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A new species of *Abacarus* (Acari: Prostigmata: Eriophyidae) damaging sugarcane, *Sacharrum officinarum* L., from Costa Rica—the first eriophyoid mite described with a tibial seta on leg II

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Abstract

A new species of eriophyoid mite, belonging in the genus *Abacarus* Keifer (Eriophyidae), causing damage to sugarcane, *Saccharum officinarum* L. (Poaceae), in Costa Rica is illustrated and described. *Abacarus doctus* **n. sp.** is the only eriophyoid species recorded so far with a tibial seta (*l′*) on the second pair of legs, an unexpected characteristic observed for the first time in the superfamily Eriophyoidea. Remarks on the phylogenetic and taxonomical aspects related to the presence of this seta are presented. Damage symptoms caused by this mite are presented as well as a key for *Abacarus* species described from sugarcane. In addition, the need to apply biosecurity procedures during sugarcane germplasm exchange to avoid dissemination of the new mite species is discussed.

Key words: Eriophyoidea, Phyllocoptini, *Saccharum officinarum* L., Poaceae, systematics, phylogeny, Central America, Neotropical, biosecurity

Introduction

Three valid species of the genus *Abacarus* Keifer 1944 have been reported infesting sugarcane, *Saccharum* spp. (Poaceae), all of them from the Eastern Hemisphere (Amrine Jr. 2003; Ozman-Sullivan *et al*. 2006). Although described from India, *Abacarus sacchari* Channabasavanna 1966 is the only species of the genus reported from sugarcane in Neotropical areas, being found in Brazil and on some Caribbean Islands (Amrine 2003, Flechtmann & Aranda 1970), localities where it is thought to be introduced. In this paper, a new species of *Abacarus* from sugarcane from Costa Rica is described and illustrated. This is the first species of this genus described from sugarcane from the Americas and not yet known elsewhere.

Surprisingly, when slide mounted specimens of the new species were examined in detail, a tibial seta (*l′*) on the dorsolateral position of leg II was clearly observed. No eriophyoid mite species have hitherto been recorded with a tibial seta (*l′*) on the second pair of legs. Such absence was, until now, considered usual for all Eriophyoidea. The phylogenetic and systematic aspects related to this unusual characteristic are discussed.

Material and methods

Specimens were collected directly from leaf samples under a dissecting stereomicroscope and stored in ethyl alcohol (70%). Mites were then slide-mounted in modified Berlese medium (Amrine & Manson 1996). Slide-mounted

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specimens were studied under a combined phase-contrast and differential interference contrast microscope (Nikon Eclipse 80i).

Terminology follows Lindquist (1996) and classification is based on Amrine *et al*. (2003). Measurements are given in micrometers (µm) and, unless stated otherwise, refer to the length of the structure. In the description of the female, the holotype measurement precedes the corresponding range of the paratypes, in parentheses. Oral stylets of male paratypes could not be measured because of the position in which they were mounted. Measurements were obtained from a micrometre ocular and conducted according to de Lillo *et al*. (2010) except for: 1) the body length, from the tip of the frontal lobe to the rear end of the anal lobe, not considering the pedipalps; 2) the distance between *sc* tubercles, in spite of the distance between the setae 3) the empodium length, including its basal portion inserted in the tarsus. The ventral opisthosomal annuli were counted from the first full annulus behind the genitalia. The dorsal opisthosomal annuli were counted from the first full annulus behind the middle of the prodorsal shield rear margin.

Micrographs were obtained using a digital system consisting of a microscope with a combination of phase-contrast and differential interference contrast (Nikon Eclipse 80i) connected to a digital camera (Nikon DS-Fil with DS-L2) which was in turn connected to a computer with the software provided by the camera.

Taxonomy

Acari: Eriophyidae: Phyllocoptinae: Anthocoptini. With character states of the genus *Abacarus*, following Keifer (1944) and Amrine *et al*. (2003): Three dorsal longitudinal ridges, the middorsal ridge shorter than the subdorsal ridges and ending in a dorsal furrow. Prodorsal tubercles on rear shield margin, directing scapular setae to rear.

