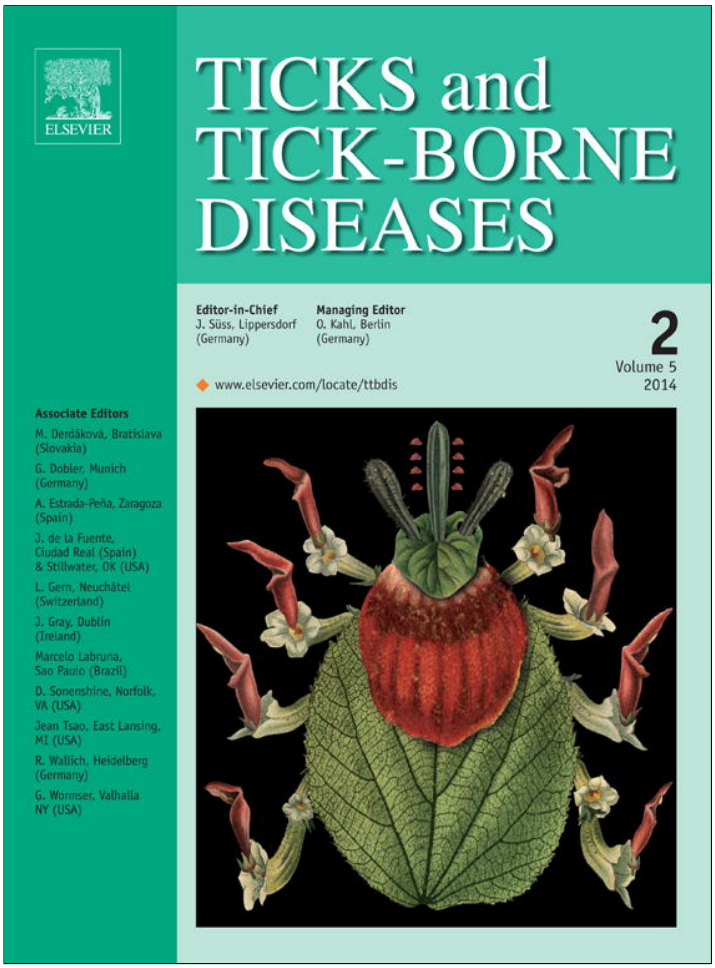

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Original article

The ticks (Acari: Ixodida: Argasidae, Ixodidae) of Bolivia

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ABSTRACT

The tick species reported in Bolivia are reviewed here as (1) endemic or established: *Ornithodoros echimys*, *O. guaporensis*, *O. hasei*, *O. kohlsi*, *O. mimon*, *O. peropteryx*, *O. rostratus*, *Otobius megnini*, *Amblyomma auricularium*, *A. cajennense*, *A. calcaratum*, *A. coelebs*, *A. dubitatum*, *A. humerale*, *A. incisum*, *A. longirostre*, *A. naponense*, *A. nodosum*, *A. oblongoguttatum*, *A. ovale*, *A. parvitarsum*, *A. parvum*, *A. pecarium*, *A. pseudoconcolor*, *A. rotundatum*, *A. scalpturatum*, *A. tigrinum*, *A. triste*, *Dermacentor nitens*, *Haemaphysalis juxtakochi*, *H. leporispalustris*, *I. boliviensis*, *I. cooleyi*, *I. luciae*, *Rhipicephalus microplus*, *R. sanguineus*, and (2) erroneously reported: *Ornithodoros puertoricensis*, *O. talaje*, *O. turicata*, *Amblyomma americanum*, *A. maculatum*, *A. multipunctum*, *Ixodes ricinus*, *I. scapularis*, *Rhipicephalus annulatus*. Many of these records are lacking locality and/or host, and some of them need new findings for confirmation. Some of the species recorded may represent a threat for human and animal health, therefore would be of great value to make a countrywide survey of ticks in order to update the information presented in this work.

Introduction

Ticks (order Ixodida, superfamily Ixodoidea) are obligatory haematophagous ectoparasites in some or all of their postembryonic stages, infesting all classes of tetrapods. Several species are vectors of agents that may cause disease and even kill their hosts; they may also cause dermatoses, loss of blood, and can inoculate toxins. Most research of ticks from the Zoogeographic Neotropical Region has been focused on species of importance to livestock or important as vector of human diseases (Guglielmone et al., 2003a).

Bolivia is currently a land-locked country with animal husbandry as an important part of its economy. Bolivia is also characterized by a great diversity of climatic conditions, and conversely a diverse autochthonous fauna, but the only comprehensive review of Bolivian ticks being that of Payno Balazans (1978). Recently, collections of Bolivian ticks have permitted the current critical review of the country's tick fauna. New data on hosts and distribution that may be useful to assess the importance of ticks on human and animal health is presented thereafter.

Materials and methods

The phylogenies followed in this review were those of Barker and Murrell (2002) for Ixodidae and of Hoogstraal (1985) for the argasid ticks. Although there has been a more recent review of the taxonomy of Argasidae (Klompen and Oliver, 1993), we follow Estrada-Peña et al. (2010) who found that the new taxonomy has no obvious improvement when compared to that of Hoogstraal (1985).

This review is based on unpublished records of ticks deposited in the Colección Boliviana de Fauna (CBF), La Paz, Bolivia, and the tick collection of the Instituto Nacional de Tecnología Agropecuaria (INTA) at Rafaela, Argentina, plus a thorough appraisal of the scientific literature. Tick stages found on hosts or in the environment are detailed; anytime that the words "adult ticks" is used, the sex of the mentioned ticks is unknown. Whenever appropriate, the recorded names of mammalian hosts have been changed to follow those in Wilson and Reeder (2005) and Dunnum and Salazar-Bravo (2010a,b) for mammals in general and Rodentia: Caviinae in particular, respectively.

The tick fauna of Bolivia is discussed under 2 major headings: (1) endemic or established tick species and (2) species erroneously recorded for Bolivia. Records of ticks with no species definition are also included under the first heading. Remarks on tick families and genera are not included because these were treated in González-Acuña and Guglielmone (2005). Unless specifically stated, the

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known world distribution of each species follows Guglielmone et al. (2003a).

The collection localities according to each Bolivian department for each tick species are listed in the text and in Table 1. The coordinates from many "unnamed localities" are the result of an approximate approach by the authors taking the maps of Bolivian tick distribution in Payno Balazans (1978).

