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Chapter 10

Abundance and Risk Factors for Dermatobiosis in Dairy Cattle of an Organic Farm in the Tropical Region

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Additional information is available at the end of the chapter

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Abstract

Studies about *Dermatobia hominis* larvae have been described, but no data were found regarding dairy cattle from organic production system in tropical region. The herd consisted of 40 dairy crossbred zebu x taurine. Fortnightly inspection (915 inspections) with mapping for the presence of larvae in the body surface was carried out over the period of a year in the area of the Integrated Agroecological Production System –IAPS/RJ – a technical cooperation project. The results indicated predominance of parasitism in females (average 21.98). In males, the highest number of nodules were on the right side (4.46); in females, highest number of nodules were on the left side. The infestation in adults (average 31.55) was highest; animals in lactation were less infested (average 8.01); in young animals, the most infested side was the left; the most infested coat was the black on white (average 36.69); the less infested coats were red with typical shades (average 14.13) and light brown and dark (12.33). Each increment of 1 mm^3 of water caused a mean increase of 1.03 in the relative risk of occurrence of dermatobiosis and with every one degree increased there was an average increase of 1.14 in the relative risk for infestation.

Keywords: Nodular subcutaneous myiasis, organic management, bovine

1. Introduction

Dermatobia hominis (Linneus Jr., 1781) (Diptera: Cuterebridae), commonly known in Brazil as "mosca do berne" (warble fly), has high incidence in cattle bred in many regions of the country. It infests a considerably large number of hosts, cattle being the most affected. This fly's larva once on the skin of those animals causes furuncular myiasis, also known as dermatobiosis, which is characterized by the formation of nodules in the host.

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The study of seasonal variations of this fly allows us to know the periods of higher parasitic intensity, and also to correlate the facts operating in the growth of its population. Several authors are engaged in studying the seasonal variation of fly's larva and its relation to climate elements: temperature, precipitation, and humidity, showing that the presence of the warble is associated with regions that have moderately high temperatures during the day and relatively cold overnights, median and abundant rainfall, dense vegetation, and a considerable number of animals. Also, the rainy season is the period of highest occurrence. Even with all these characteristics, the index of parasitism by *D. hominis* can vary according to environmental conditions, regional differences. It also depends on the location of the parasite in the host.

In conventional livestock, the larva population on the cattle is controlled with the use of chemical larvicide. On the other hand, organic rural properties must meet the standards contained in the 60th Article of Normative Instruction No. 46, 2011, Ministry of Agriculture and Supply, which regulates organic production in Brazil, restricting the use of allopathic medicines [1].

Several studies about seasonality and *D. hominis* larvae's control have already been described, but no data were found related to this infestation in dairy cattle raised under organic systems. The goal of this study was to provide subsides about this parasitic skin disease in organic breeding; to verify the location and distribution of the larvae on the body surface of the cattle; to determine the intensity of infestation related to gender, age, and coat color; and the influence of the climatic factors in infestation rates. This study also provides basis to the creation of a dermatobiosis control program in organic dairy production systems.

2. Literature review

The parasitism rate of *D. hominis* may have some variations due to climate conditions. In addition, there may be differences in the location of the parasite in the host.

2.1. *Dermatobia hominis*: Geographical distribution and biology

According to [2], flies of the species *D. hominis* are diurnal and are found in tropical forests. According to [3], flies of *D. hominis* were never found in stables and houses, being more abundant on the edges of woods, forests, and eucalyptus plantations. As [4] says, this fly is well adapted in Brazil, mainly concentrated in regions of hot and humid climate, with abundant vegetation and in altitudes lower than 1000 meters. According to [5], the life cycle of *D. hominis* has two well-defined stages. The nonparasitic stage corresponds to the soil pupation and adult flies in forest, and the parasitic stage corresponds to the entire development of larvae in the subcutaneous tissue of the host. The flies copulate in the first 24 hours after their emergence. Few hours after fertilization, the females begin to frequent the vicinity of cattle corrals, meeting several species of fly vectors. The deposition of their eggs is made during the flight in the lateral–ventral region of the vector after its capture and immobilization. The

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incubation period of eggs in the vector is of approximately eight days, and when this vector meets the host, the larvae break the eggs and penetrate through the hair follicles into the skin causing nodular myiasis. The larval period can go from 25 to 60 days. It is at night or early in the morning that mature larvae leave the host and go to the ground to pupate, avoiding the sun.

In Colombia, [6] observed higher prevalence of *D. hominis* in rainy season. [7] reported the occurrence of dermatobiosis throughout the year in Argentina, with infection peaks in rainy season, with warmer temperatures and higher humidity. [8] observed a higher incidence of infestation by larvae of *D. hominis* in the months of November and March, in São Paulo, Brazil, with decreased incidence until June. Larger infestations by warble were verified in March and April, in the state of Paraná (Brazil), with lower incidence in August and September, according to [9]. The authors linked the higher incidence of this parasitosis with rainy season. As [10] says, the highest prevalence of *D. hominis* during the rainy season is due to the better development conditions for the parasite, where a greater number of larvae can reach the pupal stage.

[11] described that the warble is distributed in approximately 20 states in Brazil, with higher abundance in Rio Grande do Sul, Santa Catarina, Paraná, Rio de Janeiro, Espirito Santo, Distrito Federal, and Goiás. The author mentions that the parasite does not occur in the states of Amapá, Rondônia, Ceara, Rio Grande do Norte, and Sergipe. According to the author, the soil conditions in these places do not offer conditions for the parasite to complete its life cycle. According to [4], *D. hominis* life cycle is complete in 80–150 days.

Observations related to seasonal variations in *D. hominis* in the city of Governador Valadares, Minas Gerais, made by [12] revealed that there is a positive correlation between parasitism by larvae *D. hominis*, relative air humidity and rainfall. However, no relationship was observed between ambient temperature and parasitism rates. Seasonality studies of the warble in cattle from the city of Guaíba, RS, mentioned by [13] have shown that in the warmer seasons of the year, that is, during the spring and summer, infestations happen with higher intensity. [14] in surveys conducted in Campo Grande – MS observed higher rates of warble infestation in periods of higher rainfall and higher relative humidity, with no positive correlation between ambience temperature and infestations in animals and also reported the presence of larvae throughout the study period with maximum amounts in March and May.

