Acarologia is proudly non-profit, with no page charges and free open access

Please help us maintain this system by encouraging your institutes to subscribe to the print version of the journal and by sending us your high quality research on the Acari.

Subscriptions: Year 2018 (Volume 58): 380 €
http://www1.montpellier.inra.fr/CBGP/acarologia/subscribe.php

Previous volumes (2010-2016): 250 € / year (4 issues)

Acarologia, CBGP, CS 30016, 34988 MONTFERRIER-sur-LEZ Cedex, France

The digitalization of Acarologia papers prior to 2000 was supported by Agropolis Fondation under the reference ID 1500-024 through the « Investissements d’avenir » programme (Labex Agro: ANR-10-LABX-0001-01)

Acarologia is under free license and distributed under the terms of the Creative Commons-BY-NC-ND which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original author and source are credited.
A REVIEW ON TICKS (ACARI: IXODOIDEA: IXODIDAE, ARGASIDAE), ASSOCIATED PATHOGENS AND DISEASES OF TRINIDAD AND TOBAGO

Asoke K. Basu1*, Mala Basu2 and Abiodun A. Adesiyun1

(Received 19 September 2011; accepted 09 January 2012; published online 30 March 2012)

1 School of Veterinary Medicine, Faculty of Medical Sciences, The University of the West Indies, St. Augustine, Trinidad and Tobago. (Corresponding author) asokebasu@gmail.com, aadesiyun@gmail.com

2 Department of Zoology, Bhairab Ganguly College, PO: Belghoria, Kolkata – 700056, India. malabasu@gmail.com

ABSTRACT — In this review article, the authors present an overview on ticks which are found on humans and animals in Trinidad and Tobago. Hitherto, 896 valid species of ticks are reported from throughout the world, but so far only 23 tick species belonging to seven genera have been recorded in Trinidad and Tobago. The growing significance of ticks in medical and veterinary fields emphasizes the need for further studies on the ecology of ticks and the epidemiology of tick-borne diseases.

KEYWORDS — Amblyomma; Rhipicephalus; Ticks; Trinidad and Tobago

INTRODUCTION

Ticks are interesting largely because of their considerable medical and veterinary importance (Jongejan and Uilenberg 2004) and have attracted a great deal of scientific attention due to their role as vectors of numerous pathogens (Kaufman 2010). They belong to the phylum Arthropoda, class Arachnida, order Acari. A total of 896 valid tick species (702 Ixodid, 193 Argasid and 1 Nuttalliella tick (sub-) species) have been recorded from all climatic zones throughout the world (Guglielmone et al. 2010).

Ticks are blood-sucking obligatory ectoparasites of mammals, birds, reptiles and amphibians. They cause anaemia, restlessness, loss of condition, decrease in milk production and tick paralysis in animals, along with irritation by injury due to bites (Jonsson 2006). Gross lesions consist of focal erosions, erythema, crusted ulcers with alopecia and nodules in some individuals.

In addition, ticks are currently considered to be second only to mosquitoes as vectors of human infectious diseases in the world (Parola and Raoult 2001) and are known to transmit numerous arboviruses (e.g., tick-borne encephalitis virus and other Flaviviridae, several Reoviridae, Bunyaviridae, and Iridoviridae), bacteria (Rickettsia, Ehrlichia, Borrelia), and protists (Babesia and Theileria) (Sonenshine 1993). Nijhof et al. (2005) recorded the vector competence of ticks, including 808 tick-pathogen relationships: 322 relationships with 84 bacteria, 302 with 124 viruses, 143 with 59 apicomplexan parasites, 4 with 3 nematodes and 3 with Trypanosoma theileri and a further 34 species of ticks are found associated with toxicosis. These authors also recorded 233 reported cases of acaricide resistance for 20 tick species of veterinary and medical importance. The
annual global cost associated with ticks and tick-borne diseases in cattle alone is considered to be in the billions of US dollars (De Castro 1997).

To date, there has been no assembled list of tick species present in Trinidad and Tobago and their role in the transmission of tick-borne diseases in the country, despite evidence of their local importance to veterinary and human health. In this review, we compile such a list, evaluate the reliability of the recorded observations, and suggest focal areas for future research.

**Ticks in the Caribbean Region**

Cruz (2001) recorded 45 tick species from 11 genera and two families from the West Indies (the Caribbean countries). This comprised 14 species of *Ornithodoros*, 10 species of *Antricola*, nine species of *Amblyomma*, three species of *Argas*, two species each of *Boophilus* and *Ixodes*, and one species each of *Parantricola*, *Dermacentor* (*Anocentor*), *Haemaphysalis*, *Aponomma*, and *Rhipicephalus*. On the basis of a study on the vector situation of tick-borne diseases, Camus and Barré (1995) mentioned that the most important ticks transmitting diseases to ruminants in the Caribbean islands are: *Amblyomma variegatum*, vector of cowdriosis and associated with acute dermatophilosis; *A. cajennense*, potential vector of cowdriosis; *Boophilus microplus*, vector of babesiosis and anaplasmosis. The annual financial loss from livestock industry due to tick infestation has been estimated to be in the millions of dollars per year in Commonwealth Caribbean only (Rawlins and Mansingh 1987). It is believed that the most important tick in the Caribbean in terms of disease transmission, the tropical bont tick *A. variegatum*, was first imported into the area by livestock coming from West Africa to the island of Guadeloupe around the 19th century (Uilenberg et al. 1984). It was speculated that the tick later spread to other Caribbean islands (Barré et al. 1995). A programme with the primary objective to eradicate *A. variegatum* from nine islands (Anguilla, Antigua and Barbuda, Barbados, Dominica, Montserrat, Nevis, St. Kitts, St. Lucia and St. Maarten) was launched in 1994 (Pegram et al. 1998) and ended in 2008 (Ahousesou et al. 2010).

