

# Seasonal prevalence and mean intensity of *Psoroptes ovis* infestation in goats in the Brazilian semiarid region

Prevalência sazonal e intensidade média de infestação por *Psoroptes ovis* em caprinos no semiárido Brasileiro

Malba Gean Rodrigues de Amorim<sup>1</sup>; Sérgio Santos Azevedo<sup>2</sup>; Franklin Riet-Correa<sup>3\*</sup>

<sup>1</sup>Programa de Pós-graduação em Medicina Veterinária, Hospital Veterinário – HV, Universidade Federal de Campina Grande – UFCG, Patos, PB, Brasil

<sup>2</sup>Unidade Acadêmica de Medicina Veterinária – UAMV, Centro de Saúde e Tecnologia Rural, Universidade Federal de Campina Grande – UFCG, Patos, PB, Brasil

<sup>3</sup>Hospital Veterinário – HV, Universidade Federal de Campina Grande – UFCG, Patos, PB, Brasil

Received December 04, 2014

Accepted December 08, 2014

## Abstract

To determine the prevalence and seasonal variation of *Psoroptes ovis* (Delafond, 1858) mange in goats in the semiarid region of Paraíba, 541 crossbred goats of both sexes and different ages were examined between June 1999 and May 2001 and between August 2011 and December 2012, by washing their ear canals. The monthly prevalence of the infestation varied between 66.66% and 100% without significant differences ( $p = 0.10$ ) among months and years. The intensity of infestation was higher between 2011–2012 ( $p < 0.05$ ), with an annual rainfall of 123 mm, than between 1999–2000, which had an annual rainfall of 614.9 mm. By the Spearman test there was a negative correlation between the relative humidity and the rainfall of the intensity of the *P. ovis* infestation. It is concluded that parasitism by *P. ovis* occurs at a similar prevalence rate during the entire year but increases during dry years.

**Keywords:** Mite, goats, prevalence, *Psoroptes*, semiarid.

## Resumo

Com o objetivo de avaliar a prevalência e a flutuação sazonal da sarna por *Psoroptes ovis* (Delafond, 1858) em caprinos, na mesorregião do sertão paraibano, foram examinados, mediante lavagem dos condutos auditivos, 541 caprinos sem raça definida, de ambos os sexos e várias idades, nos períodos compreendidos entre junho de 1999 e maio de 2001 e entre agosto de 2011 e dezembro de 2012. A prevalência de *P. ovis* nos caprinos variou de 66,66% a 100%, não apresentando diferença estatística significativa ( $p = 0,10$ ) entre os meses e entre os anos em que foi realizado o estudo. A intensidade de infestação foi maior no ano de 2011–2012 ( $p < 0,05$ ) em comparação com o ano de 1999–2000. Pelo teste de Spearman ( $r_s$ ), observou-se uma correlação negativa entre a umidade relativa e a precipitação pluvial com a intensidade de infestação por *P. ovis*. Conclui-se que o parasitismo em caprinos, na mesorregião do sertão paraibano, ocorre durante todo o ano, mas aumenta nos meses secos.

**Palavras chaves:** Ácaros, caprino, prevalência, *Psoroptes*, semiárido.

## Introduction

Mites of the genus *Psoroptes* are ectoparasites belonging to the order Astigmata, Family Psoroptidae that parasitizes many species of domestic and wild ruminants (YERUHAM et al., 1985). In goats, *Psoroptes ovis* (Delafond, 1858) is located in the auditory canal, which extends from the external auditory meatus to the beginning of the tympanic membrane. This parasite can be found in the epidermis and all evolutionary stages, where it feeds from secretions, exudate and eventually blood, causing

psoroptic mange, which may be symptomatic or asymptomatic (LITTLEJONH, 1968; COOK, 1981; MEINTJES et al., 2002; PERRUCCI, et al. 2005; WILLIAMS & WILLIAMS, 1978; MORGAN, 1991, 1992; BATES, 1996; FACCINI et al., 1981; SANTOS et al., 2006b; FACCINI & RIBEIRO, 2008). In the symptomatic form, animals are generally restless, which they demonstrate by shaking their heads, and show signs of discomfort. Crusts, increased amounts of cerumen, purulent secretion, and a brownish grumous material obstructing the auditory canal are observed (HEATH et al., 1983; SANTOS et al., 2006b).