According to Ibisch and Mérida (2003), biogeography of Bolivia comprises 3 main regions: Tierras Bajas (TB), the vertiente Oriental Andina (OA), and the Cordilleras altas y el Altiplano (CA&AP). Following the criteria of Morrone (2006), the territory of TB is divided in Chaco and Pantanal. We adopt this division for comparison with similar studies in this region (Guglielmone and Nava, 2005; Nava et al., 2007a).

Included in TB Pantanal are the Bosques del Sudoeste de la Amazonía, Cerrado (paceño and beniano), Sabanas Inundables, and Bosque seco Chiquitano, comprising the departments of Beni and Pando and parts of Cochabamba and Santa Cruz. It is characterized by an annual rainfall of 1000–7000 mm, mean annual temperatures between 23 and 28 °C, and a landscape of mountains with deep valleys, slabs, evergreen woodlands in gullies, hills, alluvial terraces, plains and amazonic flatlands, savannas, and rain flooding. TB Chaco includes Cerrado (chaqueño and chiquitano) and Gran Chaco (departments of Chuquisaca, Santa Cruz, and Tarija) with an annual rainfall of 400–1400 mm, mean annual temperatures of 20–26 °C, and landscapes of flatlands with low hills and soft undulations.

OA includes Yungas, Bosque Tucumano-Boliviano, Chaco Serrano, Bosques Secos Interandinos, and Prepuna, in the departments of Chuquisaca, Cochabamba, La Paz, Potosí, Santa Cruz, and Tarija. Mean annual rainfall of this region can be as low as 300 mm in Prepuna to 6000 mm in the Yungas, with annual mean temperatures of 5–24 °C, and landscapes shaped by steep slopes, broad valleys, semidesert valleys, ridges, low hills, small plains, and foothills. CA&AP with Puna Norteña and Puna Sureña include the department of Oruro and parts of Cochabamba, Chuquisaca, La Paz, Potosí, and Tarija, with an annual rainfall of 50–1600 mm, with annual average temperatures of 0–10 °C, and landscapes of hills, mountains, high plateaus, peaks, rocky ridges, slopes, highland plains and hills, wide valleys with glaciers, dunes, and salt flats. Figs. 1 and 2 depict the administrative division of Bolivia and the broad biogeographical division of the country.

Results

Endemic or established tick species

Argasidae *Canestrini*

Ornithodoros Koch; *Ornithodoros echimys* Kohls, Clifford & Jones: BENI, Río Iténez (= Río Guaporé), opposite of Costa Marques in Brazil is recorded by Jones et al. (1972) who found larvae on *Marmosa* sp. *Ornithodoros echimys* is also known from Venezuela (Guglielmone et al., 2003a).

Ornithodoros guaporensis Nava, Venzal, and Labruna: BENI, Guaporé River, where adults were collected from a rocky fissure inhabited by bats of the species *Centronycteris maximiliani* (Fischer, 1829) (Chiroptera: Emballonuridae) (Nava et al., 2013).

Ornithodoros hasei (Schulze): BENI, Magdalena, San Joaquín, larvae on *Noctilio labialis* and *Eumops* sp. (Kohls et al., 1965); SANTA CRUZ, 6 km West of Ascención is reported by Dick et al. (2007) from larva collected on *N. labialis*. This Neotropical species ranges from southern Mexico to Argentina (Nava et al., 2007b). Jones et al. (1972) observed morphological variation among specimens from different Venezuelan localities and concluded that more than one taxon may be included under the name *O. hasei*.

Table 1
Tick collection sites in each department of Bolivia, with their geographical range.

Department and collection site	Coordinates
BENI	
Estancia Totai (25 km south of San Joaquín)	13°16′ S, 64°40′ W
Guaporé River	12°55′ S, 62°52′ W
La Asunta	12°56′ S, 64°53′ W
Las Moscas (community near San Joaquín)	14°06′ S, 66°44′ W
Magdalena	13°20′ S, 64°07′ W
Orobayaya	13°21′ S, 63°45′ W
Providencia	14°35′ S, 64°46′ W
(Mouth of) Río Baures	12°30′ S, 64°16′ W
Río Iténez (= Guaporé), opposite of Costa Marques in Brazil	12°28′ S, 64°14′ W
San Joaquín	14°06′ S, 66°44′ W
(17 km north of) San Joaquín	13°56′ S, 66°44′ W
Trinidad	14°50′ S, 64°54′ W
Unnamed locality 1	13°07′ S, 65°16′ W
Unnamed locality 2	13°27′ S, 65°08′ W
Unnamed locality 3	13°27′ S, 64°50′ W
Unnamed locality 4	13°34′ S, 65°18′ W
Unnamed locality 5	13°44′ S, 65°25′ W
Unnamed locality 6	13°48′ S, 65°06′ W
Unnamed locality 7	13°50′ S, 66°23′ W
Unnamed locality 8	14°00′ S, 65°15′ W
Unnamed locality 9	14°08′ S, 66°36′ W
Unnamed locality 10	14°10′ S, 67°00′ W
Unnamed locality 11	15°11′ S, 64°50′ W
Unnamed locality 12	15°21′ S, 64°51′ W
Unnamed locality 13	15°23′ S, 64°34′ W
Unnamed locality 14	15°45′ S, 64°30′ W
Yucumo	15°15′ S, 67°03′ W
CHUQUISACA	
Cuevo	20°27′ S, 63°31′ W
Padilla	19°18′ S, 64°18′ W
Pirirenda	20°15′ S, 63°47′ W
South Western Region	20°00′ S, 63°50′ W
Sucre	19°02′ S, 65°15′ W
Tarabuco	19°10′ S, 64°55′ W
Unnamed locality 1	19°52′ S, 63°46′ W
Unnamed locality 2	20°32′ S, 63°30′ W
Unnamed locality 3	20°48′ S, 63°19′ W
Unnamed locality 4	20°51′ S, 63°11′ W
Unnamed locality 5	20°55′ S, 63°30′ W
COCHABAMBA	
Charapaya (= Charuplaya)	17°22′ S, 66°45′ W
Cochabamba	17°23′ S, 66°09′ W
(Close to) Cotapachi	17°26′ S, 66°18′ W
Las Lomas	17°21′ S, 66°08′ W
Quillacollo	17°24′ S, 66°17′ W
Sacaba	17°24′ S, 66°02′ W
Tiquipaya	17°20′ S, 66°13′ W
Unnamed locality 1	16°57′ S, 65°50′ W
Unnamed locality 2	17°18′ S, 66°03′ W
(26 km west of) Villa Tunari	16°54′ S, 65°36′ W
LA PAZ	
Cañuhuma	15°02′ S, 69°13′ W
Chulumani	16°24′ S, 67°31′ W
Huacochani	14°59′ S, 69°13′ W
Nube Pampa	14°53′ S, 69°13′ W
Puna norteña ecoregión	15°03′ S, 69°13′ W
Puna norteña ecoregion	14°58′ S, 69°10′ W
Valle de Yungas	15°41′ S, 67°05′ W
ORURO	
Oruro	17°58′ S, 67°06′ W
PANDO	
Chiquitos	10°24′ S, 66°24′ W
Unnamed locality 1	11°52′ S, 67°05′ W
SANTA CRUZ	
(6 km west of) Ascensión	15°43′ S, 63°09′ W
Boyuibe	20°24′ S, 63°16′ W
Buen Retiro	17°16′ S, 63°42′ W
Cabezas	18°47′ S, 63°18′ W
Cerro Cortado	19°32′ S, 62°19′ W
Charagua	19°47′ S, 63°13′ W
El Salvador	20°25′ S, 63°33′ W

