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Natural infestation by ticks as cause of death in beef cattle[1]

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ABSTRACT. Guizelini C.C., Borges D.G.L., Borges F.A., Lopes W.D.Z., Pupin R.C. & Lemos R.A.A. 2023. **Natural infestation by ticks as cause of death in beef cattle**. *Pesquisa Veterinária Brasileira 43:e07373, 2023*. Laboratório de Anatomia Patológica, Faculdade de Medicina Veterinária e Zootecnia, Universidade Federal de Mato Grosso do Sul, Av. Senador Filinto Muller 2443, Bairro Vila Ipiranga, Campo Grande, MS 79074-460, Brazil. E-mail: ricardo.lemos@ufms.br

Although infestation by *Rhipicephalus microplus* is mentioned as the cause of death among cattle, there are only studies with artificial infestations in which intense parasitism led to the death of cattle due to severe anemia. This study seems to be the first to describe the epidemiology, clinical-pathological condition, and diagnostic conduct of infestation by *R. microplus* as the cause of death of European breed calves introduced in shady, enclosed pastures in regions with rainfall prior to the onset of the outbreak. The affected calves presented apathy, anorexia, and anemia and were severely infested by *R. microplus*. The lethality rate of the outbreak was 36.5%. After the rainy period, the dry season facilitated a decrease in the nutritional status of the affected cattle. The delay in the definitive diagnosis contributed to the economic loss of the farm due to the cost of erroneous treatments and the number of dead cattle. The main factors that contributed to the deaths were climatic, environmental, and individual. This study demonstrates that severe infestations by *R. microplus* in low-quality pasture-raised calves are fatal and emphasizes the importance of diagnostic tools to reduce the economic loss caused by death due to infestation by ticks.

INDEX TERMS: Animal production, *Rhipicephalus microplus*, fatal disease, economic loss, anemia, ticks, cattle.

RESUMO.- [**Infestação natural por carrapatos como causa de morte em bovinos de corte.**] Embora a infestação por *Rhipicephalus microplus* seja mencionada como causa de morte em bovinos, existem apenas estudos com infestações artificiais em que o intenso parasitismo levou à morte de bovinos por anemia severa. O presente trabalho parece ser o primeiro a descrever a epidemiologia, o quadro clínico e patológico e a conduta diagnóstica da infestação por *R. microplus* como causa de mortes em bezerros de sangue europeu introduzidos em pastagens sombreadas e vedadas oriundas de regiões em que houve chuvas 30 a 60 dias antes do início dos casos clínicos. Os bezerros afetados apresentaram apatia, palidez das mucosas oral e oculares, anorexia, anemia e estavam severamente infestados por exemplares de *R. microplus*. A taxa de letalidade do surto foi de 36,5%. Macroscopicamente, carcaça pálida e baixo escore corporal foram as alterações predominantes no bovino necropsiado. Após os períodos chuvosos, a temporada de seca facilitou a queda no estado nutricional dos bovinos afetados. A demora na realização do diagnóstico definitivo contribuiu para o prejuízo econômico da propriedade decorrente de custos com tratamentos equivocados e pelo aumento no número de bovinos mortos. Os principais fatores que contribuíram para as mortes foram climáticos, ambientais (pastagens sombreadas, vedadas e em estágio de seca) e individuais (bezerros de raças europeias foram a categoria afetada). Este trabalho demonstra que infestações severas por *R. microplus* em bezerros criados em pastagens

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que possuem baixa qualidade são fatais devido a quadros graves de anemia, e enfatiza a importância das ferramentas diagnósticas na redução dos prejuízos econômicos causados pelas perdas decorrentes da infestação por carrapatos.

TERMOS DE INDEXAÇÃO: Produção animal, *Rhipicephalus microplus*, doença fatal, perda econômica, anemia, carrapatos, bovinos.

