J Vector Borne Dis 51, December 2014, pp. 271–275

Research Articles

Spatial epidemiology of American cutaneous leishmaniasis in a municipality of west São Paulo State, Brazil

Elivelton da Silva Fonseca[1], Lourdes A. Zampieri D'Andrea[2], Helena Hilomi Taniguchi[3], Roberto Mitsuyoshi Hiramoto[3], José Eduardo Tolezano[3] & Raul Borges Guimarães[1]

[1]*Department of Geography, College of Science and Technology of Presidente Prudente State University of São Paulo;* [2]*Adolfo Lutz Institute, Center of Regional Laboratory, Presidente Prudente, São Paulo;* [3]*Adolfo Lutz Institute, Center of Parasitology and Micology-São Paulo, São Paulo, Brazil*

ABSTRACT

Background & objectives: In the last decade, in the state of São Paulo, 5898 cases of cutaneous leishmaniasis (CL) were reported. This study was undertaken to analyze the epidemiology of CL in the municipality of Teodoro Sampaio, in São Paulo State, Brazil, based on a geographic approach, as very little is known of the relationship between CL and the spatial transformation process.

Methods: This is a population-based quantitative, descriptive and cross-sectional case study. Surveys of the official notifications in the healthcare center and official sources from 1998 to 2011 were analysed. The data were described based on statistics and the Kernel method to detect hotspots of transmission.

Results: The age group between 21 and 40 yr was most affected, with 24 cases (57.9%). Of the 41 cases reported between 1998 and 2011, 33 cases were having low education status and 31 cases (75.6%) were males. The spatial and temporal distribution was aggregated in three-year periods which permitted the identification of two microfoci, in periods I (1998–2000) and III (2005–2007).

Interpretation & conclusion: The disease has presented, in recent years, a pattern of sporadic transmission or microfoci, and continues to maintain enzootic cycles of *Leishmania* in a sylvatic environment, ensuring the perpetuation of the pathogen in nature, and the risk of emergence of new cases of CL in domestic animals and humans.

Key words Brazil; cutaneous leishmaniasis; São Paulo state; spatial analysis

INTRODUCTION

It is estimated that 350 million people, in 88 countries, are at risk of leishmaniases [visceral leishmaniasis (VL) and cutaneous leishmaniasis (CL)]. These diseases have an estimated annual incidence of between 0.9 and 1.6 million new cases; 0.2 to 0.4 of VL; and 0.7 to 1.2 million cases of CL[1]. About 90% of the CL cases occur in Afghanistan, Brazil, Iran, Peru, Saudi Arabia and Syria[2]. These are recognized as Neglected Tropical Diseases (NTD)[3–4].

It is widespread in Latin America, where it is described, and cases are recorded from the extreme south of the United States to northern Argentina, with the exception of Chile and Uruguay[5]. The disease is spread throughout the municipalities of São Paulo state, mainly due to pressure on landuse promoting the entrance and maintenance of the transmission cycle and a change in the transmission pattern[6]. Today, there are three epidemiological patterns of disease transmission: (a) wild; (b) occupational or leisure; and (c) rural or peri-urban[5].

In the last decade, 5898 cases of CL were reported in the state of São Paulo. This study is justified since very little is known of the relationship between CL and the spatial transformation process. The proposal is to analyze the epidemiological profile of cutaneous leishmaniasis from a geographical perspective in the municipality of Teodoro Sampaio-SP, from 1998 to 2011.

MATERIAL & METHODS

The city of Teodoro Sampaio is located in the western region of São Paulo state and, according to the 2010 Census; the municipality has about 22,386 inhabitants[7]. Located in the Pontal do Paranapanema region (the extreme edge of Paranapanema River), it is the last non-coastal Atlantic Forest reserve, the Morro do Diabo State Park (MDSP)[8]. It is part of the epidemiological surveillance service (ESS) XXII-Presidente Venceslau, with 21

municipalities. The study was a population-based quantitative, descriptive and cross-sectional case study.

Data were obtained from the human CL records in the health department of municipality, when use of the information system on disease notification (ISDN) became compulsory. The ISDN's role is to provide data of compulsory notification throughout the country[9].