Table 1 (*Continued*)

Department and collection site	Coordinates
Gutiérrez	19°25′ S, 62°28′ W
Ipati	19°44′ S, 63°36′ W
Izozog Indigenous Territory	19°20′ S, 62°40′ W
Lago Caimán Camp	13°35′ S, 60°54′ W
Monos	18°44′ S, 63°54′ W
Parque Nacional Gran Chaco	18°30′ S, 60°48′ W
Parque Nacional Noel Kempff Mercado, Mangabalito Camp	13°47′ S, 60°33′ W
Parque Nacional Noel Kempff Mercado 2	14°12′ S, 60°47′ W
Provincia Andrés Ibañez	17°45′ S, 63°45′ W
Provincia Ichilo	17°00′ S, 64°00′ W
Provincia Obispo Santistevan	16°40′ S, 63°30′ W
Provincia Sara	16°50′ S, 63°55′ W
Provincia Warnes	17°30′ S, 63°10′ W
Río Grande	17°24′ S, 62°42′ W
Santa Cruz de la Sierra	17°47′ S, 63°16′ W
(8 km to the east of) Santa Cruz de la Sierra	17°48′ S, 63°20′ W
Sauzalito	17°24′ S, 63°27′ W
Tierra Comunitaria de Origen	19°31′ S, 61°18′ W
Unnamed locality 1	16°07′ S, 62°14′ W
Unnamed locality 2	16°08′ S, 62°00′ W
Unnamed locality 3	16°17′ S, 62°25′ W
Unnamed locality 4	16°22′ S, 62°06′ W
Unnamed locality 5	16°25′ S, 58°31′ W
Unnamed locality 6	16°37′ S, 62°28′ W
Unnamed locality 7	16°53′ S, 62°21′ W
Unnamed locality 8	17°03′ S, 63°11′ W
Unnamed locality 9	17°17′ S, 63°11′ W
Unnamed locality 10	17°24′ S, 64°00′ W
Unnamed locality 11	17°28′ S, 62°49′ W
Unnamed locality 12	17°30′ S, 61°00′ W
Unnamed locality 13	17°45′ S, 63°18′ W
Unnamed locality 14	17°58′ S, 64°18′ W
Unnamed locality 15	18°03′ S, 63°33′ W
Unnamed locality 16	18°07′ S, 59°15′ W
Unnamed locality 17	18°07′ S, 60°18′ W
Unnamed locality 18	18°12′ S, 63°33′ W
Unnamed locality 19	18°19′ S, 64°17′ W
Unnamed locality 20	18°25′ S, 59°21′ W
Unnamed locality 21	18°37′ S, 59°00′ W
Unnamed locality 22	19°00′ S, 57°55′ W
Unnamed locality 23	19°00′ S, 63°00′ W
Unnamed locality 24	19°11′ S, 62°45′ W
Unnamed locality 25	19°19′ S, 63°23′ W
Unnamed locality 26	19°34′ S, 63°23′ W
Unnamed locality 27	19°34′ S, 63°28′ W
Unnamed locality 28	19°38′ S, 62°47′ W
Unnamed locality 29	19°38′ S, 63°14′ W
Unnamed locality 30	19°39′ S, 58°12′ W
Unnamed locality 31	19°43′ S, 63°23′ W
Unnamed locality 32	19°46′ S, 63°38′ W
Unnamed locality 33	19°57′ S, 63°26′ W
Unnamed locality 34	20°00′ S, 62°56′ W
Unnamed locality 35	20°10′ S, 63°30′ W
Valle Grande	18°29′ S, 64°06′ W
Village (unnamed)	19°23′ S, 62°31′ W
Villa Montes	14°17′ S, 62°21′ W
TARIJA	
Tarija	21°31′ S, 64°44′ W
Unnamed locality 1	21°58′ S, 63°22′ W
Unnamed locality 2	21°59′ S, 63°51′ W

Ornithodoros kohlsi Guglielmone and Keirans, originally named *Ornithodoros boliviensis* Kohls and Clifford a pre-occupied name. BENI, Estancia Totai where females were found biting man and a male crawling on a human being; La Asunta, larvae on *Myotis nigricans*; Las Moscas (an indigenous community in the surroundings of San Joaquín) where larvae were found on *M. nigricans*; Magdalena, larvae also on *M. nigricans*; Orobayaya, male, females, and nymphs were found in a house and larvae on *M. nigricans*; Providencia where male, female, nymphal, and larval ticks were determined in houses and larvae on *M. nigricans*; San Joaquín, males, females, and nymphs in houses and larvae on *M. nigricans* and *Molossus major*. All the information about *O. kohlsi* in Bolivia was obtained from Kohls and Clifford (1964). This species has been determined also in southern Mexico and Venezuela (Jones et al., 1972).

Ornithodoros mimon Kohls, Clifford & Jones: BENI, mouth of Río Baures where larvae were determined feeding on *Mimon crenulatum* by Kohls et al. (1969). *Ornithodoros mimon* is also known from Argentina, Brazil, and Uruguay (Barros-Battesti et al., 2011).

