Title: Leptospira seroprevalence in animals in the Caribbean region: a systematic review.

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Abstract

This systematic review summarises the data published on the Leptospira seroprevalence, serovar diversity and distribution among animal species in the Caribbean region. Following Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, and checklist, relevant articles were identified and data were extracted and recorded. The review provided Leptospira seroprevalence data from 16 Caribbean islands (Barbados, Trinidad, Grenada, Puerto Rico, Saint Croix, St. Kitts and Nevis, Jamaica, Antigua, Carriacou, Dominica, Guadalupe, Martinique, Monserrat, St. Lucia, St. Maarten, and St. Vincent) in a variety of animal species. Reviewing the literature highlighted the limited amount of data available from limited number of islands. Many of the studies conducted have recorded seroprevalences based on variable and small samples sizes. Besides, serovar panels used for MAT were not consistent between studies. The review indicates that the Leptospira exposure in a given geographic location may change with time and climatic and environmental conditions, and highlights the need to conduct continual surveillance in tropical countries where the climate supports the survival of Leptospira in the environment. Specific attention must be given to standardization of MAT panels and protocols and providing training across laboratories involved in testing. Further, animal and environment testing to isolate and identify circulating Leptospira spp. in geographic region must actively be pursued. This knowledge is important to implement geographically specific control programs, as risk factors of Leptospira transmission is favoured by various factors such by change in climatic conditions, urbanization, encroachment of wildlife inhabitation, import/export of animals, increase in adventure travel, and water related recreational activities.

Key words: Leptospira, serovars, Seroprevalence, Animals, Caribbean, systematic review
**Introduction**

Leptospirosis is a bacterial zoonotic disease, affecting both humans and animals. Leptospirosis, originally considered as an occupational disease affecting people in contact with animal tissues or urine, has increasingly been acknowledged as a neglected disease of poverty (Bharti et al., 2003; Hotez et al., 2008). Leptospirosis outbreaks usually occur after natural disasters such as hurricanes and flooding and in the tropics an increased incidence is often recorded coinciding with increased rainfall (Hagan et al., 2016; Lau et al., 2010b). Recently, leptospirosis has been emerging as a health threat in new locations as a result of climate change and globalization (Costa et al., 2015; Hagen et al., 2016; Lau et al., 2010b; Hartskeerl et al., 2011). There has been an upsurge in the number of travellers diagnosed with this disease (Lau et al., 2010a; Hochedez et al., 2011; Hochedez et al., 2013, Bandara et al., 2014). The rise in the popularity of adventure travel and extreme athletic events in tropical areas could result in increased incidence of this disease (Morgan et al., 2002; Sejvar et al., 2003; Monahan et al., 2009).

Pathogenic *Leptospira* are maintained in the kidneys of many animal species, including cattle, dogs, horses, pigs and several wild animals (Ellis, 2015). These bacteria asymptomatically colonize the renal tubules of the reservoir animals and are shed into the environment through urine; if conditions are right, can survive for long periods, from weeks to months. Humans and animals may develop fatal life-threatening illness. Leptospirosis can cause economic losses in livestock due to its effects on production and reproduction (Ellis, 2015). The livestock and pets who are asymptomatic maintenance hosts, may serve as a source of infection to people in contact.

A recent systematic review pertaining to human leptospirosis (Costa et al., 2015), concluded that small tropical islands generally have the highest incidence of infection, with *Leptospira* infection being one of the major zoonotic cause of morbidity in these regions. Leptospirosis accounts for significant mortality and morbidity in humans in the Caribbean region (Pappas et al., 2008; Costa et al., 2015). In 2011, Desvar et al., reviewed animal leptospirosis in small tropical areas including the Caribbean region and emphasized the presence of unique circulating serovars, which is linked to the region’s animal and environmental biodiversity. Another review article pertaining to animal leptospirosis in the region recorded incidence of leptospirosis outbreaks in animal populations, in the Caribbean and Latin America (Petrakovsky et al., 2014). This systematic review was conducted using Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines and is solely focused on *Leptospira* seroprevalence studies on the islands of the Caribbean region to obtain a detailed overview.

**Methods**

**Search Region**

The Caribbean region situated on the Caribbean plate, an oceanic tectonic plate, consists of the Caribbean Sea, the surrounding coasts and the islands within. The area is north of South America, east of Central America and southeast of the North American mainland and the Gulf of Mexico (Figure 1). The Caribbean plate is approximately 3.2 million square kilometres in area. The area is comprised of more than 700 islands, reefs and cays. It consists of the Lesser Antilles to the south and east (including the Leeward Islands) and the Greater Antilles to the north.
**Literature Search**

Following Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher et al., 2009) and checklist, pertaining studies were identified. To find studies describing *Leptospira* seroprevalence on the islands of the Caribbean region, a literature search was conducted using the following electronic databases; EBSCOhost, Wiley-Blackwell, Springer Link, Science Direct, Wiley Online and PubMed Central. In addition to these databases, a search was performed using internet based search engines, including Google Scholar, Google, Yahoo and Bing. The scientific databases were searched for eligible citations that included the terms ‘Leptospira’ or ‘leptospirosis’ AND ‘animals’ AND ‘Caribbean’. A search was also performed using the term ‘leptospi*’ and the names of the individual islands present in the Caribbean region (Table 1). The titles and abstracts were then downloaded into EndNote (Thomson Reuters, Philadelphia, PA, USA). The titles and abstracts were reviewed against pre-determined abstract inclusion criteria to determine their suitability.

**Inclusion and Exclusion Criteria**

Abstracts were included if they described data relating to *Leptospira* spp. in animals from any country within the Caribbean region. Abstracts were excluded if they did not refer to original research data on animal leptospirosis or they did not describe naturally occurring *Leptospira* infections in animal populations on the islands. All articles that were considered to fit the inclusion criteria were retrieved as full text documents. The full text documents were then assessed against specific inclusion criteria. Documents containing data obtained using the microscopic agglutination test (MAT) were specifically included. The search performed focused on articles written in English, however although non-English studies were excluded, data was extracted from studies that had English abstracts. In cases where full articles could not be obtained, the article abstract was used. Publications were selected based on the methodology used in the study and the relevance of the information. Data considered relevant included 1) studies performed on islands of the Caribbean, 2) data from serological surveys in animal populations obtained using MAT or isolation, and 3) data concerning serovar circulation. Articles describing *Leptospira* infection using PCR were excluded as PCR generally cannot give information on serogroup/serovar involved. Full text articles were also excluded if they provided insufficient data to determine whether inclusion criteria were met. Table 2 lists the criteria used for the inclusion of the article.