INTRODUCTION

Rhipicephalus microplus is an ectoparasite distributed throughout the world in countries situated between the 32° North and 32° South parallels (Andreotti et al. 2019). Due to its feeding habit, the spoliation of cattle by ticks causes debility, anemia, weight loss, and adverse effects on the ingestion, metabolism, and digestion of foods and the immune system (Jonsson 2006). Besides direct losses, there are costs with treatments, labor (Grisi et al. 2014, Miraballes & Riet-Correa 2018), and market restrictions due to acaricide residues on the carcasses. Moreover, *R. microplus* is a vector of cattle tick fever (CTF) agents, which causes severe economic loss in different regions of the world due to the death of affected animals (Pupin et al. 2019, Martins et al. 2020).

Although infestation by *R. microplus* is mentioned as a cause of death among cattle (Jonsson 2006), there are only studies that use artificial infestations in which intense parasitism led to the death of cattle due to severe anemia (Johnston & Haydock 1971, Johnston et al. 1981 apud Jonsson 2006). To the best knowledge of the authors, there are no reports of the spontaneous death of cattle directly related to natural infestation by *R. microplus* and not by agents of CTF. This study describes the epidemiologic, clinical-pathologic, and diagnostic aspects of the death in cattle due to infestation by *R. microplus*.

MATERIALS AND METHODS

Animal Ethics. This study was approved by the "Comissão de Ética no Uso de Animais" (CEUA) of the "Universidade Federal do Mato Grosso do Sul" (UFMS) under protocol no. 1215/2022.

Clinical and epidemiological data. During a visit by the team of the Pathological Anatomic Lab (LAP) of UFMS, the epidemiological, clinical, and management data about cattle and the farm where the outbreak occurred were obtained through interviews with the veterinarian and zootechnician responsible for the animals.

The cases occurred on an extensive-ranging farm located in the municipality of Paraíso das Águas (latitude 19°1'33'' South, longitude 53°0'37'' West), which is situated in the microregion of Cassilândia of Mato Grosso do Sul state, Midwest region of Brazil. The management partially consists of a rotated pasture system; the second management form is the change of paddocks when the foraging availability is insufficient. In this study, the cattle were introduced into fenced paddocks. The herd consisted of 4,300 male and female Nelore (*Bos taurus*), Angus (*Bos indicus*), and crossbreed (½ Taurine x ½ Zebuine) cattle between eight and 12 months of age introduced on the farm from April to July 2020.

In June 2020, two months after the introduction on the farm, six calves (Brangus and Angus) died after presenting apathy, reluctance to move, fatigue, hyporexia to anorexia, weight loss, and pallid mucosa for 15 to 30 days. Deaths continued to occur after one month. At the end of the outbreak, 52 animals had become ill and 19 died (1.2% morbidity, 0.44% mortality, and 36.5% lethality). Before the visit to the farm by the LAP-FAMEZ team, as the veterinarian in charge of the herd suspected of CTF, cattle who became ill received an intramuscular injection of 1ml/20kg of live weight (LW) of diminazene diaceturate (Ganaseg™ 7%; Elanco), 1ml/10kg LW of oxytetracycline (Terramycin LA®, Zoetis) and 1ml/10kg LW of ferric hydroxide (Valléefer®, Merck & Co.). None of the animals recovered.

Anatomopathological procedures. At the beginning of July, one calf was sent dead to the LAP-UFMS for necropsy and histopathologic exams. During necropsy, fragments of all organs were collected, fixed in 10% formalin, and routinely processed for histopathology. On July 10th, after the calf was necropsied, the LAP-UFMS team visited the farm and examined clinically 35 animals. All cattle underwent body temperature measurement and evaluation of the ocular and oral mucosa, as well as the degree of infestation by ticks. Blood samples were taken from the jugular vein of four animals and stored in Vacutainer® (Becton, Dickinson and Company – BD, New Jersey, USA) tubes containing EDTA for hematological exam and investigation of parasites in blood smears. After the diagnosis, the treatment protocol was instituted and the animals were followed up until complete recovery.

Weather and precipitation analysis. Data on weather and precipitation in the region where the farm is located were obtained from the Meteorological Monitoring System of the federal government (Agritempo) during the period of the outbreak.

