Tropical Biomedicine 31(2): 281–285 (2014)

The emergence of *Leptospira borgpetersenii* serovar Arborea as the dominant infecting serovar following the summer of natural disasters in Queensland, Australia 2011

Wynwood, S.J.[1,2], Craig, S.B.[1,2,4*], Graham, G.C.[3], Blair, B.R.[3], Burns, M.A.[2], Weier, S.L.[4], Collet, T.A.[4] and McKay, D.B.[1]
[1]Faculty of Science, Health and Education, University of the Sunshine Coast
Sippy Downs Drive, Sippy Downs, Queensland, 4556
[2]WHO/OIE/FAO Collaborating Centre for Reference and Research on Leptospirosis, Communicable Diseases Unit, Queensland Health Forensic and Scientific Service, Po Box 594, Archerfield, Queensland, 4108
[3]Chemical Analysis Unit, Queensland Health Forensic and Scientific Service, Po Box 594, Archerfield, Queensland, 4108
[4]School of Biomedical Sciences, Queensland University of Technology, Queensland, 4001
[*]Corresponding author email: s.craig@qut.edu.au
Received 23 October 2013; received in revised form 19 December 2013; accepted 22 December 2013

Abstract. The following research reports the emergence of *Leptospira borgpetersenii* serovar Arborea as the dominant infecting serovar following the summer of disasters and the ensuing clean up in Queensland, Australia during 2011. For the 12 month period (1 January to 31 December) *L. borgpetersenii* serovar Arborea accounted for over 49% of infections. In response to a flooding event public health officials need to issue community wide announcements warning the population about the dangers of leptospirosis and other water borne diseases. Communication with physicians working in the affected community should also be increased to update physicians with information such as clinical presentation of leptospirosis and other waterborne diseases. These recommendations will furnish public health officials with considerations for disease management when dealing with future disaster management programs.

INTRODUCTION

In late 2010 and early 2011, the state of Queensland in Australia experienced protracted, heavy rainfall which led to widespread flooding and destruction of rural and urban built environments. Subsequent to the widespread river flooding, coastal regions experienced the compounding effects of coastal flooding following the landfall of the category 5 storm, Tropical Cyclone Yasi. The rain associated with the La Niña event combined with the natural disasters resulted in a yearly average rain fall of 826mm, some 203 mm above the previous 30 year average of 623 mm. In January the average rainfall was 138 mm and in February the average rainfall was 133 mm. During both months record levels of rainfall were recorded across many locations across the state. (Australian Bureau of Meteorology, 2012a-c). Following the aftermath and clean up, health complications associated with floodwater exposure were inevitable. Leptospires, the etiological agents of leptospirosis are bacterial pathogens, ubiquitous in Queensland. Leptospires are tightly coiled (helical) spirochaetes that are approximately 6–20 µm in length and 0.1–0.2 µm in diameter. Leptospires infect the human host *via* cuts and abrasions in the skin or acquire direct access into the blood or lymphatics of the host via the conjunctivae or the lungs following the inhalation of water or aerosols (Levett, 2001). Leptospiral infections that occur in humans result from direct or indirect contact with infected soil, water, vegetation or body fluids from infected animals. Given optimum temperatures and pH values, leptospires may survive for weeks outside of their hosts. The general incidence of leptospirosis and the frequency of outbreaks of the disease tend to be high in areas where flooding is common (Tulsiani *et al.*, 2010). In the following discussion we show the emergence of *Leptospira borgpetersenii* serovar Arborea as the dominant infecting serovar following the summer of disasters in Queensland, Australia 2011, which is significant since the organism has only been recently identified in Australia (Slack *et al.*, 2006).

MATERIALS AND METHODS

The investigation was undertaken at the World Health Organisation Collaborating Centre for Reference and Research on Leptospirosis, Queensland Health Forensic and Scientific Services, Brisbane, Australia. The investigation began on January 1, 2011 with prospective surveillance and retrospective data collection and concluded on December 31, 2011. To be considered a recent leptospiral infection, patients needed to have a positive blood culture (Leptospires grown in Ellinghausen–McCullough–Johnson–Harris [EMJH] medium and observed by dark field microscopy). The leptospires cultured were later typed using the serum agglutination test (SAT) or the cross-agglutinin absorption test (CAAT) (Dikken & Kmety 1978). Both the CAAT and SAT have high specificity for identifying infecting serovars circulating in Australia. A recent infection was also defined by either a positive IgM ELISA with a microscopic agglutination test (MAT) titre $\geq$ 400, or a 4-fold or greater rise in agglutination titre between the acute and convalescent (immune-phase) sera, obtained at least 10 days apart and tested in parallel. The end-point of the MAT reaction was deemed to be the dilution of serum that caused 50% agglutination (observed under dark-field microscopy), leaving 50% of the leptospires free (Faine 1982; Anon 1984; Tulsiani *et al.*, 2010). The MAT also has high specificity for identifying infecting serovars circulating in Australia. The MAT panel consisted of the following leptospires shown in Table 1.