The website for the Zoonosis Division of the Epidemiological Surveillance Center of the Disease Control Office, São Paulo State Secretary of Health (ZD/ESC/DCO/SPSSH) was accessed for the same period[10]. Descriptive statistical techniques were used to interpret the distribution of the disease in the period and the spatial and temporal distribution of cases was aggregated in three-year periods. The Kernel method was used to observe spatial patterns, based on Global Positioning System points[11]. The structure and inter-relationship of spatial databases establish a model for aggregating the data[12], and an area was defined covering parameters of 4 km by 3 km rectangle, with a radius of 200 m and a resolution of 15 m.

RESULTS

During the period, 41 cases were notified to the ISDN, most of them (31/41) were males between 21 and 40 yr of

Table 1. Teodoro Sampaio-SP: Distribution of the population notified by CL between 1998 and 2011, with a conclusion in case confirmation criteria, according to ISDN data

Variable	Absolute confirmation criteria		
	Laboratory	Epidemiological clinical	Total*
Gender			
Male	28 (68.2)	3 (7.3)	31 (75.6)
Female	9 (21.9)	1 (2.4)	10 (24.4)
Zone			
Urban	19 (46.3)	3 (7.3)	22 (53.6)
Rural	18 (43.9)	1 (2.4)	19 (46.3)
Age(yr)			
11– 20	3 (7.3)	1 (2.4)	4 (9.7)
21–30	12 (29.3)	–	12 (29.3)
31–40	9 (21.9)	3 (7.3)	12 (29.2)
41–50	7 (17)	–	7 (17)
51–60	2 (4.9)	–	2 (4.9)
≥ 60	4 (9.7)	–	4 (9.7)
Educational attainment			
I–IV grade incomplete in ES	2 (4.9)	–	2 (4.9)
IV grade complete in ES	4 (9.7)	–	4 (9.7)
V–VIII grade incomplete in ES	13 (31.7)	3 (7.3)	16 (39)
ES complete	10 (24.4)	1 (2.44)	11 (26.8)
HS incomplete	3 (7.3)	–	3 (7.3)
HS complete	2 (4.9)	–	2 (4.9)
HE complete	1 (2.4)	–	1 (2.4)
Ignored	–	–	2 (4.9)
Three-year			
I(1998–2000)	10 (24.4)	2 (4.9)	12 (29.3)
II(2001–2004†)	6 (14.6)	–	6 (14.6)
III(2005–2007)	17 (41.4)	2 (4.9)	19 (46.3)
IV(2009–2011†)	4 (9.7)	–	4 (9.7)
Total	37 (90.2)	4 (9.8)	41 (100)

Source: ISDN, Epidemiological Surveillance Service of the Municipality of Teodoro Sampaio-SP, 2011; Figures in parentheses indicate percentages; *Values are non-cumulative, since the overall total is the sub-total for each class(41) and the percentage in relation to this value; ES–Elementary School; HS–High School; †2002 and 2008 were removed from the series because those had no notifications of CL.

Table 2. Teodoro Sampaio-SP: Distribution of the population notified by CL between 1998 and 2011, according to investigation form data, according to case confirmation criteria

Variable	Confirmation criteria		
	Laboratory	Epidemiological clinical	Total*
Form of disease			
Cutaneous	35 (85.4)	4 (9.7)	39 (95.1)
Mucosal	2 (4.9)	–	2 (4.9)
Presented lesion			
Yes	24 (58.5)	2 (4.9)	26 (63.4)
Ignored	13 (31.7)	2 (4.9)	15 (36.6)
Probable source of infection			
Municipality of residence	32 (78)	3 (7.3)	35 (85.3)
Other	2 (4.9)	–	2 (4.9)
Undetermined	3 (7.3)	1 (2.4)	4 (9.7)
Classification			
Autochthone	34 (82.9)	3 (7.3)	37 (90.2)
Imported	2 (4.9)	1 (2.4)	3 (7.3)
Undetermined	1 (2.4)	–	1 (2.4)
Type of entry			
New case	35 (85.4)	2 (4.9)	37 (90.2)
Relapse	1 (2.4)	2 (4.9)	3 (7.3)
Undetermined	1 (2.4)	–	1 (2.4)
DP			
Positive	3 (7.3)	–	3 (7.3)
Negative	4 (9.7)	–	4 (9.7)
Not done	30 (73.2)	4 (9.7)	34 (82.9)
MIDR			
Positive	23 (56.1)	1 (2.4)	24 (58.5)
Negative	4 (9.7)	2 (4.9)	6 (14.6)
Not done	10 (24.4)	1 (2.4)	11 (26.8)
Histopathology			
Compatible	24 (58.54)	–	24 (58.5)
Incompatible	2 (4.88)	–	2 (4.9)
Not done	11 (26.8)	4 (9.7)	15 (36.6)
Total			41

