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Carios fonsecai sp. nov. (Acari, Argasidae), a bat tick from the central-western region of Brazil

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Abstract

Males, females, and larvae of *Carios fonsecai* sp. nov. are described from free-living ticks collected in a cave at Bonito, state of Mato Grosso do Sul, Brazil. The presence of cheeks and legs with micromammillate cuticle makes adults of *C. fonsecai* morphologically related to a group of argasid species (mostly bat-associated) formerly classified into the subgenus *Alectorobius*, genus *Ornithodoros*. Examination of larvae indicates that *C. fonsecai* is clearly distinct from most of the previously described *Carios* species formerly classified into the subgenus *Alectorobius*, based primarily on its larger body size, dorsal setae number, dorsal plate shape, and hypostomal morphology. On the other hand, the larva of *C. fonsecai* is most similar to *Carios peropteryx*, and *Carios peruvianus*, from which differences in dorsal plate length and width, tarsal setae, and hypostome characteristics are useful for morphological differentiation. The mitochondrial 16S rDNA sequence of *C. fonsecai* showed to be closest (85–88% identity) to several corresponding sequences of different *Carios* species available in GenBank. Bats identified as *Peropteryx macrotis* and *Desmodus rotundus* were found infested by *C. fonsecai* larvae in the same cave where the type series was collected. *C. fonsecai* showed to be aggressive to humans in the laboratory.

Keywords

Carios fonsecai sp.nov., Argasidae, tick, bat, Brazil

Introduction

The argasid tick fauna of Brazil was recently reported to be composed of 14 species, distributed in the genera *Argas* Latreille, 1796 (1 species), *Antricola* Cooley et Kohls, 1942 (3 species) and *Ornithodoros* Koch, 1844 (10 species) (Venzal *et al*. 2006). More recently, Labruna *et al*. (2008) described a new argasid species from northern Brazil, which was named *Carios rondoniensis* Labruna, Terassini, Camargo, Brandão, Ribeiro et Estrada-Peña, 2008. This new species was assigned to the genus *Carios* Latreille, 1796, based partially on the classification proposed by Klompen and Oliver (1993), who concluded that bat-associated argasids (including all *Antricola* and various *Ornithodoros* species) are part of a single, monophyletic lineage of ticks. This lineage was assigned to the genus *Carios*, raised from *Argas* (*Carios*). Since this proposal would require invalidation of *Antricola*, it has not been accepted by some researchers, who consider it premature and have argued that additional evidence is needed from studies on morphology, life histories, host associations, and molecular taxonomy (Estrada-Peña *et al*. 2004; Guglielmone *et al*. 2005; Venzal *et al*. 2006, 2008). On the other hand, Labruna *et al*. (2008) considered the bat-associated *Ornithodoros* species as belonging to the genus *Carios*, but retained *Antricola* as valid genus, as supported by preliminary genetic analysis of the 16S rRNA gene. This same preliminary genetic analysis, which contain only a few Argasidae taxa, seem to support earlier proposals from Russia and France, that included bat-associated *Ornithodoros* species into a formerly proposed genus named *Allectorobius* (Pospelova-Shtrom 1946), which was subsequently reduced to a subgenus of *Ornithodoros* (Filippova 1961). When considering all bat-associated argasids to belong to the genus *Carios*, Klompen and Oliver (1993) stated that the available evidences did not allow recognition of subgenera in the genera *Carios* and *Ornithodoros*.

In the present study, we describe a new bat-associated Argasidae species, which we classified into the genus *Carios*, following Klompen and Oliver (1993) as adopted by Labruna *et*

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al. (2008). However, adoption of the genus *Carios* is still a very controversial issue, with no consensus among tick taxonomists, including between the authors of the present study. On the other hand, there is a general consensus that this issue will be solved only after further molecular analyses of Argasidae that include more taxa, and mostly importantly, data from *Carios vespertilionis* Latreille, 1796, the type species of the former subgenus *Carios*, from where the genus *Carios* was raised.

Materials and methods

Collection of ticks

On 8 April 2005, a total of 73 tick specimens were collected from the inner walls of São Miguel cave, located in the rural area of Bonito, state of Mato Grosso do Sul, Brazil. Geographical coordinates of the cave entrance are 21°06´31.6˝S, 56°34´44.8˝W. During tick collection, the temperature and relative humidity measured inside the cave were ~25°C and 74%, respectively, while outside the cave the temperature and RH were 35°C and 58%, respectively. These measurements were taken around 15:00 h, when the sky was unclouded. Collected ticks were taken alive to the laboratory, where they were separated by stage and sex, as follows: 8 males, 9 females, and 26 nymphs. Morphological characters of the adult specimens indicated that they belonged to the subgenus *Alectorobius* Pocock, 1907, genus *Ornithodoros*, according to Clifford *et al*. (1964). Since species designation of *Ornithodoros* (*Alectorobius*) spp. cannot be achieved with certainty without examining the larval stage (Kohls *et al*. 1965), species designation was performed by examining the larval stage after rearing the collected adult ticks in the laboratory, as described below.

