



The *Ixodes* (Acari: Ixodidae) of Mexico: parasite-host and host-parasite checklists

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Abstract

Parasite-host and host-parasite checklists are provided for all species of *Ixodes* known from Mexico; host and locality data are from specimens housed in the Colección Nacional de Ácaros, Instituto de Biología, Universidad Nacional Autónoma de México, and from literature. Six *Ixodes* species (*I. brunneus*, *I. conepti*, *I. dentatus*, *I. eadsi*, *I. guatemalensis*, *I. texanus*) are newly recorded from Mexico; in addition, 17 new locality records are presented for eight species (*I. affinis*, *I. boliviensis*, *I. luciae*, *I. rubidus*, *I. scapularis*, *I. spinipalpis*, *I. tancitarius*, *I. woodi*), and eight new host records are given for five species (*I. affinis*, *I. boliviensis*, *I. rubidus*, *I. spinipalpis*, *I. tancitarius*).

Key words: Ixodidae, *Ixodes*, Mexico, checklists, hosts, distribution.

Introduction

Ixodes Latreille is the largest genus of ticks in the world, currently comprising 243 species (Guglielmone *et al.* 2006), more than one quarter of the global tick fauna. In all life history stages, members of this genus possess an anal groove that curves anterior to the anus, forming an arch. Several *Ixodes* species are of major medical and veterinary importance, having been implicated in the transmission of zoonotic disease agents (Sonenshine *et al.* 2002; Goodman *et al.* 2005).

Despite the predominance of this genus in the Northern Hemisphere, relatively few species of *Ixodes* have been reported from Mexico. Hoffmann and López-Campos (2000) recorded 18 *Ixodes* species associated with Mexican birds and mammals, while Whitaker and Morales-Malacara (2005), working only with mammals, reported 14 species.

As part of a project to catalog the tick species deposited in the Colección Nacional de Ácaros (CNAC), Instituto de Biología, Universidad Nacional Autónoma de México (IBUNAM), we analyzed all specimens belonging to the genus *Ixodes*. Initially, the CNAC chiefly consisted of Dr. Anita Hoffmann's personal collection, which was donated to IBUNAM in 1992, and in 1997 was officially designated the National Collection, housing a great variety of mites and ticks from Mexico.

The objective of this paper is to compile parasite-host and host-parasite checklists for all known Mexican species of *Ixodes* and to report new host, distribution and taxonomic data derived from specimens deposited in the CNAC.

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Materials and methods

To construct our checklists, we first conducted a number of online bibliographic searches, using such databases as AGRICOLA, BIOSIS, CAB Abstracts, Medline, and the Zoological Record; these were supplemented by information contained in the CNAC database (Biota version 1.6.1). Unidentified *Ixodes* specimens were determined using conventional morphological keys to this genus (Cooley & Kohls 1942; Cooley 1943; Cooley & Kohls 1945; Kohls 1956; Kohls & Clifford 1966; Keirans & Clifford 1978; Robbins & Keirans 1992; Durden & Keirans 1996), and the resulting records were entered into the CNAC database.

The parasite-host checklist comprises previously published records obtained through bibliographic searches and, when available, new records resulting from examination of CNAC specimens. Tick collection records are presented in the following order: state (capitalized and in **boldface**), number and sex or stage of tick specimens, locality, date, host species name (updated, if necessary), and, for published records, references (in brackets) and depository (in parentheses). Some new records are accompanied by geographic coordinates, and all have been assigned CNAC accession numbers (in parentheses). Abbreviations: NA, no information available; ENV, École Nationale Vétérinaire, Toulouse, France; and RML, Rocky Mountain Laboratories. All RML specimens are now in the United States National Tick Collection (USNTC), Institute of Arthropodology and Parasitology, Georgia Southern University, Statesboro, USA.

The host-parasite checklist presents host species alphabetically within each vertebrate order and family. Host names have been updated to accord with those of Ramírez-Pulido *et al.* (1996) and Ceballos and Oliva (2005) for mammals, and the American Ornithologists' Union (1998) for birds.

Results

Our checklists contain host and distributional data for 26 *Ixodes* species parasitizing 28 species of vertebrates (five birds and 23 mammals) in Mexico. Eleven earlier records were corroborated from specimens in CNAC; the remainder are from literature. The species *I. brunneus*, *I. conepati*, *I. dentatus*, *I. eadsi*, *I. guatemalensis* and *I. texanus* represent new records for Mexico. In addition, we provide 17 new locality records for eight tick species (*I. affinis*, *I. boliviensis*, *I. luciae*, *I. rubidus*, *I. scapularis*, *I. spinipalpis*, *I. tancitaricus* and *I. woodi*), and eight new host records for five species (*I. affinis*, *I. boliviensis*, *I. rubidus*, *I. spinipalpis*, and *I. tancitaricus*). The records for *I. granulatus* are erroneous.

