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Research Note

Effect of non-genetic factors on the prevalence of *Stilesia globipunctata* in the goat

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Summary

Despite its high prevalence and pathogenicity ,*Stilesia globipunctata* is a neglected cestode infection of ruminants in the tropics and sub-tropics. The present study reports the effect of sex, age, year and month on the prevalence of *S. globipunctata* in the goat. A total of 5208 eviscerated intestines of the goat carcasses were screened for a period of seven years, from January 2001 to December 2007. The overall prevalence of 36.6 % was significantly affected by the factors studied (P<0.05). Male goats were more susceptible to the *S. globipunctata* infection than that of female (P<0.05). Goat aged between 6 months and 1 year were found to be significantly more susceptible (P<0.05) which was followed by animals between 1 and 4 years of age and then more than 4 years of age. Morbidity was high (59 to 86 %) in animals of less than one year of age. The striking observation was that the prevalence peaked during monsoon and at nadir in May.
Keywords: goats; prevalence; *Stilesia globipunctata*

Introduction

Stilesia globipunctata (Rivolta, 1874), one of the neglected and economically important tropical parasites, is predilected to the small intestine of ruminants and camels (Borji *et al*., 2010). It belongs to tapeworm of the Anoplocephalidae family and is reported from Asia, Africa and European countries (Jacquiet *et al*., 1995; Denegri *et al*., 1998; Sridevi *et al*., 2005; Moghaddar & Afrahi, 2008). Adult parasite reaches up to 60 cm length and the scolex penetrates the mucous membrane and forms numerous nodules in the duodenum due to the chronic inflammatory reaction (Amjadi, 1971; Soulsby, 1982). Heavy infection with *S. globipunctata* may cause death (Graber & Gruvel, 1967) and the morbidity ranges between 30 – 65 % in the ruminants and camels (Louw, 1995; Abebe & Esayas, 2001; Tafti *et al*., 2013). For completion of life cycle, oribatid mites serve as intermediate hosts and the cysticercoids develop inside the mite (Soulsby, 1982). *Scheloribates indica* and *Erythraeus* spp are intermediate hosts for *S. globipunctata* in India (Tandon, 1963). Studying the factors influencing the infection prevalence it is important to focus on control, diagnosis and management procedures. However, little information is available regarding seasonal and spatial variation in prevalence or intensity of this parasite globally. The present study reports the effect of non-genetic factors such as sex, age, year and month on the prevalence of *S. globipunctata* using a large sample size (n=5208) collected in the goat from over a period of seven years.

Materials and Methods

The study area, Bareilly is located at 28°10'N, 78°23'E in Uttar Pradesh, India, has a semi tropical climate. In summer, the temperature ranges from 25 °C to 44 °C. The weather during monsoon season is hot and humid. In winter, the temperature ranges from 4 °C to 24 °C. The yearly average maximum temperature

is 31.6 °C and average minimum temperature is 18.9 °C with a rainfall precipitation of 1087 mm.

In the current study, a total of 5208 eviscerated intestines of the goat carcasses from Bareilly slaughter house were screened for a period of seven years, from January 2001 to December 2007, to ascertain the prevalence of *S. globipunctata*. Barbari breed of goat and its crosses with non-descript goats formed much of the sample barring a few samples of Jamunapari (41) breed. As Barbari and its crosses dominated the overall sampling and prevalence was equal across breeds. However, the breed effect was not included in the study. The prevalence was defined as the percent positive cases and was measured in both the sexes, over three age groups (6 months to 1 year, 1 to 4 years, >4 years) for the duration of seven years. The gastrointestinal tracts were brought to the laboratory where the intestinal contents were flushed by inserting a funnel at duodenal end and passing tap water through the intestine. After flushing, the small intestines were carefully dissected to retrieve intact tapeworms. Recovered representative tapeworms were stained with acetic carmine alum and identified using the keys provided by Soulsby (1982), Schmidt (1986) and Kauffman (1996). The mucosa was examined for nodules along with embedded tapeworms. The numbers of nodules in small intestines due to *S. globipunctata* infections were counted.