By studying the seasonal fluctuation of *D. hominis* in bovine skins coming from slaughterhouses, [15] observed that the highest percentages of infestation occurred when the months before had recorded increases in average temperature and rainfall. These factors may favor the penetration of larvae in the soil decreasing the pupation time of *D. homins* larvae. In addition, such climatic conditions also benefit its vectors' pupation.

In southeastern Brazil, the months of spring and summer, which correspond to the rainy season, are the most favorable period of year for the occurrence of dermatobiosis in cattle. Smaller infestations happen during the dry season in the months of autumn and winter according to [16] and [17].

According to [18], in Brazil, losses caused by of *D. hominis* larvae reach 250 million dollars per year.

2.2. Body distribution of *Dermatobia hominis* larvae

A study on variations related to infestations of cattle by *D. hominis* larvae was held in Viamão – RS by [19], when the author observed higher incidence of warble in the anterior left part of cattle. [13] observed that, in cattle, 73% of subcutaneous nodules caused by *D. hominis* larvae were distributed in the anterior parts. The most infected parts were the ribs (31.9% of the observed nodules), scapula (21.5% of the observed nodules), forelegs (17.8% of the observed nodules), and neck (8.8%).

[20] verified the parasite dynamics of warble, noting its incidence in relation to decubitus in cattle of the Canchin race, in São Carlos – SP. The incidence of parasitism was higher on the left side (14.2 nodules on average) compared to the right side (10.5 nodules). According to the author, the higher incidence of parasitism on the left side can be explained due to the fact that this region was more exposed to the vectors of *D. hominis'* eggs. In his observations it was possible to say that most of the animals during their rest leaned on their right side, that is, 2.360 animals observed, 1.183 had the habit of lying on their left side, while 1.447 were lying on their right side. In another study, [21] found that the regions of the forelimbs and the left blades were more parasitized. According to the author, low parasitism in posterior regions was due to the tail, which acts as a broom protecting such areas up to approximately the seventh rib. The data showed that, although protected posterior regions are equivalent to 41.06 % of the body surface of the animal, only 16.20 % were infested by warble. In another study by [22], in the city of Seropédica in the state of Rio de Janeiro, it was observed that the body region with the highest number of nodules was the blade, followed by the ribs and the forelimbs. It was also observed that, in cattle antimeres, the left side had 50.46 % of the nodules, and the right side 49.54 %. But this difference was not statistically significant. [23] conducted a study regarding the seasonal fluctuation of larvae *D. hominis* on cattle skins from slaughterhouses, observed a higher incidence of nodules caused by the larvae of *D. hominis* in the anterior region, with a 97.8 % rate.

[24] observed a significantly higher frequency of *D. hominis* nodules in females (16.7%) than in males (14.7 %). The presence of larvae in adult animals (15.4 %) is also more significant than in younger animals (12.1 %) and when it comes to the coat, the highest frequency of larvae was observed in the dark ones (black). Considering the body part, the one that was the most parasitized was the left anterior quadrant.

2.3. Organic dairy production system

In conventional livestock, the larva population on the cattle is controlled with the use of chemical larvicide; on the other hand, organic rural must meet the standards contained in the 60th Article of Normative Instruction No. 46, 2011, Ministry of Agriculture and Supply, which regulates organic production in Brazil, restricting the use of allopathic medicines [1]. The term "organic" refers to animal and vegetable food that are produced without the use of fertilizers;

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pesticides; insecticides; antimicrobials; antiparasitic, transgenic, or any other drug that may contain harmful residues to human health, including agricultural products to conventional dairy farms [25].

Milk production in organic systems does not reach 0.1% of national production, which is about 25 million liters per year, due to several factors, such as: rural extension work enabling the process to small producers; the lack of scientific research adapting livestock production in organic system to the tropical reality; as well as food pasture fertilizers, racial patterns, and health care with the herd, such as endo- and ectoparasites control and mastitis [26].

3. Materials and methods

3.1. Location

The study was conducted from September 2009 to August 2010 in an area that belongs to the Sistema Integrado de Produção Agroecológica (Integrated Agroecological Production System) – SIPA (Fazendinha Agroecológica Km 47), technical cooperation project between Embrapa Agrobiologia, Empresa de Pesquisa Agropecuária do Estado do Rio de Janeiro (Agriculture Research Corporation of Rio de Janeiro State) (PESAGRO – Rio /Seropédica), and Universidade Federal Rural do Rio de Janeiro (Rural Federal University of Rio de Janeiro) [27]. SIPA is located in the city of Seropédica, metropolitan region of Rio de Janeiro state, currently occupying 70 hectares and incorporating, in addition to vegetable production area and fruits, a fragment of forest, a forest garden, and areas of agroforestry and ornamental species. Pastures subdivided into paddocks total 30 hectares.

3.2. Weather

The meteorological data used were temperature (T) of the air, relative humidity (RH), and precipitation (PP) obtained from the Agrometeorological station situated in SIPA's area.

The climate is hot and humid with little pronounced winter. The average temperature of the coldest month is higher than 20 ° C (68°F) and the maximum temperature in the summer can exceed 40 ° C (104° F). The rainfall is characterized by the existence of a rainy season in summer and dry in winter. The annual rainfall is around 1.300 mm, although it is mostly rainy in spring and summer, the occurrence of prolonged drought is common in the months of January and February [27].

3.3. Animals

The herd consisted of 40 crossbred dairy animals Zebu x European (Gir x Holstein), divided into lots of young and adult animals. The young ones were divided into two further lots: suckler calves (birth to 6 months) and weaned calves (from 7 months to 18 months or 330 kg), and a lot of adult animals consisting of dry cows, in lactation, and a bull. The determination of the coat of animals followed the Girolando characterization [28]. (Figures 1 A, B, C, and D).