Ornithodoros peropteryx Kohls, Clifford, and Jones: BENI, Guaporé River. Larval ticks were collected from 9 bats of the species *Centronycteris maximiliani* (Fischer, 1829) (Chiroptera: Emballonuridae) on a farm in northeastern Bolivia at the border with Brazil (Venzal et al., 2013).

Ornithodoros rostratus Aragão: SANTA CRUZ, Santa Cruz de la Sierra, Payno Balazans (1978) presents a general statement about this tick species feeding on man and domestic pig. Boero (1957) has a vague definition about its presence in the "Chaco Region". This species is also established in Argentina, Brazil, and Paraguay (Nava et al., 2007a).

Ornithodoros sp.: COCHABAMBA, close to Cotapachi, INTA 2162, 4 nymphs from the environment, collected on May 2009 and sent to INTA by P. Parola. SANTA CRUZ, Monos, larvae on *Lagidium viscaccia* Fonseca (1959).

Otobius Banks; *Otobius megnini* (Dugès): CHUQUISACA, Sucre, nymphs on man (Bacherer Gutiérrez, 1931); Tarabuco, unknown tick stage on donkey (Munro, 1960). COCHABAMBA, Cochabamba, nymphs and larvae on cattle (Bulman and Walker, 1979); Torregianni (1912) allegedly found females and larvae on donkey and cattle (under the name *Otophilus asini*) in the Bolivian Highplateau, but the female of this tick is not parasitic and this author probably confuses the female with the nymph of *O. megnini*. Torregianni (1914) recognizes that *O. asini* is a synonym of *O. megnini*, a tick species with an ample worldwide distribution (Keirans and Pound, 2003).

Ixodidae *Murray*

Amblyomma Koch; *Amblyomma auricularium* (Conil): BENI, 17 km north of San Joaquín where male and female ticks were found on *Chrysocyon brachyurus* by Robbins and Deem (2002). *Amblyomma auricularium* is found from Argentina throughout the Neotropics and into the southern U.S.A. (Nearctic) feeding mostly on armadillos (Guglielmone et al., 2003b).

Amblyomma cajennense (Fabricius): BENI, unnamed localities 5, 7, 8, 9, and 12, tick stages unknown, and hosts could be either cattle, deer, domestic pig, horse, man, or any combination of them (Payno Balazans, 1978); San Joaquín, male and female ticks on man (Guglielmone et al., 2006); Yucumo, where at least adult ticks were found on cattle (Condori et al., 2010). CHUQUISACA, Cuevo, where a nymph has been detected on *Galea* probably *leucoblephara* (Guglielmone and Nava, 2010); unnamed localities 1 and 5, tick stages unknown and hosts could be either cattle, deer, domestic pig, horse, man, or any combination of them (Payno Balazans, 1978). SANTA CRUZ, El Salvador, INTA 1582, 2 females, from cattle, collected by A.A. Guglielmone on November 14, 1987; Lago Caimán Camp, male ticks on *Tayassu pecari* (Robbins et al., 1998); Santa Cruz de la Sierra, several localities around this city and unnamed localities 1, 4, 10, 12, 20, 21, 24, 31, 33, and 35, tick stages unknown, and hosts could be either cattle, deer, domestic pig, horse, man, or any combination of them (Payno Balazans, 1978); Izozog indigenous territory, *Tolypeutes matacus* (Deem et al., 2009). Fiorello et al. (2006) detected adult ticks on *Pseudalopex gymnocercus* at an unknown locality within Santa Cruz department. Fonseca (1959) determined females and nymphs of *Amblyomma cajennense* on *Dasyprocta variegata* at Novillos, a locality that we were unable to relocate. *Amblyomma cajennense* is common from northern Argentina northward throughout the Neotropics and into the (Nearctic) southern U.S.A., but a complex of species are considered

