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ÁCAROS ERIOFIÓIDES (TROMBIDIFORMES: ERIOPHYOIDEA) ASSOCIADOS A ESPÉCIES DE *Theobroma* (MALVACEAE) - DESCRIÇÃO DE NOVOS TÁXONS

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ÁCAROS ERIOFIÓIDES (TROMBIDIFORMES: ERIOPHYOIDEA) ASSOCIADOS A ESPÉCIES DE *Theobroma* (MALVACEAE) - DESCRIÇÃO DE NOVOS TÁXONS

RESUMO

A superfamília Eriophyoidea é a segunda de importância econômica entre os grupos de ácaros fitófagos e pode causar danos significativos a seus hospedeiros. Foram descritas cerca de 4 mil espécies nessa superfamília. O gênero *Theobroma* (Malvaceae) é atualmente composto por 22 espécies neotropicais, sendo as de maior importância socioeconômica o cacaueiro, *T. cacao* L., e o cupuaçuzeiro, *T. grandiflorum* (Willd. Ex Spreng.) K. Schum. Três espécies de Eriophyoidea associados a *Theobroma* haviam sido descritas – *Aceria reyesi* (Nuzzaci), *Floracarus theobromae* Keifer e *Gymnaceria cupuassu* Oliveira, Rodrigues & Flechtmann, todas da América do Sul. O objetivo deste trabalho foi contribuir para o conhecimento de ácaros eriofióides associados a *T. cacao* e *T. grandiflorum*, através da identificação e descrição de novos táxons coletados na Região Amazônica. Um novo gênero e espécie de eriofiídeo, tentativamente alocado em Tegonotini (Eriophyidae), *Eriomacrotergum flechtmanni* **n. gen. n. sp.**, foi descrito do cupuaçuzeiro, coletado no Estado do Amazonas, Norte do Brasil. O novo táxon apresenta uma morfologia peculiar por apresentar um escudo prodorsal reduzido, com estruturas ocelares e setas escapulares deslocadas lateralmente; e uma placa opistossomal na região anterior do corpo. Uma discussão sobre os principais caracteres taxonômicos de *E. flechtmanni* é apresentada, comparando-os com os caracteres de outros gêneros de Eriophyidae com os quais apresenta similaridades (não apenas com os Tegonotini), assim como as incertezas sobre sua posição filogenética. As descrições de duas novas espécies de Eriophyoidea associadas ao cacaueiro foram elaboradas – um Diptilomiopidae do gênero *Davisella* Flechtmann, Amrine & Stasny, de Rondônia, Brasil; e um Eriophyidae do gênero *Tetra* Keifer, de mudas originárias da Costa Rica, interceptado na estação quarentenária no Brasil. A nova espécie de *Davisella* apresenta no trocânter-femur-genu do pedipalpo um tubérculo alongado, subcilíndrico; essa estrutura ainda não havia sido observada em Eriophyoidea; sua morfologia funcional é discutida. A nova espécie de *Tetra* é a segunda neste gênero descrita da família Malvaceae. Um olhar mais atento sobre *Shevtchenkella biseta* (Nalepa), descrita de hibisco, *Hibiscus rosa-sinensis* L., também uma Malvaceae, evidenciou que a correta posição taxonômica dessa espécie seria em Phytoptidae, Sierraphytoptinae; sua possível sinonímia com *Neoprothrix hibiscus* Reis & Navia é discutida. Além disso, é apresentada uma chave para auxiliar na identificação das seis espécies de Eriophyoidea atualmente associadas a plantas do gênero *Theobroma*, visando facilitar estudos futuros.

Palavras-chave: Eriophyidae, Diptilomiopidae, cacau, cupuaçu, Região Neotropical

ERIOPHYOID MITES (TROMBIDIFORMES: ERIOPHYOIDEA) ASSOCIATED WITH *Theobroma* SPECIES (MALVACEAE) – DESCRIPTION OF NEW TAXA

ABSTRACT

The superfamily Eriophyoidea is the second in economic importance among the groups of phytophagous mites and can cause significant damage to their hosts. About 4000 species were described in this superfamily. The genus *Theobroma* (Malvaceae) is currently composed of 22 Neotropical species, being of high socioeconomic importance the cacao, *T. cacao* L., and the cupuaçu, *T. grandiflorum* (Willd. Ex Spreng.) K. Schum. Three species of Eriophyoidea associated with *Theobroma* had been described– *Aceria reyesi* (Nuzzaci), *Floracarus theobromae* Keifer and *Gymnaceria cupuassu* Oliveira, Rodrigues & Flechtmann, all of them from South America. The objective of this study was to contribute to the knowledge of the eriophyoid mites associated with *T. cacao* and *T. grandiflorum*, through the identification and description of new taxa collected in the Amazon region. A new genus and species of eriophyid, tentatively allocated in Tegonotini (Eriophyidae), *Eriomacrotergum flechtmanni* **n. gen. n. sp.**, was described from cupuaçu, collected in the state of *Amazonas*, northern Brazil. The new taxon has a peculiar morphology by the presence of a reduced prodorsal shield with ocellar structures and scapular setae displaced laterally; and an opisthosomal plate in anterior body. A discussion of the main taxonomic characters of *E. flechtmanni* is presented, comparing them with characters of other genera of Eriophyidae with which it presents similarities (not only with Tegonotini), as well as the uncertainty about its phylogenetic position. Descriptions of two new species of Eriophyoidea associated with cacao were prepared – a Diptilomiopidae of the genus *Davisella* Flechtmann, Amrine & Stasny, from Rondônia, Brazil; and an Eriophyidae of the genus *Tetra* Keifer, from seedlings imported from Costa Rica, intercepted in the quarantine station in Brazil. The new species of *Davisella* presents an elongated tubercle in the trochanter-femur-genu of pedipalp, subcylindrical; this structure had not yet been observed in Eriophyoidea; its functional morphology is discussed. The new species of *Tetra* is the second species of the genus described from the family Malvaceae. A close look at *Shevtchenkella biseta* (Nalepa), described from hibiscus, *Hibiscus rosa-sinensis* L., also a Malvaceae, showed its correct taxonomic position in Phytoptidae, Sierraphytoptinae; its possible synonymy with *Neoprothrix hibiscus* Reis & Navia is discussed. Furthermore, aiming to facilitate future studies an identification key to help in the separation of the six species of Eriophyoidea currently associated with plants of the genus *Theobroma*, is presented.

Key-words: Eriophyidae, Diptilomiopidae, cocoa, cupuaçu, Neotropical region

SUMÁRIO

1 INTRODUÇÃO

Os ácaros (Arachnida: Acari) podem ser considerados um dos grupos de invertebrados de maior sucesso, por sua diversidade ecológica e morfológica, e pelo sucesso na colonização dos mais variados ambientes (Krantz & Walter 2009). Correspondem ao segundo maior grupo de artrópodes, depois dos insetos. Em geral, apresentam maior diversidade e abundância no solo, mas também são comuns no meio aquático, sobre plantas e animais, assim como nos depósitos de alimentos e em abrigos de animais, incluindo aí nossas residências (Moraes & Flechtmann 2008).

Entre os ácaros plantícolas podemos encontrar espécies com hábitos alimentares diversos, como fitófagos, predadores, fungívoros ou saprófitas. Muitos ácaros fitófagos tem alcançado status de praga em agroecossistemas (Hoy 2011). Entre os grupos de ácaros fitófagos que podem se tornar pragas, estão os da superfamília Eriophyoidea, segunda superfamília de importância econômica. O alto grau de especialização morfológica e biológica permite aos Eriophyoidea viverem em lugares como nas bainhas das folhas, gemas, brotos terminais, eríneas, galhas, bem como na superfície exposta das plantas (Moraes & Flechtmann 2008).

Ácaros Eriophyoidea são também chamados de microácaros, pois são menores quando comparados com os outros ácaros; o comprimento do corpo dos adultos tem em média 200 μm, variando de 80 μm a 500 μm (Lindquist 1996). Esses ácaros apresentam o corpo alongado, e podem ser vermiformes ou fusiformes; tegumento anelado transversalmente, sendo que as anelações podem ser providas de microtubérculos; e distinguem-se dos demais grupos de ácaros por possuírem apenas dois pares de pernas, situadas na região anterior do corpo (Moraes & Flechtmann 2008).

Já foram descritas cerca de 4 mil espécies de Eriophyoidea, superfamília composta por três famílias: Eriophyidae, Diptilomiopidae e Phytoptidae. Estimativas conservadoras consideram que a fauna de Eriophyoidea no mundo pode variar de 35.000 a 50.000 espécies; entretanto alguns pesquisadores fazem estimativas ainda maiores, como 250.000 espécies. (Amrine *et al*. 2003). Considera-se que em alguns países tropicais e subtropicais, incluindo o Brasil, mais de 90% dos Eriophyoidea não são conhecidos (de Lillo & Skoracka 2010).

A Amazônia é o maior bioma brasileiro e apresenta uma grande biodiversidade. Os estudos sobre ácaros Eriophyoidea associados a plantas nativas da Amazônia ainda são

escassos. A maioria dos estudos têm sido realizados apenas sobre palmeiras (Navia & Flechtmann 2005; Reis *et al.* 2012; Reis *et al.* 2014) e espécies de *Hevea* (Euphorbiaceae) (Feres 2001), enquanto outros grupos de plantas, mesmo sendo de importância socioeconômica, ainda não foram estudados, como por exemplo espécies de *Theobroma* (Malvaceae).

O gênero *Theobroma* é atualmente composto por 22 espécies (Sodré 2007). Esse gênero, anteriormente considerado como pertencente à família Sterculiaceae, agora é classificado como pertencente à família Malvaceae (Bayer *et al*. 1999). No Brasil ocorrem 13 espécies, todas da Amazônia (Esteves 2015). Dentre estas espécies com maior importância socioeconômica estão o cacaueiro, *Theobroma cacao* L., e o cupuaçuzeiro, *Theobroma grandiflorum* (Willd. Ex Spreng.) K. Schum. Os frutos do cacaueiro têm grande expressão econômica mundial, sendo as sementes utilizadas como matéria-prima na fabricação do chocolate e seus derivados e a polpa aproveitada na fabricação de sucos, licores, doces regionais e manteiga de cacau (Cohen *et al.* 2003). O cupuaçuzeiro tem o maior fruto entre as espécies de *Theobroma,* sendo sua polpa aproveitada pelas indústrias alimentícias para fabricação de sucos, doces, geleias, compotas e sorvetes, em virtude do sabor e aroma agradáveis (Calzavara *et al*. 1984).

Apenas três espécies de Eriophyoidea associados a *Theobroma* haviam sido descritas (Keifer 1973; Nuzzaci 1973; Oliveira *et al*. 2012). Como esses ácaros podem se tornar pragas agrícolas, e considerando que essas plantas possuem interesse econômico, é importante conhecer as espécies associadas a essas plantas.

O objetivo deste trabalho foi contribuir para o conhecimento de ácaros Eriophyoidea associados a duas espécies de *Theobroma* - *T. cacao* e *T. grandiflorum*, através da identificação e descrição de novos táxons coletados na Região Amazônica brasileira ou provenientes da América Central, em Costa Rica. A condução desse estudo permitiu contribuir para o conhecimento taxonômico e morfológico desse grupo de ácaros, através da descrição de caracteres morfológicos originais e da correta alocação taxonômica de uma espécie.

2 REVISÃO DE LITERATURA

2.1 Os ácaros Eriophyoidea - classificação, biologia e morfologia

Os ácaros pertencem ao filo Artropoda, subfilo Chelicerata, classe Arachnida e subclasse Acari (Moraes & Flechtmann 2008). A superfamília Eriophyoidea pertence à ordem Trombidiformes, subordem Prostigmata (Lindquist *et al.* 2009) e inclui três famílias: Phytoptidae, Eriophyidae e Diptilomiopidae. Até 2003 eram conhecidos 301 gêneros de Eriophyoidea (Amrine *et al.* 2003). A grande maioria (cerca de 78%) das espécies conhecidas são da família Eriophyidae (Moraes & Flechtmann 2008). A classificação atual dos Eriophyoidea segue Lindquist (1996) e a chave de gêneros de Amrine *et al*. (2003).

Eriophyoidea é um grande grupo de ácaros estritamente fitófagos (Moraes & Flechtmann 2008). A maioria das espécies de Eriophyoidea possui uma alta especificidade em relação à planta hospedeira, o que reflete uma íntima relação ácaro-planta. Cerca de 95% dos Eriophyoidea são encontrados em plantas de um mesmo gênero (Skoracka *et al*. 2010). Muitos destes só conseguem sobreviver em estruturas que são aparentemente formadas nas plantas em resposta à injeção de substâncias no ato de sua alimentação (Moraes & Flechtmann 2008). Esta alta especificidade hospedeira está relacionada à alta diversidade do grupo (de Lillo & Skoracka 2010).

Os Eriophyoidea, também chamados de microácaros, passam pelos estágios de ovo, larva, ninfa e adulto. Os ovos são esféricos, elípticos ou lentiformes com 20μm a 60μm de diâmetro (Moraes & Flechtmann 2008). Os ovos são depositados em folhas ou outras partes vegetais e podem ser incolores ou translúcidos, ocorrendo estágios quiescentes entre a larva e a ninfa e entre a ninfa e o adulto (Manson & Oldfield 1996). O período de desenvolvimento é de uma a duas semanas (Moraes & Flechtmann 2008).

Os Eriophyoidea são ácaros alongados, vermiformes ou fusiformes (Figura 1). São os únicos ácaros que possuem dois pares de pernas (I e II), sendo estas semelhantes em todos os estágios de desenvolvimento (Lindquist 1996). Os dois pares de apêndices anteriores, as quelíceras e os palpos, correspondem à região conhecida como gnatossoma. O restante do corpo é chamado de idiossoma, dividindo-se dorsalmente em duas regiões, uma anterior, o prodorso, e outra posterior, mas alongada, o opistossoma (Moraes & Flechtmann 2008).

O prodorso pode apresentar formas variadas e possui a superfície coberta por um escudo prodorsal, o qual pode ser quase liso ou ornamentado, com várias linhas, elevações ou

microtubérculos (Lindquist 1996). A abertura genital dos adultos, de ambos os sexos, é posicionada próximo da base das pernas. As setas das pernas e do idiossoma são quase sempre simples e cônicas (Lindquist 1996).

O opistossoma de espécies vermiformes geralmente apresenta anéis cuticulares contínuos dorso-ventralmente (Figura 1A). Já as espécies fusiformes possuem diferentes números de semi-anéis dorsais e ventrais (Figura 1B) (Moraes & Flechtmann 2008). Os imaturos geralmente são semelhantes aos adultos, mas possuem um tamanho menor e não apresentam órgãos genitais externos (Manson & Oldfield 1996).

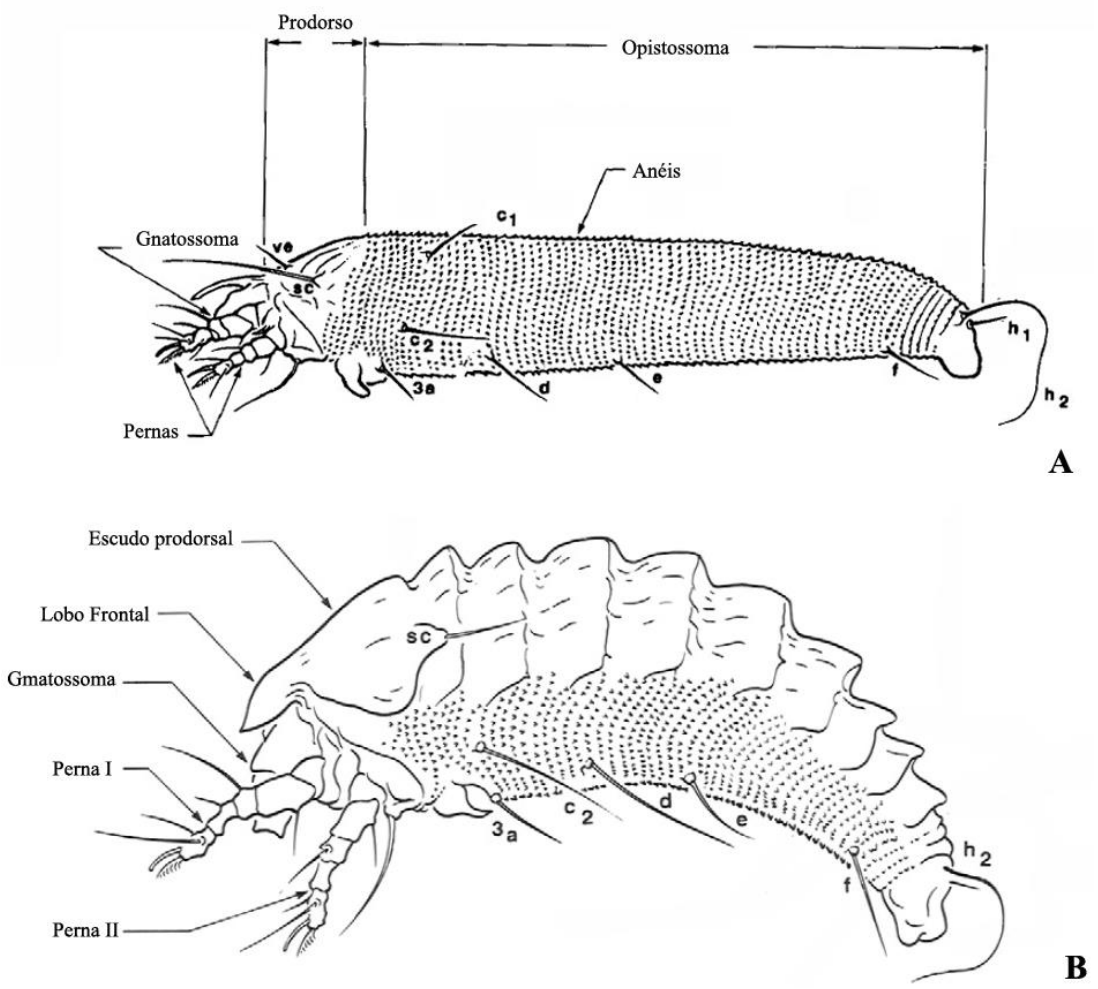

FIGURA 1. Principais estruturas morfológicas de ácaros Eriophyoidea. A. Vista lateral de um Eriophyoidea vermiforme. B. Vista lateral de um Eriophyoidea fusiforme. Modificadas de Lindquist (1996).