Table 1. Estimates for the prevalence of *Stilesia globipunctata* in goats+

Factor	Prevalence$
Mean ± SE (n=5208)	0.611 ± 0.04
Sex	**
Male (n=2662)	0.706 ± 0.01
Female (n=2546)	0.603 ± 0.01
Age (in year)	**
0.5 to 1 (n=259) (Male: 220, Female: 39)	0.908 ± 0.02^{c}
1 – 4 (n=3321) (Male: 2268, Female: 1053)	0.650 ± 0.01^{b}
>4 (n=1628) (Male: 174, Female: 1454)	0.406 ± 0.01^{a}
Month	**
1	0.675 ± 0.02^{bcd}
2	0.629 ± 0.03^{bc}
3	0.632 ± 0.02^{bcd}
4	0.638 ± 0.03^{ab}
5	0.547 ± 0.02^{a}
6	0.656 ± 0.02^{bcd}
7	0.684 ± 0.02^{d}
8	0.761 ± 0.02^{e}
9	0.659 ± 0.02^{cd}
10	0.673 ± 0.02^{cd}
11	0.636 ± 0.02^{bcd}
12	0.664 ± 0.02^{bcd}
Year x Month	**NS**
Sex x Age	**
Age x Month	**
Year x Age	**

+The percent prevalence data based on ArcSine transformation.
R Squared = 0.811 (Adjusted R Squared =0 .735)
$ NS: non-significant; **: Significant at P≤0.01;
Estimates with different superscripts (a,b,c,d) indicate differences within the groups (post-hoc)

The data on 5208 carcasses were categorized into positive and negative that took several values for each factor. According to the status of infection, the proportion of positive prevalence was calculated (positive cases/total screened samples) for each sample group. Regarding the prevalence for *S. globipunctata* the data was not normally distributed and arc sine transformation was applied to make it normally and independently distributed. The data containing 0 or 1 value was transformed by replacing 0 with (1/4n) and 1 with [1-(1/4n)], before taking angular values, where *n* is the number of observations based on which proportion was estimated for each group. The transformed values were in the radian but not degree. Descriptive statistics for the untransformed and transformed data were calculated. The transformed data were analysed by general linear model (GLM) procedure using SPSS 11.0 software (origin). The model used for studying the effect of various factors causing variation in the prevalence of *S. globipunctata* was as follows:

$$Y_{ijklmnop} = S_i + Y_j + M_k + A_l + (Y_j x M_k)_m + (S_i x A)_n + (A_l x M_k)_o + (Y_j x A)_p + e_{ijklmnop}$$

Where,

$Y_{ijklmnop}$ is the observed prevalence. S_i: is the i^{th} sex; Y_j: j^{th} year; M_k: k^{th} month; A_l: l^{th} age group; $(Y_j x M_k)_m$: m^{th} interaction between year and month; $(S_i x A)_n$: n^{th} interaction between sex and age group; $(A_l x M_k)_o$: o^{th} interaction between age group and month; $(Y_j x A)_p$: p^{th} interaction between year and age group; $e_{ijklmnop}$: residual error with respect to $Y_{ijklmnop}$. The critical difference between the mean was calculated by Duncan's Multiple Range Test (DMRT).

Results and Discussion

The intensity of nodules was more widespread in the anterior duodenum (Fig. 1) and was observed in young animals from six month to one year of age. An opening was found in many of the nodules through which one or two threadlike *S. globipunctata* surfaced. The scolexes and initial segments were embedded in the nodules and posterior segments were found free in the lumen. The overall prevalence of *S. globipunctata* in goat population of Bareilly (untransformed data) was 36.6 %. The ArcSine transformed data indicated a mean prevalence of 0.611 with standard deviation of 0.04 (Table 1). Measure of the skewness for the transformed data was -0.004, indicates normal distribution with slight inclination towards left of the mean. Measure of kurtosis (-0.85) signifies the flat top of the bell curve in the normal distribution. The effects of skewness and kurtosis, if any, would be offset by the large sample size. Thus, the pruned transformed data was subjected to ANOVA.

Four non-genetic factors along with their interactions were studied to explain the variation in the prevalence of *S. globipunctata* in the goat population. The model used here explained 73.5 percent (Adjusted R^2 = 0.735) of the total variance in the prevalence.

Fig. 1. Nodules in the duodenum infected with *Stilesia globipunctata*

Sex

Prevalence was significantly influenced by goat gender (p=0.00) (Table 1). It was observed that males were more susceptible to the infection of *S. globipunctata* than the females. In mammals and some other taxa males tend to be more heavily infected than females. Possibly due to the differences in immune function (Poulin, 1996; Schalk & Forbes, 1997). This difference may also be attributed by the fact that male animals are slaughtered at early age and females later on as they are usually retained for flock replacement while a limited number odd males are retained for the purpose of breeding.

Year

Effect of the year on the prevalence was found to be non significant. It was observed that the prevalence of the *S. globipunctata* was fairly comparable throughout the study.