**Ticks in Trinidad and Tobago**

An attempt has been made to list all tick species recorded from Trinidad and Tobago, including information on their hosts and the references (Table 1). A review of the literature revealed 23 tick species, belonging to seven genera, recorded from Trinidad and Tobago. These include nine species of the genus *Amblyomma*, six of *Ornithodoros*, two of each of the genera, *Rhipicephalus*, *Ixodes* and *Argas*, and one from each of the genera *Dermacentor* (*Anocentor*) and *Haemaphysalis*. The life cycle and control of most of these tick species, with the exception of *A. cajennense* and *Rhipicephalus (Boophilus) microplus* (Aitken et al. 1958; Thomas 1963; Smith 1973; Dindial 1977; Polar 2007), are not considered in this review. However, other available information such as the distribution, associated pathogens and effects on hosts of the 23 species are stated below, with an emphasis on the particularly problematic species.

**Argas miniatu**

*Argas (Persicargas) miniatu* was detected from chickens in Gasparee Island, Trinidad (Kohls et al. 1970). This is a common parasite of chickens in Neotropical countries which might have sometimes been misidentified as *A. persicus*. Many reports of *A. persicus*, a Palearctic species found on poultry in the Neotropics, may actually represent misidentifications of *A. miniatu* or another related species (Kohls et al. 1970).

*Argas miniatu* is known to transmit *Borrelia anse-rina* (*Borreliosis*) (Jongejan and Uilenberg 2004).

**Distribution**: Brazil, Guyana, Colombia, Panama, Venezuela, Puerto Rico, Cuba (Guglielmone et al. 2003), Mexico (Hoffman and Lopez Campo 2000), USA, Peru (Cruz 2001).

**Argas persicus**

Hart (1899) documented the presence of the fowl tick *Argas persicus* and presumed that these ticks were imported from the United States to Trinidad and Tobago. He observed that the infested birds sat down, dropped their wings and experienced fever.
Table 1: List of tick species, infested hosts and the year recorded in Trinidad and Tobago

| Tick species                  | Infested hosts                                      | References                                                                 |
|------------------------------|-----------------------------------------------------|---------------------------------------------------------------------------|
| Argas minuta                  | Fowl                                                | Kohls et al. 1970; Jones et al. 1972                                      |
| Argas persicus                | Fowl                                                | Hart 1899                                                                 |
| Ornithodoros (Alectorobius) azteci | Rats (Desmodus rotundus, Lencorhina aurita)         | Kohls et al. 1969                                                         |
| O. (A.) capensis              | Birds – Brown noddy tern (Anous stolidus), Spotted sandpiper (Actitis macularia) | Kohls et al. 1965; Aitken et al. 1968b                                    |
| O. (A.) denmarki              | Birds – Sooty tern (Sterna fuscata) & noddy terns (Anous stolidus) | Kohls et al. 1965; Aitken et al. 1968; Aitken et al. 1969; Jonkers et al. 1973 |
| O. (A.) hasei                 | Bat (Noctilio leporinus leporinus)                  | Kohls et al. 1965; Jones et al. 1972                                      |
| O. (A.) puertoricensis        | Rodents (Proechimys guyannensis trinitatus, Nectomys squamipes) | Kohls et al. 1965; Endris et al. 1989                                     |
| O. (Subparumatus) viguerasi   | Bats (Pteronotus davii & P. r. rubiginesa & Mormoops megalophylla tumidiceps) | Kohls et al. 1965; Aitken et al. 1968a                                    |
| Amblyomma auricularium        | Armadillos                                          | Jones et al. 1972; Voltzit 2007                                           |
| A. cajennense                 | Cattle, Sheep, Goats, Horses, Donkeys, Buffaloes, Dogs and Man | Neumann 1899; Nuttall et al. 1926; Aitken et al. 1958; Clarkson 1969; Smith 1973; Smith 1974; Smith 1975; Dindial 1977 |
| A. calcaratum                | Anteaters (Tamandua longicaudata), Birds, Small wild animals, Man | Aitken et al. 1968a; Jones et al. 1972; Smith 1974                        |
| A. dissimile                 | Snake, Lizard (Ameiva ameiva & Tupinambis nigropunctatus), Caimans, Toad (Bufo marinus) Amphibians, Small wild animals, Lachesis mutus, Iguana | Nuttall 1926; Turk 1948; Aitken et al. 1968a; Aitken et al. 1969; Smith 1974; Keirans 1982; Voltzit 2007 |
| A. humerali                  | Tortoise (Geocheleone denticulate), Reptiles, Rodents (Orzoymys capito and Proechimys guyannensis) | Aitken et al. 1968a; Everard and Tikasingh 1973; Robbins et al. 2003; Voltzit 2007 |
| A. longirostre               | Birds, Porcupines, Small wild animals               | Aitken et al. 1968a; Aitken et al. 1969; Smith 1974                       |
| A. nodosum                   | Birds and Anteaters                                | Jones et al. 1972; Nava et al. 2007                                       |
| A. ovale                     | Dogs                                                | Smith 1974                                                                |
| A. rotundatum                | Toads                                               | Jones et al. 1972                                                         |
| Dermacentor nitens           | Horses, Donkeys                                     | Smith 1974; Dindial 1977                                                  |
| Haemaphysalis juxtakochi     | Brocket deer (Mazama rufa)                          | Kohls 1960; Dindial 1977                                                  |
| Ixodes denticollis           | Bat (Anoura g. geoffroyi)                           | Kohls 1957                                                                |
| I. luciae                    | Rodents (Orzoymys capito, O. laticus, O. concolor, Proechimys guyannensis, Ziggedontomys, Heteromys, Didelphus marsupialis & Marmosa), Marsupials, Small wild animals | Fairchild et al. 1966; Aitken et al. 1968a; Aitken et al. 1969; Smith 1973; Smith 1974; Dindial 1977 |
| Rhizophus (Boophilus) microplus | Cattle                                               | Thomas 1963; Aitken et al. 1968a; Aitken et al. 1969; Clarkson 1969; Smith 1973; Smith 1974; Dindial 1977 |
| R. sanguineus                | Dogs                                                | Aitken et al. 1968a; Aitken et al. 1969; Smith 1974; Dindial 1977          |
He also reported that dressing infested fowl with petroleum killed the ticks.