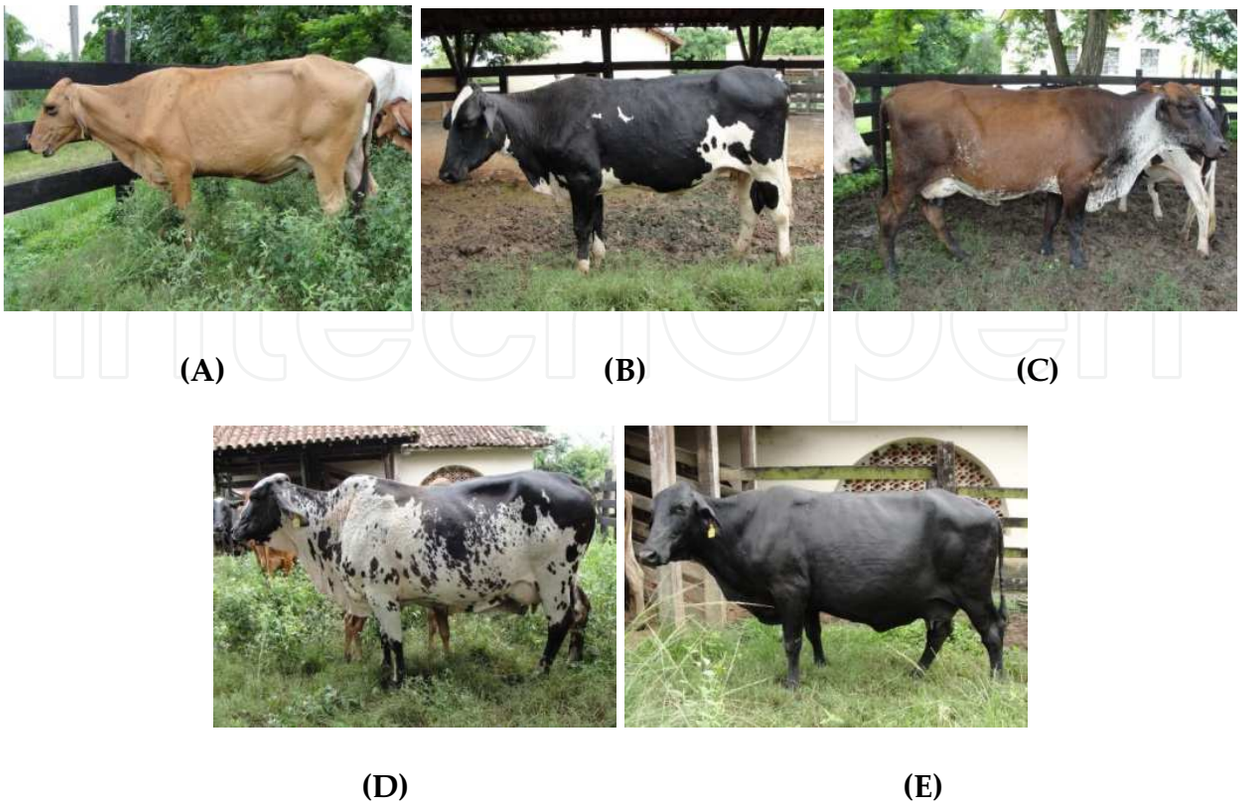

Figure 1. Colors of the coat: **(A)** brown; **(B)** black on white; **(C)** red typical shades; **(D)** white on black **(E)** black.

3.4. Management of animals

The management system was semi-intensive: the animals remained in the corral during the day, where accumulation of manure could take place, and returned to the grass in the late afternoon. A physical model for organic milk production is implemented. Throughout the management, animal welfare, including avoidance of psychological stress in the herd, is prioritized. All the pickets have access to clean drinking fountains with good-quality water and shaded areas with afforestation. Containment fences are electrified and made with flat wire, in order not to represent a risk of injury to the animals.

The pastures are used in a rotation system. To supply the smaller forage production that happens in the dry period (period of lower growth of pastures), a cultivated area is managed to offer a forage supply in the trough. It is estimated that the period of lowest forage production in the region begins in mid-June and goes on until late October; that is, 135 days (or nine Fortnights) of drought and lower temperatures at night. A dairy Gir bull is used to ensure the reproduction of cows as well as the welfare of animals.

3.5. Health Management

The health management system established was developed for the SIPA project "Fazendinha Agroecológica Km 47." It is based on the folowing: animal welfare, strategic control of

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parasites, and homeopathic therapy, always stressing prevention as the most important aspect with regard to treatment. The specific objective was the reestablishment and maintenance of herd health in that organic system, and the general goal was to facilitate the structuring of an experimental organic dairy cattle system.

Homeopathic medicines have been prepared by the Pharmacy School from Instituto Hahnemanniano do Brasil. Drugs are in accordance with the rules of the Brazilian Pharmacy in the form of liquid presentation, and packaged in appropriate amber glass containers. The ways of administration are oral, nasal, or vaginal.

As already mentioned, throughout the management, the priority is the animal's welfare, including avoiding of psychological stress in the herd. "Good management practices in dairy cattle with emphasis on preventive health" established for this breeding system follow the definitions of the 60th Article of Normative Instruction No. 46, 2011, Ministry of Agriculture and Supply.

The basic requirements under Article 60 of MAPA IN No. 46 [1] are as follows: (1) follow the principles of animal welfare at all stages of the production process; (2) keep hygiene and health throughout the breeding process, consistent with current health legislation and the use of products that are authorized in organic production; (3) provide preventive health techniques; (4) offer nutritious healthy food, with quality and in correct amounts according to the nutritional requirements of each species; (5) offer good-quality water and in appropriated quantities, free of chemical and biological agents that may compromise their health and vigor, quality product and natural resources, according to the parameters specified by law; (6) the use sanitary facilities that are functional and comfortable; and (7) dispose in an environmentally appropriate way, the production wastes.

Vaccinations against FMD, brucellosis, clostridial diseases, salmonellosis, and rabies follow the current schedule in health-surveillance Ministry of Agriculture Livestock and Supply. Homeopathy is the adopted therapy for treatment and prevention of major diseases of dairy cattle, with a Homeopathic protocol developed for this creation system.

A supplement freely provided to the entire herd was formulated according to this system, composed of salt, sulfur (for animal feeding), and dicalcium phosphate.

3.6. Monitoring dermatobiosis (berne)

Inspection was performed biweekly (mapping the presence of larvae), totaling 915 inspections. The animals were inspected by anatomical demarcation, and their body divided into antimeres: anterior upper right (RADS), anterior lower right (RADI), posterior upper right region (RPDS), lower right posterior region (RPDI), anterior upper left (RAES), left anterior inferior (RAEI), posterior upper left region (RPES), and posterior lower left region (RPEI). The presence of the larvae (Figure 2) was observed in the different regions, and the data recorded in documents, according to the methodology of [29], with modifications (Figure 3).

Figure 2. Presence of *D. hominis* larvae in subcutaneous tissue of cattle.

