damalinia* (*Bovicola*) *caprae*), three species of fleas (*Ctenocephalides felis orientis*, *C. canis* and *C. felis felis*) and only one mite species (*Sarcoptes scabiei* var. *caprae*) were encountered in goat from the study area. It was evident from this study that goats of Guwahati, Assam have a considerable high burden of different ectoparasites. Therefore, taking proper preventive measures, awareness on animal health services as well as use of acaricides in an appropriate way might help to control ectoparasites effectively under field level.

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