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Prevalence and geospatial distribution of bovine cysticercosis in the state of Mato Grosso, Brazil

Gabriel Augusto Marques Rossi[a,*], Heloisa Adélia Stefanoni de Simoni[b], Welber Daniel Zanetti Lopes[c], Henrique Meiroz de Souza Almeida[a], Vando Edésio Soares[d], Ana Maria Centola Vidal[e], Antonio Sergio Ferraudo[a], Luis Antonio Mathias[a]

[a] UNESP—Univ. Estadual Paulista, Faculdade de Ciências Agrárias e Veterinárias (FCAV), Via de acesso Paulo Castellane, s/n, CEP 14884-900, Jaboticabal, São Paulo, Brazil
[b] Esp. Instituto Qualittas de Pós-Graduação (Student) and Brazil's Federal Inspection Service (SIF), Av. Ulisses Guimarães, 889, Polo Industrial III, CEP 78500-000, Colider, Mato Grosso, Brazil
[c] Instituto de Patologia Tropical e Saúde Pública, Universidade Federal de Goiás, 74605-050 Goiânia, Goiás, Brazil,
[d] Universidade Camilo Castelo Branco (Unicastelo), Av. Hilário da Silva Passo 950, 13690-970, Descalvado, São Paulo, Brazil,
[e] Universidade de São Paulo, Faculdade de Zootecnia e Engenharia de Alimentos (FZEA), Avenida Duque de Caxias Norte 225, CEP 13635-900, Pirassununga, São Paulo, Brazil,

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ABSTRACT

This study focused on estimating the prevalence and evaluating the geospatial distribution of bovine cysticercosis in the state of Mato Grosso, Brazil. To this, we used data of 6,200,497 animals slaughtered during the years of 2013 and 2014, and from 141 municipalities of the state. The prevalence observed for this period was 0.0873% (95% CI 0.0851–0.0897). Regarding the cysticerci detected, the calcified ones were the most frequent (74.43%). The high *odds ratios* were observed in animals reared in the Administrative Regions of Sinop, Barra do Garças, Água Boa, Cáceres, Barra do Bugres, Cuiabá, Pontes Lacerda, Rondonópolis, Matupa, São Félix do Araguaia and Lucas do Rio Verde, respectively. Furthermore, the results indicate the existence of a relation between the areas with high cysticercosis prevalence and human population density. We highlight the need of the development of a risk model based on the origin to improve cysticercosis detection in endemic areas.

1. Introduction

The taeniosis-cysticercosis complex caused by *Taenia saginata* is a tropical disease that causes economical losses to the beef supply chain and has a great public health importance in developing countries such as Brazil (Rossi et al., 2015). It is estimated that, annually, approximately US$164 million are lost in Latin America due to bovine cysticercosis (Schantz et al., 1994).

Moreover, meat infected with cysticerci is the main infection source of taeniosis to humans who are the definitive hosts (Ferreira et al., 2014). Consequently, a visual inspection of beef carcasses during slaughter is required to reduce the risk for consumers (Hill et al., 2014). However, the ongoing visual inspection model fails in identifying carcasses with low infection if only the parasite's preferential sites are analyzed (Lopes et al., 2011).

Risks factors associated with cysticercosis are often described in literature, such as: the access of cattle to non controlled water sources (Kyvsgaard et al., 1991); the presence of fishermen in the surroundings of the farm (Rossi et al., 2015); the use of urban sewage sludge on pastures (Cabaret et al., 2002); the presence of roads or car parking lots adjacent to pastures as well as recreational sites (Flütsch et al., 2008); contaminated food (Jenkins et al., 2013) and organic farming (Calvo-Artavia et al., 2013a,b). Still, further studies are required for a better understanding of the global epidemiology of the complex (Laranjo-González et al., 2016).

* Corresponding author at: Via de acesso Prof. Paulo Donato Castellane s/n, Jaboticabal, CEP 14884-900, São Paulo, Brazil.
E-mail addresses: gabrielrossiveterinario@hotmail.com, gabrielrossiveterinario@gmail.com (G.A.M. Rossi), heloisa_stefanoni@hotmail.com (H.A.S. de Simoni), wdzlopes@hotmail.com (W.D.Z. Lopes), henri_almeida2003@yahoo.com.br (H.M.d.S. Almeida), soaresvando@gmail.com (V.E. Soares), anavidal@usp.br (A.M.C. Vidal), ferraudo@fcav.unesp.br (A.S. Ferraudo), lmathias@fcav.unesp.br (L.A. Mathias).

