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# Flat mites (Tenuipalpidae) from Bahia state, Northeastern Brazil - a checklist including new records and an illustrated key to species

Renata S. Nascimento <sup>a</sup>, Kaélem S. Souza <sup>a</sup>, Elisangela A. S. F. Melo <sup>a</sup>, Aline D. Tassi <sup>b</sup>, Elizeu B. Castro <sup>c</sup>, Denise Navia <sup>d</sup>, Renata S. de Mendonça <sup>e</sup>, Ronald Ochoa <sup>f</sup>, Anibal R. Oliveira <sup>g</sup>

<sup>a</sup> Programa de Pós-Graduação em Produção Vegetal, Universidade Estadual de Santa Cruz (UESC), Ilhéus, Bahia, Brazil.

<sup>b</sup> Tropical Research and Education Center, University of Florida, Homestead, USA.

<sup>c</sup> Departamento de Zoologia e Botânica, Universidade Estadual Paulista (UNESP), São José do Rio Preto, São Paulo, Brazil.

<sup>d</sup> CBGP, INRAE, CIRAD, Institut Agro, IRD, Univ Montpellier, Avenue du Campus Agropolis, Campus de Baillarguet, Montferrier-sur-Lez, France.

<sup>e</sup> Faculdade de Agronomia e Medicina Veterinária, Universidade de Brasília, Brasília, Distrito Federal, Brazil.

<sup>f</sup> Systematic Entomology Laboratory (SEL), Agricultural Research Service (ARS), United States Department of Agriculture (USDA), Beltsville Agricultural Research Centre (BARC), Beltsville, MD, USA.

<sup>g</sup> Departamento de Ciências Biológicas, Universidade Estadual de Santa Cruz (UESC), Ilhéus, Bahia, Brazil.

## Original research

### ABSTRACT


Tenuipalpidae (Trombidiformes: Tetranychoidae) is an economically important family of plant-feeding mites. The family has approximately 1,100 described species in 41 genera with worldwide distribution. Currently, 40 species of Tenuipalpidae have been recorded from Brazil, and prior to this study only 11 were known from Bahia state. Five new species records are presented here for Bahia, making a total of 16 species now known from the state. *Brevipalpus* is considered the most important genus due to their association with, and ability to transmit, devastating plant viruses. Some diseases caused by viruses transmitted by *Brevipalpus* mites (VTBs) have already been recorded in the state of Bahia, such as the Passion fruit green spot virus and citrus leprosis. This paper presents a checklist of tenuipalpid reported from the state of Bahia in Brazil, including new records and an illustrated identification key to the species.

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Corresponding author

Renata S. Nascimento 

renatanascimento@hotmail.com

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**Keywords** taxonomy; false spider mites; diversity; *Brevipalpus*; diagnostics; plant viruses

## Introduction

The flat mite family Tenuipalpidae (Trombidiformes: Tetranychoidae) is one of the most important families of plant-feeding mites world-wide (Gerson 2008; Moraes and Flechtmann 2008). The family has approximately 1,100 described species in 41 genera and is distributed worldwide (Mesa *et al.* 2009; Castro *et al.* 2022a). Studies of flat mites in Brazil began with Bondar (1928), who reported the first two species for the country from Bahia, *Brevipalpus californicus* (Banks, 1904) as “*Tenuipalpus californicus*” and *Brevipalpus obovatus* Donnadieu, 1875 as “*Tenuipalpus bioculatus*”. Currently, 40 Tenuipalpidae species have been recorded

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from Brazil, and prior to this study, only 11 species had been reported from Bahia, in the genera *Brevipalpus*, *Tenuipalpus*, *Dolichotetranychus*, and *Raoiella* (Castro *et al.* 2022a).

Several tenuipalpid species are considered pests of many crops worldwide (Mesa *et al.* 2009; Beard *et al.* 2013, 2018). They may cause damage directly by feeding on host plant tissues, and indirectly through the transmission of plant viruses (Childers *et al.* 2003; Mesa *et al.* 2009; Beard *et al.* 2015; Lillo *et al.* 2021). Due to their association with phytoviruses, species in the genus *Brevipalpus* have historically received the most attention inside the family (Mesa *et al.* 2009; Beard *et al.* 2015). Some diseases caused by viruses transmitted by *Brevipalpus* (VTBs) have already been reported in Bahia (Kitajima 2020), such as the citrus leprosis virus C (CiLV-C) (Bastianel *et al.* 2010; Ramos-González *et al.* 2016), the passion fruit green spot virus (PFGSV) (Santos Filho *et al.* 1999; Ramos-González *et al.* 2020) and the coffee ringspot virus (CoRSV) (Almeida and Figueira 2014; Ramalho *et al.* 2014), along with some suspected samples of zonate chlorosis in citrus (Kitajima 2020).

Due to their morphological similarity, *Brevipalpus* species, including those of the greatest economic importance, have consistently been confused and misidentified (Welbourn *et al.* 2003). Poor descriptions and illustrations as well as a lack of critical morphological studies have rendered the taxonomy of *Brevipalpus* species a puzzle (Beard *et al.* 2015). However, recently the taxonomic confusion surrounding the most important species belonging to the *Brevipalpus phoenicis* (Geijskes) species complex were addressed with detailed morphological studies (Beard *et al.* 2013, 2015). Following from this, taxonomists worldwide have directed efforts towards accurately identifying *Brevipalpus* species and consequently to determining the distributions of certain species.

The Bahia state territory is located in the Northeastern region of Brazil, that includes three natural biomes that are characterized by different physical and biological characteristics, such as soil, rainfall, and vegetation (Santos *et al.* 2018): (1) the “Cerrado”, which is considered the Brazilian savannah (Ratter *et al.* 1997); (2) the “Caatinga”, a typical, semi-arid biome (Sampaio 1995; Costa *et al.* 2007); and (3) the Atlantic Forest, a dense ombrophilous forest in the coastal region of the state (Câmara 2003).