During tick collection, dozens of bats were seen in the cave, especially in the ceiling above the walls where ticks were found. Five bats were caught and identified as *Peropteryx macrotis* (Wagner, 1843) (4 specimens) and *Desmodus rotundus* (E. Geoffroy, 1810) (1 specimen). Two *P. macrotis* and the *D. rotundum* specimen were infested by tick larvae (1–3 larvae per bat), which were collected and saved for comparison with the larvae derived from the adult ticks in the laboratory, as described below.

Preparation of specimens for morphological examinations

In the laboratory, adult ticks were allowed to feed on rabbits and thereafter, engorged females were left in an incubator at 25°C and 85% RH, in order to obtain larvae. Larvae were mounted in Hoyer's medium to make semi-permanent slides and examined by light microscopy for morphological analyses and morphometry. For description, a total of 42 morphological features were observed and/or measured using five larvae. A total of 48 larval morphological characters were utilized for comparison among morphologically related species (Table I). The larval terminology and measurements follow Kohls *et al*. (1965) with the modifications proposed by Estrada-Peña *et al*. (2006) and Venzal *et al*. (2008). Nymphs were fed on rabbits in order to molt to the adult stage. Eight unfed adults of each sex were measured using the KS400 Zeiss program for analysis of images and morphometry, fitted to a Stemi SV6 Zeiss stereomicroscope. In the description, all measurements, first the range and followed by the mean ± the standard deviation in parentheses, are given in millimeters. Representative specimens of larvae and adults were prepared for scanning electron microscopy (SEM) by the method of Corwin *et al*. (1979). The micrographs were obtained using a JEOL JMS-5900 scanning electron microscope.

Examination of type specimens

Three larvae (paratypes) of *Carios peropteryx* (Kohls, Clifford et Jones, 1969) and one larva (paratype) of *Carios peruvianus* (Kohls, Clifford et Jones, 1969) were loaned from the United States National Tick Collection (USNTC) for comparison with our larval specimens. These paratypes are deposited in the USNTC under the accession numbers RML48711-RML49712 for *C. peropteryx*, and RML47598 for *C. peruvianus*.

Molecular analysis

DNA was individually extracted from 1 male and 1 female specimen and processed by polymerase chain reaction (PCR) using primers targeting a ~460 bp fragment of the 16S rDNA mitochondrial gene, as previously described (Mangold *et al*. 1998). PCR products of the expected size were sequenced in an ABI automated sequencer (Applied Biosystems/Perkin Elmer, model ABI Prism 310 Genetic, Foster City, California) with the same primers used for PCR. Generated sequences were submitted to BLAST analysis (Altschul *et al*. 1990) to determine closest similarities to available corresponding 16S rDNA sequences of ticks.

Results

Ixodida Leach, 1815
Argasidae Canestrini, 1890
Carios Latreille, 1796

***Carios fonsecai* sp. nov.** (Figs 1–4, Table I)

Female

Dorsal: Body outline oval, pointed anteriorly, the curve of the posterior border slightly flattened, sides nearly parallel. Length from pointed anterior end to posterior body margin 9.00–7.10 (8.40 ± 0.54), breadth 4.90–3.20 (4.15 ± 0.19). Sub-marginal grooves distinct, fused anteriorly. Mammillae large, close but not crowded, with irregular surface on top and at the sides, convex, of similar size through the dorsum; short hairs, few in number, present mainly on the posterior and lateral marginal areas. Large, distinct discs, in large depressed areas over the medium area within the marginal grooves.

Ventral: Mammillae as dorsally, but larger on the posterior border and indefinite on the supracoxal folds. Genital opening at the level of coxa I, posterior margin triangular reaching the level of the anterior margin of coxa II. Preanal, transverse postanal, and medium postanal grooves present, the later terminating at the transverse postanal groove; coxal folds extending from genital opening to near the level of the anus, where they diverge to the postero-lateral angles. Anal plate elliptical. Spiracular plate above coxa IV. Small hood, reduced to a tongue-shaped flap which is bent downward and in contact with the cheeks with which if forms an enclosure cover-