In addition to the possible economic losses caused by the parasitism, *P. ovis* transmits mycoplasmas (COTTEW & YEATS,

\*Corresponding author: Franklin Riet-Correa, Hospital veterinário – HV, Universidade Federal de Campina Grande – UFCG, CEP 58700-000, Patos, PB, Brasil, e-mail: [franklin.riet@pq.cnpq.br](mailto:franklin.riet@pq.cnpq.br)

1982; DAMASSA, 1990; SINCLAIR & FILAN, 1991), including *Mycoplasma agalactiae*, which is responsible for outbreaks of contagious agalactia in Paraíba (AZEVEDO et al., 2006)

In northeastern Brazil, some goat ectoparasites, such as *Bovicola caprae* (SANTOS et al., 2006a) and *P. ovis*, (COSTA & VIEIRA, 1984) increase their population during the drier months, most likely due to poor nutrition due to reduced pasture and inadequate husbandry practices instead of the influence of abiotic factors. Despite its frequency, there is only one report, from the state of Ceará, on the seasonal fluctuation of *P. ovis* in goats in Brazil, which verified a rise in parasitism during the drier months of the year (COSTA & VIEIRA, 1984). The aim of this study was to evaluate the prevalence and the seasonal fluctuation of *P. ovis* in goats in the semiarid region of the state of Paraíba.

## Materials and Methods

### Location of the study

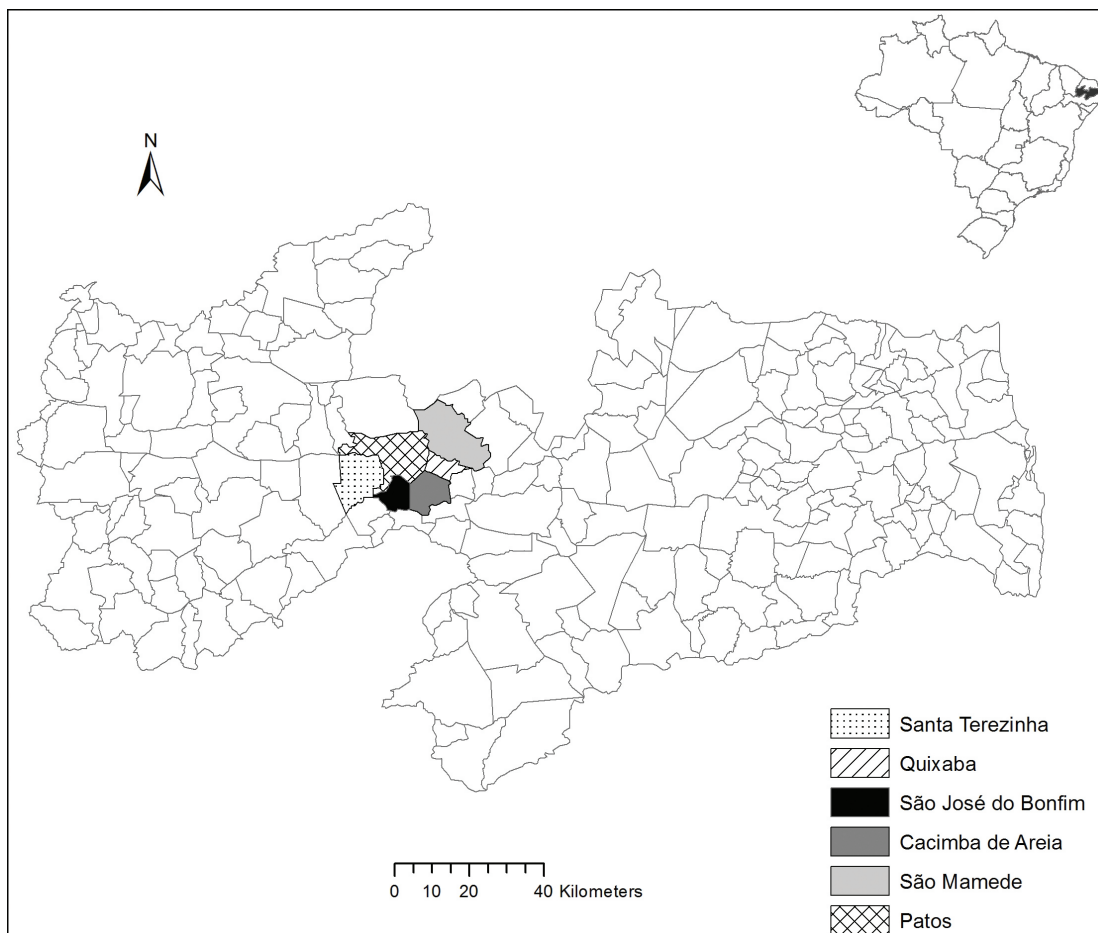
The study was carried out in the municipal slaughterhouse of the city of Patos, in the central western region of the state of Paraíba, mesoregion of the Sertão of Paraíba, with an area of 506.5 km<sup>2</sup> and an altitude of 242 m, which has an average temperature