As mentioned above, *Argas persicus*, a Palearctic species, can be easily confounded with other *Argas* species during identification, and many reports of *A. persicus* on poultry in the Neotropics may actually represent misidentifications of *A. miniatus* or another related species (Kohls et al. 1970).

*Argas persicus* is known to transmit *Borrelia anserina* (Borreliosis) and *Aegyptionella pullorum* (Aegyptianellosis) (Jongejan and Uilenberg 2004) and also transmits Slovakia virus, Slovakia (Labuda and Nuttall 2004). Larval ticks produce a toxin which causes paralysis in chickens (Walker et al. 2007).

*Ornithodoros (Alectorobius) azteci*

*Ornithodoros (A.) azteci* has been collected from bats in Trinidad (Cooley and Kohls 1944; Fairchild et al. 1965; Kohls 1969). This species was also found on vampire bats (*Desmodus rotundus rotundus*) from Coney Cave, Diego Martin in 1958 and from *Lonchorhina aurita*, Paromin, Maraval from Trinidad in 1960 (Kohls et al. 1965).

Distribution: Colombia, Cuba, Jamaica, Islands of the Lesser Antilles, Mexico, Panama, Venezuela (Kohls et al. 1965; Cruz 2001).

*Ornithodoros (Alectorobius) capensis*

Kohls et al. (1965) recorded *O. (A.) capensis* from spotted sandpipers, *Actitis macularia* from Laventile swamp, Port of Spain, Trinidad. Aitken et al. (1969) further recorded *O. (A.) capensis* during their survey of arthropods for natural virus infection.

Between 1962 and 1965, 15 strains of Hughes virus were isolated from Soldado Rock, a small limestone island located about 9.6 km off the southwestern tip of Trinidad. Seven isolates came from ticks of the *O. capensis* complex and eight from nesting terns *Sterna fuscata* (Aitken et al. 1968b). Jonkers et al. (1973) reported Soldado virus (TRVL 52214), a new viral agent, isolated from a pool of nymphal *O. capensis* ticks (either *Ornithodoros capensis sensu stricto* or *O. denmarki*) collected from a brown noddy (*Anous stolidus*) on Soldado Rock. *O. (A.) capensis* is also known to transmit other Soldado viruses in Hawaii, Seychelles, Trinidad and Ethiopia (Labuda and Nuttall 2004); Johnston Atoll virus, Abal virus in Central Pacific Islands, Australia, New Zealand, SW Africa (Hoogstraal 2003); Upolu virus in Australia; Baku virus in Azerbaijan; Aransas Bay virus in Texas, USA; Saumarez Reef virus in Tasmania; Hirota virus on Aomatsushima Island, Japan and, Midway virus in Hawaii (Labuda and Nuttall 2004).

Distribution: Dassen Island and Malagas Island (South Africa), Australia, Central Pacific, Ethiopia, Hawaii, Marshall Islands, New Zealand, Texas, Dominica, Jamaica, Cuba (Kohls et al. 1965; Cruz 2001).

*Ornithodoros (Alectorobius) denmarki*

The larvae, nymphs and adults of *O. (A.) denmarki*, a new species (Kohls et al. 1965), which was provisionally identified as *O. (A.) capensis* from Trinidad by Denmark and Clifford (1962), were found in nesting sites of sooty and noddy terns on Soldado Rock, Trinidad. Aitken et al. (1969) recorded *O. (A.) denmarki*, during their survey of arthropods for natural virus infection.

*Ornithodoros (A.) denmarki* is known to transmit Hughes viruses in USA Florida, NW Mexico, Venezuela, Cuba and Trinidad; Farallon virus in California, Oregon, USA; Soldado virus in Hawaii, Seychelles, Ethiopia and Trinidad; Raza virus in USA and Midway virus in Hawaii, Mexico (Labuda and Nuttall 2004).

Distribution: California, Hawaii, Florida, Ethiopia, Mexico, Jamaica and Cuba (Kohls et al. 1965; Guglielmone et al. 2003).

*Ornithodoros (Alectorobius) hasei*

Kohls et al. (1965) recorded *O. (A.) hasei* from bats (*Noctilio leporinus leporinus*), North Manzanilla, Trinidad.

Distribution: Barbuda, Brazil, Guyana, Colombia, Costa Rica, Dominica, Guadeloupe, Guatemala, Martinique, Mexico, Nicaragua, Panama, Bolivia, Peru, Uruguay, St. Croix (Cruz 2001), Venezuela, Bolivia (Kohls et al. 1965), Argentina (Nava et al. 2007a), Paraguay (Nava et al. 2007b), Jamaica (Guglielmone et al. 2003).
Ornithodoros (Alectorobius) puertoricensis

This tick was first identified from rats in Puerto Rico (Fox 1947). Kohls et al. (1965) recorded *O. (A.) puertoricensis* from the spiny rat (*Proechimys guyanensis trinitatus*) from Cumaca, Trinidad. A redescription by scanning electron microscope of *O. (A.) puertoricensis* was done by Endris et al. (1989). They also reported host records for larvae of *O. (A.) puertoricensis* from rodents (*Proechimys guyanensis trinitatus* and *Nectomys squamipes*) in Trinidad.

Distribution: Colombia, Jamaica, Panama, Virgin Islands, Puerto Rico, Guadeloupe, Nicaragua, Surinam, Uruguay, Argentina, Bolivia, Brazil, Paraguay, St. Croix, Venezuela (Cruz 2001).

Ornithodoros (Subparmatus) viguerasi

Kohls et al. (1965) recorded *O. (S.) viguerasi* from *Mormoops megalophylla tumidiceps* bats at Mount Tamana, and from *Pteronotus r. rubiginosa* bats in Port of Spain, Tamana Hill cave, and Diego Martin. Aitken et al. (1968a) recorded *O. (S.) viguerasi* from the lesser naked-backed bat (*Pteronotus davyi*) from Bush Forest.