RESULTS

For the 12 month period there were 154 confirmed new leptospiral infections. The most common infecting serovars were: *L. borgpetersenii* serovar Arborea with 76 (49%) recorded infections; *Leptospira interrogans* serovar Australis with 20 (13%) recorded infections; *L. interrogans* serovar Zanoni with 19 (12%) recorded infections and *Leptospira borgpetersenii* serovar Hardjo with 16 (10%) recorded infections. The majority of infections for the year occurred immediately following the floods in January, the cyclone in February and the ensuing clean up. The number of reported infections remained higher in the two months following the disasters than in the proceeding year and the 10 year average (Figure 1).

DISCUSSION

The observed increase in the number of notifications of leptospirosis were consistent with previous investigations reporting an increase in leptospirosis following flooding (Lau *et al.*, 2010). First isolated in 1955 from a wood mouse (*Apodermus sylvaticus*) in Arborea-Sardegna, Italy, *L. borgpetersenii* serovar Arborea has subsequently, been reported throughout the world and has only recently been observed in Australia (Kmety & Dikken, 1993; Slack *et al.*, 2006). Explanations as to why *L. borgpetersenii* serovar Arborea has emerged as the dominant infecting serovar in Australia is still in debate. Possible explanations may lie in changes in the distribution and abundance of animal reservoirs or ecological changes (Lau *et al.*, 2010). The research literature is replete with studies reporting disruptions to ecosystems which can lead to an increased risk of a number of vector borne and zoonotic disease such as Hantavirus and Lyme disease; (Allen *et al.*, 2003; Mills, 2006).

Table 1. Leptospiral species used in the MAT panel

	Species	Serovar	Strain
1	*L. interrogans*	Pomona	Pomona
2	*L. interrogans*	Hardjo	Hardjoprajitno
3	*L. borgpetersenii*	Tarassovi	Perepelitsin
4	*L. kirschneri*	Grippotyphosa	Moskva V
5	*L. weilii*	Celledoni	Celledoni
6	*L. interrogans*	Copenhageni	M20
7	*L. interrogans*	Australis	Ballico
8	*L. interrogans*	Zanoni	Zanoni
9	*L. interrogans*	Robinsoni	Robinson
10	*L. interrogans*	Canicola	Hond Utrecht IV
11	*L. interrogans*	Kremastos	Kremastos
12	*L. interrogans*	Szwajizak	Szwajizak
13	*L. interrogans*	Medanensis	Hond HC
14	*L. kirschneri*	Bulgarica	Nicolaevo
15	*L. kirschneri*	Cynopteri	3522C
16	*L. borgpetersenii*	Arborea	Arborea
17	*L. interrogans*	Bataviae	Swart
18	*L. interrogans*	Djasiman	Djasiman
19	*L. borgpetersenii*	Javanica	Veldrat Batavia 46
20	*L. noguchii*	Panama	CZ 214
21	*L. santarosai*	Shermani	1342K
22	*L. weilii*	Topaz	94-79970/3