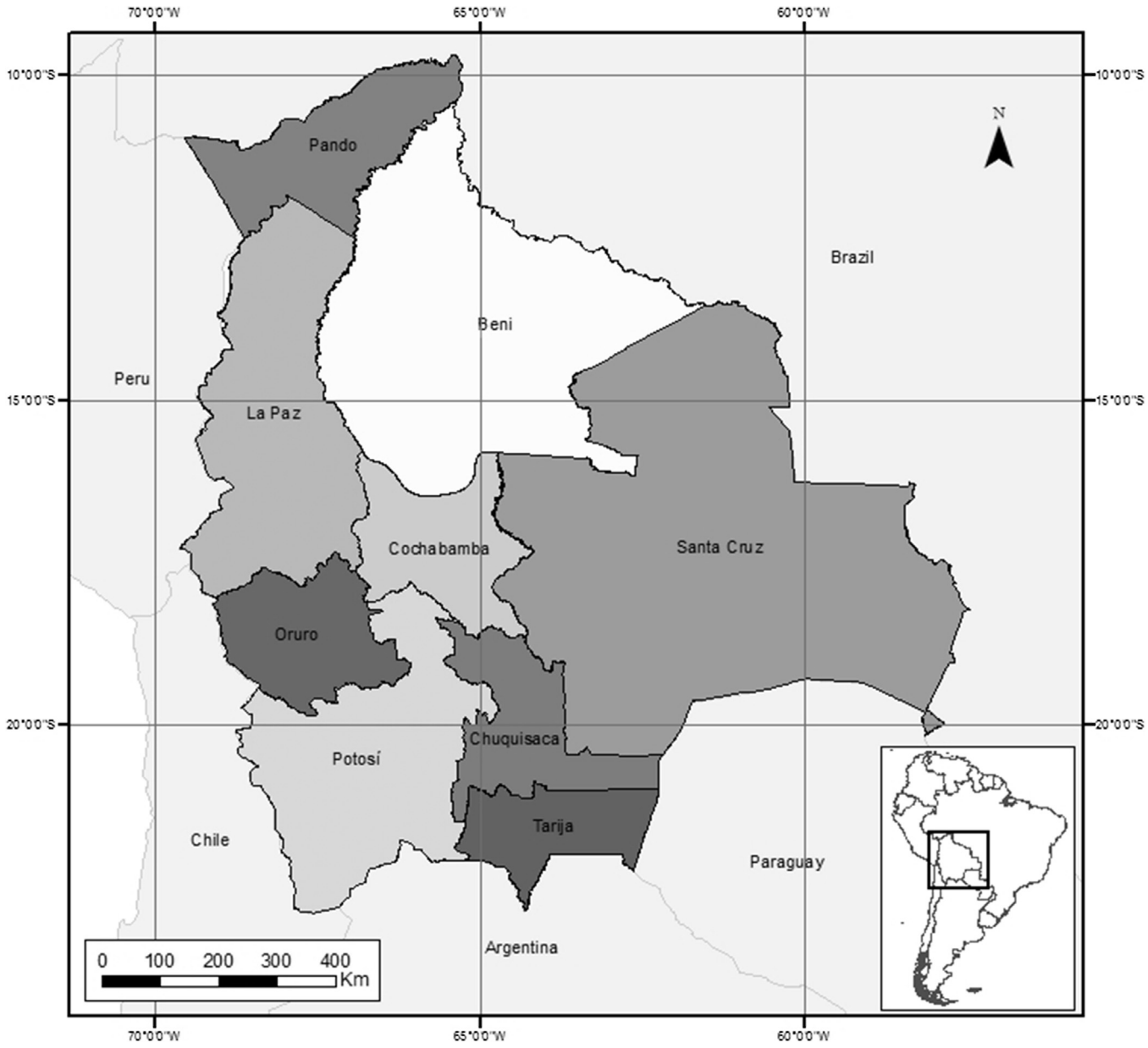

Fig. 1. Administrative division of Bolivia, showing the departmental borders.

to be included under this name (Labruna et al., 2011; Mastropaolo et al., 2011).

Amblyomma calcaratum Neumann: SANTA CRUZ, Buen Retiro, male ticks on *Tamandua tetradactyla* (Fonseca, 1959). *Amblyomma calcaratum* is a common parasite of *T. tetradactyla* from southern Mexico to Argentina (Guglielmone et al., 2003a; Guzmán-Cornejo et al., 2006).

Amblyomma coelebs Neumann: COCHABAMBA, 26 km West of Villa Tunari, males, females, and probably nymphs were found on *Tapirus terrestris* by Boero and Prosen (1955). PANDO, Chiquitos, male and female ticks on *Tapirus* sp. (Neumann, 1906). *Amblyomma coelebs* adults are mostly found on Tapiridae from Mexico to Argentina (Guglielmone et al., 2003a).

Amblyomma dubitatum Neumann: Keirans and Brewster (1981) vaguely refer that this tick species (under the name *Amblyomma cooperi* Nuttall and Warburton) is a parasite of capybaras and tapirs in Paraguay, Bolivia, Brazil, Uruguay, and Argentina. *Amblyomma dubitatum* is a common parasite of the capybara *Hydrochoerus hydrochaeris*, and its hosts and distribution have been recently reviewed by Nava et al. (2010).

Amblyomma humerale Koch: SANTA CRUZ, Parque Nacional Noel Kempff Mercado, 2 male ticks found on *Chelonoidis denticulata* (= *Geochelone denticulata*) by Robbins et al. (2003).

Amblyomma incisum Neumann: COCHABAMBA, 26 km west of Villa Tunari, female ticks were found on its commonest host, *Tapirus terrestris*, by Boero and Prosen (1955). Neumann (1906) registered the presence of a male on *Tapirus* sp., but provides no data about of the Bolivian locality where the tick was collected. Labruna et al. (2005) demonstrated, however, that, on several occasions, *A. incisum* has been confused with *Amblyomma scalpturatum* Neumann or *Amblyomma latepunctatum* Tonelli-Rondelli. *Amblyomma incisum* is also known from Argentina, Brazil. Paraguay, and Peru, while its presence in Ecuador, French Guiana, Guyana, and Venezuela is uncertain.

Amblyomma longirostre (Koch): COCHABAMBA, Charapaya, a male on *Coendou bicolor* (Keirans, 1982).