RESULTS

Clinical and epidemiological data

During the visit to the farm, cattle severely infested by ticks were found in all pens. The highest intensity of infestation was on animals located in previously fenced pens and in pens located near native forests. To control the ticks, a product containing 25% diflubenzuron (Difly S3®, Champion, Goiás, Brazil) was administered in the diet at a quantity of 1g of product/animal/day. After the diagnosis of the cause of the deaths, severely infested animals were sprayed using medications with cypermethrin, fenthion + chlorpyrifos (Colosso FC30, Ourofino, São Paulo, Brazil), and cypermethrin + chlorpyrifos (Texvet® Max pour on, Bimeda, São Paulo, Brazil) every 15 days – both at the dose recommended by the manufacturer.

The LAP-UFMS team examined 35 Angus crossbred calves from pens with high tick infestation. These animals had severe tick infestation and were removed from the pasture to be allocated to the nursery for treatment with the previously mentioned protocol. All calves had highly pale ocular and oral mucosa, poor body score, and excessively long hair coat. The body temperature ranged from 37 to 37.5°C, which is considered within physiological parameters (Terra & Reynolds 2015). At the end of the outbreak, all 35 calves recovered.

The hematological exams of the blood samples from four animals demonstrated microcytic anemia (Table 1). No blood parasites were found in any of the blood smears analyzed.

Anatomopathological findings

A male 10-month-old ½ Nelore x ½ Angus calf was sent dead to LAP-UFMS and necropsied. The animal was in a poor nutritional condition (ribs and bone prominences were evident) and had an accentuated quantity of specimens of *Rhipicephalus microplus* in different evolutive stages (Fig.1-2) dispersed throughout the skin of the inguinal and axillary

regions. The carcass and the ocular and oral membranes were pale, and the liver was slightly enlarged, with rounded edges and an evident lobular pattern. Microscopically, no significant abnormalities were found. Due to the absence of findings such as jaundice, splenomegaly, hemoglobinuria, dark red kidneys, and thick, lumpy bile, which would be suggestive of CTF, the diagnosis of anemia secondary to tick spoliation was instituted. The lack of specimens of *Haemonchus* spp. in the abomasum and the absence of cavitary or subcutaneous edema also excluded haemonchosis from the differential diagnosis.

Weather and precipitation analysis

Regarding meteorological data, peak rainfall in the microregion where the farm is located occurred in May (138.6mm), together with temperatures of 21.2 to 24.5°C. April had the second-highest rainfall index among all months analyzed. June (the onset of the outbreak) was the beginning of a severe decrease in rainfall, which reached a minimum of 0.1mm until the month of August. In June, the temperature ranged from 21.9 to 29.5°C (Fig.3).

Table 1. Results of the hematological exam of cattle clinically examined by the LAP-FAMEZ team during a visit to the farm

Erythrogram	Cattle				Reference value*
	A	B	C	D	
Red blood cells	4.16	5.54	4.82	5.16	5.5 to 8.5 million/mm^3
Hemoglobin	7.4	7.5	8.6	7.2	12 to 18g/dL
Hematocrit	25	24	27.5	23	37 to 55%
MCV	60.1	43.3	57.1	44.5	60 to 77 fl

* Kaneko et al. (2008), MCV = mean corpuscular volume.

DISCUSSION

The diagnosis of anemia due to severe infestation by ticks as the cause of death was based on the clinical parameters (high tick infestation and severe anemia), macroscopic and microscopic findings, exclusion of other possible causes, and the recovery of adequately treated animals. In all cattle, microcytic anemia was detected. This finding is compatible with chronic blood loss (Constable et al. 2017), which reinforces parasitism by ticks as the cause of death.

Infection by *Babesia* spp. and *Anaplasma* sp. were excluded based on the absence of suggestive gross findings (Almeida et al. 2006, Pupin et al. 2019) and the absence of these agents in blood smears of the necropsied calf as well as of other cattle with clinical signs. Haemoncosis was excluded based on the lack of *Haemonchus* sp. specimens in the abomasum and the absence of findings such as submandibular, cavitary, mesenteric, and mucosal edema (Lima et al. 2022) in the necropsied animal. Moreover, no edema was found in any cattle clinically examined on the farm.