2.2 Caracteres taxonômicos dos ácaros Eriophyoidea

Os caracteres utilizados para o estudo taxonômico dos Eriophyoidea são: escudo prodorsal, região coxigenital de ambos os sexos, pernas, empódio, vista lateral do ácaro e genitália interna das fêmeas (Amrine & Manson 1996).

O escudo prodorsal pode ser liso ou ornamentado. Geralmente possui um formato subtriangular ou semicircular e pode ou não ter uma extensão antero-mediana, o lobo frontal. A seta vertical interna (*vi*), vertical externa (*ve*) e escapular (*sc*) podem estar presentes ou ausentes. O número, posição e orientação dessas setas são usados para caracterizar espécies (Lindquist 1996).

A região coxisternal geralmente possui três pares de setas. O par anterior ou antero-lateral de setas no coxisterno I (*lb*) varia consideravelmente em tamanho e posição, e é vestigial ou ausente em vários gêneros de Eriophyidae e alguns de Diptilomiopidae. O segundo par de setas proximais no coxisterno I (la) raramente está ausente. O par de setas no coxisterno II (*2a*) está presente em todos os táxons conhecidos de Eriophyoidea (Lindquist 1996).

As pernas dos Eriophyoidea possuem cinco segmentos articulares (trocânter, fêmur, genu, tíbia e tarso) (Lindquist 1996). O trocânter não possui setas. A seta basiventral femoral (*bv*) é inserida ventralmente e pode estar presente ou ausentes na perna I e II. A seta antaxial genual (*l"*), inserida dorsalmente ou dorsolateralmente, é geralmente a maior seta da perna I. A seta paraxial tibial (*l'*) está presente apenas na perna I, com exceção de *Abacarus doctus* que possui a seta *l'* na perna I e II (Navia *et al.* 2011) e é inserida dorsalmente. O tarso possui um par de setas dorsolaterais, a paraxial fastigial (*ft'*) e a antaxial fastigial (*ft"*), sendo a *ft'* menor que a *ft"* em alguns táxons. O tarso geralmente tem uma pequena terceira seta anteroventral, a seta paraxial unguinal (*u'*) (Lindquist 1996; Amrine *et al.* 2003).

Nos tarsos das pernas I e II está presente um solenídeo (ω) normalmente curvo e ligeiramente ampliado apicalmente, com ápice bulboso em alguns táxons (Lindquist 1996). O empódio, também presente no tarso, é constituído por um ramo central e raios laterais, sendo o ramo central às vezes bifurcado (Moraes & Flechtmann 2008). O empódio geralmente é simétrico e apresenta de dois a cerca de 20 raios, em cada lado do eixo central, podendo estes últimos ser secundariamente ramificados. A forma do empódio é quase sempre a mesma nas pernas I e II (Lindquist 1996).

A abertura genital dos Eriophyoidea é transversal. Um par de setas (proximal seta no coxiesterno III, *3a*) posiciona-se lateralmente à abertura genital em ambos os sexos e está

presente nas larvas, ninfas e adultos (Lindquist 1996). Nas fêmeas, a câmara pró-genital é coberta por uma única aba subtriangular ou subelíptica, o epigínio. Esta aba pode ser não ornamentada como em todos os Phytoptidae e em alguns Eriophyidae e Diptilomiopidae, ou, geralmente, coberta por estrias longitudinais dispostas em uma ou duas faixas transversais (Lindquist 1996). Nos machos a câmara pró-genital é mais exposta do que a das fêmeas, sendo delimitada anteriormente por uma margem transversal elevada e relativamente curva, que pode ser equivalente ao epigínio da fêmea, porém reduzido (Lindquist 1996).

Estudos recentes têm evidenciado a importância de se descrever a estrutura da genitália interna das fêmeas, mostrando que esta pode ser característica distintiva de grupos em Eriophyoidea (Nuzzaci & Alberti 1996; Chetverikov 2014; Chetverikov *et al*. 2014). A descrição das estruturas da genitália interna e um refinamento da terminologia referente ao oviduto distal e à câmara genital foram apresentados em Chetverikov (2014) e Chetverikov *et al*. (2014). Estruturas da genitália podem variar e ser utilizadas na diferenciação dos grupos, por exemplo: a forma dos apódemas genitais, a forma da espermateca, o ângulo entre o eixo longitudinal da espermateca e a ponte longitudinal, o comprimento da ponte longitudinal e o comprimento e a forma do ducto espermático, entre outras características qualitativas e quantitativas (Chetverikov 2014; Chetverikov *et al*. 2014).

2.3 O gênero *Theobroma* e espécies de importância econômica

Análises moleculares, morfológicas e biogeográficas envolvendo o gênero *Theobroma*, anteriormente considerado como pertencente à família Sterculiaceae, sugeriram a necessidade de sua reclassificação, juntamente com outros gêneros das famílias Sterculiaceae, Tiliaceae e Bombacaceae, como pertencente a uma única família monofilética, Malvaceae *sensu lato*, subdividida em nove subfamílias (Bayer *et al*. 1999).

O gênero *Theobroma* (subfamília Byttnerioideae, tribo Theobromeae) contém 22 espécies, é neotropical e está distribuído nas florestas tropicais do hemisfério ocidental, que se estende entre as latitudes 18º Norte a 15º Sul (Cuatrecasas 1964). No Brasil ocorrem 13 espécies, *T. bicolor* Bonpl., *T. cacao* L., *T. canumanense* Pires & Fróes ex Cuatrec., *T. duckei* Huber, *T. glaucum* H.Karst., *T. grandiflorum* (Willd. ex Spreng.) K. Schum., *T. microcarpum* Mart., *T. obovatum* Klotzsch ex Bernoulli, *T. simiarum* Donn.Sm., *T. speciosum* Willd. ex Spreng., *T. subincanum* Mart., *T. sylvestre* Mart. e *T. velutinum* Benoist, distribuídas no Acre, Amazonas, Amapá, Rondônia, Bahia, Maranhão, Mato Grosso, Mato Grosso do Sul e Rio de

Janeiro (Esteves 2015). Das espécies de *Theobroma*, o cacaueiro (*T. cacao*) e o cupuaçuzeiro (*T. grandiflorum*) são as de maior importância econômica.

Theobroma cacao é originário das regiões tropicais da América Central e Amazônia (Cuenca & Nazario 2004; Müller & Valle 2012). Como uma típica planta tropical é muito sensível a baixas temperaturas, razão pela qual, a maior parte das plantações comerciais encontra-se nos trópicos (Müller & Valle 2012). No Brasil, adaptou-se bem ao clima e aos solos da Amazônia e do Sul da Bahia, onde foi introduzido e desenvolveu uma importante economia cacaueira (Cuenca & Nazario 2004). Em condições silvestres, cresce no substrato intermediário da floresta e pode alcançar 20 m de altura, atingindo entre 3 e 5 m quando cultivado (Müller & Valle 2012). É uma planta de grande interesse econômico, visto que suas sementes, após secas e beneficiadas, são utilizadas para compor a base de chocolates e derivados (Sodré 2007). Os maiores produtores mundiais de cacau são a Costa do Marfim, Gana, Indonésia, Nigéria, Camarões, Brasil e Equador; os países que mais consomem o cacau são os Estados Unidos, Alemanha, Reino Unido, França, Rússia e Japão (Midlej & Santos 2012). No Brasil, os principais estados produtores de cacau são Bahia, Espírito Santo, Amazonas, Pará e Rondônia (Ceplac 2016). A produção brasileira anual do cacau (amêndoas) em 2014 foi de 273 793 toneladas (IBGE 2014).

O nome da planta (cacahuati) e o da bebida (chocoatl) vem dos antigos astecas e maias, que com o cacau preparavam uma bebida (Cuenca & Nazario, 2004). O cacaueiro possui dois grupos importantes, o Criollo e o Forastero. O Criollo, presente na América Central e Sul do México, produz frutos grandes, com superfície enrugada e sementes grandes, com o interior branco ou violeta pálido. O Forastero, considerado o verdadeiro cacau brasileiro, caracteriza-se por frutos ovóides, com a superfície lisa, sulcada ou enrugada e com sementes violeta escuro ou quase pretas (Ceplac 2016).

Theobroma grandiflorum é nativo da Região Amazônica, sendo que o cultivo desta frutífera em escala comercial teve seu início nos anos 70 (Alves 1999). Encontra-se em estado silvestre na parte sul e sudeste da Amazônia Oriental e Noroeste do Estado do Maranhão, sendo atualmente disseminada por toda a Bacia Amazônica, Colômbia, Venezuela, Equador e Costa Rica (Venturieri *et al*. 1985 apud Ferreira *et al*. 2006). A produção do cupuaçuzeiro no Brasil concentra-se na região Amazônica, sendo o Estado do Pará o principal produtor, seguido do Amazonas, Rondônia e Acre (Fraife Filho *et al*. 2009). A maior concentração de plantio dessa fruteira, introduzida no Estado da Bahia, localiza-se nos municípios de Ilhéus, Camamu, Ituberá, Nilo Peçanha, Taperoá, Valença e Una (Lopes 1999), sendo cultivada com maior frequência em pequenas propriedades, ocupando mão-de-obra familiar, e consorciado

com outras culturas (Fraife Filho *et al*. 2009). O cupuaçuzeiro tem o maior fruto entre as espécies de *Theobroma,* sendo sua polpa aproveitada pelas indústrias alimentícias para fabricação de sucos, doces, geleias, compotas e sorvetes, em virtude do sabor e aroma agradáveis (Calzavara *et al*. 1984).

2.4 Ácaros Eriophyoidea associados a plantas do gênero *Theobroma*

Três espécies de ácaros Eriophyoidea foram descritas de plantas do gênero *Theobroma* (Figura 2), *Aceria reyesi* (Nuzzaci, 1973), *Floracarus theobromae* Keifer, 1973, do cacaueiro, e *Gymnaceria cupuassu* Oliveira, Rodrigues e Flechtmann, 2012, do cupuaçuzeiro.

Aceria reyesi, o ácaro-das-gemas-do-cacaueiro, tem sido considerado como praga agrícola emergente nos estados da Bahia e de Rondônia (Oliveira & Navia 2013). Esse ácaro foi descrito em 1973, de Caucágua, Venezuela, infestando cacaueiros, onde o dano causado por essa espécie é conhecido como "engurruñadera del cacao" (Nuzzaci 1973). No Brasil, este organismo foi registrado pela primeira vez em 1979, infestando cacaueiros em uma área de transição entre cacauais e pastagens no estado da Bahia (Abreu & Soria 1979). O único hospedeiro conhecido de *A. reyesi* é o cacaueiro (Amrine & Stasny 1994). As colônias desse ácaro se desenvolvem nas gemas e outros tecidos meristemáticos, provocando atrofiamento dos brotos terminais e encurtamento de entrenós, causando, consequentemente, a queda das folhas e a morte de brotos terminais. Infestações severas podem afetar o desenvolvimento dos ramos terminais e levar à morte das plantas (Soria *et al.* 1991). O primeiro relato de *A. reyesi* em Rondônia foi feito na Estação Experimental de Ouro Preto (ESTEX-OP), da Comissão Executiva do Plano da Lavoura Cacaueira - CEPLAC, no município de Ouro Preto do Oeste, onde se observou a ocorrência de ácaros Eriophyoidea associados a cultivos de cacaueiros para a produção de sementes híbridas e, sobretudo, no banco de germoplasma da ESTEX-OP, onde foram observados danos severos de encurtamento de entrenós e morte de ramos terminais (Trevisan *et al*. 2010).

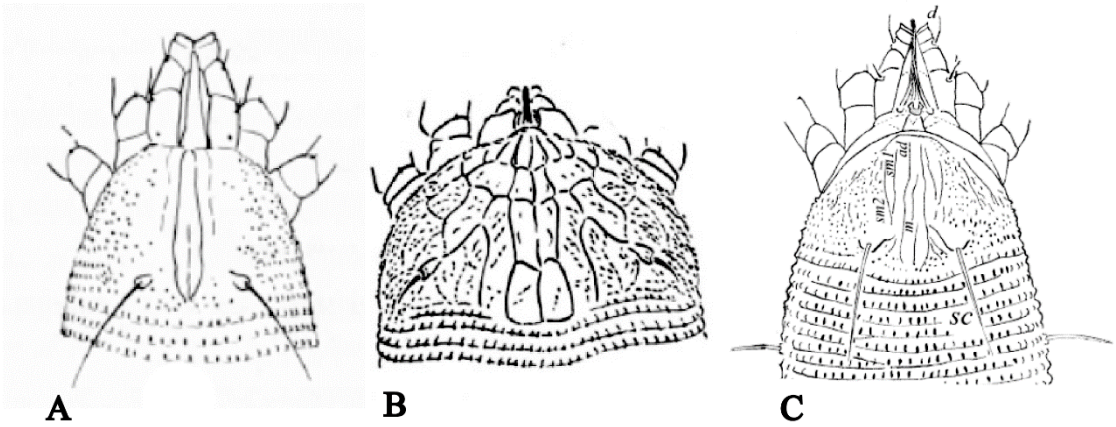

FIGURA 2 – Eriophyoidea associados a *Theobroma cacao* e *Theobroma grandiflorum*. A. *Aceria reyesi*. B. *Floracarus theobromae*. C. *Gymnaceria cupuassu*. Modificadas de Keifer (1973), Nuzzaci (1973) e Oliveira *et al*. (2012), respectivamente.

3 ARTIGO PUBLICADO NA ZOOTAXA

Eriomacrotergum flechtmanni n. gen. n. sp. (Trombidiformes: Eriophyidae), a new eriophyoid mite from the cupuaçu tree, *Theobroma grandiflorum*, from northern Brazil[1]

Abstract

A new eriophyid genus and species, tentatively placed in the Tegonotini, namely *Eriomacrotergum flechtmanni* **n. gen. n. sp.**, is described from the Amazonian fruit tree cupuaçu *Theobroma grandiflorum* (Willd. Ex Spreng.) K. Schum. (Malvaceae), collected in northern Brazil. The new taxon presents a peculiar morphology in having a large opisthosomal plate and a very reduced prodorsal shield, with ocellar-like structures and scapular setae displaced laterally. Discussion on the most remarkable taxonomic traits is presented as well as similarities of the new genus with other genera of Eriophyidae.

Key words: Taxonomy, Eriophyoidea, Phyllocoptinae, Tegonotini, Neotropical, Amazon

Introduction

The cupuaçu, *Theobroma grandiflorum* (Willd. Ex Spreng.) K. Schum. (Malvaceae), is an arboreal fruit tree considered to be a pre-Colombian crop plant which is still found wild in the eastern Brazilian Amazonia. It has been considered as one of the most promising fruits among the rich Amazonian flora and is among the few domesticated fruit species native to this ecosystem (Giacometti 1998; Cavalcante 2010). This fruit tree, related to cacao, has a white creamy-fleshed pulp uniquely fragrant and flavored (Scott-Thomas 2009). Its pulp is of high commercial value and is used in desserts, juices and sweets. In Brazil its production is concentrated in the northern region in the States of Pará, Amazonas, Rondônia and Acre (Fraife Filho *et al.* 2009).

Studies on eriophyoid mites from native plants in the Amazonia are extremely scarce considering it is one of the richest ecosystems on earth. Most studies have been conducted on palm trees (Navia & Flechtmann 2005; Reis *et al*. 2012; Reis *et al*. 2014) or on species of *Hevea* (Euphorbiaceae) (Feres 2001). Other groups of plants are still unexplored, such species of *Theobroma* (Malvaceae).

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[1] Rodrigues, D.F.S., Navia, D., Oliveira, A.R. & Ferragut, F. (2016) *Eriomacrotergum flechtmanni* n. gen. n. sp. (Trombidiformes: Eriophyidae), a new eriophyoid mite from the cupuaçu tree, *Theobroma grandiflorum*, from northern Brazil. *Zootaxa*, 4072, 465–476. http://dx.doi.org/10.11646/zootaxa.4072. 4.5.

Three eriophyoid mite species associated with *Theobroma* have been reported: *Aceria reyesi* (Nuzzaci) and *Floracarus theobromae* Keifer, from *Theobroma cacao* L. in Venezuela and Brazil (Nuzzaci 1973; Keifer 1973; Abreu & Soria 1979); and *Gymnaceria cupuassu* Oliveira, Rodrigues & Flechtmann, from *T. grandiflorum* in Brazil (Oliveira *et al*. 2012). This last species was described from cultivated cupuaçu trees in the northeast region of the State of Bahia.

