

## Rickettsioses in Latin America, Caribbean, Spain and Portugal

### Rickettsiosis en América Latina, el Caribe, España y Portugal

Marcelo B. Labruna,<sup>1\*</sup> Ph.D, Salim Mattar V,<sup>2</sup> Ph.D, Santiago Nava,<sup>3</sup> Ph.D, Sergio Bermudez,<sup>4</sup> M.Sc, Jose M. Venzal,<sup>5</sup> Ph.D, Gaby Dolz,<sup>6</sup> Ph.D, Katia Abarca,<sup>7</sup> M.D, Luis Romero,<sup>8</sup> M.Sc, Rita de Sousa,<sup>9</sup> Ph.D, Jose Oteo,<sup>10</sup> M.D, Jorge Zavala-Castro,<sup>11</sup> Ph.D.

<sup>1</sup>Universidade de São Paulo, Departamento de Medicina Veterinária Preventiva e Saúde Animal, Faculdade de Medicina Veterinária e Zootecnia, São Paulo, SP, Brazil; <sup>2</sup>Universidad de Córdoba, Instituto de Investigaciones Biológicas del Tópico, Montería, Colombia, <sup>3</sup>Instituto Nacional de Tecnología Agropecuaria, Estación Experimental, Agropecuaria Rafaela, Rafaela, Santa Fe, Argentina. <sup>4</sup>Instituto Conmemorativo Gorgas de Estudios de la Salud, Ciudad de Panamá, Panamá. <sup>5</sup>Universidad de la República de Uruguay. Facultad de Veterinaria, Departamento de Parasitología Veterinaria, Regional Norte-Salto, Uruguay. <sup>6</sup>Universidad Nacional de Costa Rica, Facultad Ciencias de la Salud, Escuela de Medicina Veterinaria. Heredia, Costa Rica. <sup>7</sup>Pontificia Universidad Católica de Chile, Facultad de Medicina, Chile. <sup>8</sup>Laboratorio Central de Diagnóstico Veterinario, Ministerio de Agricultura y Ganadería (MAG), San Salvador, El Salvador. <sup>9</sup>Laboratorio de Saude Publica, Lisboa, Portugal. <sup>10</sup>Hospital San Pedro, Área de Enfermedades Infecciosas, Logroño (La Rioja), España. <sup>11</sup>Universidad Autónoma de Yucatan. Centro de investigaciones regionales "Dr. Hideyo Noguchi", Merida Yucatan, Mexico. Corresponding author: labruna@usp.br

Recibido: Enero de 2011; Aceptado: Agosto de 2011.

#### ABSTRACT

Data on genus and infectious by *Rickettsia* were retrospectively compiled from the critical review literature regarding all countries in Latin America, Caribbean islands, Portugal and Spain. We considered all *Rickettsia* records reported for human and/or animal hosts, and/or invertebrate hosts considered being the vector. In a few cases, when no direct detection of a given *Rickettsia* group or species was available for a given country, the serologic method was considered. A total of 13 *Rickettsia* species have been recorded in Latin America and the Caribbean. The species with the largest number of country confirmed records were *Rickettsia felis* (9 countries), *R. prowazekii* (7 countries), *R. typhi* (6 countries), *R. rickettsii* (6 countries), *R. amblyommii* (5 countries), and *R. parkeri* (4 countries). The rickettsial records for the Caribbean islands (West Indies) were grouped in only one geographical area. Both *R. bellii*, *R. akari*, and *Candidatus 'R. andeane'* have been recorded in only 2 countries each, whereas *R. massiliae*, *R. rhipicephali*, *R. monteiroi*, and *R. africae* have each been recorded in a single country (in this case, *R. africae* has been recorded in nine Caribbean Islands). For El Salvador, Honduras, and Nicaragua, no specific *Rickettsia* has been reported so far, but there have been serological evidence of human or/and animal infection. The following countries remain without any rickettsial records: Belize, Venezuela, Guyana, Surinam, and Paraguay. In addition, except for a few islands, many Caribbean islands remain without records. A total of 12 *Rickettsia* species have been reported in Spain and Portugal: *R. conorii*, *R. helvetica*, *R. monacensis*, *R. felis*, *R. slovacica*, *R. raoultii*, *R. sibirica*, *R. aeschlimannii*, *R. rioja*, *R. massiliae*, *R. typhi*, and *R. prowazekii*. Amongst these *Rickettsia* species reported in Spain and Portugal, only *R. prowazekii*, *R. typhi*, *R. felis*, and *R. massiliae* have also been reported in Latin America. This study summarizes the current state of art on the rickettsial distribution in Latin America, Caribbean, Spain and Portugal. The data obtained allow a better understanding on rickettsial epidemiology and distribution of vector ecology.

**Key words:** Acari, epidemiology, rocky mountain spotted fever, vector control. (Source: DeCS).

## RESUMEN

Reportes del género *Rickettsia* y sus asociadas infecciones fueron compilados en una revisión crítica retrospectiva de la literatura científica de los países de Latinoamérica, el Caribe, Portugal y España. Se consideraron todos los reportes para huéspedes humanos y/o animales y también para huéspedes invertebrados los cuales fueron considerados como vectores asociados con *Rickettsia*. En algunos casos, cuando no existió detección directa a un determinado grupo de rickettsias o especies no disponible en un país, se tuvo en cuenta la detección indirecta por serología. Un total de 13 especies de *Rickettsia* han sido reportadas en Latinoamérica y el Caribe. Las especies más encontradas en los países fueron: *Rickettsia felis* (9 países), *R. prowazekii* (7 países), *R. typhi* (6 países), *R. rickettsii* (6 países), *R. amblyommii* (5 países) y *R. parkeri* (4 países). Los datos de las islas del Caribe (antillas menores o Indias occidentales), fueron agrupados en una sola área geográfica como un solo país. Ambas *R. bellii*, *R. akari* y *Candidatus 'R. andeane'* fueron reportadas en solo 2 países, mientras que *R. massiliae*, *R. rhipicephali*, *R. monteiroi*, y *R. africanae* fueron informadas en un solo país. En este caso *R. africanae* fue reportada en 9 islas de las Antillas menores. Para El Salvador, Honduras y Nicaragua, hasta ahora no se han reportado especies de *Rickettsia*, pero si evidencia serológica de infección humana y/o animal. Sin reportes de infección por *Rickettsia* permanecen: Belice, Venezuela, Guayana, Surinam y Paraguay. Además, a excepción de algunas islas del Caribe, muchas de ellas permanecen sin reportes. Un total de 12 especies de *Rickettsia* han sido documentadas en España y Portugal: *R. conorii*, *R. helvetica*, *R. monacensis*, *R. felis*, *R. slovacica*, *R. raoultii*, *R. sibirica*, *R. aeschlimannii*, *R. rioja*, *R. massiliae*, *R. typhi* y *R. prowazekii*. Entre estas, solamente *R. prowazekii*, *R. typhi*, *R. felis* y *R. massiliae* han sido documentados en Latinoamérica, España y Portugal. Los datos de este estudio permiten entender mejor la epidemiología de las rickettsias en Latinoamérica, Caribe, España y Portugal, y la distribución de los vectores.

**Palabras clave:** Ácaros, control de vectores, epidemiología, fiebre maculosa de las montañas rocosas, garrapatas. (Fuente: DeCS).

## Introduction

The genus *Rickettsia* includes bacteria of the order rickettsiales in the alpha subdivision of the class Proteobacteria. They are Gram-negative coccobacilli in obligate association with eukaryote cells. A number of species have been identified in various terrestrial arthropods, and more recently in leeches and amoeba (1,2). Traditionally, pathogenic rickettsiae were classified into two groups: the typhus group (TG), composed of *Rickettsia prowazekii* and *Rickettsia typhi*, vectored by lice (*Pediculus humanus*) and fleas, respectively; and the spotted fever group (SFG), composed of more than 20 species mostly vectored by ticks (3). Other rickettsiae have shown antigenic and genetic particularities that preclude their inclusion in either the TG or SFG, such as *Rickettsia bellii* and *Rickettsia canadensis*, reported in ticks from the American continent (4,5). With the discovery of a variety of new rickettsiae

## Introducción

El género *Rickettsia* incluye las bacterias del orden rickettsiales subdivisión alfa de la clase Proteobacteria, son cocobacilos Gram negativos de crecimiento obligado intracelular. Un número apreciable de especies ha sido identificado en varios artrópodos y recientemente en sanguijuelas y amebas (1,2). Tradicionalmente, las rickettsias patógenas fueron clasificadas en dos grupos: el tifus (TG) compuesta por *Rickettsia prowazekii* y *Rickettsia typhi*, cuyos vectores son piojos (*Pediculus humanus*) y pulgas respectivamente y, el grupo de las fiebres manchadas (SFG), compuesto por más de 20 especies con garrapatas como vector principal (3). Otras rickettsias han mostrado antigénica y genéticamente particularidades que impiden su inclusión en el TG o en el SFG, tales como *Rickettsia bellii* y *Rickettsia canadensis*, reportadas en garrapatas del continente americano (4,5). Con el descubrimiento de una variedad de nuevas rickettsias en diferentes órdenes de artrópodos terrestres, la mayoría

in different orders of terrestrial arthropods, mostly free-living, and also with genetic analysis of rickettsial plasmids as *R. felis*, the genus *Rickettsia* has been re-classified into different groups, including the SFG, TG, transitional group (TRG), *bellii* group (BG), *canadensis* group (CG), and several other basal groups (6,7).

During the last decades, there has been an increasing number of new *Rickettsia* species of unknown pathogenicity, mostly isolated from ticks (8,9). Some of them, previously considered non-pathogenic, were recently shown to be pathogenic to humans, such as the SFG *Rickettsia slovaca*, *Rickettsia aeschlimannii*, *Rickettsia massiliae*, and *Rickettsia monacensis* in Europe (8,9). In addition, *R. parkeri*, an 'old' SFG organism first reported in ticks in the 1939 was shown to be pathogenic 65 years later (10). These facts indicate that any novel described *Rickettsia* from invertebrate hosts, especially ticks, should be regarded as potentially pathogenic for humans.

The aim of this study was to analyze and to summarize the rickettsial reports in Latin America, Caribbean, Portugal and Spain.

### Data collection

For the present study, retrospective data on bacteria of the genus *Rickettsia* were compiled from the available literature regarding all countries in Latin America, and Caribbean. Efforts were done to gather all available information for each country. Furthermore, for comparison purposes, we also compiled all *Rickettsia* species that have been reported in Spain and Portugal, since these two countries were responsible for the main colonization of Latin America. We considered all *Rickettsia* records reported for human and/or animal hosts, and/or invertebrate hosts (e.g., ticks, lice, fleas), which were considered to be the vector associated with the agent. In a few cases, when no direct detection of a given *Rickettsia* group TG or SFG or species was available for a given country, the indirect detection through serologic-based methods was considered, when this was the only record available.

viviendo de forma libre y también con los análisis genéticos de plásmidos como el de *Rickettsia felis*, el género ha sido reclasificado en diferentes grupos: TG, SFG, grupo transicional (TRG), grupo *bellii* (BG), grupo *canadensis* (CG) y otros grupos básicos (6,7).

En las últimas décadas ha habido un incremento de nuevas especies de *Rickettsia* de patogenicidad desconocida, muchas de ellas aisladas de garrapatas (8,9). Algunas de ellas previamente fueron consideradas no patógenas, pero recientemente demostraron ser patógenas para humanos, tal es el caso del SFG *Rickettsia slovaca*, *Rickettsia aeschlimannii*, *Rickettsia massiliae* y *Rickettsia monacensis* en Europa (8,9). Además, *R. parkeri* un viejo miembro del SFG reportado por primera vez en 1939, demostró 65 años más tarde ser patógena (10). Estos hechos demuestran que cualquier nueva rickettsia descrita en huéspedes invertebrados, especialmente garrapatas, deberían ser consideradas potencialmente patógenas para los humanos.

El objetivo de este trabajo fue el de analizar y resumir los estudios de *Rickettsia* en Latinoamérica, el Caribe, España y Portugal.

### Recolección de datos

Para el presente estudio, se obtuvieron datos retrospectivos del género *Rickettsia* de la literatura científica de los países de Latinoamérica y de las islas del Caribe. Se realizaron esfuerzos para obtener toda la información disponible de cada país. Además, para efectos de comparación, también se obtuvo información de España y Portugal, ya que estos países fueron los que colonizaron principalmente a Latinoamérica. Se consideraron todas las rickettsias reportadas como patógenas tanto para humanos como animales o huéspedes animales, y/o huéspedes invertebrados (ej, garrapatas, piojos y pulgas) y que fueron consideradas ser el vector asociado al agente etiológico. Cuando no existió evidencia directa de *Rickettsia* del grupo TG o SFG u otra especie disponible en el cada país, la detección indirecta basada en la serología fue considerada como el único reporte disponible.