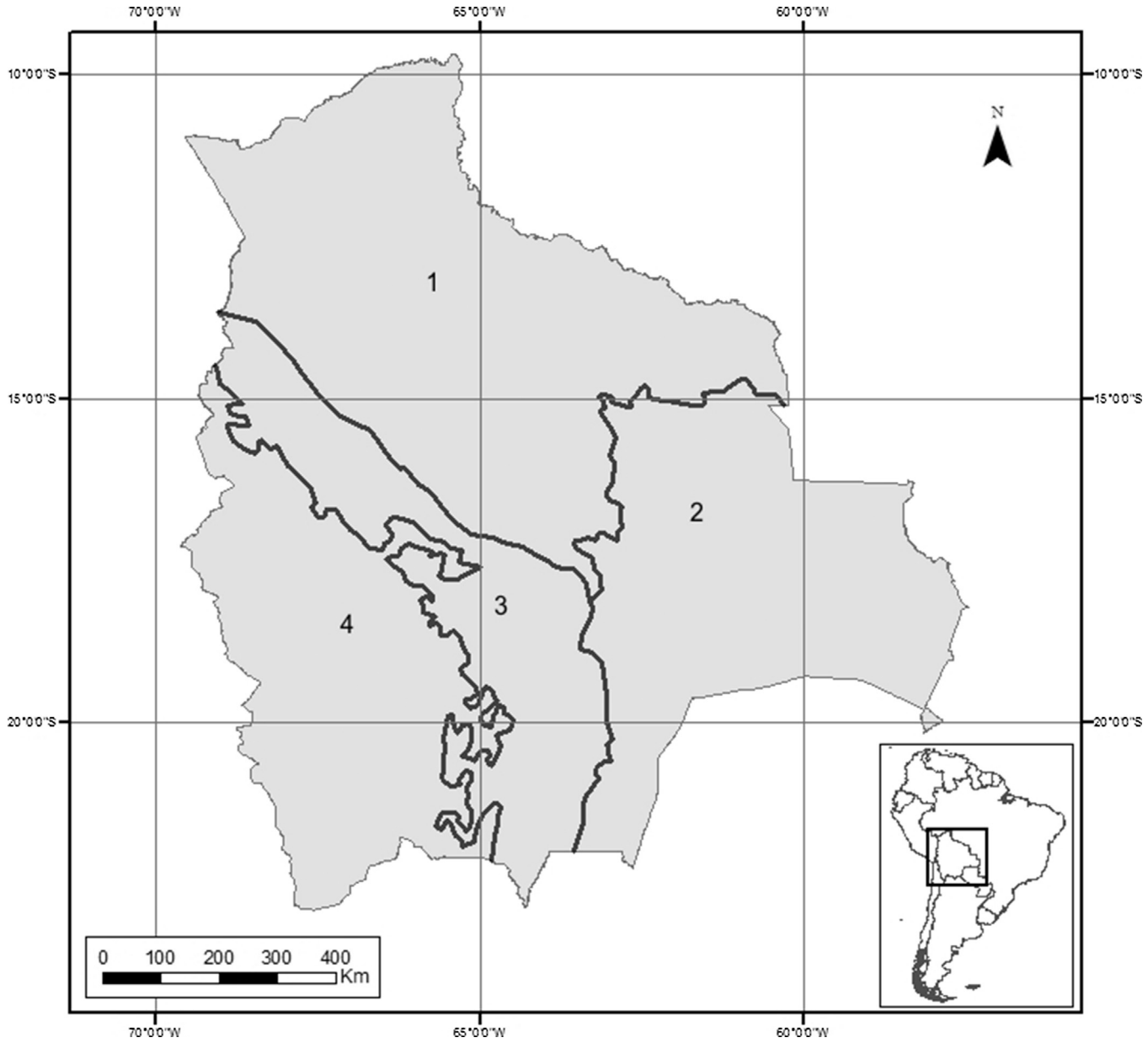

Fig. 2. The biogeography of Bolivia modified from Ibisch and Mérida (2003). (1) Tierras bajas, Pantanal; (2) Tierras bajas, Chaco; (3) Vertiente Oriental Andina; (4) Cordilleras altas and Altiplano.

Amblyomma naponense (Packard): SANTA CRUZ: Lago Caimán Camp, male and female ticks on *Tayassu pecari* (Robbins et al., 1998).

Amblyomma nodosum Neumann: SANTA CRUZ, Buen Retiro, male ticks were detected on *Tamandua tetradactyla* by Fonseca (1959).

Amblyomma oblongoguttatum Koch: SANTA CRUZ: Lago Caimán Camp, male and female ticks on *T. pecari* (Robbins et al., 1998). Neumann (1899) had a record of a female of *A. oblongoguttatum* (under the name *Amblyomma vittatum*) for Bolivia, but there is no identification of the locality.

Amblyomma ovale Koch: COCHABAMBA, Charapaya, male and female ticks on *Speothos venaticus* (Keirans, 1982); 26 km west of Villa Tunari, male ticks were found on *Tapirus terrestris* under the name *Amblyomma fossum* Neumann by Boero and Prosen (1955). SANTA CRUZ, Mangabalito Camp in Noel Kempff Mercado National Park where a female tick was found on *Chrysocyon brachyurus* by Robbins and Deem (2002), while Fiorello et al. (2006) reported adults of *A. ovale* for *Cerdocyon thous* for this department, but the locality was not identified.

Amblyomma parvitarsum Neumann: LA PAZ, Cañuhuma, Huacochani, Nube Pampa, adult ticks collected from *Vicugna vicugna* (Beltrán-Saavedra et al., 2011); Puna norteña Ecoregion, INTA 2154, 2 males, *V. vicugna*, collected by L.F. Beltrán-Saavedra on November 4, 2006; Puna norteña Ecoregion, INTA 2153, 2 females, *V. vicugna*, collected by L.F. Beltrán-Saavedra on October 28, 2006. Dios (1917) vaguely reported the presence of males and females of *A. parvitarsum* (under the name *Amblyomma altiplanum* Dios) on llamas in the Argentinean-Bolivian Andean Highplateau, while Neumann's original description of *A. parvitarsum* mentions a female tick from Bolivia without any further information (Neumann, 1901).

Amblyomma parvum Aragão: SANTA CRUZ, Izozog Indigenous Territory where adult ticks were found on *Mazama gouazoubira* by Deem et al. (2004) and male and female ticks on *Tolypeutes mataco* and *Dasypus novemcinctus* by Deem et al. (2009); Parque Nacional

Gran Chaco, adult ticks on *C. thous* and *Leopardus pardalis* (Fiorello et al., 2006); Isoseño-Guarani Indigenous Territory, adult ticks on *C. thous*, *Puma yaguaroundi* (= *Herpailurus yaguaroundi*), *L. pardalis*, *L. geoffroyi* (= *Oncifelis geoffroyi)*, and *P. gymnocercus* (Fiorello et al., 2006); unnamed village, adult ticks on *L. geoffroyi* and *P. gymnocercus* (Fiorello et al., 2006). Guglielmone et al. (1990) recorded 2 males of *A. parvum* on a human being in Bolivia without any further data.

Amblyomma pecarium Dunn: SANTA CRUZ: Lago Caimán Camp, male and female ticks on *T. pecari* (Robbins et al., 1998).

Amblyomma pseudoconcolor Aragão: SANTA CRUZ, Cerro Cortado, male and female ticks on *D. novemcinctus*, *T. matacus*, and male ticks on *M. gouazoubira* and *Euphractes sexcinctus* (Robbins et al., 2003); Izozog Indigenous Territory where adult ticks were found on *M. gouazoupira* by Deem et al. (2004) and male and female ticks on *T. matacus* and *D. novemcinctus* by Deem et al. (2009).

Amblyomma rotundatum Koch: Jones et al. (1972) vaguely referred that this tick species to be established in Bolivia and other Neotropical countries.

Amblyomma scalpturatum Neumann: COCHABAMBA, 26 km west of Villa Tunari, male and female ticks were found on *T. terrestris* by Boero and Prosen (1960). Neumann (1906) registered the presence of a female on *Tapirus* sp., but provides no data about of the Bolivian locality where the tick was collected.

Amblyomma tigrinum Koch: COCHABAMBA, Cochabamba, adult ticks on dog, Las Lomas and Tiquipaya, male and female ticks on dogs (Tomassone et al., 2010). CHUQUISACA, Cuevo and Padilla where nymphs were detected on *Galea* probably *leucoblephara* (Guglielmone and Nava, 2010). SANTA CRUZ, Charagua, nymphs on *Galea* probably *leucoblephara* (Guglielmone and Nava, 2010); Ipati, a male tick on *C. thous* (Fonseca, 1959); Mangabalito Camp in Noel Kempff Mercado National Park where male and female ticks were found on *C. brachyurus* by Robbins and Deem (2002); Parque Nacional Noel Kempff Mercado, 2 adult ticks on *C. thous* (Fiorello et al., 2006), INTA 1947, one male, *C. brachyurus*, collected by E. Bronson, September or October 2005; INTA 1949, one male and 2 females, *C. brachyurus*, collected by E. Bronson, September or October 2005; Isoseño-Guarani Indigenous Territory, adult ticks on *P. gymnocercus* (Fiorello et al., 2006). Vale grande (sic), nymph on *Galea* (*leucoblephara*?) (Guglielmone and Nava, 2010).