of 26 °C, a relative air humidity of approximately 50%, annual sunshine of 2800 hours, evaporation of 2000 mm/year, rains of 350-800 mm/year, and a long dry period, from May-June to February-March (MOURA et al., 2007).

### Mite collection

The collections of *P. ovis* were carried out monthly, over the periods of June 1999 to May 2001 and from August 2011 to December 2012. Fifteen goats were examined monthly, for a total of 360 goats during the first period and 255 in the second. The animals used in the study were crossbred goats, of both sexes and different ages, from the municipalities of Patos (S 7° 1' 32" W 37° 16' 40") Quixaba (S 07° 01' 53" W 37° 08' 55"), São Mamede (S 6° 55' 36" W: 37° 5' 46"), Cacimba de Areia (S 7° 5' 56" W 37° 9' 55"), São José do Bonfim (S 7° 9' 55" W 37° 18' 26"), and Santa Terezinha (S 7° 5' 19" W 37° 27' 23") (Figure 1).

The mites were collected by washing the auditory canal (the ear flushing technique) (FACCINI et al., 1987; LEITE et al., 1989). After slaughtering the goats, the right and left auditory conducts were washed with 100 ml of water each. Following each washing, the mites were collected and stored in glasses containing 70% alcohol and then identified and transferred to the Parasitic Diseases Laboratory of the Health and Technology Center of the



**Figure 1.** Municipalities of the mesoregion of Sertão of Paraíba, delimited by dotted lines, from where the animals that participated in the study were derived.

**Table 1.** Prevalence and intensity of infestation by *Psoroptes ovis* in goats slaughtered in the public slaughterhouse of the municipality of Patos in the mesoregion of the Sertão of Paraíba, in the periods between 1999-2001 and 2011- 2012.

Month	Year					
	1999-2000			2000-2001		
	Positive conducts	Prevalence (%)	Average infestation intensity	Total of mites	Positive conducts	Prevalence (%)
Jun	11	73.3	140.8	1549	11	73.3
Jul	12	66.6	88.1	1058	13	86.6
Aug	12	80	98.1	1178	14	93.3
Sept	13	80	121.6	1582	13	86.6
Oct	15	100	164.5	2468	14	93.3
Nov	14	93.3	71.8	1006	14	93.3
Dec	13	86.6	69.9	909	12	80.0
Jan	14	80	80.7	969	15	100.0
Feb	13	93.3	78.5	1100	11	73.3
Mar	12	80	69.8	908	15	100.0
Apr	13	73.3	77.6	932	15	100.0
May	14	86.6	103.3	1343	13	86.6
Jun	-	-	-	-	-	-
Jul	-	-	-	-	-	-
Aug	-	-	-	-	-	-
Sept	-	-	-	-	-	-
Oct	-	-	-	-	-	-
Nov	-	-	-	-	-	-
Dec	-	-	-	-	-	-
Total	154			15002	160	
Median±DI		80.0 ± 9.9 <sup>a</sup>	88.2±25.6 <sup>a</sup>			90.0 ±9.9 <sup>a</sup>
						93.3 ± 20 <sup>a</sup>
						145.8 ± 68.8 <sup>c</sup>

Averages followed by equal lower case letters in the same line do not differ statistically (P > 0.05).

Federal University of Campina Grande, where they were counted and identified according to the life-cycle stage of the parasite, following Sweatman's taxonomic key (SWEATMAN, 1958).

Meteorological data

The monthly meteorological data of temperature (°C), relative humidity of the air (UR%) and pluvial precipitation (mm<sup>3</sup>), were obtained at the Conventional Meteorological Station of the 3rd District of Meteorology (INMET – 3<sup>rd</sup> DISME) of the National Institute of Meteorology, located in the municipality of Patos, Paraíba. Other municipalities where the goats came from are situated at a distance of up to 15 km from Patos and have no meteorological data.