**Geographic distribution of *Rickettsia*.**

All available records on rickettsial infection on hosts (humans and animals) and vectors in Latin America and the Caribbean are represented by country, in tables 1-6. Spain and Portugal are presented in table 7.

A total of 13 *Rickettsia* species have been recorded in Latin America and the Caribbean. The species with the largest number of country confirmed records were *Rickettsia felis* (9 countries), *R. prowazekii* (7 countries), *R. typhi* (6 countries), *R. rickettsii* (6 countries), *R. amblyommii* (5 countries), and *R. parkeri* (4 countries).

Since the rickettsial records for the Caribbean islands were restricted to West Indies, we grouped these records like that they were represented as a single country (Table 6). *R. bellii*, *R. akari*, and *Candidatus 'R. andeane'* have been recorded in

**Distribución geográfica de *Rickettsia*.**

Todos los datos disponibles por infección de *Rickettsia* o huéspedes (humanos o animales) y vectores de Latinoamérica y el Caribe se presentan para cada país en las tablas 1-6. España y Portugal se muestran en la tabla 7.

Un total de 13 especies de *Rickettsia* se han documentado en Latinoamérica y el Caribe. Las especies con mayor frecuencia reportadas en los diferentes países fueron: *Rickettsia felis* (9 países), *R. prowazekii* (7 países), *R. typhi* (6 países), *R. rickettsii* (6 países), *R. amblyommii* (5 países) y *R. parkeri* (4 países).

Los datos de las islas de las antiguas Antillas, se agruparon como un solo país (Tabla 6). *R. bellii*, *R. akari* y *Candidatus 'R. andeane'* han sido reportados en solo 2 países cada uno, mientras que *R.*

**Table 1.** Infections by *Rickettsia* in Argentina, Chile and Uruguay.

| Species                                 | Geographical distribution       | Vector   | Clinical cases confirmed | Animal infection | References |
|---|---------------------------------|--|--------------------------|------------------|------------|
| <b>ARGENTINA</b>                        |                                 |  |                          |                  |            |
| <i>R. amblyommii</i>                    | Córdoba                         | <i>Amblyomma neumanni</i>                                      | No                       | No               | 11         |
| <i>R. bellii</i>                        | Córdoba                         | <i>A. neumanni</i>   | No                       | No               | 11,12      |
|   | Santiago del Estero             | <i>Amblyomma tigrinum</i>                                      |                          |                  |            |
| <i>R. massiliae</i>                     | Ciudad Autónoma de Buenos Aires | <i>Rhipicephalus sanguineus</i>                                | Yes                      | No               | 13,14      |
| <i>R. parkeri</i>                       | Buenos Aires                    | <i>Amblyomma triste</i>  | Yes                      | No               | 15-17      |
| <i>R. rickettsii</i>                    | Jujuy                           | <i>Amblyomma cajennense</i>                                    | Yes                      | No               | 18         |
| <i>Cand. 'R. andeanae'</i> <sup>1</sup> | Córdoba                         | <i>Amblyomma parvum</i>  | No                       | No               | 12,19      |
|   | Santiago del Estero             | <i>Amblyomma pseudoconcolor</i>                                |                          |                  |            |
| <i>R. felis</i>                         | Santa Fe                        | <i>Ctenocephalides felis</i>                                   | No                       | No               | 20         |
| <i>R. prowazekii</i>                    | Jujuy                           | <i>Pediculus humanus</i>                                       | Yes                      | No               | 21         |
| <b>CHILE</b>                            |                                 |  |                          |                  |            |
| <i>R. felis</i>                         | Metropolitan <sup>2</sup>       | <i>Ctenocephalides felis</i>                                   | No                       | Yes <sup>3</sup> | 22         |
|   | Metropolitan                    | <i>Rhipicephalus sanguineus</i>                                | No                       | No               | 23         |
| <i>R. prowazekii</i>                    | Metropolitan                    | <i>Pediculus humanus</i>                                       | Yes                      | No               | 24         |
| <i>Orientia tsutsugamushi</i>           | Isla de Chiloé                  | Leech  | Yes                      | No               | 25         |
| <b>URUGUAY</b>                          |                                 |  |                          |                  |            |
| <i>R. parkeri</i>                       | Canelones                       | <i>Amblyomma triste</i>  | Yes <sup>4</sup>         | No               | 26-31      |
|   | Maldonado                       | <i>A. triste</i>   | Yes                      | No               | 29,31      |
|   | Montevideo                      | <i>A. triste</i>   | Yes                      | No               | 31         |
|   | San José                        | <i>A. triste</i>   | Yes                      | No               | 27         |
|   | Lavalleja                       | <i>A. triste</i>   | Yes                      | No               | 27         |
| <i>R. felis</i>                         | Montevideo                      | <i>Ctenocephalides felis</i> ,<br><i>Ctenocephalides canis</i> | No                       | No               | 32         |

<sup>1</sup>Reported as *Rickettsia* sp. strain Argentina (33). <sup>2</sup>Santiago metropolitan area. <sup>3</sup>Serologic evidence of infection of cats by this *Rickettsia*.<sup>4</sup>Serologic evidence of infection in humans by this *Rickettsia*.

**Table 2.** Infections by *Rickettsia* in Brazil.

| Species                | Geographical distribution                       | Vector                                       | Clinical cases confirmed | Animal infection | References  |
|------------------------|---|--|--------------------------|------------------|-------------|
| <b>BRAZIL</b>          |   |  |                          |                  |             |
| <i>R. rickettsii</i>   | Bahia   | <i>Amblyomma cajennense</i>                  | Yes                      | No               | 34          |
|                        | Espírito Santo                                  | <i>Amblyomma cajennense</i>                  | Yes                      | Yes*             | 35,36       |
|                        | Minas Gerais                                    | <i>A. cajennense</i>                         | Yes                      | Yes              | 37-40       |
|                        |   | <i>Rhipicephalus sanguineus</i>              |                          |                  |             |
|                        | Rio de Janeiro                                  | <i>A. cajennense</i><br><i>R. sanguineus</i> | Yes                      | No               | 41-43       |
| São Paulo              | <i>Amblyomma aureolatum</i>                     | Yes  | Yes                      | 44-48            |             |
|                        | <i>A. cajennense</i>                            |  |                          |                  |             |
|                        | <i>R. sanguineus</i>                            |  |                          |                  |             |
| <i>R. typhi</i>        | São Paulo                                       | <i>Xenopsylla cheopis</i>                    | Yes                      | Yes              | 49,50       |
| <i>R. parkeri</i>      | São Paulo                                       | <i>Amblyomma triste</i>                      | Yes                      | Yes*             | 51-56       |
|                        |   | <i>Amblyomma ovale</i>                       |                          |                  |             |
|                        |   | <i>Amblyomma dubitatum</i>                   |                          |                  |             |
|                        |   | <i>Amblyomma nodosum</i>                     |                          |                  |             |
| <i>R. felis</i>        | Bahia   | No   | Yes                      | No               | 58          |
|                        | Minas Gerais                                    | <i>Ctenocephalides felis</i>                 | Yes                      | No               | 59,60       |
|                        | Rio de Janeiro                                  | <i>C. felis</i>                              | No                       | Yes*             | 61          |
|                        | Sao Paulo                                       | <i>C. felis</i>                              | No                       | No               | 52,62,63    |
|                        |   | <i>Ctenocephalides canis</i>                 |                          |                  |             |
| <i>R. amblyommii</i>   | Rondonia  | <i>A. cajennense</i>                         | No                       | Yes*             | 64-67       |
|                        |   | <i>Amblyomma coelebs</i>                     |                          |                  |             |
|                        |   | <i>Amblyomma longirostre</i>                 |                          |                  |             |
|                        | São Paulo                                       | <i>A. longirostre</i>                        |                          |                  |             |
|                        | Bahia   | <i>A. longirostre</i>                        |                          |                  |             |
| Pará                   | <i>A. longirostre</i><br><i>Amblyomma geayi</i> |  |                          |                  |             |
| <i>R. rhipicephali</i> | Rondônia  | <i>Haemaphysalis juxtakochi</i>              | No                       | Yes*             | 68,69       |
|                        | São Paulo                                       | <i>H. juxtakochi</i>                         | No                       | No               | 70          |
| <i>R. bellii</i>       | Rondônia  | <i>A. ovale</i>                              | No                       | No               | 64          |
|                        |   | <i>Amblyomma oblongoguttatum</i>             |                          |                  |             |
|                        |   | <i>Amblyomma scalpturatum</i>                |                          |                  |             |
|                        |   | <i>Amblyomma humerale</i>                    |                          |                  |             |
|                        | São Paulo                                       | <i>Amblyomma rotundatum</i>                  |                          |                  |             |
|                        |   | <i>A. aureolatum</i>                         | No                       | Yes*             | 46, 51, 52, |
|                        |   | <i>A. dubitatum</i>                          |                          |                  | 54, 55,     |
|                        |   | <i>A. ovale</i>                              |                          |                  | 70-72       |
|                        |   | <i>Amblyomma incisum</i>                     |                          |                  |             |
|                        |   | <i>A. nodosum</i>                            |                          |                  |             |
|                        | <i>Ixodes loricatus</i>                         |  |                          |                  |             |
|                        | <i>H. juxtakochi</i>                            |  |                          |                  |             |
| <i>R. monteiroi</i>    | São Paulo                                       | <i>A. incisum</i>                            | No                       | No               | 73          |
| Spotted fever group    | Paraná  | No   | Yes                      | Yes*             | 74-77       |
|                        | Santa Catarina                                  |  |                          |                  |             |
|                        | Rio Grande do Sul                               |  |                          |                  |             |
| Typhus group           | Minas Gerais                                    | No   | Yes                      | No               | 78          |

\* Serologic evidence of infection by this *Rickettsia*

**Table 3.** Infections by *Rickettsia* in Bolivia, Colombia, Perú and Ecuador.

| Species                            | Geographical distribution | Vector                       | Clinical cases confirmed | Animal infection | References |
|------------------------------------|---------------------------|------------------------------|--------------------------|------------------|------------|
| <b>BOLIVIA</b>                     |                           |                              |                          |                  |            |
| <i>R. parkeri</i>                  | CochaBamba                | <i>Amblyomma tigrinum</i>    | No                       | Yes              | 79         |
| <i>R. prowazekii</i>               | La Paz                    | <i>Pediculus humanus</i>     | No                       | No               | 80         |
| <i>Rickettsia</i> sp. <sup>1</sup> | CochaBamba                | <i>A. tigrinum</i>           | No                       | No               | 79         |
| <b>COLOMBIA</b>                    |                           |                              |                          |                  |            |
| <i>R. rickettsii</i>               | Cundinamarca              | <i>Amblyomma cajennense</i>  | Yes                      | No               | 81,82      |
|                                    | Antioquia                 | No                           | Yes                      | No               | 83,84      |
|                                    | Córdoba                   | No                           | Yes                      | No               | 85,86      |
| <i>R. typhi</i>                    | Caldas                    | No                           | Yes                      | No               | 84         |
| Spotted fever group                | Córdoba                   | No                           | No                       | No               | 87         |
|                                    | Cundinamarca              | No                           | No                       | No               | 88         |
|                                    | Córdoba                   | No                           | No                       | Yes              | 89         |
| <b>PERÚ</b>                        |                           |                              |                          |                  |            |
| <i>R. felis</i>                    | Piura                     | <i>Ctenocephalides felis</i> | No                       | No               | 90         |
| <i>Cand. 'R. andeanae'</i>         | Piura                     | <i>Amblyomma maculatum</i>   | No                       | No               | 90         |
| <i>R. prowazekii</i>               |                           | <i>Ixodes boliviensis</i>    |                          |                  |            |
|                                    | Apurimac                  | <i>Pediculus humanus</i>     | Yes                      | No               | 91,92      |
|                                    | Arequipa                  | <i>P. humanus</i>            | Yes                      | No               | 91,92      |
|                                    | Ayacucho                  | <i>P. humanus</i>            | Yes                      | No               | 91,92      |
|                                    | Cuzco                     | <i>P. humanus</i>            | Yes                      | No               | 91,92      |
| Spotted fever group                | Puno                      | <i>P. humanus</i>            | Yes                      | No               | 91,92      |
|                                    | Cuzco                     | No                           | Yes                      | No               | 90,93      |
|                                    | Piura                     | No                           | Yes                      | No               | 90,93      |
|                                    | Junin                     | No                           | Yes                      | No               | 94         |
| Typhus group                       | Loreto                    | No                           | Yes                      | Yes              | 95         |
|                                    | Loreto                    | No                           | Yes                      | Yes              | 95         |
|                                    | Loreto                    | No                           | Yes                      | Yes              | 95         |
| <b>ECUADOR</b>                     |                           |                              |                          |                  |            |
| <i>R. prowazekii</i>               | Pichincha                 | <i>Pediculus humanus</i>     | Yes                      | No               | 96         |
|                                    | Azuay                     | No                           | Yes                      | No               | 97         |
|                                    | Cañar                     | No                           | Yes                      | No               | 97         |
|                                    | Carchi                    | No                           | Yes                      | No               | 97         |
|                                    | Cotopaxi                  | No                           | Yes                      | No               | 97         |
|                                    | Chimborazo                | No                           | Yes                      | No               | 98         |
|                                    | Imbabura                  | No                           | Yes                      | No               | 97         |
|                                    | Loja                      | No                           | Yes                      | No               | 97         |
|                                    | Tungurahua                | No                           | Yes                      | No               | 97         |
|                                    | Napo                      | No                           | Yes                      | No               | 97         |
|                                    | Pastaza                   | No                           | Yes                      | No               | 97         |

<sup>1</sup>Close-related to *R. aeschlimannii*

only 2 countries each, whereas *R. massiliae*, *R. rhipicephali*, *R. monteiroi*, and *R. africae* have each been recorded in a single country in this case, *R. africae* has been recorded in nine islands from the West Indies.