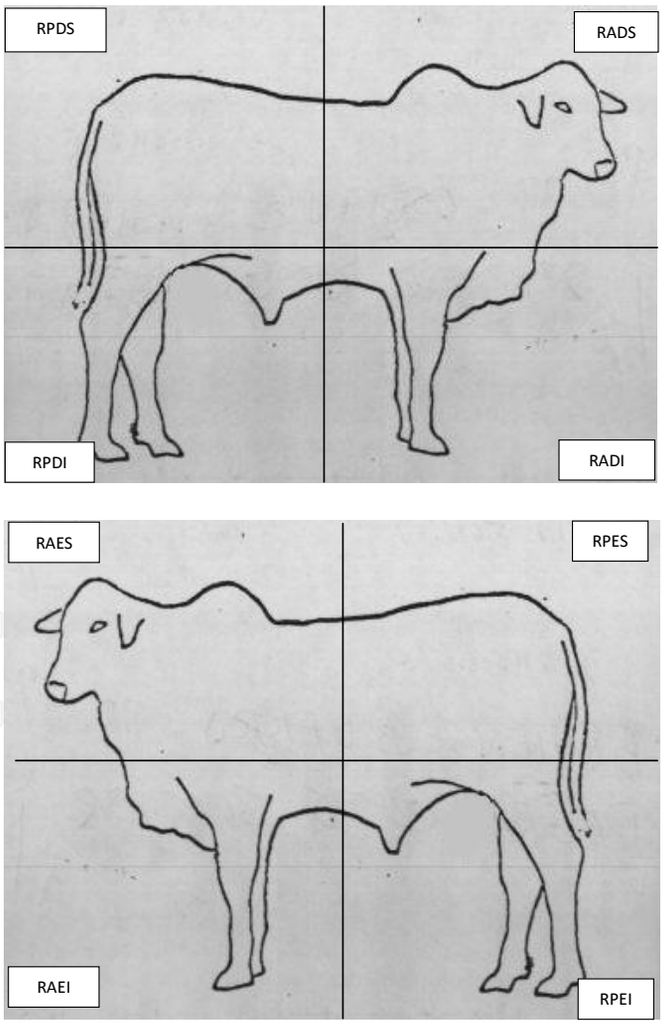

Figure 3. Field spreadsheet to map the dermatobiosis in cattle, according to the methodology of [29] with modifications.

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3.7. Statistical Analysis

The berne description of the amounts into categories of each attribute were studied, and performed some exploratory data analysis through bar charts, box plots and calculating the average number of warble per studied animal. To compare the berne counts among the quadrants defined by anatomical demarcation, we used nonparametric Wilcoxon and Kruskal-Wallis test [30], due to the presence of nonnormal data [31]. To verify the association between the inherent variables to the animals and climate we used the generalized linear bivariate model of *Poisson* [32]. The dependent variable was the larva counted in each animal, the independent variables or explanatory variables were related to the animal profile (gender, age, and coat) and climatic factors (average temperature, rainfall, and relative humidity). As the dates of collection were different between adults and young animals (suckling calves and weaned calves), a stratified analysis was made taking into consideration the age of the animals involved in the study. The relative risk indicator is a measure of association, where two or more variables are correlated, being one of the ways used to the assessment in epidemiological statistics to answer the correlations between two outcome and exposure variables, where RR = 1 lack of association occurred; 0 <RR <1 protection factor, and RR> 1 risk factor.

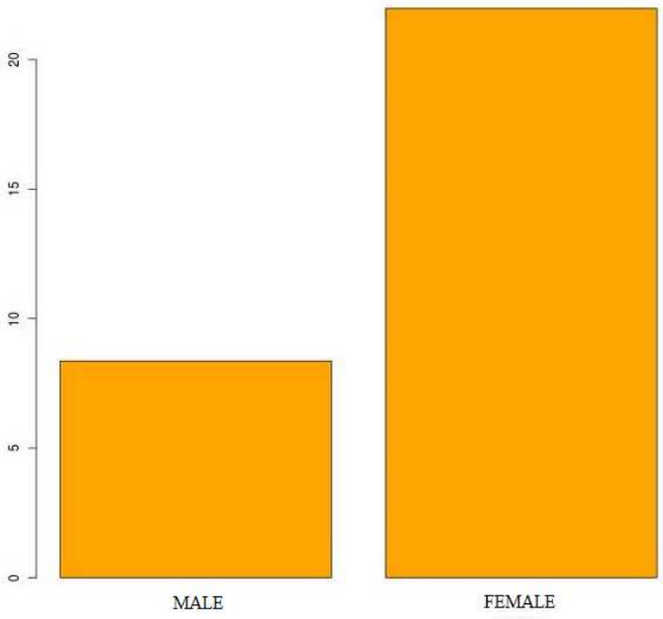
In the period of study, 915 berne counts in cattle were made (inspections), in which 391 were in adult cattle, 356 in weaned calves, and 168 in suckling calves. Of the total, 784 females and 131 males were counted. Of the 915 counts, 354 were made in cattle coat with red color in typical shades, 180 in fur animals with white on black, 87 in cattle with black color coat, 198 counts in animal with light brown and dark coat, and 96 counts in animal with black on white coat.

To adjust the climate data to the study database, the average was calculated for each of them (Average temperature, rainfall, and relative humidity) taking into consideration a fifteen-day delay period preceding the collecting day.

All statistical analyses were performed using statistical package R [33].

4. Results and discussion

The results of monitoring of the herd dermatobiosis indicated that there was a significant predominance of parasitism in the females (total average 21.98 bernes per female against total average rating of 8.37 bernes per male), as shown in Figure 4 (A), where the average number of nodules per sex in each animal is observed. Also, greater variability in females than in males was observed, as shown in Figure 4 (B). Also in relation to gender, males showed a higher number of nodes on the right side (total of 4.46 against 3.90 on the left), where the RPDs (Posterior Right Upper Region) was the most infested (2.16). In females, the highest number of nodules were concentrated on the left side (total of 11.17 against 10.70 on the right) and RADS (Anterior Right Upper Region) was the most affected (6.98). Table 1 shows the average number of nodules per animal according to sex. It was found that there was significant difference (p-value <0.001) regarding the amount of bernes between males (8.37) and females (21.98).