**Data Extraction**

The following data were extracted from the publications selected for inclusion, the author(s), year of publication, geographic location in which the study was conducted and the design of the study. Other extracted data included were the serovars used in the MAT panel, titre value considered positive, serovar prevalence recorded for each species tested and the animal species tested. Serovars are also recorded, when culture and characterization of isolates were available. A data extraction form was prepared and used to record relevant data.

**Results**

The database search resulted in a possible 95 articles using the criteria described in the methods. Of these, 18 did not fit the selection criteria, and 10 were rejected as duplicates. From the remaining articles, 25 studies examined the incidence in humans and another three documents used methods other than MAT and so did not fit the selection criteria. An additional three documents were excluded as they were review articles that described etiology and disease, leptospirosis or described leptospirosis in the Caribbean region in humans. Another nine studies...
were excluded as either no full text or abstract was available and six were excluded as they had been published in Spanish, with one in French, and no English abstract was available. A flow chart showing the selection of article is shown in the Figure 2. Twenty articles met the overall inclusion criteria, were selected and are listed (Table 3) with publication dates ranging from 1979 to 2014.

**Leptospira Prevalence in various Caribbean islands:** The studies provided *Leptospira* seroprevalence data from 16 Caribbean islands. Much of the seroprevalence information came from a single study published by Levett *et al.*, in 1996 in livestock animals in the Lesser Antilles. This study encompassed 12 islands and used 22 *Leptospira* serovars for MAT testing. Variations in exposure to serovars were observed between islands in this study ranging from exposure to 0-9 serovars. Other relevant studies we identified are from Barbados (n=9), Trinidad (n=7) Grenada (n=3), Jamaica (n=2) Puerto Rico (n=1), Saint Croix (n=1). The number of serovars used in the MAT panel in these studies ranged from 2 to 23 (Supplemental Table 1.) The seroprevalence data for the individual islands are shown in tables 4-10.

**Seroprevalence in animal species in the Caribbean:** A list of various animal species and seroprevalence observed in various studies in the region are given in supplemental tables 2-16.

**Cats:** Only one study was identified in the region that surveyed cats on the island of Trinidad (Everard *et al.*, 1979). A low seroprevalence in cats was observed 12.5% (5/40) for the serovars Shermani, Panama, Canicola and a mixed reaction of Canicola/Copenhageni was recorded. The serovar Canicola was isolated from a cat with a mixed serological reaction.

**Cattle:** Surveys on the Caribbean islands have recorded prevalence in cattle ranging from 0% in Nevis (Levett *et al.*, 1996) to 92% on the island of Trinidad (Everard *et al.*, 1985). On Trinidad, a second study conducted 25 years later found a reduced seroprevalence of 21.5% (Suepaul *et al.*, 2011).

**Dogs:** Canine seroprevalence studies conducted on Barbados, Puerto Rico and Trinidad, recorded seroprevalence in stray dogs to be 62% (48/78) (Weeks *et al.*, 1997). This study found the most common serovars to be Autumnalis (45%), Icterohaemorrhagiae (16%), Australis (16%) and Pomona (13%). The study also tested acutely ill dogs that had been presented to a veterinary clinic on the island with a presumptive diagnosis of leptospirosis. The study found that 75% (46/61) of these animals tested positive by MAT. The most prevalent serovars being Icterohaemorrhagiae (36%), with Australis, Autumnalis and Ballum having little significance. In Puerto Rico, Farrington & Sulzer (1982), looked at leptospirosis in stray dogs and the seroprevalence was found to be 62.9% (73/116) with the serovar Icterohaemorrhagiae 72.6% (53/73) being the most common. Positive reactions were also recorded for the serogroups Andamana 8.2% (6/73) and Pyrogenes 4.1% (3/73). (Suepaul *et al.* 2010), conducted a further study in dogs and rodents on Trinidad. The group looked at two populations of dogs on the island. The first group were suspected cases of canine leptospirosis presented to local veterinarians, the frequency of isolation was found to be 18% (9/50) with the isolates been identified as the serovar Copenhageni. The second group studied were clinically healthy stray
dogs, with the frequency of isolation found to be 3.4% (7/207) again with the serovar Copenhageni being identified.

In an earlier study looking at different populations of canines on Trinidad by Adesiyun et al., (2006), the seroprevalence in the populations of suspected canine cases, stray dogs, hunting dogs, farm dogs and house dogs was found to be 48.0% (24/50), 4.4% (5/113) 25.5% (12/47), 20.4% (10/49) and 8.1% (13/160) respectively. The seropositivity of the dog populations as a whole was 15.3% (61/419). The serovars detected included Icterohaemorrhagiae 32.8% (20/61), Copenhageni 16.4% (10/61), Mankarso 47.5% (29/61), Bratislava 13.1% (8/61), Autumnalis 41% (25/61) and Ballum, Pomona, Georgia and Wolfi all at a prevalence of 1.6% (1/61) (Adesiyun et al., 2006) with a number of dogs having positive reactions to more than one serovar. Seroprevalence studies looking at rats and studies involving isolation of Leptospira spp. from rats have shown them to be maintenance hosts and as such a source of infection for serovar Copenhageni in dogs on Trinidad (Suepaul et al., 2010 and 2014). In an earlier study conducted on Trinidad by Everard et al. (1979), they found a seroprevalence of 20.0% in stray dogs with the predominant serovars being Canicola, Icterohaemorrhagiae and Hebdomadis, however, in the study by Adesiyun et al. (2006), the group recorded no positive reactors to the serovar Canicola in either stray dogs or in owned dogs suspected of having leptospirosis. This absence of the serovar Canicola has been noted in other countries. This change in predominant Leptospira spp. was also documented in a study by Weekes et al. (1997), on the island of Barbados. They reported that the serovar Autumnalis was the predominant serovar in canine Leptospira infection. However, in previous years (Damude et al., 1997) it had never been recorded as the prevalent serovar. Serovar Bim also has been isolated from dogs in Barbados (Jones et al., 1984). The difference in predominant serovar in the studies could indicate a similar change in the epidemiology of exposure. The prevalence was found to have increased during the second study (Suepaul et al., 2010) where samples were collected at a time of higher temperatures and increased rainfall and mirrors the increase seen in prevalence in stray dogs at that time.

**Horses** In this review, in horses, seroprevalence ranged from 76% (66/87) horses and donkeys on the island of Trinidad (Everard et al., 1985) to 61% on the island of Guadeloupe (Desvars et al., 2011).