In this paper a new genus and a new species of eriophyid mite, tentatively placed in the Phyllocoptinae, Tegonotini, is described from adults and immatures collected on cupuaçu leaves in the state of Amazonas, Brazil. The new taxon, namely *Eriomacrotergum flechtmanni* **n. gen. n. sp.**, presents a peculiar morphology and its most remarkable traits are discussed. Similarities of the new genus with other Eriophyidae genera are pointed out as well as its uncertain phylogenetic relationships in the family.

Materials and methods

Cupuaçu leaves were collected in the municipality of Novo Airão, in the east of the State of Amazonas, Northern Region, Brazil. Material was collected under the Brazilian government official authorization conceded to D. Navia by Chico Mendes Institute for Biodiversity Conservation, Ministry of Environment (permanent collection permit No. 20650-1).

Mites were collected by examining leaves with a stereomicroscope, a Leica EZ4 (40x), and stored in 70% ethyl alcohol. Eriophyoid mites were mounted in modified Berlese's medium (Amrine & Manson 1996) and heated at 55 ºC for 14 days. Slide-mounted specimens were studied using a phase-contrast microscope Leica DM2500 at 1,500× magnification (oil immersion). Drawings were made using a drawing tube under the same microscope and magnification and then scanned, digitized and edited using the Adobe Illustrator CS6 program. Micrographs were obtained using two digital systems consisting of: a phase and differential interference contrast microscope (Nikon Eclipse 80i) connected to a digital camera (Nikon DS-Ri 1,12.7 mega pixels) using the NIS Elements software (Nikon); or a phase and differential interference contrast microscope (Leica DM2500) connected to a digital camera (Leica DFC 310FX, 1.4 mega pixels) using the Leica Application Suite, v.4.5.0 and Combine ZP software.

Morphology and nomenclature follow Lindquist (1996), as presented by Amrine *et al.* (2003). Systematic classification follows that of Amrine *et al*. (2003). Terminology of the internal female genital apparatus follows Chetverikov (2014) and Chetverikov *et al*. (2014).

Measurements are given in micrometers (µm) and, unless stated otherwise, refer to the length of the structure. In the description of the female, each measurement of the holotype precedes the corresponding range for the paratypes, in parentheses, when measurements/counts differ. For the male and nymphs, when more than one specimen was available, the ranges of particular characters are provided. No larvae were available for study. The count of ventral opisthosomal semiannuli started from the rear margin of the genitalia for adults and from the proximal setae on coxisternum III (*3a*) for immatures. The dorsal opisthosomal annuli count started from the mid prodorsal shield rear margin. Measurements were conducted according to de Lillo *et al*. (2010) except for the following: 1) the body length, which was measured from the tip of the frontal lobe to the end of the anal lobe, less pedipalps; 2) the distance between the inner base of the scapular setae (*sc*) tubercles, not between the *sc* setae distance; 3) empodium length, which includes its basal portion inserted into the tarsus. Some measurements were not presented for the holotype or for the nymphs due to improper position, difficult visualization, or reduced size.

Taxonomy

Family: Eriophyidae Nalepa

Subfamily: Phyllocoptinae Nalepa

Tribe: Tegonotini Bagdasarian

***Eriomacrotergum* n. gen. Rodrigues, Navia & Oliveira**

(Figs.1–6)

Type species: *Eriomacrotergum flechtmanni* **n. sp.**

Diagnosis. Reduced prodorsal shield with short narrow-based frontal lobe, not emarginated; scapular setae (*sc*) laterally displaced, on posterolateral shield margin; *sc* tubercles with perpendicular bases in relation to dorsal annuli, directing setae dorsally upwards or laterally. Dorsal opisthosoma with first annuli narrow followed by broad annuli; first broad annulus forming an opisthosomal plate, elevated in relation to prodorsal shield and gnathosoma, without lateral projections. Opisthosoma abruptly downcurved at level of setae *f*. Margins of broad dorsal annuli enlarged, laterally rounded. All coxal, lateral and ventral setae present. Paraxial tibial setae (*l'*) absent on both legs. Anterior genital apodeme T-shaped, with shortened longitudinal bridge; long axis of spermathecae directed laterad.

Remarks. According to the classification of Amrine *et al.* (2003) *Eriomacrotergum* is placed in the Tegonotini because of: its entire empodium; presence of scapular setae and tubercles; and opisthosoma presenting lateral lobes and plate.

Eriomacrotergum **n. gen.** is similar to the tegonotine genera *Scolocenus* Keifer, 1962; *Dicrothrix* Keifer, 1966; *Phyllocoptacus* Mohanasundaram, 1984; *Hemiscolocenus* Mohanasundaram, 1986; *Tumoris* Huang, 2001; *Glabrisceles* Navia & Flechtmann, 2002; and *Asetidicrothrix* Wei, Wang & Qin, 2009 in the presence of an opisthosomal plate. However it differs from all these genera in: the reduced prodorsal shield and frontal lobe (in these genera the prodorsal shield is not reduced and the frontal lobe is broad-based, covering at least the palpcoxal base); the presence of a narrow first dorsal annulus anterior to the opisthosomal plate (in these genera the opisthosomal plate is situated just posterior to the prodorsal shield); and in the *sc* seta near the rear shield margin (placed ahead of rear shield margin in other genera). The new genus is also similar to *Paniculatus* Boczek and Chandrapatya, 2000 in the *sc* setae laterally displaced on the rear shield margin. However it can be distinguished from this genus by the reduced prodorsal shield (not reduced in *Paniculatus*) and the opisthosomal plate (lacking in *Paniculatus*).

The new genus also presents some traits similar to genera not belonging to the Tegonotini. It is similar to *Ashieldophyes* Mohanasundaram, 1984 (Ashieldophyinae) in the reduced prodorsal shield; however the new genus can be distinguished from this by the well developed *sc* setae tubercles and the ventral setae *d* and *e* (lacking in *Ashieldophyes*). It is similar to *Tumescoptes* Keifer, 1939 (Phyllocoptinae: Acaricalini) in the dorsal opisthosoma with narrow annuli anterior to the opisthosomal plate; however, in addition to the divided empodium (which characterize the Acaricalini), it differs from the new genus in the: prodorsal shield size (well developed in *Tumescoptes*, reduced in the new genus); and position of the *sc* setae and tubercles (centrad, anterior to rear shield margin in *Tumescoptes*; laterally displaced, on the rear shield margin in the new genus). It is similar to *Neooxycenus* Abou-Awad, 1981 (Phyllocoptinae: Anthocoptini) in the *sc* setae laterally displaced on the rear shield margin, but differs from this by the reduced prodorsal shield (not reduced in *Neooxycenus*) and opisthosomal plate (lacking in *Neooxycenus*).

The female internal genitalia in *Eriomacrotergum* **n. gen.** are not similar to those described from other Tegonotini genera (see Amrine *et al*. 2003). Instead, its shape resembles those of the Cecidophyinae; the anterior genital apodeme of the new genus looks like a T-shaped structure and it is most likely a plate situated in a vertical plane, with a shortened

longitudinal bridge; and the long axis of the spermathecae are directed laterad; while in most of the tegonotine genera the genital apodeme is trapezoidal, as e.g. in *Acalox* Keifer, 1975; *Dicrothrix* Keifer, 1966; *Oxycenus* Keifer, 1961; or *Tegonotus*, Nalepa, 1890. However, the new genus differs from cecidophyine genera in the most important trait of this subfamily: the gonopore and external associated genitalic structures. In the new genus, the female genitalia are not appressed to the coxae (which are not distinctly separated) and do not project remarkably from the venter as in the cecidophyine.

Etymology. The generic name is composed of *Erio*, prefix of Eriophyidae, the family to which the new taxon belongs; plus the Ancient Greek term *macro* for "large" and the Latin term *tergum* for "back", regarding the first broad dorsal annulus expanded, forming an opisthosomal plate. The gender is neuter.

***Eriomacrotergum flechtmanni* n. sp. Rodrigues, Navia & Oliveira**
(Figs. 1–6)

FEMALE (n=6). Body fusiform, yellow-orange, 128 (120–131), 41 (38–45) wide, which can be uniformly covered by wax plates. **Gnathosoma** projecting obliquely downwards; pedipalp coxal seta (*ep*) 2 (2); dorsal pedipalp genual seta (*d*) 4 (4–5), simple; subapical pedipalp tarsal seta (*v*) 2 (1–2); cheliceral stylets 10 (10–13). **Prodorsum** downcurved. **Prodorsal shield** reduced, around one tenth (1/10) of body length, 12 (9–12), 27 (23–28) wide, trapezoid; frontal lobe subtriangular, short 3 (3), narrow-based, apically rounded; ornamental pattern visible in some specimens, consisting of median lines curved basally and laterally extended, anterolateral areas punctuated by fine granules, ordered in diagonal rows; tubercles and scapular seta (*sc*) on posterolateral area**,** near rear shield margin, *sc* 15 (15–18), laterally displaced, tubercles 21 (21–22) apart; *sc* tubercles subcylindrical with perpendicular bases in relation to dorsal annuli, directing setae dorsally upwards or laterally**;** ocellar-like structures in laterad area, outer than *sc* tubercles. **Legs**, paraxial, unguinal, tarsal setae (*u'*) not seen on legs. **Leg I** 17 (16–18); femur 5 (5–6), basiventral femoral seta (*bv*) 6 (4–6); genu 4 (3–4), antaxial genual seta (*l''*) 16 (14–17); tibia 4 (3–4), *l'* absent; tarsus 5 (4–5), antaxial fastigial tarsal seta (*ft''*) 11 (11–15), paraxial fastigial tarsal seta (*ft'*) 3 (3–4), *u'* apparently absent, tarsal solenidion (*ω*) 6 (6–7), thin, uniform thickness; empodium 4 (4–5), undivided, symmetrical, 5-rayed, each ray (except first) with sub-ray at extremity. **Leg II** 16 (15–16); femur 5 (5–6), *bv* 4 (4–5); genu 3 (3), *l''* 9 (9–15); tibia 3 (3–4); tarsus 5 (4–5), *ft''* 14 (11–14),

ft' 2 (2–3), *u'* apparently absent, *ω* 6 (6–7); empodium same as leg I, 4 (4–5), 5-rayed. **Coxisternal region**, mostly smooth (ornamentation not observed). Anterolateral seta on coxisternum I (*1b*) 8 (8), 8 (8–9) apart; proximal seta on coxisternum I (*1a*) 10 (9–10), 6 (6–7) apart; proximal seta on coxisternum II (*2a*) 13 (13–16), 14 (14–20) apart; prosternal apodeme 6 (6); coxigenital region with 3 (3) semiannuli, not microtuberculated. **External genitalia** 8 (5–9), 15 (7–15) wide, genital coverflap subtriangular, smooth; proximal seta on coxisternum III (*3a*) 7 (5–7). **Internal genitalia**, anterior genital apodeme T-shaped, spermathecae spherical or slightly elongated and thus ovoid-like, long axis of spermathecae directed laterad (average angle of 90º between spermatheca and longitudinal bridge); spermathecal duct short, ~ 2 long, tube- or funnel-like; oblique apodeme distinct, forming flattened V-like figure; longitudinal bridge ~ 5 long, postspermathecal part of longitudinal bridge reduced. **Opisthosoma** with 4 (4–5) first dorsal annuli narrow, with elongated thin microtubercles, in lateral view perpendicular to prodorsal shield; 12 (12–13) broad dorsal annuli posterior to narrow annuli; first broad annulus expanded, at least three times longer than others, forming an opisthosomal plate, elevated in relation to prodorsal shield; 34 (30–40) ventral annuli; plus 8 (7–11) annuli on posterior opisthosoma, which is abruptly downcurved around level of setae *f*. Dorsal broad annuli smooth, ventral annuli with elongated microtubercles near rear annuli margin. Lateral seta *c2* 13 (12–14), on ventral annulus 5 (3–6); ventral seta *d* 24 (22–26), on annulus 12 (9–14), 30 (25–32) apart; ventral seta *e* 15 (13–17), on annulus 22 (21–28), 17 (17–20) apart; ventral seta *f* 11 (9–11), on 4th annulus (2–8) from caudal lobes, 8 (8–9) apart; caudal seta *h2* 20 (18–27); accessory seta *h1* 2 (2–3).

MALE (n=3). Most males smaller than female (one as long as a female), body 118–122, 37–38 wide. **Gnathosoma,** pedipalp *ep* 2, *d* 4, *v* 1–2, cheliceral stylets 10–14. **Prodorsal shield** as in female 12, 28 wide; sc 13–15, 20 apart, frontal lobe 3. **Coxisternal region.** *1b* 6–8, 7–8 apart; *1a* 7–10, 6–7 apart; *2a* 14–18, 14–19 apart, prosternal apodeme 6–7; coxigenital region with 3 semiannuli. **Legs** as in female. Leg **I** 17–20; femur 5–6, *bv* 4; genu 3–5, *l''* 15–16; tibia 4–5; tarsus 5, *ft''* 7–9, *ft'* 2, *u'* apparently absent, *ω* 6; empodium 4–5, 5-rayed. Legs **II** 17–18; femur 5, *bv* 3–4; genu 4, *l''* 7–9; tibia 3–5; tarsus 4–5, *ft''* 11–14, *ft'* 3, *u'* apparently absent, *ω* 6; empodium 4–5, 5-rayed. **External genitalia.** 6–8, 11–12 wide, area flanked by *3a* and posterior to gonopore finely granulated; eugenital setae not observed; *3a* 5. **Opisthosoma** as in female, with 4–5 narrow annuli between prodorsal shield rear margin and first broad opisthosomal annulus, followed by 12–13 broad dorsal annuli, with 36–42 ventral annuli; plus 7 annuli of posterior opisthosoma with minute microtubercles. *c2* 9–10, on

ventral annulus 1–3; *d* 21–26, on annulus 7–11, 24–26 apart; *e* 14–17, on annulus 21–27, 16–18 apart. *f* 9–10, on annulus 2–5, 8–9 apart. *h2* 24–26; *h1* 1–2.

NYMPH (n=2). Body slightly fusiform, 90–108, 27–36 wide. **Gnathosoma** chelicera 8–12. **Prodorsal shield** not remarkably reduced as in adults, subquadrangular, frontal lobe and ornamentation not seen; 10–11, 20 wide; *sc* tubercles and seta present, tubercles elongated (almost subcylindrical), **on latero-posterior area, near rear shield margin**, *sc* 6–7, tubercles 14–16 apart. **Coxisternal region.** *1b* not seen; *1a* 3, 4 apart; 2*a* 8–11, 8 apart; *3a* 2, on ventral semiannulus 7. **Legs.** Leg **I** 10; femur 3, *bv* 2; genu 2, *l″* 8; tibia 2, *l′* absent; tarsus 3, *ft″* 5, *u′* and *ft′* not seen, *ω* 5, as in adults; empodium 3, 5-rayed. Leg **II** 10; femur 3, *bv* 2–3; genu 2, *l″* 8; tibia 2; tarsus 3, *ft″* 5, *u′* and *ft′* not seen, *ω* 5; empodium 2–3, 5-rayed. **Opisthosoma** with dorso-ventral differentiation, except for telosoma annuli; dorsal annuli with small microtubercles on anterior margin, ventral annuli with slightly elongated microtubercles on rear margin; dorsal annuli at same level as prodorsal shield, evenly arched; 18 dorsal annuli, first four narrowest (probably corresponding to first narrow annulus in adults); other 14 dorsal annuli broader (probably corresponding to broad annuli in adults), 30–31 ventral annuli posterior to seta *3a;* plus 7 annuli on posterior opisthosoma. All lateral and ventral setae present; *c2* 8, on annulus 1; *d* 14–16, on annulus 9–10, 17–19 apart; *e* 14–15, on annulus 17–19, 12–14 apart; *f* 8–10, on annulus 3, 6–8 apart; *h2* 12–15; *h1* 1; *c1* absent.

Type material. Fourteen specimens collected from *Theobroma grandiflorum* (Malvaceae) leaves, municipality of Novo Airão, Amazonas, Brazil (02° 37' 17" S, 60° 56' 39" W), on 5 September 2013, coll. Denise Navia & Francisco Ferragut. Female holotype and 6 paratypes (3 females, 1 male and 2 nymphs) on one slide deposited in the Acarological collection of Universidade Estadual de Santa Cruz (UESC), Ilhéus, Bahia, Brazil. Three paratypes (2 females and 1 male) in one slide deposited in the Acarological collection at Embrapa Recursos Genéticos e Biotecnologia. Four paratypes (3 females and 1 male) on two slides deposited in the Acarological collection of the Departamento de Entomologia e Acarologia, Universidade de São Paulo, Escola Superior de Agricultura ‘Luiz de Queiroz’ (ESALQ), Piracicaba, São Paulo, Brazil.

Host plant. *Theobroma grandiflorum* (Willd. Ex Spreng.) K. Schum. (Malvaceae).

Relation to host. A vagrant species found on young leaves, no symptoms observed.

Etymology. The new species exhibits an unusual and peculiar morphology among eriophyid mites. The authors would like to highlight this characteristic naming it in honor to Prof. Carlos Holger Wenzel Flechtmann, acarologist well-known by his overwhelming

(strong) personality, for his contribution to the knowledge of Eriophyoidea, and formation of a new generation of mite taxonomists in Brazil. The specific name flechtmanni is derived from the last surname of the honored professor in the genitive possessive case.

