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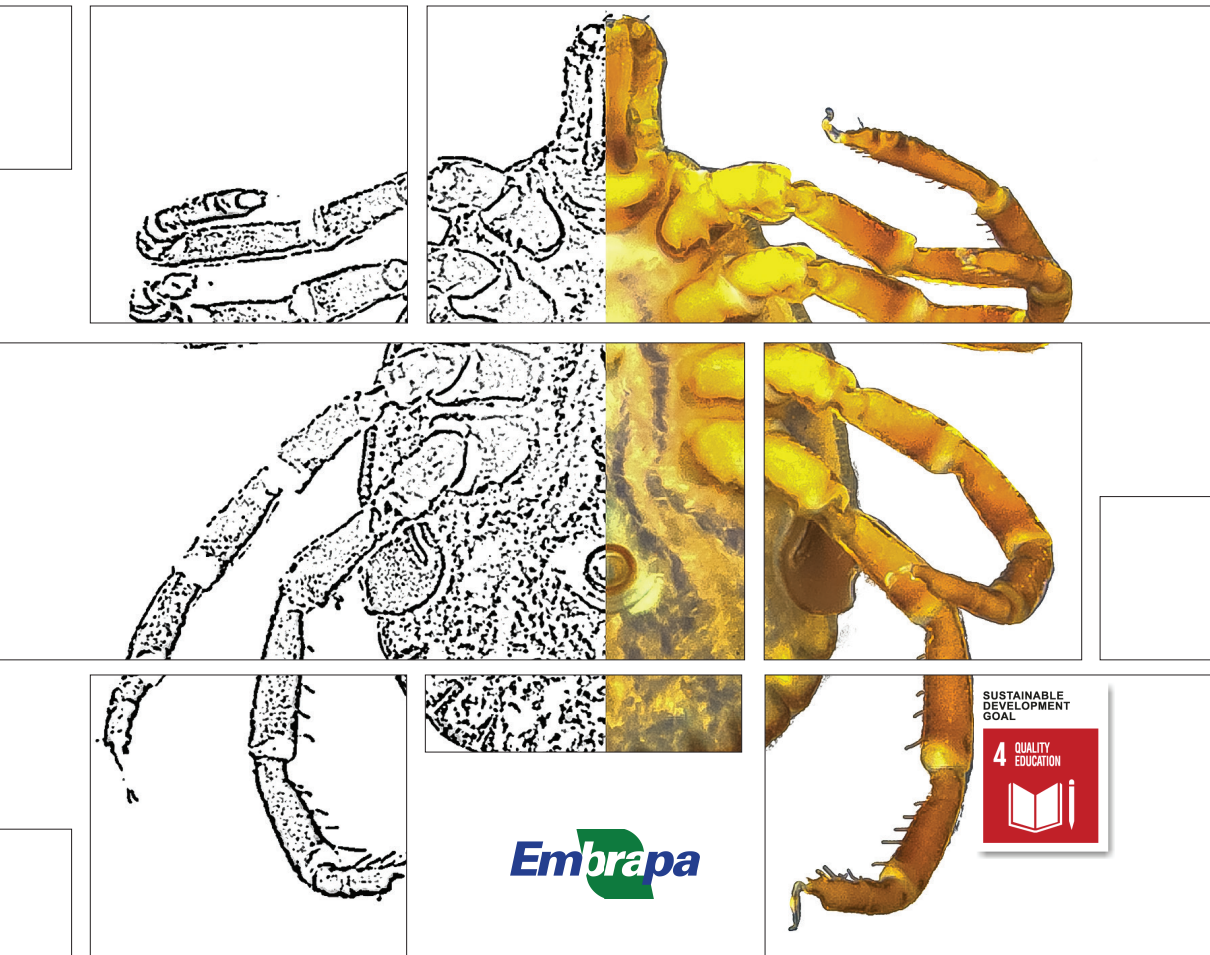

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Sumário

Introduction

Ticks are ectoparasites belonging to the phylum Arthropoda and class Arachnida and are divided into three families: Ixodidae, Argasidae and Nuttalliellidae. They are necessarily hematophagous, parasitizing all classes of terrestrial vertebrates, and their main relevance is the ability to transmit infectious agents, such as viruses, bacteria, protozoa and nematodes, to their hosts (JONGEJAN; UILENBERG, 2004). Ticks have great importance to One Health, with a very important economic bias worldwide related to animal production (GRISI *et al*., 2014).

More than 940 species of ticks have been reported across the globe, and approximately 10% of these have been recorded in Brazil. These ectoparasites (75 species) are distributed in two families: Ixodidae, which are known as hard ticks (51 species), and Argasidae (24 species), which are called soft ticks (MARTINS *et al*., 2019; MUÑOZ-LEAL *et al*., 2020; ONOFRIO *et al*., 2020; LABRUNA *et al*., 2020).

Some species stand out in Brazil, either due to their economic importance, as is the case for *Rhipicephalus microplus* (GRISI *et al*., 2014), or due to their impact on public health, as is the case for *Amblyomma sculptum*, a vector of the causative agent of Brazilian spotted fever (BSF) (LABRUNA, 2009).

Ticks are found in all Brazilian biomes, and there are some peculiarities regarding tick species (ANDREOTTI *et al*., 2019). In this document, we aim to present some morphological and diagnostic characteristics as well as general information about some of the main tick species occurring in Brazil to highlight the unique health risks they pose and their economic importance. By summarizing this information, technicians working in the field will be able to quickly and accurately access information about the importance, morphology, biology and taxonomy of the main tick species of national interest.

The tick species considered are *Amblyomma dubitatum* (Neumann, 1899), *A. sculptum* (Berlese, 1888), *Argas miniatus* (Koch, 1844), *Dermacentor nitens* (Neumann, 1897), *R. microplus* (Canestrinni 1887); and *Rhipicephalus sanguineus* sensu lato (Latreille, 1806).

Amblyomma dubitatum (Neumann, 1899)

Importance

In Brazil, *A. dubitatum* is widely distributed, with reports in the states of Amazonas, Roraima, Acre, Mato Grosso, Mato Grosso do Sul, Espírito Santo, São Paulo, Santa Catarina, Paraná, Rio Grande do Sul, Minas Gerais and Rio de Janeiro; that is, it is present in almost all biomes, including the Cerrado, Atlantic Forest, and Amazon and in the Paraná and Araucaria Forests (ONOFRIO, 2007; NAVA *et al*., 2010; GIANIZELLA *et al*., 2018; MARTINS *et al*., 2014; ZIMMERMANN *et al*., 2018). The main host of adult *A. dubitatum* is the capybara (*Hydrochoerus hydrochaeris*), which is also commonly parasitized by immature stages. However, this tick species has been found parasitizing other mammal species, and there have been reports of parasitism by larvae and nymphs of some bird species (DEBÁRBORA *et al*., 2012; WITTER *et al*., 2016). All instars parasitize humans, and larvae and nymphs are more aggressive than other growth forms (LABRUNA *et al*., 2007; NAVA *et al*., 2010). There are several reports of *A. dubitatum* infected with pathogens, such as *Rickettsia parkeri*, *R. parkeri* strain Atlantic Forest, *Rickettsia belli* and *Rickettsia* sp. (LADO *et al*., 2014; MONJE *et al*., 2015; LABRUNA *et al*., 2007; PAROLA *et al*., 2013; MATIAS *et al*., 2015). Nevertheless, the vectorial capacity of *A. dubitatum*, as well as the pathogenicity of the agents it carries, are still unclear.

Biology

A. dubitatum has a heteroxenous cycle (similar to *A. sculptum*), and the main host of adults is capybaras (*H. hydrochaeris*). Conversely, juvenile instars, as previously mentioned, are generalists and can parasitize a wide range of hosts. According to Nava *et al*. (2017), *A. dubitatum* have one generation per year, in which larvae are abundant from May to July (autumn/winter), nymphs from July to October (winter/spring) and adults from November to March (spring/summer). However, all the instars can be found throughout the year. This species of tick prefers flooded and riparian environments.

Morphological diagnosis of *Amblyomma dubitatum* (Figures 1 and 2)

MALE

- Oval body, narrower in the anterior part
- Deep, short, comma-shaped cervical groove
- Complete marginal groove
- Ornate scutum, external garland
- Basis capituli dorsally rectangular
- Spatulate hypostome
- Dental formation 3/3
- Coxae I with two subequal spur, short and triangular
- Coxae II and III each with a short triangular spur
- Coxae IV with thin and long triangular spur
- Trochanters without spur
- Oval plaques

FEMALE

- Large body with oval contour
- Scutum ornamented, with whitish spot in the central area
- Rounded scapulae
- Deep cervical sulci anteriorly and shallow posteriorly
- Flat eyes
- Numerous scores, evenly distributed
- Basis capituli dorsally rectangular
- Spatulated hypostome
- Dental formation 3/3
- Coxae I with two distinct thorns, triangular and subequal
- Coxae II and IV, each with a short triangular spur
- Trochanters without spur
- Oval plaques

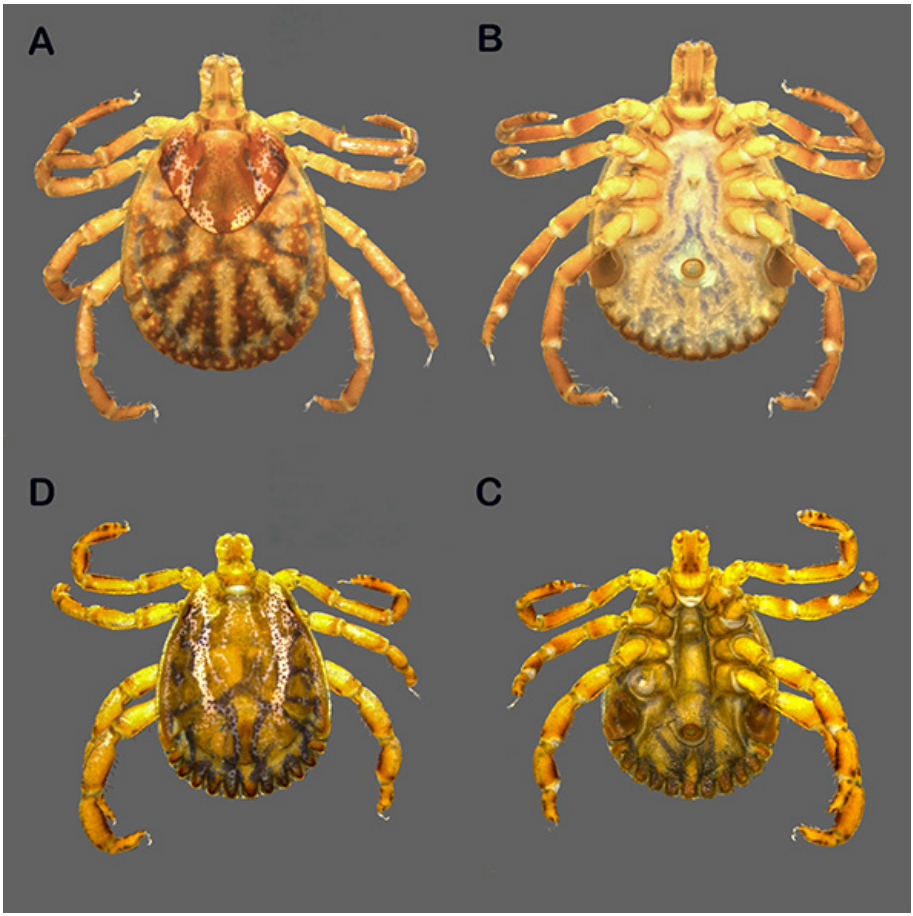

Figure 1. *Amblyomma dubitatum*: (A) Dorsal view of the female idiosome, (B) ventral view, (C) dorsal view of the male idiosome, (D) ventral view. Light microscopy images.