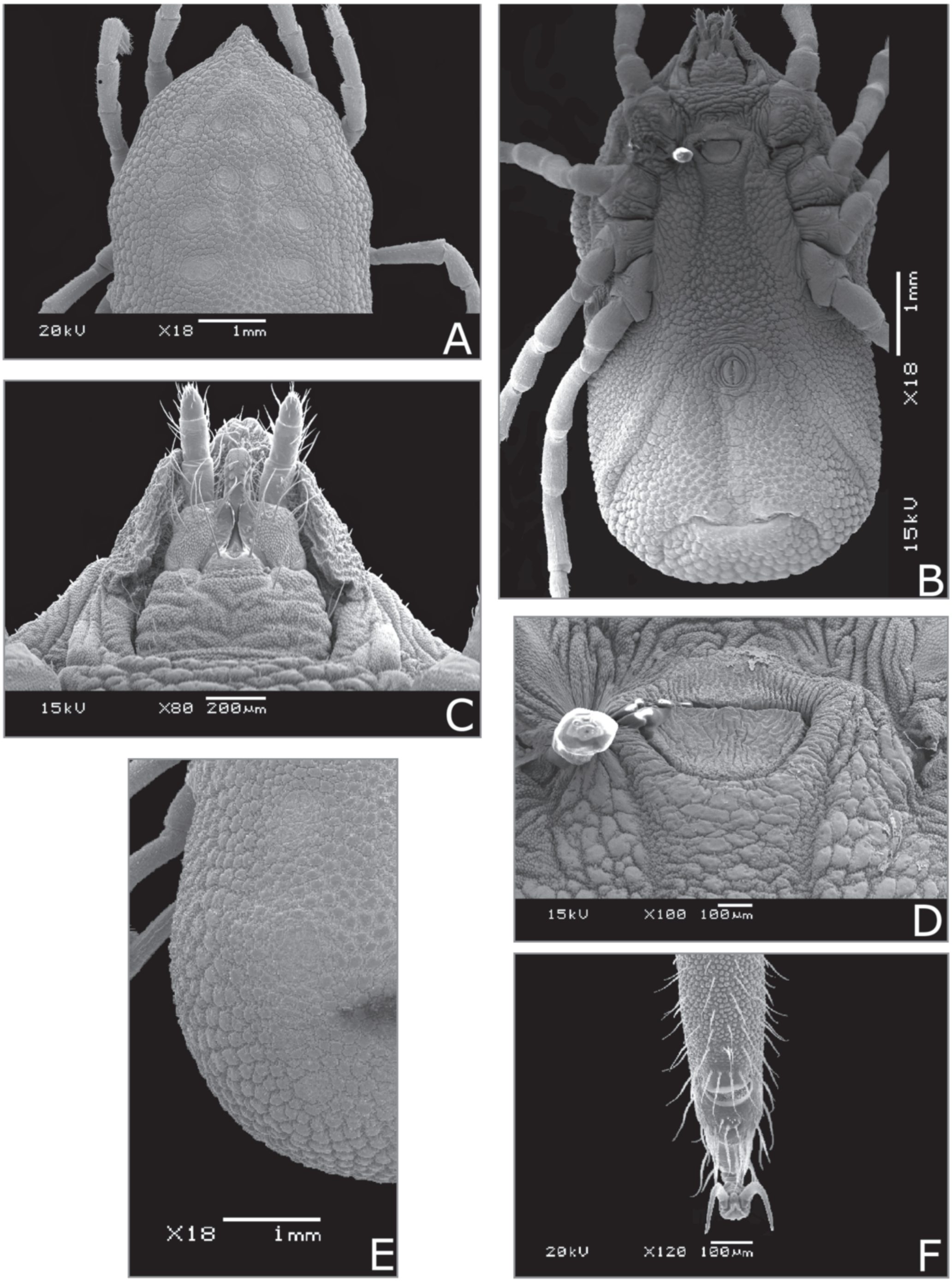

Fig. 1. Scanning electron microscopy of *Carios fonsecai* sp. nov., female: **A** – dorsal; **B** – ventral; **C** – capitulum ventral; **D** – genital opening; **E** – detail on dorsal integument. **F** – tarsus I