Parasite-host list

Ixodes affinis Neumann

Previous records

CHIAPAS: 1♀, Ocozocoautla, XII-1946, *Nasua narica* [Kohls & Rogers 1953]; same data except 1♂, 7♀, *Mazama americana*; NA, Mapastepec, "deer" [Hoffmann 1962].

New records

CHIAPAS: 14♀, 6♂, NA, NA, (CNAC002247); 3♀, 1♂, Mapastepec, 29-II-1954, "deer" (CNAC002159). **YUCATÁN:** 1♀, NA, *Bos taurus* (recorded as "bovine"), (CNAC002293).

Comments: The earlier record from Mapastepec, cited by Hoffmann (1962), lacks a date, and the collector was recorded as Macías. Our new record includes a date, and the collector was a Dr. Tort.

Ixodes angustus Neumann

Previous records

CHIAPAS: NA, Cerro Tzontehuitz, 13 km NE San Cristóbal de las Casas, San Juan Chamula, 24-X-1993, *Reithrodontomys microdon microdon* [Estébanes-González & Cervantes 2005]; NA, Cerro Tzontehuitz, 13 km NE San Cristóbal de las Casas, San Juan Chamula, 24-X-1993, *Microtus guatemalensis* [Estébanes-González & Cervantes 2005]. **COAHUILA:** 10♀, Sabinas, I-1944, nest of *Neotoma* sp. [Hoffmann 1962] (RML21723). **OAXACA:** NA, 3 km SE Totontepec, Totontepec, 5-XI-1990, *Peromyscus melanocarpus* [Estébanes-González & Cervantes 2005]; NA, 11 km SW Esperanza to San Isidro, Santiago Comaltepec, 9-IX-1990, *Sorex* sp. [Estébanes-González & Cervantes 2005]; NA, 1 km N Esperanza, Santiago Comaltepec, Distrito Ixtlán, 8-XII-1989, *Oryzomys alfaroi* [Estébanes-González & Cervantes 2005]; NA, San Martín Caballero, Distrito Teotitlán, San José Tenango, 24-V-1994, “mouse” [Estébanes-González & Cervantes 2005].

Comments: We examined the specimens cited by Estébanes-González & Cervantes (2005) from *Reithrodontomys microdon microdon* and *Peromyscus melanocarpus* and have concluded that they do not correspond to *I. angustus*, thus casting doubt on all determinations of this species by these authors. We have not seen the specimens studied by Hoffmann (1962), but in light of this species’ largely North Temperate distribution (Robbins & Keirans 1992), we can only tentatively include it in the Mexican tick fauna.

Ixodes bequaerti Cooley and Kohls

Previous record

CHIAPAS: 1♀, Catharinus (sic), 4-V-1942, NA [Cooley & Kohls, 1945].

Ixodes boliviensis Neumann

Previous records

CHIAPAS: 1♀, Planta de Luz, Huixtla, VI-1945, *Canis familiaris* (recorded as “dog”) [Hoffmann 1962] (CNAC002165); 2♀, Santa Rosa, Comitán, 14-VI-1937, NA [Hoffmann 1962] (CNAC002162). **GUERRERO:** 3♀, Atoyac, *Panthera onca*, *Homo sapiens* [Neumann 1906] (ENV). **NAYARIT:** 1♀, NA, “deer” [Cooley & Kohls 1945] (RML19820). **OAXACA:** 1♀, Teotila, Cuicatlán, Oaxaca, II-1953, NA [Hoffmann 1962] (CNAC002160); 3♀, Yaviche, VII-1950, *Canis familiaris* (recorded as “dog”) [Hoffmann 1962] (CNAC002164). **QUINTANA ROO:** 1♀, Bacalar, 29-VIII-1939, “fox” [Hoffmann 1962] (CNAC002163).

Comments: The specimens from Guerrero and Nayarit were originally reported as *Ixodes bicornis* Neumann, which was relegated to a junior synonym of *I. boliviensis* by Kohls (1956).

New records

CHIAPAS: 11♀, Finca Prusia, 12-XII-1944, NA (CNAC005123). **OAXACA:** 1♀, Tarabundí (17° 36' 34”N, 96° 18' 55”W), 6-XII-1948, “coati” (CNAC002252); 2♀, Tarabundí, 10-XII-1948, “pheasant” (CNAC002253). **VERACRUZ:** 1♀, 0.8 km NE Las Minas (19° 41' 27”N, 97° 8' 47”W), 10-V-1963, *Sciurus* sp. (CNAC002352); 1♀, Rancho la Encantada, San Andrés Tuxtla, 5-XI-2002, NA (vegetation) (CNAC005059); 1♀, Cerro el Vigía, Santiago Tuxtla, 7-IV-1967, *Homo sapiens* (recorded as “man”) (CNAC005075).

Ixodes brunneus Koch

New record

MEXICO D. F.: 1♀, Chapultepec, 4-XI-1950, NA (CNAC005161).

Ixodes conepati Cooley and Kohls

New records

COAHUILA: 1♀, Cueva la Manga, Rancho San Judas Tadeo, Acuña (29° 21' 47”N; 101° 1' 47”W), 2-

IV-2005, NA (cave) (CNAC002353); 1 ♀, Cueva Popo de Oso, Zaragoza (28° 38' 4"N; 101° 7' 17"W), 24-XI-2006, NA (cave) (CNAC002362).