Statistical analysis

After testing the data by the Kolmogorov-Smirnov test to verify the type of distribution, non-parametric statistics were chosen. To verify if there were significant differences in the prevalence of animals with mites during the different periods of the research, and in the monthly means of the different life-cycle stages of the parasite the Kruskal-Wallis test was used with post-hoc comparisons by the Dunn test.

To verify if there was a correlation between the intensity of the parasitism by *P. ovis* and the abiotic factors (temperature, relative humidity and rainfall) a parametric test (*r<sub>s</sub>*) was used. This analysis was carried out grouping the years 1999 to 2001. The significance level adopted for the statistical tests was 5% ( $\alpha = 0.05$ ). All the analyses were performed using the SPSS 20.0 program for Windows.

Results

During the two periods in which the study was carried out (1999-2001 and 2011-2012), 541 goats parasitized by *P. ovis* were identified, and a total of 73,954 mites were collected. Among the infested animals, only 4.4% (24 goats) presented clinical signs of otocariasis, with an annual variation from 3.8% to 5%.

The clinical signs observed were the obstruction of the auditory conducts with an increased amount of cerumen, laminated crusts, and purulent secretion.

The monthly prevalence of *P. ovis* infestation in goats of the mesoregion of Sertão of Paraíba varied between 66.6% and 100%, and there were no significant differences ( $p = 0.10$ ) among the months and the periods in which the study was carried out (Table 1). The statistical analysis did not reveal a significant correlation between the monthly and annual prevalence and the abiotic factors (Table 2).

Comparing the intensity of *P. ovis* infestation in the goats slaughtered during the three years of collection of the mites and based on the mean, it was verified that mite parasitism was greater between 2011-2012 ( $p < 0.05$ ) in comparison with the years between 1999-2000 (Table 1). Despite the absence of significant differences among months, the months with a higher intensity of infestation during the first year of the study were June, September, and October. In the second year, a different pattern of *P. ovis* infestation was verified consisting of a rise in parasitism in the months between August 2000 to February 2001. For the periods from 2011-2012, the infestation intensity was high for the whole period, with peaks in the months of October, November and December 2012 (Table 1), when rains did not occur in the region (Tables 1 and 3).

The results obtained in the Spearman correlation (*r<sub>s</sub>*) show that the infestation intensity presented a negative correlation with the relative humidity of the air in the period from 1999 to 2001 (Table 2). In the period of 2011–2012 the infestation intensity was negatively correlated with the relative humidity of the air and with the total pluvial precipitation (Table 2). The seasonal fluctuation of *P. ovis* is demonstrated in Figures 2 and 3.

The average numbers of females and males were similar in the three periods in which the study was carried out ( $p > 0.05$ ); however, nymphs, larvae and eggs were found in smaller amounts ( $p < 0.05$ ).

The meteorological data obtained during the three periods of study in the mesoregion of the Sertão of Paraíba is found in Tables 3 and 4. The average annual rainfall (mm<sup>3</sup>) for the region in the period in which the study was carried out was of 614.4 mm,

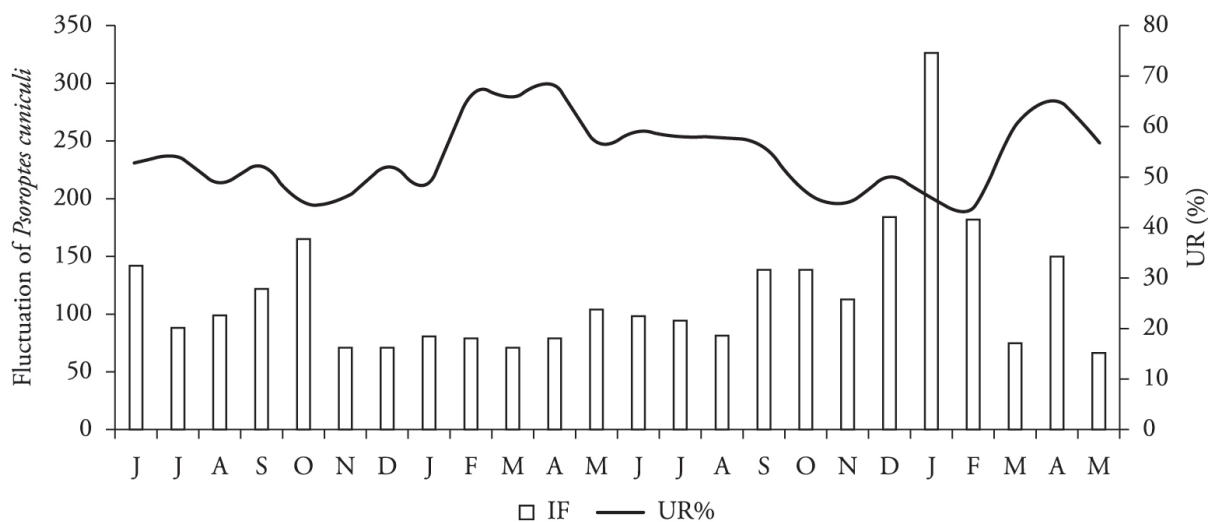
**Table 2.** Results of the Spearman coefficient between the prevalence and infestation intensity of *Psoroptes ovis* in goats from the mesoregion of the Sertão of Paraíba and the abiotic factors.