**Mongoose:** Mathias and Levett (2002) recorded the seroprevalence in mongoose on the island of Barbados as 40.7% (48/118) with positive reactors to the serogroup Autumnalis. They obtained isolates from four mongooses. The seroprevalence in mongoose was recorded as high (40.7%) but evidence of renal infection was found in only four animals (< 3%). In 1983, Everard et al., recorded the seroprevalence of Grenadian mongoose to be 36% (71/200). Leptospira were isolated from the kidneys of 5.3% (10/190) of the mongoose, these isolates were identified as the serovars Copenhageni, Brasiiliensis and Atchafalya (Tarassovi) (Everard et al., 1983). On the island of Trinidad, the proportion of mongoose seropositive ranged between 33.3% and 51.1% (Everard & Green, 1976). In 1983, the seroprevalence in mongoose was recorded as 48% (Everard et al., 1983). The serogroup Canicola was isolated from the kidneys of the captured mongoose (Everard et al., 1976; Everard et al., 1983) with an infectivity rate of 4.7% (5/106) (Everard et al., 1976). These studies would seem to confirm that the mongoose is an infrequent
carrier of *Leptospira* spp. on these islands. Within the Caribbean region, *Leptospira* spp. have been isolated previously from mongoose in Jamaica, Grenada and Trinidad (Everard & Everard, 1993).

**Monkeys:** In 1987, Baulu *et al.* recorded a seroprevalence of 42% in captured Vervet monkeys.

**Pigs:** In pigs seroprevalences ranged from 5% in Trinidad (Suepaul *et al.*, 2011) to 53%, again on Trinidad but several years earlier (Everard *et al.*, 1985).

**Rodents:** Suepaul *et al.*, conducted a seroprevalence study on the island of Trinidad they found the seroprevalence in rats to be 16.5% (33/200) with all reactors to the Icterohaemorrhagiae serogroup. Suepaul *et al.* (2010), conducted a further study on the serovars that were isolated from dogs and rodents on the island. The study found that in rodents the frequency of isolation was 25.6%. This frequency of isolation was statistically greater than for the frequency of isolation in dogs (6.2%, 16/257) emphasising the importance of rodents as reservoirs of *Leptospira* on the island of Trinidad. The group found that the predominant serovar that was isolated was Copenhageni, 68.5% (37/54). However, this is contrast to the study conducted by Levett *et al.* (1998), who recorded a seroprevalence in Barbadian rats of 42%, and a frequency of isolation of *Leptospira* of 16%. Isolates were recovered from cultures of kidney, urine or blood. Using MAT that study also recorded the most prominent serovar as Copenhageni. The seroprevalence in rats on Barbados appears to have been slowly increasing over time. In the period 1964-1965 Taylor *et al.* (1991), recorded the seroprevalence in *Rattus rattus* as 33% (32.98) and 35% (48/138) in *Rattus norvegicus* and Levett *et al.* (1998), recording the prevalence as 42%. On the island of Barbados, Matthias & Levett (2002) recorded seroprevalence in mice to be 28.2% (24/85) with serogroups Ballum and Autumnalis being identified. *Leptospira* were isolated from the kidneys of 28 mice out of 97 tested and these isolates were identified as Arborea (n=17) and Bim (n=7).

**Sheep and Goat:** From the review, only limited studies were found on sheep on two separate occasions by two different groups of investigators. Damude *et al.* (1979), found the prevalence in sheep on the island to be 18% while Levett *et al.* (1996), recorded a prevalence of 4.3%. In goats, a prevalence rate as high as 40% was recorded in Belize, 19% in Barbados, (Damude *et al.*, 1979), while almost 20 years later a lower prevalence of 9.3% was found in goats (Levett *et al.*, 1996). A similar situation was documented on the island of Grenada where Everard *et al.* in 1985, recorded prevalence rates in goats of 35% and later Levett *et al.* (1996), recorded a prevalence of 19%.

**Wildlife:** Everard *et al.* (1983), recorded in the bats of the family *Pyllostomide*, on the island of Grenada, 21% (13/61) of *Anoura* spp. 8% (4/52) *Glossaphaga* spp. were found to be positive. None of the bat kidneys that were cultured gave a positive result. In the same study on the island of Trinidad, of the 8 species of bats caught, 4 species presented with a positive result using MAT (Everard *et al.*, 1983). Studies conducted on the island of Barbados, showed that amphibians there were carriers of *Leptospira* and from kidney tissue of toads (*Bufo marinus*) and frogs (*Eleutherodactylus johnstonei*) 2 pathogenic strains were isolated (Everard *et al*., 1988, 1990; Gravekamp *et al.*, 1991). The studies showed that the most prevalent strain in amphibians was *L.*
noguchii serovar bajan (Everard et al., 1990; Gravekamp et al., 1991), followed by the serovar bim (Everard et al., 1988, 1990; Gravekamp et al., 1991). These studies also noted that the serology of the toads from which isolates were recovered was not a good gauge of infection neither was it a reliable indicator of the infecting serogroup. On Grenada Everard et al. (1983), reported a seroprevalence of 15% (10/66) in the toad (Bufo marinus). From 2 of these animals the serovars navet (Tarassovi) and peruviana (Australis) were cultured. While on the island of Trinidad, Everard et al. (1983), showed that 25% (20/80) of the marine toads tested positive by MAT, whereas none of the lesser tree frogs captured (0/2) tested positive. Of other wildlife on the island of Trinidad, Everard et al. (1983), showed that of the family Muridae, 29% of rice rats (2/7) and 24% (4/17) of scaly-footed water rats were serologically positive.

Discussion

Reviewing the literature highlighted the limited amount of data available from a limited number of islands. Many of the studies conducted have recorded seroprevalences based on variable and small samples sizes. Besides, serovar panels used for MAT were not consistent between studies. MAT detects agglutinating antibodies to Leptospira generated mainly towards the lipopolysaccharide component of this bacterium. Although considered as serovar specific, cross reactivity, paradoxical reactions, false negative results in the early stages of infection and in the maintenance hosts are the common limitations of this test (Goris & Hartskeerl, 2014). These issues related to MAT testing are often underestimated when results are interpreted and reported. Therefore, combination of testing protocols targeting organism detection and exposure is needed to understand the true distribution of Leptospira within a population.

Successful Leptospira isolations were reported from few islands (isolations are indicated in tables when data is available). Two manuscripts reviewing Leptospira isolates from the region (Everard et al., 1980; Jones et al., 1982) described the presence of diverse serogroups. Everard et al. (1980), described 80 Leptospira isolates belonging to 10 serogroups in Trinidad, 20 isolates belonging to 5 serogroups in Grenada and 2 isolates belonging one serogroup in St. Vincent from animals. Among 11 different serogroups described in this study, six were first discovered from the region emphasizing the presence of unique types of Leptospira in the insular locations described in these studies. Another important concern this review highlights, is the role of amphibians in the environmental contamination and transmission of Leptospira (Everard et al., 1980). New serovars such as Bim and Bajan were isolated from Whistling frogs and Marine toads which are commonly found in the region and their role Leptospira maintenance and water contamination needs to be explored.