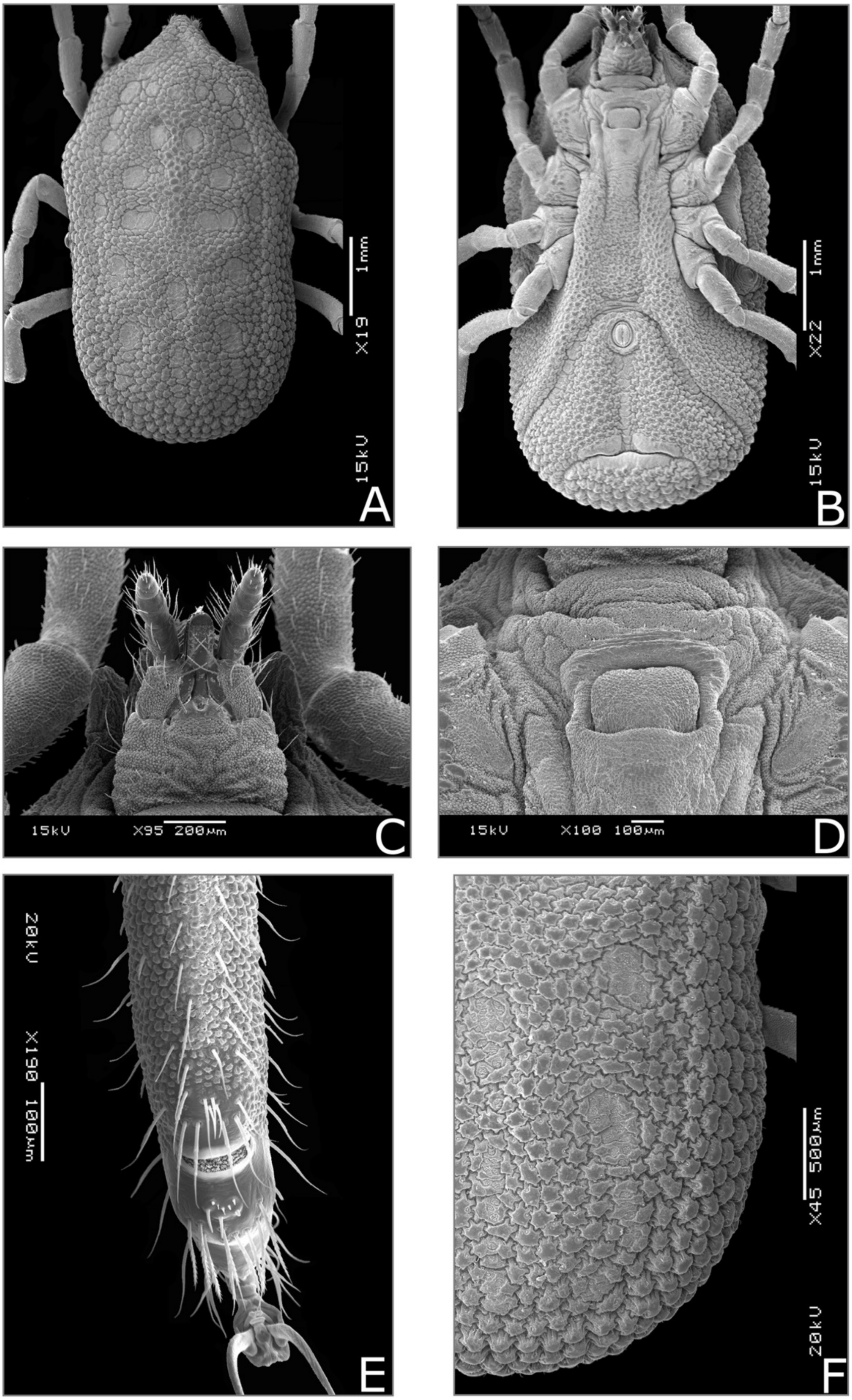

Fig. 2. Scanning electron microscopy of *Carios fonsecai* sp. nov., male: **A** – dorsal; **B** – ventral; **C** – capitulum ventral; **D** – genital opening; **E** – tarsus I; **F** – detail on dorsal integument

ing only the lateral sides of the mouth parts. Camerostome well-developed as a depression receiving capitulum; surface micromammillated; cheeks distinct laterally to capitulum, not covering the mouth parts, even in unfed specimens.

Capitulum: Basis capituli slightly wider than long with irregular transverse wrinkles and micromammillated. Palpi moderate in size, with various long setae; article 1 micromammillated with ventro-medial integumental ridge-like extension covering part of the hypostomal base. Hypostome short and small rounded apically, reaching the level of the articulation of palpal articles 2 and 3. Hypostomal dentition 2/2; denticles arranged with about 4 large ones in each file, and with those in the medium and lateral files about equal in size. Length of toothed portion 1.75, width 0.96.

Legs: Long, with the surface micromammillated; coxa I with various mammillae and coxae II–IV with few mammillae over the micromammillated surface. Small setae sparsely distributed through the articles. Coxa I well separated by coxa II by an inter-coxal fold, coxae II–IV contiguous. Tarsi I–IV with a subapical dorsal protuberance harboring a tuft of long setae; dorsal humps and claws absent. Anterior tip of Haller's organ with distinct anterior and posterior sections; capsule opening transverse, slit-like.

Male

Dorsal: Length from pointed anterior end to posterior body margin 7.10–6.20 (6.60 ± 0.37), breadth 4.90–3.20 (3.90 ± 0.72). Other features as in female.

Ventral: Genital opening rectangular with rounded angles, located at level of coxa I. Other features as in females.

Capitulum: Length of hypostome toothed portion 1.70, breadth 0.88. Other features as in females.

Legs: as in females.

Larva

Body: Subcircular, broadest near midlength. Length 0.990–1.050 (1.020 ± 0.032) including capitulum, and 0.600–0.630 (0.610 ± 0.015) excluding capitulum, width 0.600–0.630 (0.610 ± 0.015).

Dorsal plate: Elongate, pyriform, broadest posteriorly. Length 0.247–0.250 (0.249 ± 0.001), width 0.167–0.180 (0.174 ± 0.006).

Setae of body: Dorsum with 13–14 pairs of setae (typically 14), with 10–11 dorsolateral pairs (typically 11) and 3 central pairs; DAL (dorsal anterolateral) setae length 0.112–0.128 (0.120 ± 0.007), DPL (dorsal posterolateral) setae length 0.065–0.077 (0.072 ± 0.002). Venter with 8 pairs of setae plus 1 PMS (posteromedian setae). Circumanal setae: Ca_1 length 0.045–0.065 (0.056 ± 0.008), Ca_2 length 0.090–0.095 (0.092 ± 0.001), Ca_3 length 0.100–0.110 (0.105 ± 0.004).