Abacarus doctus Navia & Flechtmann n. sp.

(Figs. 1–3)

Diagnosis. An *Abacarus* species with *sc* seta reaching the 2nd or 3rd dorsal annulus; 39–44 dorsal annuli; female epyginum with two rows of transversal curved lines in the basal area and longitudinal lines in the distal area; empodium with 7–8 rays, and presence of a tibial seta (*l′*) on leg II. The new species is close to *Abacarus sacchari* ChannaBasavanna 1966 and to *Abacarus queenslandiensis* Ozman-Sullivan, Amrine & Walter 2006. It differs from these species mainly in having the short *sc* setae, reaching at most to the 2nd or 3rd dorsal annulus (in *A. queenslandiensis* reaching the 4th annulus and in *A. sacchari* reaching the 7th annulus); female epyginum basally with two rows of transverse lines (absence of basal transverse lines in *A. queenslandiensis* and in *A. sacchari*; in these species, longitudinal lines occupying the whole epigynum); and in the presence of tibial seta (*l′*) on leg II (absent in *A. queenslandiensis* and *A. sacchari*).

FEMALE (n=10). Body fusiform, 161 (135–216), 58 (54–61) wide, yellowish or creamish colour in life. **Gnathosoma** downcurved, 22 (21–25); basal seta (*ep*) 3 (2–3), unbranched; apical seta (d) 13 (12–13), prominent; chelicerae 17 (17–20); oral stylets 12 (11–13). **Prodorsal shield** subtriangular, 58 (51–60), 60 (50–60) wide. Frontal lobe slightly emarginate apically, broad basally, 19 (17–22), 32 (27–32) wide. Scapular setae (*sc*) 6 (6–8), on tubercles on rear shield margin and directed backwards, 35 (33–38) apart. Admedian lines in the central area (extending from 1/4 to 3/4 of shield), faint, especially when covered with wax; in the 1/4 anterior shield, admedian lines can be closer together than in posterior area and in this transition, a curved transversal line can be seen joining admedial lines. **Legs** with all segments, all usual setae and also tibial seta on leg II present. **Leg I** 27 (25–29); femur 10 (9–12), femoral seta (*bv*) 11 (10–12); genu 5 (4–6), genual seta (*l″*) 27 (26–29); tibia 5 (5–7), tibial seta (*l′*) 6 (6–8); tarsus 6 (6–7), lateral seta (*ft″*) 22 (20–25), dorsal seta (*ft′*) 18 (18–23), unguinal seta (*u′*) 6 (4–6), solenidion (*ω*) 7 (7–9), empodium 7 (6–8), 7 (7–8)-rayed. **Leg II** 25 (25–29); femur 11 (10–11), *bv* 18 (18–21); genu 4 (4–5), *l″* 6 (6–8); tibia 4 (4-6), *l′* 4 (4–6); tarsus 7 (6–7), *ft″* 22 (21–23), *ft′* 7 (6–8), *u′* 5 (4–5), *ω* 7 (7–9); empodium 7 (7–8), 7-rayed. **Coxae** I and II densely dashed. Sternal line 6 (6–8). Coxal seta I (*1b*) 7 (7–11), 13 (13–14) apart; coxal seta II (*1a*) 24 (24–27), 7 (6–8) apart; coxal seta III (*2a*) 47 (47–51), 24 (21–24) apart; 7 (6–7) coxigenital annuli, microtuberculated. **Genital** coverflap 14 (13–18), 19 (18–22) wide, resembling a curtain, with 17