Distribution: Cuba, Dominican Republic, Jamaica, Puerto Rico, Venezuela. Costa Rica, Haiti and Mexico (Cruz 2001; Guglielmone et al. 2003)

Amblyomma auricularium

Jones et al. (1972) and Voltzit (2007) mentioned the presence of *A. auricularium* in Trinidad. This species feeds on different *Xenarthra* species (anteaters and armadillos), mainly armadillos (Guglielmone et al. 2003).

Distribution: ranges from Mexico to Argentina (Jones et al. 1972; Voltzit 2007)

Amblyomma cajennense

Neumann (1899) is credited for the identification of *A. cajennense* from Trinidad. Nuttall et al. (1926) mentioned that *A. cajennense*, a common tick species in the West Indies and Central and South America, was often a troublesome pest at certain seasons of the year, when the larvae swarm in thousands in the grass and herbage and attack both man and domestic animals with avidity. Aitken et al. (1958) recorded ‘The 1958 Cayenne tick outbreak’ at the Lagoon Doux Estate, south of Mayaro, where only the labourers showed serious effects of tick exposure, such as bout and skin irritations. These authors found *A. cajennense* on a variety of animals including man. Spraying dichlorodiphenyltrichloroethane (DDT), Gamma Benzene Hexachloride (GBH), chlordane and dieldrin helped to control the tick population. Smith (1973) found very large populations of *A. cajennense* ticks in infested areas with uncontrolled grass growth and suggested that a reduction in grass length and the removal of tree shade could help reduce the tick populations. He also studied the distribution of *A. cajennense* in Trinidad and Tobago; this tick was found only in Trinidad on the Cedros peninsula and on east coast at Mayaro. Smith (1974) recorded *A. cajennense* in ruminants, equines, dogs and man. The ecology and life cycle of this tick was also investigated by Dindial (1977) and Smith (1975), respectively. Dindial (1977) found that *A. cajennense* was present in the coastal regions of Manzanilla, Mayaro, Guayaguauare and the Cedros Peninsula area of Trinidad and was absent in Tobago. The presence of *A. cajennense* on cattle was also established by Clarkson (1969) and Rawlins (1977) in Trinidad. Lans (2002) reported a second outbreak of this tick from 1994 to 1996 in Cedros and Mayaro linked to the presence of free-ranging cattle on the coconut estates.

*Amblyomma cajennense* is known to transmit Wad Medani in Jamaica and *Rickettsia rickettsii* (Rocky Mountain Spotted Fever) (Jongejan and Uilenberg 2004).

Distribution: ranges from southern USA to northern Argentina and Caribbean Islands (Cruz 2001; Voltzit 2007).

Amblyomma calcaratum

*Amblyomma calcaratum* was recorded from Trinidad on anteaters, birds (Aitken et al. 1968a), small wild animals and humans (Smith 1974).

Distribution: Brazil, Bolivia, Colombia, Costa Rica, Belize, Guyana, Ecuador, Panama, Paraguay,
Venezuela, Argentina, Peru (Jones et al. 1972; Caceres et al. 2002; Guglielmone et al. 2003; Voltzit 2007).

**Amblyomma dissimile**

Neumann (1899) is credited for the identification of *A. dissimile* in Trinidad. Nuttall et al. (1926) recorded this tick in Trinidad from snakes (*Lachesis mutans*) and iguanas. Turk (1948) found *Amblyomma trinitatis*, a synonym of *A. dissimile*, on a ground lizard at St. Augustine. Aitken et al. (1968a and 1969) recorded *A. dissimile*, during their survey of arthropods for natural virus infection and found it on various species of snake, large lizards, caimans, large toads and tortoises. Dindial (1977) reported the presence of *A. dissimile* from iguanas, frogs and snakes both in Trinidad and Tobago. Voltzit (2007) also mentioned the presence of *A. dissimile* which feeds on reptiles and toads.

Distribution: Florida, Mexico, Georgia, West Indies to Argentina (Cruz 2001; Voltzit 2007).

**Amblyomma humerale**

*Amblyomma humerale* was collected from yellow-footed tortoise, *Geochelone denticulate* from Mayaro (Aitken et al. 1968a; Robbins et al. 2003). Everard and Tikasingh (1973) found *A. humerale* on rodents (*Oryzomys capito* and *Proechimys guyannensis*) from Turure Forest, Trinidad. Nava et al. (2007b) and Voltzit (2007) also mention the presence of *A. humerale* in Trinidad. Other observed hosts include birds (Morshed et al. 2005), lizards, opossums, anteaters (Labruna et al. 2002), and dogs (Barros-Battesti et al. 2006).

Distribution: Brazil, Guyana, Venezuela, Colombia, Ecuador and French Guiana (Guglielmone et al. 2003; Voltzit 2007).

**Amblyomma longirostre**

Nuttall et al. (1926) recorded this tick from Trinidad. Aitken et al. (1968a and 1969) recorded *A. longirostre* during their survey of arthropods for natural virus infection and its immature stages frequently parasitized birds. Everard and Tikasingh (1973) found this tick on rodents (*Oryzomys capito* and *Proechimys guyannensis*) from Turure Forest. Smith (1974) recorded *A. longirostre* in Trinidad from small wild animals. Nava et al. (2007b) also indicated the presence of tick *A. longirostre* in Trinidad. Voltzit (2007) mentioned that in 1955 T.H.G. Aitken collected 2 males and a female *A. longirostre* respectively from porcupines (*Coendou prehensilis*) and birds (*Turdus nudigensis*) at Sangre Grande, Trinidad.

Distribution: ranges from Mexico to Argentina (Voltzit 2007; Nava et al. 2010).

**Amblyomma nodosum**

The presence of *A. nodosum*, a tick that feeds on birds and anteaters, was recorded in Trinidad by several authors (Jones et al. 1972; Nava et al. 2007b; Voltzit 2007).