Eight *Rickettsia* species have been associated with human diseases in Latin America and

*massiliae*, *R. rhipicephali*, *R. monteiroi* y *R. africae* han sido reportados en un solo país. En este caso *R. africae* ha sido documentada en nueve islas del Caribe.

Ocho especies de *Rickettsia* han sido asociadas con enfermedad humana en Latinoamérica y el Caribe: *R. rickettsii* agente de etiología de

**Table 4.** Infections by *Rickettsia* in Costa Rica, El Salvador, Guatemala, French Guayana, Honduras, Nicaragua and Panamá .

| Species               | Geographical distribution | Vector  | Clinical cases confirmed | Animal infection | References |
|-----------------------|---------------------------|---|--------------------------|------------------|------------|
| <b>COSTA RICA</b>     |                           |   |                          |                  |            |
| <i>R. rickettsii</i>  | Alajuela                  | No  | Yes                      | No               | 99,100     |
|                       | Cartago                   | No  | Yes                      | No               | 100,101    |
|                       | Heredia                   | No  | Yes                      | No               | 100,102    |
|                       | Limón                     | <i>Haemaphysalis leporispalustris</i>   | Yes                      | No               | 100-103    |
| <i>R. akari</i>       | Limón                     | No  | Yes                      | No               | 104        |
| <i>R. amblyommii</i>  |                           | <i>Amblyomma cajennense</i>   | No                       | No               | 105        |
| <i>R. felis</i>       |                           | <i>Ctenocephalides felis</i>  | No                       | No               | 105        |
| Spotted fever group   | Alajuela                  | No  | Yes                      | Yes              | 106        |
|                       | Limon                     | No  | Yes                      | Yes              | 106        |
| <b>EL SALVADOR</b>    |                           |   |                          |                  |            |
| Spotted fever group   | No data                   | No  | Yes <sup>1</sup>         | No               | 107,108    |
| Typhus group          | No data                   | No  | Yes <sup>1</sup>         | No               | 107,108    |
| <b>GUATEMALA</b>      |                           |   |                          |                  |            |
| <i>R. prowazekii</i>  | Highlands (>1.300 m)      | No  | Yes <sup>1</sup>         | No               | 104        |
| <i>R. typhi</i>       | Lowlands (<1.300 m)       | No  | Yes <sup>1</sup>         | No               | 109        |
| <b>FRENCH GUAYANA</b> |                           |   |                          |                  |            |
| <i>R. amblyommii</i>  | Régina                    | <i>Amblyomma coelebs</i>  | No                       | No               | 109        |
| <b>HONDURAS</b>       |                           |   |                          |                  |            |
| Spotted fever group   | No data                   | No  | Yes <sup>1</sup>         | No               | 104        |
|                       | Islas de la Bahía         | No  | Yes <sup>1</sup>         | No               | 110        |
|                       | No data                   | No  | no                       | Yes <sup>2</sup> | 111        |
| <b>NICARAGUA</b>      |                           |   |                          |                  |            |
| Spotted fever group   | No data                   | No  | Yes <sup>1</sup>         | No               | 104        |
| <b>PANAMÁ</b>         |                           |   |                          |                  |            |
| <i>R. rickettsii</i>  | Panamá                    | <i>Amblyomma cajennense</i><br><i>Amblyoma</i> sp.  | Yes                      | No               | 112-115    |
|                       | Coclé                     | No  | Yes                      | Yes              | 116        |
|                       | Darién                    | <i>Dermacentor nitens</i>   | No                       | No               | 117        |
| <i>R. amblyommii</i>  | Coclé                     | <i>Amblyomma cajennense</i>   | No                       | Yes              | 116        |
|                       |                           | <i>Rhipicephalus sanguineus</i><br><i>Dermacentor nitens</i>                                |                          |                  |            |
|                       | Darién                    | <i>Amblyomma cajennense</i><br><i>Rhipicephalus sanguineus</i><br><i>Dermacentor nitens</i> | No                       | No               | 115,117    |
|                       | Kuna Yala                 | <i>Rhipicephalus sanguineus</i>   | No                       | Yes              | 115        |
| <i>R. felis</i>       | Coclé                     | <i>Ctenocephalides felis</i>  | No                       | No               | 116        |
| <i>R. typhi</i>       | Panamá                    | No  | Yes                      | No               | 118        |

<sup>1</sup>Serologic evidence of infection in humans by this *Rickettsia*, <sup>2</sup> Serologic evidence of infection in animals.

**Table 5.** Infections by *Rickettsia* in México.

| Species              | Geographical distribution | Vector                          | Clinical cases confirmed | Animal infection | References |     |
|----------------------|---------------------------|---------------------------------|--------------------------|------------------|------------|-----|
| <b>MÉXICO</b>        |                           |                                 |                          |                  |            |     |
| <i>R. rickettsii</i> | Baja California           | <i>Rhipicephalus sanguineus</i> | Yes                      | No               | 119,120    |     |
|                      | Coahuila                  | <i>R. sanguineus</i>            | Yes                      | No               | 121        |     |
|                      | Durango                   | <i>R. sanguineus</i>            | Yes                      | No               | 120,122    |     |
|                      | Nuevo León                | <i>Amblyomma imitator</i>       | Yes                      | No               | 123        |     |
|                      | San Luis Potosí           | <i>R. sanguineus</i>            | Yes                      | No               | 121,122    |     |
|                      | Sinaloa                   | <i>R. sanguineus</i>            | Yes                      | No               | 124        |     |
|                      | Sonora                    | <i>R. sanguineus</i>            | Yes                      | No               | 125-129    |     |
|                      | Veracruz                  | <i>Amblyomma cajennense</i>     | Yes                      | No               | 119,130    |     |
|                      | Yucatán                   | No                              | Yes                      | No               | 131,132    |     |
| <i>R. felis</i>      | Yucatán                   | <i>Ctenocephalides felis</i>    | Yes                      | No               | 133-136    |     |
| <i>R. akari</i>      | Yucatán                   | <i>R. sanguineus</i>            | Yes                      | Yes              | 137,138    |     |
| <i>R. prowazekii</i> | Chiapas                   | No                              | Yes                      | No               | 139        |     |
|                      | Hidalgo                   | No                              | Yes                      | No               | 122        |     |
|                      | Jalisco                   | No                              | Yes                      | No               | 140        |     |
|                      | Estado de México          | No                              | Yes                      | No               | 122,141    |     |
|                      | Nuevo León                | <i>Amblyomma</i> sp             | Yes                      | No               | 142,143    |     |
|                      | Oaxaca                    | No                              | Yes                      | No               | 122        |     |
|                      | Puebla                    | No                              | Yes                      | No               | 122        |     |
|                      | Veracruz                  | No                              | Yes                      | No               | 122        |     |
|                      | <i>R. typhi</i>           | Ciudad de México                | No                       | Yes              | No         | 144 |
|                      |                           | Guerrero                        | No                       | Yes              | No         | 122 |
| Hidalgo              |                           | No                              | Yes                      | No               | 122        |     |
| Jalisco              |                           | No                              | Yes                      | No               | 122        |     |
| Estado de México     |                           | No                              | Yes                      | No               | 122        |     |
| Michoacán            |                           | No                              | Yes                      | No               | 122        |     |
| Nayarit              |                           | No                              | Yes                      | No               | 122        |     |
| Nuevo León           |                           | No                              | Yes                      | No               | 122        |     |
| Oaxaca               |                           | No                              | Yes                      | No               | 122,145    |     |
| Puebla               |                           | No                              | Yes                      | No               | 122        |     |
| Querétaro            |                           | No                              | Yes                      | No               | 122        |     |
| Tamaulipas           |                           | No                              | Yes                      | No               | 122        |     |
| Zacatecas            |                           | No                              | Yes                      | No               | 122        |     |
| Yucatán              | No                        | Yes                             | No                       | 146              |            |     |

**Table 6.** Infections by *Rickettsia* in Caribbean Islands.

| Species                | Geographical distribution | Vector                       | Clinical cases confirmed | Animal infection | References |
|------------------------|---------------------------|------------------------------|--------------------------|------------------|------------|
| <b>CARIBBEAN ISLES</b> |                           |                              |                          |                  |            |
| <i>R. africae</i>      | Guadaloupe                | <i>Amblyomma variegatum</i>  | Yes                      | Yes              | 147,148    |
|                        | St. Kitts                 | <i>A. variegatum</i>         | No                       | No               | 149        |
|                        | Nevis                     | <i>A. variegatum</i>         | No                       | No               | 149        |
|                        | Dominica                  | <i>A. variegatum</i>         | No                       | No               | 150        |
|                        | Virgin islands            | <i>A. variegatum</i>         | No                       | No               | 150        |
|                        | Montserrat                | <i>A. variegatum</i>         | No                       | No               | 150        |
|                        | St. Lucia                 | <i>A. variegatum</i>         | No                       | No               | 150        |
|                        | Martinique                | <i>A. variegatum</i>         | No                       | No               | 151        |
|                        | Antigua                   | <i>A. variegatum</i>         | No                       | No               | 152        |
| <i>R. felis</i>        | St. Kitts                 | <i>Ctenocephalides felis</i> | No                       | No               | 153        |
| <i>R. typhi</i>        | Puerto Rico               | <i>Xenopsylla cheopis</i>    | Yes                      | Yes              | 154        |



**Tabla 7.** Infections by *Rickettsia* in Spain and Portugal.

| Species                 | Geographical distribution            | Vector   | Clinical cases confirmed | Animal infection | References       |
|-------------------------|--------------------------------------|--|--------------------------|------------------|------------------|
| <b>SPAIN</b>            |                                      |  |                          |                  |                  |
| <i>R. conorii</i>       | All Spain                            | <i>Rhipicephalus sanguineus</i>  | Yes                      | No               | 155              |
| <i>R. helvetica</i>     | All Spain                            | <i>Ixodes ricinus</i>  | No                       | No               | 156              |
| <i>R. monacensis</i>    | All Spain                            | <i>I. ricinus</i>  | Yes                      | No               | 9                |
| <i>R. felis</i>         | All Spain, Canary Islands            | <i>Ctenocephalides felis</i>   | Yes                      | No               | 157              |
| <i>R. slovaca</i>       | All Spain                            | <i>Dermacentor marginatus</i>  | Yes                      | No               | 158              |
| <i>R. raoultii</i>      | All Spain                            | <i>D. marginatus</i>   | Yes                      | No               | 158              |
| <i>R. sibirica</i>      | Pais Vasco, La Rioja                 | No   | Yes                      | No               | 159              |
| <i>R. aeschlimannii</i> | Castilla León, La Rioja              | <i>Hyalomma marginatum</i>   | No                       | No               | 160              |
| <i>R. typhi</i>         | South Spain, Canary Islands          | <i>Xenopsylla cheopis</i> , <i>C. felis</i>  | Yes                      | No               | 161              |
| <i>R. prowazekii</i>    | All Spain                            | <i>Pediculus humanus</i>   | Yes                      | No               | 162              |
| <i>R. rioja</i>         | Galicia, Pais Vasco, La Rioja        | <i>D. marginatus</i>   | Yes                      | No               | 158,163          |
| <b>PORTUGAL</b>         |                                      |  |                          |                  |                  |
| <i>R. conorii</i>       | Continental Portugal                 | <i>Rhipicephalus sanguineus</i>  | Yes                      | No               | 164-168          |
| <i>R. helvetica</i>     | Continental Portugal, Madeira Island | <i>Ixodes ricinus</i>  | No                       | No               | 166,169          |
| <i>R. monacensis</i>    | Continental Portugal, Madeira Island | <i>I. ricinus</i>  | No                       | No               | 170,171          |
| <i>R. felis</i>         | Continental Portugal, Madeira Island | <i>Archaeopsylla erinacei maura</i> ,<br><i>Ctenophthalmus sp.</i><br><i>Ctenocephalides felis</i> | No                       | No               | 172,173          |
| <i>R. slovaca</i>       | Continental Portugal                 | <i>Dermacentor marginatus</i><br><i>Dermacentor reticulatus</i>                                    | Yes                      | No               | 166, 169,<br>174 |
| <i>R. raoultii</i>      | Continental Portugal                 | <i>D. marginatus</i>   | No                       | No               | 171,175          |
| <i>R. sibirica</i>      | Continental Portugal                 | <i>Rhipicephalus pusillus</i> ,<br><i>Rhipicephalus bursa</i> ,                                    | Yes                      | No               | 175,176          |
| <i>R. aeschlimannii</i> | Continental Portugal                 | <i>Hyalomma marginatum</i>   | No                       | No               | 166, 179,<br>177 |
| <i>R. typhi</i>         | Continental Portugal, Madeira Island | <i>Leptopsylla segnis</i>  | Yes                      | No               | 175, 178-<br>180 |
| <i>R. prowazekii</i>    | Continental Portugal                 | <i>Pediculus humanus</i>   | Yes                      | No               | 162              |
| <i>R. massiliae</i>     | Continental Portugal                 | <i>R. sanguineus</i>   | No                       | No               | 166              |