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(16–18) longitudinal lines in the distal area and with two rows of transversal curved lines in the basal area, genital seta (*3a*) 22 (22–27). **Opisthosoma** with 39 (39–44) dorsal annuli and 48 (48–56) ventral annuli. Three dorsal longitudinal ridges, mid-dorsal ridge ending at about 3/4 of opisthosoma, lateral ridges joining caudally fading on 3rd or 4th last opisthosomal annuli; ventral opisthosomal annuli with elongate microtubercles, restricted to the median region. Lateral seta (c_2) 36 (34–38), on annulus 2 (1–2); ventral seta I (*d*) 63 (59–63), on annulus 13 (11–15), 25 (25–31) apart, 27 (22–27) microtubercles apart; ventral seta II (*e*) 13 (13–16), on annulus 27 (27–34), 12 (11–13) apart, 10 (10–12) microtubercles apart; ventral seta III (*f*) 25 (22–29), on annulus 44 (41–52), 22 (18–22) apart, 22 (18–25) microtubercles apart. Caudal seta (h_2) 62 (62–67) and accessory seta (h_1) 3 (3–4).

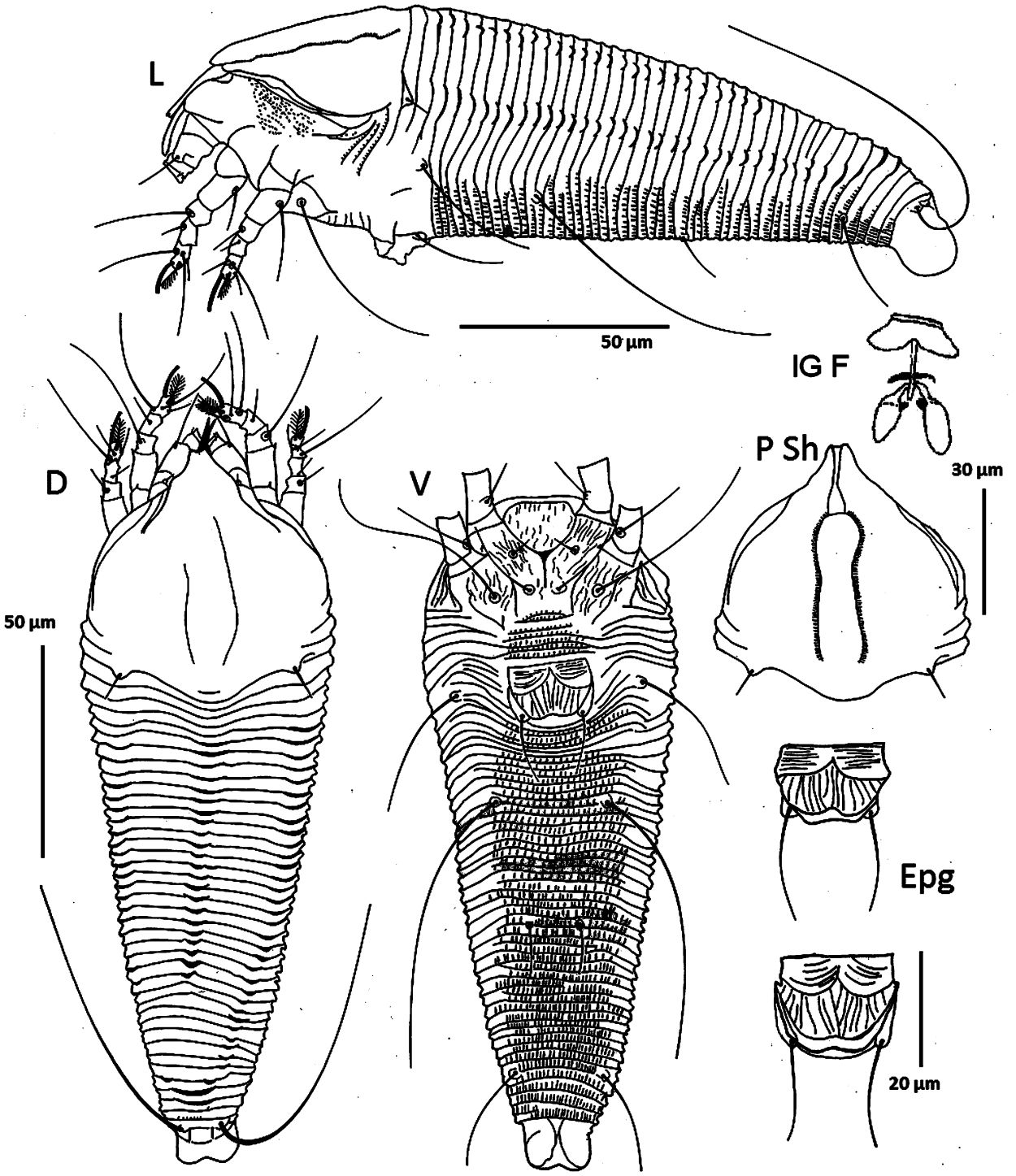

FIGURE 1. ***Abacarus doctus*** **n. sp**. **L.** Lateral habitus of female; **D**. Dorsal habitus of female; **V.** Ventral habitus of female. **P Sh.** Prodorsal shield ornamentation in detail; **Epg. E**pigynum, **IGF**. Internal genitalia of female.

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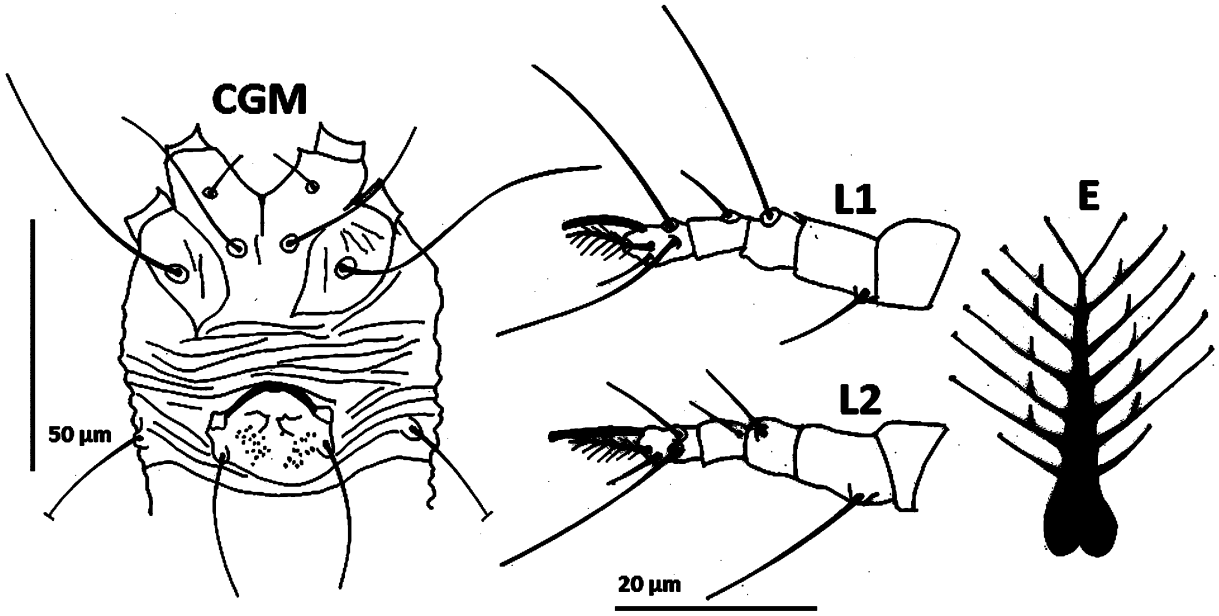

FIGURE 2. ***Abacarus doctus*** **n. sp**. **CGM.** Coxigenital region of male; **L1.** Leg I of female; **L2.** Leg II of female; **E.** Empodium (enlarged).

