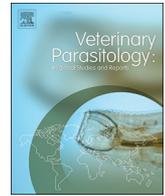




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Bovine fasciolosis in São Paulo state, Brazil

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ABSTRACT

Fasciolosis is a zoonotic disease with a worldwide distribution caused by *Fasciola hepatica*, which leads to severe economic losses in cattle such as reducing meat and milk production, livers condemnation, growth retardation and increase in mortality. From October 2008 to April 2011, condemned bovine livers in slaughterhouses of different municipalities from São Paulo state, Brazil were evaluated for the presence of *Fasciola hepatica*. Out of 20,635 analyzed livers, 1422 were infected with *F. hepatica*. These cattle came from 33 municipalities, out of which 16 showed infected animals and where 7 municipalities did not show statistical difference between each month throughout the year: Tuiuti – 276/1408 (19,6%), Atibaia – 44/257 (17,1%), Joanópolis – 116/738 (15,7%), Bragança Paulista – 318/2316 (13,3%), Piracaia – 182/1442 (12,6%), Santo Antonio de Posse – 118/1005 (11,7%), Amparo 131/2003 (6,5%). The other nine municipalities, Monte Alegre do Sul, Descalvado, Campinas, Morungaba, Pedreira, Socorro, Munhoz, Jaguariúna and Itatiba showed a positive percentage varying from 5.08% to 1.46%. Our results demonstrated the presence of *F. hepatica* in this region was higher than official data, bringing the need for control measures. There is also an apparent increase in fasciolosis two to three months after low to medium precipitation, however high precipitation causes a decrease in fasciolosis prevalence.

1. Introduction

Fasciola hepatica is a cosmopolitan trematode parasite that infects the liver ducts of ruminants, rodents, humans and other mammals, worldwide (Bennema et al., 2014). Fasciolosis is a zoonotic foodborne disease of great importance in both veterinary and human medicine, causing severe economic losses in both cattle and sheep rearing, and it has been included in the World Health Organization list of neglected tropical diseases (Carmona and Tort, 2016).

F. hepatica requires an intermediate host to complete its life cycle, usually using molluscs of the Lymnaeidae family. Snails of the genus *Lymnaea* are the worldwide known vectors (D Almeida et al., 2016; Medeiros et al., 2014) and three known species act as natural hosts in Brazil: *Lymnaea viatrix*, *Lymnaea cubensis* and *Lymnaea columella* (D Almeida et al., 2016), where the species *L. columella*, has been found naturally infected in the state of São Paulo (Ueta, 1980).

In Brazil, based in the official government records, several states are

reported to have fasciolosis, namely Espírito Santo, Goiás, Minas Gerais, Mato Grosso do Sul, Mato Grosso, Pará, Paraná, Rio de Janeiro, Rio Grande do Sul, Santa Catarina and São Paulo, however their prevalence numbers may be grossly underestimated (Bennema et al., 2014). Several cases have been published in different animals including cattle (*Bos taurus*), sheep (*Ovis aries*), capybaras (*Hydrochoerus hydrochaeris*), feral nutria (*Myocastor coypus*) and the greater rhea (*Rhea americana*). There are also several reports of human infection (do Amaral and Busetti, 1979; Dracz and Lima Wdos, 2014; Dracz et al., 2016; El-Kouba et al., 2009; Fiss et al., 2013; Luz et al., 1999; Neto and da Silva, 1977; Pile et al., 2000; Santarem et al., 2006; Soares et al., 2007). In the state of São Paulo, most records are restricted to municipalities in the South Paraíba Vale River region and in capybaras in the municipality of Presidente Prudente (Ueta, 1980; Santarem et al., 2006; Abilio and Watanabe, 1998; Amato et al., 1986). Considering the lack of reported cases in the northeast region of the state of São Paulo, our purpose was to evaluate for the first time, the number of infected animals among

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Table 1
Number of livers collected per municipality and number of infected livers.