This review suggests that the Leptospira exposure in animals in a given geographic location may change with time and with climatic and environmental conditions, and highlights the continual need to conduct surveillance studies in tropical countries where the climate supports the survival of Leptospira in the environment. Our recent studies have recorded a high seroprevalence in vervet monkeys on Saint Kitts with significant difference in exposure and serovar exposed (Rajeev et al., 2016). While implementing these studies, specific attention must also be given to standardization of MAT panels and protocols and training across laboratories involved in testing. Further, animal and environment testing to isolate and identify circulating Leptospira spp. in a
geographic region must be attempted. This is important as risk factors of *Leptospira* transmission changes and are favoured by change in climatic conditions, urbanization, human encroachment of wildlife inhabitation, import/export of animals, increase in travel, tourism, and water related recreational activities.

As much as animals and the environment can play a crucial role in the transmission of leptospirosis to humans, leptospirosis can have a negative impact on production and reproduction in animals and can affect livelihood of people especially those using the animals for subsistence. Future studies must be targeted to investigate the impact of animal leptospirosis in both human, animal and environmental health. This knowledge is important to implement geographically specific control programs to improve animal and human health.

**Conclusion:**

Leptospirosis is a leading zoonotic cause of morbidity and mortality and an underecognized public health issue in the Caribbean region where environmental and social conditions favors disease clusters occurring during adverse weather related events. Animal surveillance is vital in prevention and control of human leptospirosis but relevant studies are very limited. This review summarising the seroprevalence data in animal species in the Caribbean region highlighted the scarcity of data from the region and need for active animal surveillance.
Acknowledgement: This study was a part of MSc thesis of Dr. Nicola Pratt. Dr. Nicola Pratt was supported through a Graduate scholarship from RUSVM for the completion of her Master of Science program by research. We thank Dr. Lee Willingham and Dr. Aspinas Chapwanya, (Graduate committee members), and Dr. Patrick Kelly (Chair of the Graduate Committee) for their guidance and support to Nicola Pratt. We also would like to thank all those researchers in the region who made significant contributions to the leptospirosis field.

References


Figure 1: Map of the Caribbean region
Figure 2. Flow chart for the selection of articles.

95 reports identified by searching online databases

67 reports related to animal leptospirosis

18 articles rejected as they did not fit selection criteria, 10 articles rejected as duplicates

30 articles identified that fulfilled inclusion criteria

37 excluded:
25 reported incidences in people only
3 articles did not fit inclusion criteria
3 review articles
6 articles rejected as published in Spanish with either no full text or no English abstract available

9 articles excluded as no full text available
1 article rejected as published in French with no English abstract available

20 articles fulfilled inclusion criteria
Table 1. Full search terms used for database search. The search was conducted using the search string ‘Leptospirosis’ OR ‘Leptospira’ and ‘Caribbean’.

<table>
<thead>
<tr>
<th>Database</th>
<th>Publication Date Limits</th>
<th>Search Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>EBSCOhost</td>
<td>1950 - Present</td>
<td>leptospira' OR 'leptospirosis' AND 'Caribbean' * AND 'animals'</td>
</tr>
<tr>
<td>PubMed Central</td>
<td>1950 - Present</td>
<td>('leptospir*) AND Caribbean *</td>
</tr>
<tr>
<td>Science Direct</td>
<td>1950 - Present</td>
<td>leptospira' OR 'leptospirosis' AND 'Caribbean' * AND 'animals'</td>
</tr>
<tr>
<td>Springer Link</td>
<td>1950 - Present</td>
<td>leptospira' OR 'leptospirosis' AND 'Caribbean' * AND 'animals'</td>
</tr>
<tr>
<td>Wiley-Blackwell</td>
<td>1950 - Present</td>
<td>leptospira' OR 'leptospirosis' AND 'Caribbean' * AND 'animals'</td>
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<tr>
<td>Wiley Online</td>
<td>1950 - Present</td>
<td>leptospira' OR 'leptospirosis' AND 'Caribbean' * AND 'animals'</td>
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<tr>
<td>Bing</td>
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<td>leptospira' OR 'leptospirosis' AND 'Caribbean' * AND 'animals'</td>
</tr>
<tr>
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<tr>
<td>Google Scholar</td>
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<td>Yahoo</td>
<td>No limit</td>
<td>leptospira' OR 'leptospirosis' AND 'Caribbean' * AND 'animals'</td>
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* a search was also conducted using the names of the individual islands: Bahamas, Turks & Caicos Islands, Cayman Islands, Cuba, Hispaniola (Haiti & Dominican Republic), Jamaica, Puerto Rico, Saint Croix, Saint Thomas, Saint John, Water Island, Tortola, Virgin Gorda, Anegada, Jost Van Dyke, Anguilla, Barbuda, Redonda, Saint Maarten, Saba, Saint Eustatius, Saint Barthelemy, Saint Kitts & Nevis, Montserrat, Guadeloupe, Dominica, Martinique, Saint Lucia, Saint Vincent & the Grenadines, Grenada, Carriacou & Petite Martinique, Barbados, Trinidad & Tobago
Table 2. Definitions of selection criteria. Full text articles were assessed with the above criteria to determine their suitability for inclusion.

<table>
<thead>
<tr>
<th>Criteria for Inclusion</th>
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<tbody>
<tr>
<td>Pathogenic <em>Leptospira</em> spp. detected in animal populations</td>
</tr>
<tr>
<td>Pathogenic <em>Leptospira</em> spp. detected using MAT/isolation</td>
</tr>
<tr>
<td>Original study conducted on an island of the Caribbean</td>
</tr>
<tr>
<td>Animal populations including domestic and wild animals</td>
</tr>
</tbody>
</table>
Table 3. The list of articles meeting inclusion criteria