Capitulum: Basis capituli length to PH_1 0.170–0.187 (0.180 ± 0.007), length to insertion of hypostome 0.230–0.236 (0.231 ± 0.003), width 0.225–0.250 (0.243 ± 0.014). Two pairs of posthypostomal setae: PH_1 length 0.012–0.015 (0.013 ± 0.001), PH_2 length 0.040–0.045 (0.042 ± 0.002). Distance between setae of PH_1 0.022, between setae of PH_2 0.080–0.087 (0.082 ± 0.004).

Palpi: Length 0.320–0.350 (0.335 ± 0.001). Length of palpal articles 1–4: 0.075–0.080 (0.077 ± 0.003), 0.037–0.045 (0.041 ± 0.004), 0.095–0.100 (0.099 ± 0.003), 0.042–0.045 (0.043 ± 0.001), respectively. Number of setae on palpal articles 1–4 is 0, 4, 5 and 9, respectively.

Hypostome: Long, pointed apically, length to apex from PH_1 0.260–0.280 (0.270 ± 0.006), length to point of inferior toothed portion 0.217–0.230 (0.223 ± 0.005). Width: in basis portion of hypostome 0.065–0.075 (0.069 ± 0.002), average in medial portion of hypostome 0.052–0.057 (0.055 ± 0.002). Dental formula 3/3 in the anterior half, 2/2 posteriorly almost to base. Dentition: file 1 with 17 to 18 denticles, 2 with 15 to 17, and 3 with 9 to 10. Occasionally, an accessory file with a single denticle (4/4 in apex) was observed.

Legs: Setal formula of tarsus I: 1 pair A, 1 DM, 5 PC, 1 PM, 1 pair B, 1 pair AV, 1 pair MV, 1 pair BV, and 1 pair PL.

Taxonomic summary

Type hosts: Bats.

Type locality: Brazilian cave, associated with bats (*P. macrotis* and *D. rotundum*).

Type specimens: holotype female (accession number CNC1402) and allotype male (CNC1402), collected in São Miguel cave, rural area of Bonito, state of Mato Grosso do Sul, Brazil, 8 April 2005, by M.B. Labruna, S.R. Favoretto, L.F.A. Martorelli, C.C. Aires, and L.F. Sanfilippo, deposited in the "Coleção Nacional de Carrapatos" (CNC), Faculty of Veterinary Medicine of the University of São Paulo, São Paulo, SP, Brazil; 4 paratype males, and 4 paratype females deposited in the CNC with same collection data (CNC1400); 77 paratype larvae originated from eggs laid by paratype females in the laboratory, deposited in the CNC with same collection data (CNC1397-CNC1399); 4 paratype males, 4 paratype females (accession number DPVURU509) and 30 paratype larvae (DPVURU510) deposited in the Department of Veterinary Parasitology, Veterinary Faculty (Montevideo, Uruguay); 2 paratype males, 2 paratype females (accession number IBSP10019), 15 paratype larvae (IBSP10020) deposited in the Acari Collection of the Instituto Butantan, São Paulo, Brazil; 2 paratype males, 2 paratype females (accession number INTA2084), 15 paratype larvae (INTA2085) deposited in the INTA tick collection (Rafaela, Argentina); 2 paratype males, 2 paratype females, 15 paratype larvae deposited in the U.S. National Tick Collection, Georgia Southern University (Statesboro, Georgia). Three larvae (paratypes) collected from the bats *P. macrotis* and *D. rotundum* in the same cave where the type series were collected, were examined by light microscopy and identified as *C. fonsecai* (CNC900).

Etymology: The species is named for Dr. Flávio da Fonseca, acarologist, first curator of the Acari Collection of the In-