Municipality	Number of collected livers	Number of positive livers	Infected livers (%)
Itatiba	18	4	22%
Tuiuti	1431	276	19%
Atibaia	257	44	17%
Joanópolis	738	116	16%
Bragança Paulista	2386	318	13%
Piracicaba	1442	182	13%
Santo Antônio da Posse	1005	118	12%
Amparo	2003	131	7%
Monte Alegre do Sul	295	15	5%
Descalvado	2368	101	4%
Campinas	697	24	3%
Socorro	1152	21	2%
Pedreira	2033	42	2%
Morungaba	594	13	2%
Jaguariuna	766	10	1%
Munhoz	479	7	1%
Caconde	19	0	0%
Mogi Mirim	664	0	0%
Tapiratiba	1240	0	0%
Holambra	135	0	0%
Bueno Brandão	32	0	0%
São João da Boa Vista	120	0	0%
Campos de Jordão	78	0	0%
Sumaré	21	0	0%
Serra Negra	295	0	0%
Jarinu	20	0	0%
Limeira	67	0	0%
Martim Francisco	21	0	0%
Santa Rita do Passa	38	0	0%
Quatro			
Mogi Guaçu	18	0	0%
Pirassununga	38	0	0%
Artur Nogueira	82	0	0%
Itapira	83	0	0%
Total	20,635	1422	7%

those whose liver were condemned.

2. Methodology

In this work, from October 2008 to April 2011, 20,635 bovine livers were collected from 33 slaughterhouses in municipalities from Campinas and surrounding areas (Table 1).

Upon inspection by health inspectors from the Federal Inspection Service (SIF) of the Ministry of Agriculture, Livestock and Supply (Ministério da Agricultura, Pecuária e Abastecimento, MAPA) if a liver was declared unfit for consumption it would be collected for examination.

The collected livers were opened and the bile ducts were examined (Fig. 1) for the presence of *Fasciola* parasites. Parasites were collected and washed in saline solution, pressed between two slides and identification was confirmed under a stereoscope.

Rainfall (mm) data from each month was acquired from the Center of Meteorological and Climatic research applied to agriculture (CEPAGRI-UNICAMP).

For statistical analyses, data obtained were transformed in log for Analysis of Variance (ANOVA) and means of infected livers were compared through Tukeys test (BioEstat 5.0).

3. Results

From the 33 municipalities visited, *F. hepatica* was detected in 16 (Table 1). From these 16 slaughterhouses, seven did not show statistical differences in the number of parasites found throughout the year. They were: Tuiuti 276/1408 (19,6%), Atibaia 44/257 (17,1%), Joanópolis 116/738 (15,7%), Bragança Paulista 318/2316 (13,3%), Piracica 182/

1442 (12,6%), Santo Antônio de Posse 118/1005 (11,7%), Amparo 131/2003 (6,5%). The other nine municipalities Monte Alegre do Sul, Descalvado, Campinas, Morungaba, Pedreira, Socorro, Munhoz, Jaguariuna and Itatiba showed percentages varying between 1.46 and 5.08%. Our results also show a higher number of infected livers in municipalities closer to rivers (Fig. 2), as well as an increase during spring, in the beginning of rain season (Fig. 3). These results proved, for the first time, the presence of fasciolosis in this region, showing a need for control measures against this parasite.

4. Discussion

In Brazil, fasciolosis in cattle is monitored through inspection in slaughterhouses, however, in each state, inspection regularity may vary and may be carried out by different entities (Federal, State or Municipal), which also influences the available data related to the number of cases (Bennema et al., 2014).