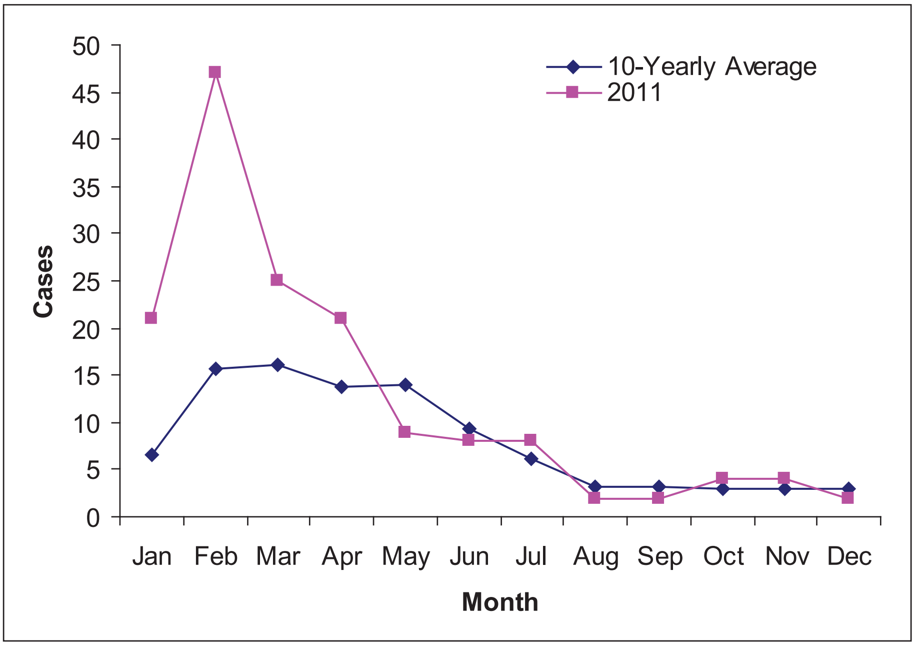

Figure 1. Leptospirosis notifications for 2011

Further, it has been reported that there is a significant negative correlation between the incidence of leptospirosis and the number of terrestrial mammalian species in a location (Derne *et al.*, 2011). Extinction, either natural (including natural disasters), or by the urbanisation of many regional centres, may provide the genesis for a decrease in the regulation of rodent populations by predatory species. Alternatively, the loss of species in a given area may result in the loss of the 'dilution effect' of having less competent host reservoirs in a location to absorb pathogens from the environment resulting in increasing pathogen proliferation and disease risk from the environment (Allan *et al.*, 2003; Mills, 2006). A number of molecular variants of serovar Arborea isolated in Queensland have also been reported however it unclear whether the genomic plasticity of this serovar is affording serovar Arborea with a selective advantage (Slack *et al.*, 2010). Other members of the Ballum serogroup, for example, *L. borgpetersenii* serovar Ballum, *L. borgpetersenii* serovar Ballum 3/ Guangdong, *L. borgpetersenii* serovar Kenya, *L. borgpetersenii* serovar Castellonis, *L. borgpetersenii* serovar Soccoestomes and *L. santarosai* serovar Peru, were not considered as they have not been isolated in Australia.

As with serovars Zanoni and Australis, the other infecting serovars with the highest incidence, mice and other rodents are associated with the transmission of serovar Arborea. Therefore, it is prudent for public health officials to advocate for stringent rodent control measures year round not only prior to any wet season. Rodent control measures should also be adhered to during any clean up phase following flooding. In response to a flooding event public health officials need to issue community wide announcements warning the population about the dangers of leptospirosis and other water borne diseases. The warnings should also be accompanied by advice outlining the need to avoid entering flood waters unless it is absolutely necessary. Communication with physicians working in the affected community should also be increased to update physicians with information such as clinical presentation of leptospirosis and other waterborne diseases. Given the logistical and compliance difficulties with community broad antibiotic prophylaxis and the lack of a safe multi-valent vaccine to cover the all the possible infecting serovars in a region, preventative control measures during flood recovery should include wearing gloves and other protective equipment such as enclosed foot wear. Injuries sustained from the flood water should be washed and dressed with waterproof dressings.

REFERENCES

Allan, B.F., Keesing, F. & Ostfeld, R. (2003). Effect of forest fragmentation on Lyme disease risk. *Conservation Biology* **17**(1): 267-272.

Anon. (1984). International Committee on Systematic Bacteriology. Subcommittee on the Taxonomy of Leptospira. *International Journal of Systematic Bacteriology* **34**: 258-259.

Australian Bureau of Meteorology (2012a). Climate Summary Review 2011. http://www.bom.gov.au/climate/current/annual/qld/archive/2011.summary.shtml

Australian Bureau of Meteorology (2012b). Queensland rainfall January 2011. http://www.bom.gov.au/climate/current/month/qld/archive/201101.summary.shtml

Australian Bureau of Meteorology (2012c). Queensland rainfall February 2011. http://www.bom.gov.au/climate/current/month/qld/archive/201102.summary.shtml

Derne, B.T., Fearnley, E.J., Lau, C.L., Paynter, S. & Weinstein, P. (2011). Biodiversity and leptospirosis risk: A case of pathogen regulation. *Medical Hypotheses* **77**: 339-344.

Dikken, H. & Kmety, E. (1978). *Serological typing methods of leptospires*. Methods in Microbiology, Vol 11. London: Academic Press.

Faine, S. (1982). *Guidelines for the Control of Leptospirosis*. Offset Publication No. 67. Geneva: World Health Organization.

Kmety, E. & Dikken, H. (1993). *Classification of the Species Leptospira interrogans and history of Its Serovars*. Groningen, The Netherlands: University Press Groningen.

Lau, C.L., Smythe, L.D., Craig, S.B. & Weinstein, P. (2010). Climate change, flooding, urbanisation and leptospirosis: fuelling the fire? *Transactions of the Royal Society of Tropical Medicine and Hygiene* **104**(10): 631-638.

Levett, P. (2001). Leptospirosis. *Clinical Microbiology Reviews* **14**: 296-326.

Mills, J.N. (2006). Biodiversity loss and emerging infectious disease: an example from the rodent-borne hemorrhagic fevers. *Biodiversity* **7**(1): 9-17.

Slack, A.T., Symonds, M.L., Dohnt, M.F. & Smythe, L.D. (2006). The epidemiology of leptospirosis and the emergence of Leptospira borgpetersenii serovar Arborea in Queensland, Australia, 1998-2004. *Epidemiology and Infection* **134**(6): 1217-1225.

Slack, A.T., Symonds, M.L, Dohnt, M.F., Craig, S.B. & Smythe, L.D. (2010). Molecular epidemiology of *Leptospira borgpetersenii* serovar Arborea, Queensland, Australia, 1998-2005. *American Journal of Tropical Medicine and Hygiene* **83**(4): 820-821.

Tulsiani, S.M., Lau, C.L., Graham, G.C., Van Den Hurk, A.F., Jansen, C.C., Smythe, L.D. & McKay, D.B. (2010). Emerging tropical diseases in Australia. Part 1. Leptospirosis. *Annals of Tropical Medicine and Parasitology* **104**(7): 543-556.