**Table 8.** Imported cases of *Rickettsia* in Latin America and Iberian peninsula.

| Species             | Country of origin | Country of event occurrence | Reference |
|---------------------|-------------------|-----------------------------|-----------|
| <i>R. massiliae</i> | Argentina         | Spain                       | 14        |
| <i>R. africae</i>   | South Africa      | Spain                       | 181       |
| <i>R. conorii</i>   | Portugal          | Brazil                      | 182       |
| <i>R. conorii</i>   | South Africa      | Brazil                      | 183       |

Caribbean: *R. rickettsii* causing rocky mountain spotted fever in Mexico, Costa Rica, Panama, Colombia, Brazil and Argentina; *R. prowazekii* causing epidemic typhus in Argentina, Bolivia, Chile, Ecuador, Guatemala, Mexico, and Peru; *R. typhi* causing endemic typhus in Brazil, Colombia, Guatemala, Mexico, Panama, and Puerto Rico; *R. felis* causing flea spotted fever

la fiebre de las montañas rocosas en México, Costa Rica, Panamá, Colombia, Brasil y Argentina; *R. prowazekii* es el causante del tifus epidémico en Argentina, Bolivia, Chile, Ecuador, Guatemala, México y Perú; *R. typhi* es el agente en Brasil, Colombia, Guatemala, México, Panamá y Puerto Rico; *R. felis* causa la fiebre manchada de las pulgas en México

in Mexico and Brazil; *R. parkeri* causing spotted fever in Brazil, Uruguay, and Argentina; *R. africae* causing African tick bite fever in the Caribbean islands; *R. akari* causing rickettsial pox in Costa Rica and Mexico; and *R. massiliae* causing spotted fever in Argentina. This *R. massiliae* case was reported in a Spanish traveler presumed to have acquired the infection in Argentina, but suffered the disease after her return to Spain (Table 8). The distribution of *R. felis*-infected fleas included seven countries (Costa Rica, Panama, Caribbean islands, Peru, Argentina, Chile, and Uruguay) where no human cases of infection have been reported so far. A total of five *Rickettsia* species of unknown pathogenicity has been reported: *R. amblyommii* (5 countries), *R. bellii* (2 countries), *Candidatus 'R. andeanae'* (2 countries), *R. monteiroi* (1 country), and *R. rhipicephali* (1 country).

A total of 10 *Rickettsia* species have been reported in both Spain and Portugal: *R. conorii*, *R. helvetica*, *R. monacensis*, *R. felis*, *R. slovacica*, *R. raoultii*, *R. sibirica*, *R. aeschlimannii*, *R. typhi*, and *R. prowazekii*. In addition, *R. rioja* has been reported in Spain, and *R. massiliae* has been reported to occur in Portugal (Table 7). Amongst these *Rickettsia* species reported in Portugal and Spain, only *R. prowazekii*, *R. typhi*, *R. felis*, and *R. massiliae* have also been reported in Latin America.

Two fatal cases of spotted fever caused by *R. conorii* have been diagnosed in Brazil, however, patients of these cases were considered to have acquired the infection in Portugal and South Africa, respectively, and then suffered the disease few days after they arrived in Brazil (Table 8). Likewise, one case of *R. africae* infection was acquired in Africa before the patient returned to Spain.

For El Salvador, Honduras and Nicaragua, although no specific *Rickettsia* species has been reported so far, there have been serological evidence of human and animal infection by spotted fever and/or typhus group rickettsioses in these countries (Table 4).

According to our compiled data, the following countries remain without any rickettsial records in Central America and South America: Belize, Venezuela, Guayana, Surinam and Paraguay. In addition, except for the 10 Caribbean islands of

y Brasil; *R. parkeri* es la causa de la fiebre manchada en Brasil, Uruguay y Argentina; *R. africae* produce la fiebre africana por garrapatas en las Antillas menores; *R. akari* es la causa de la viruela rickettsial en Costa Rica y México; *R. massiliae* es el agente de la fiebre manchada en Argentina, que fue reportada en un viajero español procedente de Argentina el cual se presume adquirió la infección en ese país suramericano (Tabla 8). La distribución de pulgas infectadas por *R. felis* incluyó siete países (Costa Rica, Panamá, Antillas menores, Perú, Argentina, Chile y Uruguay) donde sin embargo, no se han presentado casos humanos hasta ahora. Un total de cinco especies de *Rickettsia* aún no han sido descritas como patógenas para humanos: *R. amblyommii* (5 países), *R. bellii* (2 países), *Candidatus 'R. andeanae'* (2 países), *R. monteiroi* (1 país) y *R. rhipicephali* (1 país).

Un total de 10 especies de *Rickettsia* han sido reportadas en España y Portugal: *R. conorii*, *R. helvetica*, *R. monacensis*, *R. felis*, *R. slovacica*, *R. raoultii*, *R. sibirica*, *R. aeschlimannii*, *R. typhi* y *R. prowazekii*. Además, *R. rioja* ha sido reportada en España y *R. massiliae* en Portugal (Tabla 7). De estas especies de *Rickettsia*, solamente *R. prowazekii*, *R. typhi*, *R. felis* y *R. massiliae* han sido documentadas en Latinoamérica.

Dos casos fatales de fiebre manchada por *R. conorii* se diagnosticaron en Brasil, sin embargo, estos 2 pacientes adquirieron la infección en Portugal y Sur África respectivamente y desarrollaron la enfermedad unos días después de arribar a Brasil (Tabla 8). De igual manera, un caso de *R. africae* fue adquirido en África antes que el paciente regresara a España.

Con respecto a El Salvador, Honduras y Nicaragua, aunque hasta ahora no se han reportado específicamente especies de *Rickettsia*, se han demostrado evidencia serológica de infección humana y/o animal por los grupos de las fiebres manchadas y/o tifus (Tabla 4).

De acuerdo con los datos compilados, los siguientes países no presentan ningún tipo de registro de rickettsias en América Central y América del Sur: Belice, Venezuela, Guyana, Surinam y Paraguay. Además, a excepción de

this paper, many of them also remain without records. The geographical distribution of the 13 *Rickettsia* species that have been identified in Latin America and Caribbean are shown in figure 1.

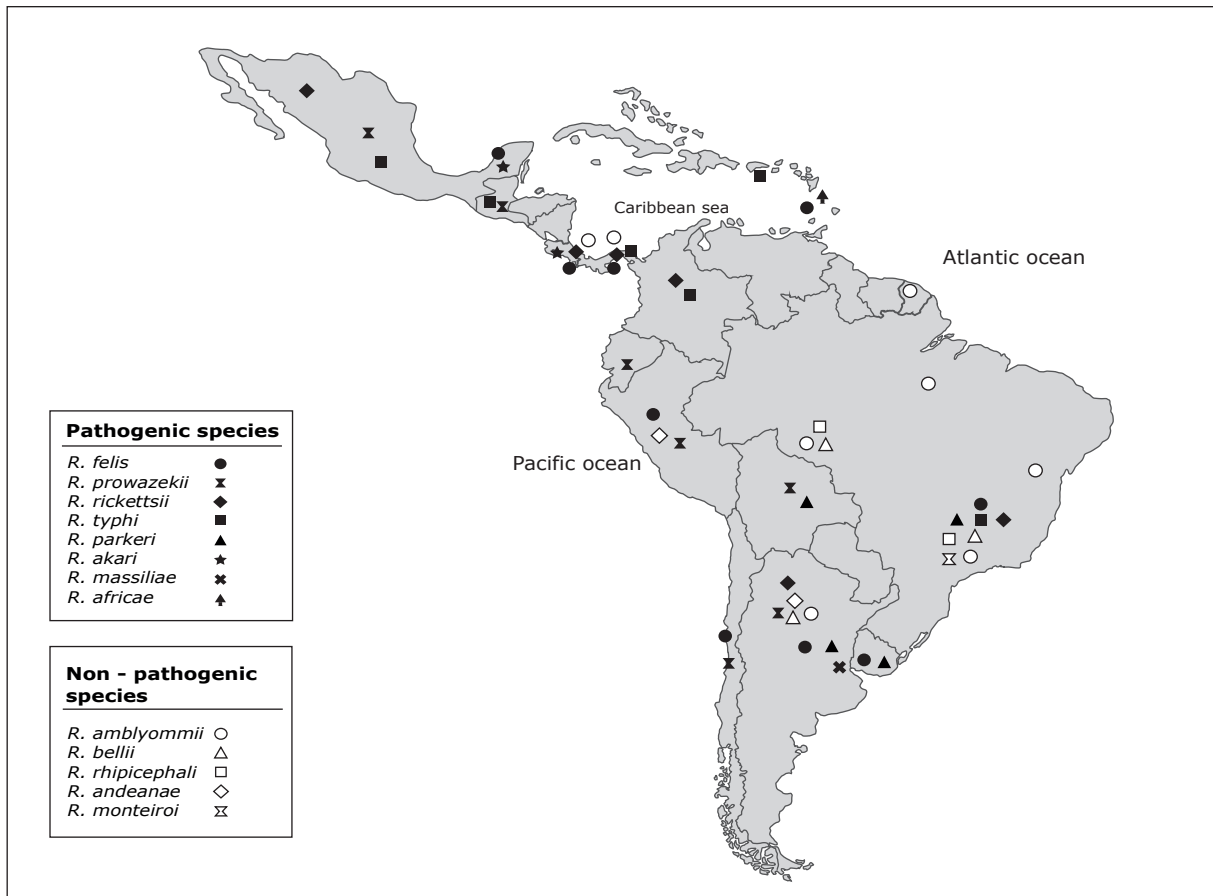
**Analysis of data**

Until the end of the last century, only three *Rickettsia* species were known to occur in Latin America and Caribbean: *R. rickettsii*, *R. prowazekii*, and *R. typhi*. With the increasing use of molecular methods since the 1990s, other *Rickettsia* species were discovered in the continent, such as *R. africae* in West Indies (147), and *R. felis* in Mexico (133) and later in Brazil (59). In this new century, there was a bulk in the study of *Rickettsia* in Latin America, with the discovery of at least 8 other *Rickettsia* species in the continent during the last 10 years, mostly associated with ticks: *R. amblyommii*, *R. bellii*, *R. rhipicephali*, *R. parkeri*, *R. massiliae*, *R. akari*, *R. monteiroi*, and Candidatus '*R. andeanae*' (73,93,105,137).

las 10 islas del Caribe de este trabajo, muchas de ellas también permanecen sin registro. La distribución geográfica de las 13 especies de *Rickettsia* que se han identificado en América Latina y el Caribe se muestra en la figura 1.

**Análisis de los datos**

Al final del último siglo, solamente *R. rickettsii*, *R. prowazekii* y *R. typhi* eran conocidas en Latinoamérica y el Caribe. Con la aparición de los métodos moleculares en los años 90, otras especies fueron descubiertas tales como *R. africae* en las Antillas (147), y *R. felis* en México (133) y más tarde en Brasil (59). En este siglo, se han desarrollado una gran cantidad de investigaciones sobre *Rickettsia* en Latinoamérica y al menos 8 especies nuevas se han descubierto en los últimos 10 años, la mayoría asociadas con garrapatas: *R. amblyommii*, *R. bellii*, *R. rhipicephali*, *R. parkeri*, *R. massiliae*, *R. akari*, *R. monteiroi*, and Candidatus '*R. andeanae*' (73,93,105,137).