Correlations	YEAR					
	1999-2001		P	2011-2012		
	r (IC 95%)	r <sub>s</sub>		R (IC 95%)	r <sub>s</sub>	P
Prevalence X PP (mm)	0.31 (−0.11 a 0.63)	0.09	0.14 ns <sup>a</sup>	−0.29 ( −0.68 a 0.22)	0.08	0.25ns
Prevalence X UR (%)	−0.07 (−0.44 a 0.34)	0.005	0.72ns	−0.04 (−0.52 a 0.44)	0.002	0.85ns
Prevalence X T(°C)	0.28 (0.14 a 0.62)	0.28	0.18 ns	0.14 (−0.36 a 0.69)	0.02	0.56ns
Infestation intensity X PP(mm)	−0.26 (−0.61 a 0.15)	0.07	0.20ns	−0.57 (−0.83 a −0.12)	0.32	0.01s <sup>b</sup>
Infestation intensity X UR (%)	−0.45 (−0.72 a −0.06)	0.20	0.02 s	−0.61 (−0.85 a −0.19)	0.37	0.008s
Infestation intensity X T (°C)	−0.21 (−0.21 a 0.57)	0.04	0.31ns	0.20 (−0.30 a 0.63)	0.04	0.42ns

ns<sup>a</sup> – non significant; s<sup>b</sup> – significant.

**Table 3.** Monthly averages of the temperature-compensated (°C), relative humidity (%), and total pluvial precipitation (mm<sup>3</sup>) during 2011–2012 in the mesoregion of the Sertão of Paraíba. National Institute of Meteorology (INMET).

Months	Average temperature (°C)	Average relative humidity (%)	Total precipitation (mm <sup>3</sup> )
August/2011	26.5	59	7.6
September	29.5	57	0
October	27	54	13.6
November	27	57	15.6
December	28.5	50	0
January/2012	29.5	58	20.7
February	29	59	14.6
March	29.5	56	14.5
April	29	54	14.3
May	29	59	2.7
June	28	64	13
July	27	56	1
August	27.5	54	0
September	28.5	52	0
October	29.5	52	0
November	29.5	49	0
December	30	45	6

**Figure 2.** Relative humidity of the air (UR%) and seasonal fluctuation of the mean intensity of *Psoroptes ovis* infestation (IF) in goats slaughtered in the public slaughterhouse of Patos in the mesoregion of the Sertão of Paraíba (PB) between June 1999 and May 2001.