Amblyomma triste Koch: SANTA CRUZ, Noel Kempff Mercado National Park, INTA 1948, INTA 1950, one male each, *C. brachyurus*, collected by E. Bronson, September or October 2005; INTA 1951, 3 females, *C. brachyurus*, collected by E. Bronson, September or October 2005.

Amblyomma sp.: CHUQUISACA, Cuevo and Padilla where immature ticks (larvae, nymphs) were detected on *Galea* probably *leucoblephara*, and Pirirenda where immature ticks were detected on *Rattus alexandrinus* (Fonseca, 1959). SANTA CRUZ, Buen Retiro, immature ticks were detected on *Dasyprocta variegata*; Cabezas, immature ticks on *Hesperomys muricolis* and *Lagostomus maximus*; Charagua, immature ticks on *Galea* probably *leucoblephara* and *Rattus alexandrinus*; Gutiérrez, immature ticks on *Oryzomys* sp. (Fonseca, 1959); Izozog Indigenous Territory where immature ticks were found on *M. gouazoubira* by Deem et al. (2004) and nymphs on *T. matacus* and *D. novemcinctus* by Deem et al. (2009); Lago Caimán Camp, nymphs and larvae on *T. pecari* (Robbins et al., 1998); Valle Grande, immature ticks on *Galea* probably *leucoblephara* (Fonseca, 1959); Villa Montes, larvae and/or nymphs on *Tamandua tetradactyla* (Fonseca, 1959); TARIJA, Tarija, where a nymph and a larva was detected on *Galea* probably *leucoblephara* (Guglielmone and Nava, 2010).

Haemaphysalis Koch; *Haemaphysalis juxtakochi* Cooley: Jones et al. (1972) vaguely referred that this tick species is established in Bolivia and other Neotropical countries.

Haemaphysalis leporispalustris (Packard): Boyuibe and Buen Retiro, males, females, nymphs, and larvae on *Sylvilagus brasiliensis* (Fonseca, 1959).

Haemaphysalis sp.: SANTA CRUZ, unnamed locality 14, on cattle, tick stage found on hosts not given (Payno Balazans, 1978).

Ixodes Latreille; *Ixodes boliviensis* Neumann: Charuplaya, a male, a female, and a nymph on *Speothos venaticus* (Neumann, 1904).

Ixodes cooleyi Aragão and Fonseca: ORURO, Oruro, a female tick on *Ctenomys* sp. (Barros-Battesti and Knysak, 1999).

Ixodes luciae Sénevet: SANTA CRUZ, Buen Retiro, males, females, nymphs, and larvae on *Didelphis albiventris* (= *D. paraguayensis*), a female on *Cuniculus paca* (Fonseca, 1959).

Ixodes sp.: SANTA CRUZ, Buen Retiro, immature ticks were detected on *D. variegata*, *Graomys griseoflavus*, *Oecomys mamorae* (Fonseca, 1959).

Dermacentor Koch; *Dermacentor nitens* Neumann: BENI, San Joaquín, larvae on human being (Guglielmone et al., 2006); unnamed localities 1 and 8, tick stages unknown, and hosts could be either horse, goat, and deer or any combination of them (Payno Balazans, 1978). CHUQUISACA, unnamed localities 3 and 4, tick stages unknown and hosts could be horse, goat, and deer or any combination of them (Payno Balazans, 1978). SANTA CRUZ, Santa Cruz de la Sierra, unknown tick stages on horses (Munro, 1960); unnamed localities 3, 7, 11, and 17, tick stages unknown, and hosts could be horse, goat, or deer or any combination of them (Payno Balazans, 1978).

Rhipicephalus Koch; *Rhipicephalus microplus* (Canestrini): BENI, Trinidad and 8 localities close to, tick stages unknown, and hosts could be cattle, goat, horse, or sheep or any combination of them (Payno Balazans, 1978); San Joaquín, male ticks on man (Guglielmone et al., 2006); unnamed localities 3, 4, 6, 9, 11, and 14, tick stages unknown, and hosts could be cattle, goat, horse or sheep or any combination of them (Payno Balazans, 1978); Yucumo, at least adult ticks were found on cattle (Condori et al., 2010). CHUQUISACA, South Western Region, tick stages unknown, and hosts could be cattle, goat, horse, or sheep or any combination of them (Payno Balazans, 1978). COCHABAMBA, Quillacollo, INTA 1585, 2 males, one female, and one nymph from cattle collected by A.A. Guglielmone on November 24, 1987; unnamed localities 1 and 2, tick stages unknown, and hosts could be cattle, goat, horse, or sheep or any combination of them (Payno Balazans, 1978). LA PAZ, Chulumani, unknown tick stages on cattle and horses (Munro, 1960, who named this species *Boophilus annulatus microplus*); Valle de Yungas, tick stages unknown, and hosts could be cattle, goat, horse, or sheep or any combination of them (Payno Balazans, 1978). PANDO, unnamed locality 1, tick stages unknown, and hosts could be cattle, goat, horse, or sheep or any combination of them (Payno Balazans, 1978). SANTA CRUZ, El Salvador, INTA 1583, 2 females from cattle, collected by A.A. Guglielmone on November 14, 1987; Provinces Andrés Ibañez, Ichilo, Obispo Santistevan, Sara, and Warnes, female ticks on cattle (Villarroel-Alvarez et al., 2006); 8 km east of Santa Cruz de la Sierra, INTA 1584, one male, one female, and 2 nymphs from cattle, collected by A.A. Guglielmone on November 20, 1987; Sauzalito, INTA 1586, one male, one female, and one nymph each from cattle, collected by A.A. Guglielmone on November 18, 1987; unnamed localities 5, 16, 22, and 30, tick stages unknown, and hosts could be cattle, goat, horse, or sheep or any combination of them plus many localities for *R. microplus* sites around Santa Cruz de la Sierra, but most of them along the border of Santa Cruz department with Chuquisaca department up to the border with Tarija department with no information on hosts or tick stages found (Payno Balazans, 1978). TARIJA, unnamed locality 2, tick stages unknown, and hosts could be cattle, goat, horse, or sheep

or any combination of them (Payno Balazans, 1978). Torregianni (1912, 1914) presented confusing information on what appear to be records of *R. microplus* from Santa Cruz department with many synonyms including some erroneous ones like *Rhipicephalus sanguineus* (Latreille).