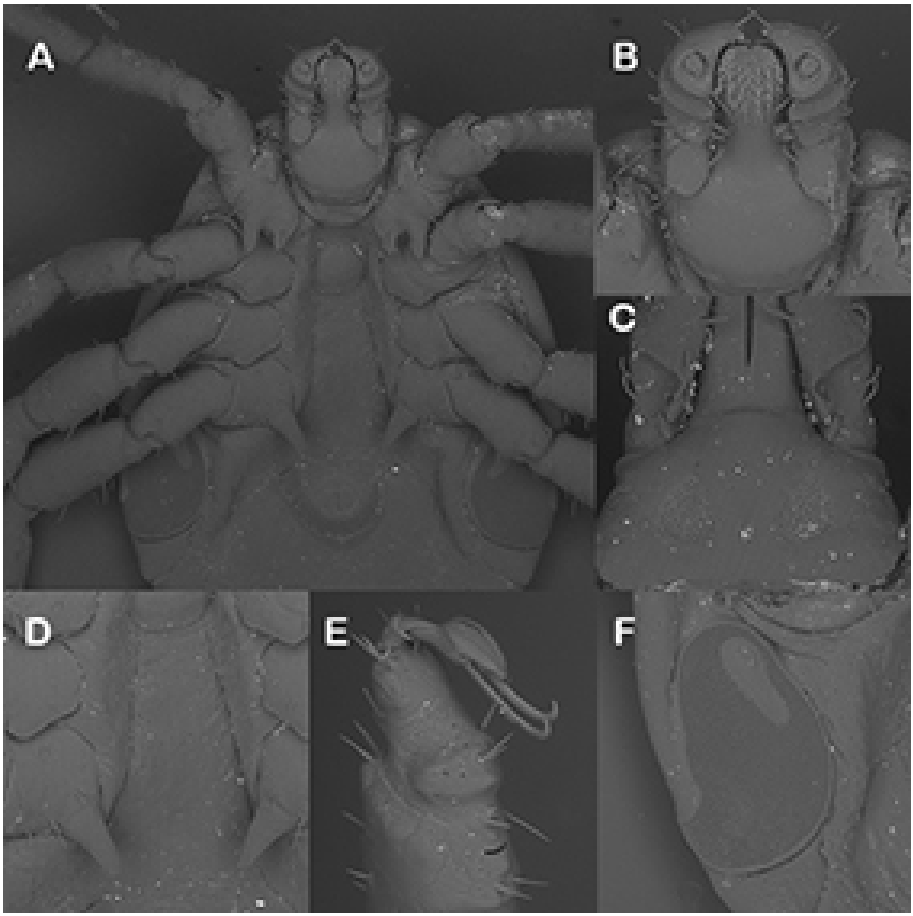

Figure 2. *Amblyomma dubitatum*: (A) Ventral view of the spur on the four coxae, (B) ventral view of the basis capituli, palps and dentition, (C) dorsal view of the *basis capituli* and porous areas, (D) coxae IV thorn, (E) view of the tarsus, tibia and pulvillus and Haller's organ, (F) view of the spiracular plate. Scanning electron microscopy images.

Amblyomma sculptum (Berlese, 1888)

Importance

Until 2014, *Amblyomma cajennense* represented a single species, whose distribution ranged from the southern United States to northern Argentina. Nava *et al*. (2014), after morphological and molecular analyses of *A. cajennense* specimens from different regions of the Americas, found that it was actually a species complex called the *A. cajennense* sensu lato complex. This complex consists of six species, namely, *A. cajennense* sensu stricto, *Amblyomma mixtum*, *A. sculptum*, *Amblyomma tonelliae*, *Amblyomma interandinum* and *Amblyomma patinoi*.

Only two species of the complex occur in Brazil: *A. cajennense* sensu stricto and *A. sculptum* (NAVA *et al*., 2014). Of these, the first occurs in the Amazon region, being more adapted to the conditions of this biome, while *A. sculptum* is more typically found in the Cerrado, being very well adapted to degraded and anthropized areas (LABRUNA, 2018). We will emphasize the species *A. sculptum*, whose importance in public health is widely known.

In the adult stage, *A. sculptum* is popularly known as the horse tick, star tick or rodoleiro. The immature phases (larvae and nymphs) are called micuim or powder tick and are also assigned the names little tick, red tick or little red. The popular names vary among regions, and the same common names may also be attributed to other species of ticks.

Horses (*Equus caballus*), capybaras (*H. hydrochaeris*) and tapirs (*Tapirus terrestris*) are considered the main hosts of *A. sculptum* (LABRUNA *et al*., 2001; SOUZA *et al*., 2006). This species has low parasitic specificity, especially in the immature stages. Thus, they parasitize a wide range of hosts, including humans (PAJUABA *et al*., 2018).

In Brazil, *A. sculptum* is the main vector of the *Rickettsia rickettsii* bacterium, which is responsible for causing BSF (LABRUNA, 2009). It is worth noting that the tick *Amblyomma aureolatum* is another vector of this pathogen, but this species is found more often in the southern and southeastern regions of Brazil, as it prefers areas of the Atlantic Forest biome (LABRUNA *et al*.,

2005). The transmission of this bacteria to humans occurs through tick bites, particularly by infected nymphs (LABRUNA, 2009; DEL FIOL *et al*., 2010).

Biology

A. sculptum has a trioxenous life cycle (i.e., it requires three hosts). This means that each of the life stages of *A. sculptum* (larvae, nymphs and adults) needs a different host, and host period may vary for each instar. After a blood meal, the ticks detach themselves from the host, fall to the ground and seek shelter to perform ecdysis (larvae and nymphs); in the case of adults, engorged females detach and seek a safe place for oviposition.

It is worth noting that engorged larvae, after ecdysis, become nymphs, which differ not only in size but also in that they have four pairs of legs. Nymphs may actively search for a host (attacking) or remain on the tips of leaves waiting for a host (lurking).

Adult ticks are differentiated from nymphs by the presence of a genital orifice. Upon gaining the ability to feed, they exhibit behavior similar to that described for nymphs. As soon as adults find a host, they fixate, feed and copulate. Only females become completely filled with blood (engorged), at which point they are called teleogynes, which detach themselves and fall to the ground in search of a safe place for oviposition. After oviposition, the female dies, leaving its egg mass for incubation. After the incubation period, the larvae hatch. This entire process is affected by climatic conditions, especially temperature.

In general, in the climate conditions in Brazil, this tick has only one annual generation with very well-defined seasonality. Often, the larvae appear in the dry season (April to July), and nymphs are also predominant in the dry season (July to October). Adults occur in the warmer and wetter months (October to March). All these population dynamics are related to the diapause of the larvae, which hatch between October and March remain inactive in the soil until the beginning of the driest period, from April to June (LABRUNA *et al*., 2002 and 2003; CABRERA; LABRUNA, 2009). In Brazil, this seasonality can directly influence the transmission of BSF to humans. (LEMOS, 2013)

Morphological diagnosis of *Amblyomma sculptum* (Figures 3 and 4)

We emphasize that the morphological identification of ticks, in most cases, is performed through the use of dichotomous keys. In Brazil, ticks of the genus *Amblyomma* are identified according to descriptions provided by Barros-Battesti *et al*. (2006) and Dantas-Torres *et al*. (2019), and nymphs are identified according to descriptions from Martins *et al*. (2010) and Martins *et al*. (2016). Larvae, however, are identified only up to the genus level, as there are still no keys available to identify larvae to the species level.

MALE

- Body (idiosome) rounded oval
- Complete marginal groove
- Ornate scutum
- Basis capituli subrectangular dorsally
- Spatulate hypostome; dental formation 3/3
- Genital opening located at the level of coxae II
- Coxae I with two distinct spur, short and wide
- Coxae II and III each with a short triangular spur
- Coxae IV with pointed and long spur
- Trochanters without spur

FEMALE

- Body (idiosome) rounded oval
- Flat eyes
- Chitinous tubercles present in the festoons
- Scutum ornamented, with an irregular and diffuse central area
- Spatulate hypostome; dental formation 3/3
- Genital opening located at the level of coxae II, U-shaped
- Coxae I with two evident spur
- Coxae IV with triangular spur
- Trochanters without spur

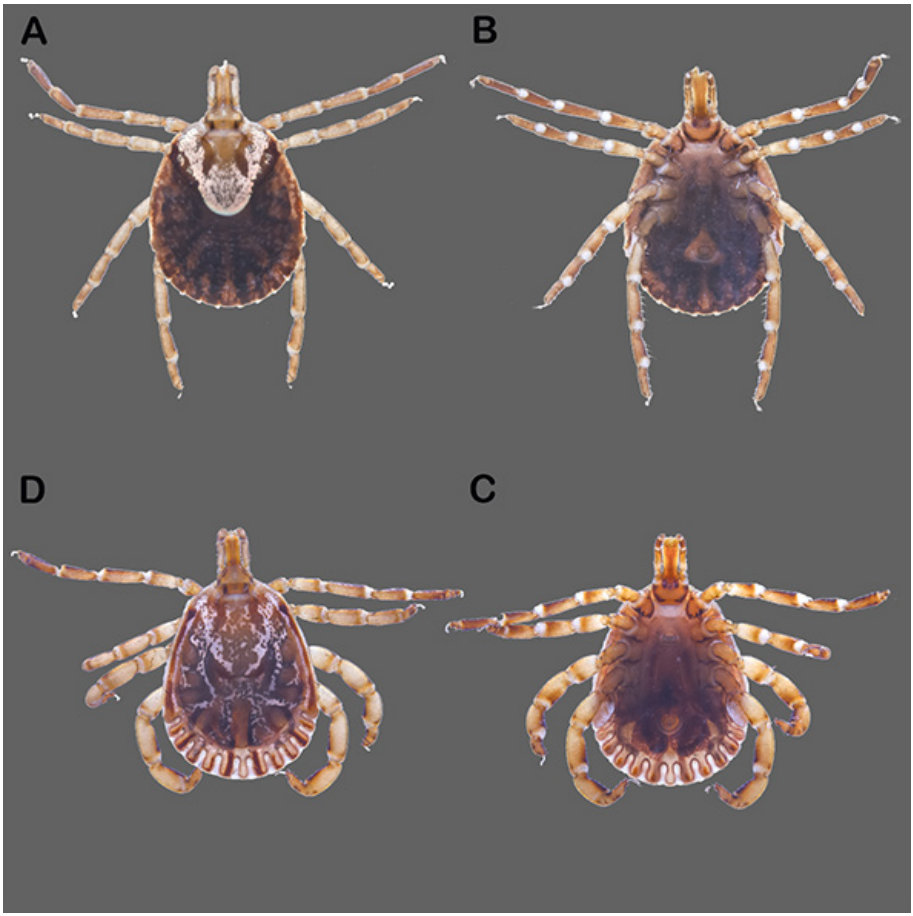

Figure 3. *Amblyomma sculptum*: (A) Dorsal view of the female idiosome, (B) ventral view, (C) dorsal view of the male idiosome, (D) ventral view. Light microscopy images.