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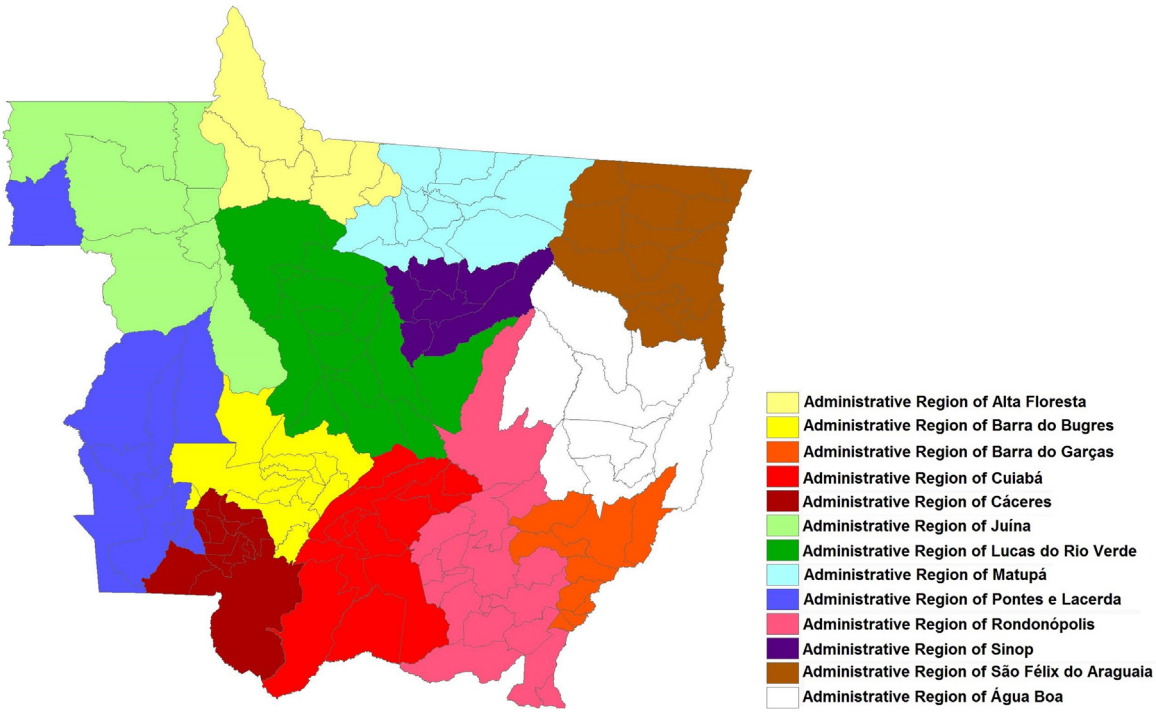

Fig. 1. Geospatial distribution of the Administrative Regions which had cattle slaughtered in the state of Mato Grosso, Brazil, during the years of 2013 and 2014.

In Brazil, the prevalence of the disease variates in the different regions and states, and the epidemiology needs to be better understood (Dutra et al., 2012), mainly in the state of Mato Grosso, which has the country's largest cattle population (Brazil, 2014). Considering this, the purpose of this study was estimating the prevalence and evaluating the geospatial distribution of bovine cysticercosis in the state of Mato Grosso, Brazil.

2. Material and methods

Data regarding the occurrence of cysticerci in 6,200,497 bovine carcasses of both sexes, with age ranging from 18 to 60 months, originated from all the 141 municipalities in the state of Mato Grosso, Brazil and slaughtered throughout the years 2013 and 2014, was obtained. All information was gathered from reports of carcasses rejection occurrence, of the Brazilian Federal Inspection Service (SIF). Such reports listed the municipality, the total number of slaughtered animals and the number of animals infected with viable and/or calcified cysticerci.

However, besides analyzing the data by each municipality, we also analyzed the data by administrative region. The studied area is divided into 13 administrative regions: Água Boa, Alta Floresta, Barra do Bugres, Barra do Garças, Cáceres, Cuiabá, Juína, Lucas do Rio Verde, Matupá, Pontes e Lacerda, Rondonópolis, São Félix do Araguaia and Sinop (Fig. 1).

The animals' slaughter was according to the standard production technology for bovines adopted in Brazil. SIF inspection agents properly trained to perform *post mortem* inspection performed the inspection of carcasses and viscera. The routine examination for the detection of cysticerci occurred in the inspection lines (head, tongue, heart, diaphragm and esophagus) (Brazil, 1952). If cysticerci were detected in the carcass, the lesions were identified and the half carcass, altogether with the viscera and the head were sent to the Final Inspection Department (DIF), where it was examinated by a veterinarian agent. Afterwards, the cysticerci found were classified into viable or calcified (Costa et al., 2012).

The statistical analysis was performed using the software Epi-info 3.5.1. The prevalence and the 95% confidence interval (95% CI) were calculated through the Wilson's Method (Thrusfield, 2010). The relation among animal's cysticercosis and the Administrative Regions was calculated using that one with lower prevalence, which were considered as OR = 1 and the others were compared with it (Thrusfield, 2010).

Statistical data of the state of Mato Grosso total area of corn production (hectares), soy (hectares), total bovine herd (number of animals), total human population, population density (pop. per km^2), human development index (HDI), life expectancy human development index (HDIL) and percentage of humans living in a poor sanitary condition were obtained through the website of the Brazilian Institute of Geography and Statistics (IBGE, 2015) for the same period than the cysticercosis occurrence data.

The association between the mentioned variables with cysticercosis occurrence in the municipalities was evaluated. Cysticercosis prevalence was dichotomized being considered as negative (0) in municipalities with prevalence included in first quartile (0.00–0.04) and as positive (1) when included in second, third and fourth quartiles. The population density (pop. per km^2) was divided into six categories as 1 (0.30–1.00), 2 (1.01–2.00), 3 (2.01–3.00), 4 (3.01–5.70), 5 (6.20–10.00) and 6 (11.30–241.00). HDI index was divided into three groups: 1 (0.54–0.65), 2 (0.80–0.82) and 3 (0.83–0.85) and HDIL into groups 1(0.76–0.79), 2(0.80–0.82) and 3 (0.83–0.86). Furthermore, the percentage of humans living in a poor sanitary condition was divided into four groups, classified as 1 (29.89–10.35), 2 (9.99–3.16), 3 (2.97–1.21) and 4 (0.96–0.14).

Initially the association was analyzed using logistic regression one variable at a time. Those one in which were observed $p > 0.20$ were evaluated together in a multivariate logistic model. Maps were created using the Terraview® Software.

3. Results and discussion

The prevalence observed among 6,200,497 bovines from the 141 municipalities located in the state of Mato Grosso, during the years