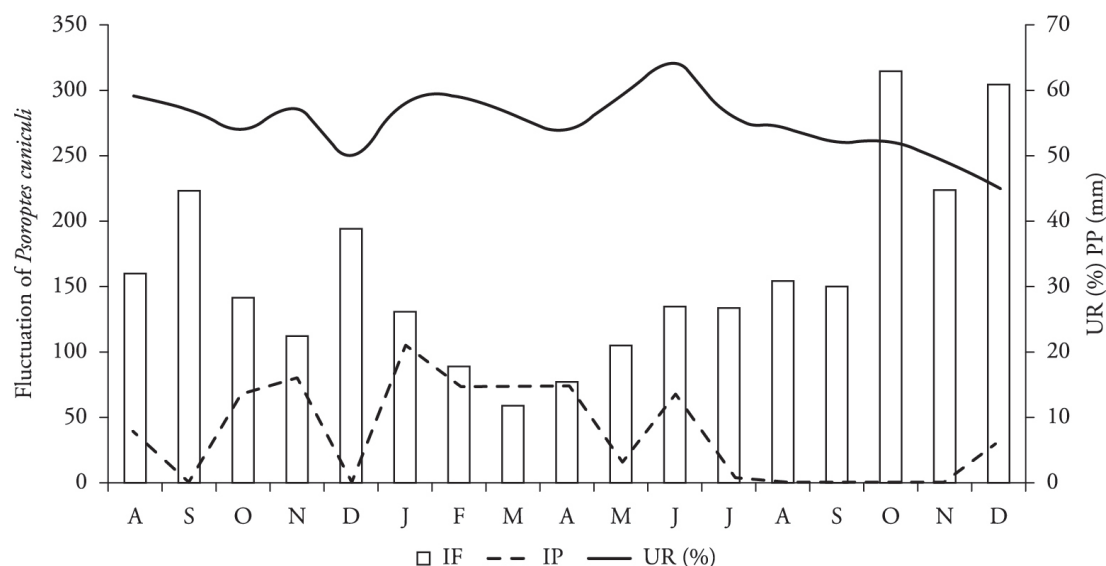
499 mm, and 123 mm for the years between 1999–2000, 2000–2001 and 2011–2012, respectively (Tables 3 and 4).

## Discussion

*Psoroptes ovis* was found to parasitize goats in the mesoregion of the Sertão of Paraíba during all months of the year, without a significant correlation between the prevalence of the parasitism and the abiotic factors, suggesting that the climatic variations of the region do not interfere with the prevalence of the parasitism. Similar results were found by Costa & Vieira (1984) in goats in the state of Ceará.

The monthly prevalence (66.6–100%) found in this study is similar to that observed in goats in the states of Acre (89%), Rio de Janeiro (70%), Minas Gerais (70%) (FACCINI & COSTA, 1992), and Paraíba (73%) (SANTOS et al., 2006a). However, in other northeastern states the prevalence reported for *P. ovis* was smaller: 37% in Bahia (BAVIA et al. 1984/1985) and 36.2% for does, 41.7% for bucks, and 34.2% for kids in Ceará (COSTA & VIEIRA, 1984). These differences are most likely related to the methodology applied in the collection of the mites; in Bahia and Ceará, the mites were collected using swabs, which seems to be less efficient than washing the auditory conducts.

With regard to the seasonal fluctuation of the infestation intensity by *P. ovis*, the results of the Spearman test ( $r$ ) indicate



**Figure 3.** Relative humidity of the air (UR%), pluvial precipitation (PP), and seasonal fluctuation of the mean intensity of *Psoroptes ovis* infestation (IF) in goats from the mesoregion of the Sertão of Paraíba slaughtered at the public slaughterhouse of the municipality of Patos, between August 2011 and December 2012.

**Table 4.** Monthly averages of temperature-compensated ( $^{\circ}\text{C}$ ) and relative humidity (%), and total pluvial precipitation ( $\text{mm}^3$ ) of the years between 1999 to 2001 in the mesoregion of the Sertão of Paraíba. National Institute of Meteorology (INMET).

Months	Mean temperature ( $^{\circ}\text{C}$ )	Mean relative humidity (%)	Total precipitation ( $\text{mm}^3$ )
June/1999	26.7	53	2.5
July	26	54	15.1
August	26.7	48	0
September	28	52	0
October	28.3	45	19.4
November	29.5	46	16.7
December	29.3	52	90.4
January/2000	28	49	40.6
February	28	66	151.3
March	27.7	66	156
April	27.5	68	92
May	27.7	57	30.9
June	27.1	59	0
July	26.8	58	9.1
August	26.9	58	64.2
September	27.1	56	9.9
October	28.4	47	0
November	29.1	45	0.3
December	28.3	50	51.7
January/2001	28.6	46	14.4
February	30	44	7.2
March	27.9	60	171.2
April	26.9	65	169.7
May	28.2	57	11.4

that there is a negative correlation between the number of parasites and the relative humidity of the air and the rainfall; the quantity of mites increases as the relative humidity and rainfall decreases. The greatest intensity of infestation occurred during a very dry period (2011-2012) in the semiarid region of the state of Paraíba, with a total rainfall of 123 mm. In the period 1999-2000, when the infestation intensity was significantly lower, the total rainfall

reached 614.9 mm. According to Costa & Vieira (1984), in the state of Ceará, the parasitism by *P. ovis* of goats rises during the dry months, reaching its maximum rate in December. With the beginning of the rains in January, a reduction in rates of parasitism is observed. The increase in the infestation by *P. ovis* in goats during drier years and during the dry period of the year may be associated with the deficient nutritional state resulting



from the scarcity of food during this period. Other factors, such as the agglomeration of animals in small places, the goat's physiological status (pregnancy), age, and stress may increase the susceptibility of goats to ectoparasites (SANTOS, et al., 2006a; LITTLEJONH, 1968).