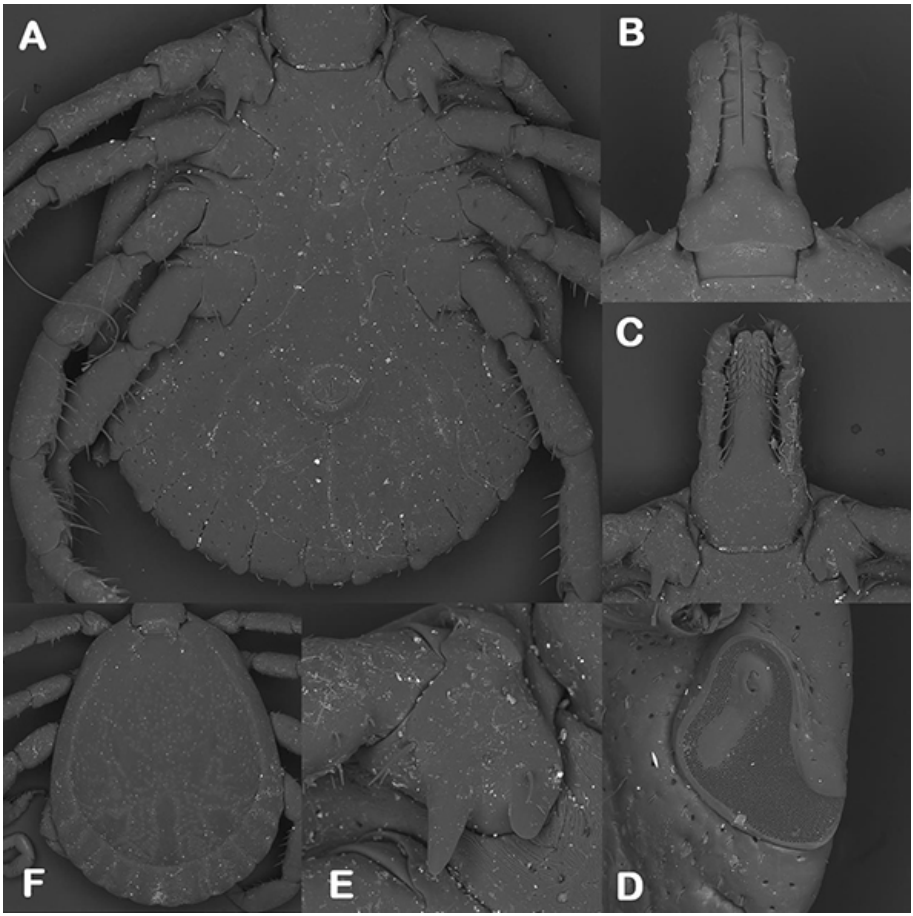

Figure 4. *Amblyomma sculptum*: (A) View of thigh I of a female, (B) dorsal view of the basis capituli, palps and hypostome, (C) ventral view of the capitulum, palps and 3/3 dentition, (D) spiracular plate, (E) thorns on coxae I, with the external thorn being larger than the internal thorn, (F) dorsal view of the male scutum. Scanning electron microscopy images.

Argas miniatus (Koch, 1844)

Importance

Argasids are represented by four genera: *Antricola*, *Argas*, *Nothoaspis* and *Ornithodoros*, with the latter having the largest number of species (MUÑOZ-LEAL *et al*., 2020).

In particular, *A. miniatus* is a Neotropical tick reported in the Americas. This species is maintained in nature and especially on small domestic chickens (*Gallus gallus*) that, when infested, may suffer or present losses in productivity due to intense hematophagism or even by the transmission of pathogens such as *Borrelia anserina* (MARCHOUX; SALIMBENI, 1903; HOOGSTRAAL, 1979; LISBÔA *et al*., 2008).

These ticks can induce paralysis due to the action of larvae in young birds (MAGALHÃES *et al*., 1987), which are heteroxenous and have nocturnal feeding habits. During the feeding process, a larva remains on its host for several days (SCHUMAKER *et al*. 1988; SANTOS *et al*., 2008). However, nymphs and adults collect their blood meals in a few minutes (SANTOS *et al*., 2011).

In the free-living phase, *A. miniatus* are found in shelters and nests used by their hosts, where copulation occurs (ROHR, 1909). They can also be found in cracks of wood stacked near perches (SANTOS *et al*., 2011).

This species has two to four nymphal instars, and adults develop from the second nymphal instar. Females can lay up to 16 clutches of eggs throughout the biological cycle, laying an average of 136 eggs per clutch (RHOR, 1909). After a single copulation, the female attains a blood meal. The eggs undergo an incubation period, which varies from 12 to 41 days, depending on the temperature, and the mean percentage of hatching is 82.7%. Under controlled temperature and relative humidity (RH) conditions, the complete cycle can last up to 201 days, while under natural conditions, it can last up to 317 days (SCHUMAKER; OBA, 1988).

Females lay up to 18 egg clutches under controlled conditions (27 ± 1 °C and 80 ± 10% RH), while in the rainy and dry seasons, they lay 9 and 12 egg clutches, respectively. The total number of eggs under controlled conditions was 1,350,

reaching 443 eggs in the rainy season and 894 eggs in the dry season. Under fasting conditions, male ticks survived for 165 days under controlled conditions (27 ± 1 °C and 80 ± 10% RH) and 135 days under laboratory conditions, while females survived for 300 days under controlled conditions (27 ± 1 °C and 80 ± 10% RH) and 240 days in a laboratory environment (SANTOS *et al*., 2011).

Morphological diagnosis of *Argas miniatus* (Figures 5 and 6)

The morphology of ticks of the family Argasidae is completely different from that of hard ticks, i.e., those belonging to Ixodidae; this is because ticks belonging to the Argasidae have a characteristic cuticle with an elastic aspect and no sclerotized dorsal scutum. They also have a basis capituli on the ventral surface without fovea glands, and the body surface is formed by a series of discs and nipples that appear in both adults and nymphs. Spiral plates are small and often difficult to observe. An important morphological detail is the occurrence of a coxal pore (orifice) in thigh I of adult ticks and some nymphal stages; the function of this pore is related to the concentration of excess water during blood ingestion (ESTRADA-PEÑA, 2015).

There are no major morphological differences between male and female *A. miniatus*, with the only different being only the shape of the opening of the genital apparatus.

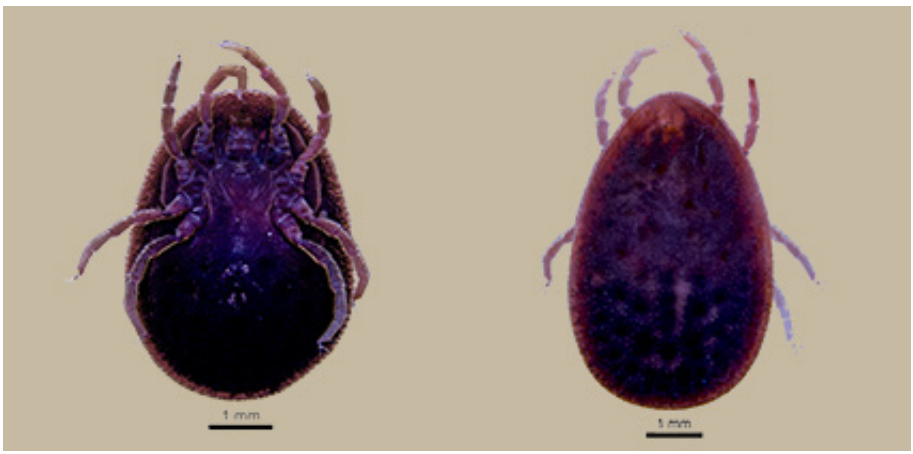

Figure 5. *Argas miniatus*: (A) ventral view, (B) dorsal view. Light microscopy image.

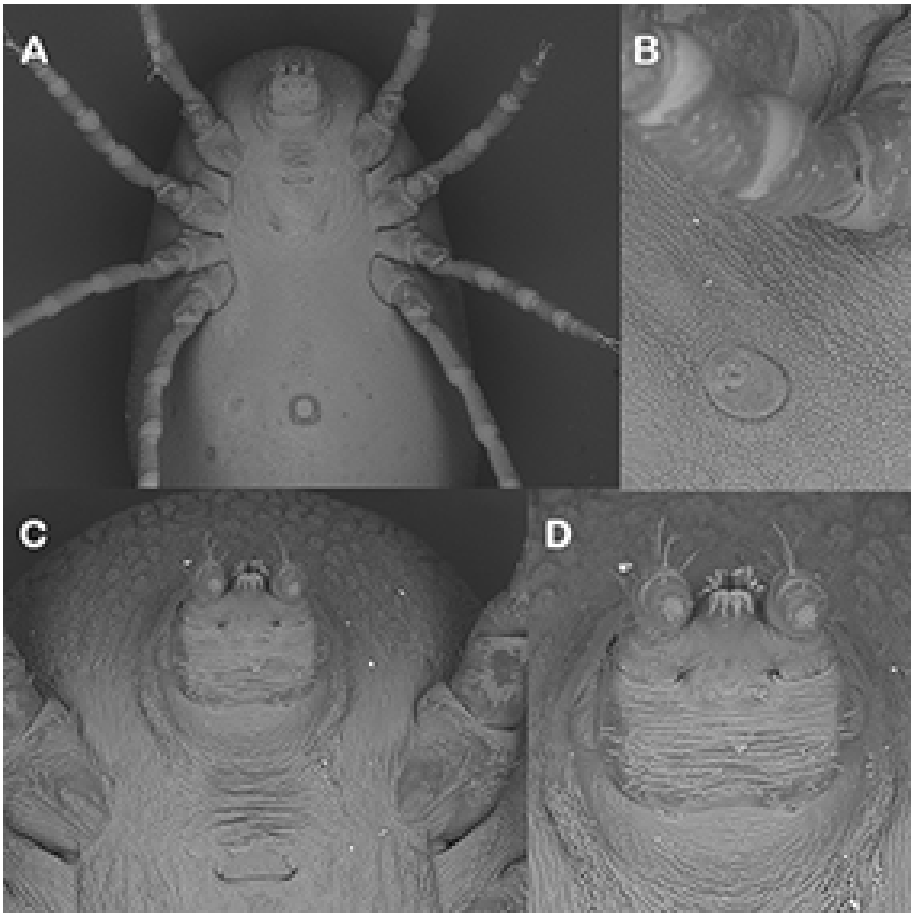

Figure 6. *Argas miniatus*: (A) ventral view, (B) spiracle, (C) view of the genital orifice and capitulum, (D) view of the capitulum, palpus and hypostome. Scanning electron microscopy images.