<table>
<thead>
<tr>
<th>Author</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damude et al. (1979)</td>
<td>A study of leptospirosis among animals in Barbados W.I.</td>
</tr>
<tr>
<td>Everard et al. (1979)</td>
<td>Leptospirosis in dogs and cats on the island of Trinidad: West Indies</td>
</tr>
<tr>
<td>Farrington et al. (1982)</td>
<td>Canine leptospirosis in Puerto Rico</td>
</tr>
<tr>
<td>Everard et al. (1983)</td>
<td>Leptospirosis in wildlife from Trinidad and Grenada</td>
</tr>
<tr>
<td>Jones et al. (1984)</td>
<td>Bim, a new serovar of <em>Leptospira interrogans</em> isolated from a dog in Barbados</td>
</tr>
<tr>
<td>Everard et al. (1985)</td>
<td>Serological studies on leptospirosis in livestock and chickens from Grenada and Trinidad</td>
</tr>
<tr>
<td>Baulu et al. (1987)</td>
<td>Leptospires in vervet monkeys (<em>Cercopithecus aethiops Sabaeus</em>) on Barbados</td>
</tr>
<tr>
<td>Everard et al. (1988)</td>
<td>Leptospires in the marine toad (<em>Bufo marinus</em>) on Barbados</td>
</tr>
<tr>
<td>Everard et al. (1990)</td>
<td>Leptospires in the whistling frog (<em>Eeutherodactylus johnstonei</em>) on Barbados</td>
</tr>
<tr>
<td>Johnachan et al. (1990)</td>
<td>Serological survey for leptospiral antibodies in goats in St Elizabeth Parish, Jamaica, 1985-1986</td>
</tr>
<tr>
<td>Taylor et al. (1991)</td>
<td>Lepospires in <em>Rattus</em> spp. on Barbados</td>
</tr>
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<td>Ahl et al. (1992)</td>
<td><em>Leptospira</em> serology in small ruminants on St Croix, U.S. Virgin Islands</td>
</tr>
<tr>
<td>Levett et al. (1996)</td>
<td>Serological survey of leptospirosis in livestock animals in the Lesser Antilles</td>
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<tr>
<td>Authors</td>
<td>Title</td>
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</tr>
<tr>
<td>Weekes <em>et al.</em> (1997)</td>
<td>Seroepidemiology of canine leptospirosis on the island of Barbados</td>
</tr>
<tr>
<td>Levett <em>et al.</em> (1998)</td>
<td>Surveillance of leptospiral carriage by ferel rats in Barbados</td>
</tr>
<tr>
<td>Matthias &amp; Levett (2002)</td>
<td>Leptospiral carriage by mice and mongooses on the island of Barbados</td>
</tr>
<tr>
<td>Adesiyun <em>et al.</em> (2006)</td>
<td>Sero-epidemiology of canine leptospirosis in Trinidad: Serovars, implications for vaccination and public health</td>
</tr>
<tr>
<td>Suepaul <em>et al.</em> (2010)</td>
<td>Serovars of <em>Leptospira</em> isolated from dogs and rodents</td>
</tr>
<tr>
<td>Suepaul <em>et al.</em> (2011)</td>
<td>Seroepidemiology of leptospirosis in livestock in Trinidad</td>
</tr>
<tr>
<td>Suepaul <em>et al.</em> (2014)</td>
<td>Seroepidemiology of leptospirosis in dogs and rats in Trinidad</td>
</tr>
</tbody>
</table>
Table 4. Summary of *Leptospira* seroprevalence and serovars in animals on the island of Barbados.

<table>
<thead>
<tr>
<th>Author</th>
<th>Species</th>
<th>Prevalence</th>
<th>Serogroup/Serovar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Damude et al. (1979); Study 1971-1972</strong></td>
<td>Cattle</td>
<td>51% (571/1110)</td>
<td>Autumnalis, Hebdomadis, Ballum, Pyrogenes, Pomona, Canicola, Icterohaemorrhagiae, Tarassovi and Bataviae (NID)</td>
</tr>
<tr>
<td></td>
<td>Pigs</td>
<td>13% (29/219)</td>
<td>Autumnalis, Australis, Ballum and Pyrogenes (NID)</td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td>18% (13/70)</td>
<td>Autumnalis, Pyrogenes, Bataviae and Ballum (NID)</td>
</tr>
<tr>
<td></td>
<td>Horses</td>
<td>64% (28/44)</td>
<td>Pyrogenes, Autumnalis, Icterohaemorrhagiae and Pomona (NID)</td>
</tr>
<tr>
<td></td>
<td>Goats</td>
<td>19% (5/26)</td>
<td>Autumnalis (NID)</td>
</tr>
<tr>
<td><strong>Damude et al. (1979); Study 1975-1976</strong></td>
<td>Clinically ill Cattle</td>
<td>81% (60/74)</td>
<td>Autumnalis, Hebdomadis, Ballum, Pyrogenes, Pomona, Canicola and Icterohaemorrhagiae (NID)</td>
</tr>
<tr>
<td><strong>Jones et al. (1984)</strong></td>
<td>Dogs</td>
<td>1.5% (2/130)*</td>
<td>Bim (50%) and Copenhageni (50%)</td>
</tr>
<tr>
<td><strong>Baulu et al. (1987)</strong></td>
<td>Vervet Monkeys</td>
<td>28.5% (184/646)</td>
<td>Ballum (61%), Icterohaemorrhagiae (16%), Autumnalis (15%), Pomona (1%), Pyrogenes (3%), Panama (2%), Canicola (1%) and Tarassovi (1%)</td>
</tr>
<tr>
<td><strong>Everard et al. (1988)</strong></td>
<td>Marine Toad</td>
<td>22% (47/211)</td>
<td>Australis (38.3%), Autumnalis (23.4%), Panama (10.6%), Canicola (4.3%) and Icterohaemorrhagiae (2.1%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.9% (4/211)*</td>
<td>Bim (50%) and Australis (50%)</td>
</tr>
<tr>
<td><strong>Everard et al. (1990)</strong></td>
<td>Whistling frog</td>
<td>6% (6/99)*</td>
<td>Bim (16.7%) and bajan (33.3%), 2 isolates died</td>
</tr>
<tr>
<td>Group I</td>
<td></td>
<td></td>
<td>Bajan (100%)</td>
</tr>
<tr>
<td>Group II</td>
<td></td>
<td>2.6% (3/117)*</td>
<td>Australis, Pyrogenes, Toad strain 60, Bratislava, Panama, Toad strain 60/67 and Copenhageni (NID)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.8% (15/117)</td>
<td></td>
</tr>
<tr>
<td><strong>Taylor et al. (1991); Study 1964-1965</strong></td>
<td><em>Rattus norvegicus</em></td>
<td>34% (47/138)</td>
<td>Icterohaemorrhagiae (recorded as predominant)</td>
</tr>
<tr>
<td></td>
<td><em>Rattus rattus</em></td>
<td>30% (30/98)</td>
<td>Autumnalis (recorded as predominant)</td>
</tr>
<tr>
<td><strong>Weekes et al. (1997)</strong></td>
<td>Stray dogs</td>
<td>62% (48/78)</td>
<td>Australis (16%), Autumnalis (45%), Icterohaemorrhagiae (16%) and Pomona (13%)</td>
</tr>
<tr>
<td></td>
<td>Acutely ill dogs</td>
<td>75% (46/61)</td>
<td>Icterohaemorrhagiae (36%), Australis (13%), Autumnalis and Ballum (NID)</td>
</tr>
<tr>
<td>Study</td>
<td>Host</td>
<td>Proportion (N)</td>
<td>Serovar</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------</td>
<td>----------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Levett et al. (1996)</td>
<td>Sheep</td>
<td>4.3% (1/23)</td>
<td>Cynopteri (100%)</td>
</tr>
<tr>
<td></td>
<td>Goats</td>
<td>9.3% (4/43)</td>
<td>Cynopteri (100%)</td>
</tr>
<tr>
<td>Levett et al. (1998); First study 1986/87; Second study 1994/95</td>
<td><em>Rattus rattus</em></td>
<td>19% (12/63)*</td>
<td>Copenhageni (91.7%), Arborea (8.3%)</td>
</tr>
<tr>
<td></td>
<td><em>Rattus norvegicus</em></td>
<td>16% (16/100)*</td>
<td>Copenhageni (56.2%), Arborea (31.2%) and Bim (6.2), 1 isolate lost</td>
</tr>
<tr>
<td></td>
<td><em>Rattus spp.</em></td>
<td>19.1% (31/162)**</td>
<td>Icterohaemorrhagiae (60.3%), Ballum (23.3%), Autumnalis (9.8%), Canicola (3.2%) and Pyrogenes (3.2%)</td>
</tr>
<tr>
<td>Matthias &amp; Levett (2002)</td>
<td>Mongoose</td>
<td>40% (48/118)</td>
<td>Autumnalis (recorded as predominant serovar)</td>
</tr>
<tr>
<td></td>
<td>Mice</td>
<td>28.2% (24/85)</td>
<td>Autumnalis (45.8) and Ballum (52%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28.9% (28/97)*</td>
<td>Arborea (61%) and Bim (25%) (4 isolates lost)</td>
</tr>
</tbody>
</table>