Ixodes cookei Packard

Previous records

NUEVO LEÓN: 15 NN, 5 LL, 8.0 km N, 4.1 km W San Josecito, 22-II-1990, *Bassariscus astutus* [Montiel-Parra *et al.* 2007] (CNAC); 2 LL, 10.8 km S, 10.8 km E San Josecito, 12-VI-1991, *Peromyscus* sp. [Montiel-Parra *et al.* 2007] (CNAC). **VERACRUZ:** 1 ♂, Área Natural Protegida San Juan del Monte, 3.2 km SW, Las Vigas de Ramírez, 25-VIII-2003, *Urocyon cinereoargenteus* [Montiel-Parra *et al.* 2007] (CNAC).

Ixodes cuernavacensis Kohls and Clifford

Previous record

MORELOS: 1 ♀, Cuernavaca, 30-V-1961, *Streptoprocne semicollaris* [Kohls & Clifford 1966] (RML 37920).

Ixodes dampfi (Cooley)

Previous records

ESTADO DE MÉXICO: 5 ♀, Valle de México, Chalco, IV-1932, *Geomys* sp. [Cooley 1943] (RML 20165); Collection of Dr. A. Dampf (Mexico City); National Museum of Natural History (formerly United States National Museum), Washington, DC; and Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA.

Ixodes dentatus Marx

New record

NUEVO LEON: 2 ♀, 2 ♂, El Potosí (24° 49' 42"N; 100° 20' 26"W), 22-V-1963, *Sylvilagus* sp. (CNAC002366).

Ixodes eadsi Kohls and Clifford

New record

PUEBLA: 1 ♀, 6 km E Totimehuacán, 13-III-1965, *Liomys* sp. (CNAC002287).

Ixodes granulatus Supino

Previous records

OAXACA: NA, 1 km S, 0.5 km E Vista Hermosa, Santiago Comaltepec, 20-X-1989, *Peromyscus mexicanus totontepecus* [Estébanes-González & Cervantes 2005]; NA, 11 km SW La Esperanza to San Isidro, Santiago Comaltepec, 30-V-1990, *Oryzomys chapmani chapmani* [Estébanes-González & Cervantes 2005].

Comments: *Ixodes granulatus* is an exclusively Asian species, ranging from Japan through Southeast Asia and westward to India (Petney & Keirans 1994). The larvae from *Peromyscus mexicanus totontepecus* do not correspond to this species, and other purported Mexican "*I. granulatus*" should also be redetermined.

Ixodes guatemalensis Kohls

New records

GUERRERO: 6 ♀, Omiltemi (17° 33' 24"N; 99° 41' 8"W), 4-IV-1963, *Sciurus* sp. (CNAC002325); 2 ♀, Omiltemi, 5-IV-1963, *Sciurus* sp. (CNAC002359); 2 ♀, Omiltemi, IV-1963, *Sciurus* sp. (CNAC002356); 1 ♀, Omiltemi, 2-IV-1963, *Sciurus* sp. (CNAC002360); 3 ♀, 1.6 km NW Omiltemi, 13-IV-1963, *Sciurus* sp. (CNAC002335); 18 ♀, 1.6 km NW Omiltemi, 15-IV-1963, *Sciurus* sp. (CNAC002367). **VERACRUZ:** 1 ♀, 0.8 km NE Las Minas, 5-V-1963, *Sciurus* sp. (CNAC002337).

Ixodes loricatus Neumann

Previous record

TABASCO: NA, Frontera, *Ateles geoffroyi* [Nuttall & Warburton 1911].

Comments: The locality cited by Nuttall and Warburton (1911), “Tabasco de la Frontera,” is probably the city of Frontera, in Tabasco. *Ateles “melanochoerus”* (= *melanocercus* or *melanochir*) is a junior synonym of *A. geoffroyi*.

Ixodes luciae Sénevet

Previous records

CHIAPAS: 1♀, 1♂, Finca Germania, 27-XII-1943, *Didelphis* sp. [Vázquez 1946] (CNAC000569, CNAC000570). **TABASCO:** 3♀, Frontera, V, “large opossum” [Nuttall 1910; Nuttall & Warburton 1911].

Comments: The specimens from Finca Germania were originally reported as *Ixodes scuticrenatus* Vázquez, while those from Frontera were reported as *Ixodes loricatus* variety *spinosus* Nuttall; both these names are junior synonyms of *I. luciae* (Camicas *et al.* 1998). The locality cited by Nuttall and Warburton (1911), “Tabasco de la Frontera,” is probably the city of Frontera, in Tabasco.

New records

COLIMA: 1♀, 1♂, La Barragana, 12-IX-1978, *Didelphis marsupialis* (CNAC002316). **VERACRUZ:** 4♂, 0.8 km NE Las Minas, 9-V-1963, *Didelphis* sp., (CNAC002354).