Discussion

At first glance, particularly in lateral view, the opisthosomal plate of *E. flechtmanni* could be misinterpreted as a prodorsal shield since it is enlarged and elevated, and at the same level as the posterior opisthosoma, while the propodosoma and anterior opisthosoma are relatively reduced and downcurved. In a lateral view, the first narrow opisthosomal annuli, which are located between the prodorsal shield and opisthosomal plate, could be interpreted as striation (accordion-like folds) similar to those observed in some vagrant mites between the frontal lobe and gnathosomal base, when the frontal lobe is well developed and elevated in relation to the gnathosoma, e.g. in the *Dicrothrix anacardii* Keifer, 1966 and *Glabrisceles euterpis* Navia & Flechtmann, 2002 (Tegonotini). However *E. flechtmanni* instead presents a remarkably reduced prodorsal shield with setae *sc* laterally displaced and an enlarged opisthosomal plate. In a dorsal view of specimens without a wax-covered anterior idiosoma (Fig. 6B), narrow microtuberculated annuli are clearly observed between the prodorsal shield and the opisthosomal plate, ruling out the possibility of any striation anterior to the opisthosomal plate.

Further evidence for our interpretation of the prodorsal shield is obtained by observation of prodorsal structures on the prodorsal shield, i.e., the frontal lobe, *sc* setae and ocellar-like structures. The frontal lobe is small, narrow-based, subtriangular and can be clearly seen at the level of the gnathosomal base (Fig. 6A). The ocellar-like structures present on the latero-posterior propodosoma of the new taxon are known from several taxa, and are always on the posterior (e.g. *Palmiphytoptus oculatus* Navia & Flechtmann, 2002 and *Distaceria ommatos* Flechtmann, Amrine & Stasny, 1995) or on the anterolateral margins (e.g. *Colomerus novahebridensis* Keifer, 1977) of the prodorsal shield. The scapular setae of the new taxon are placed on the rear shield margin, laterally displaced, and the tubercle bases are mesad the ocellar-like structures.

The ontogenetic development of eriophyoid mites is poorly known and for most taxa immature stages are not described. We present the following evidence to support co-specificity between adults and nymphs: two similar nymphs were found among the fourteen studied specimens; just one eriophyoid mite species was found on the host plant; and similar

morphological traits were related between adults and nymphs. The main morphological similarities observed between adults and nymphs were: *sc* setae position, shape of *sc* setae tubercles, dorso-ventral differentiation, and the first dorsal opisthosomal annuli narrower than posterior ones. Although the prodorsal shield is not remarkably reduced in the nymph, setae *sc* are laterally displaced and the *sc* tubercles are cylindrical, and with bases perpendicular to dorsal annuli, as observed in adults. In addition, despite differences in dorsal opisthosomal annuli in adults and nymphs, it was possible relate them; nymphs present the three first opisthosomal annuli narrower than others and these annuli probably correspond to the first narrow annuli observed between the prodorsal shield and opisthosomal plate in adults. Counting of annuli suggest that the 3rd, 4th and 5th annuli of the nymph were fused, constituting the adult opisthosomal plate.

Some of the morphological traits observed in the new taxon have also been observed on eriophyoid genera not belonging to Tegonotini, not even to the Phyllocoptinae subfamily, and probably refers to homoplasic characters. As detailed in the *Remarks* we consider the following unusual character states homoplastic: a reduced prodorsal shield; laterally displaced *sc* setae; and ocellar-like structures on the prodorsal shield. Therefore the most remarkable traits that distinguish the new genus probably are not phylogenetically useful. Female internal genitalia has been considered as useful and phylogenetically informative character to Eriophyoidea (Chetverikov *et al.* 2015), however it has not yet been characterized for all groups in the superfamily. In *Eriomacrotergum*, the shape of the female internal genitalia most resembles those of the Cecidophyinae, however the position of gonopore and associated external structures is similar to other eriophyids (not cecidophyines). In parallel to observations by Chetverikov *et al*. (2015) (see pg. 237, remark "Group #2,''abberant type'' of internal genitalia) this might indicate a homoplastic nature of genitalic characters, as observed for traits mentioned above. Considering the combination of remarkable morphological character states from different subfamilies in *Eriomacrotergum* (yet possessing the character states for the Tegonotini, sensu Amrine *et al.* 2003), we encourage phylogenetic studies on this mite, including molecular data, to resolve its position.

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To Philipp Chetverikov for valuable suggestions and mainly for inciting further discussion on the new genus morphology and taxonomic placement during the manuscript review process.

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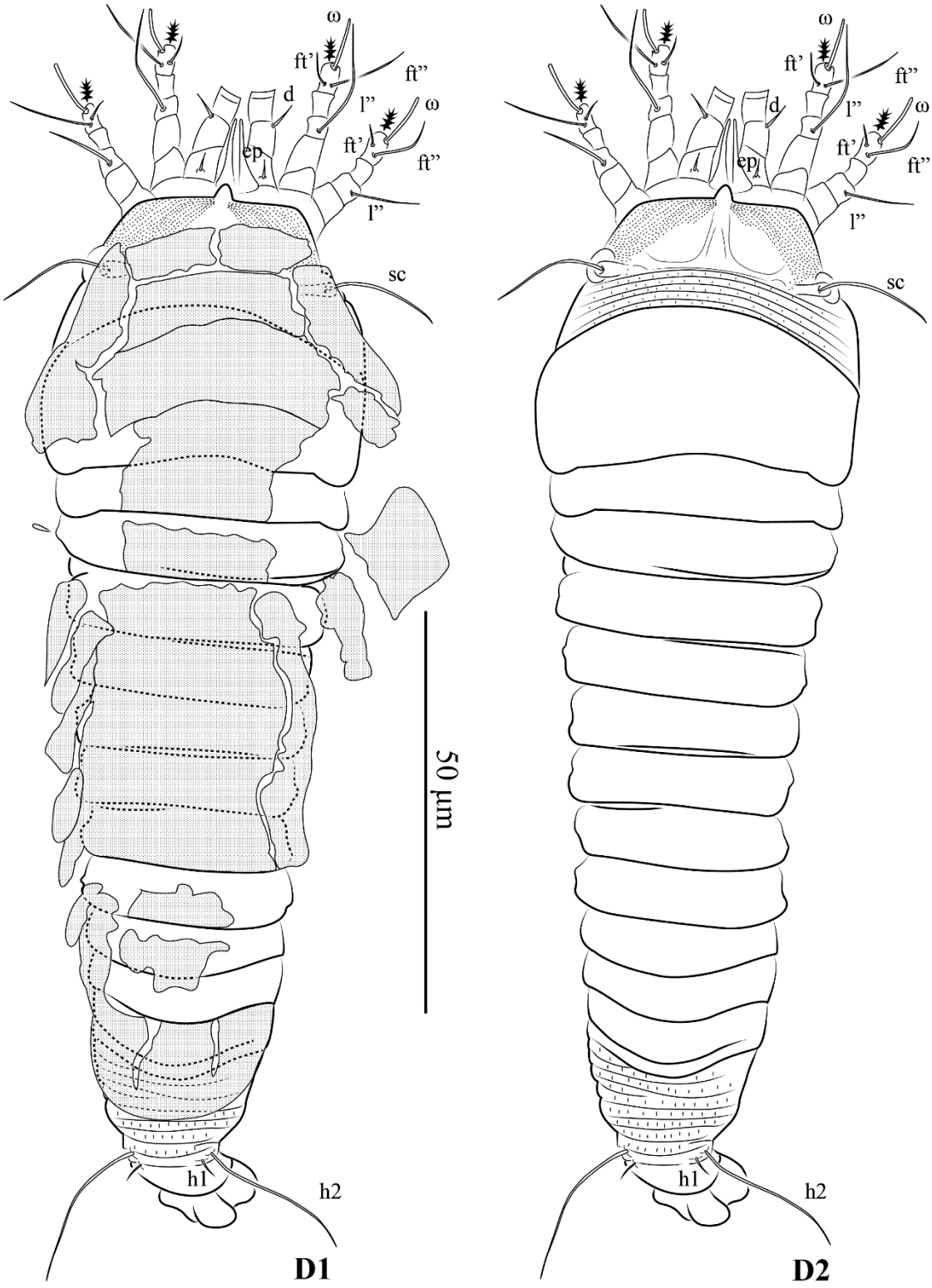

FIGURE 1. *Eriomacrotergum flechtmanni* **n. gen. et n. sp.**, female dorsal habitus. **D1**. With wax; **D2**. Without wax.

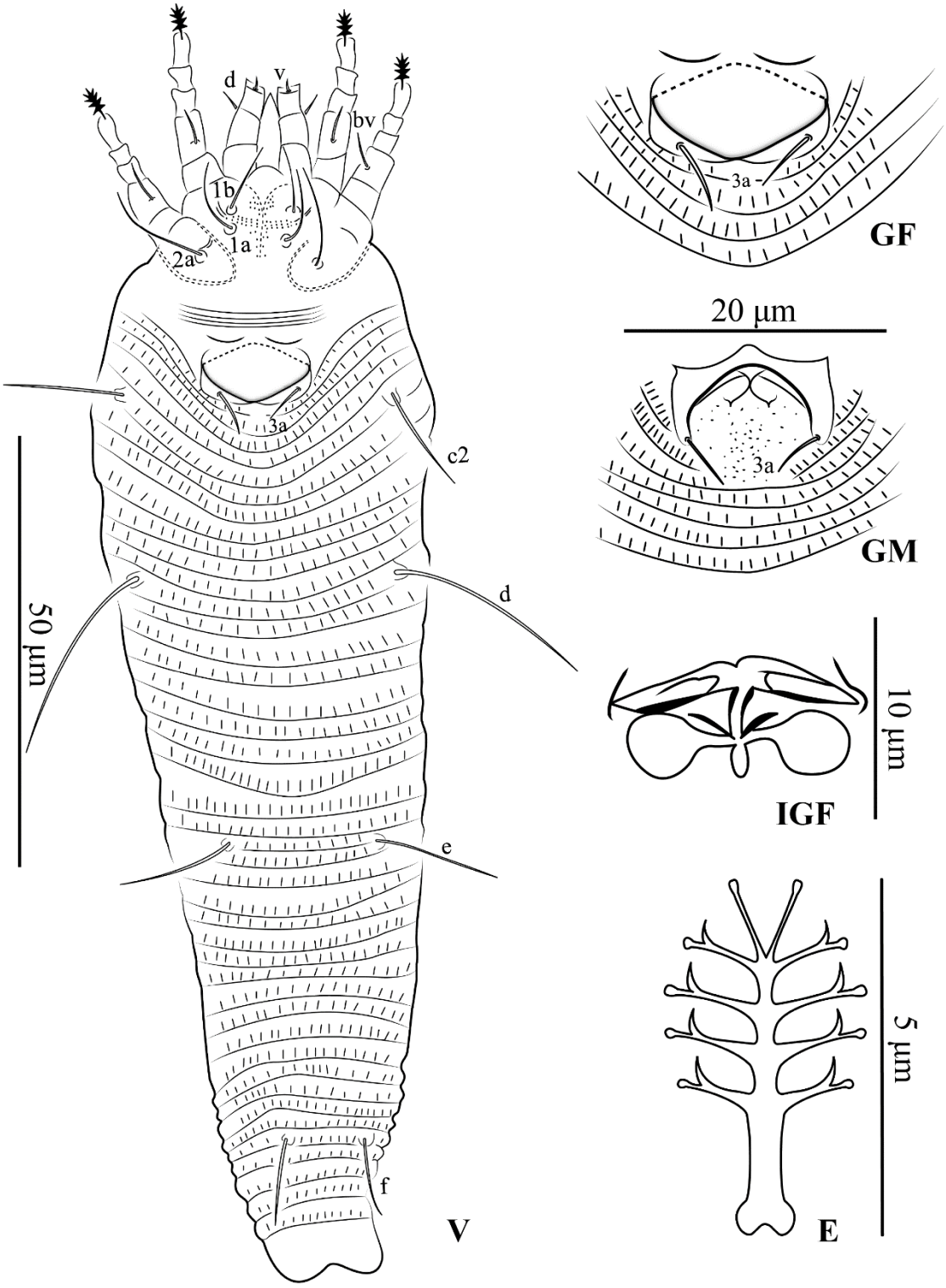

FIGURE 2. *Eriomacrotergum flechtmanni* **n. gen. et n. sp. V**. Ventral habitus, female; **GF**. External genitalia, female; **GM**. External genitalia, male; **IGF**. Internal genitalia, female; **E**. Ventral view of empodium, female (enlarged).

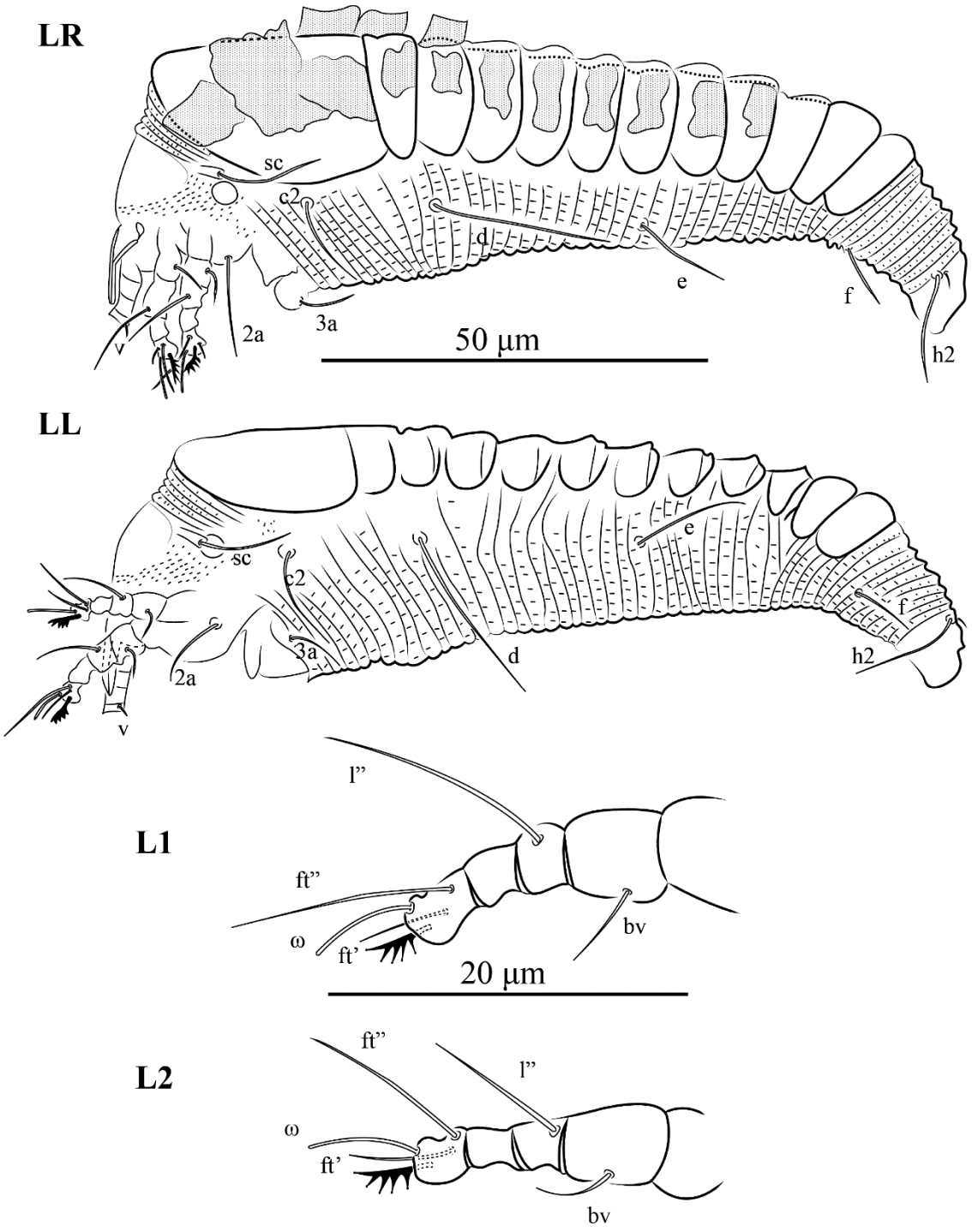

FIGURE 3. *Eriomacrotergum flechtmanni* **n. gen. et n. sp.**, female. **LR**. Lateral right habitus; **LL**. Lateral left habitus; **L1**. Leg I, antaxial view; **L2**. Leg II, antaxial view.