Dermacentor nitens (Neumann, 1897)

Importance

This genus of ticks is represented by a single species in Brazil. Popularly known as the horse ear tick, its main host is Equidae, but it can parasitize other animals, as shown by reports of little and/or intense parasitism in a large number of mammal species (MARTINS *et al*., 2015; NAVA *et al*., 2017).

Rodrigues *et al*. (2017), when evaluating other species as possible hosts for *D. nitens* under experimental conditions, found that cattle, sheep, guinea pigs, dogs and chickens (domestic) were not competent hosts for *D. nitens*. This species was capable of completing its parasite phase only on rabbits, thus reinforcing *D. nitens*' notorious preference for equids.

Large infestations of this tick in horses can cause chronic damage to the ears of the animals, since this species prefers to parasitize the pinna (Rodrigues *et al*. 2017), and may also support the emergence of myiasis and secondary infections (LABRUNA; AMAKU, 2006). *D. nitens* is the vector of the bacterium *Babesia caballi*, an infectious agent responsible for equine babesiosis, a disease that triggers a fever, leading to anemia and jaundice and causing hepatomegaly and weight loss (ROBY; ANTHONY, 1963; NIZOLI, 2019). The major concern related to equine babesiosis is the decrease in the performance of animals participating in sports competitions (BOTTEON *et al*., 2005; PEREIRA, 1999).

It is worth noting that to date, this tick species does not represent and important public health threat in Brazil because *D. nitens* is rarely found on humans. However, there have been reports of the presence of pathogens, such as *R. rickettsii*, *Ehrlichia chaffensis* and *Borrelia burgdorferi*, infecting *D. nitens* (BERMÚDEZ *et al*., 2011; GONÇALVES *et al*., 2013; NAVA *et al*., 2017).

Biology

D. nitens depends on a single host to complete its life cycle (monoxenous cycle), and this cycle can, in a simplified way, be divided into two phases: parasitic and nonparasitic.

The parasitic phase begins with the fixation of the larvae to an animal and ends with the detachment of the female tick. This phase lasts an average of 25 to 27 days (LABRUNA; AMAKU, 2006). In the central western part of Brazil, Rodrigues *et al*. (2017) found that the parasitic phase lasts an average of 25 days. Each stage of tick development has an average feeding period, and larvae, nymphs and females take an average of eight, nine and eight days, respectively, to complete their blood meals (RODRIGUES *et al*., 2017). Finally, when a female tick completes its feeding, it detaches from its animal host, falls to the ground and initiates the nonparasitic phase.

The nonparasitic life stage is directly influenced by abiotic factors, such as climatic conditions (temperature and humidity) and biotic factors, such as natural enemies (e.g., ants and some bird species) (BASTOS *et al*., 1996).

Regarding population dynamics, in the southeastern region of Brazil, *D. nitens* has three to four generations per year, and the highest infestation peaks occur in the first half of the year (BORGES *et al*., 2000; LABRUNA *et al*., 2002).

Morphological diagnosis of *Dermacentor nitens* (Figures 7 and 8)

Onofrio *et al*. (2007) presented a key for the genus *Dermacentor*, although it is represented by a single species.

MALE

- Body size: total length, 2.5 mm; width 1.8 mm
- Elongated oval body
- Pointed scapulae; shallow cervical grooves
- Small eyes

- Seven festoons
- Basis capituli dorsally rectangular
- Spatulate hypostome; 4/4 dental formation
- Coxae I to III with two short spurs with blunt tips
- Coxae IV well developed, with a thorn
- Subcircular plaques

FEMALE

- Body size: total, 2.8 mm; width, 1.9 mm
- Scutum length: total, 1.6 mm; width 1.6 mm
- Elongated oval body
- Pointed scapulae; shallow, narrow and linear cervical grooves
- Small eyes
- Rounded shield length, smooth surface
- Seven festoons
- Basis capituli dorsally rectangular
- Spatulate hypostome; 4/4 dental formation
- Coxae I to III with two short spurs with blunt tips
- Coxae IV well developed, with a thorn
- Subcircular plaques.

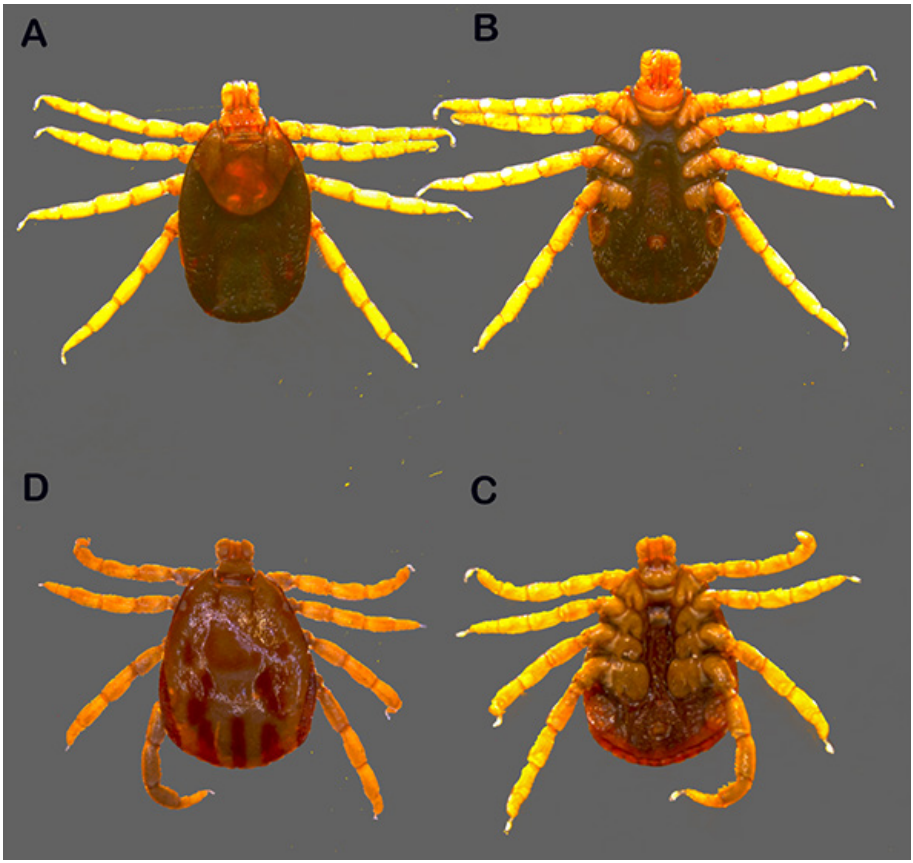

Figure 7. *Dermacentor nitens*: (A) dorsal view of the female idiosome, (B) ventral view, (C) dorsal view of the male idiosome, (D) ventral view. Light microscopy images.

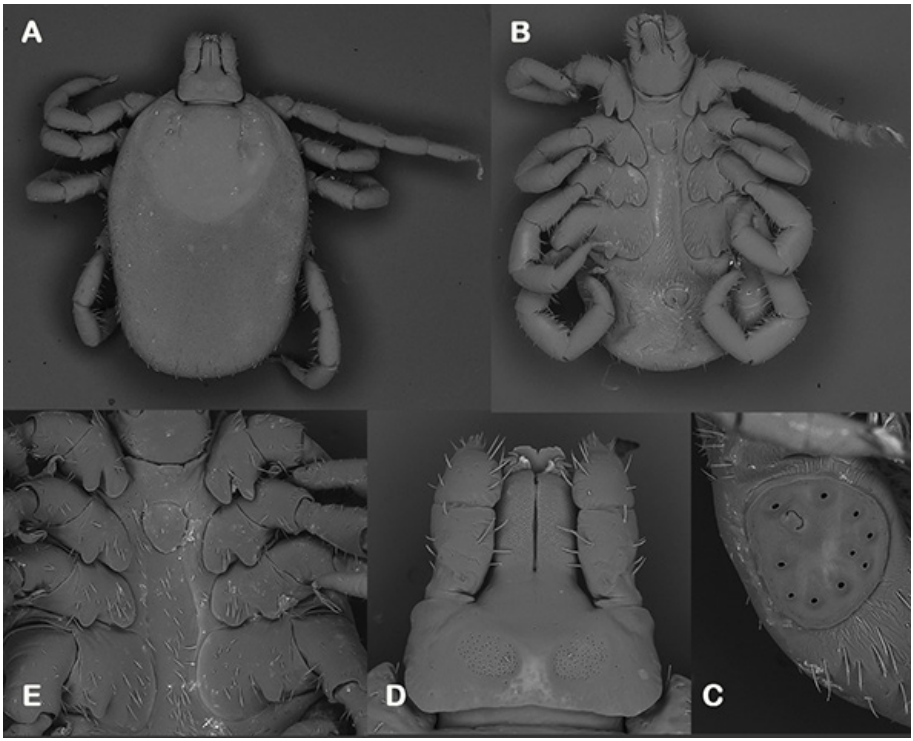

Figure 8. *Dermacentor nitens*: (A) dorsal view of the female idiosome, (B) ventral view, (C) view of the spiracular plate, (D) dorsal view of the basis capituli, palps and hypostome, (E) view of the spur on the four coxae.

Rhipicephalus microplus (Canestrini, 1887)

Importance

Rhipicephalus microplus, known as carrapato-do-boi, is one of the most important ectoparasites in the cattle production chain, not only in Brazil but also worldwide. In addition to direct losses due to blood spoliation, it is the main transmitter of bacteria of the genus Anaplasma (*Anaplasma marginale*) and protozoa of the genus *Babesia* (*Babesia bovis* and *B. bigemina*), infectious agents of bovine cerebral babesiosis (GUGLIELMONE *et al*., 1995; SACCO, 2002; SILVA *et al*., 2015).

Bites from this species of tick can cause several lesions on the skin of an animal, allowing contamination by opportunistic bacteria and the onset of myiasis (RECK *et al*., 2014). These lesions can also cause depreciation of the value of the leather of the animals (ANDREOTTI *et al*., 2019).

The damage caused by *R. microplus* is demonstrated in infected animals by weight loss, intense blood spoliation and irritability, causing reduced production; large infestations can lead to the death of animals. The expenses associated with the control of this tick should also be considered. In Brazil, according to Grisi *et al*. (2014), *R. microplus* causes an annual loss of 3.24 billion US dollars.