**Figure 1.** Geographical distribution of the 13 *Rickettsia* species in Latin America and Caribbean.

Considering the three species (*R. rickettsii*, *R. prowazekii*, and *R. typhi*) known to occur in the continent since the first half of the last century, only *R. rickettsii*, the agent of rocky mountain spotted fever, showed an increased expansion on its distribution area during the last decades. In fact, rocky mountain spotted fever is currently considered a re-emerging disease in Mexico, Central and South America (81,93,112,131).

The occurrence of *R. typhi* in the American continent has been practically neglected. Although this agent has been only scarcely reported in a few Latin American countries recently (49,146,184), most rickettsiologists believe that this rickettsia is widely distributed in the continent, together with its main hosts, synantropic rats and their flea *Xenopsylla cheopis* (185). Finally, the scarce number of recent records of *R. prowazekii* during the last few decades seems to be a result of decreased prevalence of its main vector, the body louse *Pediculus humanus* (185). Thus, almost all records of *R. prowazekii* in Latin America refer to the last century. More recent reports of human cases seem to have been restricted to highland areas of Peru, where body louse infestations are still a problem (185).

The significant advance in our knowledge on rickettsiology during the last decade in Latin America and Caribbean was certainly a result of the increased interest of researchers on this subject in the continent. However, this advance should be considered still very incipient, if we compare the modest list of *Rickettsia* species and rickettsial diseases of Latin America and Caribbean with the greater lists here reported for the Iberian countries, where rickettsiology has had much greater attention from researchers and governmental institutions. Indeed, the list of rickettsial diseases in Latin America will increase during the next years, not only in the countries with previous records, but also, in many of the American countries where *Rickettsia* has never been reported. A basal condition for this increase is the urgent need of increased capacity of Latin American laboratories to perform diagnosis of *Rickettsia*, since the absence of rickettsial diseases in such countries might be merely a result of absence of investigations.

Teniendo en cuenta que *R. rickettsii*, *R. prowazekii* y *R. typhi* se describieron a mediados del siglo veinte, solamente *R. rickettsii* el agente de la fiebre manchada de las montañas rocosas, mostró en Latinoamérica un incremento en su distribución y expansión en las últimas décadas. De hecho, la fiebre manchada de las montañas rocosas, es actualmente considerada una enfermedad reemergente en México, Sur y Centro América (81,93,112,131).

La presencia de *R. typhi* en el continente americano ha estado prácticamente descuidada. Sin embargo, este agente ha sido reportado en algunos países de Latinoamérica recientemente (49,146,184), la mayoría de los rickettsiólogos creen que *R. typhi* está ampliamente distribuida en el continente, junto con las ratas sinantropicas y su pulga *Xenopsylla cheopis* (185). Finalmente, el escaso número de datos recientes de *R. prowazekii* en las últimas décadas parece ser el resultado del descenso de la prevalencia de su principal vector el piojo del cuerpo *Pediculus humanus* (185). Por lo tanto, casi todos los datos de *R. prowazekii* en Latinoamérica se refieren al último siglo. Recientes estudios de casos humanos han sido reportados en áreas altas de Perú, donde las infestaciones por el piojo del cuerpo son todavía un problema (185).

El avance significativo del conocimiento sobre rickettsiología durante la última década en Latinoamérica y el Caribe fue sin duda el resultado del gran interés de los investigadores sobre esta materia en el continente. Sin embargo, este avance debería ser considerado todavía muy incipiente, si se tiene en cuenta la modesta lista de especies de *Rickettsia* y enfermedades rickettsiales de Latinoamérica y el Caribe, comparada con la de España y Portugal, donde la rickettsiología ha tenido mucha más atención de los investigadores e instituciones gubernamentales. De verdad, que la lista de las enfermedades por *Rickettsia* se incrementarán en Latinoamérica en los próximos años, no solamente en los países con reportes previos, sino en otros donde nunca ha sido reportada. Una condición básica para este incremento es la necesidad urgente de aumentar la capacidad de los laboratorios de Latinoamérica para llevar a cabo diagnóstico de *Rickettsia*, ya que la ausencia de la enfermedad en estos países podría ser meramente un resultado de la ausencia de investigaciones.

## Acknowledgments

This work was supported by the Programa Iberoamericano de Ciencias y Tecnología para el Desarrollo (CYTED) to Red Iberoamericana para la Investigación y Control de las Enfermedades Rickettsiales (RIICER). To Janneth Gallegos M.Sc, Escuela Superior Politécnica de Chimborazo. Facultad de Ciencias. Riobamba, Ecuador. To Jorge Miranda M.Sc, University of Córdoba, Colombia for the technical assistance.

## Agradecimientos

Este trabajo fue financiado por el Programa Ciencia y Tecnología para el Desarrollo (CYTED) para la Red Iberoamericana de Investigación y Control de Enfermedades por Rickettsia (RIICER). A Janneth Gallegos, M.Sc. Escuela Politécnica de Chimborazo. Facultad de Ciencias. Riobamba Ecuador. A Jorge Miranda, M.Sc. Universidad de Córdoba, Montería, Colombia.

## REFERENCES

1. Dykova I, Veverkova M, Fiala I, Machackova B, Peckova H. *Nuclearia pattersoni* sp n. (Filosea), a new species of amphizoic amoeba isolated from gills of roach (*Rutilus rutilus*), and its rickettsial endosymbiont. *Folia Parasitol* 2003; 50:161–170.
2. Perlman SJ, Hunter MS, Zchori-Fein E. The emerging diversity of *Rickettsia*. *Proc Biol Sci* 2006; 273:2097–2106.
3. Raoult D, Roux V. Rickettsioses as paradigms of new or emerging infectious diseases. *Clin Microbiol Rev* 1997; 10:694-719.
4. Labruna MB, Pacheco RC, Nava S, Brandao PE, Richtzenhain LJ, Guglielmone AA. Infection by *Rickettsia bellii* and *Candidatus "Rickettsia amblyommii"* in *Amblyomma neumanni* ticks from Argentina. *Microbial Ecology* 2007; 54:126-133.
5. McKiel JA, Bell EJ, Lackman DB. *Rickettsia canada*: a new member of the typhus group of rickettsiae isolated from *Haemaphysalis leporispalustris* ticks in Canada. *Can J Microbiol* 1967; 13:503-510.
6. Gillespie JJ, Beier MS, Rahman MS, Ammerman NC, Shallom JM, Purkayastha A. Plasmids and rickettsial evolution: insight from *Rickettsia felis*. *PLoS ONE* 2007; 2:e266.
7. Weinert LA, Werren JH, Aebi A, Stone GN, Jiggins FM. Evolution and diversity of *Rickettsia* bacteria. *BMC Biol* 2009; 7:6.
8. Parola P, Davoust B, Raoult D. Tick- and flea-borne rickettsial emerging zoonoses. *Vet Res* 2005; 36:469-492.
9. Jado I, Oteo JA, Aldámiz M, Gil H, Escudero R, Ibarra V et al. *Rickettsia monacensis* and human disease, Spain. *Emerg Infect Dis* 2007; 13:1405-1407.
10. Paddock CD, Summer JW, Comer JA, Zaki SR, Goldsmith CS, Goddard J et al. *Rickettsia parkeri*: A newly recognized cause of spotted fever rickettsiosis in the United States. *Clin Infect Dis* 2004; 38:805-811.
11. Labruna MB, Pacheco RC, Nava S, Brandão PE, Richtzenhain LJ, Guglielmone AA. Infection by *Rickettsia bellii* and *Candidatus "Rickettsia amblyommii"* in *Amblyomma neumanni* ticks from Argentina. *Microb Ecol* 2007; 54:126-133.
12. Tomassone L, Nuñez P, Ceballos LA, Gurtler RE, Kitron U, Farber M. Detection of "*Candidatus Rickettsia* sp. strain Argentina" and *Rickettsia bellii* in *Amblyomma* ticks (Acari: Ixodidae) from Northern Argentina. *Exp Appl Acarol* 2010; 52:93-100.
13. Cicuttin GL, Rodríguez Vargas M, Jado I, Anda P. Primera detección de *Rickettsia massiliae* en la Ciudad de Buenos Aires. Resultados Preliminares. *Revista Argentina de Zoonosis* 2004; 1:8-10.

14. García- García JC, Portillo A, Núñez MJ, Santibáñez S, Castro B, Oteo JA. Case report: a patient from Argentina infected with *Rickettsia massilliae*. *Am J Trop Hyg* 2010; 82:691-692.
15. Seijo A, Picollo M, Nicholson W, Paddock C. Fiebre manchada por rickettsias en el Delta del Parana: una enfermedad emergente. *Medicina (B Aires)*. 2007; 67:723-726.
16. Nava S, Elshenawy Y, Eremeeva ME, Sumner JW, Mastropaolo M, Paddock CD. *Rickettsia parkeri* in Argentina. *Emerg Infect Dis* 2008; 14:1894-1897.
17. Romer Y, Seijo AC, Crudo F, Nicholson WL, Varela-Stokes A, Lash RR et al. *Rickettsia parkeri* rickettsiosis, Argentina. *Emerg Infect Dis* 2011; 17:1169-1173.
18. Paddock CD, Fernández S, Echenique GA, Sumner JW, Reeves WK, Zaki SR et al. Rocky Mountain spotted fever in Argentina. *Am J Trop Med Hyg* 2008; 78:687-692.
19. Pacheco RC, Moraes-Filho J, Nava S, Brandao PE, Richtzenhain LJ, Labruna MB. Detection of a novel spotted fever group rickettsia in *Amblyomma parvum* ticks (Acari: Ixodidae) from Argentina. *Exp Appl Acarol* 2007; 43:63-71.
20. Nava S, Pérez-Martínez L, Venzal JM, Portillo A, Santibáñez S, Oteo JA. *Rickettsia felis* in *Ctenocephalides felis* from Argentina. *Vector-Borne Zoonotic Dis* 2008; 8:465-466.
21. Seijo A. Enfermedades por Rickettsias. In: Cacchione RA, Durlach R, Larghi OP, Martino P. *Temas de Zoonosis III*. Buenos Aires; Asociación Argentina de Zoonosis: 2006.
22. Labruna M, Ogrzewalska M, Moraes-Filho J, Lepe P, Gallegos JL, López J. *Rickettsia felis* in Chile. *Emerg Infect Dis* 2007; 13:1794-1795.
23. López J, Pacheco R, Lepe P, Abarca K, Ogrzewalska M, Richtzenhain L. Detection of *Rickettsia felis* in *Rhipicephalus sanguineus* in Chile. *Book of Abstracts, VI International Conference on Ticks and Tick-borne Pathogens (TTP-6)*. Poster N°274. Buenos Aires; 2008.
24. Krauss R. La fiebre petequial (tifus exantemático), sus focos americanos y su diagnóstico, *Rev Méd Chile* 1919; 47:131-138.
25. Balcells ME, Rabagliati R, García P, Poggi H, Oddó D, Concha M et al. An endemic scrub typhus-like illness in South America: a case in Chile. *Emerg Infect Dis* 2011.
26. Conti-Díaz IA, Rubio I, Somma Moreira R, Pérez Dormida G. Rickettsiosis cutáneo-ganglionar por *Rickettsia conorii* en el Uruguay. *Rev Inst Med trop S Paulo* 1990; 32:313-318.
27. Conti-Díaz IA. Rickettsiosis por *Rickettsia conorii* (fiebre botonosa del Mediterráneo o fiebre de Marsella). Estado actual en Uruguay. *Rev Med Uruguay* 2001; 17:119-124.
28. Conti-Díaz IA. Rickettsiosis caused by *Rickettsia conorii* in Uruguay. *Ann N Y Acad Sci* 2003; 990:264-266.
29. Conti-Díaz IA, Moraes-Filho J, Pacheco RC, Labruna MB. Serological evidence of *Rickettsia parkeri* as etiological agent of rickettsiosis in Uruguay. *Rev Inst Med Trop Sao Paulo* 2009; 51:337-339.
30. Pacheco RC, Venzal JM, Richtzenhain LJ, Labruna MB. *Rickettsia parkeri* in Uruguay. *Emerg Inf Dis* 2006; 12:1804-1805.
31. Venzal JM, Portillo A, Estrada-Peña A, Castro O, Cabrera PA, Oteo JA. *Rickettsia parkeri* in *Amblyomma triste* from Uruguay. *Emerg Infect Dis* 2004; 10:1493-1495.
32. Venzal JM, Pérez-Martínez L, Félix ML, Portillo A, Blanco JR, Oteo JA. Prevalence of *Rickettsia felis* in *Ctenocephalides felis* and *Ctenocephalides canis* from Uruguay. *Ann N Y Acad Sci* 2006; 1078:305-308.
33. Paddock CD, Fournier PE, Sumner JW, Goddard J, Elshenawy Y, Metcalfe MG et al. Isolation of *Rickettsia parkeri* and identification of a novel spotted fever group *Rickettsia* sp. from Gulf Coast ticks (*Amblyomma maculatum*) in the United States. *Appl Environ Microbiol* 2010; 76:2689-2696.