MALE (n=5). Smaller than female, 152–172, 47–52 wide. **Gnathosoma** 23–25, basal seta (*ep*) 2–3, apical seta (*d*) 11–12, chelicerae 16–18. **Prodorsal shield** same/similar to female, 52–54, 42–49 wide. Scapular setae (*sc*) 5–7 on tubercles, 29–32 apart. Frontal lobe 14–18, 22–26 wide. **Legs** same/similar to female. **Leg I** 27–28; femur 10, femoral seta (*bv*) 10–12; genu 5–6, genual seta (*l″*) 21–25; tibia 5–6, tibial seta (*l′*) 7–8; tarsus 6–8, lateral seta (*ft″*) 20–23, dorsal seta (*ft′*) 17–20, unguinal seta (*u′*) 5–6, solenidion (*ω*) 7–8, empodium 7–8, 7-rayed. **Leg II** 24–25; femur 8–10, *bv* 14–15; genu 5–6, *l″* 5–7; tibia 4–5, *l′* 4–6; tarsus 6, *ft″* 18–20, *ft′* 6–8, *u′* 5–6, *ω* 8, empodium 7–8, 7-rayed. **Coxae** with a few dashes. Sternal line 7–10. Coxal seta I (*1b*) 6–7, 9–13 apart; coxal seta II (*1a*) 17–19, 6–7 apart; coxal seta III (*2a*) 33–40, 19–22 apart; 6–7 coxigenital annuli, microtuberculated. **Genitalia** 13–14, 18–19 wide, with granules, eugenital setae as figured; genital seta (*3a*) 19–22. **Opisthosoma** with three longitudinal ridges same as in female, with 37–41 dorsal annuli and 43–49 ventral annuli. Lateral seta (c_2) 26–28, on annulus 2; ventral seta I (*d*) 43–48, on annulus 11–12, 24–26 apart; ventral seta II (*e*) 10–14, on annulus 22–24, 10–12 apart; ventral seta III (*f*) 20–23, on annulus 39–43, 18–20 apart. Caudal seta (h_2) 56–63 and accessory seta (h_1) 2–3.

Type material. Holotype female, 30 female and 15 male paratypes from *Saccharum officinarum* L. (Poaceae), El Ingenio El Palmar, District of Pitahaya, Provincia de Puntarenas, Costa Rica. September 2008, coll. Carlos Sanabria. Specimens are arranged on 13 microscope slides (holotype ringed). The holotype and paratypes are deposited in the reference collection of the Laboratório de Quarentena Vegetal, Embrapa Recursos Genéticos e Biotecnologia, Brasília, DF, Brazil. Paratypes (5 specimens: 4 females and 1 male, on 2 microscope slides) are also deposited in the collection of the Departamento de Entomologia e Acarologia, ESALQ, Universidade de São Paulo, Piracicaba, SP, Brazil.

Relation to the host. This new species is a vagrant on the inner surface of the leaves (Fig. 4). However, high mite infestation can cause reddish or bronzed spots to spread randomly on the inner leaf surfaces which can extend to cover almost the entire leaf sheath (Fig. 4). At a distance, such damage symptoms could be confused with those caused by rust fungi, which is commonly associated with sugarcane.

Etymology. The specific designation *doctus* is derived from Latin, meaning “to instruct”, referring to the presence of a seta on the tibia of leg II which is reminiscent of an atavistic character.