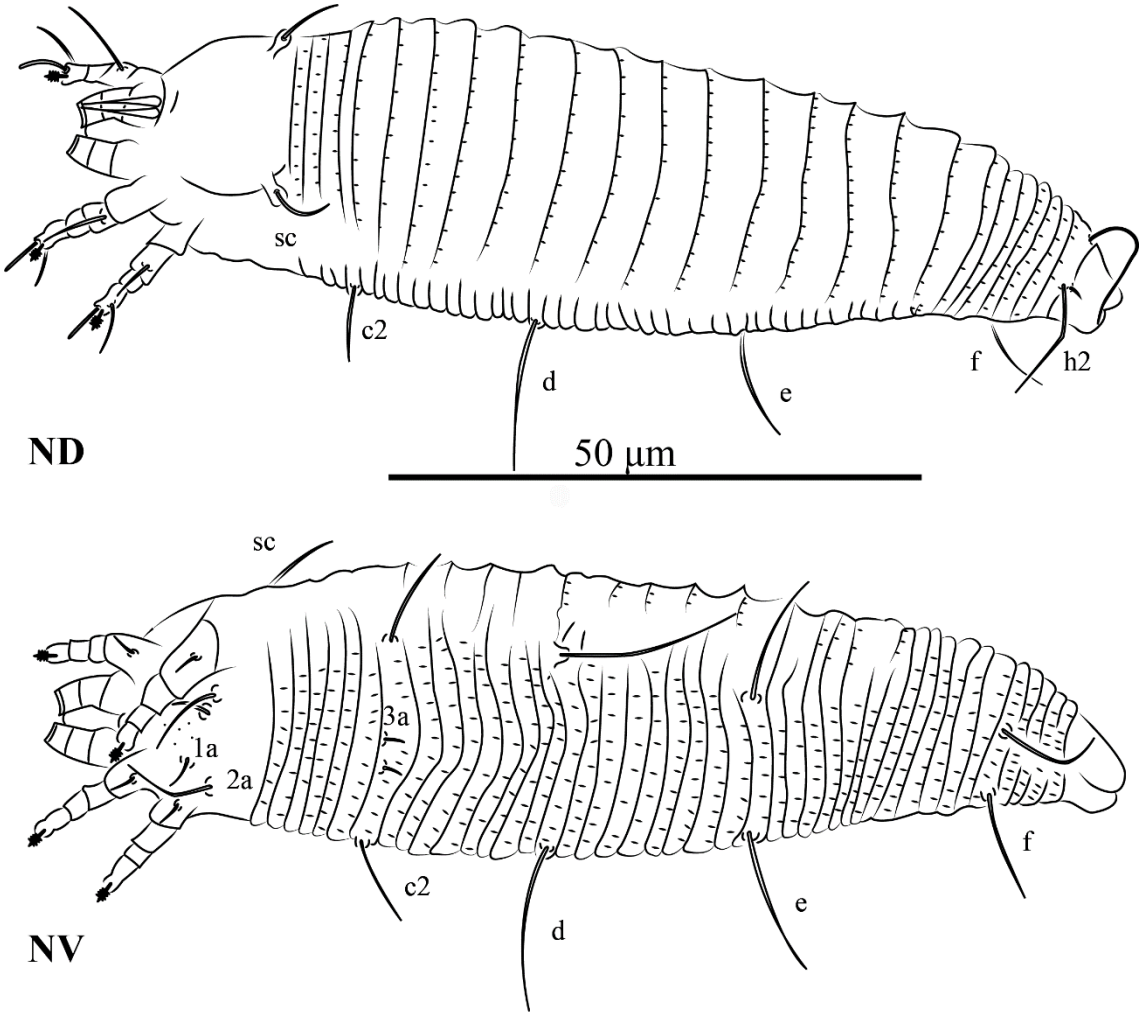

FIGURE 4. *Eriomacrotergum flechtmanni* **n. gen. et n. sp.**, nymph. **ND**. Dorsal habitus; **NV**. Ventral habitus. Some setae from gnathosoma- pedipalp coxal seta (*ep*) and dorsal pedipalp genual seta (*d*) - and from legs- paraxial fastigial tarsal seta (*ft'*) and anterolateral seta on coxisternum I (*1b*) - could not be clearly visualized, probably due to its reduced size.

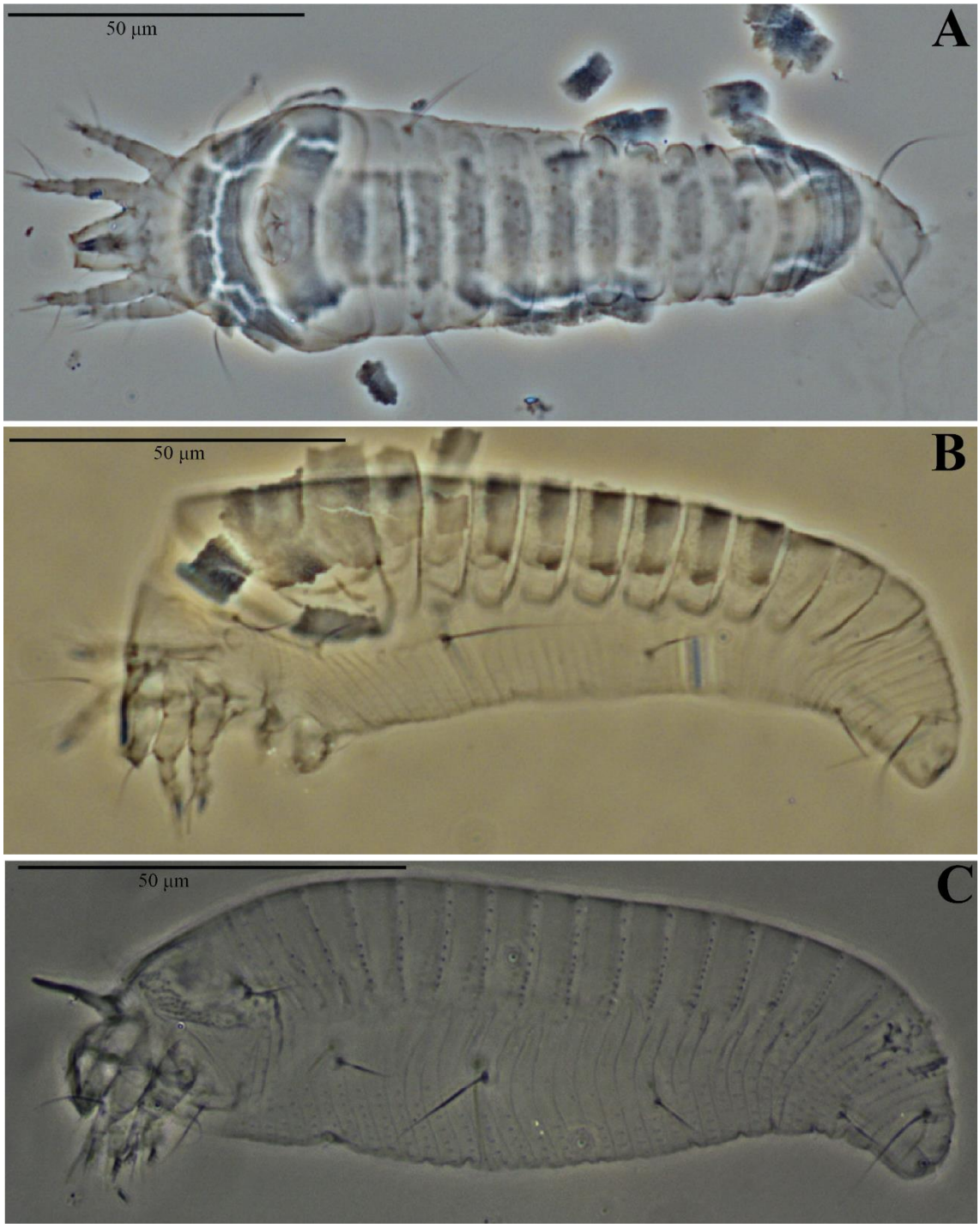

FIGURE 5. *Eriomacrotergum flechtmanni* **n. gen. et n. sp. A**. Dorsal habitus, female; **B.** Lateral habitus, female; **C.** Lateral habitus, nymph.

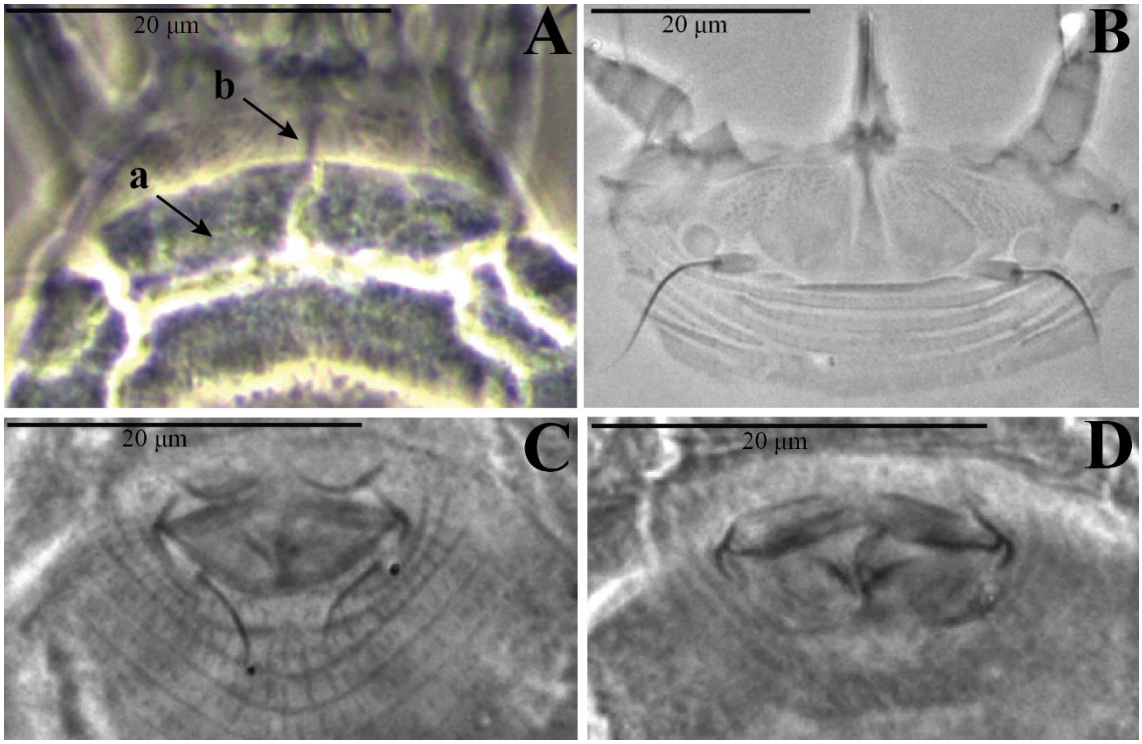

FIGURE 6. *Eriomacrotergum flechtmanni* **n. gen. et n. sp. A**. Propodosoma, female, enlarged dorsal view; anterior idiosoma is wax covered, preventing observation of annuli. Notation: a – wax, b – anterior portion of prodorsal shield; **B**. Prodorsal shield, enlarged dorsal view; **C.** External genitalia, female; **D.** Internal genitalia, female.

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4 ARTIGO FORMATADO PARA SUBMISSÃO À ZOOTAXA

Two new eriophyoid mite species (Acari: Trombidiformes) from the cocoa tree, *Theobroma cacao* L. (Malvaceae), from South and Central America, and a key for *Theobroma* associated species

Abstract

Two new eriophyoid mite species are described from the cocoa tree, *Theobroma cacao* L. (Malvaceae) – a Diptilomiopidae in the genus *Davisella* Flechtmann, Amrine & Stasny, from Brazil, and an Eriophyidae in the genus *Tetra* Keifer, from Costa Rica. The new *Davisella* species presents an enlarged subcylindrical tubercle bearing pedipalp genual seta *d*, a very interesting structure not yet observed on eriophyoid mites. Its functional morphology is discussed. Summarized information on *Davisella* species and its main diagnostic traits is presented. The new *Tetra* species is the second in this genus described from the Malvaceae family. A closer look on *Shevtchenkella biseta* (Nalepa), described from the Malvaceae *Hibiscus rosa-sinensis* L., bring to light its taxonomic assignement to the Phytoptidae, Sierraphytoptinae and its possible synonym. In addition a dichotomous key to distinguishing the six eriophyoid species currently associated with *Theobroma* plants is presented.

Key words: Phyllocoptinae, Diptilomiopinae, Neotropical, plant quarantine, gnathosoma interlocking apparatus, *Shevtchenkella biseta* (Nalepa).

Introduction

The cocoa tree, *Theobroma cacao* L. (Malvaceae, previously placed in Sterculiaceae), is originated from the tropical regions of Central America and Amazon (Cuenca & Nazario 2004; Müller & Valle 2012). As a typical tropical plant, it is very sensitive to low temperatures, and most commercial plantations are in the tropics (Müller & Valle 2012). The largest world producers of cocoa are Ivory Coast, Ghana, Indonesia, Nigeria, Cameroon, Brazil and Ecuador (Midlej & Santos 2012). It is a plant with great economic interest, as their seeds, after dried and processed, will form the basis of chocolates and derivatives, and the pulp is utilized in the production of juices, liquors, sweets and cocoa butter (Cohen et al. 2003; Sodré 2007).

Four eriophyoid species associated with plants of the genus *Theobroma* are currently known: *Gymnaceria cupuassu* Oliveira, Rodrigues & Flechtmann, 2012 and *Eriomacrotergum flechtmanni* Rodrigues, Navia & Oliveira, 2016, from *T. grandiflorum* (Willd. Ex Spreng.) K. Schum. in Brazil (Oliveira *et al*. 2012, Rodrigues *et al.* 2016), and *Aceria reyesi* (Nuzzaci, 1973) and *Floracarus theobromae* Keifer,1973 from *T. cacao* in Venezuela and Brazil (Keifer 1973; Nuzzaci 1973; Abreu & Soria 1979). *Aceria reyesi* was reported causing severe damage in cocoa trees in Venezuela (Abreu & Soria 1979) and has been considered an emergent agricultural pest in the Brazilian states of Bahia and Rondônia (Oliveira & Navia 2013; Trevisan *et al*. 2010).

In this paper we describe two new species of eriophyoid mites associated with the cocoa tree: *Davisella* **n. sp.** Rodrigues, Navia & Oliveira (Diptilomiopidae: Diptilomiopinae) from the Amazonian region in Brazil, and *Tetra* **n. sp.** Rodrigues, Navia & Oliveira (Eriophyidae: Phyllocoptinae), from Costa Rica, intercepted at a plant quarantine station in Brazil.

The new *Davisella* species is the eighth species to be described in this genus. All *Davisella* species were described from the Americas [except *D. haramotonis* (Keifer, 1974), described from Hawaii], and are associated with dicotyledon host plants [except for *D. palmea* (Flechtmann, 1998), described from a palm tree] (Davis 1964; Keifer 1969; Keifer 1974; Flechtmann 1995; Flechtmann 1998; Flechtmann 1999; Reis *et al.* 2010). No *Davisella* species have been reported from Malvaceae or Sterculiaceae plants. Host plants, type localities and main morphological traits to distinguishing *Davisella* species are summarized. An original structure in the pedipalp genu was observed in the *Davisella* species and its possible function is discussed.

The genus *Tetra* Keifer, 1944 is specious, currently composed by 137 species (de Lillo & Amrine 2011; Wang & Huang 2011; Li, Xue & Hong, 2012; Xue *et al*. 2013; Ballari *et al*. 2014; Li *et al*. 2014; Han *et al*. 2015; Rajput *et al*. 2015), four of them described from the Neotropical region– *Tetra tuttlei* Keifer, 1975, from *Solidago sparsifolia* A. Gray (Compositae), from Mexico; *Tetra striata* Navia, 1999, from *Matisia cordata* (Humb. & Bonpl.) Visch. (Bombacaceae), from Colombia; *Tetra indiciva* Flechtmann, 2009, from *Murraya paniculata* (L.) Jack. (Rutaceae), from Brazil; and *Tetra gibbosa* Flechtmann, 2014, from *Solanum sisymbrifolium* Lam. (Solanaceae), from Argentina (in Ballari *et al.* 2014). Only one species in this genus has been reported associated with Malvaceae host plants- *Tetra coimbatorensis* Mohanasundaram, 1994, described from *Grewia* sp. (previously classified in

the Tiliaceae family), from Tamil Nadu, India. No *Tetra* species have been described from Sterculiaceae plants.

In addition a dichotomous key to distinguishing the six eriophyoid species currently associated with *Theobroma* plants is presented.

Materials and methods

Cocoa tree leaves were collected at the municipality of Ouro Preto do Oeste, State of Rondônia, Northern Region, Brazil. Material was collected under the Brazilian government official authorization conceded to D. Navia by Chico Mendes Institute for Biodiversity Conservation, Ministry of Environment (permanent collection permit No. 20650-1). Mites were collected by direct inspection of leaves under a stereomicroscope Leica EZ4 (40x).

Cocoa tree seedlings originated from Costa Rica, introduced as germplasm in Brazil, were inspected at "Estação Quarentenária de Germoplasma Vegetal, Embrapa Recursos Genéticos e Biotecnologia," Brasília, Distrito Federal, Brazil. Mites were collected through a washing method using a granulometric sieving set and retained in the basal sieving with aperture of 28 µm diameter.

Specimens were stored in 70% ethyl alcohol and then mounted in modified Berlese's medium (Amrine & Manson 1996) and heated at 55 ºC for 14 days. Slide-mounted specimens were studied using a phase-contrast microscope Leica DM2500 at 1,500× magnification (oil immersion). Drawings were made using a drawing tube under the same microscope and magnification and then scanned, digitized and edited using the Adobe Illustrator CS6 program.