In a study carried out by Bennema et al. (Bennema et al., 2014) using government official records, the state of Rio Grande do Sul (Brazil) showed a fasciolosis prevalence of 14.39%, the highest in Brazil. In another work, in the same state (Fiss et al., 2013), sheep faeces were collected and searched for the presence of *F. hepatica* eggs during several outbreaks between 1980 and 2011, with an average prevalence of 12.25%, therefore being in accordance with the official data. It is important to notice that the state of Rio Grande do Sul possesses the most complete amount of data regarding fasciolosis, however other states have a lower amount of data available. In the state of Santa Catarina, for example, official number shows a prevalence of 4.5% (Bennema et al., 2014), however in a paper by da Serra-Freire and Nuernberg (da Serra-Freire and Nuernberg, 1992), where 7156 bovine fecal samples were analyzed, a *F. hepatica* prevalence of 27.86% was reported, suggesting that official available data may underestimate the real situation of this disease. Another such example is the state of Minas Gerais, where official data shows a prevalence of 0.1% (Bennema et al., 2014), whereas a study by Dracz and Lima (Dracz and Lima Wdos, 2014) showed a prevalence of 13.51 and 41.66%. Similarly in the state of São Paulo, with an official prevalence of 0.09% (Bennema et al., 2014), we detected, out of 20,635 livers, 1422 infected with *F. hepatica*, representing a 6.8% infection rate among condemned liver, which may suggest that fasciolosis is a larger problem than official numbers lead us to believe.

The South Paraíba Valley region, in the state of São Paulo, is an important known source of infection where *L. columella* snails were found naturally infected with *F. hepatica* with a prevalence of up to 1.22% (Ueta, 1980). In another work by Carvalho et al. (de Carvalho et al., 2001) naturally infected *L. columella* snails were also found in Miracatu, in Ribeira Valley region (São Paulo state), which may also represent another infection source region for fasciolosis. Our work shows that the number of cases follows the rivers in the Piracicaba, Camanducaia, Jaguari and Atibaia Rivers Bay, pointing to another potential risk areas in the state. It is also interesting to notice that there was an increase in fasciolosis cases from two to three months after low to moderate precipitation, conversely, after high precipitation there was a decrease in rates of fasciolosis, according to Qin et al. (Qin et al., 2016) rainfall creates humid microhabitats that are favorable for *F. hepatica* and it also benefits *L. columella*, increasing the snail survival and reproduction, however excessive amounts of rainfall wash away the parasite larvae separating it from the intermediate hosts and inhibiting *F. hepatica* infestation.

5. Conclusion

Our data and previous works (Bennema et al., 2014; Dracz and Lima Wdos, 2014; Fiss et al., 2013; da Serra-Freire and Nuernberg, 1992), point to the existence of a larger problem than presented by the official government data, therefore it is extremely important to create/increase