Remarks. A tibial seta on leg II was observed, in dorsal or lateral position, on all specimens which, due to the mounting position, allowed for the visualisation of this segment. Up to the present, no eriophyoid mite species, among about 3700 valid species (Amrine 2003) have been described with a tibial seta (*l′*) on the second pair of

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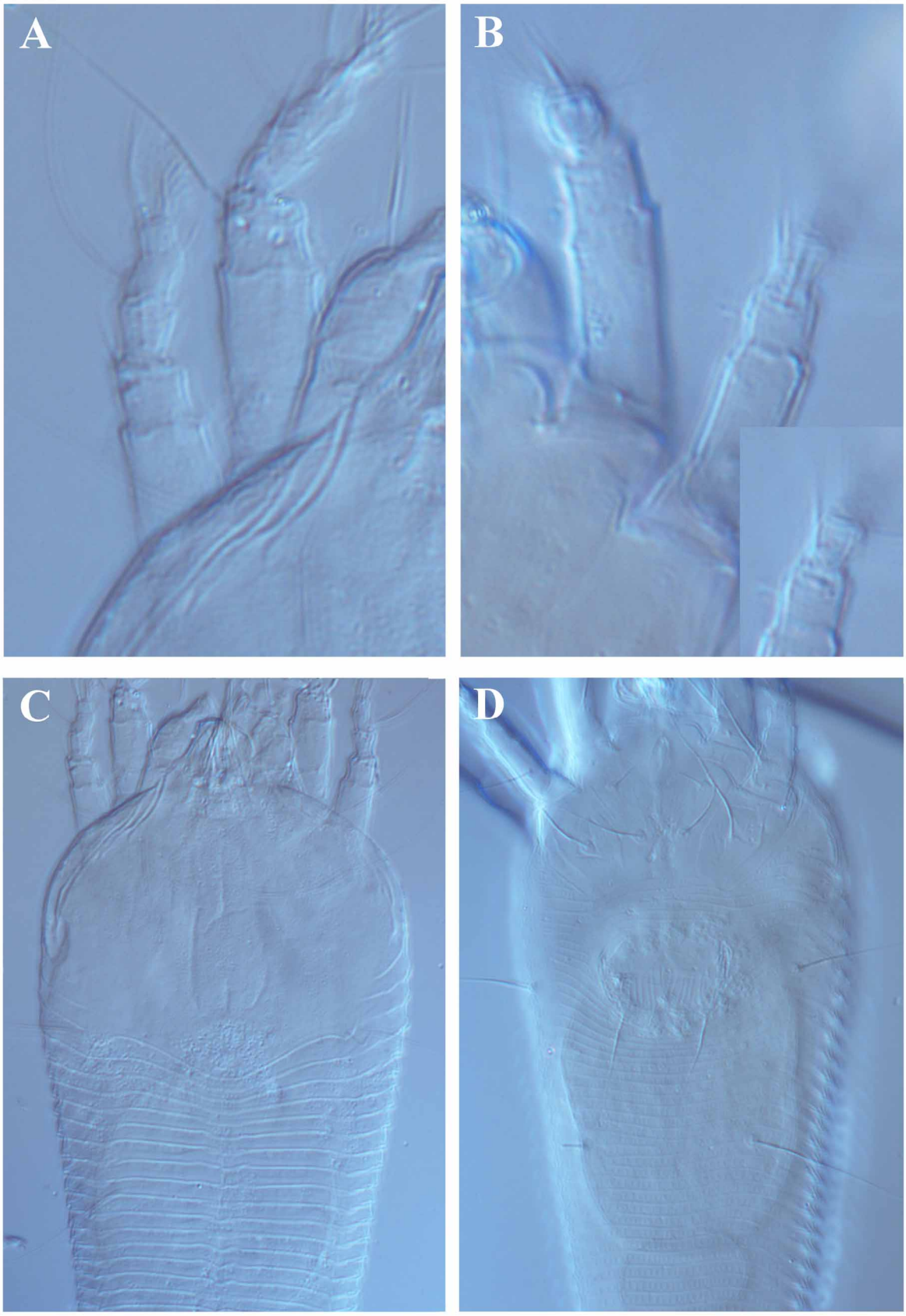

FIGURE 3. ***Abacarus doctus*** **n. sp**. Micrographs showing: **A.** and **B.** Tibial seta (*l′*) on dorsal position of Leg II; **C.** Prodorsal shield; **D.** Coxigenital region. The specimen in the micrograph appears to show an incomplete median line on the prodorsal shield. However, such a line was not visible on any of the specimens studied under phase contrast or DIC microscopy.