Comments: The specimens from Colima were previously identified by R. H. Manzanilla L.; however, this is a new locality record for Mexico.

Ixodes mexicanus Cooley and Kohls

Previous records

MICHOACÁN: 1♀, Cerro Tancítaro, VIII-1940, *Campylorhynchus gularis* [Cooley & Kohls 1942]; same data except 17-VII-1940, *Junco phaeonotus* (RML 17469).

Ixodes murreleti Cooley and Kohls

Previous record

BAJA CALIFORNIA SUR: 1♀, Isla los Coronados, 4-IV-1940, “Scripps’ [= Xantus’s] murrelet,” *Synthliboramphus hypoleucus* (formerly *Endomychura hypoleucus*) [Cooley & Kohls 1945] (RML 17799).

Ixodes pacificus Cooley and Kohls

Previous record

BAJA CALIFORNIA: NA, NA [Bishopp & Trembley 1945].

Comments: Bishopp and Trembley (1945) stated that *Ixodes ricinus californicus* Banks occurs along the Pacific coast of North America from Mexico to British Columbia; however, this name is a junior synonym of *I. pacificus* (Cooley & Kohls 1945). Hoffmann (1962), citing Bishopp and Trembley (1945) but using the nomenclature of Cooley and Kohls (1945), referred Mexican records of *I. pacificus* to Baja California.

Ixodes rubidus (Neumann)

Previous records

GUANAJUATO: 1♀, 3NN, NA, *Bassariscus astutus* [Neumann 1911; Nuttall & Warburton 1911; Cooley & Kohls 1945] (ENV).

New record

GUERRERO: 3♀, 36NN, Omiltemi, 8-IV-1963, *Urocyon* sp. (CNAC002364).

Comments: The host of these specimens must be *Urocyon cinereoargenteus* because only one species of this genus occurs in Mexico (Ceballos & Oliva, 2005).

Ixodes scapularis Say

Previous records

JALISCO: NA, Purificación, “cattle” [Chavarría, 1941]. **OAXACA:** NA, Finca “El Sinaí,” Santos Reyes Nopala, Distrito Juquila (16° 06'N, 97° 09'W), NA [Marín & Hoffmann 2002]. **TAMAULIPAS:** 1♀, 1♂, west of Tampico, NA [Hooker *et al.* 1912]; same data except *Canis familiaris*, “cattle” [Macías Valadez, 1923].

Comments: Chavarría (1941) used the name *Ixodes ricinus* variety *scapularis* Say, which is a junior synonym of *I. scapularis* (Camicas *et al.* 1998). Hoffmann (1962), citing Macías Valadez (1923), stated that *Felis pardalis*, now *Leopardus pardalis*, is a host of *I. scapularis*; however, this record is from Costa Rica.

New record

COAHUILA: 9♀, 1♂, Las Herminias, Zaragoza, 23-II-1975, *Bos taurus* (recorded as “bovine”) (CNAC002166).

Comments: These specimens were previously identified by A. de la Torre; however, this is a new locality record for Mexico.

Ixodes sinaloa Kohls and Clifford

Previous records

NAYARIT: 1♀, 32 km SE Tepic, 18-VII-1963, *Oryzomys couesi mexicanus* [Kohls & Clifford 1966] (RML 46302). **SINALOA:** 1♀, 5 km SW San Ignacio, 20-VII-1963, *Liomys pictus escuinapae* [Kohls & Clifford 1966] (RML 39478); same data except 2♀, 19-VII-1965 (RML 39475, RML 39477); 1♀, 1 km NE Santa Lucia, 24-VII-1965, *Liomys pictus escuinapae* [Kohls & Clifford 1966] (RML 39479); 1♀, 4.8 km NE Copala, 12-VII-1963, *Liomys pictus escuinapae* [Kohls & Clifford 1966] (RML 46296); 1♀, 6.4 km SW Copala, 2-VIII-1960, *Liomys pictus escuinapae* [Kohls & Clifford 1966] (RML 46294).

Ixodes spinipalpis Hadwen and Nuttall

Previous record

MORELOS: 1♀, km 43 Carretera México-Cuernavaca, 26-VI-1949, *Romerolagus diazi* [Hoffmann 1962] (CNAC005180).

Comments: Hoffmann's (1962) record was for *Ixodes neotomae* Cooley; however, Norris *et al.* (1997) argued that this taxon is conspecific with, and therefore a junior synonym of, *I. spinipalpis*.

New records

GUERRERO: 1N, Omiltemi, (17° 33' 24"N; 99° 41' 8"W), 2-IV-1963, NA (CNAC002358); 5NN, Omiltemi, 3-IV-1960, *Peromyscus* sp. (CNAC002331); 6NN, Omiltemi, 3-IV-1963, *Peromyscus* sp. (CNAC002332); 7NN, Omiltemi, 6-IV-1963, *Peromyscus* sp. (CNAC002333); 3NN, Omiltemi, 5-IV-1963, *Sciurus* sp. (CNAC002341); 2NN, 1.6 km NW Omiltemi, 2-IV-1963, *Peromyscus* sp. (CNAC002355). **MORELOS:** 2NN, Zempoala, *Peromyscus* sp. (CNAC002326). **VERACRUZ:** 1N, 0.8 km NE Las Minas, 2-V-1963, *Peromyscus* sp. (CNAC002350).