In this study, only 4.4% of goats presented mild to moderate clinical signs, in accordance with the classification of Littlejohn (1968). No cases with severe clinical signs (restlessness, itching, and facial and fore limbs dermatitis) were observed, suggesting that the psoroptic mange, despite its high frequency, does not cause severe losses of goats in the semiarid region. However, research should be conducted to detect possible losses in the productivity of the asymptomatic goats or those with mild or moderate clinical signs.

It is concluded that *P. ovis* is found year-round in the mesoregion of the Sertão of Paraíba, with a prevalence of 66.6 to 100%; however, the intensity of the infestation increases in the drier years. The frequency of clinical signs in infected goats is low, varying from 3.8% to 5%, and the clinical signs are mild or moderate.

## References

- Azevedo EO, Alcântara MDB, Nascimento ER, Tabosa IM, Barreto ML, Almeida JF, et al. Contagious agalactia by *Mycoplasma agalactiae* in small ruminants in Brazil: first report. *Braz J Microbiol* 2006; 37(4): 576-581. <http://dx.doi.org/10.1590/S1517-83822006000400033>.
- Bates PG. Epidemiology of subclinical ovine psoroptic otocariasis in Great Britain. *Vet Rec* 1996; 138(16): 388-393. <http://dx.doi.org/10.1136/vr.138.16.388>. PMID:8732192
- Bavia ME, Caldas EM, Tinôco A. Otocariase psorótica em caprinos da região Nordeste do estado da Bahia. *Arq Esc Med Vet* 1984/1985; 9(1): 34-38.
- Cook RW. Ear mites (*Raillietia manfredi* and *Psoroptes cuniculi*) in goats in New South Wales. *Aust Vet J* 1981; 57(2): 72-74. <http://dx.doi.org/10.1111/j.1751-0813.1981.tb00448.x>. PMID:7259648
- Costa CAF, Vieira LS. Ectoparasitos permanentes em caprinos e ovinos em Sobral, CE. *Pesq Agropec Bras* [online] 1984 [cited 2012 Mar 13]; 19(5): 639-646. Available from: <http://seer.sct.embrapa.br/index.php/pab/article/view/15727/9754>
- Cottew GS, Yeats FR. Mycoplasmas and mites in the ears of clinically normal goats. *Aust Vet J* 1982; 59(3): 77-81. <http://dx.doi.org/10.1111/j.1751-0813.1982.tb02731.x>. PMID:7159311
- DaMassa AJ. The ear canal as a culture site for demonstration of mycoplasmas in clinically normal goats. *Aust Vet J* 1990; 67(7): 267-269. <http://dx.doi.org/10.1111/j.1751-0813.1990.tb07786.x>. PMID:2393377
- Faccini JLH, Padilha TN, Fonseca AH. Otocariase psorótica dos caprinos. Infestação subclínica. *Pesq Agropec Bras* [online] 1981 [cited 2012 Mar 13]; 16(5): 725-726. Available from: <http://seer.sct.embrapa.br/index.php/pab/article/view/18092/12139>
- Faccini JLH, Lignon GB, Leite RC. Evaluation of an ear flushing technique as a postmortem measure of infestation of *Raillietia auris* (Leidy) (Acari) in cattle. *Exp Appl Acarol* 1987; 3(2): 175-178. <http://dx.doi.org/10.1007/BF01270479>. PMID:3453336
- Faccini JLH, Costa AL. Subclinical psoroptic otocariasis in Brazilian sheep with comments on a technique for mite collection. *Exp Appl Acarol* 1992; 13(3): 227-229. <http://dx.doi.org/10.1007/BF01194938>. PMID:1563304
- Faccini JLH, Ribeiro VR. *Raillietia caprae* (Acari: Raillietidae) and *Psoroptes ovis* (Acari: Psoroptidae) in the ears of goats in the state of Rio de Janeiro, Southeast Brazil. *Rev Bras Parasitol Vet* 2008; 17(1): 59-61. <http://dx.doi.org/10.1590/S1984-29612008000100014>. PMID:18554445