Biology

R. microplus is a monoxenous tick because it requires only one host and has high specificity, parasitizing almost exclusively cattle (GONZALES, 1975). The life cycle of *R. microplus* can be divided into two stages: the parasitic phase and the free-living phase. The parasitic phase begins with the fixation of the larvae to the host, and some body regions (e.g., dewlap, between legs, udder, posterior and perineum) are preferred as a function of temperature and for protection from the self-cleaning performed by the animals in an attempt to remove larvae and ectoparasites (ANDREOTTI *et al*., 2019).

From four to seven days after larval fixation, the larval stage changes, with the individual becoming a nymph; after nine to 16 days, the nymph undergoes ecdysis, transforming into an adult. In turn, the adults copulate, and the females, called teleogynes, detach from the host after between 18 and 35 days (mean of 21 days). Male ticks usually remain on the host (GONZALES, 1975). It is worth noting that as long as a tick is fixed to its host, the climatic conditions do not have much influence on its biology (ANDREOTTI *et al*., 2019).

The free-living phase begins with the detachment of the female tick from the host; once in the soil, females seek shelter from sunlight and predators (HITCHCOCK, 1955). The initial period of three to five days is characterized as preoviposition, the time required for ovarian maturation, egg production and development. This is followed by oviposition, which lasts on average 14 to 26 days (CRUZ *et al*., 2020). Each female can lay up to 3,000 eggs, which represents approximately 50% of the total weight of the female tick (LEGG, 1930).

After the eggs have incubated for necessary time, which on average is 38.56 days, hexapod larvae hatch. The larvae remain quiescent for approximately 6.14 days, and then rise to the tips of leaves waiting for a host (CRUZ *et al*., 2020). According to Gauss and Furlong (2002), the larvae can remain in a pasture for 82 days. However, Cruz *et al*. (2020) observed an average larval longevity of 70.7 days. These same authors reported that this tick species can have three to five generations per year, depending on the region and climatic conditions. The nonparasitic phase ends when the larvae reach a host.

We highlight that approximately 95% of the ticks found in nature are in the egg, larvae and/or teleogyne stages, while only 5% of ticks are in the parasitic phase (PEREIRA *et al*., 2008).

Morphological diagnosis of *Rhipicephalus microplus* (Figures 9 and 10)

Pereira *et al*. (2008) provided the taxonomic key used for five species of the genus *Rhipicephalus* and subgenus *Boophilus*, translated and modified from keys developed by Arthur (1960), Aeschlimann and Morel (1965) and Gothe (1967)

MALE

• Total body length, 1.8 mm; width, 1.1 mm

• Oval body contour, rounded scapulae, shallow and almost imperceptible cervical grooves

• Presence of caudal appendix

• Scutum without ornamentation; marginal groove absent

• Small, flat eyes

• Dorsal basis capituli hexagonal, small cornea

• Palpus shorter than the hypostome

• Short hypostome

• Dental formation 4/4

• Genital opening located between second coxae

• Coxae I with two short and subequal triangular spur

• Coxae II and III each with a single short external spur

• Coxae IV without a thorn or with a rounded protrusion

• Spiracle rounded

FEMALE

• Total body length, 2.2 mm; width, 1.1 mm

• Oval body contour, rounded scapulae

• Scutum length, 1.0 mm; width, 0.9 mm

• Small, flat eyes

• Dorsal basis capituli hexagonal; oval porous area

• Short hypostome

• Dental formation 4/4

• Genital opening located between second coxae

• Coxae I with two short and blunt spurs

• Coxae II and IV each with a single blunt external spur

• Rounded spiracles

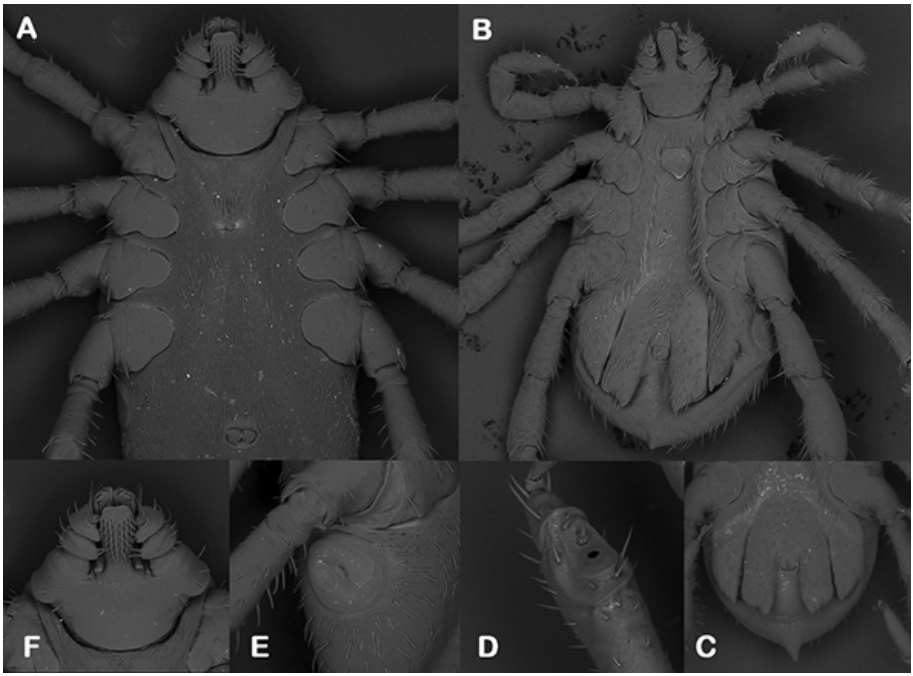

Figure 9. *Rhipicephalus microplus*: (A) dorsal view of the female idiosome, (B) ventral view, (C) dorsal view of the male idiosome, (C) ventral view. Light microscopy images.

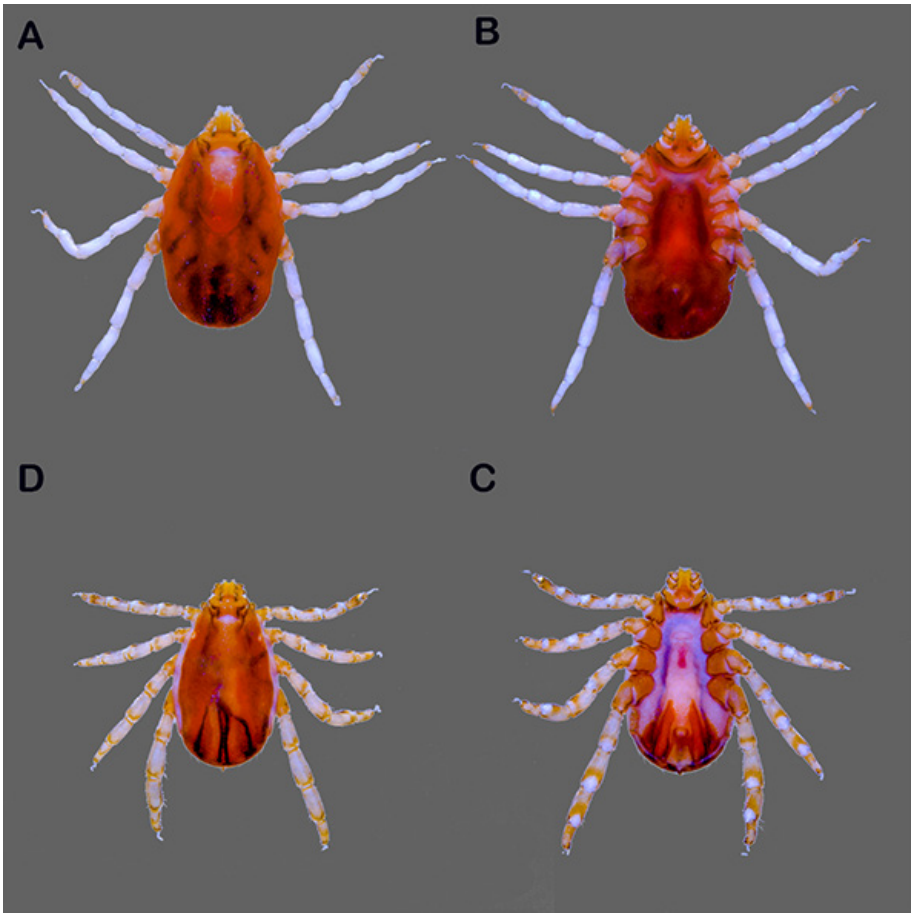

Figure 10. *Rhipicephalus microplus*: (A) ventral view, capitula and coxae, (B) ventral view and the presence of adanal plates, (C) adanal plates and caudal appendix, (D) Haller's organ, (E) spiracle, (F) basis capituli, palpus and hypostome.

Rhipicephalus sanguineus sensu lato (Latreille, 1806)

Importance

R. sanguineus sl is popularly known as the red dog tick. It has a wide geographic distribution and is present on all continents; domestic dogs are its preferred hosts, and parasitism of humans has been reported in some locations (LABRUNA, 2004; NAVA *et al*., 2017).

In Brazil, *R. sanguineus* sl is one of the main ectoparasites of pet animals, and because of this position, it receives great interest and attention from the pharmaceutical industries related to veterinary medicine (LABRUNA, 2004). It is worth noting that *R. sanguineus* sl is a potential vector of various infectious agents for humans and dogs, such as *Ehrlichia canis*, *Anaplasma platys*, *Babesia canis*, *B. vogeli*, *B. gibsoni*, *Hepatozoon canis*, *R. rickettsii*, *R. conorii* and *R. massiliae* (WALKER *et al*., 2000; PAROLA *et al*., 2005; CICUTTIN *et al*., 2015). In Brazil, *R. sanguineus* sl is the main transmitter of *H. canis* (O'DWYER *et al*., 2001).

Biology

R. sanguineus sl requires three hosts to complete its life cycle, which comprises parasitic and nonparasitic phases. During the nonparasitic phase, the instars involved, engorged females, eggs, larvae, engorged larvae, nymphs, engorged nymphs and nonfed adults, are concentrated in an environment close to where the host is often found (e.g., in a burrow, hut, or kennel or in crevices or cracks in the walls). This behavior is called nesting. the ticks can remain in these locations for weeks or even months waiting for a host if it is removed from its location.

The parasitic phase begins with the fixation of any of the nonfed instars (larvae, nymphs and/or adults) to a host. In the case of the larvae, when they encounter a host, the feeding process (engorgement) lasts an average of two to four days. Soon after the feeding period, the larva, already full (engorged), detaches from the animal and seeks shelter to undergo

ecdysis (molt). This process can last up to eight days, depending on the climatic conditions.

Then, the engorged larva gives rise to a nymph, which again seeks a host. After fixation, approximately five to six days are needed to complete engorgement, after which the nymph detaches from the host, and seeks shelter for ecdysis. This period can vary from 14 to 16 days and results in adult males or females.

Adult *R. sanguineus* sl copulate on a host, and the female, after a period of seven to nine days, is engorged, detaches from the host and finds a safe place close to the host habitat. Under ideal temperature and humidity conditions, the female begins oviposition around the third day after detaching, with the period before oviposition called the prelaying period. After oviposition, the eggs are incubated, which also requires suitable climatic conditions, and finally, approximately 30 days later, larvae begin to hatch from the eggs. Similar to the larvae of other species, *R. sanguineus* sl larvae require a period of time before they are able to actively seek a host.