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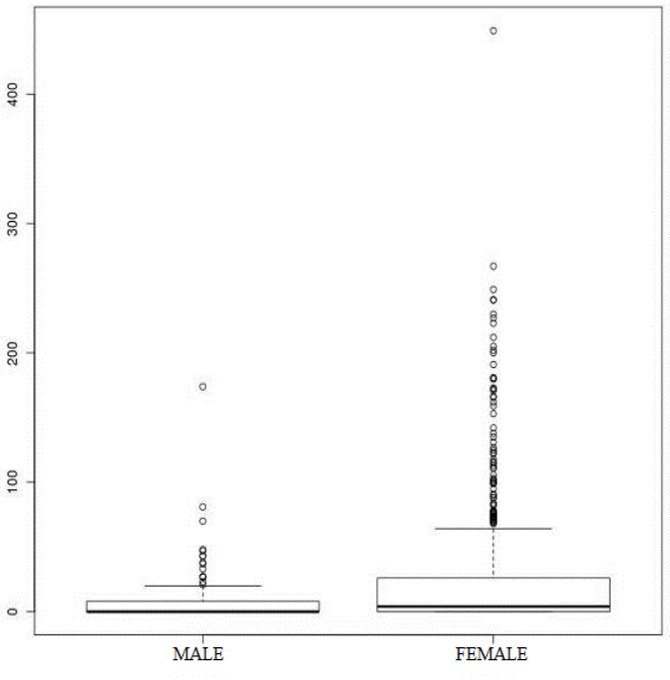

(b)

Note: Total of 915 counts of warble in cattle (inspections), with 784 females and 131 males in cattle. The average total number of bernes per female on the herd was 21.98 and the average total number of bernes per male was 8.37.

Figure 4. Distribution of parasitism in cattle according to gender **(A)**. Degree of infestation variability between sexes in the herd **(B)**.

http://dx.doi.org/10.5772/62150

Average number of warbles per animal		Gender		Wilcoxon P-value
		Male	Female	
	Animal Total	8.3 7	21.98	*<0.001**
Left quadrant	Lower Anterior	0.59	1.55	*0.004**
	Upper Posterior	1.44	2.58	*0.017**
	Upper Anterior	1.75	6.46	*<0.001**
	Lower Posterior	0.12	0.60	*<0.001**
	Total	3.90	11.17	*<0.001 **
Right quadrant	Lower Anterior	0.29	1.51	*<0.001 **
	Upper Posterior	2.16	1.88	*0.362*
	Upper Anterior	1.89	6.98	*<0.001 **
	Lower Posterior	0.12	0.55	*0.0111 **
	Total	4,46	10,75	*<0,001 **

* Significant values assuming a significance level of 5%

Table 1. Average number of bernes per animal according to sex and distribution in their respective quadrants

A significant prevalence of parasitism in females agrees with the results found by [24]. Regarding the most infected body region, there was divergence of results in other studies since all author studies cited here [19, 13, 21, 22, and 23] indicate a predominance of infestation in the anterior region, unlike the results found in males in this study, where the most affected body region was the posterior upper right region (RPDS) with an average of 2.16 bernes per animal. Also, in relation to the group of males in the herd, the prevalence of nodules on the right (total of 4.46 against 3.90 on the left) contradicts the results found by [19] in the study of Viamão – RS; as well as [20], who observed that the incidence on the left side is related to prevalence of the right lateral-sternal decubitus at rest time. [21] also found prevalence of parasitism on the left and [22] in a study conducted in Seropédica – RJ found no statistically significant difference between the number of nodules on the right and left sides of cattle.

Considering the age of the animals, it was found that the number of adult animals that were affected by berne (total of 31.55) was significantly higher (p <0,001) than younger animals of the herd (total of 8.0 in suckling calves and 12.21 in weaned calves); the variability in this group was also higher than the variability in the younger group. In the group of young animals, the most affected ones by the parasitosis were weaned calves and (total of 12.21 per animal), therefore, the group of suckler calves was the least infested by the larvae of *D. hominis* (total of 8.01 per animal) as shown in Figure 4 (A), where the average number of bernes per animal according to the age is observed. Figure 4 (B) shows the variability of the total number of bernes, considering the age of cattle. Based on age, in both groups of young animals, the most infested side was the left one (total of 4.04 and 6.47 per animal), and the most affected body part in the group of suckling calves was the RADS (Anterior Right Upper Region), averaging 1.69 berne

per animal, while in the group of weaned calves it was the RAES (Left Anterior Upper Region), averaging 3.53 bernes per animal. In the group of adults, the more infested side was the left (total of 15.71 nodules per animal) and the most affected region was the RADS (Anterior Right Upper Region) (average of 10.68 bernes per animal), as shown in Table 2. It was found that there is significant difference ($p < 0.001$) compared to the amount of bernes related to age.

Average number of grubs per animal		**Age**			***Kruskal-Wallis p-value***
		Suckling	**Weaned**	**Adults**	
	The animal Total	8.01	12.21	31.55	*<0.001* *
Left quadrant	Lower Anterior	0.47	0.73	2.38	*<0.001* *
	Upper Posterior	1.65	1.83	3.28	*0.7614*
	Upper Anterior	1.63	3.53	9.37	*<0.001* *
	Lower Posterior	0.29	0.38	0.76	*0.0033* *
	Total	4.04	6.47	15.71	*<0.001* *
Right quadrant	Lower Anterior	0.40	0.78	2.19	*<0.001* *
	Upper Posterior	1.69	1.38	2.48	*0.6788*
	Upper Anterior	1.69	3.23	10.68	*<0.001* *
	Lower Posterior	12.26	12.43	0.62	*0.1312*
	Total	4.02	5.79	15.68	*<0.001* *

* Significant values assuming a significance level of 5%

Table 2. Average number of berne per animal in the herd according to age and distribution in their respective quadrants

This study regarding the age of the animals, including the evaluation of results referring to the sides in which the highest level of infestations occurred, has shown in the youth group and adult group an agreement with results of previous researches. But, in the adults' group and in the suckling calves' group, although presenting a predominance of infestation on the left side (total of 15.71 and 4.02, respectively), it was observed that the most infested body region was the RADS (Anterior Superior Right Region), averaging 10.68 bernes per animal and RPDS (Posterior Superior Right Region), averaging 1.69 bernes per animal, respectively, different from that indicated in previous studies by [19] held in Viamão – RS, as well as [20], which linked the prevalence of parasitism on the left side to the right lateral-sternal decubitus at rest time. [21] also found prevalence of parasitism on the left and [22] in Seropédica – RJ did not find statistically significant difference between the number of nodules on the right and left sides of cattle.