- Heath ACG, Bishop DM, Tenquist JD. The prevalence and pathogenicity of *Chorioptes bovis* (Hering, 1845) and *Psoroptes cuniculi* (Delafond, 1859) (Acari: Psoroptidae) infestations in feral goats in New Zealand. *Vet Parasitol* 1983; 13(2): 159-169. [http://dx.doi.org/10.1016/0304-4017\(83\)90076-6](http://dx.doi.org/10.1016/0304-4017(83)90076-6). PMID:6605609
- Littlejohn AI. Psorotic mange in the Goat. *Vet Rec* 1968; 10: 148-155.
- Leite RC, Faccini JLH, Costa AL. Avaliação de uma técnica *in vivo* para medir a infestação por ácaros do gênero *Raillietia* Trouessart (Acari) em bovinos. *Mem Inst Oswaldo Cruz* 1989; 84(S4): 309-311. <http://dx.doi.org/10.1590/S0074-02761989000800054>.
- Meintjes T, Fourie LJ, Horak IG. Host preference of the sheep scab mite, *Psoroptes ovis*. *J S Afr Vet Assoc* 2002; 73(3): 135-136. <http://dx.doi.org/10.4102/j.sava.v73i3.577>. PMID:12515303.
- Morgan KL. Aural haematomata, cauliflower ears and *Psoroptes* in sheep [corrected]. *Vet Rec* 1991; 128(19): 459-460. <http://dx.doi.org/10.1136/vr.128.19.459>. PMID:1858278
- Morgan KL. Parasitic otitis in sheep associated with *Psoroptes* infestation: a clinical and epidemiological study. *Vet Rec* 1992; 130(24): 530-532. <http://dx.doi.org/10.1136/vr.130.24.530>. PMID:1441096
- Moura MSB, Galvincto JD, Brito LTL, Souza LSB, Sá IIS, Silva TGF. Clima e água de chuvas no semi-árido. In: Brito LTL, Moura MSB, Gama GFB. *Potencialidades da água de chuva no semi-árido brasileiro* [online]. Petrolina: Embrapa Semiarido, 2007 [cited 2013 Dec 09]. p. 35-59. Available from: <http://ainfo.cnptia.embrapa.br/digital/bitstream/CPATSA/36534/1/OPB1515.pdf>
- Perrucci S, Rossi G, Fichi G, O'Brien DJ. Relationship between *Psoroptes cuniculi* and the internal bacterium *Serratia marcescens*. *Exp Appl Acarol* 2005; 36(3): 199-206. <http://dx.doi.org/10.1007/s10493-005-4511-5>. PMID:16132734
- Santos SB, Faccini JLH, Santos ACG. Variação estacional de *Bovicola caprae* parasitando caprinos no Estado da Paraíba. *Pesqui Vet Bras* 2006a; 26(4): 249-253. <http://dx.doi.org/10.1590/S0100-736X2006000400010>.
- Santos ACG, Santos SB, Guerra RMSN. Artrópodes parasitos de caprinos do Sertão Paraibano. *Agropec Cient Semi-árido* [online] 2006b [cited 2012 Mar 13]; 2(1): 9-17. Available from: <http://150.165.111.246/ojs-patos/index.php/ACSA/article/view/15>
- Sinclair AN, Filan SJ. Confirmation of degenerative effects on psoroptic mites from scab lesions. *Vet Rec* 1991; 129(22): 492. <http://dx.doi.org/10.1136/vr.129.22.492>. PMID:1781146
- Sweatman GK. On the life history and validity on the species in *Psoroptes*, a genus of a mange mites. *Can J Zool* 1958; 36(6): 905-929. <http://dx.doi.org/10.1139/z58-078>.
- Williams JF, Williams CS. Psoroptic ear mites in dairy goats. *J Am Vet Med Assoc* 1978; 173(12): 1582-1583. PMID:748298.
- Yeruham I, Hadani A, Rosen S. Psoroptic ear mange (*Psoroptes cuniculi*, Delafond, 1859) in domestic and wild ruminants in Israel. *Vet Parasitol* 1985; 17(4): 349-353. [http://dx.doi.org/10.1016/0304-4017\(85\)90026-3](http://dx.doi.org/10.1016/0304-4017(85)90026-3). PMID:4002605