**NID** No individual data

* indicates the data from studies that have performed cultures and and characterized the isolates by serogrouping

** Serovars recorded in first study (1986/87) and the second study (1994/95)
Table 5. Summary of *Leptospira* prevalence in various species on the island of Grenada.

<table>
<thead>
<tr>
<th>Author</th>
<th>Species</th>
<th>Prevalence</th>
<th>Serogroup/Serovar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Everard <em>et al.</em> (1983)</td>
<td><em>Anoura</em> spp. (Bats)</td>
<td>21% (13/61)</td>
<td>Icterohaemorrhagiae (8%), Hebdomadis (38%), Autumnalis (8%), Panama (23%), Tarassovi (8%), Bataviae (8%) and Canicola (8%)</td>
</tr>
<tr>
<td></td>
<td><em>Glossophaga</em> spp. (Bats)</td>
<td>8% (4/52)</td>
<td>Hebdomadis (25%), Autumnalis (25%), Tarassovi (25%) and Shermani (25%)</td>
</tr>
<tr>
<td></td>
<td>Asian mongoose</td>
<td>36% (71/200)</td>
<td>Icterohaemorrhagiae (63%), Autumnalis (11%), Pryogenes (7%), Panama (8.5%), Bataviae (1.4%), Shermani (2.8%), Grippotyphosa (2.8%) and Javanica (2.8%)</td>
</tr>
<tr>
<td></td>
<td>Marine toad</td>
<td>15% (10/66)</td>
<td>Hebdomadis (30%), Icterohaemorrhagiae (20%), Ballum (10%), Autumnalis (10%), Panama (20%) and Shermani (10%)</td>
</tr>
<tr>
<td>Everard <em>et al.</em> (1985)</td>
<td>Cattle</td>
<td>25% (80/324)</td>
<td>Icterohaemorrhagiae (26%), Autumnalis (23%), Hebdomadis (11%), Panama (3%), Canicola (6%), Pyrogenes (9%), Bataviae (1%), Ballum (4%), Tarassovi (3%), Javanica (4%) and Shermani (4%)</td>
</tr>
<tr>
<td></td>
<td>Pigs</td>
<td>35% (45/130)</td>
<td>Autumnalis (27%), Icterohaemorrhagiae (24%), Hebdomadis (4%), Canicola (2%), Pyrogenes (2%), Grippotyphosa (2%), Ballum (7%) and Shermani (7%)</td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td>35% (51/146)</td>
<td>Autumnalis (55%), Icterohaemorrhagiae (10%), Pyrogenes (12%), Tarassovi (2%) and Canicola (2%)</td>
</tr>
<tr>
<td></td>
<td>Goats</td>
<td>23% (10/44)</td>
<td>Autumnalis (30%), Pyrogenes (50%), Tarassovi (10%) and Grippotyphosa (10%)</td>
</tr>
<tr>
<td></td>
<td>Chickens</td>
<td>11% (19/175)</td>
<td>Autumnalis (5%), Hebdomadis (42%), Grippotyphosa (5%), Tarassovi (5%) and Shermani (32%)</td>
</tr>
<tr>
<td>Levett <em>et al.</em> (1996)</td>
<td>Cattle</td>
<td>13.5% (5/37)</td>
<td>Pomona (20%), Sejroe (20%) and Pyrogenes (40%)</td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td>8.5% (6/71)</td>
<td>Autumnalis (17%), Bataviae (33%), Pomona (33%), Cynopteri (33%) and Pyrogenes (17%)</td>
</tr>
<tr>
<td></td>
<td>Goats</td>
<td>19% (7/36)</td>
<td>Autumnalis (71%) and Cynopteri (29%)</td>
</tr>
</tbody>
</table>
Table 6. Summary of *Leptospira* prevalence in dogs on Puerto Rico.

<table>
<thead>
<tr>
<th>Author</th>
<th>Species</th>
<th>Prevalence</th>
<th>Serogroup/Serovar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farrington &amp; Sulzer (1982)</td>
<td>Stray dogs</td>
<td>62.9% (73/116)</td>
<td>Icterohaemorrhagiae (72.6%), Andamana (8.2%), Canicola (2.7%), Australis (1.4%) and Pyrogenes (2.7%)</td>
</tr>
</tbody>
</table>

Table 7. Summary of *Leptospira* prevalence sheep and goats on Saint Croix.