34. Magalhães O. Contribuição para o conhecimento das doenças do grupo "Tifo Exantemático" no Brasil. Mem Inst Oswaldo Cruz 1957; 55:191-208.
35. Sexton DJ, Muniz M, Corey GR, Breitschwerdt EB, Hegarty BC, Dumler S et al. Brazilian spotted fever in Espirito Santo, Brazil: description of a focus of infection in a new endemic region. Am J Trop Med Hyg 1993; 49:222-226.
36. Spolidorio MG, Labruna MB, Machado RZ, Moraes-Filho J, Zago AM, Donatele DM et al. Survey for tick-borne zoonoses in the state of Espirito Santo, southeastern Brazil. Am J Trop Med Hyg 2010; 83:201-206.
37. Moreira JA, Magalhães O. *Thypho exanthematico* em Minas Gerais. Brasil-Médico 1935; 44:465-470.
38. Galvão MA, Dumler JS, Mafra CL, Calic SB, Chamone CB, Cesarino Filho G et al. Fatal spotted fever rickettsiosis, Minas Gerais, Brazil. Emerg Infect Dis 2003; 9:1402-1405.
39. Guedes E, Leite RC, Prata MCA, Pacheco RC, Walker DH, Labruna MB. Detection of *Rickettsia rickettsii* in the tick *Amblyomma cajennense* in a new Brazilian spotted fever-endemic area in the state of Minas Gerais. Mem Inst Oswaldo Cruz 2005; 100:841-845.
40. Pacheco RC, Moraes-Filho J, Guedes E, Silveira I, Richtzenhain LJ, Leite RC et al. Rickettsial infections of dogs, horses and ticks in Juiz de Fora, southeastern Brazil, and isolation of *Rickettsia rickettsii* from *Rhipicephalus sanguineus* ticks. Med Vet Entomol 2011; 25:148-155.
41. Gonçalves AJR, Lopes PFA, Melo JCP, Pereira AA, Pinto AMM, Lazera MS et al. Rickettsioses – a propósito de quatro casos diagnosticados no Rio de Janeiro de febre maculosa brasileira. F Méd (BR) 1981; 82:127-134.
42. Lamas C, Favacho A, Rozental T, Bóia MN, Kirsten AH, Guterres A et al. Characterization of rickettsia rickettsii in a case of fatal Brazilian spotted fever in the city of Rio de Janeiro, Brazil. Braz J Infect Dis 2008; 12:149-151.
43. Gehrke FS, Gazeta GS, Souza ER, Ribeiro A, Marrelli MT, Schumaker TT. *Rickettsia rickettsii*, *Rickettsia felis* and *Rickettsia* sp. TwKM03 infecting *Rhipicephalus sanguineus* and *Ctenocephalides felis* collected from dogs in a Brazilian spotted fever focus in the State of Rio De Janeiro/Brazil. Clin Microbiol Infect 2009; 15(Suppl 2):267-268.
44. Travassos J. Identification d'un virus semblable a celui du "Typhus exanthématique de Sao Paulo", isolé de la sarigue marsupiale (*Didelphis paraguayensis*). Compt Rend Soc Biol 1937; 126:1054-1056.
45. Vallejo-Freire A. Spotted fever in Mexico. Mem Inst Butantan 1946; 19:159-180.
46. Pinter A, Labruna MB. Isolation of *Rickettsia rickettsii* and *Rickettsia bellii* in cell culture from the tick *Amblyomma aureolatum* in Brazil. Ann N Y Acad Sci 2006; 1078:523-529.
47. Moraes-Filho J, Pinter A, Pacheco RC, Gutmann TB, Barbosa SO, Gonzáles MA et al. New epidemiological data on Brazilian spotted fever in an endemic area of the state of São Paulo, Brazil. Vector Borne Zoonot Dis 2009; 9:73-78.
48. Labruna MB, Kamakura O, Moraes-Filho J, Horta MC, Pacheco RC. Rocky Mountain spotted fever in dogs, Brazil. Emerg Infect Dis 2009; 15:458-460.
49. Silva LJ, Papaiordanou PMO. Tifo murino (endêmico) no Brasil: relato de caso e revisão. Rev Inst Med Trop S Paulo 2004; 46:283-285.
50. Travassos J, Rodrigues PM, Carrizo LN. Tifo murino em São Paulo. Identificação da *Rickettsia mooseri* isolada de um caso humano. Mem Inst Butantan 1949; 21:77-106.
51. Labruna MB, Whitworth T, Horta MC, Bouyer DH, McBride JW, Pinter A et al. *Rickettsia* species infecting *Amblyomma cooperi* ticks from an area in the state of São Paulo, Brazil, where Brazilian spotted fever is endemic. J Clin Microbiol 2004; 42:90-98.

52. Horta MC, Labruna MB, Pinter A, Linardi PM, Schumaker TT. *Rickettsia* infection in five areas of the state of São Paulo, Brazil. Mem Inst Oswaldo Cruz 2007; 102:793-801.
53. Silveira I, Pacheco RC, Szabó MP, Ramos HG, Labruna MB. *Rickettsia parkeri* in Brazil. Emerg Infect Dis 2007; 13:1111-1113.
54. Ogrzewalska M, Pacheco RC, Uezu A, Richtzenhain LJ, Ferreira F, Labruna MB. Rickettsial infection in *Amblyomma nodosum* ticks (Acari: Ixodidae) from Brazil. Ann Trop Med Parasitol 2009; 103:413-425.
55. Pacheco RC, Horta MC, Moraes-Filho J, Ataliba AC, Pinter A, Labruna MB. Rickettsial infection in capybaras (*Hydrochoerus hydrochaeris*) from São Paulo, Brazil: serological evidence for infection by *Rickettsia bellii* and *Rickettsia parkeri*. Biomedica 2007; 27:364-371.
56. Spolidorio MG, Labruna MB, Mantovani E, Brandao PE, Richtzenhain LJ, Yoshinari NH. Novel spotted Fever group rickettsiosis, Brazil. Emerg Infect Dis 2010; 16:521-523.
57. Sabatini GS, Pinter A, Nieri-Bastos FA, Marcili A, Labruna MB. Survey of ticks (Acari: Ixodidae) and their rickettsia in an Atlantic rain forest reserve in the State of São Paulo, Brazil. J Med Entomol 2010; 47:913-916.
58. Silva N, Eremeeva ME, Rozental T, Ribeiro GS, Paddock CD, G Ramos EA et al. Eschar-associated Spotted Fever Rickettsiosis, Bahia, Brazil. Emerg Infect Dis 2011; 17:275-278.
59. Raoult D, La Scola B, Enea M, Fournier PE, Roux V, Fenollar F et al. A flea-associated *Rickettsia* pathogenic for humans. Emerg Infect Dis 2001; 7:73-81.
60. Oliveira RP, Galvão MA, Mafra CL, Chamone CB, Calic SB, Silva SU et al. *Rickettsia felis* in *Ctenocephalides* spp. fleas, Brazil. Emerg Infect Dis 2002; 8:317-319.
61. Horta MC, Scott FB, Correia TR, Fernandes JI, Richtzenhain LJ, Labruna MB. *Rickettsia felis* infection in cat fleas *Ctenocephalides felis felis*. Braz J Microbiol 2010; 41:813-818.
62. Horta MC, Pinter A, Cortez A, Soares RM, Gennari SM, Schumaker TTS et al. *Rickettsia felis* (Rickettsiales:Rickettsiaceae) in *Ctenocephalides felis felis* (Siphonaptera: Pulicidae) in the State of São Paulo, Brazil. Arq Bras Med Vet Zootec 2005; 57:321-325.
63. Horta MC, Chiebao DP, de Souza DB, Ferreira F, Pinheiro SR, Labruna MB et al. Prevalence of *Rickettsia felis* in the fleas *Ctenocephalides felis felis* and *Ctenocephalides canis* from two Indian villages in Sao Paulo Municipality, Brazil. Ann N Y Acad Sci 2006; 1078:361-363.
64. Labruna MB, Whitworth T, Bouyer DH, McBride JW, Camargo LMA, Camargo EP et al. *Rickettsia bellii* and *Rickettsia amblyommii* in *Amblyomma* ticks from the state of Rondônia, Western Amazon, Brazil. J Med Entomol 2004; 41:1073-1081.
65. Ogrzewalska M, Pacheco RC, Uezu A, Ferreira F, Labruna MB. Ticks (Acari: Ixodidae) infesting wild birds in an Atlantic Forest area in the State of São Paulo, Brazil, with isolation of *Rickettsia* from the tick *Amblyomma longirostre*. J Med Entomol 2008; 45:770-774.
66. Ogrzewalska M, Uezu A, Labruna MB. Ticks (Acari: Ixodidae) infesting wild birds in the eastern Amazon, Northern Brazil, with notes on rickettsial infection in ticks. Parasitol Res 2010; 106:809-816.
67. Ogrzewalska M, Uezu A, Labruna MB. Ticks (Acari: Ixodidae) infesting wild birds in the Atlantic Forest in northeastern Brazil, with notes on rickettsial infection in ticks. Parasitol Res 2011; 108:665-670.
68. Labruna MB, Camargo LM, Camargo EP, Walker DH. Detection of a spotted fever group *Rickettsia* in the tick *Haemaphysalis juxtakochi* in Rondonia, Brazil. Vet Parasitol 2005; 127:169-174.
69. Labruna MB, Horta MC, Aguiar DM, Cavalcante GT, Pinter A, Gennari SM et al. Prevalence of *Rickettsia* infection in dogs from the urban and rural areas of Monte Negro municipality, western Amazon, Brazil. Vector Borne Zoonotic Dis 2007; 7:249-255.



70. Labruna MB, Pacheco RC, Richtzenhain LJ, Szabó MP. Isolation of *Rickettsia rhipicephali* and *Rickettsia bellii* from ticks *Haemaphysalis juxtakochi* in the state of Sao Paulo, Brazil. *Appl Environ Microbiol* 2007; 73:869-873.
71. Pacheco RC, Rosa S, Richtzenhain LJ, Szabó MPJ, Labruna MB. Isolation of *Rickettsia bellii* from *Amblyomma ovale* and *Amblyomma incisum* ticks from southern Brazil. *Rev MVZ Córdoba* 2008; 13:1273-1279.
72. Pacheco RC, Horta MC, Pinter A, Moraes-Filho J, Martins TF, Nardi MS et al. Pesquisa de *Rickettsia* spp em carrapatos *Amblyomma cajennense* e *Amblyomma dubitatum* no Estado de São Paulo. *Rev Soc Bras Med Trop* 2009; 42:351-353.
73. Pacheco RC, Moraes-Filho J, Marcili A, Richtzenhain LJ, Szabó MP, Catroxo MH et al. *Rickettsia monteiroi* sp. nov. Infecting the tick *Amblyomma incisum* in Brazil. *Appl Environ Microbiol* 2011; 77(15):5207-11.
74. Saito TB, Cunha-Filho NA, Pacheco RC, Ferreira F, Pappen FG, Farias NA et al. Canine infection by rickettsiae and ehrlichiae in southern Brazil. *Am J Trop Med Hyg* 2008; 79:102-108.
75. Angerami RN, da Silva AM, Nascimento EM, Colombo S, Wada MY, dos Santos FC et al. Brazilian spotted fever: two faces of a same disease? A comparative study of clinical aspects between an old and a new endemic area in Brazil. *Clin Microbiol Infect* 2009; 15(Suppl 2):207-208.
76. Fortes FS, Silveira I, Moraes-Filho J, Leite RV, Bonacim JE, Biondo AW et al. Seroprevalence of *Rickettsia bellii* and *Rickettsia felis* in dogs, São José dos Pinhais, State of Paraná, Brazil. *Rev Bras Parasitol Vet* 2010; 19:222-227.
77. Freitas MC, Grycajuk M, Molento MB, Bonacin J, Labruna MB, Pacheco RC et al. Brazilian spotted fever in cart horses in a non-endemic area in Southern Brazil. *Rev Bras Parasitol Vet* 2010; 19:130-131.
78. Costa PS, Brigatte ME, Greco DB. Antibodies to *Rickettsia rickettsii*, *Rickettsia typhi*, *Coxiella burnetii*, *Bartonella henselae*, *Bartonella quintana*, and *Ehrlichia chaffeensis* among healthy population in Minas Gerais, Brazil. *Mem Inst Oswaldo Cruz* 2005; 100:853-859.
79. Tomassone L, Conte V, Parrilla G, De Meneghi D. *Rickettsia* infection in dogs and *Rickettsia parkeri* in *Amblyomma tigrinum* ticks, Cochabamba Department, Bolivia. *Vector Borne Zoonotic Dis* 2010; 10:953-958.
80. Boletín de la Oficina Sanitaria Panamericana. Washington; Año20: 1941.
81. Hidalgo M, Orejuela L, Fuya P, Carrillo P, Hernandez J, Parra E et al. Rocky Mountain spotted fever, Colombia. *Emerg Infect Dis* 2007; 13:1058-1060.
82. Patino L, Afanador A, Paul JH. A spotted fever in Tobia, Colombia. *Am J Trop Med Hyg* 1937; 17:639-53.
83. Acosta J, Urquijo L, Díaz A, Sepúlveda M, Mantilla G, Heredia D et al. Brote de rickettsiosis en Necodí, Antioquia, febrero-marzo de 2006. *Inf Quinc Epidemiol Nac* 2006; 11:177-192.
84. Pacheco O, Giraldo M, Hidalgo M, Galeano A, Echeverri I, Echevarria L et al. Estudio de brote febril hemorrágico en el corregimiento de Alto de Mulatos - Distrito Especial Portuario de Turbo, Antioquia, enero de 2008. *Inf Quinc Epidemiol Nac* 2008; 13:145-160.
85. Hidalgo M, Lizarazo D, Ovalle M, Castañeda E, Heredia D, Zambrano P et al. Brote de rickettsiosis en Los Córdoba, departamento de Córdoba, febrero-marzo 2007. *Inf Quinc Epidemiol Nac* 2007; 12:367-378.
86. Hidalgo M, Miranda J, Heredia D, Zambrano P, Vesga JF, Lizarazo D et al. Outbreak of Rocky Mountain spotted fever in Córdoba, Colombia. *Mem Inst Oswaldo Cruz*. 2011; 106:117-118.