Morphological diagnosis of *Rhipicephalus sanguineus* (Figures 11 and 12)

MALES

- Elongated oval body, narrower anterior part
- Rounded scapulae; deep cervical grooves
- Incomplete marginal groove
- Scutum without ornamentation; grooves unequal in size
- Presence of a pair of adanal plates, subtriangular in shape
- Flat eyes
- Dorsal basis capituli hexagonal
- Short hypostome
- Dental formation 3/3
- Genital opening located between second coxae
- Coxae I with two long triangular spurs

• Coxae II to IV with a single short spine

FEMALE

• Oval body contour; rounded scapulae
• Deep grooves
• Scutum without ornamentation
• Grooves unequal in size
• Flat eyes
• Basis capituli hexagonal
• Palps short and apically rounded
• Short hypostome
• Dental formation 3/3
• Genital opening located between second coxae, U-shaped
• Coxae I with two long triangular spurs
• Coxae II to IV with a single short spur
• Spiral plates elongated, with narrow dorsal extension

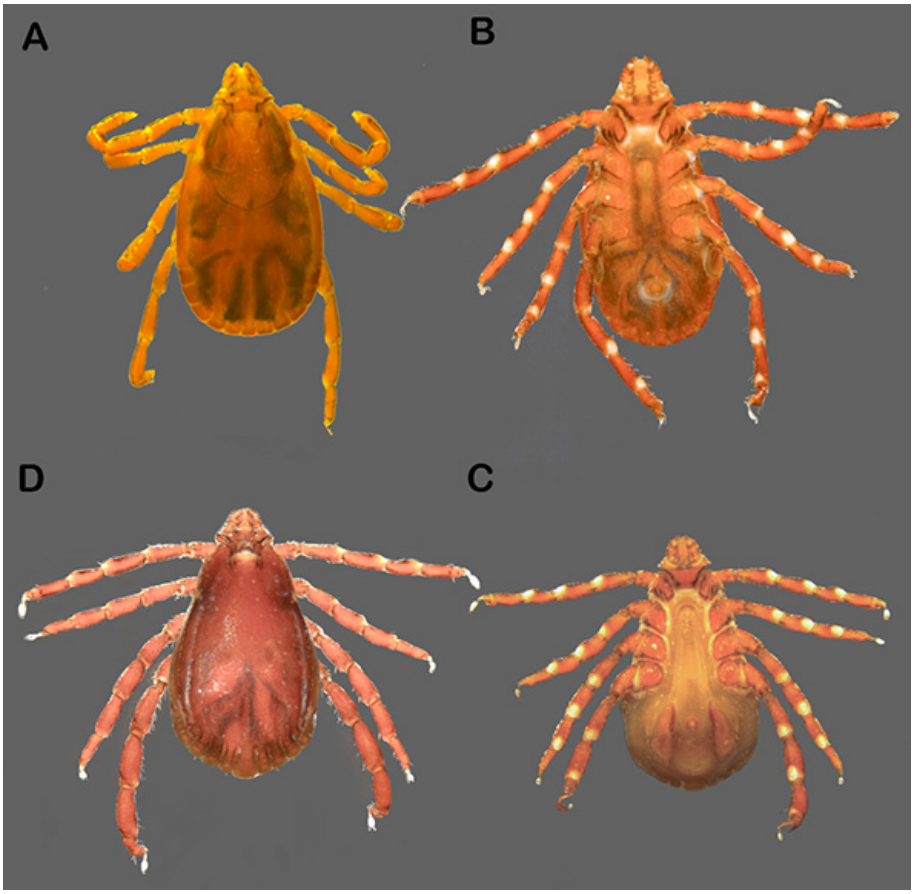

Figure 11. *Rhipicephalus sanguineus* sl: (A) dorsal view of the female idiosome, (B) ventral view, (C) dorsal view of the male idiosome, (C) ventral view. Light microscopy images.

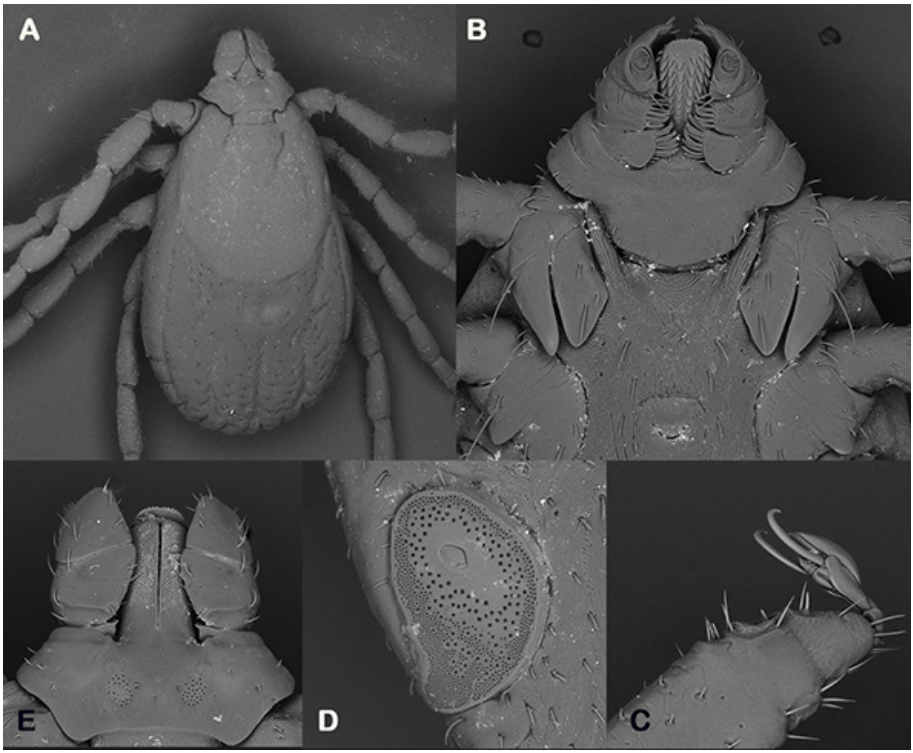

Figure 12. *Rhipicephalus sanguineus* sl: (A) dorsal view of the female idiosome, (B) ventral view of the basis capituli, palps and hypostome, and thorns of coxae I, (C) view of the tarsus, tibia and pulvillus, (D) spiracle, (E) dorsal view of the basis capituli, palps and hypostome.

Final considerations

Describing the main species of ticks that are important to the mission of One Health due to their hematophagous habits and ability to transmit infectious agents and with respect to animal production was the aim of this study. Through this readily accessible document (via the Carrapato Museum website: https://cloud.cnpgc.emorpa.br/controle-do-carrapato-ms/museu-do-carrapato/), the reader will receive quality information on the subject addressed, including technical contributions to the identification of tick species that occur in Brazil as well as their potential risks. Of the 75 species identified and distributed in Brazil, we selected those related mainly to domestic animals, with an emphasis on Central Brazil.

References

AESCHLIMANN, A.; MOREL, P.C. *Boophilus geigyi* n. sp. (Acarina:Ixodoidea) une nouvelle tique du bétail de l'Ouest Africain. **Acta tropica,** v. 22, p. 162-168, 1965.

ANDREOTTI, R.; GARCIA, M. V.; KOLLER, W. W. Carrapatos na cadeia produtiva de bovinos. **Brasilia, DF. Embrapa,** 2019. 240 p.

ARTHUR, D. R. Ticks: A monograph of the Ixodoidea. Part V. On the genera *Dermacentor, Anocentor, Cosmiomma, Boophilus* and *Margaropus*. **London: Cambridge University Press**, 1960. 279 p.

BARROS-BATTESTI, D. M.; ARZUA, M.; BECHARA, G. H. Carrapatos de importância médico-veterinária da região neotropical: um guia ilustrado para identifcação de espécies, .**1ed. São Paulo: ICTTD - Butantan,** 223p., 2006.

BASTOS, K. M. S.; DAEMON, E.; FACCINI, J. L. H.; CUNHA, D. W. Efeitos de diferentes temperaturas sobre a fase não parasitária de *Dermacentor* (*Anocentor*) *nitens* (Neumann, 1897) (Acari: Ixodidae) em condições de laboratório. **Revista Brasileira de Parasitologia Veterinária**, v. 5, p. 29-32, 1996.

BERMÚDEZ, C. S. E.; ZALDIVAR, A. Y.; SPOLIDORIO, M. G.; MORAES-FILHO, J.; MIRANDA, R. J.; CABALLERO, C. M.; MENDOZA, Y.; LABRUNA, M. B. Rickettsial infection in domestic mammals and their ectoparasites in El Valle de Anton, Coclé, Panamá. **Veterinary Parasitology**, v. 177, p. 134-138, 2011.

BORGES, L. M. F.; OLIVEIRA, P. R.; RIBEIRO, M. F. B. Seasonal dynamics of *Anocentor nitens* on horses in Brazil. **Veterinary Parasitology**, v. 89, p. 165-171, 2000.

BOTTEON, P. T. L.; BOTTEON, R. C. C. M.; REIS, T. P.; MASSARD, C. L. Babesiose em cavalos atletas portadores. **Ciência Rural**, v. 35, p. 1-8, 2005.

CABRERA; R.; LABRUNA, M. B. Influence of photoperiod and temperature on the larval behavioral diapause of *Amblyomma cajennense* (Acari: Ixodidae). **Journal of Medical Entomology**, v. 46, p. 1303-1309, 2009.

CICUTTIN, G. L.; TARRAGONA, E. L.; DE SALVO, M. N.; MANGOLD, A. J.; NAVA, S. Infection with *Ehrlichia canis* and *Anaplasma platys* (Rickettsiales: Anaplasmataceae) in two lineages of *Rhipicephalus sanguineus* sensu lato (Acari: Ixodidae) from Argentina. **Ticks and Tick-borne Diseases**, v.6, n.6, p.724- 729. 2015.

CRUZ, B. C.; MENDES, A. F. L.; MACIEL, W. G.; DOS SANTOS, I. B.; GOMES, L. V. C.; FELIPPELLI, G.; TEIXEIRA, W. F. P.; FERREIRA L. L.; SOARES, V. E.; LOPES, W. D. Z.; DA COSTA, A. J.; DE OLIVEIRA, G. P. Biological parameters for *Rhipicephalus microplus* in the field and laboratory and estimation of its annual number of generations in a tropical region. **Parasitology Research,** v. 119, p. 2421-2430, 2020. https://doi.org/10.1007/s00436-020-06758-5

DANTAS-TORRES, F.; MARTINS, T. F.; MUÑOZ-LEAL, S.; ONOFRIO, V. C.; BARROS-BATTESTI, D. M. Ticks (Ixodida: Argasidae, Ixodidae) of Brazil: Updated species checklist and taxonomic keys. **Ticks and Tick-borne Diseases** ,v. 10 (6): 101252, 2019. https://doi.org/10.1016/j.ttbdis.2019.06.012.