<table>
<thead>
<tr>
<th>Author</th>
<th>Species</th>
<th>Prevalence</th>
<th>Serogroups/Serovars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahl <em>et al.</em> (1992)</td>
<td>Goats</td>
<td>26% (11/42)</td>
<td>Autumnalis (31%), Ballum (14.3%), Bataviae (4.8%), Bratislava (28.6%), Canicola (7.1%), Copenhageni (2.4%) and Pyrogenes (11.9%)</td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td>32% (8/24)</td>
<td>Autumnalis (29.3%), Ballum (12.5%), Bataviae (4.2%), Bratislava (12.3%), Canicola (12.5%), Copenhageni (8.3%), Hardjo (12.5%) and Pyrogenes (8.3%)</td>
</tr>
</tbody>
</table>

Table 8. Summary of *Leptospira* prevalence in various species on Saint Kitts.

<table>
<thead>
<tr>
<th>Author</th>
<th>Species</th>
<th>Prevalence</th>
<th>Serogroups/Serovars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levett <em>et al.</em> (1996)</td>
<td>Cattle</td>
<td>4.8% (1/21)</td>
<td>Cynopteri</td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td>1.6% (1/62)</td>
<td>Cynopteri</td>
</tr>
<tr>
<td></td>
<td>Goats</td>
<td>23.8% (5/21)</td>
<td>Autumnalis, Ballum, Cynopteri and Grippotyphosa</td>
</tr>
</tbody>
</table>
Table 9. Summary of *Leptospira* prevalence in various animal species on Trinidad.

<table>
<thead>
<tr>
<th>Author</th>
<th>Species</th>
<th>Prevalence</th>
<th>Serogroups/Serovars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Everard <em>et al.</em> (1979)</td>
<td>Stray Canines</td>
<td>20% (10/50)*</td>
<td>Canicola (20%), Icterohaemorrhagiae (10%), Portland-Vere (60%) and Hebdomadis (10%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>55% (53/96)</td>
<td>Canicola (40%), Copenhageni (30%), Pyrogenes (15%), Hebdomadis (6%), Tarassovi (6%), Autumnalis (2%) and Grippotyphosa (2%)</td>
</tr>
<tr>
<td></td>
<td>Cats</td>
<td>2.5% (1/40)*</td>
<td>Canicola (100%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.5% (5/40)</td>
<td>Canicola (20%), Panama (20%) and Shermani (40%)</td>
</tr>
<tr>
<td>Everard <em>et al.</em> (1983)</td>
<td>Seba’s short-tailed bat</td>
<td>11% (2/19)</td>
<td>Cynopteri (100%)</td>
</tr>
<tr>
<td></td>
<td>Greater spear-nosed bat</td>
<td>27% (13/48)</td>
<td>Hebdomadis (53.8%), Autumnalis (7.5%), Cynopteri (15.2%), Tarassovi (7.5%) and Javanica (7.5%)</td>
</tr>
<tr>
<td></td>
<td>Giant velvety-tailed bat</td>
<td>10% (2/20)</td>
<td>Javanica (100%)</td>
</tr>
<tr>
<td></td>
<td>Jamaican fruit bat</td>
<td>0% (0/15)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>American phyllotomine bats</td>
<td>0% (0/3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Little big-eared bats</td>
<td>0% (0/8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Asian Mongoose</td>
<td>46% (17/37)</td>
<td>Icterohaemorrhagiae (5.9%), Canicola (35.3%), Javanica (5.9%), Panama (11.8%), Pyrogenes (23.5%), Ballum (11.8%) and Bataviae (5.9%)</td>
</tr>
<tr>
<td></td>
<td>Common opossum</td>
<td>5% (1/22)</td>
<td>Bataviae (100%)</td>
</tr>
<tr>
<td></td>
<td>Woolly Opossum</td>
<td>5.5% (4/73)</td>
<td>Hebdomadis (25%), Javanica (50%) and Ballum (25%)</td>
</tr>
<tr>
<td></td>
<td>Delphidia</td>
<td>7% (1/14)</td>
<td>Javanica (100%)</td>
</tr>
<tr>
<td><em>Marsoma fuscata</em></td>
<td></td>
<td>0% (0/73)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Black Rat</td>
<td>16% (5/32)</td>
<td>Icterohaemorrhagiae (40%), Hebdomadis (20%) and Autumnalis (40%)</td>
</tr>
<tr>
<td></td>
<td>Brown Rat</td>
<td>43% (3/7)</td>
<td>Autumnalis (33.3%) and Javanica (66.6%)</td>
</tr>
<tr>
<td></td>
<td>Spiney Rats</td>
<td>22% (8/37)</td>
<td>Hebdomadis (12.5%), Javanica (37.5%) and Pyrogenes (50.0%)</td>
</tr>
<tr>
<td></td>
<td>Kangaroo Rat</td>
<td>5.9% (1/17)</td>
<td>Autumnalis (100%)</td>
</tr>
<tr>
<td></td>
<td>Unidentified Rattus species</td>
<td>0% (0/7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>House Mouse</td>
<td>29% (2/7)</td>
<td>Icterohaemorrhagiae (100%)</td>
</tr>
<tr>
<td></td>
<td>Climbing Mouse</td>
<td>0% (0/2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short-tailed Mouse</td>
<td>0% (0/1)</td>
<td></td>
</tr>
<tr>
<td>Animal Species</td>
<td>Percentage</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Northern Grass Mouse</td>
<td>0% (0/1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Mouse species</td>
<td>24% (4/17)</td>
<td>Hebdomadis (25%), Ballum (25%), Grippotyphosa (25%) and Javanica (25%)</td>
<td></td>
</tr>
<tr>
<td>Capuchin Monkey</td>
<td>0% (0/2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black Vulture</td>
<td>0% (0/6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tupinabis lizard</td>
<td>45% (5/12)</td>
<td>Icterohaemorrhagiae (40%), Ballum (20%), Autumnalis (20%) and Javanica (20%)</td>
<td></td>
</tr>
<tr>
<td>Ground Lizard</td>
<td>100% (4/4)</td>
<td>Icterohaemorrhagiae (100%)</td>
<td></td>
</tr>
<tr>
<td>Green Iguana</td>
<td>100% (1/1)</td>
<td>Autumnalis (100%)</td>
<td></td>
</tr>
<tr>
<td>Cane Toad</td>
<td>25% (5/20)</td>
<td>Icterohaemorrhagiae (10%), Hebdomadis (25%), Autumnalis (35%), Javanica (10%), Panama (5%) and Tarassovi (15%)</td>
<td></td>
</tr>
<tr>
<td>Tree Frog</td>
<td>0% (0/2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi-aquatic Rodents</td>
<td>28.6% (2/7)</td>
<td>Canicola (50%) and Javanica (50%)</td>
<td></td>
</tr>
<tr>
<td>Everard et al. (1985)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
<td>92% (24/26)</td>
<td>Grippotyphosa (25%), Autumnalis (17%), Hebdomadis (33%), Grippotyphosa (25%) and Ballum (4%)</td>
<td></td>
</tr>
<tr>
<td>Pigs</td>
<td>53% (65/122)</td>
<td>Icterohaemorrhagiae (56%) and Autumnalis (29%)</td>
<td></td>
</tr>
<tr>
<td>Horses/Donkeys</td>
<td>76% (66/87)</td>
<td>Panama (23%), Icterohaemorrhagiae (15%), Canicola (9%) and Hebdomadis (9%)</td>
<td></td>
</tr>
<tr>
<td>Chickens</td>
<td>11% (16/87)</td>
<td>Autumnalis (6%), Hebdomadis (25%), Canicola (6%), Tarasovi (13%) and Shermani (50%)</td>
<td></td>
</tr>
<tr>
<td>Ducks/Geese</td>
<td>0% (0/8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adesiyun et al. (2006)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspected Canine Cases</td>
<td>48% (24/50)</td>
<td>Autumnalis (41.7%), Bratislava (20.8), Copenhageni (29.2), Icterohaemorrhagiae (50%) and Mankarso (62.5%),</td>
<td></td>
</tr>
<tr>
<td>Stray canines</td>
<td>4.4% (5/113)</td>
<td>Autumnalis (40%), Ballum (20%), Icterohaemorrhagiae (40%) and Mankarso (40%)</td>
<td></td>
</tr>
<tr>
<td>Hunting Canines</td>
<td>25.5% (12/47)</td>
<td>Autumnalis (70%), Bratislava (30%), Pomona (10%) and Wolffi (10%)</td>
<td></td>
</tr>
<tr>
<td>Farm Canines</td>
<td>20.4% (10/49)</td>
<td>Autumnalis (30%), Ballum, Georgia (10%) and Mankarso (60%)</td>
<td></td>
</tr>
<tr>
<td>House Canines</td>
<td>6.25% (10/160)</td>
<td>Autumnalis (40%), Ballum (2.7), Bratislava (8.1%), Copenhageni (8.1%), Georgia (2.7%), Icterohaemorrhagiae (21.6%), Mankarso (37.8%), Pomona (2.7%) and Wolffi (2.7%)</td>
<td></td>
</tr>
<tr>
<td>Suepaul et al. (2010)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rodents</td>
<td>2.4% (5/211)*</td>
<td>Copenhageni (79.1%), Icterohaemorrhagiae (2.3%), Mankarso (11.6%), Inconclusive (7%)*</td>
<td></td>
</tr>
<tr>
<td>Suspected Canine Cases</td>
<td>18% (9/50)*</td>
<td>Copenhageni (100%)*</td>
<td></td>
</tr>
<tr>
<td>Healthy Stray Canines</td>
<td>3.4% (2/207)*</td>
<td>Copenhageni (50%), Inconclusive (50%)*</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Animals</td>
<td>Percentage</td>
<td>Serogroup/Serovars</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------</td>
<td>------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Suepaul et al.</strong> (2011)</td>
<td><strong>Cattle</strong></td>
<td>21.5%</td>
<td>Icterohaemorrhagiae (4.4%), Copenhageni (1.5%), Mankarso (3.4%), Bim (0.68%), Hebdomadis (1.0%), Bratislava (0.17%), Arborea (1.0%), Ballum (3.1%), Autumnalis (1.2%), Panama (0.34%), Hardjo (3.9%) and Sejroe (0.17%)</td>
</tr>
<tr>
<td>Sheep</td>
<td>5%</td>
<td>(11/222)</td>
<td>Icterohaemorrhagiae (1.4%), Copenhageni (0.45%), Mankarso (0.45%), Bim (1.4%) and Autumnalis (1.4%)</td>
</tr>
<tr>
<td>Goats</td>
<td>3.3%</td>
<td>(6/180)</td>
<td>Icterohaemorrhagiae (0.56%), Copenhageni (1.7%) and Mankarso (1.1%)</td>
</tr>
<tr>
<td>Pigs</td>
<td>5%</td>
<td>(10/200)</td>
<td>Icterohaemorrhagiae (0.5%), Copenhageni (0.5%), Mankarso (1.5%), Bratislava (2.0%) and Ballum (0.5%)</td>
</tr>
<tr>
<td><strong>Suepaul et al.</strong> (2014)</td>
<td><strong>Stray dogs</strong></td>
<td>15.5%</td>
<td>Icterohaemorrhagiae (31%), Mankarso (25%), Copenhageni (38%), Bim (3%) and Hebdomadis (3%)</td>
</tr>
<tr>
<td>Suspected cases</td>
<td>72%</td>
<td>(36/50)</td>
<td>Icterohaemorrhagiae (3%), Copenhageni (61%), Mankarso (19%), Bim (6%), Bratislava (3%), Arborea (6%) and Ballum (3%)</td>
</tr>
<tr>
<td>Rats</td>
<td>16.5%</td>
<td>(32/200)</td>
<td>Icterohaemorrhagiae (34%), Copenhageni (59%) and Mankarso (9%)</td>
</tr>
</tbody>
</table>