87. Miranda A, Florez S, Mattar S. Alta seroprevalencia de rickettsiosis en trabajadores del campo en el municipio de Ciénaga de Oro, Córdoba. *Inf Quinc Epidemiol Nac.* 2001; 7:71-75.
88. Hidalgo M, Sánchez R, Orejuela L, Hernández J, Walker DH, Valbuena G. Prevalence of antibodies against spotted fever group rickettsiae in a rural area of Colombia. *Am J Trop Med Hyg.* 2007; 77(2):378-380.
89. Miranda J, Contreras V, Negrete Y, Labruna MB, Mattar S. Vigilancia de la infección por *Rickettsia* sp en capibaras (*Hydrochaeris hydrochaeris*) un modelo potencial de alerta epidemiológica en zonas endémicas. *Biomédica* 2011; 31: 216-221.
90. Blair PJ, Jiang J, Schoeler GB, Moron C, Anaya E, Cespedes M et al. Characterization of spotted fever group rickettsiae in flea and tick specimens from northern Peru. *J Clin Microbiol* 2004; 42:4961-497.
91. Raoult D, Birtles RJ, Montoya M, Perez E, Tissot-Dupont H, Roux V et al. Survey of three bacterial louse-associated diseases among rural Andean communities in Peru: prevalence of epidemic typhus, trench fever, and relapsing fever. *Clin Infect Dis* 1999; 29:434-436.
92. Anaya E. Prevenção e controle das rickettsioses no Peru. In: Consulta de especialistas OPAS/OMS sobre rickettsioses nas Américas. Relatório final. Rio de Janeiro, Brazil: Organização Pan-Americana da Saúde; 2004.
93. Labruna MB. Ecology of rickettsia in South America. *Ann N Y Acad Sci* 2009; 1166:156-166.
94. Schoeler GB, Morón C, Richards A, Blair PJ, Olson JG. Human spotted fever rickettsial infections. *Emerg Infect Dis* 2005; 11:622-624.
95. Forshey BM, Stewart A, Morrison AC, Gálvez H, Rocha C, Astete H et al. Epidemiology of spotted fever group and typhus group rickettsial infection in the Amazon basin of Peru. *Am J Trop Med Hyg* 2010; 82:683-690.
96. Macchiavello A. El tifo Exantemático en el Ecuador. I Estudio Experimental de Cepas Aisladas en el Ecuador Interandino. *Revista ecuatoriana de Higiene y Medicina Tropical* 1944; 1:3-16.
97. González Hidalgo, G. Campaña contra el Tifo Exantemático. Boletín No 11. Quito: Ministerio de Prevision Social; 1942.
98. Macchiavello A. Aspectos Clínicos de las Enfermedades Rickettsiales. Primera Reunión Interamericana de Tifo, México; 1945.
99. Fuentes LG. Primer caso de fiebre de las Montañas Rocosas en Costa Rica, América Central. *Rev Latinoam Microbiol* 1979; 21:167-172.
100. Hun L, Cortés X, Taylor L. Molecular characterization of *Rickettsia rickettsii* isolated from Human Clinical Samples and from the Rabbit Tick *Haemaphysalis leporispalustris* Collected at Different Geographic Zones in Costa Rica. *Am J Trop Med Hyg* 2008; 79:899-902.
101. Hun-Opfer L. Revisión. Las fiebres manchadas y su importancia en Costa Rica. *Acta Médica Costarricense* 2008; 50:77-86.
102. Hun L, Herrero L, Fuentes L, Vargas M 1991. Tres nuevos casos de Fiebres Manchadas de las Montañas Rocosas en Costa Rica. *Rev Costarricense Ciencias Medicas* 1991; 12:51-56.
103. Fuentes L, Calderón A, Hun L. Isolation and identification of *Rickettsia rickettsii* from the rabbit tick *Haemaphysalis leporispalustris* in the Atlantic zone of Costa Rica. *Am J Trop Med Hyg* 1985; 34:564:567.
104. Peacock MG, Ormsbee RA, Johnson KM. Rickettsioses of Central America. *Am J Trop Med Hyg* 1971; 20:941-949.

105. Hun L, Troyo A, Taylor L, Barbieri AM, Labruna MB. First Report of the Isolation and Molecular Characterization of *Rickettsia amblyommii* and *Rickettsia felis* in Central America. Vector Borne Zoonotic Dis 2011; [Epub ahead of print]
106. Fuentes L. Ecological Study of Rocky Mountain Spotted Fever in Costa Rica. Am J Trop Med Hyg 1986; 35:192-196.
107. WHO 1993. Global surveillance of rickettsial diseases: memorandum from a WHO meeting. Bull World Health Organ 1993; 71:293-296.
108. Kováčová E, Sixl W, Stünzner D, Urvölgyi J, Kazár J. Serological examination of human and animal sera from six countries of three continents for the presence of rickettsial antibodies. Eur J Epidemiol 1996; 12:85-89.
109. Parola P, Matsumoto K, Socolovschi C, Parzy D, Raoult D. A tick-borne rickettsia of the spotted-fever group, similar to *Rickettsia amblyommii*, in French Guyana. Ann Trop Med Parasitol 2007; 101:185-188.
110. Chen LH, Wilson ME. Tick-borne rickettsiosis in traveler returning from Honduras. Emerg Infect Dis 2009; 15:1321-1323.
111. McCown M, Grzeszak B. Zoonotic and infectious disease surveillance in Central America: Honduran feral cats positive for *Toxoplasma*, *Trypanosoma*, *Leishmania*, *Rickettsia*, and *Lyme disease*. J Spec Oper Med. 2010; 10:41-43.
112. Estripeaut D, Aramburú MG, Sáez-Llorens X, Thompson HA, Dasch GA, Paddock CD, et al. Rocky mountain spotted fever, Panama. Emerg Infect Dis 2007; 13:1763-1765.
113. Rodaniche EC, Rodaniche A. Spotted fever in Panama. Isolation of the etiologic agent from a fatal case. Am J Trop Med Hyg 1950; 30:511-517.
114. Rodaniche EC. Natural infection of the tick *Amblyomma cajennense* with *Rickettsia rickettsii* in Panama. Am J Trop Med Hyg 1953; 2:696-699.
115. Yunker CE, Brennan JM, Hughes LE, Philip CB, Clifford CM, Peralta PH et al. Isolation of viral and rickettsial agents from Panamanian Acarina. J Med Entomol 1975; 12:250-255.
116. Bermúdez SE, Zaldívar Y, Spolidorio M, Moraes-Filho J, Miranda R, Caballero C et al. Rickettsial infection in domestic mammals and their ectoparasites in El Valle de Antón, Coclé, Panamá. Vet Parasitol 2011;(doi:10.1016/j.vetpar.2010.11.020).
117. Bermúdez SE, Eremeeva ME, Karpathy SE, Samudio FE, Zambrano ML, Zaldívar YL et al. Detection and identification of Rickettsial agents in ticks from domestic mammals in Eastern Panama. J Med Entomol 2009; 46:856-861.
118. Calero C. Outbreak of Typhus of Murine Type. Am J Trop Med 1948; 28:313-321.
119. Secretaría de Salud, Sistema Nacional de Vigilancia Epidemiológica. Rickettsiosis. Semana 6. Vigilancia Epidemiológica 2010; 6(27).
120. Eremeeva ME, Zambrano ML, Anaya L, Beati L, Karpathy S, Santos-Silva MM et al. *Rickettsia rickettsii* in *Rhipicephalus* ticks, Mexicali, Mexico. J Med Entomol 2011; 48:418-421.
121. Zarate-Aquino ML. Las rickettsias y las rickettsiasis en Mexico. In: Escobar GA, Valdespino GJ, Sepulveda AJ, ed. Vacunas, ciencia y salud. Mexico: Secretara de Salud; 1992.
122. Bustamante ME, Varela G. Distribucion de las rickettsiasis en Mexico (tifo murino, tifo clásico y fiebre manchada). Rev Inst Salub Enf Trop 1947; 8:3-14.
123. Oliveira KA, Pinter A, Medina-Sanchez A, Boppana VD, Wikel SK, Saito TB et al. *Amblyomma imitator* ticks as vectors of *Rickettsia rickettsii*, Mexico. Emerg Infect Dis 2010; 16:1282-1284.

124. Bustamante ME, Varela G. Una nueva rickettsiosis en México. Existencia de la Fiebre Manchada americana en los estados de Sinaloa y Sonora. Rev Inst Salub Enf Trop 1943; 4:189-211.
125. Martínez-Medina MA, Solís-Gallardo LP, Padilla-Zamudio G, Guevara-Tovar M. Fiebre manchada de las montañas rocosas. Informe de dos casos. Gac Méd Méx 2005; 141:309-312.
126. Mariotte CO, Bustamante ME. Hallazgo del *Rhipicephalus sanguineus* infectado naturalmente con Fiebre Manchada en Sonora (México). Rev Inst Salud Enf Trop 1944; 5:297-300.
127. Bustamante ME, Varela G. Características de la fiebre manchada de las Montañas Rocosas en Sonora y Sinaloa. Rev Inst Salub Enf Trop 1944; 5:129-136.
128. Álvarez-Hernández G. La Fiebre Manchada de las Montañas Rocosas, una epidemia olvidada. Salud Pública de México 2010; 52:1-3.
129. Martínez-Medina MA, Álvarez-Hernández G, Rojas-Guerra MG, Padilla-Zamudio JG. Fiebre Manchada de las Montañas Rocosas en niños: consideraciones clínicas y epidemiológicas. Gac Méd Méx 2007; 143:137-140.
130. Bustamante ME, Varela G. Estudios de fiebre manchada en México: Hallazgo del *Amblyomma cajennense* naturalmente infectado en Veracruz. Rev Inst Salub Enfs Trop 1946; 7:75-78.
131. Zavala-Castro JE, Zavala-Velázquez JE, Walker DH, Ruiz Arcila EE, Laviada-Molina H, Olano JP et al. Fatal human infection with *Rickettsia rickettsii*, Yucatán, Mexico. Emerg Infect Dis 2006; 12:672-674.
132. Zavala-Castro JE, Dzul-Rosado KR, León JJ, Walker DH, Zavala-Velázquez JE. An increase in human cases of spotted fever rickettsiosis in Yucatan, Mexico, involving children. Am J Trop Med Hyg 2008; 79:907-910.
133. Zavala-Velázquez JE, Ruiz-Sosa JA, Sánchez-Elias RA, Becerra-Carmona G, Walker DH. *Rickettsia felis* rickettsiosis in Yucatán. Lancet 2000; 356(9235):1079-1080.
134. Zavala-Castro JE, Zavala-Velázquez J, Walker D, Pérez-Osorio J, Peniche-Lara G. Severe human infection with *Rickettsia felis* associated with hepatitis in Yucatan, Mexico. Int J Med Microbiol 2009; 299:529-533.
135. Zavala-Velázquez JE, Zavala-Castro JE, Vado-Solís I, Ruiz-Sosa JA, Moron CG, Bouyer DH. Identification of *Ctenocephalides felis* fleas as a host of *Rickettsia felis*, the agent of a spotted fever rickettsiosis in Yucatán, Mexico. Vector Borne Zoonotic Dis 2002; 2:69-75.
136. Zavala-Velázquez J, Laviada-Molina H, Zavala-Castro J, Perez-Osorio C, Becerra-Carmona G, Ruiz-Sosa JA et al. *Rickettsia felis*, the agent of an emerging infectious disease: Report of a new case in Mexico. Arch Med Res 2006; 37:419-422.
137. Zavala-Castro JE, Zavala-Velázquez JE, del Rosario García M, León JJ, Dzul-Rosado KR. A dog naturally infected with *Rickettsia akari* in Yucatan, México. Vector Borne Zoonotic Dis 2009; 9:345-347.
138. Zavala-Castro JE, Zavala-Velázquez JE, Peniche-Lara GF, Sulú Uicab JE. Human rickettsialpox, southeastern Mexico. Emerg Infect Dis 2009; 15:1665-1667.
139. Sistema Nacional de Investigación Epidemiológica. Una Enfermedad Presente pero Olvidada, Número 46 Volumen 27 Semana 46 Del 14 al 20 de Noviembre de 2010.
140. Mercado Uribe MC, Martínez Arce PA, Contreras García H, Paredes Casillas P. Tifo epidémico en Jalisco, presentación de un caso clínico pediátrico. Enf Inf Microbiol 2006; 26:64-66.
141. Alcantara VE, Gallardo EG, Hong C, Walker DH. Typhus group *Rickettsiae* antibodies in rural Mexico. Emerg Infect Dis 2004; 10:549-551.