DEBÁRBORA, V. N.; NAVA, S.; CIRIGNOLI, S.; GUGLIELMONE, A. A.; POI, A. S. G. Ticks (Acari: Ixodidae) parasitizing endemic and exotic wild mammals in the Esteros del Iberá wetlands, Argentina. **Systematic & Applied Acarology**. V. 17, p. 243-250, 2012.

DEL FIOL, F. S.; JUNQUEIRA, F. M.; ROCHA, M. C. P.; TOLEDO, M. I.; BARBERATO FILHO, S. A febre maculosa no Brasil. **Revista Panamericana de Salud Pública**, v. 27, n. 6, p. 461-466, 2010.

ESTRADA-PEÑA, A.; de la FUENTE, J.; OSTFELD, R. S.; CABEZAS-CRUZ, A. Interactions between tick and transmitted pathogens evolved to minimise competition through nested and coherent networks. **Scientific Reports**, v. 5, 10361, 2015. DOI: 10.1038/srep10361.

GAUSS, C. L. B.; FURLONG, J. Comportamento de larvas infestantes de *Boophilus microplus* em pastagem de *Brachiaria decumbens*. **Ciência Rural**, v.32, p.467-472, 2002.

GIANIZELLA, S. L.; MARTINS, T. F.; ONOFRIO, V. C.; ·AGUIAR, N. O.; GRAVENA, W.; NASCIMENTO, C. A. R.; NETO, L. C.; · FARIA, D. L.; LIMA, N. A. S.; SOLORIO, M. R.; MARANHÃO, L.; LIMA, I. J.; COBRA, I. V. D.; SANTOS, T.; LOPES, G. P.; ·RAMALHO, E. E.; ·LUZ, H. R.; LABRUNA, M. B. Ticks (Acari: Ixodidae) of the state of Amazonas, Brazil. **Experimental and Applied Acarology,** v. 74, n. 2, p. 177-183, 2018. https://doi.org/10.1007/s10493-018-0221-7

GONÇALVES, D. D.; CARREIRA, T.; NUNES, M.; BENITEZ, A.; LOPES-MORI, F. M.; VIDOTTO, O.; FREITAS, J. C.; VIEIRA, M. L. First record of *Borrelia burgdorferi* B31 strain in *Dermacentor nitens* ticks in the northern region of Paraná (Brazil). **Brazilian Journal of Microbiology**, v. 44, p. 883-887, 2013.

GONZALES, J. C. O controle dos carrapatos dos bovinos. **Porto Alegre: Sulina,** 1975, 104 p.

GOTHE, R. Ticks in the South African Zoological Survey Collection. Part XII The general Boophilus. Curtice 1891 and Margaropus Karsch, 1879. **Onderstepoort Journal of Veterinary Research,** v. 34, p. 81–108. 1967.

GRISI, L.; LEITE, R. C.; MARTINS, J. R. S.; BARROS, A. T. M.; ANDREOTTI, R.; CANÇADO, P. H. D.; LEON, A. A. P.; PEREIRA, J. B.; VILLELA, H. S. Reassessment of the potential economic impact of cattle parasites in Brazil. **Brazilian Journal of Veterinary Parasitology**, v. 23, p. 150-156, 2014.

GUGLIELMONE, A. A. Epidemiology of babesiosis and anaplasmosis in South and Central America. **Veterinay Parasitology**, v. 57, p. 109-119, 1995.

HITCHCOCK, L. F. Studies on the parasitic stages of the cattle fever tick*, Boophilus microplus* (Canestrini) (Acarina: Ixodidae). **Australian Journal of Zoology**, v.3, p. 145–155, 1955

HOOGSTRAAL, H. Ticks and Spirochetes. **Acta. Tropica**, v, 36, p. 133-136, 1979.

JONGEJAN, F.; UILENBERG, G. The global importance of ticks. **Parasitology**, v. 129, p. 3-14, 2004.

LABRUNA, M. B. Comparative survival of the engorged stages of *Amblyomma cajennense* sensu stricto and *Amblyomma sculptum* under different laboratory conditions. **Ticks and Tick-borne Diseases**, v. 9, p. 996-1001, 2018.

LABRUNA, M. B. Ecology of Rickettsia in South America. **Annals of the New York Academy of Sciences**, v. 1166, p. 156-166, 2009.

LABRUNA, M. B.; AMAKU, M. Rhythm of engorgement and detachment of *Anocentor nitens* females feeding on horses. **Veterinary Parasitology**, v. 137, p. 316-332, 2006.

LABRUNA, M. B.; JORGE, R. S.; SANA, D. A.; JÁCOMO, A. A. T.; KASHIVAKURA, C. K.; FURTADO, M. M.; FERRO, C.; PEREZ, S. P.; SILVEIRA, L.; SANTOS JR, T. S.; MARQUES, S. R.; MORATO, R. G.; NAVA, A.; ADANIA, C. H.; TEIXEIRA, R. H. F.; GOMES, A. A. B.; CONFORTI, V. A.; AZEVEDO. F. C. C.; PRADA, C. S; SILVA, J. C. T.; BATISTA, A, F.; MARVULO, M. F. V.; MORATO, R. L. G.; ALHO, C. J. R.; PINTER, P.; FERREIRA, P. M.; FERREIRA, F.; BARROS-BATTESTI, D. B. Ticks (Acari: Ixodida) on wild carnivores in Brazil. **Experimental and Applied Acarology**, v. 36, n. 1-2, p. 149-163, 2005.

LABRUNA, M. B.; AMAKU, M.; METZNER, J. A.; PINTER, A.; FERREIRA, F. Larval behavioral diapause regulates life cycle of *Amblyomma cajennense* (Acari: Ixodidae) in Southeast Brazil. **Journal of Medical Entomology**, v. 40, n. 2, p. 170-178, 2003.

LABRUNA, M. B.; KASAI, N.; FERREIRA, F.; FACCINI, J. L. H.; GENNARI, S. M. Seasonal dynamics of ticks (Acari: Ixodidae) on horses in the state of São Paulo, Brazil. **Veterinary Parasitology**, v. 105, p. 65-77, 2002.

LABRUNA, M. B.; KERBER, C. E.; FERREIRA, F.; FACCINI, J. L. H.; WAAL, D. T.; GENNARI, S. M. Risk factors to tick infestations and their occurrence on horses in the state of São Paulo, Brazil. **Veterinary Parasitology**, v. 97, p. 1-14, 2001.

LABRUNA, M. B. Carta acarológica. **Revista Brasileira de Parasitologia Veterinária**, v. 13, n. 1, 199-202, 2004.

LABRUNA, M. B.; ONOFRIO, V. C.; BARROS-BATTESTI, D. M.; GIANIZELLA, S. L.; VENZAL, J. M.; GUGLIELMONE, A. A. Synonymy of *Ixodes aragaoi* with *Ixodes fuscipes*, and reinstatement of *Ixodes spinosus* (Acari: Ixodidae). **Ticks Tick-borne Diseases, v.** 11, p. 1-9. 2020. https://doi.org/10.1016/j.ttbdis.2019.101349.

LABRUNA, M. B.; WHITWORTH, T.; HORTA, M. C.; BOUYER, D. H.; MCBRIDE, J.; PINTER, A.; POPOV, V.; GENNARI, S. M..; WALKER, D. H . Rickettsia species infecting *Amblyomma cooperi* ticks from an area in the state of São Paulo, Brazil, where Brazilian spotted fever is endemic. **Journal of Clinical Microbiology,** v. 42, p. 90-98, 2004

LADO, P.; CASTRO, O.; LABRUNA, M. B.; VENZAL, J. M. First molecular detection of *Rickettsia parkeri* in *Amblyomma tigrinum* and *Amblyomma dubitatum* ticks from Uruguay. **Ticks Tick-borne Diseases**, v. 5, 660-2, 2014. https://doi: 10.1016/j.ttbdis.2014.04.021.

LEGG, J. Some observations on the life history of the cattle tick (*Boophilus australis*). **Journal article:** Proceedings of the Royal Society of Queensland, v. 41, p. 121–132, 1930.

LEMOS, E. R. S. Rickettsioses. In: Coura JR, organizador. Dinâmica das doenças infecciosas e parasitárias. São Paulo: Guanabara Koogan; 2013. p. 1626-45.

LISBÔA R. S.; GUEDES D. S.; SILVA F. J. M.; CUNHA N. C.; MACHADO C. H.; FONSECA A. H. Alterações nos parâmetros hematológicos de *Gallus gallus domesticus* experimentalmente infectados por *Borrelia anserina*. Pesquisa Veterinária Brasileira, v. 28, p. 527-532, 2008.

MAGALHÃES, F. E. P.; MASSARD, C. L.; SERRA-FREIRE, N. M. Paralysis in *Gallus gallus* and Carina moschata induced by larvae of *Argas (Persicargas) miniatus*. **Pesquisa Veterinária Brasileira**. v. 7, p . 4 7 - 4 9 , 1987.

MARCHOUX, E.; SALIMBENI, A. La spirillose des poules. **Annales de l'Institut Pasteur Lille, Paris,** v.17, p.569-580, 1903.

MARTINS, T. F.; BARBIERI, A. R.; COSTA, F. B.; TERASSINI, F. A.; CAMARGO, L. M.; PETERKA, C. R.; PACHECO, R. C.; DIAS, R A.; NUNES, P. H.; MARCILI, A.; SCOFIELD, A.; CAMPOS, A. K.; HORTA, M. C.; GUILLOUX, A. G. A.; BENATTI, H. R.; RAMIREZ, D. G.; BARROS-BATTESTI, D. M.; LABRUNA, M. B. Geographical distribution of *Amblyomma cajennense* (*sensu lato*) ticks (Parasitiformes: Ixodidae) in Brazil, with description of the nymph of *A. cajennense* (*sensu stricto*). **Parasites and Vectors,** v. 9, p. 1-14, 2016.

MARTINS, T. F.; LUZ, H. R.; MUNŐZ-LEAL, S.; RAMIREZ, D. G.; MILANELO, L.; MARQUES, S.; SANCHES, T. C.; ONOFRIO, V. C.; ACOSTA, I. C. L.; BENATTI, H. R.; MATURANO, R.; OLIVEIRA, P. B.; ALBUQUERQUE, G. R.; MARCILI, A.; FLAUSINO, W.; SILVEIRA, L. F.; MCINTOSH, D.; FACCINI, J. L. H.; LABRUNA, M. B. A new species of *Amblyomma* (Acari: Ixodidae) associated with monkeys and passerines of the Atlantic rainforest biome, Southeastern Brazil. **Ticks and Tick-borne Diseases**. 2019. https://doi.org/10.1016/j.ttbdis.2019.07.003.

MARTINS, T. F.; ONOFRIO, V. C.; BARROS-BATTESTI, D. M.; LABRUNA, M. B. Nymphs of the genus *Amblyomma* (Acari: Ixodidae) of Brazil: descriptions, redescriptions, and identification key. **Ticks and Tick-borne Diseases**, v. 1, p. 75-99, 2010.