Ixodes tamaulipas Kohls and Clifford

Previous record

TAMAULIPAS: 1♀, Rancho del Cielo southeast of Tamaulipas State, 8-VIII-1963, *Sciurus deppei negligens* [Kohls & Clifford 1966] (RML 39326).

Ixodes tancitaris Cooley and Kohls

Previous record

MICHOACÁN: 1♀, Cerro Tancítaro, 5-VII-1941, *Reithrodontomys* sp. [Cooley & Kohls 1942] (RML 19236).

New record

VERACRUZ: 1 ♀, 0.8 km NE Las Minas, 2-V-1963, *Peromyscus* sp. (CNAC002336).

Ixodes texanus Banks

New records

GUERRERO: 1 ♀, 1N, Omiltemi (17° 33' 24"N; 99° 41' 8"W), 6-IV-1963, *Bassariscus* sp. (CNAC002370).

Ixodes tovari Cooley

Previous records

GUANAJUATO: 2 ♀, 2 ♂, Torrecilla and Comontoso, "hares" [Cooley 1945] (RML 21620–21621); **NUEVO LEON:** 19 "adults," 9 ♂, 7NN, 2LL, Bravo, "hares" [Cooley 1945] (RML 21618, 21623–21625, 21628).

Ixodes woodi Bishop

Previous records

COAHUILA: 3 ♀, 1N, Sabinas (27° 50'N; 101° 9'W), I-1944, *Neotoma micropus* [Robbins & Keirans 1987] (RML 47170). **TAMAULIPAS:** Rancho del Cielo, NA [Robbins & Keirans 1987] (RML correspondence files).

New record

MORELOS: 1 ♀, Zempoala (19° 3' 11"N; 99° 18' 44"W), 23-III-1963, *Neotoma* sp. (CNAC002340)

Host-parasite list

AVES

APODIFORMES

Apodidae

Streptoprocne semicollaris (De Saussure)

Ixodes cuernavacensis

CHARADRIIFORMES

Alcidae

Synthliboramphus hypoleucus (Xantus de Vesey)

Ixodes murreleti

GALLIFORMES

"pheasant"

Ixodes boliviensis

PASSERIFORMES

Emberizidae

Junco phaeonotus Wagler

Ixodes mexicanus

Troglodytidae

Campylorhynchus gularis Sclater

Ixodes mexicanus

MAMMALIA

ARTIODACTYLA

| | |
|--|---------------------------|
| Bovidae | |
| <i>Bos taurus</i> L. | <i>Ixodes affinis</i> |
| “cattle” | <i>Ixodes scapularis</i> |
| Cervidae | <i>Ixodes scapularis</i> |
| “deer” | |
| <i>Mazama americana</i> (Erxleben) | <i>I. affinis</i> |
| | <i>I. boliviensis</i> |
| | <i>Ixodes affinis</i> |
| CARNIVORA | |
| Canidae | |
| “fox” | <i>Ixodes boliviensis</i> |
| <i>Canis familiaris</i> L. | <i>Ixodes boliviensis</i> |
| | <i>Ixodes scapularis</i> |
| <i>Urocyon cinereoargenteus</i> (Schreber) | <i>Ixodes cookei</i> |
| <i>Urocyon</i> sp. | <i>Ixodes rubidus</i> |
| Felidae | |
| <i>Panthera onca</i> (L.) | <i>Ixodes boliviensis</i> |
| Procyonidae | |
| <i>Bassariscus astutus</i> (Lichtenstein) | <i>Ixodes cookei</i> |
| | <i>Ixodes rubidus</i> |
| <i>Bassariscus</i> sp. | <i>Ixodes texanus</i> |
| “coati” | <i>Ixodes boliviensis</i> |
| <i>Nasua narica</i> (L.) | <i>Ixodes affinis</i> |
| DIDELPHIMORPHIA | |
| Didelphidae | |
| <i>Didelphis marsupialis</i> L. | <i>Ixodes luciae</i> |
| <i>Didelphis</i> sp. | <i>Ixodes luciae</i> |
| “opossum” | <i>Ixodes luciae</i> |
| LAGOMORPHA | |
| Leporidae | |
| <i>Lepus</i> sp. (“hares”) | <i>Ixodes tovari</i> |
| <i>Romerolagus diazi</i> (Ferrari-Pérez) | <i>Ixodes spinipalpis</i> |
| <i>Sylvilagus</i> sp. | <i>Ixodes dentatus</i> |
| PRIMATES | |
| Atelidae | |
| <i>Ateles geoffroyi</i> Kuhl | <i>Ixodes loricatus</i> |
| Hominidae | |
| <i>Homo sapiens</i> L. | <i>Ixodes boliviensis</i> |
| RODENTIA | |
| “mouse” | <i>Ixodes</i> sp. |