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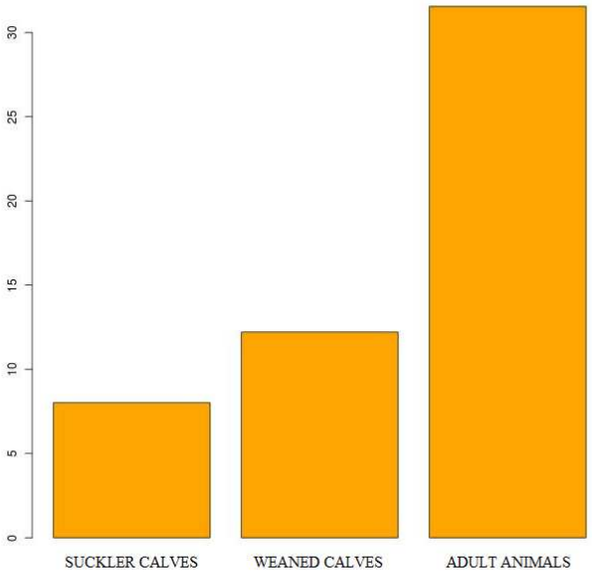

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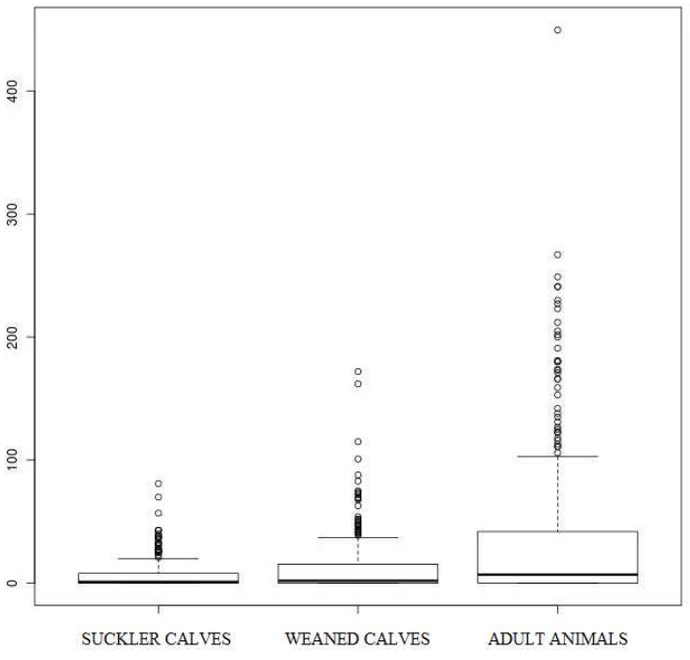

(b)

Note: Total of 915 bernes counts in cattle (inspections) in which 391 were in adult cattle, 356 in weaned calves, and 168 in suckling calves. The average total number of bernes per adult animal was 31.55, the average total number of bernes per weaned calf was 12.21, and the average total number of nodules per suckling calf was 8.01.

Figure 5. Average number of nodules per animal according to the age of the animal (A). Variability of the total number of bernes considering the age of animals **(B).**

Considering the presence of the larvae of *D. hominis* and the animal's coat, it is observed that the coat with a higher level of infestation is the black on white (total 36.69), while showing lesser infestation rates were typical red shades (14.13) and the light and dark brown (12.33).

In Table 3 we observe the average number of bernes per animal according to type of animal coat. There is a significant difference (p-value <0.001) comparing the amount of bernes between the coats. In Figure 5 (A) the average number of bernes per coat type in each animal is shown. Figure 5 (B) shows the variability of the total number of bernes in relation to the type of coat of the animal.

According to a study conducted by [24], the parasite frequency of occurrence was higher in dark-coat animals (black) unlike what was found in this study.

Average number of warbles per animal		**Coat color**					***Kruskal-Wallis*** *p-value*
		White-Black	**Red**	**Black-White**	**Black**	**Brown**	
	Total per animal	17.08	14.13	36.69	29.82	12.33	*<0.001* *
Left quadrant	Lower Anterior	1.80	0.86	3.37	1.59	0.31	*<0.001* *
	Upper Posterior	1.05	1.70	5.04	2.33	1.98	*<0.006* *
	Upper Anterior	4.30	4.72	10.69	8.74	2.57	*<0.001* *
	Lower Posterior	0.44	0.38	0.91	0.80	0.40	*0.0016* *
	Total	7.59	7.66	19.94	13.46	5.25	*<0.001* *
Right quadrant	Lower Anterior	1.26	0.85	2.79	2.30	0.47	*<0.001* *
	Upper Posterior	1.08	1.07	3.01	2.83	2.44	*<0.007* *
	Upper Anterior	6.82	4.25	10.22	11.02	3.83	*<0.001* *
	Lower Posterior	0.53	0.35	0.83	0.48	0.39	*0.0892*
	Total	9.59	6.52	16.52	16.08	7.07	*<0.001* *

* Significant values assuming a significance level of 5%

Table 3. Average number of bernes per herd animal taking into consideration the coat type and distribution in their respective quadrants

As shown in Table 4, the months of highest occurrence of dermatobiosis were November and December, 2009, while the lowest levels of infestation by larvae of *D. hominis* were recorded in June and July, 2010. The period of highest infestation was the rainy season (spring and summer), and the record of the lower parasitism rates occurred during the dry season (fall and winter). The occurrence of parasites was observed throughout the study period. These findings coincide with observations of [6, 7, 10, 13, 16, and 17]. They also coincide with a study made by [14] on the observations of larvae presence throughout the study period, but differing in the months of maximum count. The results of this study also confirmed the observations of [8] in his study in the State of São Paulo, where he found higher occurrence of parasitosis in