This tick is known to transmit rickettsial infections (Ogrzewalska et al. 2009).

Distribution: Brazil, Bolivia, Costa Rica, Colombia, Guatemala, Nicaragua, Panama, Venezuela, Argentina, Mexico and Paraguay (Nava et al. 2007b; Voltzit 2007; Ogrzewalska et al. 2009).

**Amblyomma ovale**

Everard and Tikasingh (1973) and Smith (1974) recorded *A. ovale* from dogs. Dindial (1977) found *A. ovale* associated with hunting dogs at Sans Souci and Charlotteville, Trinidad.

Distribution: Mexico to Argentina (Jones et al. 1972; Voltzit 2007).

**Amblyomma rotundatum**

Jones et al. (1972) stated that *Amblyomma rotundatum*, exclusively a parasite of cold-blooded animals (Floch and Fauman 1958), was exploited toads in Trinidad.

Distribution: ranges from southern US to northern Argentina and Caribbean Islands (Jones et al. 1972; Voltzit 2007; Guglielmone and Nava 2010).
**Dermacentor nitens**

Smith (1974) and Rawlins (1977) recorded *D. nitens* from equines in Trinidad. *Dermacentor nitens* is known to transmit *Babesia caballi* (Equine babesiosis) (Jongejan and Uilenberg 2004). Asgarali *et al.* (2007) investigated 93 horses in Trinidad for serum antibodies to *Theileria equi* and *Babesia caballi* using an immunofluorescent antibody test and found 77 to be seropositive. However, the authors did not study the transmitted agents. Earlier, Floch and Fauman (1958) confirmed the presence of the tick, *D. nitens*, in Trinidad. Very recently, Georges (2010) diagnosed some tick-transmitted haemopathogens (*Anaplasma platys*, *Babesia canis vogeli*, *B. caballi*, *Theileria equi*) in companion animals using molecular tools.

*Distribution*: throughout the West Indies, Central America, Bolivia, Brazil (Cruz 2001).

**Haemaphysalis juxtakochi**

Kohls (1960) first recorded the identity of *H. juxtakochi*, collected by T.H.G. Aitken on 24 June 1954 from Cumaca, Trinidad. This tick parasitizes deer (*Mazama rufa*) and paca (*Coelogenys paca*). Keirans (1982) also recorded this tick from Caparo, Trinidad.

*Distribution*: ranges from USA to northern Argentina (Guglielmone *et al.* 2003)

**Ixodes downsi**

Kohls (1957) first recorded a new species of tick, *I. downsi* on bats (*Anoura geoffroyi*) in Aripo Cave, Trinidad. Gonzalez-Acuna *et al.* (2008) mentioned the presence of this tick in Trinidad and Tobago and stated that it is unclear whether the principal hosts are Chiroptera or Aves.

*Distribution*: Venezuela (Gonzalez-Acuna *et al.* 2008).

**Ixodes luciae**

Aitken *et al.* (1969) recorded *I. luciae* during their survey of arthropods for natural viral infections. Everard and Tikasingh (1973) found *I. luciae* on rodents (*Oryzomys capito* and *Proechimys guyannensis*) from Turure Forest. In 1974, Smith recorded *I. luciae* from small wild animals from Trinidad.

*Distribution*: Argentina, Brazil, Bolivia, Colombia, Guyana, Guatemala, Peru, Mexico, Nicaragua, Surinam, Venezuela. Belize, Costa Rica, Ecuador, French Guiana and Panama (Guglielmone *et al.* 2011)

**Rhipicephalus (Boophilus) microplus**

Aitken *et al.* (1958) recorded a few specimens of the southern cattle tick *R. (B.) microplus* from cattle and sheep in Trinidad. Williams and Gonzalez (1968) observed that Holstein heifers imported into Trinidad from Canada with the intent to develop a dairy industry were exposed to tick-infested pastures and that these exotic cattle suffered from a febrile disease associated with marked anaemia, occasional haemoglobinuria and sometimes death within two to six weeks after importation and introduction to tick-infested pastures. They also confirmed the detection of *Babesia spp.* and *Anaplasma marginale* from the blood of the infected cattle. This established the presence of *R. (B.) microplus* ticks in Trinidad, as these ticks are vectors of both the pathogens. The presence of *R. (B.) microplus* on cattle in Trinidad was confirmed by Aitken *et al.* (1969), Clarkson (1969) and Rawlins (1977). Smith (1973) studied the distribution of *R. (B.) microplus* in Trinidad and Tobago. *Rhipicephalus (B.) microplus* was found throughout both islands, except on land newly cleared from forest. Furthermore, Smith (1974) recorded this tick exploiting ruminants and equines. The prevalence and biology of *R. (B.) microplus* was investigated by Dindial (1977) and he also found the presence of *R. (B.) microplus* ticks all over the country. Spraying dichlorodiphenyl-trichloroethane (DDT), Gamma Benzene Hexachloride (GBH), chlordane and dieldrin was reported to have helped to control this tick population in Trinidad. Polar and co-investigators (2005) reported the use of entomopathogenic fungi *Metarhizium anisopliae* to control *R. (B.) microplus* at Aripo livestock station in Trinidad. Polar (2007) found that *Metarhizium anisopliae* was effective against all development stages of *R. (B.) microplus* and *Rhipicephalus sanguineus*, except larvae of the latter.
R. (B.) microplus is known to transmit numerous parasites: Babesia bovis and B. bigemina (Bovine babesiosis), Anaplasma marginale (bovine anaplasmosis) and Theileria equi (equine piroplasmosis) (Jongejan and Uilenberg 2004). A virus, Wad Medani has also been reported to be transmitted by R. (B.) microplus in Singapore and Malaysia (Labuda and Nuttall 2004).

**Distribution: Cosmopolitan**

*Rhipicephalus sanguineus*

Aitken et al. (1969) recorded *R. sanguineus* during their survey of arthropods for natural virus infection. Smith (1974) documented *R. sanguineus* from dogs.