MARTINS, T. F.; TEIXEIRA, R. H. F.; LABRUNA, M. B. Ocorrência de carrapatos em animais silvestres recebidos e atendidos pelo Parque Zoológico Municipal Quinzinho de Barros, Sorocaba, São Paulo, Brasil. **Brazilian Journal of Veterinary Research and Animal Science**, São Paulo, v. 52, n. 4, p. 319-324, 2015.

MARTINS, T. F.; VENZAL, J. M.; TERASSINI, F. A.; COSTA, F. B.; MARCILI, A.; CAMARGO, L. M. A.; BARROS-BATTESTI, D. M.; LABRUNA, M. B. New tick records from the state of Rondônia, western Amazon, Brazil. **Experimental and Applied Acarology**, v. 62, p. 121–128, 2014.

MATIAS, J.; GARCIA, M. V.; AGUIRRE, A. A. R.; BARROS, J. C.; CSORDAS, B. G.; ANDREOTTI, R. Spotted fever group Rickettsia in *Amblyomma dubitatum* tick from the urban area of Campo Grande, Mato Grosso do Sul, Brazil. **Ticks and Tick-borne Diseases** v.6, 2, p. 107 -110. 2015.

MONJE, L. D.; NAVA, S.; EBERHARDT, A. T.; CORREA, A. I.; GUGLIELMONE, A. A.; BELDOMENICO, P. M. Molecular detection of the human pathogenic Rickettsia sp. strain Atlantic Rainforest in *Amblyomma dubitatum* ticks from Argentina. **Vector-borne Zoonotic Disease**, v. 15p. 167-9, 2015.

MUÑOZ-LEAL, S.; MARTINS, M. M.; NAVA, S.; GABRIEL, A.; LANDULFO, G. A.; SIMONS, S. M.; RODRIGUES, V. S.; RAMOS, V. N.; SUZIN, A.; SZABÓ, M. P. J.; LABRUNA, M. B. *Ornithodoros cerradoensis* n. sp. (Acari: Argasidae), a member of the *Ornithodoros talaje* (Guérin-Méneville, 1849) group, parasite of rodents in the Brazilian Savannah. **Ticks and Tick-borne Diseases**, v. 11, p. 1-17, 2020. https://doi.org/10.1016/j.ttbdis.2020.101497

NAVA, S.; BEATI, L.; LABRUNA, M. B.; CÁCERES, A. G.; MANGOLD, A. J.; GUGLIELMONE, A. A. Reassessment of the taxonomic status of *Amblyomma cajennense* (Fabricius, 1787) with the description of three new species, *Amblyomma tonelliae* n. sp., *Amblyomma interandinum* n. sp. and *Amblyomma patinoi* n. sp., and reinstatement of *Amblyomma mixtum* Koch, 1844, and *Amblyomma sculptum* Berlese, 1888 (Ixodida: Ixodidae). **Ticks and Tick-borne Diseses**, v. 5, p. 252-276, 2014.

NAVA, S.; VENZAL, J. M.; GONZÁLES-ACUÑA, D.; MARTINS, T. F.; GUGLIELMONE, A. A. **Ticks of the southern cone of America**, 2017, 374p.

NAVA, S.; VENZAL, J.M.; LABRUNA, M.B.; MASTROPAOLO, M.; GONZÁLEZ, E.M.; MANGOLD, A.J.; GUGLIELMONE, A. A. Hosts, distribution and genetic divergence (16S rDNA) of *Amblyomma dubitatum* (Acari: Ixodidae). **Experimental & Applied Acarology**, v. 51, p. 335-351, 2010.

NIZOLI, L. Q. 101 – 112 p.Piroplasmose equina. In ANDREOTTI, R.; GARCIA, M.V.; KOLLER, W.W. Carrapatos na cadeia produtiva de bovinos. **Brasilia, DF. Embrapa**, 2019. 240 p.

O'DWYER, L. H.; MASSARD, C. L.; SOUZA, J. C. P. *Hepatozoon canis* infection associated with dog ticks of rural areas of Rio de Janeiro State, Brazil. **Veterinary Parasitology,** v. 94, p. 143- 150, 2001.

ONOFRIO, V. C. Revisão do Gênero *Amblyomma* Koch, 1884 (Acari: Ixodidae) no Brasil. 2007. 80f. **Tese (Doutorado em Ciências Veterinárias**) - Universidade Federal Rural do Rio de Janeiro, Rio de Janeiro.

ONOFRIO, V. C.; GUGLIELMONE, A. A.; BARROS-BATTESTI, D. M.; GIANIZELLAE, S. L.; MARCILI, A.; QUADROS, R. M.; MARQUES, S.; LABRUNA, M. B. Description of a new species of *Ixodes* (Acari: Ixodidae) and first report of *Ixodes lasallei* and *Ixodes bocatorensis* in Brazil. **Ticks and Tick-borne Diseases**, v. 11, 101423, 2020.

PAJUABA, A. A.; RAMOS, V. N.; MARTINS, M. M.; OSAVA, C. F.; PASCOAL J. O.; SUZIN, A.; YOKOSAWA, J.; SZABÓ, M. P. J. Influence of microhabitat use and behavior of *Amblyomma sculptum* and *Amblyomma dubitatum* nymphs (Acari: Ixodidae) on human risk for tick exposure, with notes on *Rickettsia* infection. **Ticks and Tick-borne Diseases**, v. 9, p. 67-71, 2018.

PAROLA, P.; DAVOUST, B.; RAOULT, D. Tick- and flea-borne rickettsial emerging zoonoses**. Veterinary Research***,* v. 36, p. 469-492, 2005.

PAROLA, P.; PADDOCK, C. D.; SCOLOVSCHI, C.; LABRUNA, M. B.; MEDIANNOKOV, O.; KERNIF, T.; ABDAD*, M. Y.;* STENOS*, J.;* BITAM*, I.;* FOURNIER*, P. E.;* RAOULT, D. Update on tick-borne rickettsioses around the world: a geographic approach. **Clinical Microbiology Reviews**, v. 26, p. 657-702, 2013.

PEREIRA, M. A. V. C. Situação do parasitismo por *Babesia equi* (Laveran, 1901) e *Babesia caballi* (Nuttall & Strickland, 1912) em equinos da raça PSI, nos diferentes sistemas de manejo, no Estado do Rio de Janeiro. 1999. **Tese (Doutorado em Parasitologia Veterinária)**, Universidade Federal Rural do Rio de Janeiro.

PEREIRA, M. C.; LABRUNA, M. B.; SZABÓ, M. P. J.; KLAFKE, G. M. *Rhipicephalus* (*Boophilus*) *microplus* Biologia, Controle e Resistência. (1 ed. São Paulo: MedVet). 2008, 169 p.

RECK, J.; MARKS F. S.; RODRIGUES, R. O.; SOUZA, U. A.; WEBSTER, A.; LEITE, R. C.; GONZALES, J. C.; KLAFKE, G. M.; MARTINS, J. R. Does *Rhipicephalus microplus* tick infestation increase the risk for myiasis caused by *Cochliomyia hominivorax* in cattle? **Preventive Veterinary Medicine**, v. 1, p. 59-62. 2014.

ROBY, T. O.; ANTHONY, D. W. Transmission of equine piroplasmosis by *Dermacentor nitens* Neumann. **Journal of the American Veterinary Medical Association***,* v. 142, p. 768-769, 1963.

RODRIGUES, V. S.; GARCIA, M. V.; CRUZ, B. C.; MACIEL, W. G.; ZIMMERMANN, N. P.; KOLLER, W. W.; BARROS, J. C.; ANDREOTTI, R. Life cycle and parasitic competence of *Dermacentor nitens* Neumann, 1897 (Acari: Ixodidae) on different animal species. **Ticks and Tick-borne Diseases**, v. 8, n. 3, p. 379-384, 2017.

ROHR, C. J. Estudo sobre Ixodidas do Brasil. Rio de Janeiro: Gomes, Irmão & C., 1909, 226p.

SACCO, A. M. S. Controle de Surtos de Tristeza Parasitária Bovina. Circ. Téc. 26, Embrapa Pecuária Sul, Bagé. 4p. 2002.

SANTOS, H. A.; ANGELO, I. C.; FRANQUE, M. P.; BALDANI, C. D.; THOME, S. M. G.; FACCINI, J. L. H.; MASSARD, C. L. Ciclo biológico de *Argas miniatus* em laboratório: estágio adulto. **Ciência Rural**, v.41, n.1, p.164-170, 2011.

SCHUMAKER, T. T. S.; OBA, M. S. P. Aspectos Morfo-biológicosde *Argas* (Persicargas) *miniatus.* Koch, 1844 (Ixodoidea,Argasidae). **Revista Brasileira de Entomologia**, v.32, n.2, p.161-173, 1988.

SILVA, J. B.; GONÇALVES, L. R.; VARANI, A. M.; ANDRÉ, M. R.; MACHADO. R. Z. Genetic diversity and molecular phylogeny of *Anaplasma marginale* studied longitudinally under natural transmission conditions in Rio de Janeiro, Brazil. **Ticks and Tick Borne Diseases,** v. 6, p. 499-507, 2015. http://dx.doi.org/10.1016/j. ttbdis.2015.04.002. PMid:25985719.

SOUZA, S. S. A. L.; SOUZA, C. E.; RODRIGUES NETO, E. J.; PRADO, A. P. Dinâmica sazonal de carrapatos (Acari: Ixodidae) na mata ciliar de uma área endêmica para febre maculosa na região de Campinas, São Paulo, Brasil. **Ciência Rural**, v. 36, n. 3, p. 887-891, 2006.

WALKER, J. B.; KEIRANS, J. E.; HORAK, I. G. The Genus *Rhipicephalus* (Acari: Ixodidae): A Guide to the Brown Ticks of the World. **Cambridge University Press, Cambridge**, 2000, 643 p.

WITTER, R.; MARTINS, T. F.; CAMPOS, A.K.; MELO, A.L.T.; CORRÊA, S.H.R.; MORGADO, T.O.; WOLF, R.W.; MAY-JÚNIOR, J.A.; SINKOC, A.L.; STRUSSMANN, C.; AGUIAR, D.M.;

ROSSI, R.V.; SEMEDO, T.B.F.; CAMPOS, Z.; DESBIEZ, A.L.J.; LABRUNA, M.B.; PACHECO, R.C. Rickettsial infection in ticks (Acari: Ixodidae) of wild animals in midwestern Brazil. **Ticks Tick-borne Diseases**. 2016. 7:415-423.

ZIMMERMANN, N.P.; AGUIRRE, A.A.R.; RODRIGUES, V.S.; GARCIA M.V; MEDEIROS, J. F. BLECHA, I. M, Z.;DUARTE, P. O.; CRUZ, B. C.; CUNHA, R. C.; MARTINS, T. F.; ANDREOTTI, R. Wildlife species, Ixodid fauna and new host records for ticks in an Amazon forest area, Rondônia, Brazil. **Revista Brasileira de Parasitologia Veterinária**, v.27, p.177-182, 2018.

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