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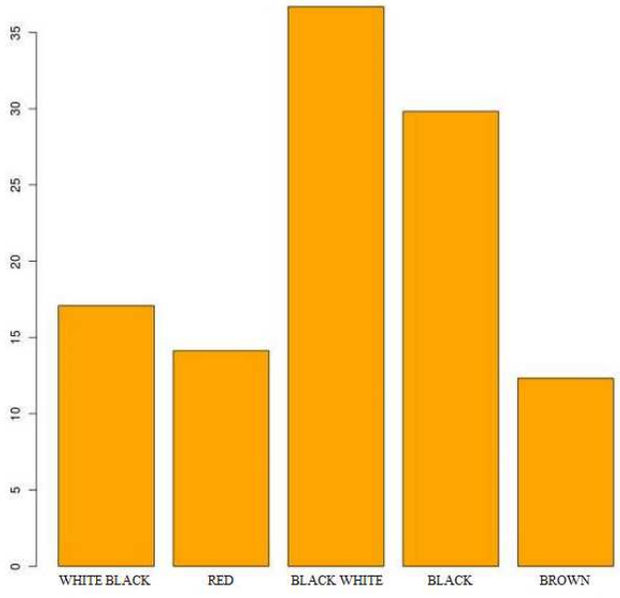
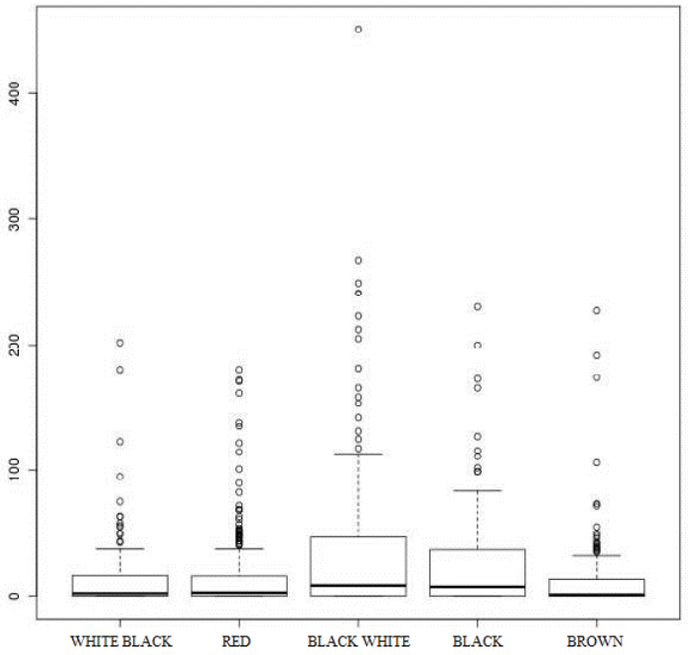


(a)



(b)

Note: Total 915 warble counts in cattle (inspections), of which 354 were in cattle with red coat color in typical shades, 180 in animals with white on black coat, 87 in black coat color cattle, 198 in animals with light brown and dark coat, and 96 in white on black coat color. The average total number of bernes per animal was 14.13 in cattle with red coat color in typical shades; 36.69 in animals with black on white coat; 29.82 in animals with a black coat color; 12.33 in cattle with light or dark brown coats; and 17.08 in animals with white on black coat.

Figure 6. Average number of bernes by coat type in each herd animal **(A).** Variability of the total number of bernes in relation to the type of coat of animals **(B).**

November, with a decrease until July, as well as the results found by [9] in his study in the state of Paraná, where major infestations in the rainy season period was also noted, differing only in the months of highest and lowest occurrence of dermatobiosis.

Months/Years			Quantity of Bernes			
			Young animals		Adult animals	
			Average	Total	Average	Total
Rainy season	Spring	September/2009	26	1.381	63	2.263
		October/2009	21	821	52	1.886
		November/2009	35	1.422	99	3.546
	Summer	December/2009	33	1.393	104	3.748
		January/2010	5.3	223	20	709
		February/2010	3.1	125	11	409
Dry season	Autumn	March/2010	0.2	10	0.2	8
		April/2010	0.5	24	1,2	43
		May/2010	0.6	32	2.3	82
	Winter	June/2010	0	2	0.2	6
		July/2010	0.1	3	0.4	6
		August/2010	4	209	5.8	198

Table 4. Monthly averages of the average number of larvae *Dermatobia hominis* from September 2009 to August 2010

The fluctuation of the larvae of *D. hominis* during the studied period along with the climatic data are found in Figures 6 and 7, which show the highest levels of infestation occurring at the beginning of the study period as well as the highest rates of rainfalls, relative humidity air, and average temperature. The lowest averages in the occurrence of dermatobiosis occurred in the second half of the study period, coinciding with the lowest levels of rainfalls, relative humidity, and average temperature.

Risks relating to possible risk factors (intrinsic characteristics of the animal itself – gender, age coat, and climatic factors – rainfall, average temperature, and relative humidity) related to the occurrence of dermatobiosis are shown in Table 5. The results found, with reference to climatic variables, showed that with regard to rainfall and relative humidity, each increase of 1 mm^3 of water generates an average increase of 1.03 in the relative risk of occurrence of dermatobiosis in the herd, and each increase of 1°C in average temperature generates an average increase of 1.14 of relative risk to infestation by larvae of *D. hominis* in cattle. The results were significant for all studied weather variables. According to the study made by [15], increased percentages of infestation by larvae of *D. hominis* are related to the increase in average temperature and rainfall, which favors the penetration of larvae in the soil, reducing its time of pupation. Such