This tick is known to transmit *Ehrlichia canis* (canine ehrlichiosis), Babesia vogeli (canine babesiosis), Hepatozoon canis (canine hepatozoonosis), *Rickettsia conorii* (tick bite fever in humans) (Jongejan and Uilenberg 2004) and also transmits Wad Medani virus in Sudan, East Africa, Asia and Jamaica (Labuda and Nuttall 2004).

**Distribution: Cosmopolitan**

**CONCLUSION**

Trinidad and Tobago harbour a high diversity of tick species, some of which are known to play a significant role in animal and human health. The reported detection of a total of 23 different tick species may be considered to be very high considering the relatively small size of the twin Island country (Trinidad – 4828 km²; Tobago – 300 km²). Tobago, being the smaller of the two islands, has fewer animal populations and recorded lower tick species richness. *Amblyomma cajennense*, the main species of concern to humans and animals, is found only in some pockets of Trinidad and has not been reported from Tobago. The main factor limiting the distribution of this tick appears to be its intolerance of wet soil and high rainfall. The relatively small areas infested with this species have common features such deep sandy well-drained soil with a well-marked dry season and low rainfall (Smith 1973).

All reported surveys of ticks in the Caribbean suggest the absence of *Antricola mexicanus* and *Amblyomma variegatum* in Trinidad and Tobago, except an unpublished report (Rawlins et al. 1992) and an unconfirmed record by Rawlins et al. (1993) which was published in a newsletter. Alderink and McCauley (1988) mentioned Trinidad and Tobago as one of the 12 non-infested *A. variegatum* island groups in the Lesser Antilles. The absence of *A. variegatum* in Trinidad and Tobago may be due to strict vigilance during animal importation. In addition, according to the annual report on Animal Health 2009, cowdriosis, a rickettial pathogen transmitted by *Amblyomma* spp, is considered absent in Trinidad and Tobago (Anon. 2010). Though *A. cajennense* is an experimental and potential vector of cowdriosis, it is thought to be a poor vector as successful transmission by this tick species seems to be low (Uilenberg 1983; Jongejan 1992). Moreover, *A. cajennense* has not been incriminated so far in the natural transmission of this disease (http://www.oie.int). All the facts lead us to conclude that *A. variegatum* may be absent in this country.

Hunter (1945) reported the presence of R. (B.) annulatus in Trinidad. However, Smith (1974) concluded that the presence of this species was probably an incorrect identification of R. (B.) microplus, a species found in abundance throughout Trinidad and Tobago. Subsequently, there has been no record of the presence of R. (B.) *annulatus* from Trinidad.

Since 1977, there has been no comprehensive study on ticks in Trinidad and Tobago and only sporadic information is available on disease transmission. Future studies on the ecology of ticks and epidemiology of tick-borne diseases in Trinidad and Tobago will therefore be rewarding, and veterinarians and researchers should be encouraged to update the list of prevalent ticks as this will lead to a better understanding of the epidemiology of tick-borne human and animal diseases in the country.

**ACKNOWLEDGEMENTS**

The authors wish to thank Dr. Alberto A. Guglielmoné, Argentina for providing valuable scientific articles. The authors are also thankful to Dr. Karen
D. McCoy for her valuable advice and suggestions. The authors acknowledge the support of Mr. Sookdeo Bhagwandeen, Ms. Arlene Dolabaille and other library staff members of the University of the West Indies, St. Augustine, for cooperation during the study.

REFERENCES

Ahoussou S., Lancelot R., Sanford B., Porphyre T., Bartlette-Powell P., Compton E., Henry L., Maitland R., Lloyd R., Mattili R., Chavernac D., Stachurski F., Martinez D., Meyer D.F., Vachiery N., Pegram R., Lefrançois T. 2010 — Analysis of Amblyomma surveillance data in the Caribbean: lessons for future control programmes — Vet. Parasitol., 167(2-4): 327-35. doi:10.1016/j.vetpar.2009.09.035

Aitken T.H.G., Jonkers A.H., Tikasingh E.S. 1968b — Hughes virus from Trinidadian ticks and terns — J. Med. Ent., 5: 501-503.

Aitken T.H.G., Jonkers A.H., Tikasingh E.S., Worth C.B. 1968a — Arbovirus studies in Bush Bush Forest, Trinidad, W.I., September 1959 - December 1964. III. Entomological Studies — Am. J. Trop. Med. Hyg., 17(2): 253-268.

Aitken T.H.G., Omardeen T.A., Giles C.D.1958 — The 1958 Cayenne tick outbreak — J. Agric. Soc. Trinidad, 58: 153-157.

Aitken T.H.G., Spence L., Jonkers A.H., Downs W.G. 1969 — A 10-year survey of Trinidad arthropods for natural virus infection (1953-1963) — J. Med. Ent., 6: 207-215.

Alderink F. J., McCauley E.H.1988 — The probability of the spread of Amblyomma variegatum in the Caribbean — Prevent. Vet. Med., 6: 285-294. doi:10.1016/0167-5877(88)90040-2

Anon. 2010 — Animal Health Annual Report 2009 — Ministry of Agriculture, Land and Marine resources. Trinidad and Tobago. pp. 12.

Asgarali A., Coombs D.K., Mohammed F., Campbell M.D., Caesar E. 2002 — First evidence of the occurrence of Amblyomma calcaratum Neumann, 1899 in Peru — Rev. Per. Entomol., 9: 116-117.

Camus E., Barre N. 1995 — Vector situation of tick-borne diseases in the Caribbean islands — Vet. Parasitol, 57: 167-176. doi:10.1016/0304-4017(94)03118-G

Clarkson M.J. 1969 — 'Tick-borne diseases of cattle in Trinidad and Tobago' — Report to the Ministry of Overseas Development. London.

Cooley R.A., Kohls G.M. 1944 — The argasidae of North America, Central America, and Cuba — Amer. Midland Nat. Monogr. N° 1: pp. 152.