Morphology and nomenclature follow Lindquist (1996), as presented by Amrine *et al.* (2003). Systematic classification follows that of Amrine *et al*. (2003). Terminology of the internal female genital apparatus follows Chetverikov (2014) and Chetverikov *et al*. (2014). Measurements are given in micrometers (µm) and, unless stated otherwise, refer to the length of the structure. In the description of the female, each measurement of the holotype precedes the corresponding range for the paratypes, in parentheses, when measurements/counts differ. For the male and immature stages, when more than one specimen was available, the ranges of particular characters are provided. Immature stages were available only for the *Davisella* **n. sp.** The three studied immature specimens were similar, indicating they belong to the same developmental stage, however it was no possible to defining whether they refer to the larva or

nymph. Internal female genitalia could not be visualized for *Davisella* specimes; structures were not clearly visible in any of the dorso-ventral specimens. The count of ventral opisthosomal annuli started from the rear margin of the genitalia for adults and from the proximal setae on coxisternum III (*3a*) for immatures. The dorsal opisthosomal annuli count started from the mid prodorsal shield rear margin. Measurements were conducted according to de Lillo *et al*. (2010), except for the following: 1) the body length, which was measured from the tip of the frontal lobe to the end of the anal lobe, less pedipalps; 2) the distance between the inner base of the scapular setae (*sc*) tubercles, not between the *sc* setae distance; 3) empodium length, which includes its basal portion inserted into the tarsus. Some measurements were not presented for the holotype or for the nymphs due to improper position, difficult visualization, or reduced size.

Taxonomy

Family: Diptilomiopidae Keifer

Subfamily: Diptilomiopinae Keifer

***Davisella* n. sp. Rodrigues, Navia & Oliveira**

(Figs. 1–2)

Diagnosis. A *Davisella* species presenting three wax-like bearing ridges on dorsal opisthosoma, the median one extending along whole opisthosoma. Enlarged subcylindrical tubercle bearing pedipalp genual seta *d*. Prodorsal shield without tubercles; ocellar-like structures on lateral area; broad-based and rounded frontal lobe; median and admedian lines not joined by transversal lines. Each empodium branch 5-rayed. Coverflap basally with dashes and distally with 16-24 radiating longitudinal lines. Dorsal annuli lacking microtubercles.

FEMALE (n=10). Body fusiform, brown-yellowish, 134 (126–158), 76 (66–76) wide. **Gnathosoma** abruptly bent dowm in lateral view; pedipalp coxal seta (*ep*) 2 (2); dorsal pedipalp genual seta (*d*) 2 (2), thickened, curved, slightly hook-like, inserted in the apex of an enlarged cylindrical tubercle, around three times as longer as wide, which extends dorsally over pedipalp tibiae allowing seta *d* reach tarsal pedipalp base; subapical pedipalp tarsal seta (*v*) 1 (1); cheliceral stylets 48 (40–48); base of gnathosoma (anterior to prodorsal shield) finely microtuberculated. **Prodorsum** downcurved. **Prodorsal shield** 32 (30–34), 58 (53–58) wide, subelliptical; short, broad-based frontal lobe, apically curved. Shield design of faint

sinuous longitudinal lines (median, admedian, submedian and sublateral); median and admedian lines extending along 3/4 anterior shield, other lines shorter; ocellar-like structures in lateral area; tubercles and scapular setae (*sc*) absent. Posterior margin in a peaked sharp medially. **Legs** with all segments present; paraxial tibial seta (*l'*) and basiventral femoral seta (*bv*) lacking on both legs; genual seta (*l''*) absent on leg II. **Leg I** 26 (25–29); femur 13 (9–13); genu 3 (3–5), antaxial genual seta (*l''*) 38 (35–39); tibia 3 (3–5); tarsus 9 (8–9), antaxial fastigial tarsal seta (*ft''*) 22 (21–26), paraxial fastigial tarsal seta (*ft'*) 27 (25–30), unguinal seta (*u'*) angulated 5 (4–5), tarsal solenidion (*ω*) 5 (5); empodium 6 (6), divided, symmetrical, each branch 5-rayed and each ray bifurcated at base (except apical ray). **Leg II** 20 (20–23); femur 8 (8–10); genu 3 (3–4); tibia 4 (3–4); tarsus 6 (5–8), *ft''* 20 (16–20), *ft'* 5 (4–5), *ω* 5 (5); empodium 6 (6), 5-rayed similar as in leg I. **Coxisternal region** finely microtuberculated, mainly on coxa I**.** Anterolateral seta on coxisternum I (*1b*) 11 (7–11), 8 (6–10) apart; proximal seta on coxisternum I (*1a*) 13 (10–13), 8 (6–9), apart; proximal seta on coxisternum II (*2a*) 20 (16–20), 25 (21–26) apart; coxigenital region with 4 (4) annuli, finally microtuberculated. **External genitalia** 20 (16–23), 32 (28–33) wide, coverflap semicircular, basally with short irregular dashes or with granules and short dashes, apically with 23 (16–24) radiating longitudinal lines; proximal seta on coxisternum III (*3a*) 6 (5–8). **Internal genitalia**, not seen. **Opisthosoma** with three well defined dorsal ridges, wax-bearing; median ridge extending along whole opisthosoma (except for last 4-5 annuli) and lateal ridges extending along 3/4 anterior opisthosoma; 56 (54–64) dorsal annuli, not microtuberculated; 53 (47–56) ventral annuli with microtubercles on posterior margin, whose are more elongated in between ventral setae or on annuli posterior to ventral seta *f*. Lateral seta *c2* absent; ventral seta *d* 47 (42–48), on annulus 11 (9–12), 30 (25–34) apart; ventral seta *e* 29 (21–29), on annulus 26 (18–28), 19 (18–21) apart; ventral seta *f* 20 (16–20), on annulus 44 (37–46), 23 (14–23) apart; caudal seta *h2* 34 (28–34); accessory seta *h1* minute.

MALE (n=5). Most males smaller than female, body 120–132, 60–64 wide. **Gnathosoma** pedipalp as in female, *ep* 2, *d* 2, *v* 1, cheliceral stylets 34–39. **Prodorsal shield** as in female, 26–35, 52–54 wide. **Coxisternal region.** *1b* 5–9, 5–8 apart; *1a* 11–13, 6–13 apart; *2a* 10–15, 19–25 apart, 2 annuli. **Legs** as in female. Leg **I** 26–28; femur 9–11; genu 4–5, *l''* 34–38; tibia 4–6; tarsus 5, *ft''* 20–28, *ft'* 21–26, *u'* 4–5, *ω* 5; empodium 6, 5-rayed. Legs **II** 19–23; femur 7–10; genu 3; tibia 3–4; tarsus 6, *ft''* 13–16, *ft'* 4, *u'* 4–5, *ω* 4–6; empodium 5–6, 5-rayed. **External genitalia** 9–13, 21–24 wide; *3a* 6–8, granules not seen, eugenital setae seen on anterior median area. **Opisthosoma** as in female, with 53–58 dorsal annuli; 49–55

ventral annuli. *c2* absent; *d* 42–49, on annulus 10–14, 23–26 apart; *e* 28–32, on annulus 25–30, 14–16 apart; *f* 14, on annulus 39–47, 10–19 apart. *h2* 29–34; *h1* minute.

IMMATURE STAGE (n=3). Body slightly fusiform, 98–107, 49–58 wide. **Gnathosoma** Setae not seen, probably due to reduced size, cheliceral stylets 30–35; *d* minute bearing from an elongated cylindrical tubercle (as in adults). **Prodorsal shield** as in adults, except for ocellar-like structures whose were not seen, 29–32, 40 wide. **Coxisternal region.** *1b* 4, 6 apart, *1a* 5, 6 apart, 2*a* 9, 9–14 apart. **Legs** as in adults. Leg **I** 21–23; femur 9–10; genu 4, *l″* 23–28; tibia 3–4; tarsus 5–6, *ft″* 19, *ft′* 18–19, *u′ 4*, *ω* 4, as in adults; empodium 5, 5-rayed. Leg **II** 14–15; femur 5; genu 3; tibia 1–3; tarsus 4–5, *ft″* 11–13, *ft′* 4, *u′* 4, *ω* 4; empodium 4–5, 5-rayed. **Genitalia** absent, *3a* 3–4, on ventral annulus 9. **Opisthosoma** evenly curved **(**without dorsal ridges); 49–52 dorsal annuli, not microtuberculated, except for three longitudinal rows with small slightly elongated microtubercles (probably corresponding to the wax-bearing ridges observed in adults); 41–42 ventral annuli posterior to seta *3a*, with small, slightly elongated microtubercles. *c2* absent; *d* 13, on annulus 8–9, 18–21 apart; *e 8*–9, on annulus 17–19, 11–13 apart. *f* 8–11, on annulus 33–35, 11–14 apart. *h2* 10–11; *h1* not seen.

Type material. Twenty-nine specimens collected from *Theobroma cacao* (Malvaceae) leaves, at "Estação Experimental de Ouro Preto do Oeste (ESTEX-OP), Comissão Executiva do Plano da Lavoura Cacaueira (CEPLAC)", municipality of Ouro Preto do Oeste, Rondônia, Brazil (10°44'30" S, 62°13'30" W), on 6 September 2012, coll. Francisco Ferragut and Denise Navia. Female holotype and nine paratypes (7 females, 1 male and 1 nymphs) on four slides deposited in the Acarological collection of Universidade Estadual de Santa Cruz (UESC), Ilhéus, Bahia, Brazil. Nine paratypes (5 females, 1 male and 3 nymphs) in two slides deposited in the Acarological collection of Embrapa Recursos Genéticos e Biotecnologia. Ten paratypes (6 females and 4 male) in two slides deposited in the Acarological collection of “Departamento de Entomologia e Acarologia, Universidade de São Paulo, Escola Superior de Agricultura ‘Luiz de Queiroz’ (ESALQ)", Piracicaba, São Paulo, Brazil.

Host plant. *Theobroma cacao* L. (Malvaceae).

Relation to host. A vagrant species found on young leaves, no symptoms observed.

Remarks. *Davisella* **n. sp.** is the 8th species to be assigned to this genus (Table 1). It can be distinguished from all other species by the dorsal opisthosoma wax-bearing ridges. In other species dorsal ridges are slight (not very well defined) or extending just along anterior opisthosoma – *D. breitlowi* (Davis, 1964), *D. paucisetosa* (Flechtmann, 1999), *D. palmea*

(Flechtmann, 1998), *D. notosa* (Flechtmann, 1995), *D. spondias* Reis & Navia, 2010. Though *D. haramotonis* (Keifer, 1974) and *D. globosa* (Keifer, 1969) also present a noticeable median ridge extending along the whole opisthosoma, lateral ridges are not present and/or ridges are not wax-like bearing. The new species is similar to *D. palmea*, *D. notosa* and *D. spondias* in the absence of prodorsal shield tubercles (in *D. breitlowi*, *D. globosa*, *D. haramotonis*, and *D. paucisetosa* tubercles are present ahead of rear shield margin). It is also similar to *D. breitlowi* in the 5-rayed branch empodium (all other species present 6-7 rays in each empodium branch, see Table 1). The new species can be distinguished from *D. breitlowi*, *D. globosa*, *D. palmea*, and *D. paucisetosa* by the absence of microtubercles on dorsal annuli (dorsal microtubercles present in these species, see Table 1). Coverflap of the new species is similar to that of *D. haramotonis* and *D. paucicetosa*, by presenting basally short irregular dashes and distally less than 30 radiating longitudinal lines.

Ocellar-like structures are present in the lateral area of the prodorsal shield of *D.* **n. sp.**. Flechtmann (1998) represented the presence of two circles in the prodorsal shield median area near rear shield margin of *D. palmea*. These circles could also constitute ocellar-like structures. If this is the case, then *D.* **n. sp.** and *D. palmae* would be similar in the presence of ocellar-like structures in the prodorsal shield, although these structures are placed in different positions in the two species (lateral in *D.* **n. sp.** and median in *D. palmae*).

TABLE 1. World species in the genus *Davisella* Flechtmann, Amrine and Stasny: host plants, type localities and diagnostic traits.[2]

Species	***D. breitlowi*** **(Davis 1964)**	***D. globosa*** **(Keifer 1969)**	***D. haramotonis*** **(Keifer 1974)**	***D. notosa*** **(Flechtmann 1995)**	***D. palmea*** **(Flechtmann 1998)**	***D. paucisetosa*** **(Flechtmann 1999)**	***D. spondias*** **(Reis *et al.* 2010)**	***D.* n. sp.**
host plant, and type locality	*Magnolia grandiflora* L., Magnoliaceae Georgia, USA	*Anacardium occidentale* L., Anacardiaceae São Paulo, Brazil	*Psidium guajava* L., Myrtaceae Oahy, Hawaii, USA	*Acinodendron candollearum* (Triana) Kuntze, Melastomataceae Rio de Janeiro, Brazil	*Syagrus romanzoffiana* (Cham.) Glassm. Arecaceae Rio de Janeiro, Brazil	*Trema micrantha* (L.) Blum. Ulmaceae São Paulo, Brazil	*Spondias mombin* L., Anacardiaceae Pernambuco, Brazil	*Theobroma cacao* L., Malvaceae Rondônia, Brazil
no. rays each empodium branch	5	7	6	7	6-7	7	6	5
prodorsal shield tubercles/ ocellar-like structures	minute, ahead rear shield margin/ absent	minute, ahead rear shield margin/ absent	minute, ahead rear shield margin/ absent	absent/absent	absent/circles near shield margin (probably ocellar-like)	minute or absent (missing in 5% of specimens)/ absent	absent/absent	absent/presents in the lateral area
prodorsal shield ornamentation	longitudinal lines (median and admedian lines)	longitudinal lines (weak median line; admedian lines complete; submedian lines)	faint longitudinal lines (median line on rear posterior half; admedian lines complete; submedian lines)	longitudinal lines (admedian lines meeting curved cross lines at its 1/4 posterior; submedian lines)	smooth	longitudinal lines (median line long flanked by two admedian narrow, elongated bosses)	longitudinal lines (median and admedian, not joined)	faint sinuous median and admedian longitudinal lines
dorsal opisthosoma ridges	slight median ridge	median and lateral ridges	median ridge	slight median and lateral ridges	slight median and lateral ridges	slight median ridges	slight median ridge	three well defined wax-like bearing ridges

[1] Morphological traits were extracted from text and/or drawings of species original descriptions.

TABLE 1. World species in the genus *Davisella* Flechtmann, Amrine and Stasny: host plants, type localities and diagnostic traits, continuation.[3]

Species	*D. breitlowi* (Davis 1964)	*D. globosa* (Keifer 1969)	*D. haramotonis* (Keifer 1974)	*D. notosa* (Flechtmann 1995)	*D. palmea* (Flechtmann 1998)	*D. paucisetosa* (Flechtmann 1999)	*D. spondias* (Reis *et al.* 2010)	*D.* n. sp.
coverflap ornamentation	distally 32 short longitudinal lines	basally granulated, distally 22-25 short irregular longitudinal lines	basally with short dashes mainly set in longitudinal lines, distally 16-18 short radiating lines	basally granulated, distally 20-22 radiating lines	44-52 longitudinal lines occupying whole coverflap (median 12-16 lines interrupted halfway)	basally with irregular short dashes, distally 22-26 radiating longer lines	basally with granules or short dashes; distally 35-38 radiating longitudinal lines	basally with short irregular dashes and/or granules, apically with 16–24 radiating longitudinal lines
coxigenital ornamentation	smooth	lines of fine dashes	curved lines of short dashes	granulated around tubercles	granulated	smooth	granulated	finely microtuberculated
no. dorsal annuli	62	78	75	78-95	45-53	76-83	69-77	54–64
opisthosoma microtubercles	small, beadlike, on rear annulus margin, spacer dorsally	dorsally absent; fine on ventral side, weak or absent laterally	dorsally faint or absent; laterally as fine points; ventrally present	dorsally absent; ventrally very small beadlike	dorsally small beadlike microtubercles; ventrally fine	dorsally spaced; ventrally fine	dorsally absent (except for last twelve); ventrally pointed	dorsally absent; ventrally with microtubercles, whose are more elongated in between ventral

[3] Morphological traits were extracted from text and/or drawings of species original descriptions.

