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Validation of the taxon *Ixodes aragai* Fonseca (Acari: Ixodidae) based on morphological and molecular data

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Abstract

The species *Ixodes aragai* Fonseca was described as *Ixodes ricinus aragai*, and later placed in synonymy with *Ixodes affinis*. However, this synonymy was rejected and the subspecies was elevated to species, and named as *I. aragai*. Some researchers did not consider the validity of *I. aragai* and maintained the synonymy proposed until 1998 when *I. aragai* was revalidated, and it was suggested that *Ixodes pararicinus* could be a synonym. The aim of this study was to confirm the taxonomic validity of *I. aragai* by means of redescription of adults and molecular analysis. Morphological studies were performed by optical and scanning electron microscopy; types of *I. aragai* were compared with those of *I. pararicinus* from Argentina, and also with material of *I. pararicinus* from Uruguay and *I. affinis* from the United States. Mitochondrial 16S rDNA sequences were obtained for determining phylogenetic relationships based on maximum parsimony. Morphological and molecular differences between *I. aragai*, *I. pararicinus* from Argentina, and *I. affinis* confirm the validity of the first each of these species. The morphological similarities of *I. pararicinus* from Uruguay with *I. aragai*, and the small distance of nucleotide sequences between them, confirm that the Uruguayan ticks are in fact *I. aragai* and expand the geographical distribution of this species. Based on the specimens of *Ixodes* examined in the present study, from the same locality of the types of *I. ricinus rochensis* in Uruguay, we agree with the synonymy of this subspecies with *I. aragai* as previously reported. Finally, our analyses indicate that both *I. aragai* and *Ixodes fuscipes*, another South American tick species, belong to the *I. ricinus* complex, currently composed of 19 species.

Key words: *Ixodes aragai*, taxon validity, Brazil, Uruguay

Introduction

According to Keirans *et al.* (1985) the first record of the European tick *Ixodes ricinus* (Linnaeus) in South America refers to specimens from Brazil dated 1842. Subsequently *I. ricinus* was recorded in Chile (Gervais 1849), Bolivia (Torregiani 1914), Peru (Escomel 1929), Uruguay (Calzada 1936), Argentina (Aragão 1938) and Colombia (Reyes 1938). Calzada (1936) described the subspecies *I. ricinus rochensis* from ticks collected on cattle in Uruguay. Keirans & Clifford (1985), after comparing specimens from South America with European *I. ricinus*, found that these 2 populations were morphologically distinct, and based on Argentinian specimens they described the species *Ixodes pararicinus*. Keirans *et al.* (2003) comments that earlier published records of South American *I. ricinus*

punctations (in posterior region), while the number of large punctations in *I. minor* is 50, in *I. affinis* and *I. muris* is around 80, and in *I. scapularis* is approximately 150. There are no large punctations in the median plate of *I. pacificus* (Keirans & Clifford 1978).

Males of *I. muris*, *I. pacificus* and *I. scapularis* have a V-shaped flattened demarcation between the adanal, median and anal plates, whereas in *I. aragaoi* (Figure 4), *I. jellisoni*, *I. minor*, *I. affinis*, and *I. pararicinus* this angle is widely open (Keirans *et al.* 1985). In males of *I. minor*, *I. muris*, *I. pacificus* and *I. scapularis*, the posterior median lobe of the ventral basis capituli is moderate, while in *I. aragaoi* (Figure 2), *I. affinis* and *I. pararicinus* this lobe is prominent. It is absent in *I. jellisoni*.

The above morphological comparisons support the classification of *I. aragaoi* as a valid species with its distribution in southeastern and southern Brazil, and Uruguay. These results are supported by molecular analysis, which clearly showed that the Uruguayan ticks, previously classified as *I. pararicinus*, are in fact *I. aragaoi*.

Guglielmone & Nava (2005) discuss the distribution of *I. pararicinus* from Argentina and Uruguay, and explain that populations of this species within Argentina are disjunct. According to these authors the northwestern populations are distributed in localities above 800m above sea level within the Amazonian Domain, while other populations are located in northeastern and eastern Argentina in flat terrain within the Chaco Domain. Their hypothesis was that the true *I. pararicinus* are represented by northwestern populations while northeastern, eastern and Uruguayan populations belong to *I. aragaoi*. In fact, this hypothesis, at least about the Uruguayan species, has been supported in the present study.

The taxon *I. ricinus rochensis* has been synonymized with *I. aragaoi* by Camicas *et al.* (1998), but Guglielmone *et al.* (2003) preferred not to mention it as a synonym of *I. aragaoi* because the types of *I. rochensis* were not found. Based on the material examined in the present study, from the same locality of the types of *I. ricinus rochensis*, and the scutum of female, the widely open angle between the adanal, median and anal plates in male, that resemble the Uruguayan *I. pararicinus*, we agree with the synonymy of *I. ricinus rochensis* with *I. aragaoi* as previously reported by Camicas *et al.* (1998).

Based on molecular analysis, Barbieri *et al.* (2013) observed that the 16S rDNA partial sequences of *I. pararicinus* from Uruguay and Argentina are different. They also reported the presence of *Borrelia burgdorferi* sensu lato group infecting *I. pararicinus* ticks from Uruguay. With the present study, these reports of borrelial infection must be associated with *I. aragaoi*, which is currently the only tick species of the *I. ricinus* complex known in Uruguay.

According to the results of morphological and molecular analysis in this study, we also propose the inclusion of *I. fuscipes* into the *ricinus* complex, which should be composed by 19 species.

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