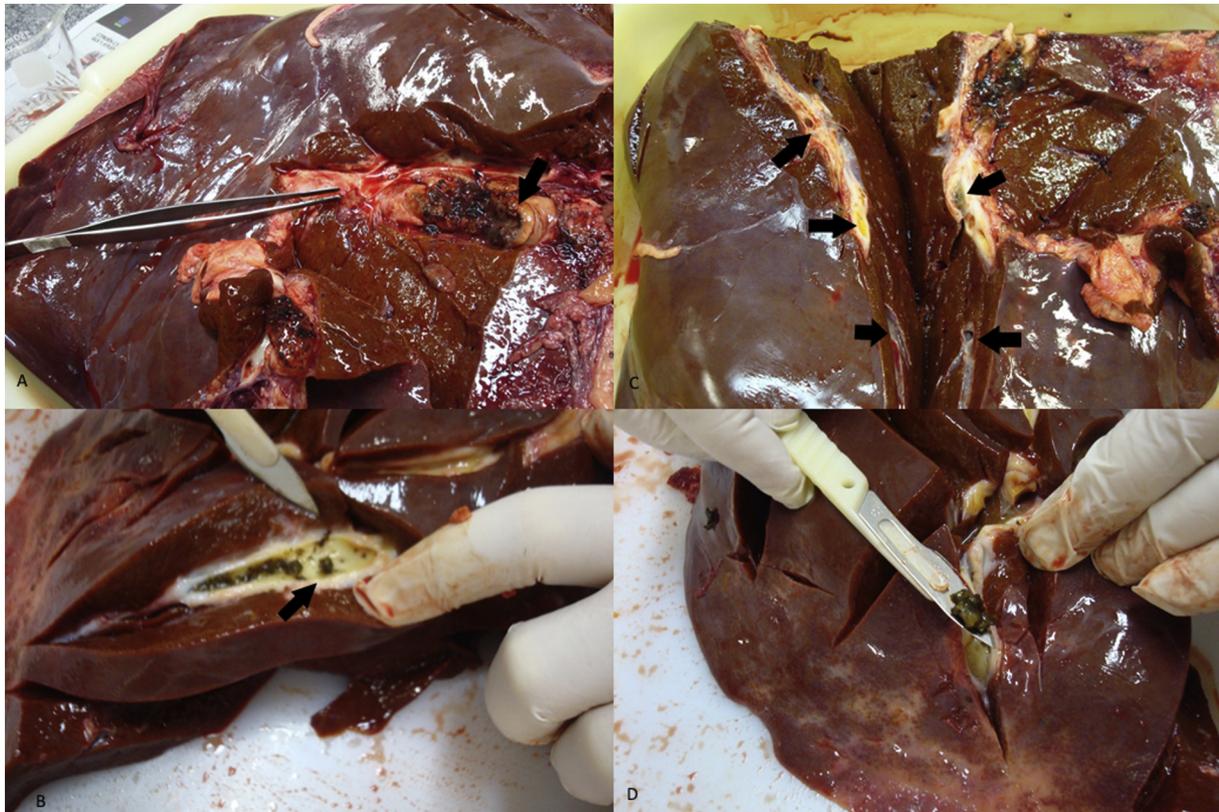


Fig. 1. Livers being examined for the presence of *Fasciola* parasites: A-C –Arrows show liver necrosis and calcification of the bile ducts; D – *Fasciola hepatica*.

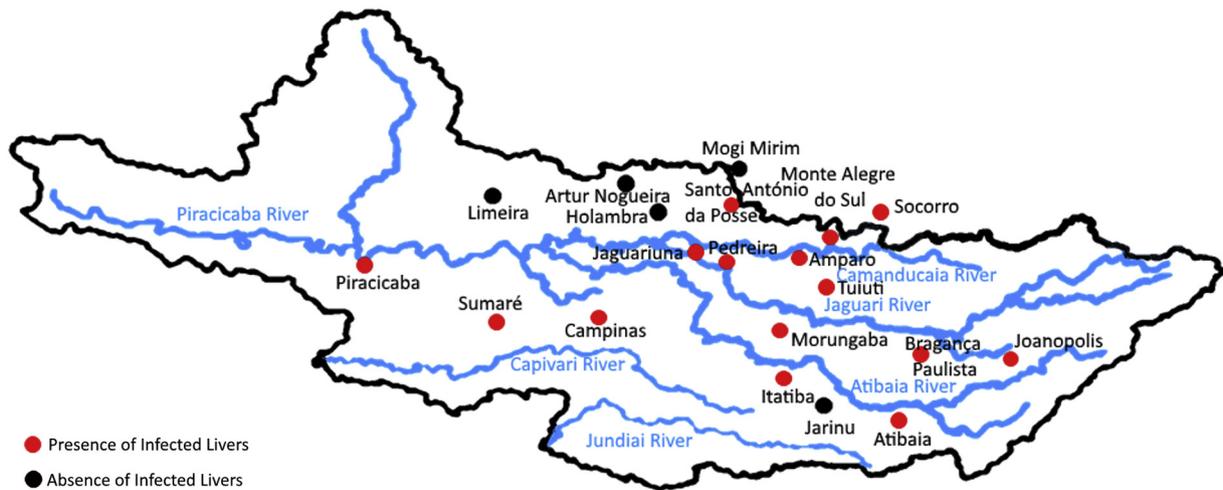


Fig. 2. Geographical distribution of infected livers found in slaughterhouses throughout São Paulo state (Brazil) from 2008 to 2011.