The epidemiology of this outbreak is related to other conditions that favor infestation by *Rhipicephalus microplus,* such as aspects of the animals (breed and age) and the environment (temperature, humidity, and vegetation). It is noteworthy that even with a severe infestation, well-fed animals with adequate nutritional status do not present anemia, making death by ticks unlikely (Jonsson 2006). During the outbreak, mineral supplementation was adequate and forage was available, but it was dry due to the season of the year. This suggests that low-quality foraging was an environmental factor that contributed to the severity of the clinical condition and anemia in affected animals.

Fig.1-2. Tick infestation as a cause of death in cattle. (**1**) Skin of sternal and abdominal regions with multiple areas of alopecia and moderately infested by *Rhipicephalus microplus* specimens of different sizes. (**2**) Accentuated infestation by *R. microplus* on skin in the medial portion of the right pelvic limb.

Due to its climatic conditions, the Cerrado (savannah) biome facilitates the development of four *R. microplus* generations annually (Siqueira et al. 2021). In years when higher temperatures occur in winter, as in the present case, there can be five generations per year (Cruz et al. 2020, Nicaretta et al. 2021), with the highest challenge by ticks occurring in autumn (Nicaretta et al. 2021). As this is one of the main risk factors of high tick parasitism and their losses when European cattle are allocated in this region, as occurred in the present case, the odds of infestation and diseases due to ectoparasites increase (Wambura et al. 1998, Jonsson et al. 2014).

Affected animals presented a clinical course of 15 to 30 days until death characterized by signs that culminated in weight loss and reduction in animal development, commonly related to intense parasitism by ticks and the consequent anemia (Jonsson 2006). The high lethality (36.5%) recorded at the end of the outbreak occurred mainly due to the delay in the establishment of a definitive diagnosis. As CTF was the initial suspicion, cattle were treated specifically for this condition, even without confirmation of the diagnosis through the investigation of *Babesia* spp. and *Anaplasma* sp. in affected animals. This demonstrates the importance of confirmatory exams in suspected cases of CTF. Along with the equivoque treatment, the delay in the conclusion of the diagnosis led to the illness and death of more calves. Besides the causes of economic loss mentioned above, the cost of unnecessary treatments and the death of animals when the diagnosis is not performed promptly also have to be included in that list.

The pens which had the greater number of severely infested animals were fenced or had parts of native forest. Both situations are favorable to the development of the tick free-living stage by ensuring shelter for the females, eggs, and larvae, protecting them from exposure to direct sunlight, and providing the necessary humidity and temperature (Nava et al. 2013, Canevari et al. 2017, Mastropaolo et al. 2017). Moreover, the rainfall peak index in the region occurred 30 to 60 days prior to the onset of the outbreak, followed by 21 to 24°C temperatures, which are considered favorable to the larval development of *R. microplus* and possibly contributed to its lifecycle (Sungirai et al. 2018).

The acaricidal protocols used are based on the continuous administration of diflubenzuron in the diet and tactical treatments involving spraying with active ingredients belonging to the groups of pyrethroids and organophosphates in cases of high infestation. Despite spraying every 15 days, treatment was not effective, as cattle still became ill. The established control program had failed and an emergency treatment was required. Based on several reports in Brazil (Reck et al. 2014, Higa et al. 2015), we cannot discard the possibility of resistance to the acaricides used. However, only an *in vitro* sensitivity test, which was not performed in the present study, would be able to confirm the occurrence of resistance and the determination of whether acaricides were inappropriately used on the farm.

The necropsied calf did not have significant macroscopic or microscopic abnormalities beyond the indication of anemia demonstrated by the pallor of the ocular and oral mucous membranes and carcass. Based on the pathological