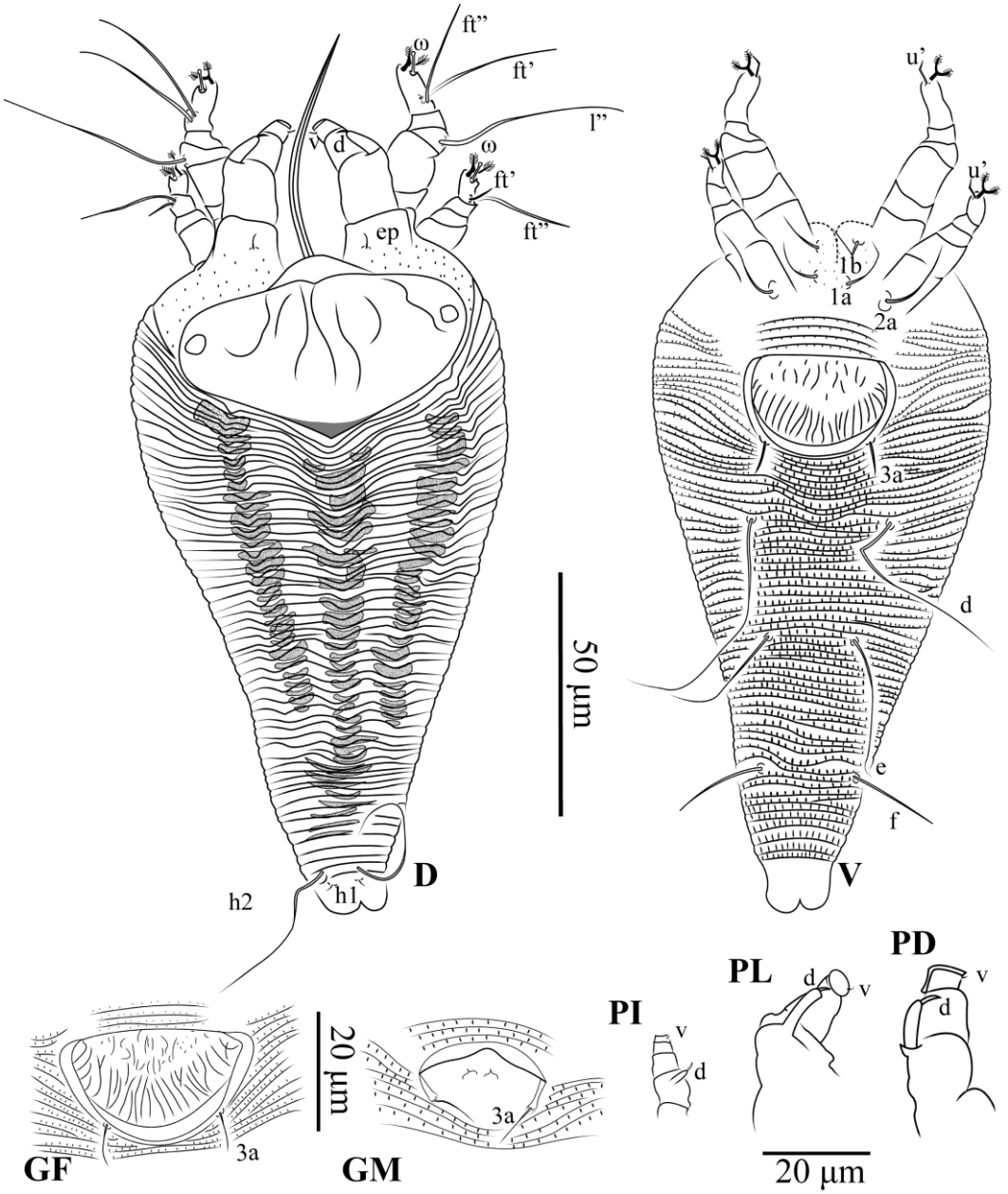

FIGURE 1. *Davisella* **n. sp**. **D**. Dorsal habitus, female; **V**. Ventral habitus, female; **GF**. External genitalia, female; **GM**. External genitalia, male; **PI.** Pedipal, immature (enlarged). **PD.** Detail of dorsal pedipal, female (enlarged). **PL.** Detail of lateral pedipal, female (enlarged).

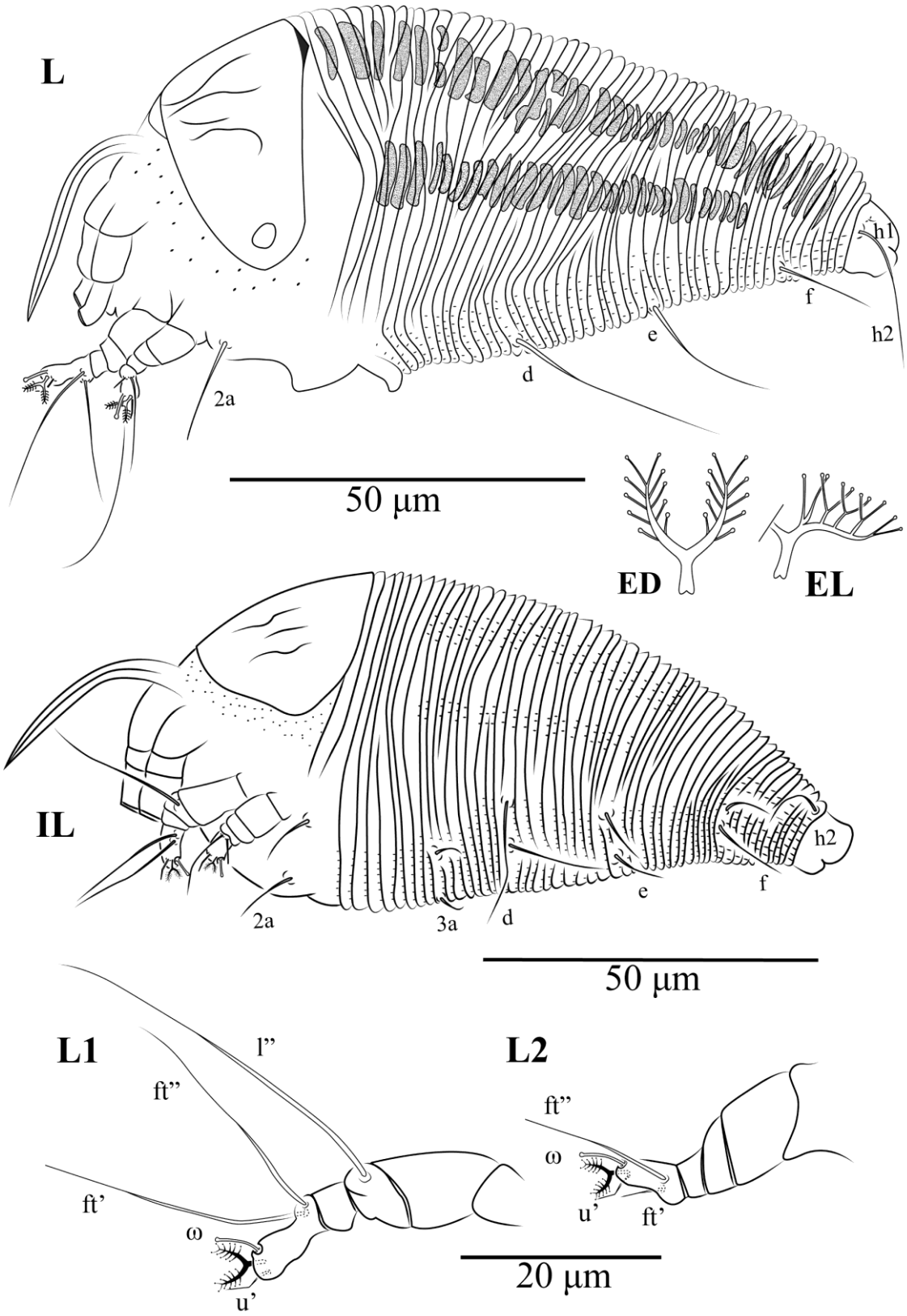

FIGURE 2. *Davisella* **n. sp**. **L**. Lateral habitus, female; **IL**. Lateral habitus, immature; **ED**. Dorsal view of empodium, female (enlarged); **EL**. Lateral view of empodium, female (enlarged); **L1**. Leg I, antaxial view, female; **L2**. Leg II, antaxial view, female.

Family: Eriophyidae Nalepa

Subfamily: Phyllocoptinae Nalepa

Tribe: Anthocoptini Amrine & Stasny

***Tetra* n. sp. Rodrigues, Navia & Oliveira**

(Figs. 3–4)

Diagnosis. A *Tetra* species presenting dorsal annuli bearing thin elongated microtubercles occupying 3/4 posterior annuli; posterior margin of dorsal annuli with sharp subtriangular indentations, mainly in the sublateral area where these are arranged in longitudinal rows; prodorsal shield design of two connected curved lines in each side which touch on anterior shield and which the anterior one extends laterally; 6-rayed empodium; coxisternal region finely microtuberculated; coverflap medially emarginated in the posterior margin and with 12-16 longitudinal or radiating lines.

FEMALE (n=14). Body fusiform, 130 (130–159), 50 (46–56) wide. **Gnathosoma** projecting downwards; pedipalp coxal seta (*ep*) 4 (2–4); dorsal pedipalp genual seta (*d*) 4 (4–5), simple; subapical pedipalp tarsal seta (*v*) 2 (2); cheliceral stylets 16 (16–21). **Prodorsal shield** semicircular, wider than long, with a curved posterior margin, 24 (23–25), 41 (39–41) wide; short, broad-based frontal lobe, apically curved, 3 (3–4), 11 (9–11) wide; antero-lateral area of prodorsal shield finely microtuberculated. Shield design of two curved irregular lines (in the position of admedian lines) which touch on anterior shield (1/3 anterior); the anterior one is shorter and extends laterally outwards; tubercles and scapular setae (*sc*) near rear shield margin, *sc* 21 (19–23), *sc* tubercles robust and broad-based, 23 (19–24) apart. **Legs** with all segments and usual setae present. **Leg I** 21 (21–24); femur 7 (7–9), basiventral femoral seta (*bv*) 7 (7–9); genu 4 (3–5), antaxial genual seta (*l''*) 16 (15–19); tibia 5 (5–6), paraxial tibial seta (*l'*) 5 (4–6); tarsus 5 (5), antaxial fastigial tarsal seta (*ft''*) 15 (17–18), paraxial fastigial tarsal seta (*ft'*) 14 (13–16), unguinal seta (*u'*) 4 (3–4), tarsal solenidion (*ω*) 6 (6), not knobbed; empodium 5 (5–6), undivided, symmetrical, 6-rayed. **Leg II** 20 (19–21); femur 7 (6–8), *bv* 8 (7–10); genu 3 (3–4), *l'' 7* (5–7); tibia 5 (4–5); tarsus 5 (4–5), *ft''* 16 (15–17), *ft'* 5 (4–6), *u'* 3 (3–4), *ω* 6 (5–6) as in leg I; empodium 5 (4–5), 6-rayed, as in leg I. **Coxisternal region** finely microtuberculated. Anterolateral seta on coxisternum I (*1b*) 5 (5–8), 6 (6–8) apart; proximal seta on coxisternum I (*1a*) 12 (11–15), 7 (6–7) apart; proximal seta on coxisternum II (*2a*) 27 (27–31), 17 (17–20) apart; prosternal apodeme 6 (5–6); coxigenital region with 6 (5–7) annuli, microtuberculated. **External genitalia** 11 (9–13), 19 (18–20) wide, coverflap semicircular, distal margin medially emarginated, basally with two curved w-shaped lines

finely microtuberculated, distally with 14 (12–16) longitudinal or radiating lines; proximal seta on coxisternum III (*3a*) 9 (8–11). **Internal genitalia**, anterior genital apodema trapezoidal; oblique apodeme distinct, forming an inverted V-like figure, with bent arms laterally directed; spermatheca spherical or slightly elongated, directed posteriorar or laterad; spermathecal duct short, ~ 1 long, tube like, directed posteriad (average angle of 120º between spermathecal apparatus and longitudinal bridge); longitudinal bridge ~ 8 long, postspermathecal part of longitudinal bridge reduced. **Opisthosoma.** Dorsal opisthosoma with a wide furrow, except for the first annulus which presents a broad median ridge; dorsal annuli bearing thin elongated microtubercles (occupying 3/4 posterior annuli) whose looks like to be linked by an irregular line in the anterior extremity forming a distinct transversal rows; posterior margin of dorsal annuli with sharp subtriangular indentations, mostly on the lateral ridges, where are arranged in longitudinal rows, whose extends from the 3rd annulus along whose opisthosoma (except for 5-6 annuli); 21 (21–24) dorsal annuli,; 50 (45–54) ventral annuli with slightly elongated microbubercles on posterior margin, which became more elongated on last annuli posterior to ventral seta *f*. Opisthosoma downcurved around the level of setae ***e*.** Lateral seta *c2* 18 (18–22), on ventral annulus 3 (2–5); ventral seta *d* 36 (32–36), on annulus 14 (13–16), 27 (27–33) apart; ventral seta *e* 6 (5–8), on annulus 27 (26–32), 14 (14–19) apart; ventral seta *f* 14 (12–14), on annulus 46 (41–50), 15 (13–16) apart; caudal seta *h2* 39 (35–40); accessory seta *h1* 2(2).

MALE (n=1). Smaller than female, body 115, 44 wide. **Gnathosoma** pedipalp *ep* 5, *d* 4, *v* not seen, cheliceral stylets 20. **Prodorsal shield** as in female, 22, 35 wide; *sc* 16, 19 apart, frontal lobe 3, 10 wide. **Coxisternal region.** *1b* 5, 8 apart; *1a* 13, 5 apart; *2a* 27, 15 apart, prosternal apodeme 5, 5 annuli. **Legs** as in female. Leg **I** 19; femur 7, *bv* 8; genu 3, *l″* 15; tibia 5, *l'* 5; tarsus 4, *ft″* 15, *ft'* 14, *u'* 4, *ω* 6; empodium 5, 6-rayed. Legs **II** 18; femur 7, *bv* 7; genu 3, *l″* 7; tibia 4; tarsus 4, *ft″* 15, *ft'* 6, *u'* 3, *ω* 6; empodium 5, 6-rayed. **External genitalia** 10, 13 wide; *3a* 7, area flanked by *3a* and posterior to gonopore finely granulated, eugenital setae seen on anterior median area. **Opisthosoma** as in female, with 21 dorsal annuli and 43 ventral annuli. *c2* 19, on ventral annulus 3; *d* 31, on annulus 13, 28 apart; *e* 5, on annulus 23, 16 apart. *f* 11, on annulus 38, 14 apart. *h2* 42; *h1* 2.

Type material. Sixteen specimens intercepted at the plant quarantine station "Estação Quarentenária de Germoplasma Vegetal, Embrapa Recursos Genéticos e Biotecnologia", Brasília, DF, Brazil, from *Theobroma cacao* L. (Malvaceae) seedlings, originated from the germplasm bank, Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), Turrialba, Costa Rica, on 13 June 2013, collected by F. J. Carvalho and H.M.C. Rocha.

Female holotype and five paratypes (5 females) on three slides deposited in the Acarological collection of "Embrapa Recursos Genéticos e Biotecnologia", Brasília, Distrito Federal, Brazil. Six paratypes (5 females and 1 male) in four slides deposited in the Acarological collection of Universidade Estadual de Santa Cruz (UESC), Ilhéus, Bahia, Brazil. Four paratypes (4 female) in four slides deposited in the Acarological collection of the Departamento de Entomologia e Acarologia, Universidade de São Paulo, Escola Superior de Agricultura 'Luiz de Queiroz' (ESALQ), Piracicaba, São Paulo, Brazil.

Host plant. *Theobroma cacao* L. (Malvaceae).

Relation to host. A vagrant species found on young leaves, no symptoms observed.

Remarks. The new *Tetra* species is very distinct from *T. coimbatorensis* Mohanasundaram, 1994, the only species in this genus associated with a Malvaceae host plant. Remarkable differences between these species are: dorsal opisthosoma microtubercles pattern (thin elongated occupying 3/4 posterior annuli in *T.* **n. sp**.; absent in *T. coimbatorensis*); sharp subtriangular annuli indentations in the posterior margin of dorsal annuli, mostly arranged in sublateral longitudinal rows (absent in *T. coimbatorensis*); the prodorsal shield ornamentation (two curved irregular lines in *T.* **n. sp**.; absent in *T. coimbatorensis*); the number of empodium rays (6 rays in *T.* **n. sp**.; 4 rays in *T. coimbatorensis*).

Tetra **n. sp.** also differs from the other four Neotropical species of this genus. The new species differs from *T. tuttlei* Keifer, 1975 and *T. gibbosa* Flechtmann, 2014 in the dorsal opisthosomal annuli (with microtubercles thin elongated occupying 3/4 posterior annuli in *T.* **n. sp.**; with beadlike acuminate microtubercles on rear annuli margins in *T. tuttlei;* smooth in *T. gibbosa*); the prodorsal shield ornamentation pattern (two curved irregular lines in admedian lines position in *T.* **n. sp**.; median lines present on 2/5 area enclosed by admedians, admedians complete, submedian extending back from lateral lines just behind anterior lobe base, longitudinal lines are linked by transversal lines forming cells in *T. tuttlei*; and with dorsal elevations or callosities, delimited by mainly longitudinal lines and one transversal line, surface of bulges with short irregular dashes in *T. gibbosa*); and the number of empodium rays (6 rays in *T.* **n. sp**.; 8 rays in *T. tuttlei;* and 4 rays in *T. gibbosa*).

Although *Tetra* **n. sp.** is similar to *T. striata* Navia, 1999 in the dorsal annuli bearing thin elongated microtubercles, these species differ in its distribution (microtubercles evenly distributed along dorsal annuli in *T.* **n. sp**.; absent in the median area of annuli in *T. striata*). These species also differs in the: coverflap ornamentation (longitudinal lines in *T.* **n. sp**.; smooth in *T. striata*); prodorsal shield ornamentation pattern (median line absent, two

irregular curved lines in the position of admedian lines in *T.* **n. sp.**; median line present and connected by curved transversal lines to admedian ones in *T. striata*); the number of empodium rays (6 rays in *T.* **n. sp.**; 5 rays in *T. striata*).

Tetra indiciva Flechtmann, 2009, described from Brazil, presents proeminent groups of pointed wax-like secreting structures in the two lateral ridges of dorsal opisthosoma. In the new species we observed the presence of sharp subtriangular indentations mostly arranged in longitudinal rows on the area of lateral ridges. It is possible that these structures are homologous. Related to other traits these species are very distinct- in *T. indiciva* dorsal annuli are not microtuberculated (thin elongated microtubercles in *T.* **n. sp**.); in *T. indiciva* prodorsal shield not present lines (curved lines in *T.* **n. sp.**); *T. indiciva* presents a 4-rayed empodium (6-rayed in *T.* **n. sp.**).