*indicates the data from studies that have performed cultures and characterized the isolates by serogrouping

**indicates the isolates were grouped into serogroup/serovars using the monoclonal antibodies
Table 10. Summary of seroprevalence of *Leptospira* in goats on the island of Jamaica

<table>
<thead>
<tr>
<th>Author</th>
<th>Species</th>
<th>Herds</th>
<th>Serogroup/Serovar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnachan <em>et al.</em> (1990)</td>
<td>Goat</td>
<td>21 Family Herds</td>
<td>Canicola (57%), Icterohaemorrhagiae (18%) Jules (22%), Pomona (14%), Grippotyphosa (6%), Portland-Vere (54%) and Hardjo (20%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 Commercial Herds</td>
<td>Canicola (55%), Icterohaemorrhagiae (9%), Jules (22%), Pomona (0.3%), Portland-vere (61%) and Hardjo (6%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADC Facility</td>
<td>Canicola (39%), Icterohaemorrhagiae (6%), Jules (11%), Grippotyphosa (4%), Portland-vere (41%) and Hardjo (0.6%)</td>
</tr>
<tr>
<td></td>
<td>Sheep</td>
<td>ADC Facility</td>
<td>Canicola (76%), Icterohaemorrhagiae (18%), Jules (15%), Pomona (4%), Grippotyphosa (nt), Portland-vere (51%) and Hardjo (0.5%)</td>
</tr>
</tbody>
</table>

(nt) - not tested

ADC Facility - Agricultural Development Corporation Hounslow

Data represents averages of all sampling