appropriate animal sanitary programs against fasciolosis. Also, in Brazil, there is some correlation between the number of bovine cases and the number of human cases, where the population in rural areas are at higher risk, making it also a public health problem (Bennema et al., 2014). It is important to create educational programs informing the at risk population of the potential of infection via consuming uncooked/contaminated vegetables and also sharing water sources with animals preventing them from reaching this sources (e.g. creating fences), to reduce this parasite prevalence. It is also extremely important to train health workers, since quite often they are not properly trained to recognize fasciolosis symptomatology.

Performing epidemiologic studies is extremely important to clarify the status of the disease, helping reduce economic losses and risk

towards the human population living in endemic areas.

Conflict of interest

The authors confirm that there are no known conflicts of interest associated with this publication and there has been no financial support for this work that could have influenced its outcome.

Ethical statement

This Project was approved by the Ethics Committee for Animal Use – CEUA/Unicamp (Protocol: 2217-1). No animal was used specifically for this study, only livers declared unfit for consumption by the Federal

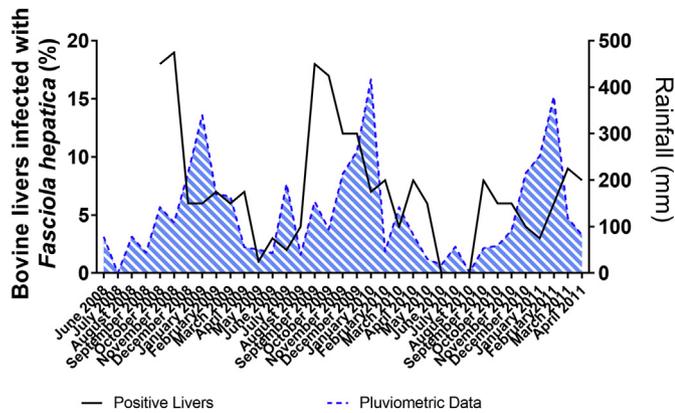


Fig. 3. Percentage of bovine livers infected with *F. hepatica* throughout each month along with the mm of rainfall.

Inspection Service (SIF) of the Ministry of Agriculture, Livestock and Supply (Ministério da Agricultura, Pecuária e Abastecimento, MAPA) were collected for examination.

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References

- Abilio, F.J., Watanabe, T., 1998. Occurrence of *Lymnaea columella* (Gastropoda: Lymnaeidae), intermediate host of *Fasciola hepatica*, for the State of Paraíba, Brazil. *Rev. Saude Publ.* 32, 184–185.
- Amato, S.B., De Rezende, H.E., Gomes, D.C., Da Serra Freire, N.M., 1986. Epidemiology of *Fasciola hepatica* infection in the Paraíba River Valley, Sao Paulo, Brasil. *Vet. Parasitol.* 22, 275–284.