Cruz J.O.de la 2001 — Patterns in the Biogeography of West Indian Ticks[Internet] — In: Woods C.A. and Sergile F.E.(Eds). Biogeography of West Indies. CRC Press. Available from (http://www.crcnetbase.com/doi/abs/10.1201/9781420039481.ch7)

De Castro J.J. 1997 — Sustainable tick and tick borne disease control in livestock improvement in developing countries — Vet. Parasitol., 71: 77-97. doi:10.1016/S0304-4017(97)00033-2

Denmark H.A., Clifford C.M. 1962 — A tick of the Ornithodoros capensis group established on Bush Key; Dry Tortugas, Florida — Florida Ent., 45(3): 139-142.

Dindial P. 1977 — Studied on the life cycle and seasonal incidence of Boophilus microplus in Trinidad and Tobago. [MSc Thesis] — The University of the West Indies, St. Augustine, Trinidad.

Endris R.G., Keirans J.E., Robbins R.G., Hess W.R. 1989 — Ornithodoros (Alectorobius) puertoricensis (Acari: Argasidae): Redescription by Scanning Electron Microscopy — J. Med. Ent., 26(3): 146-154.

Everard C.O.R., Tikasingh E.S. 1973 — Ecology of the rodents, Proechimys guyannensis truncatus and Oryzomys capito velutinus, on Trinidad — J. Mammal., 54(4): 875-886. doi:10.2307/1379082

Fairchild G.B., Kohls G.M., Tipton V.J. 1965 — The ticks of Panama (Acarina: Ixodidae). The Ectoparasites of Panama — R.R. Donnelley and Sons Co., Chicago.

Floch H., Fauman P. 1958 — Ixodides de la Guyane et des Antilles Francaises. Archives de l’institute Pasteur de Panama — R.R. Donnelley and Sons Co., Panama — R.R. Donnelley and Sons Co., Chicago.

Fox I. 1947 — Ornithodoros puertoricensis, a new tick from rats in Puerto Rico — J. Parasitol., 33(3): 253-259. doi:10.2307/3273558

Georges K. 2010 — Molecular diagnosis of haemopathogen infection of companion animals [PhD Thesis]— The University of the West Indies, St. Augustine, Trinidad.

Gonzalez-Acuna D., Nava S., Mangold A.J., Guglielmone A.A. 2008 — Ixodes downsii Kohls, 1957 in Venezuela — Syst. Appl. Acarol., 13: 39-42.
Guglielmone A.A., Estrada-Pena A., Luciana C.A., Manguel A.J., Keirans J.E. 2003 — Hosts and distribution of Amblyomma auricularium (Conil 1878) and Amblyomma pseudoconcolor Aragao, 1908 (Acari: Ixodidae) — Exp. Appl. Acarol., 29: 131-139. doi:10.1023/A:1024251020035

Guglielmone A.A., Estrada-Pena A., Keirans J.E. and Robbins R.G. 2003 — Ticks (Acari: Ixodidae) of the Neotropical Zoogeographic region — Special Publication of the International Consortium on Ticks and Tick-borne Diseases, ISBN 987-43-6828-4, Atlanta, Houten, The Netherlands, pp. 174.

Guglielmone A.A., Robbins R.G., Apanaskevich D.A., Petney T.N., Estrada-Pena A., Horak I.G., Shoa R., Barker S.C. 2010 — The Argasidae, Ixodidae and Nuttalliellidae (Acari: Ixodida) of the world: a list of valid species names — Zootaxa, 2528: 1-28.

Guglielmone A.A., Nava S. 2010 — Hosts of Amblyomma dissimile Koch, 1844 and Amblyomma rotundatum Koch, 1844 — Zootaxa, 2548: 27-49.

Guglielmone A.A., Nava, S., Diaz, M.M. 2011 — Relationships of South American marsupials (Didelphimorphia, Microbiotheria and Paucituberculata) and hard ticks (Acari: Ixodidae) with distribution of four species of Ixodes — Zootaxa, 3086: 1-30.

Hart J.H. 1899 — The tick of the domestic fowl and fowl fever — Bulletin of miscellaneous information, Trinidad, 19, pt II, April: 180.

Hoffmann A., Lopez-Campos G. 2000 — Biodiversidad de los ácaros en México. Jiménez Editores e Impresores, México, pp. 230.

Hoogstraal H. 1973 — Viruses and ticks. In A.J. Gibbs [ed], Viruses and Invertebrates. North-Holland, Amsterdam, Elsevier, New York.

Hunter S. 1945 — The cattle tick Boophilus annulatus: studies of the effect on the dairy cow in Trinidad [A.I.C.T.A. Thesis] — The University of the West Indies, Trinidad.

Jones E.K., Clifford C.M., Keirans J.E., Kohls G.M. 1972 — The ticks of Venezuela (Acarina: Ixodoidea) with a key to the species of Amblyomma in the Neotropical Hemisphere — Brigham Young University Science Bulletin, Biological Series, 17(4): 25.

Jonkers A.H., Casals, Aitken T.H.G., Spence L.1973 — Soldado Virus, a new agent from Trinidadian Ornithodoros ticks — J. Med. Ent., 10: 517-519.

Jonsson N.N. 2006 — The productivity effects of cattle tick (Boophilus microplus) infestation on cattle, with particular reference to Bos indicus cattle and their crosses — Vet. Parasitol., 137: 1-10. doi:10.1016/j.vetpar.2006.01.010

Kaufman W.R. 2010 — Ticks: Physiology aspects with implications for pathogen transmission — Ticks and Tick-borne Diseases, 1: 11-22.

Keirans J.E. 1982 — The tick collection (Acarina: Ixodidae) of the Hon. Nathaniel Charles Rothschild deposited in the Nuttall and general collections of the British Museum (Natural History) — Bulletin of the British Museum of Natural History Zoology Series, 42: 1-36.

Kohls G.M. 1957 — Ixodes downsi, a new species of tick from a cave in Trinidad, British West Indies (Acarina: Ixodidae) — Proceedings of the Entomological Society of Washington, 59: 257-264.