Source: ISDN, Epidemiological Surveillance Service of the Municipality of Teodoro Sampaio-SP, 2011; Figures in parentheses indicate percentages; *Values are non-cumulative, since the overall total is the sub-total for each class (41) and the percentage in relation to this value. DP – Direct parasitological; MIDR–Montenegro's intradermal reaction.

age on the date of the notification. Most had completed elementary school (33/41) (Table 1). The year with most recorded cases was 1998 (8 cases), followed by 2004 (7 cases). The average age for all notified cases is 37 yr; median age is 32 yr, with a standard deviation of 14.86.

The official source of ZD/ESC in the state of São Paulo shows data that considers Teodoro Sampaio-SP as a probable infection site where there were 35 cases between 1998 and 2011. The years when most cases were recorded according to this source were 2004, with nine cases, 2003 and 2005, with five cases each (Fig. 1). With regard to case confirmation criteria, 90.2% was laboratory based, with a greater proportion in men (68.29%) than women (21.95%) (Table 1). Lesions in CL are classified into three types: cutaneous lesion, diffuse cutaneous or mucosal[5]. The type of lesion presented by the patient is entered on the investigation form. Among the notifications studied, 26 (63.41%) of the individuals presented a confirmed lesion, without specifying the kind of lesion. Histopathology was compatible in 24 cases. Most CL cases in the study period were new cases, 37 (90.24%). Three cases were imported and one was undetermined (Table 2). The data on the investigation form was cross-checked with the confirmation criteria and it was observed

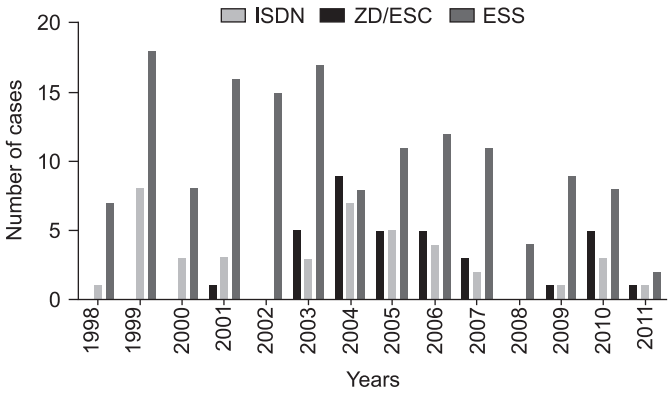

Fig. 1: Teodoro Sampaio-SP: Compulsory notifications of CL and as the probable source of infection, and Epidemiological Surveilance Service (*Source:* ISDN, ZD/ESC, ESS. Provisional data updated on December 13, 2011; *Partial data, because 2011 had not been closed at ISDN).

that 35/41 (85.37%) were of the cutaneous type. Nearly, 60% of cases showed a lesion and in nearly 80% the source of infection was the municipality of residence (Table 2). Kernel shows that CL presented two micro outbreaks: three-year period I (from 1998 to 2000) and three-year period III (from 2005 to 2007) (Fig. 2).