142. Martín-Cortés G, Gámez-Moreno R. Tifus epidémico en Nuevo León. Presentación del primer caso clínico pediátrico. *Revista de Enfermedades Infecciosas en Pediatría* 2008; v.22, n.86.
143. Medina-Sanchez A, Bouyer DH, Alcantara-Rodriguez V, Mafra C, Zavala-Castro J, Whitworth T et al. Detection of a typhus group *Rickettsia* in *Amblyomma* ticks in the state of Nuevo Leon, Mexico. *Ann N Y Acad Sci* 2005; 1063:327-332.
144. Acuna-Soto R, Calderón-Romero L, Romero-López D, Bravo-Lindoro A. Murine typhus in Mexico City. *Trans R Soc Trop Med Hyg* 2000; 94:45.
145. García GJ, Garciadiego FP, Mendoza AR, Espinosa AL, Moreno SF, Rábago AJ. Tifo murino en el estado de Oaxaca después del huracán Wilma. *An Med Asoc Med Hosp ABC* 2007; 52:198-205.
146. Zavala-Castro JE, Zavala-Velázquez JE, Sulú Uicab JE. *Murine typhus* in child, Yucatan, Mexico. *Emerg Infect Dis* 2009; 15:972-974.
147. Parola P, Jourdan J, Raoult D. Tick-borne infection caused by *Rickettsia africae* in the West Indies. *N Engl J Med* 1998; 338:1391.
148. Parola P, Vestris G, Martinez D, Brochier B, Roux V, Raoult D. Tick-borne rickettsiosis in Guadeloupe, the French West Indies: isolation of *Rickettsia africae* from *Amblyomma variegatum* ticks and serosurvey in humans, cattle, and goats. *Am J Trop Med Hyg* 1999; 60:888-893.
149. Kelly PJ, Fournier PE, Parola P, Raoult D. A survey for spotted fever group rickettsiae and ehrlichiae in *Amblyomma variegatum* from St. Kitts and Nevis. *Am J Trop Med Hyg* 2003; 69:58-59.
150. Kelly P, Lucas H, Beati L, Yowell C, Mahan S, Dame J. *Rickettsia africae* in *Amblyomma variegatum* and domestic ruminants on eight Caribbean islands. *J Parasitol* 2010; 96:1086-1088.
151. Parola P, Attali J, Raoult D. First detection of *Rickettsia africae* on Martinique, in the French West Indies. *Ann Trop Med Parasitol* 2003; 97:535-537.
152. Thorton SA. The 41st Annual meeting of Infectious Diseases Society of America, San Diego, USA, 2003: ([http://www.idsociety.org/me/am2003/ABS-\\_invitedOral.pdf](http://www.idsociety.org/me/am2003/ABS-_invitedOral.pdf)).
153. Kelly PJ, Lucas H, Eremeeva ME, Dirks KG, Rolain JM, Yowell C et al. *Rickettsia felis*, West Indies. *Emerg Infect Dis* 2010; 16:570-571.
154. Tamsitt JR, Valdivieso D. Los murcielagos y la salud pública. Estudio con especial referencia a Puerto Rico. *Boletín de la Oficina Sanitaria Panamericana (OSP)* 1970; 69:122-140.
155. Cardeñosa N, Roux V, Font V, San Feliu I, Raoult D, Segura F. Isolation and identification of two spotted fever rickettsial strains from patients in Catalonia, Spain. *Am J Trop Med Hyg* 2000; 62:142-144.
156. Fernández-Soto P, Pérez-Sánchez R, Encinas-Grandes A, Sanz RA. Detection and identification of *Rickettsia helvetica* and *Rickettsia* sp. IRS3/IRS4 in *Ixodes ricinus* ticks found on humans in Spain. *Eur J Clin Microbiol Infect Dis* 2004; 23:648-649.
157. Oteo JA, Portillo A, Santibáñez S, Blanco JR, Pérez-Martínez L, Ibarra V. Cluster of cases of human *Rickettsia felis* infection from Southern Europe (Spain) diagnosed by PCR. *J Clin Microbiol* 2006; 44:2669-2671.
158. Oteo JA, Ibarra V, Blanco JR, Martínez de Artola V, Márquez FJ, Portillo A et al. Dermacentor-borne necrosis erythema and lymphadenopathy: clinical and epidemiological features of a new tick-borne disease. *Clin Microbiol Infect* 2004; 10:327-331.
159. Aguirrebengoa K, Portillo A, Santibáñez S, Marín JJ, Montejo M, Oteo JA. Human *Rickettsia sibirica mongolitimonae* infection, Spain. *Emerg Infect Dis* 2008; 14:528-529.

160. Oteo JA, Portillo A, Blanco JR, Ibarra V, Pérez L, Izco C, et al. Low risk of developing human *Rickettsia aeschlimannii* infection in the North of Spain. *Ann N Y Acad Sci* 2005; 1063:349-351.
161. Hernández Cabrera M, Angel-Moreno A, Santana E, Bolaños M, Francès A, Martín-Sánchez MS et al. *Murine typhus* with renal involvement in Canary Islands, Spain. *Emerg Infect Dis* 2004; 10:740-743.
162. Blanco JR, Oteo JA. Rickettsiosis in Europe. *Ann N Y Acad Sci* 2006; 1078:26-33.
163. Portillo A, Ibarra V, Santibáñez S, Pérez-Martínez L, Blanco JR, Oteo JA. Genetic characterisation of ompA, ompB and gltA genes from *Candidatus Rickettsia rioja*. *Clin Microbiol Infect* 2009; 15(Suppl 2):307-308.
164. Bacellar F, Regnery RL, Nuncio MS, Filipe AR. Genotypic evaluation of rickettsial isolates recovered from various species of ticks in Portugal. *Epidemiol Infect* 1995; 114:169-178.
165. Bacellar F, Beati L, França A, Poças J, Regnery R, Filipe A. Israeli spotted fever rickettsia (*Rickettsia conorii* complex) associated with human disease in Portugal. *Emerg Infect Dis* 1999; 5:835-836.
166. Bacellar F. Ticks and Spotted fever rickettsiae in Portugal. In: Raoult D, Brouqui F, (Eds.) *Rickettsiae and rickettsial diseases at the turn of the third millennium*. Paris: Elsevier; 1999.
167. Sousa R, Santos-Silva M, Santos AS, Barros SC, Torgal J, Walker DH. *Rickettsia conorii* Israeli tick typhus strain isolated from *Rhipicephalus sanguineus* ticks in Portugal. *Vector Borne Zoonotic Dis* 2007; 7:444-447.
168. Sousa R, França A, Dória Nóbrega S, Belo A, Amaro M, Abreu T et al. Host- and microbe-related risk factors for and pathophysiology of fatal *Rickettsia conorii* infection in Portuguese patients. *J Infect Dis* 2008; 198:576-585.
169. Santos-Silva MM, Sousa R, Santos AS, Melo P, Encarnação V, Bacellar F. Ticks parasitizing wild birds in Portugal: detection of *Rickettsia aeschlimannii*, *R. helvetica* and *R. massiliae*. *Exp Appl Acarol* 2006; 39:331-338.
170. De Carvalho IL, Milhano N, Santos AS, Almeida V, Barros SC, De Sousa R. Detection of *Borrelia lusitaniae*, *Rickettsia* sp. IRS3, *Rickettsia monacensis*, and *Anaplasma phagocytophilum* in *Ixodes ricinus* collected in Madeira Island, Portugal. *Vector Borne Zoonotic Dis* 2008; 8:575-579.
171. Milhano N, De Carvalho IL, Alves AS, Arrube S, Soares J, Rodriguez P et al. Coinfections of *Rickettsia slovaca* and *Rickettsia helvetica* with *Borrelia lusitaniae* in ticks collected in a Safari Park, Portugal. *Ticks and Tick-borne Dis* 2010; 1:172-177.
172. Sousa R, Edouard-Fournier P, Santos-Silva M, Amaro F, Bacellar F, Raoult D. Molecular detection of *Rickettsia felis*, *Rickettsia typhi* and two genotypes closely related to *Bartonella elizabethae*. *Am J Trop Med Hyg* 2006; 75:727-731.
173. Alves AS, Milhano N, Santos-Silva M, Santos AS, Vilhena M, de Sousa R. Evidence of *Bartonella* spp., *Rickettsia* spp. and *Anaplasma phagocytophilum* in domestic, shelter and stray cat blood and fleas, Portugal. *Clin Microbiol Infect* 2009; 15(Suppl 2):1-3.
174. Bacellar F, Nuncio MS, Alves MJ, Filipe AR. *Rickettsia slovaca*: an agent of the group of exanthematous fevers, in Portugal. *Enferm Infecc Microbiol Clin* 1995; 13: 218-223.
175. Sousa R, Barata C, Vitorino L, Santos-Silva M, Carrapato C, Torgal J et al. *Rickettsia sibirica* isolation from a patient and detection in ticks, Portugal. *Emerg Infect Dis* 2006; 12:1103-1108.
176. Sousa R, Duque L, Anes M, Poças J, Torgal J, Bacellar F et al. *Lymphangitis* in a Portuguese patient infected with *Rickettsia sibirica*. *Emerg Infect Dis* 2008; 14:529-530.

177. Santos-Silva M, Sousa R, Santos AS, Lopes D, Queijo E, Doreta A et al. Ticks and tick-borne *Rickettsiae* surveillance in Montesinho Natural Park, Portugal. *Ann N Y Acad Sci* 2006; 1078:137-1342.
178. Bacellar F, Lencastre I, Filipe AR. Is murine typhus re-emerging in Portugal? *Euro Surveill* 1998; 3:18-20.
179. Freitas E, Freitas L, Barros A, Bacelar F, Filipe A, Almeida V. *Murine typhus*: an outbreak in Porto Santo Island-Madeira Archipelago. *Eur J Int Med* 1997; 8:120.
180. André E, Correia R, Castro P, Neto M, Roler J, Bacelar F et al. Tifo murino em Portugal. *Acta Médica Portuguesa* 1998; 11:81-85.
181. Oteo JA, Portillo A, Blanco JR, Ibarra V, Santibáñez S. *Rickettsia africae* infection. Three cases confirmed by PCR. *Med Clin (Barc)* 2004; 122:786-788.
182. Gehrke FS. Detecção e caracterização molecular de riquetsias em humanos, potenciais vetores e animais domésticos da região sudeste do Brasil. [Tese de Doutorado]. Sapo Paulo, Brasil: Instituto de Ciências Biomédicas, Universidad de São Paulo; 2010.
183. Almeida DN, Favacho AR, Rozental T, Barcauib H, Guterres A, Gomes R et al. Fatal spotted fever group rickettsiosis due to *Rickettsia conorii* conorii mimicking a hemorrhagic viral fever in a South African traveler in Brazil. *Ticks and Tick-borne Diseases* 2010; 1:149-150.
184. Hidalgo M, Salguero E, de la Ossa A, Sánchez R, Vesga JF, Orejuela L et al. *Murine typhus* in Caldas, Colombia. *Am J Trop Med Hyg* 2008; 78:321-322.
185. OPAS. Consulta de especialistas OPAS/OMS sobre rickettsioses nas Américas. Relatório final. Rio de Janeiro: Organização Pan-Americana da Saúde, Brazil; 2004.