| | |
|--|-----------------------------|
| Geomyidae | |
| <i>Geomys</i> sp. | <i>Ixodes dampfi</i> |
| Heteromyidae | |
| <i>Liomys pictus escuinapae</i> J. A. Allen | <i>Ixodes sinaloa</i> |
| <i>Liomys</i> sp. | <i>Ixodes eadsi</i> |
| Muridae | |
| <i>Microtus guatemalensis</i> Merriam | <i>Ixodes</i> sp. |
| <i>Neotoma micropus</i> Baird | <i>Ixodes woodi</i> |
| <i>Neotoma</i> sp. | <i>Ixodes angustus</i> |
| | <i>Ixodes woodi</i> |
| <i>Oryzomys alfaroi</i> (J. A. Allen) | <i>Ixodes</i> sp. |
| <i>Oryzomys couesi</i> (Alston) | <i>Ixodes sinaloa</i> |
| <i>Peromyscus melanocarpus</i> Osgood | <i>Ixodes</i> sp. |
| <i>Peromyscus</i> sp. | <i>Ixodes cookei</i> |
| | <i>Ixodes spinipalpis</i> |
| | <i>Ixodes tancitarius</i> |
| <i>Reithrodontomys microdon microdon</i> Merriam | <i>Ixodes</i> sp. |
| <i>Reithrodontomys</i> sp. | <i>Ixodes tancitarius</i> |
| Sciuridae | |
| <i>Sciurus deppei negligens</i> Nelson | <i>Ixodes tamaulipas</i> |
| <i>Sciurus</i> sp. | <i>Ixodes boliviensis</i> |
| | <i>Ixodes guatemalensis</i> |
| | <i>Ixodes spinipalpis</i> |
| SORICOMORPHA | |
| Soricidae | |
| <i>Sorex</i> sp. | <i>Ixodes</i> sp. |

Discussion

Mexico is considered a megadiverse country, so it is not surprising that its invertebrate fauna has been incompletely cataloged. Taxonomic knowledge of Mexican ticks remains limited, particularly in the case of *Ixodes*, which is currently represented by just 26 species, *i.e.*, only 10.7% of the known species in this genus (Mexican records of *I. granulatus* are erroneous). By contrast, 35 species of *Ixodes* are known from the United States and Canada, despite the temperate and boreal conditions that prevail over most of northern North America. Furthermore, in the United States, species of *Ixodes* are known to parasitize reptiles, birds and mammals (Cooley & Kohls 1945, Durden & Keirans 1996, Wright *et al.* 1998, Tälleklint-Eisen & Eisen 1999, and Eisen *et al.* 2001), whereas in Mexico only birds and mammals have been reported as hosts, and among mammals, rodents predominate, hosting 11 *Ixodes* species. Of some 1,050 species of birds and 452 species of mammals found in Mexico, only 0.47% and 5.1%, respectively, have been recorded as hosts for *Ixodes* ticks. Clearly, there is a pressing need for extensive parasitological sampling of Mexico's approximately 2,306 species of terrestrial vertebrates (Flores-Villela 1993, Ramírez-Pulido *et al.* 1996, Ceballos & Márquez 2000, Flores-Villela & Canseco-Márquez 2004, Ceballos & Oliva 2005). Currently, *Bassariscus astutus*, *Bos taurus* and *Canis familiaris* are each known to host two *Ixodes* species; the rodent genera *Peromyscus* and *Sciurus* both host three *Ixodes* species, but in these cases more than one host species may be involved.

To date, research on Mexican *Ixodes* has largely been conducted outside Mexico (Cooley & Kohls 1942, Kohls & Clifford 1966), with the result that most literature records are based on specimens in foreign collec-

tions, such as the RML and ENV. Currently, the CNAC contains representatives of only 15 of the 26 *Ixodes* species known to occur in Mexico. We have corroborated the identity of three of the CNAC species (*I. boliviensis*, *I. luciae*, and *I. spinipalpis*); 12 more, including six new national records, resulted from the present study. All determinations were based on adults except for *I. spinipalpis*, which was based on nymphs. The first report of *Ixodes cookei* in Mexico was published separately (Montiel-Parra *et al.* 2007).

Species of *Ixodes* have been collected in 21 of the 32 states of Mexico; the highest number of species has been recorded in Veracruz (six species), followed by Chiapas and Guerrero (five species), and Coahuila (four species). The most widespread tick species in Mexico appear to be *I. boliviensis* (Chiapas, Guerrero, Nayarit, Oaxaca, Quintana Roo and Veracruz), *I. luciae* (Chiapas, Colima, Tabasco, Veracruz), and *I. scapularis* (Coahuila, Jalisco, Oaxaca, Tamaulipas). The broad range of *I. boliviensis* also corresponds with the highest number of associated hosts.