- Bennema, S.C., Scholte, R.G.C., Molento, M.B., Medeiros, C., Carvalho, Ods, 2014. *Fasciola hepatica* in Bovines in Brazil: data availability and spatial distribution. *Rev. Inst. Med. Trop. Sao Paulo* 56, 35–41.
- Carmona, C., Tort, J.F., 2016. Fasciolosis in South America: epidemiology and control challenges. *J. Helminthol.* 1–11.
- D Almeida, S.C.G., Freitas, D.F., Carneiro, M.B., Camargo, P.F., Azevedo, J.C., et al., 2016. The population density of *Lymnaea columella* (Say, 1817) (Mollusca, Lymnaeidae) an intermediate host of *Fasciola hepatica* (Linnaeus, 1758), in the Caparaó microregion, ES, Brazil. *Braz. J. Biol.* 76, 334–340.
- da Serra-Freire, N.M., Nuernberg, S., 1992. Geopolitical distribution of the occurrence of *Fasciola hepatica* in Santa Catarina State, Brazil. *Mem. Inst. Oswaldo Cruz.* 87 (Suppl. 1), 263–269.
- de Carvalho, G.A., Ueta, M.T., de Andrade, C.F., 2001. Search of natural occurrence of xiphidiocercariae (trematoda) in fresh water snails of nine countries from Sao Paulo State, Brazil. *Bol. Chil. Parasitol.* 56, 3–9.
- do Amaral, A.D., Buseti, E.T., 1979. Human fascioliasis hepatica in Brazil. *Rev. Inst. Med. Trop. Sao Paulo* 21, 141–145.
- Dracz, R.M., Lima Wdos, S., 2014. Autochthonous infection of buffaloes and cattle by *Fasciola hepatica* in Minas Gerais, Brazil. *Rev. Bras. Parasitol. Vet.* 23, 413–416.
- Dracz, R.M., Ribeiro, V.M., Pereira, C.A., Lima Wdos, S., 2016. Occurrence of *Fasciola hepatica* (Linnaeus, 1758) in capybara (*Hydrochoerus hydrochaeris*) (Linnaeus, 1766) in Minas Gerais, Brazil. *Rev. Bras. Parasitol. Vet.* 25, 364–367.
- El-Kouba, M.M., Marques, S.M., Pilati, C., Hamann, W., 2009. Presence of *Fasciola hepatica* in feral nutria (*Myocastor coypus*) living in a public park in Brazil. *J. Zoo. Wildl. Med.* 40, 103–106.
- Fiss, L., de Lourdes Adrien, M., Marcolongo-Pereira, C., Assis-Brasil, N.D., Sallis, E.S., et al., 2013. Subacute and acute fasciolosis in sheep in southern Brazil. *Parasitol. Res.* 112, 883–887.
- Luz, J.E., Focaccia Siciliano, R., de Oliveira, A.G.F., Pisani, J.C., 1999. Human fascioliasis in the metropolitan area of Curitiba, Brazil evaluation of the foci of infection and report of nine cases treated with triclabendazole. *Braz. J. Infect. Dis.* 3, 220–225.
- Medeiros, C., Scholte, R.G.C., D'ávila, S., Caldeira, R.L., Carvalho, Ods, 2014. Spatial distribution of Lymnaeidae (Mollusca, Basommatophora), intermediate host of *Fasciola hepatica* Linnaeus, 1758 (Trematoda, Digenea) in Brazil. *Rev. Inst. Med. Trop. Sao Paulo* 56, 235–252.
- Neto, V.A., da Silva, L.J., 1977. Human infection by *Fasciola hepatica* in Brazil: report of a new case and analysis of the problem. *Rev. Inst. Med. Trop. Sao Paulo* 19, 275–277.
- Pile, E., Gazeta, G., Santos, J., Coelho, B., Serra-Freire, N., 2000. Occurrence of human fascioliasis in Volta Redonda, Rio de Janeiro, Brazil. *Rev. Saude Publ.* 34, 413–414.
- Qin, H., Gao, X., Wang, H., Xiao, J., 2016. Relative importance of meteorological and geographical factors in the distribution of *Fasciola hepatica* infestation in farmed sheep in Qinghai province, China. *Parasite* 23, 59.
- Santarem, V.A., Tostes, R.A., Alberti, H., Sanches Ode, C., 2006. *Fasciola hepatica* in capybara. *Acta Trop.* 98, 311–313.
- Soares, M.P., da Silva, S.S., Nizoli, L.Q., Felix, S.R., Schild, A.L., 2007. Chronic fascioliasis in farmed and wild greater rheas (*Rhea americana*). *Vet. Parasitol.* 145, 168–171.
- Ueta, M.T., 1980. Occurrence of natural infection of *Fasciola hepatica* Linnaeus, 1758 in *Lymnaea columella* Say, 1817 in the Paraíba River Valley, Brazil. *Rev. Saude Publ.* 14, 230–233.