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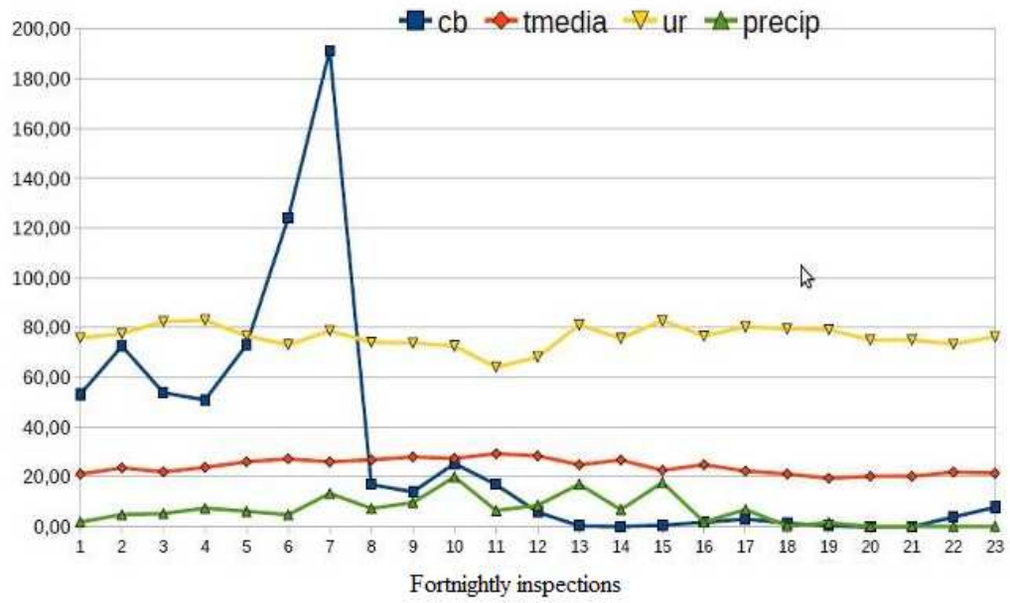
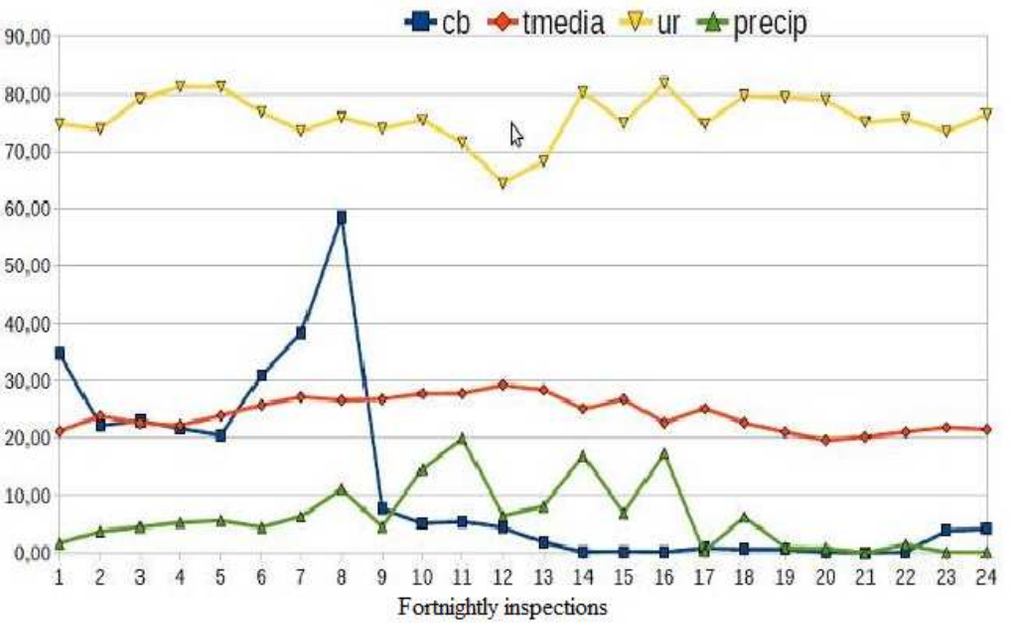


Note: The climatic variables are lagged by 15 days, so the average was calculated for each climate variable in the 15 days before each visit.

Figure 7. (cb) Average number of bernes in adult animals, (tmedia) average temperature, (ur) relative humidity, and (precip) rainfall during the experimental period.



Note : The climatic variables are lagged by 15 days, so the average was calculated for each climate variable in the 15 days before each visit.

Figure 8. (cb) Average number of bernes in young animals, (tmedia) average temperature, (ur) relative humidity, and (precip) rainfall during the experimental period.

observations are confirmed by the results of this study, unlike the findings of [12, 5] in Governador Valadares, Minas, Gerais, and [14] in surveys conducted in Campo Grande – MS, which found no positive relationship between parasitism and average temperature.

Also, with regard to the results shown in Table 5, it was observed that adult females of the herd presented a relative risk 2.63 times higher than males to infestation by larvae of *D. hominis*.

Adult bovine animals had a relative risk for dermatobiosis 3.94 times higher than suckler calves, while weaned calves showed a relative risk of 1.52 times more than the suckling calves.

The black on white coats were the most susceptible to infestation by larvae of *D. hominis*.

The white on black coats showed a relative risk 2.98 times higher for developing dermatobiosis than light and dark-brown coated animals.

Variables	RR	IC 95%
Gender		
Male (ref.)	1.00	[1.00; 1.00]
Female	2.63*	[2.47; 2.79]
Age		
Suckler calves (ref.)	1.00	[1.00; 1.00]
Weaned calves	1.52*	[1.43; 1.62]
Adult animals	3.94	[3.72; 4.17]
Coat Color		
Brown (ref.)	1.00	[1.00; 1.00]
Black white	2.98*	[2.84; 3.12]
Black	2.42*	[2.29; 2.56]
White black	1.39*	[1.30; 1.48]
Red	1.15*	[1.09; 1.20]
Rainfall	1.03*	[1.02; 1.04]
Average temperature	1.14*	[1.13; 1.15]
Relative humidity	1.03*	[1.02; 1.04]

* Significant at 0.05 level

Table 5. Estimate of the relative risks (RR) and their respective confidence intervals of 95% (CI 95%) from the bivariate analysis of generalized linear models

The area occupied by Fazendinha Agroecológica Km47 incorporates a fragment of forest, a forest garden, and areas of agroforestry, and the climate is hot and humid with rainfall characterized by a rainy season in summer, and according to [4], the habitat of *Dermatobia hominis* is in hot and humid regions, with abundant vegetation and [5, 3, 2, and 14] state that there are plenty of those parasites on the margins of tropical forests and areas. It is noteworthy

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that the area or location of this study presents excellent conditions for the development of dermatobiosis, thus favoring the occurrence of high infestation levels as it was observed in the early months of the study. Also, because it is an organic system, the use of antiparasitic is strictly prohibited and contrary to the national law [1 and 25]; yet, this work observed improvement in the general appearance of the herd and improvement in conditions while handling of animals, as they have become extremely docile and receptive. Beyond these observations, the development of clinical diseases in cattle caused by parasitic load has not been registered.

5. Conclusions

- The ideal coats in this situation are the light and dark red and brown coated in typical shades;
- The degree of infestation was significantly higher in females than in males;
- It was not possible to say that there is influence of the right external–lateral decubitus in a parasitized body side;
- The temperature is the climatic factor that most influenced the parasitosis;
- The largest infestation rates occurred during the rainy season between spring and summer.

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