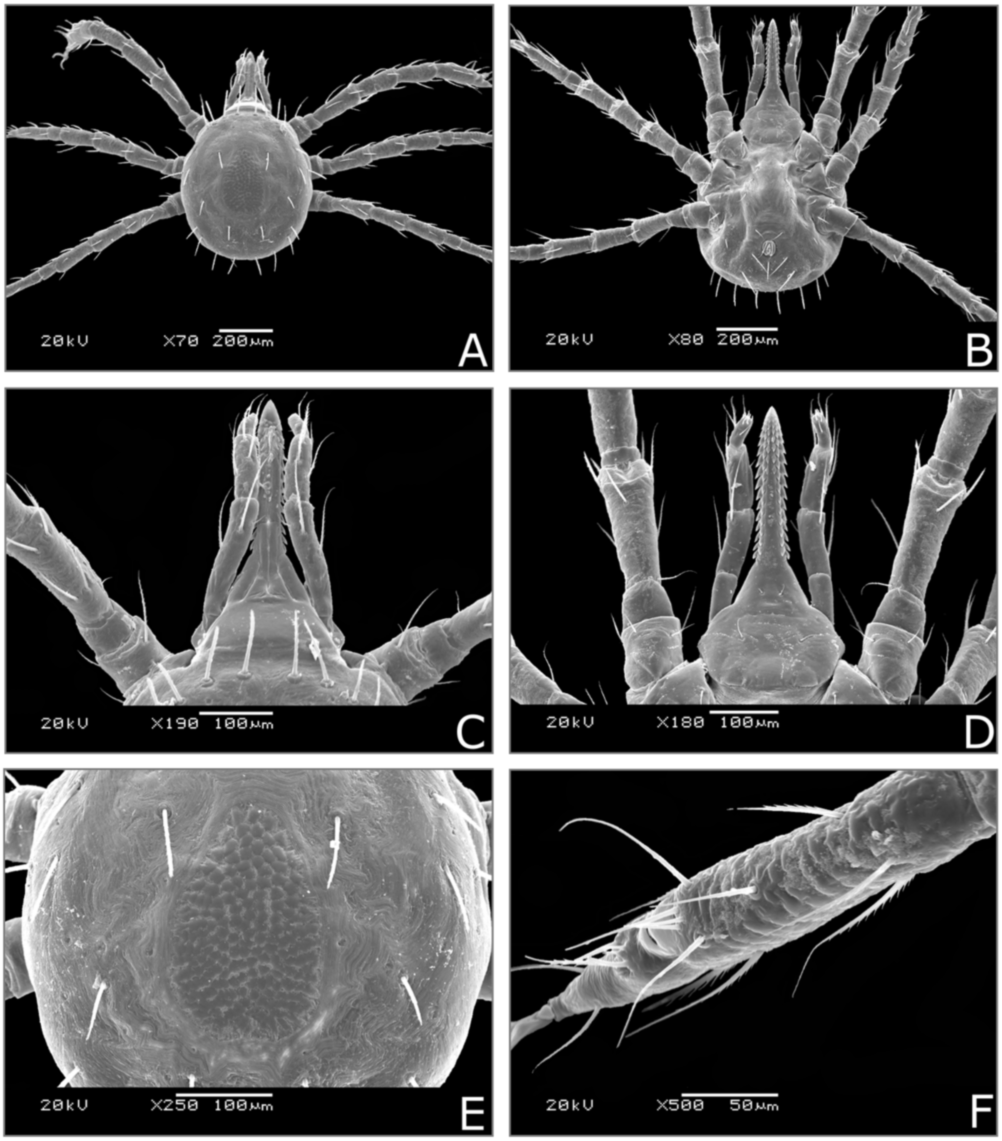

Fig. 3. Scanning electron microscopy of *Carios fonsecai* sp. nov., larva: **A** dorsal; **B** – ventral; **C** – capitulum dorsal; **D** – capitulum ventral; **E** – dorsal plate; **F** – tarsus I

stituto Butantan, Brazil, for his outstanding contributions to the systematic and ecology of ticks and mites.

Species relationship

The presence of cheeks and legs with micromammillate cuticle makes adults of *C. fonsecai* morphologically related to a group of argasid species (mostly bat-associated) that have been previously classified into the subgenus *Alectorobius*, genus *Ornithodoros*, according to Clifford *et al*. (1964). According to Klompen and Oliver (1993), the *Ornithodoros* species previously classified into the subgenus *Alectorobius*, should be classified into the genus *Carios*. These authors also stated that there has been no available evidence to allow recognition of subgenera in Argasidae as a whole (Klompen and Oliver 1993). Based on these studies, we described the present new species into the genus *Carios*, since it is closest related to a number of *Carios* species previously classified into the subgenus *Alectorobius*. This group includes 14 species known only from the larval stage [*Carios casebeeri* (Jones et Clifford, 1972), *Carios chironectes* (Jones et Clifford, 1972), *Carios clarki* (Jones et Clifford, 1972), *Carios echimys* (Kohls, Clifford et Jones, 1969), *Carios eptesicus* (Kohls, Clifford et Jones, 1969), *Carios knoxjonesi* (Jones et Clifford, 1972), *Carios marmosae* (Jones et Clifford, 1972), *Carios mimon* (Kohls, Clifford et Jones, 1969), *C. peropteryx*, *C. peruvianus*, *Carios rossi* (Kohls, Sonenshine et Clifford, 1965), *Carios setosus* (Kohls, Clifford et Jones, 1969), *Carios tiptoni* (Jones et Clifford, 1972), *Carios tuttlei* (Jones et Clifford, 1972)], 14 species known from both the larval and adult stages [*Carios* *amblus* (Chamberlain, 1920), *Carios azteci* (Matheson, 1935), *Carios brodyi* (Matheson, 1935), *Carios capensis* (Neumann, 1901), *Carios concanensis* (Cooley et Kohls, 1941), *Carios coniceps* (Canestrini, 1890), *Carios denmarki* (Kohls, Clifford et Jones, 1969), *Carios dyeri* (Cooley et Kohls, 1941), *Carios hasei* (Schulze, 1935), *Carios kelleyi* (Cooley et Kohls, 1941),