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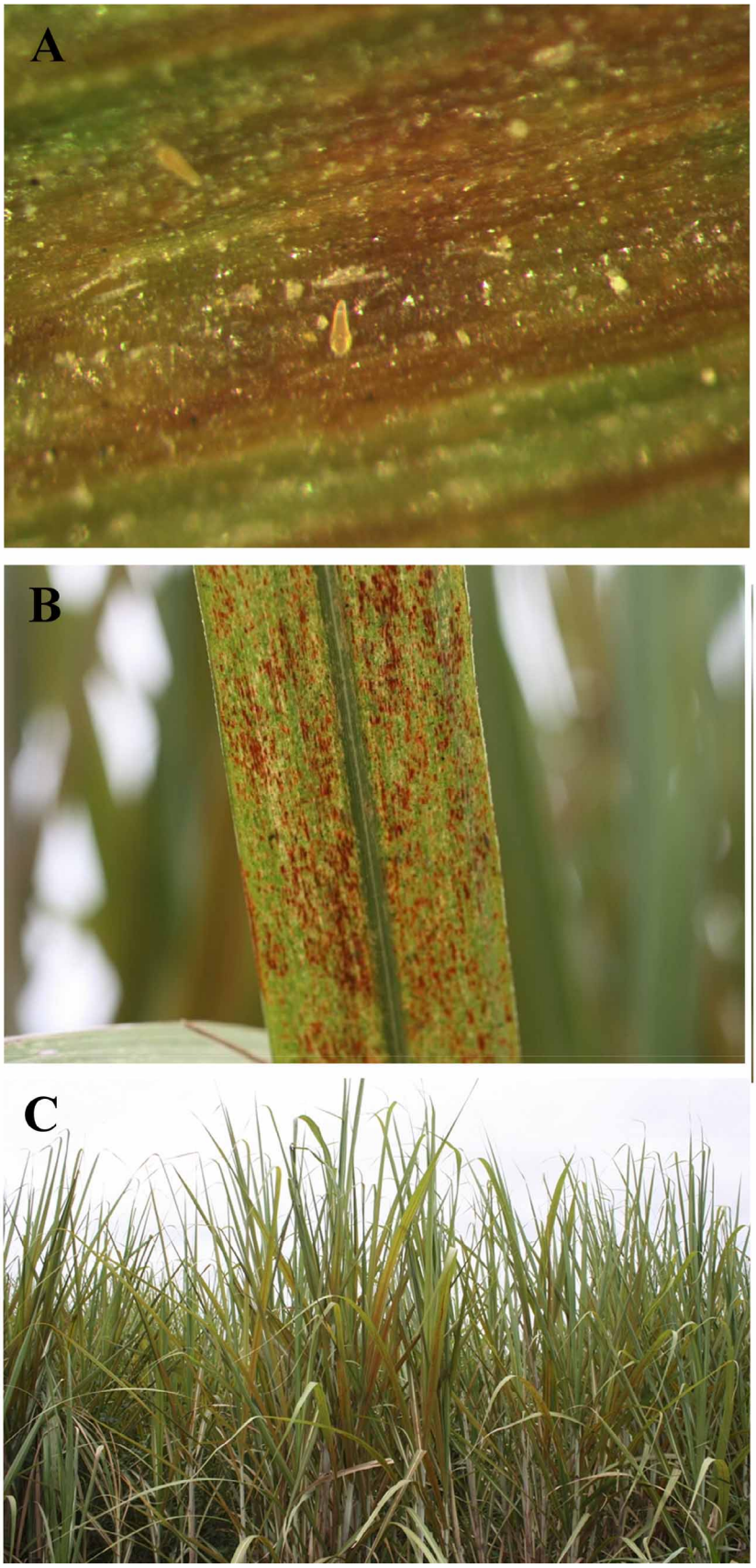

FIGURE 4. ***Abacarus doctus*** **n. sp.** Infestation of sugarcane in Costa Rica: **A.** General aspect of mites on the inner surface of leaves; **B.** Bronzed spots on leaf sheath due to high infestation; **C.** Sugarcane plants showing damage symptoms (Photos: P. Murillo).