Age group

It was observed that the age group as a factor had a strong influence on the prevalence of *S. globipunctata* (p=0.00) (Tables 1, 2). Definitive trend was observed between the age group and the prevalence. Animals between 6 – 12 months of age were found to be the most vulnerable followed by animals between 1 – 4 years of age and then by more than 4 years of age. In other words, susceptibility was inversely to the related age. Younger ruminants are more susceptible to many gastrointestinal helminthic infections than older animals (Hansen & Perry, 1994; Negasi *et al*., 2012). Morbidity was very high (59 to 86 %) in animals up to one year age, whereas it was low (6.8 to 21.2 %) in older animals (Table 2, Fig. 2). Despite the fact that goat has a tendency to browse rather than to graze, young animals are likely to get cycticercoid infection as they prefer to graze the top of lush pasture, which is contaminated with infected mites during monsoon. In addition, the difference in the immunocompetence between the kids and adults may explain the differential prevalence (Negasi *et al*., 2012). However, the present results are in contrast with Louw (1995), who observed heavy infection in animals between 4 – 5 years of age.

Table 2. The prevalence of *Stilesia globipunctata* across different age groups⁺

Age Group	% Prevalence
0.5 to 1 year (n=259)	68.92 %
1 – 4 year (n=3321)	37.77 %
>4 year (n=1628)	13.17 %

⁺Estimates based on raw data

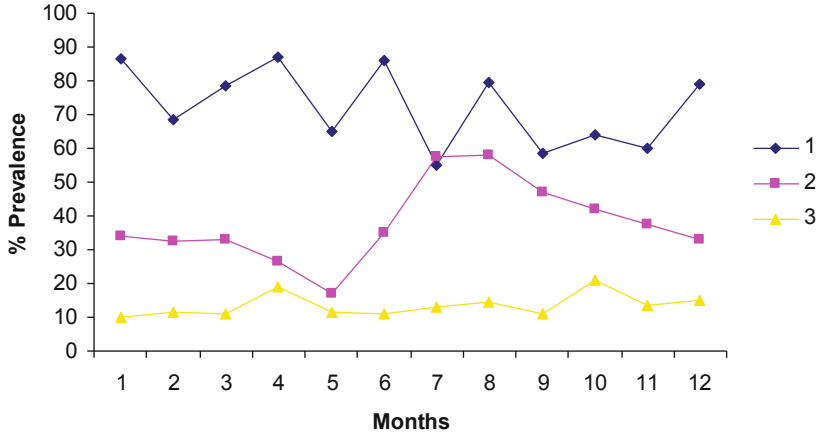

Fig. 2. The prevalence of *Stilesia globipunctata* across different months and age groups⁺

⁺Age groups: (1: 0.5 to 1 year; 2: 1 to 4 years; 3: >4 years)

Month

Effect of month on the prevalence of *S. globipunctata* was found to be highly significant (*p*=0.00) (Fig.2) (Table.1). Prevalence was lowest in the month of May followed by April and February that might be due to the lack of infective mites in the pasture due to temperature extremes. Most of the months excluding monsoon season showed similar prevalence in the infection. Significantly higher estimate for the prevalence was observed in the months of July and August. This pattern can be assigned to variation in the rainfall and weather temperature that favours the spurt of infective intermediate hosts. The development of infective stages in the mite depends upon environmental factors. The development of the cysticercoid of another anoplocephala *Moniezia expansa* in the oribatid mites at 28 °C and 85 % relative humidity is completed within 27 days. However, at 18 – 20ºC and the same relative humidity the development lasts up to 97 days (Narsapur & Prokopic, 1979). The rainy season had a significant effect on the prevalence of another Anoplocephalidae cestode, *M. benedini*. The occurrence of *M. benedini* in calves was higher when compared with dry season (Pfukenyi *et al*., 2007). Seasonal variation in parasite infection was observed mainly due to variation in both host physiology and host exposure to the parasite infective stages. The occurrence of infective stages, either free living or in the intermediate hosts depends on the climatic factors such as temperature, rainfall and humidity (Hudson *et al*., 2002).

Interaction effects

Except year x month (p=0.676), other combinations significantly contributed to the prevalence of *S. globipunctata* (Table1). The relationship between the year and month in untransformed data revealed comparable prevalence for each month over seven years. The striking observation was that the prevalence was at its peak during the months of monsoon and at nadir in May. As discussed elsewhere, age groups differed significantly from each other (p=0.00); they also showed distinct pattern across different ages and months (Fig. 2). The present study failed to observe a sex effect in the young kids (0.5 to 1 year). However, with advancing age, males were found to be highly susceptible than the females, which can be attributed to preferential slaughter of the former. This might have led to the biasness in the sex-wise prevalence rate. Distinct differences between the age groups were observed across month's variation in the prevalence of the *S. globipunctata* (Fig. 2). Despite the fact that the young animals were the most susceptible, middle aged goats have shown typical rise in the prevalence of infection during the months of July and August and lowest in the month of May.

The significant contribution of the factors such as sex, age, year and month for variation in the prevalence of *S. globipunctata* in the goat would be useful when control strategies are contemplated.

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