There were 19 cases in rural areas occurring mainly

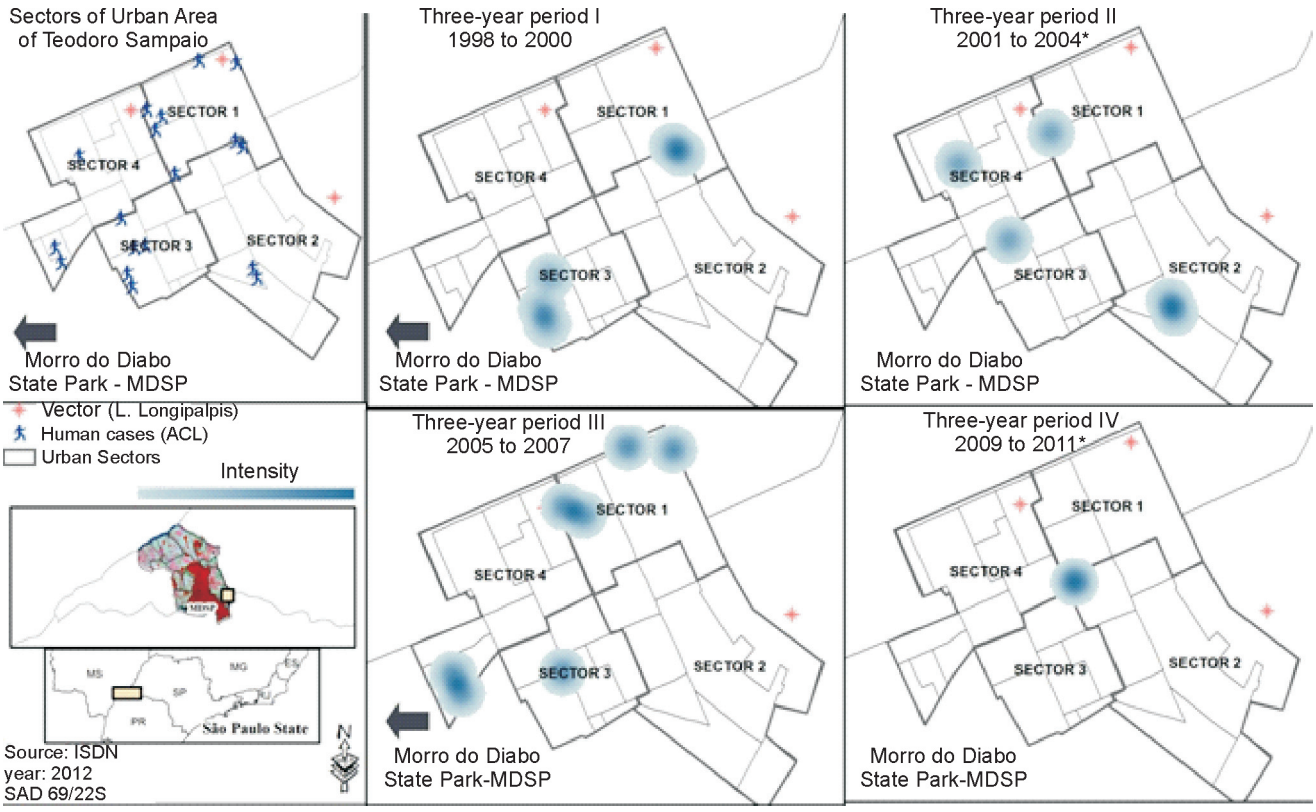

Fig. 2: Teodoro Sampaio-SP: Spatial distribution of compulsory notifications of CL. (*Source:* ISDN, IBGE, ZD/ESC; *2002 and 2008 were removed from the series because they had no notifications of CL).

in settlements: Ribeirao Bonito (6 cases), Corrego Seco (3 cases), Sitio Capim Santo (2 cases). It is suggested that the municipal authorities could raise awareness of any possible foci of CL in these rural locations, because 20% of the inhabitants live in rural areas.

DISCUSSION

The municipality has differing numbers when compared as a municipality of notification (ISDN) and as a probable source of infection (ZD/ESC) (Fig. 1). This may indicated that some transmission reports in Teodoro Sampaio-SP were not recorded in both data sources in the municipality. In 2005, the municipality presented parity between the notified data as a source of infection and the municipality of notification, with five cases. In 2011, it contributed one of the two cases among all ESS municipalities.

Analyzing this in percentages, the municipality's participation in notifications from the state of São Paulo, according to ZD/ESC, ranged between 0.21% in 1998 and 1.20% in 1999 of all notified cases, and the participation in relation to Presidente Venceslau's ESS varied between 14.3%, with one case out of a total of seven, and seven of the eight cases presented in 2004. The municipality contributed in every year, except for 2002 and 2008, when the ESS recorded 15 and 4 cases, respectively (Fig. 1).

The epidemiological profile of CL identified in other studies is similar to this study, suggesting patterns as described in Isfahan, Iran, studying 1213 patients[13], in the rural areas of Mirjaveh, southeast Iran, studying 122 patients[14], on the northern coast of São Paulo State where 689 cases occurred: in Caraguatatuba (81), in Ilhabela (229), in Sao Sebastiao (164) and in Ubatuba (215)[15]. In the Parana municipalities of Cianorte, Jussara, Japura and Sao Tome[16], 68.8%, in Acre State[17], 83% in Parana State[18], and 60% in Minas Gerais State[19] all showed a higher proportion in men. Other research also detected more cases among individuals with low educational attainment[17]. An association exists in the literature of transmission with the age groups[13–14, 17, 20].