Additional systematic research on Mexican ticks is urgently needed, not only to catalog this group, but also to augment regional studies of ecology, biogeography, and host-parasite coevolution. Moreover, taxonomic elucidation of the Mexican tick fauna will substantively contribute to investigations of zoonotic infections, such as Lyme disease, that merit increased attention in Mexico.

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References

- American Ornithologists' Union. (1998) *Check-list of North American Birds. The species of Birds of North America from the Arctic through Panama, including the West Indies and Hawaiian Islands*. American Ornithologists' Union, Lawrence, Kansas. 829 pp.
- Bishopp, F.C. & Trembley, H.L. (1945) Distribution and hosts of certain North American ticks. *Journal of Parasitology*, 31, 1–54.
- Camicas, J.-L., Hervy, J.-P. Adam, F. & Morel P.-C. (1998) *Les tiques du monde. Nomenclature, stades décrits, hôtes, répartition (Acarida, Ixodida)*. ORSTOM, Paris, 233 pp.
- Ceballos, G. & Márquez L. (Eds). (2000) *Las Aves de México en Peligro de Extinción*. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, Fondo de Cultura Económica, Instituto de Ecología, UNAM, México, D.F. 430 pp.
- Ceballos, G. & Oliva G. (2005) *Los mamíferos silvestres de México*. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad y Fondo de Cultura Económica, México, D. F. 981 pp.
- Chavarría, C.M. (1941) Garrapatas determinadas en México. Caracteres genéricos de las más comunes. *Revista del Instituto Pecuario*, 1, 18–24.
- Cooley, R.A. (1943) *Ixodes dampfi* n. sp., nueva garrapata de Mexico (Acarina, Ixodidae). *Revista de la Sociedad Mexicana de Historia Natural*, 4, 21–24.
- Cooley, R.A. (1945) *Ixodes tovari*, a new species from Mexico (Ixodidae). *Pan-Pacific Entomologist*, 21, 144–148.
- Cooley, R.A. & Kohls, G.M. (1942) *Ixodes mexicanus* n. sp. e *Ixodes tancitarium* n. sp. dos nuevas garrapatas mexicanas (Acarina, Ixodidae). *Revista de la Sociedad Mexicana de Historia Natural*, 3, 149–154.
- Cooley, R.A. & Kohls, G.M. (1945) The genus *Ixodes* in North America. *National Institute of Health Bulletin*, 184, 1–246.
- Durden, L.A. & Keirans, J.E. (1996) *Nymphs of the genus Ixodes (Acari: Ixodidae) of the United States: Taxonomy, Identification Key, Distribution, Hosts, and Medical/Veterinary Importance*. Entomological Society of America, Lanham, Maryland. iv + 95pp.
- Eisen, R.J., Eisen L. & Lane R.S. (2001) Prevalence and abundance of *Ixodes pacificus* immatures (Acari: Ixodidae) infesting western fence lizards (*Sceloporus occidentalis*) in northern California: temporal trends and environmental correlates. *Journal of Parasitology*, 87, 1301–1307.