Rhipicephalus sanguineus (Latreille) complex tick group: SANTA CRUZ, Santa Cruz de la Sierra, adult ticks and nymphs on dogs (Payno Balazans, 1978). See also *R. microplus* above.

Tick species erroneously reported from Bolivia

Argasidae *Canestrini*

Ornithodoros puertoricensis Fox. Capriles and Gaud (1977) vaguely reported the presence of this tick species in Bolivia given no hosts or locality to back this statement, but there is no evidence that *O. puertoricensis* is established in Bolivia (Venzal et al., 2008).

Ornithodoros talaje (Guérin-Méneville). Ryelandt et al. (2011) asserted that this species (named as *Carios talaje*) was found in the Central Valley of Cochabamba, ignoring the study of Venzal et al. (2008) who found no evidence to consider Bolivia within the range of this species.

Ornithodoros turicata (Dugés). Hoogstraal (1985) clearly stated that this species is distributed within the Nearctic Region; therefore, we consider the record of this tick in the Valle Grande (Santa Cruz department) by Torregianni (1914) as erroneous.

Ixodidae *Murray*

Amblyomma americanum (Linnaeus). Payno Balazans (1978) registered the presence of *A. americanum* in Beni (unnamed locality 12), Chuquisaca (unnamed locality 4), and Santa Cruz (unnamed localities 2, 13, 23, 26, 27, 28, and 29) on cattle, dog, horse or man, but this is strictly a Nearctic species (Guglielmone et al., 2003a). One of us (AAG) revised tick species deposited in the Laboratorio de Investigación y Diagnóstico Veterinario (LIDIVET) in Santa Cruz city named as *A. americanum*. All of them were *A. parvum*.

Amblyomma maculatum Koch. Squire (1972) vaguely reported this species for Bolivia, while Payno Balazans (1978) allegedly found *A. maculatum* on cattle and dog in Santa Cruz department (unnamed localities 25 and 26). Prior to the resurrection of *A. tigrinum* and *A. triste* by Kohls (1956), these species were often misidentified as *A. maculatum*, which does not occur in southern South America. This tick is a Neotropical-Nearctic tick species with bona fide records from Belize, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Peru, the U.S.A., and Venezuela. We found no reason to consider *A. maculatum* established in Bolivia.

Amblyomma multipunctum Neumann. Boero and Prosen (1959) reported an *A. multipunctum* male from a lowland tapir, *T. terrestris*, in the Chipiriri River, near Villa Tunari, Amazon region, Bolivia. Labruna et al. (2013) stated that the description and the figure of the Bolivian *A. multipunctum* male provided by these authors is compatible with *A. scalpturatum*, which is known to occur on *T. terrestris* in Bolivia (Labruna et al., 2005). We consider therefore *A. multipunctum* as not established in Bolivia.

Ixodes ricinus (Linnaeus). Torregianni (1912, 1914) reported the presence of this Palearctic species on horses in undetermined localities of Santa Cruz department with no indication of the parasitic tick stages found on hosts. Keirans et al. (1985) inferred that the Bolivian specimens may belong to *I. pararicinus*; nevertheless, *I. aragaoi* is also morphologically close to *I. pararicinus* and *I. ricinus*, and perhaps the specimens observed by Torreggiani belong to this species. In any case, we regard the diagnosis of *I. ricinus* from Bolivia as erroneous.

Ixodes scapularis Say. Payno Balazans (1978) allegedly found this species on cattle (tick stages not given) in Santa Cruz (unnamed localities 19 and 32), but the southern limit of *I. scapularis* is in Mexico (Guzmán-Cornejo et al., 2007). Probably the tick specimens seen by Payno Balazans (1978) belong to *I. pararicinus* or *I. aragaoi*.

Rhipicephalus annulatus (Say). There are 8 records in Payno Balazans (1978) that are probably based on a wrong diagnosis because bona fide American records for this species are from the Nearctic Region (Guglielmone et al., 2003a). The alleged Bolivian records of *B. annulatus* are from the departments of Beni (unnamed locality 2), Santa Cruz (unnamed localities 6, 8, 9, 15, 18, and 34), and Tarija (unnamed locality 1).

Discussion

According to this work, the tick fauna of Bolivia comprises 36 species. Most of the records for ticks from Bolivia, however, were reported more than 20 years ago. During the past 2 decades, the knowledge on Neotropical ticks and tick-borne diseases has experienced a notable growth. Sanitarily important species are under taxonomic reassessment, like *Amblyomma cajennense*, a recognized vector of *Rickettsia rickettsii*. Molecular, biological, and morphological studies show conclusive evidence that *A. cajennense* is in fact a complex of at least 6 different species (Beati et al., 2010; Mastropaolo et al., 2011; Labruna et al., 2011). The situation of this complex of species in Bolivia is unknown. Molecular and morphological studies support also the recognition of at least 2 species of the *R. sanguineus* complex in the region (Moraes-Filho et al., 2011; Nava et al., 2012; Oliveira et al., 2005; Szabó et al., 2005). A differential vectorial competence for canine diseases is attributed to these species, whose distribution areas may overlap at the Bolivian southern borderline (Nava et al., 2012). Together with this, several new tick species were described in South America during the past decades (Venzal et al., 2012). In addition, an increasing number of tick-borne rickettsiae were identified in the region (Labruna et al., 2011), and ecological and epidemiological studies have reinforced the role of ticks as important vectors of pathogens affecting public and animal health (Labruna, 2009; Romer et al., 2011). As stated in this paper, many records of Bolivian ticks are lacking locality or/and host, and some of them need new findings for confirmation. For many records, we were not able to clarify the locality, and the coordinates listed are approximations. A countrywide survey of ticks could be of great value in order to depict the distribution of the species of medical or veterinary importance, but also as a contribution of biodiversity, confirming the presence of doubtfully established species, and those probably established, but not confirmed yet.

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