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legs, such that its absence has been considered typical for all Eriophyoidea (Lindquist 1996). Although the presence of a tibial seta on leg II may be considered a primitive (plesiomorphic) retention, its consistent absence among all the known early derivative taxa of Eriophyoidea (for example, members of 18 genera in four subfamilies of Phytoptidae) does not support this hypothesis, especially in view of *Abacarus* being a relatively recently derived genus of the tribe Anthocoptini, in the subfamily Phyllocoptinae of the more derivative family Eriophyidae. Another possibility is that the presence of a tibial seta on leg II may be an atavistic character, that is, a reappearance of a previously suppressed seta, thus a character state reversal and derivative (apomorphic) condition. We suggest that the absence of a tibial seta on leg II not be regarded as an assumed characteristic, or the only possibility in eriophyoid leg chaetotaxy, when describing a new taxon. Indeed, we wonder whether the occasional presence of this seta may have been overlooked in some previous descriptions. This attribute should also be considered in future phylogenetic studies of the group.

Probably *A. doctus* **n. sp.** is not native to Neotropical areas in Central America, but spread from the region of origin of its host plant, the sugarcane, in the tropical areas of Asia. Intensive surveys in the centre of origin of the several species in the genus *Saccharum* where cultivated hybrids originated might confirm this hypothesis. An alternative possibility is that the new species, *A. doctus*, could be native to Neotropical areas where it may occur on other plant hosts and has adapted to sugarcane as a new host. An example of this is *Aceria guerreronis* Keifer, which is not known from the area of origin of its coconut host (Navia *et al.* 2005). Further surveys for *A. doctus* on other suitable hosts in areas where sugarcane is grown in the Neotropics could test this hypothesis.

Sugarcane germplasm is mainly traded between countries in the form of stalk pieces (Bailey *et al*. 2000). The hazards presented by germplasm exchange are well known and most importing countries apply strict quarantine procedures to detect diseases, especially viruses and phytoplasmas (Croft *et al*. 1996). However, attention should also be directed to mites, mainly eriophyoid mites, which are easily overlooked and can be disseminated through propagation material. The presence of the new *Abacarus* species here described was associated with sugarcane damage on leaves. As a consequence, this mite is of concern to growers in different provinces throughout Costa Rica (Aguilar *et al*. 2010). Information about this new eriophyoid mite infesting sugarcane in Costa Rica is highly relevant in order to guide the adoption of quarantine measures to avoid its dissemination to other countries.

Key to adult females in the genus *Abacarus* Keifer from sugarcane, *Saccharum* spp.

1. Tibia of leg II with a seta; seta *sc* (6–8 µm) reaching at most to 3rd dorsal annulus; epigynum with two rows of transverse lines basally . . . . . *Abacarus doctus* **n. sp.**
- Tibia of leg II without a seta; seta *sc* longer, reaching at least to 4th dorsal annulus; epigynum with longitudinal lines and/or basal rows of microtubercles. 2
2. Prodorsal shield with median line complete, sparsely granular . . . . . *Abacarus delhiensis* ChannaBasavanna
- Prodorsal shield without or short median line, smooth. 3
3. Scapular seta *sc* (11–15 µm) reaching 4th dorsal annulus; empodium 6-rayed . . . . . *Abacarus queenslandiensis* Ozman-Sullivan, Amrine & Walter
- Scapular seta *sc* (18 µm) extending beyond 7th dorsal annulus; empodium 7-rayed . . . .*Abacarus sacchari* ChannaBasavanna

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