Most (85.37%) confirmations using laboratory criteria were new cases and, in 56.1%, MIDR was conducted. There was a predominance (95%) of the cutaneous clinical form, which was also found in 84.6% cases in Caratinga, Minas Gerais[21].

Municipalities along the north coast of São Paulo underscored a heterogeneous spatial distribution of the disease, occurring in urban and rural areas, although predominant in urban areas[16]. In the case of this study in Teodoro Sampaio, possible foci of infection occurred in rural as well as urban environments.

There was a much higher proportion of cases in rural environments (78%) compared to urban in the micro region of Caratinga/MG, and a significant number of cases in rural workers, among the 2782 notified cases between 1966 and 2003[21].

The pattern for the disease in Teodoro Sampaio has been considered wild or peri-urban, because of the MDSP, just 5 km away from the main district, in which the following vector species were found: *Brumptomyia brumpti*, *Nyssomyia neivai*, *Nyssomyia whitmani*, *Pintomyia fischeri* and *Pintomyia pessoai*[8].

The male population was most affected. However, the affirmatives regarding the disease's occupational pattern were not detected by the ISDN notifications, and relapses and new cases were not well explained. It is very difficult to work with secondary data due to the large number of sub-notifications and notification and investigation forms poorly completed by the service[22]. This occurs because the investigation is often not concluded and address information may not be correct.

In conclusion, the municipality should maintain a constantly active surveillance service because environmental and socioeconomic factors in the area lend themselves to the dissemination of the disease. These include the presence of the vector, favorable peri-urban conditions, underscoring the presence of MDSP, reduction in impacts on the municipality's forest coverage, *etc*. As in the past, the enzootic cycles of *Leishmania*, probably *L. (Viannia) braziliensis* continue among wild animals, thus, guaranteeing the perpetuation of the pathogen in nature and the risk of further outbreaks of cases of CL in reservoirs and humans. *Lutzomyia longipalpis* has been encountered in urban areas. In the future, it may contribute to an overlapping of the two forms of disease, VL and CL.

ACKNOWLEDGEMENTS

Marcia Cristina dos Santos Vieira Cruz, nurse of the Municipality of Teodoro Sampaio, for providing the CL records. São Paulo Research Foundation (FAPESP), Grant 2013/20781-7.

REFERENCES

1. Alvar J, Vélez ID, Bern C, Herrero M, Desjeux P, Cano J, *et al.* WHO Leishmaniasis Control Team. Leishmaniasis worldwide and global estimates of its incidence. *Plos One* 2012; *7*(5): 35671. Doi:10.371/journal.pone.0035671.
2. *Leishmaniasis control, Geographical distribution.* Geneva: Division of Control of Tropical Disease, World Health Organiza-