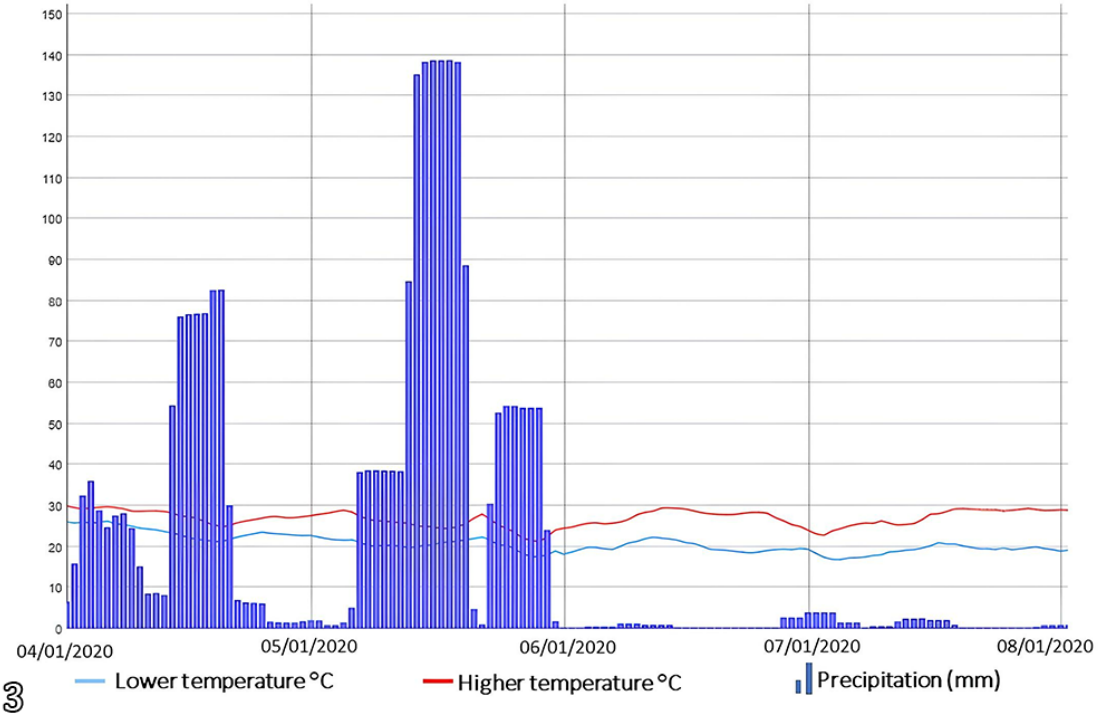

Fig.3. Daily precipitation and temperature data in the microregion of Cassilândia, Mato Grosso do Sul, from April to August 2020, the period of occurrence of deaths caused by *Rhipicephalus microplus* infestation[6].

[6] Available at <agritempo.gov.br> Accessed on Jan. 12, 2023.

and clinical findings, the absence of hyperthermia in the animals clinically examined and the absence of parasites in the blood samples contributed to excluding babesiosis and anaplasmosis from the differential diagnosis. Cattle that died from *Babesia* spp. and *Anaplasma* sp. frequently present jaundice, splenomegaly, and hepatomegaly during necropsy. Specifically, with babesiosis, diffusely dark red kidneys and red urine are found. In case of infection by *B. bovis*, the telencephalic cortex has a cherry red color (Pupin et al. 2019). None of these findings was present in the necropsied animal. This reinforces the importance of performing necropsies and collecting blood for investigation of blood parasites in cases of suspected CTF (Parodi et al. 2021) to confirm or exclude this condition from the differential diagnosis.

The annual economic losses caused by *R. microplus* on beef cattle are estimated to be U$2,313 million considering only daily weight loss (Grisi et al. 2014). However, the present study suggests that losses could be greater when the costs of treatments and deaths of highly infested animals are included.

In summary, the main factors that contributed to the death of cattle highly infested by *R. microplus* in the present study were 1) climatic – rains occurred 30 to 60 days before the onset of cases; 2) environmental – use of shady, dry and fenced pastures in the feeding of cattle belonging to the most affected lots; and 3) host – calves of European breeds in poor nutritional condition were the affected category due to their high susceptibility to injuries related to the ticks.

CONCLUSION

High infestations by *Rhipicephalus microplus* in calves raised on low-quality pastures can be fatal due to the occurrence of severe anemia. Necropsy and histopathology associated with additional exams, such as hematological exams and investigation of blood parasites, are essential to confirming the cause of death and reducing the economic loss caused by tick infestation.

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