Table I. Comparative morphological characteristics and measurements (in mm) for the larvae of *Carios fonsecai*, *Carios peropteryx*, and *Carios peruvianus* (1)

Character	*C. fonsecai*	*C. peropteryx*	*C. peruvianus*
Body length (a)	0.990–1.050	1.008–1.012 (2)	1.520 (3)
Body length (b)	0. 600–0.630	ND	ND
Body width	0.600–0.630	0.520–0.600	1.300
Dorsal plate	pyriform	elongate	pyriform
Dorsal plate: length	0.247–0.250	0.276–0.312	0.320–0.340
Dorsal plate: width	0.167–0.180	0.116–0.140	0.170–0.250
Dorsal setae: total pairs	13 to 14	14	14
Dorsal setae: dorso-lateral pairs	10 to 11	11	11
Dorsal setae: central pairs	3	3	3
Anterolateral setae: length	0.112–0.127	0.120–0.132	0.132–0.142
Posterolateral setae: length	0.065–0.077	0.080–0.096	0.100
Ventral setae: total	8 pairs + 1 PM	8 pairs + 1 PMS	8 pairs + 1 PMS
Circumanal setae 1	0.450–0.650	0.640–0.680	0.640–0.920
Circumanal setae 2	0.090–0.095	0.080–0.088	0.072–0.088
Circumanal setae 3	0.100–0.110	0.088–0.096	0.104–0.108
Length of basis capituli (c)	0.170–0.187	ND	ND
Length of basis capituli (d)	0.230–0.236	ND	ND
Length of basis capituli (e)	0.440–0.460	0.450–0.480	0.510
Width of basis capituli	0.225–0.250	0.200–0.220	0.260
Posthypostomal setae 1	0.0125–0.015	0.020	0.012
Posthypostomal setae 2	0.040–0.045	0.040–0.060	0.032–0.044
Distance of PH_1	0.022	0.020	0.028
Distance of PH_2	0.080–0.087	0.080–0.096	0.100–0.120
Palpal length	0.320–0.350	ND	ND
Length article I	0.075–0.080	0.072–0.088	0.092–0.096
Length article II	0.037–0.045	0.100–0.108	0.088–0.112
Length article III	0.095–0.100	0.096–0.104	0.100–0.116
Length article IV	0.042–0.045	0.048–0.056	0.056
Width article I	0.095–0.105	ND	ND
Width article II	0.040–0.042	ND	ND
Width article III	0.050–0.060	ND	ND
Width article IV	0.025–0.032	ND	ND
Setae of palpal article I	0	0	0
Setae of palpal article II	4	4	4
Setae of palpal article III	5	5	5
Setae of palpal article IV	9	9	9
Hypostome length (f)	0.260–0.280	0.260	0.300
Hypostome length (g)	0.217–0.230	0.200–0.204	ND
Hypostome width (h)	0.065–0.075	ND	0.084
Hypostome width (i)	0.052–0.057	ND	ND
Apex	pointed	pointed	blunt
Corona dental formula	3/3 (4)	3/3	3/3
Median dental formula	2/2	2/2	2/2
Basal dental formula	2/2	2/2	2/2
Denticles in hypostomal row 1	17–18	17–18	18
Denticles in hypostomal row 2	15–17	17	17
Denticles in hypostomal row 3	9–10	8–10	13
Haller's organ capsule	not reticulate	reticulate	not reticulate
Description	this study	Kohls *et al*. (1969)	Kohls *et al*. (1969)

For explanations: (a) including capitulum; (b) not including capitulum; (c) length of basis capituli to PH_1; (d) length of basis capituli to insertion of hypostome; (e) length of basis capituli to final hypostome; (f) measured to point to PH_1; (g) measured to point to inferior toothed portion; (h) measured in basis portion of hypostome; (i) measured in medial portion of hypostome; ND, not determined; (1) in some descriptions the averages are not detailed; (2) partially engorged; (3) engorged; (4) 4/4 in one larvae.