tion. WHO/CTA [Internet] 2005. Available from: *http://www.who.int/ctd/html/leisgeo. html* (Accessed on March 3, 2012).
3. Yamey G, Torreele E. *The world's most neglected diseases. Brit Med J* 2002; *325*(7357): 176–7.
4. *Report of the Scientific Working Group meeting on Leishmaniasis*. Geneva, 2–4 February, 2004. Available from: *http://whqlibdoc.who.int/hq/2004/TDR_SWG_04.pdf* (Accessed on March 3, 2012).
5. Brasil. Ministério da Saúde. Secretaria de Vigilância em Saúde. *Manual de Vigilância da LTA*/Ministério da Saúde, Secretaria de Vigilância em Saúde–2. ed. atual. – Brasília: Editora do Ministério da Saúde 2007; p. 180 .
6. Centers of Disease Control and Prevention. Parasites–Leishmaniasis. Available from: *http://www.cdc.gov/parasites/leishmaniasis/* (Accessed on March 3, 2012).
7. Instituto Brasileiro de Geografia e Estatística (IBGE). Cidades@: São Paulo-Teodoro Sampaio-SP. Available from: *http://www.ibge.gov.br/cidadesat* (Accessed on March 3, 2012).
8. Alessi CAC, Galati EAB, Alves JR, Corbett CEP. American cutaneous leishmaniasis in the Pontal do Paranapanema – SP, Brazil: Ecological and entomological aspects. *Rev Inst Med Trop* 2009; *51*(5): 277–82.
9. Lima CRA. Fontes de Informacão para a Geografia Saúde. In Barcellos C (Org.). A Geografia e o Contexto dos Problemas de Saúde. ABRASCO: ICICT: ESPJV. Rio de Janeiro 2008.
10. Divisão de Zoonoses – Centro de Vigilância Epidemiológica da Secretaria de Estado da Saúde de São Paulo. LTA. Available from: *http://www.cve.saude.sp.gov.br/htm/zoo/lta_gve.htm* (Accessed on March 3, 2012).
11. Smith MJ, Goodchild MF , Longley PA. *Geospatial analysis: A comprehensive guide to principles, techniques and software tools.* II edn. Leicester, Britain: Thwinchelsea Press 2007; p. 130–1.
12. Barcellos C, Bastos FI. Geoprocessamento, ambiente e saúde, uma união possível? *Cad Saúde Pública* 1996; *12:* 389–97.
13. Karami M, Doudi M, Setorki M. Assessing epidemiology of cutaneous leishmaniasis in Isfahan, Iran. *J Vector Borne Dis* 2013; *50*(1): 30–7.
14. Fazaeli A, Fouladi B, Sharifi I. Emergence of cutaneous leishmaniasis in a border area at southeast of Iran: An epidemiological survey. *J Vector Borne Dis* 2009; *46*(1): 36–42.
15. Condino MLF. Leishmaniose tegumentar americana no Litoral Norte Paulista, período 1993 a 2005. [dissertação]. 2007, Faculdade de Saúde Pública da Universidade de São Paulo.
16. Lima AP, Minelli L, Teodoro U, Comunelo E. Distribuição da leishmaniose tegumentar por imagens de sensoriamento remoto orbital, no Estado do Paraná, Sul do Brasil. *An Bras Dermatol* 2002; *77:* 681–92.
17. Silva NS, Muniz VD. Epidemiologia da LTA no Estado do Acre, Amazônia brasileira. *Cad Saúde Pública* 2009; *25*(6): 1325–36.
18. Lopes SN, Ribas CR, Ribas AD, Teixeira JJV, Silveira TGV, Lonardoni MVC. Características Epidemiológicas, Nível de Conhecimento e o Tratamento em Pacientes com LTA, Estado do Paraná, Sul do Brasil. *In: Anais da 27ª Reunião de Pesquisa Aplicada em Doença de Chagas/ 15ª Reunião de Pesquisa Aplicada em Leishmanioses.* Uberaba. Outubro 2011; p. 155.
19. Temponi AOD, Ferraz ML. Aspectos epidemiológicos dos Casos de LTA ocorridos em Minas Gerais, 2001 a 2010. *In*: *Anais da 27ª Reunião de Pesquisa Aplicada em Doença de Chagas/15ª Reunião de Pesquisa Aplicada em Leishmanioses.* Uberaba. Outubro 2011; p. 163.
20. Souza YB. Leishmaniose Tegumentar Americana no município de Ilhéus-BA: caracterização de casos humanos e fatores de risco associados. [dissertação]. Viçosa, MG, 2007, xvii, 111.
21. Resende SM. Análise eco-epidemiológica da leishmaniose tegumentar americana em uma área endêmica da microrregião de Caratinga, Minas Gerais (Brasil), submetida a ensaio comunitário com vacina antiLTA. 2004. [dissertação]. Universidade Federal de Minas Gerais, Escola de Veterinária.
22. Nasser JT, Donalisio MR, Vasconcelos CH. Distribuição espacial dos casos de LTA no município de Campinas, Estado de São Paulo, no período de 1992 a 2003. *Rev Soc Bras Med Trop* (Impresso) 2009; *42:* 309–14.

Correspondence to: Mr Elivelton da Silva Fonseca, Department of Geography, School of Sciences and Technology, São Paulo State University, Presidente Prudente Campus, Roberto Simonsen Street, 305 19060-900 - Presidente Prudente, São Paulo State, Brazil.
E-mail: elivelton.fonseca@gmail.com

Received: 17 February 2014 *Accepted in revised form:* 4 August 2014