- Estébanes-González, M.L. & Cervantes, F.A. (2005) Mites and ticks associated with some small mammals in Mexico. *International Journal of Acarology*, 31, 23–37.
- Flores-Villela, O. (1993) Herpetofauna Mexicana: lista anotada de las especies de anfibios y reptiles de México, cambios taxonómicos recientes, y nuevas especies. *Special Publications of the Carnegie Museum of Natural History*, 17, 1–73.
- Flores-Villela, O. & Canseco-Márquez, L. (2004) Nuevas especies y cambios taxonómicos para la herpetofauna de México. *Acta Zoológica Mexicana (Nueva Serie)* 20, 115–144.
- Goodman, J.L., Dennis, D.T. & Sonenshine, D.E. (2005) *Tick-Borne Diseases of Humans*. ASM Press, Washington, DC. xvi + 401 pp.
- Guglielmone, A.A., Venzal, J.M., González-Acuña, D., Nava, S., Hinojosa, A. & Mangold, A.J. (2006) The phylogenetic position of *Ixodes stilesi* Neumann, 1911 (Acari: Ixodidae): morphological and preliminary molecular evidences from 16S rDNA sequences. *Systematic Parasitology*, 65, 1–11.
- Hoffmann, A. (1962) Monografía de los Ixodoidea de México. Parte I. *Revista de la Sociedad Mexicana de Historia Natural*, 23, 191–307.
- Hoffmann, A. & López-Campos, G. (2000) *Biodiversidad de los ácaros en México*. Fideicomiso Fondo para la Biodiversidad, México D. F., 230 pp.
- Hooker, W.A., Bishopp, F.C. & Wood, H.P. (1912) The life history and bionomics of some North American ticks. *Bulletin of the Bureau of Entomology, U. S. Department of Agriculture*, (106), 1–239.
- Keirans, J.E. & Clifford, C.M. (1978) The genus *Ixodes* in the United States: a scanning electron microscope study and key to the adults. *Journal of Medical Entomology*, Supplement 2: 1-149.
- Kohls, G.M. (1956) The identity of *Ixodes boliviensis* Neumann 1904 and *I. bicornis* Neumann 1906 (Ixodidae). *Proceedings of the Entomological Society of Washington*, 58, 232–233.
- Kohls, G.M. & Clifford, C.M. (1966) Three new species of *Ixodes* from Mexico and description of the male of *I. auritulus auritulus* Neumann, *I. conepati* Cooley and Kohls, and *I. lasallei* Mendez and Ortiz (Acarina: Ixodidae). *Journal of Parasitology*, 52, 810–820.
- Kohls, G.M. & Rogers, A.J. (1953) Note on the occurrence of the tick *Ixodes affinis* Neumann in the United States. *Journal of Parasitology*, 39, 669.
- Macías Valadez, S. (1923) Ensayo de una monografía sobre ixódidos mexicanos vulgo garrapatas. *Memorias de la Sociedad Científica 'Antonio Alzate'*, 41, 197–216.
- Marín, B.E. & Hoffmann, A. (2002) Un caso probable de parálisis por garrapatas en la Sierra Sur de Oaxaca en la Finca el Sinaí. In: Romero N. J., Estrada V. E. G. & Equihua M. A. (Eds.). *Entomología Mexicana*. Sociedad Mexicana de Entomología, México, D. F. pp. 64–66.
- Montiel-Parra, G., Fuentes-Moreno, H. & Vargas, M. (2007) Primer registro de *Ixodes cookei* (Acari: Ixodidae) para México. *Revista Mexicana de Biodiversidad*, 78, 205–206.
- Neumann, L. G. (1906) Notes sur les ixodidés. IV. *Archives de Parasitologie*, 10, 195–219.
- Neumann, L. G. (1911) Ixodidae. *Das Tierreich*, (26), xvi + 169 pp.
- Norris, D.E., Klompen, J.S.H., Keirans J.E., Lane R.S., Piesman, J. & Black, W.C. IV. (1997) Taxonomic status of *Ixodes neotomae* and *I. spinipalpis* (Acari: Ixodidae) based on mitochondrial DNA evidence. *Journal of Medical Entomology*, 34, 696–703.
- Nuttall, G.H.F. (1910) New species of ticks (*Ixodes*, *Amblyomma*, *Rhipicephalus*). *Parasitology*, 3, 408–416.
- Nuttall, G.H.F. & Warburton, C. (1911) *Ticks. A Monograph of the Ixodoidea*. Part II. Ixodidae. Cambridge University Press, London. xx + 105–348.
- Petney, T.N. & Keirans, J.E. (1994) Ticks of the genus *Ixodes* in South-east Asia. *Tropical Biomedicine*, 11, 123–134.
- Ramírez-Pulido, J., Castro-Campillo, A., Arroyo-Cabrales, J. & Cervantes, F.A. (1996) Lista taxonómica de los mamíferos terrestres de México. *Ocasional Papers of the Museum of Texas Tech University*, 158, 1-62.
- Robbins, R.G. & Keirans, J.E. (1987) *Ixodes (Ixodiopsis) woodi* (Acari: Ixodidae): Description of the larva and redescription of the nymph. *Journal of Medical Entomology*, 24, 310–314.
- Robbins, R.G. & Keirans, J.E. (1992) *Systematics and Ecology of the Subgenus Ixodiopsis (Acari: Ixodidae: Ixodes)*. Thomas Say Foundation Monographs. Vol. 14. Entomological Society of America, Lanham, Maryland. viii + 159 pp.
- Sonenshine, D.E., Lane, R.S. & Nicholson, W.L. (2002) Ticks (Ixodida). In: Mullen, G. & Durden, L. (Eds.), *Medical and Veterinary Entomology*. Academic Press, New York, pp. 517–558.
- Tälleklint-Eisen, L. & Eisen, R.J. (1999) Abundance of ticks (Acari: Ixodidae) infesting the western fence lizard, *Sceloporus occidentalis*, in relation to environmental factors. *Experimental and Applied Acarology*, 23, 731–740.
- Vázquez, L. (1946). *Ixodes scuticrenatus*, una especie nueva de garrapata de México (Acarina: Ixodidae). *Anales del Instituto de Biología, Universidad Nacional Autónoma de México*, 17, 237–245.
- Whitaker, J.O. & Morales-Malacara, J.B. (2005) Ectoparasites and other associates (ectodytes) of mammals of Mexico. In: Sánchez-Cordero, V. & Medellín, R.A. (Eds), *Contribuciones Mastozoológicas en Homenaje a Bernardo Villa*. Instituto de Biología e Instituto de Ecología, Universidad Nacional Autónoma de México; Comisión Nacional para

el Conocimiento y Uso de la Biodiversidad, México, D. F., pp. 535–666.

Wright, S.A., Lane, R.S. & Clover J.R. (1998) Infestation of the southern alligator lizard (Squamata: Anguidae) by *Ixodes pacificus* (Acari: Ixodidae) and its susceptibility to *Borrelia burgdorferi*. *Journal of Medical Entomology*, 35, 1044–1049.