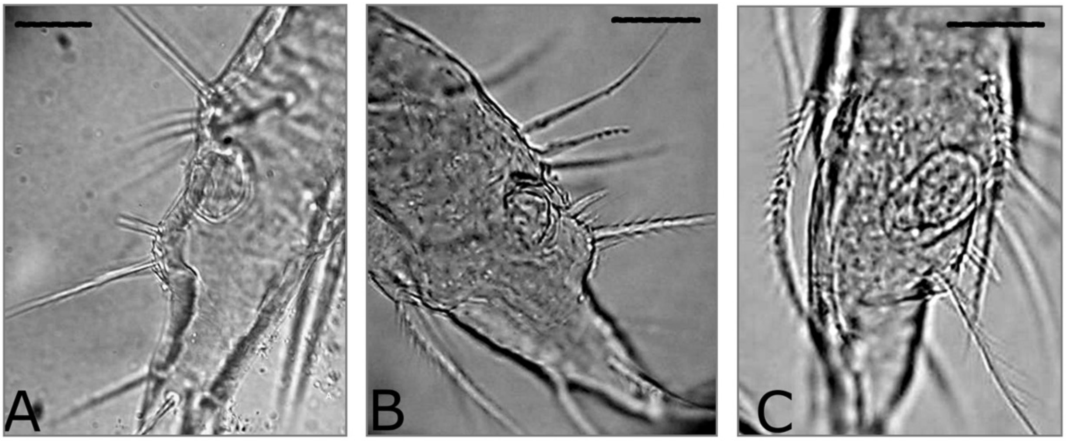

Fig. 4. Detail of tarsus I, showing few and short barbs in the hairs of *Carios fonsecai* sp. nov. (**A**) and more and longer barbs in the hairs of *Carios peruvianus* (**B**) and *Carios peropteryx* (**C**). Scale bars = 50 μm

Carios puertoricensis (Fox, 1947), *Carios stageri* (Cooley et Kohls, 1941), *Carios talaje* (Guérin-Méneville, 1849), *Carios yumatensis* (Cooley et Kohls, 1941)], and 1 species known only from the adult stage [*Carios jul* (Schulze, 1940)]. Following this classification, a recently described species *Ornithodoros (Alectorobius) rioplatensis* Venzal, Estrada-Peña et Mangold, 2008, should also be classified into the genus *Carios*, but as stated before, adoption of the genus *Carios* is still a controversial issue (Venzal *et al*. 2008).

Differentiation of *Alectorobius* species by the adult stage is complicated in many cases (Kohls *et al*. 1965, Jones and Clifford 1972); therefore the larval stage is indicated for species identification. In this context, the larva of *C. fonsecai* is clearly distinct from most of the previously described *Carios* species formerly classified into the subgenus *Alectorobius*, based primarily on its larger body size, dorsal setae number, dorsal plate shape, and hypostomal morphology. On the other hand, the larva of *C. fonsecai* is most similar to *C. peropteryx*, and *C. peruvianus*. Differences in dorsal plate length and width is useful for differentiation of *C. fonsecai* and *C. peropteryx* (see Table I); in addition, *C. peropteryx* possesses the Haller's organ capsule reticulated, in contrast to non visible reticulations in the Haller's organ capsule of *C. fonsecai*. A larger dorsal plate and a hypostome with blunt apex and larger number of denticles per row differs *C. peruvianus* from *C. fonsecai*. Finally, the larvae of *C. fonsecai* can be separated with certainty from *C. peropteryx* and *C. peruvianus* by examining the tarsal setae, which have more and longer barbs in the hairs of the last two species (Fig. 4).

It is not possible at this moment to discriminate with certainty adults of *C. fonsecai* and *C. jul*, since this last species is known only from the type specimens, post-larval stages collected in southern Brazil (Guimarães *et al*. 2001). The type-specimens of *O. jul* seem to be not available for examination (Guglielmone *et al*. 2003). Even if they were available, the taxonomic status of *C. jul* would still be clarified only if there were larvae for examination, or by molecular analysis.

Molecular analysis

PCR products were amplified from the two *C. fonsecai* adult specimens, which generated identical sequences of 418 nucleotides, corresponding to a portion of the 3'-half of the 16S rRNA gene of tick sequences available in GenBank. By BLAST analysis, this partial sequence of the 16S rRNA gene of *C. fonsecai* showed to be closest to *C. capensis* (AB242431), *Carios sawaii* (Kitaoka et Suzuki, 1973) (AB242430), and *C. puertoricensis* (AF113932) with 85–88% sequence identities. Nucleotide sequence of the *C. fonsecai* 16S rDNA region generated in the present study has been deposited in GenBank under the accession number GQ120967.

Fig. 5. Inflammatory response to an accidental tick bite by a *Carios fonsecai* female on the base of the left thumb (note reddish scar) of a human. Note intense swelling of the thumb extending to the wrist, in comparison with the normal right hand

Health implications

The role of *C. fonsecai* in tick-borne diseases is still unknown, in contrast to a few close-related Neotropical species, such as *C. talaje* and *C. puertoricensis*, which have been associated with the transmission of recurrent fever and African swine fever, respectively (Hoogstraal 1985, Endris *et al*. 1992). However, while working with live ticks in the laboratory, all postembryonic stages of *C. fonsecai* showed to be very aggressive to humans, resulting in several accidental infestations on laboratory workers. One of these infestations on one of us (M.B.L.) by an adult female that fed for a few minutes on the base of the left thumb, resulted in an intense inflammatory response mostly pronounced 24–48 hours after the tick bite, with intense swelling (edema), redness, heat, and pain (Fig. 5). Possibly, this intense inflammatory response was a delayed hypersensitivity response to tick saliva inoculated into the feeding site, as the victim was previously bitten accidently by *C. fonsecai* few months before, when a less intense inflammatory response was observed.

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