Tetra **n. sp.** differs from *T. eldoradensis* Keifer, 1966 in the prodosal shield shape (semicircular, wider than long in *T.* **n. sp.**; subtriangular, at least as wide as long in *T. eldoradensis***);** frontal lobe (short, not extending over gnathosoma base in *T.* **n. sp.**; prominent extending over gnathosoma base in *T. eldoradensis***),** and ornamentation (median line absent, two irregular curved lines in the position of admedian lines in *T.* **n. sp.**; median line present and connected by transversal lines to admedian ones in *T. eldoradensis*); and in the 6-rayed empodium (4-5 in *T. eldoradensis*).

Internal female genitalia of the new species presents some similarities with that of *T. tuttlei*; anterior and oblique apodemes present similar shape and orientation, as well as relative length of the longitudinal bridge and spermathecal shape. However in the *T.* **n. sp.** spermathecal are smaller than in *T. tuttlei* and spermathecal duct is directed posteriorad (directed laterad in *T. tuttlei*). Female internal genitalia of the new species also presents some similarities with that of *T. eldoradensis* (e.g. spermatheca is spherical; spermathecal tube and vesicle are directed postero-laterad). However some remarkable differences are observed: anterior apodeme is relatively wider in *T.* **n. sp.** (in *T.* **n. sp.** it is longer than the longitudinal bridge; in *T. eldoradensis* is shorter than the longitudinal bridge); in *T.* **n. sp.** oblique apodeme present laterally curved extremities (in *T. eldoradensis* are directed posteriorad); in *T.* **n. sp.** spermathecal tubes are tube-like (funnel-like in *T. eldoradensis*); in *T.* **n. sp.** spermathecal vesicles are smaller than in *T. eldoradensis.*

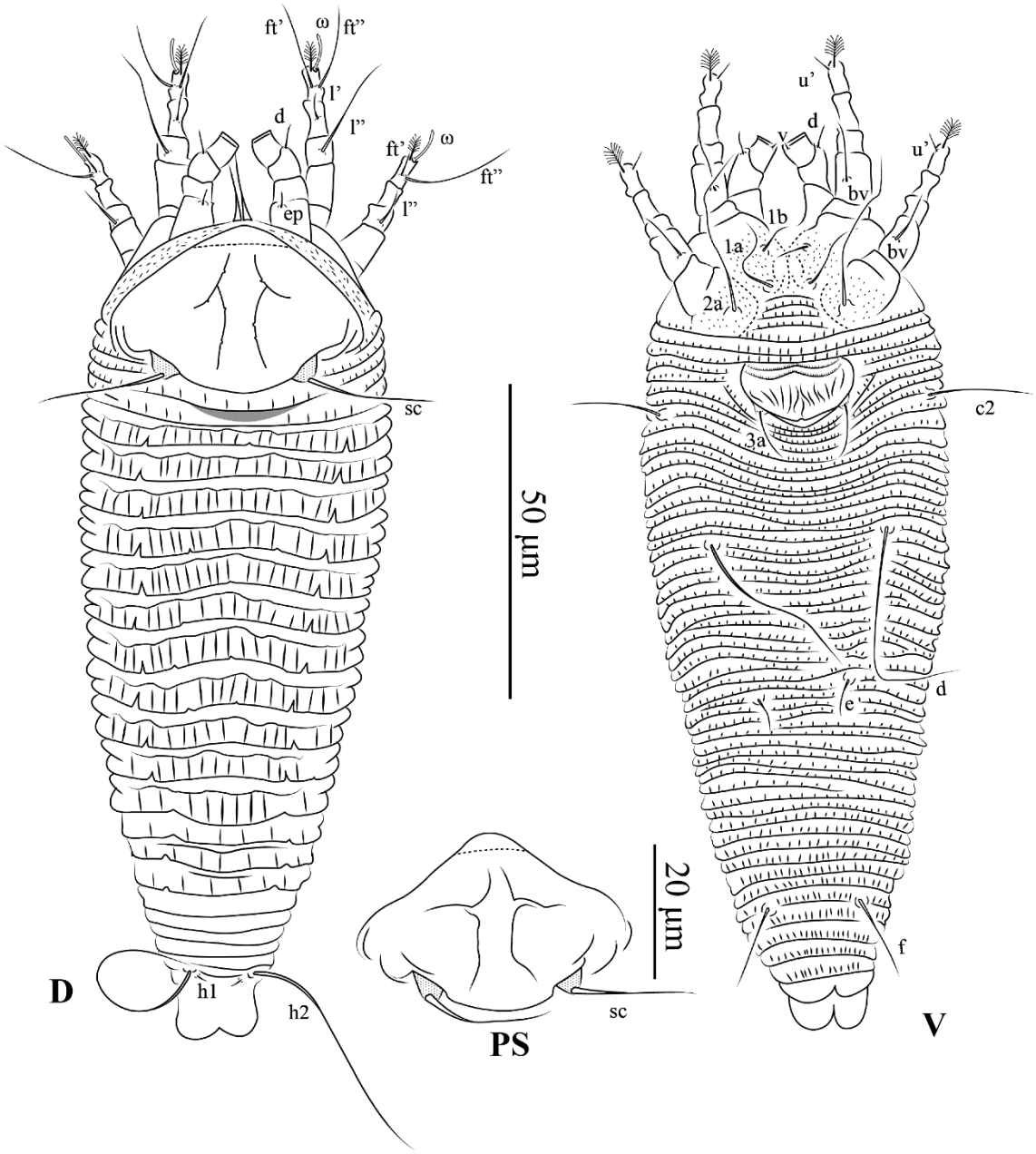

FIGURE 3. *Tetra* **n. sp. D**. Dorsal habitus. **V**. Ventral habitus. **PS**. Prodorsal shield, female.

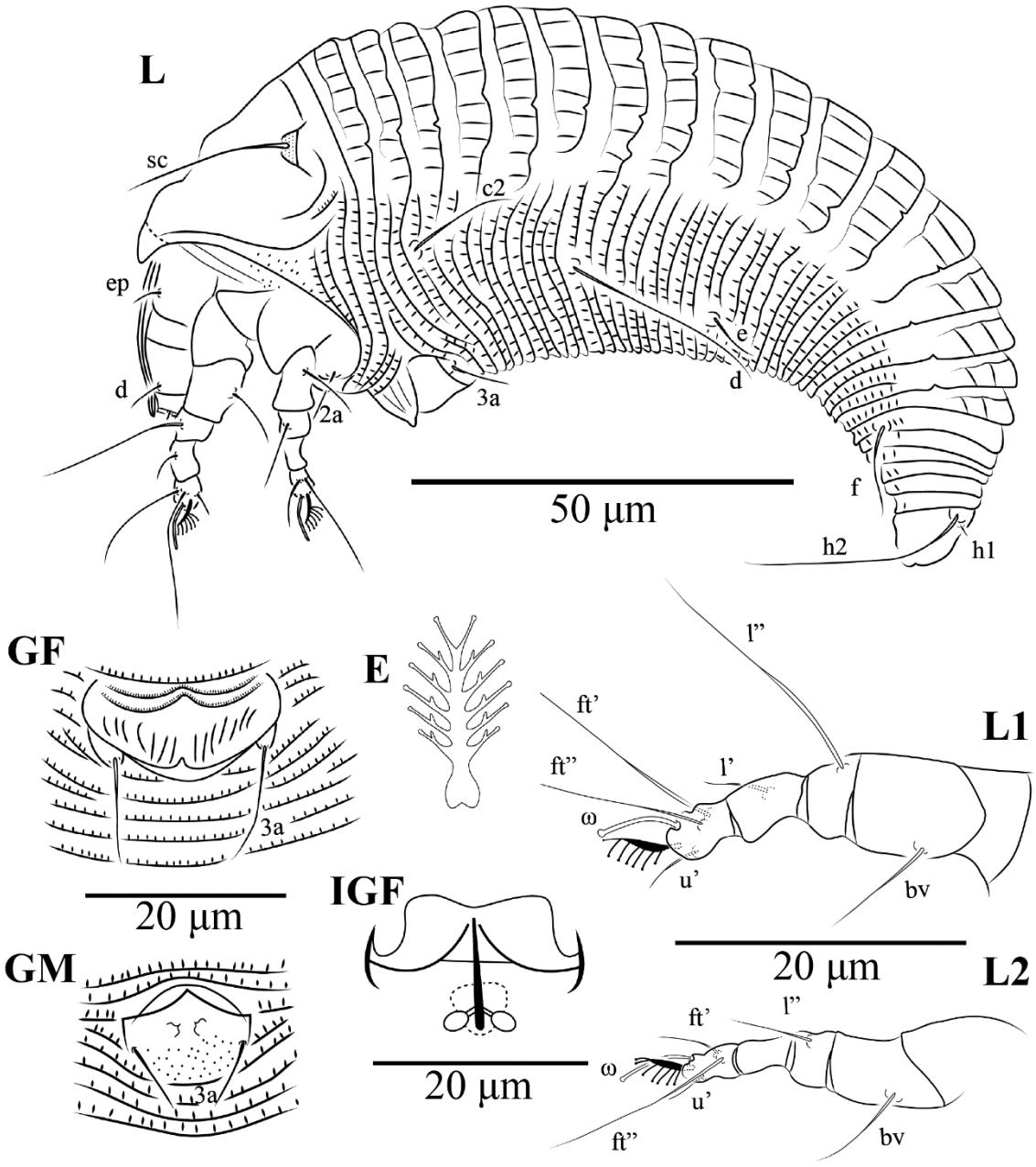

FIGURE 4. *Tetra* **n. sp. L**. Lateral habitus, female; **GM**. External genitalia, male; **GF**. External genitalia, female; **IGF.** Internal genitalia, female; **E**. Dorsal view of empodium, female (enlarged); **L1**. Leg I, antaxial view, female; **L2**. Leg II, antaxial view, female.

Discussion

Enlarged subcylindrical tubercles bearing pedipalp genual seta like those observed in the new *Davisella* species herein described have never been observed in other Eriophyoid mites. Using sophisticated microscopy techniques Chetverikov & Craemer (2015) conducted a detailed study on the gnathosoma morphology of about 80 mite species in the three Eriophyoidea recognized families, including three Diptilomiopidae genera- two in the Diptilomiopinae, *Diptacus* Keifer, 1951 and *Diptilomiopus* Nalepa, 1916; and one in the Rhyncaphytoptinae, *Rhyncaphytoptus* Keifer, 1939. These authors did not observed similar structures on the pedipalp trochanter, femur genu segment of any of the studied species. Minute gnathosomal structures which seem to be involved in keeping the mouthparts in position, specially stylets sheaf, named "gnathosomal interlocking apparatus", were observed as being restricted to the basal parts of chelicerae, medioproximal palpcoxae and antero-dorsal margin of the prodorsal shield. The enlarged pedipalp genual tubercle observed in *Davisella* **n. sp.** possibly act as stopper to prevent "losing" stylets from the "envelop" between palps, similar function that of the "cheliceral retainer" observed in Eriophyidae and Diptilomiopidae species by Chetverikov & Craemer (2015). These authors described four types of gnathosomal interlocking apparatus, therefore the original structure observed in *Davisella* **n. sp.** would be classified as the Type V.

Some *Tetra* species can cause severe symptoms on their host plants. Some examples of *Tetra* species causing damage to its host plants are the two associated with *Ulmus americana* L. (Ulmaceae) – *T. nielseni* Keifer, 1959 which can cause leaf browning and drop (Keifer 1959); and *T. americana* Keifer, 1959 which can cause browning of leaves (Keifer 1959). Also *Tetra martini* Manson, 1984 associated with *Solanum aviculare* Forst. (Solanaceae) can cause gross distortion of leaves and damage to growing tips (Manson 1984).

Some studies have been conducted on eriophyoid mites associated with cocoa trees in Brazil (Oliveira & Navia 2013; Trevisan et al. 2010), even in its natural occurrence areas (Brazilian Amazon) (in this study) and this *Tetra* species was not found. Cocoa tree presents a broad natural occurrence area, which extends from Central to South America (Cuenca & Nazario 2004; Müller & Valle 2012). Although cocoa tree occurs naturally in Brazil, it is possible that *T.* **n. sp.** is associated with this host plant only in a restricted area of its broad natural distribution area, e.g. in Central America, and it indeed constitute an exotic species to Brazil. Preventing introduction of herbivore species that constitute potential pest is an extremely important benefit-cost measure in plant protection (Miranda 2012). Phytophagous mites represent a group of quarantine importance and there are several examples of

inadvertent introductions that seriously affected host plant crops, e.g. *Aceria litchii* (Keifer, 1943) infesting lichia fruit trees in Brazil (Mineiro *et al*. 2015). This reinforce importance of the interception of *T.* **n. sp.** at a plant quarantine station in Brazil, which avoid its entry and spread to cocoa production areas; it also emphasizes the need for a detailed acarological inspection of plant material introduced in the country (specially as propagation material) jointly with an accurate identification of the intercepted specimens.

In a closer look on *Shevtchenkella biseta* (Nalepa, 1906) original description during preparation of this article we realized that this taxon was erroneously assigned to *Shevtchenkella*, since ventral seta *d* and ventral seta *e* are missing; neither to the Eriophyidae family, since external vertical setae *ve* are present on the anterior margin of the prodorsal shield. *Shevtchenkella biseta* was originally described as *Oxypleurites bisetus* Nalepa, 1906, from the Malvaceae *Hibiscus rosa sinensis* L. (Nalepa 1906), from the Fiji Islands. Distribution of this species still restricted to type locality and no additional morphological studies were conducted after its description. This taxon actually should be assigned to the Sierraphytoptinae subfamily in the Phytoptidae. It is possible that *S. biseta* is a senior synonym of *Neoprothrix hibiscus* Reis & Navia 2014 (Reis *et al.* 2014), also described from hibiscus (*H. rosa-sinensis*), from Brazil. This last species, originally described as belonging to the Prothricinae (Phytoptidae), was correctly assigned to the Sierraphytoptinae by Chetverikov *et al*. (2015). Comparing morphological traits between *S. biseta* and *N. hibiscus*, several similarities are observed: body length and width (150μm in *S. biseta* and 153-168μm in *N. hibiscus*; 80 μm in *S. biseta* and 75-87μm in *N. hibiscus*); prodorsal shield and frontal lobe shape; scapular *sc* and ventral *d* and *e* setae missing; empodium 4-5-rayed; 14-15 dorsal annuli; coverflap smooth (Nalepa 1906, 1909, 1923; Reis *et al*. 2014). A minute dorsal setae *c1* present in *N. hibiscus* (3-4μm) can also be observed in Nalepa drawing (see Nalepa 1909), although not mentioned in the description text. However some differences between these species are the ventral microtubercles (absent in *S. biseta*; slightly elongated restricted to the median ventral area in *N. hibiscus*). Although similarities observed between *S. biseta* and *N. hibiscus* would be indispensable examine *S. biseta* type material to establish this synonym. *Shevtchenkella biseta* type material should be accessed from the Nalepa collection.

Theobroma genus includes 22 species native to the tropical forests of Central and South America (Cuatrecasas 1964). Studies of Eriophyoidea mites associated to this group of plants has been limited to only two of these species, which are more commonly cultivated and present economic importance – *T. grandiflorum* and *T. cacao* –, with six known mite species.

Numerous other eriophyoid mites are probably associated with wild species in this group of plants; it would be interesting to study them. Below is presented a dichotomous key to help identification of the six currently known eriophyoid species associated with *Theobroma* plants, which could support future taxonomic studies.

Identification key to help in the separation of the eriophyoid species associated to *Theobroma*

1 Chelicerae abruptly curved and bent down near base, longer than palps; scapular seta *sc* absent; empodium divided; paraxial tibial seta (*l'*) lacking, genual setae absent only form legs II; dorsal opisthosoma with three ridges; opisthossomal setae c2 absent ……..……...…….. ***Davisella* n. sp.**

- Chelicerae straight or slightly curved, shorter or as long as palps; scapular seta *sc* present; empodium entire; genual setae present; dorsal opisthosoma evenly rounded or with two slight ridges; opisthossomal setae c2 present ……..… 2

2 Tibia of leg I fused with tarsus; anterolateral setae on coxisternum I (*1b*) absent ……...….. ***Floracarus theobromae***

- Tibia of leg I not fused with tarsus; anterolateral setae on coxisternum I (*1b*) present ……..…...……. 3

3 Body vermiform; opisthosomal annuli subequal dorsoventrally; prodorsal shield lacking a frontal lobe ……...……..…...…….....……. 4

- Body fusiform; opisthosomal annuli with dorsoventral differentiation; prodorsal shield with a broad-based frontal lobe over gnathossoma base ……....… 5

4 Opisthosomal ventral seta *e* present ..... ***Aceria reyesi***

- Opisthosomal ventral seta *e* absent ..... ***Gymnaceria cupuassu***

5 Prodorsal shield reduced; scapular setae (*sc*) laterally displaced; presence of a dorsal opisthosomal plate ……..……. ***Eriomacrotergum flechtmanni***

- Prodorsal shield not reduced; scapular setae (*sc*) in usual subdorsal position (not laterally displaced); absence of a dorsal opisthosomal plate ……..... ***Tetra* n. sp.**

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