Kohls G.M. 1960 — Records and new synonymy of new world Haemaphysalis ticks, with descriptions of the nymph and larva of H. juxtakochi Cooley — J. Parasitol., 46: 355-361. doi:10.2307/3275499

Kohls G.M., Sonenshine DE, Clifford C.M. 1965 — The systematics of the subfamily Ornithodorinae (Acarina: Argasidae). II. Identification of the larvae of the Western Hemisphere and descriptions of three new species — Ann. Entomol. Soc. Am., 58(3): 331-364.

Kohls G.M. 1969 — A new species of Amblyomma from iguanas in the Caribbean (Acarina: Ixodidae) — J. Med.l Entomol., 6: 439-442.

Kohls G.M., Hoogstraal H., Clifford C.M., Kaiser M.N. 1970 — The subgenus Persicargas (Ixodoidea, Argasidae, Argas), 9. Redescription and new world records of Argas (P.) persicus (Oken), and resurrection, re-description, and records of A.(P.) radiatus Railliet, A.(P.) sanchezi Duges, and A.(P.) miniatus Koch, new world ticks misidentified as A.(P.) persicus — Annals of the Entomological Society of America, 63(2): 590-606.

Labuda, M. and Nuttall, P.A. 2004 — Tick-borne viruses — Parasitology, 129: S221-S245.

Labruna M.B., Camargo L.M., Terrassini F.A., Schumaker T.T.S., Camargo E.P. 2002 — Notes on parasitism by Amblyomma humerale (Acarina: Ixodidae) in the State of Rondonia, Western Amazon, Brazil — J. Med. Ent.,39: 814-817. doi:10.1603/0022-2585-39.6.814

Lans C. 2002 — Natural Pest Control. (http://www.farmingsolutions.org/successtories/stories.asp?id=109).
Nava S., Venzal J.M., Diaz M.M., Mangold A.J., Guglielmona A.A. 2007a — The Ornithodoros hasei (Schulze, 1935) (Acari: Argasidae) species group in Argentina — Syst. Appl. Acarol., 12: 27-30.

Nava S., Velazco P.M., Guglielmone A.A. 2010 — First record of Amblyomma longistre (Koch, 1844) (Acari: Ixodidae) from Peru, with a review of this tick’s host relationship — Syst. Appl. Acarol., 15: 21-30.

Neumann L.G. 1899 — Revision de la famille des Ixodides. Mémoires de la Société Zoologique de France, 12: 107-294. cited by Smith, M.W.1975. Some aspects of the ecology and lifecycle of Amblyomma cajennense (Fabricius 1787) in Trinidad and their influence on tick control measures — Annals of Tropical Medicine and Parasitology, 101(3): 255-270. doi:10.1179/136485907X176319

Nava S., Lareschi M., Rebollo C., Benitez Usher C., Beati L., Robbins R.G., Durden L.A., Mangold A.J., Guglielmona A.A. 2007b — The ticks (Acari: Ixodidae) from the avian tick, Ixodes auritulus Fabricius, 1787 parasitic on cattle at the field station, University of the West Indies, St. Augustine, Trinidad — Caraphin News No. 6, April: 8-9.

Rawlins S.C., Mansingh A. 1987 — A review of tick and screwworms affecting livestock in the Caribbean — Insect Science and Application, 8: 259-267.

Smith M.W. 1977 — Toxicological and biological studies on Jamaican and other Caribbean populations of the cattle tick Boophilus microplus (canestrini) (Acarina:Ixodidae) — PhD Thesis — The University of the West Indies, Mona, Jamaica.

Smith M.W. 1973 — The ecology of Amblyomma cajennense a parasite of man and animals in Trinidad — Trans. R. Soc. Trop. Med. Hyg., 67(1): 36. doi:10.1016/0035-9203(73)90311-8

Smith M.W. 1974 — A survey of the distribution of the Ixodid ticks Boophilus microplus (Canestrini, 1888) and Amblyomma cajennense (Fabricius, 1787) in Trinidad and Tobago and the possible influence of the survey results on planned livestock development — Trop. Agric. (Trinidad), 51(4) : 559-567.

Smith M.W. 1975 — Some aspects of the ecology and lifecycle of Amblyomma cajennense (Fabricius 1787) in Trinidad and their influence on tick control measures — Annals of Tropical Medicine and Parasitology, 69 (1): 121-129.

Sonenshine D.E. 1993 — Biology of Ticks, vol. 2. Oxford University Press, Oxford.

Thomas R.A. 1963 — Studies on the biology of the cattle tick Boophilus microplus, parasitic on cattle at the field station, University of the West Indies, Trinidad — DTA Report. The University of the West Indies.

Turk F. 1948 — On two new species of tick — Parasitology, 38 (4): 243-246.
Basu A.K. et al.

Uilenberg G. 1983 — Acquisitions nouvelles dans la connaissance du rôle vecteur de genre *Amblyomma* (Ixodidae) — Rev. Elev. Med. Vet. Pays. Trop., 36(1): 61-66.

Uilenberg G., Barré N., Camus E., Burridge M.J., Garris G.I. 1984 — Heartwater in the Caribbean — Prev. Vet. Med., 2: 255-267. doi:10.1016/0167-5877(84)90068-0

Voltzit O.V. 2007 — A review of neotropical *Amblyomma* species (Acari: Ixodidae) — Acarina, 15(1): 3-134.

Walker A.R., Bouattour A., Camicas J.L., Estrada-Pena A., Horak I.G., Latif A.A., Pegram R.G., Preston P.M. 2007 — Ticks of domestic animals in Africa: a guide to identification of species — Bioscience report, 1-22.

Williams H.E., Gonzalez F.O. 1968 — Two tick-borne diseases affecting exotic cattle introduce into Trinidad — Tropical Agriculture, Trinidad, 45: 22-32.

**COPYRIGHT**

Basu A.K. et al. Acarologia is under free license. This open-access article is distributed under the terms of the Creative Commons-BY-NC-ND which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original author and source are credited.