This paper presents a compilation of the tenuipalpid species reported from Bahia, including published and five new species records from twenty-nine plant species/varieties in fifteen municipalities, along with an illustrated identification key to all species and a map locating each record in the biomes where they were collected.

## Materials and methods

The checklist of the tenuipalpid mites reported from the Bahia state territory includes all the species records published in periodical journals, annals, and/or books, and newly identified specimens collected in the present study. The acquisition of published records was based on internet searches, the catalog of Mesa *et al.* (2009), and the database of Castro *et al.* (2022a). All the records were confirmed through direct consultation with original publications, voucher specimens and the type image reference at the Flat Mites of the World.

Mite specimens collected between March 2007 and November 2021 from fifteen municipalities in the Bahia state territory, northeastern Brazil were identified for the present study. Samples consisted of leaves and branches of twenty-nine plant species/varieties in seventeen families: Anarcadiaceae – (1) *Spondias mombin*; Arecaceae – (2) *Cocos nucifera*, (3) *Euterpe oleracea*, (4) *Veitchia merrillii*; Boraginaceae – (5) *Cordia trichotoma*; Bromeliaceae – (6) *Ananas comosus*; Euphorbiaceae – (7) *Hevea brasiliensis*; Heliconiaceae – (8) *Heliconia bihai*, (9) *Heliconia psittacorum* x *H. spathocircinada* cv. Golden Torch, (10) *Heliconia rostrata*, (11) *Heliconia* sp., (12) *Heliconia* sp. var. Irish Red; Lecythidaceae – (13) *Lecythis lurida*; Malpighiaceae – (14) *Malpighia emarginata*; Malvaceae – (15) *Malvaviscus arboreus*, (16) *Theobroma cacao*, (17) *Theobroma grandiflorum*; Musaceae – (18) *Musa* sp.; Myrtaceae – (19) *Psidium guajava*; Orchidaceae – (20) *Phalaenopsis* sp.; Oxalidaceae – (21) *Averrhoa carambola*; Passifloraceae – (22) *Passiflora edulis*; Rubiaceae – (23) *Coffea arabica*, (24) *Morinda*

*citrifolia*; Rutaceae – (25) *Citrus* sp.; Zingiberaceae – (26) *Alpinia purpurata* var. Rose, (27) *Alpinia purpurata* var. Red, (28) *Etilingera elatior*, (29) *Zingiber spectabile*. Numbers in parenthesis referred to above for each plant species are presented in Table 1 with the respective sampling localities.

Leaves and branches samples collected on the field were placed in paper and/or polythene bags, and brought to the laboratory in polystyrene boxes containing Gelox, where they were stored at 10 °C for up to five days before analysis. Vegetal parts were inspected under a stereomicroscope (Leica EZ4) and all the tenuipalps found were mounted in Hoyer's medium (Krantz and Walter 2009). Mites were identified under Phase Contrast (PC) and Differential Interference Contrast (DIC) microscopy (Leica DM 2500 and Zeiss Imager D2). Voucher specimens were deposited in the Acarological Collection of Universidade Estadual de Santa Cruz (UESC), Ilhéus, Bahia, Brazil (AC-UESC).

The species names adopted in the checklist are those of Castro *et al.* (2022a), although alternative names and/or synonymies referred to in the publications are also presented. References to published records relating to each species are given under “Records in Bahia” in chronological order, followed by the first page the species record was provided in the original publication. Information concerning the sampling locality, plant species, month and year of collection, number of individuals, and the sex of all the tenuipalps examined and identified in the present study are provided under “Specimens examined”. When necessary, comments on

**Table 1** Localities and host plants from which tenuipalps mites were collected between March 2007 and November 2021 from the Bahia state territory, Brazil.

Municipality	Coordinates	Sampling locality	Host*
Arataca	15°15'38" S, 39°24'54" W	Açaí Point	3
Barra	11°05'23" S, 43°08'30" W	Urban area	2, 25
Camaçari	12°45'41" S, 38°16'54" W	Distrito de Machadinho	2, 18
Camamu	13°54'35" S, 39°09'23" W	Fazenda Bela Vista	1, 2
Cruz das Almas	12°40'47" S, 39°05'21" W	Campus of EMBRAPA**	6
Ibirapitanga	14°16'41" S, 39°37'34" W	Assentamento Serra de Areia	22
	13°88'78" S, 39°38'02" W	Jacuba (Distrito de Itamaraty)	25
Igrapiúna	13°49'31" S, 39°07'50" W	Distrito de Limeira	2, 3
Ilhéus	14°46'58" S, 39°13'16" W	Campus of CEPLAC**	7, 16, 18
	14°47'53" S, 39°10'20" W	Campus of UESC**	1, 2, 5, 7, 10, 12, 13, 14, 15, 16, 17, 22, 23, 24, 25, 28, 29
	14°49'00" S, 39°04'00" W	Fazenda Olho D'Água	28
	14°50'35" S, 39°11'35" W	Fazenda Santo Antônio	25
	14°79'78" S, 39°17'87" W	Fazenda Sossego	25
	14°43'52" S, 39°09'16" W	Fazenda Terra Nova	10, 16
	14°79'63" S, 39°20'08" W	Rodovia BR-415	11
	14°49'33" S, 39°05'00" W	Urban área	20
Itabuna	14°43'29" S, 39°20'42" W	Fazenda Monte Alegre	2, 9, 18, 19, 26, 27
Ituberá	13°46'29" S, 39°11'04" W	Colônia Japonesa	2
	13°45'23" S, 39°10'58" W	Fazenda Frupical	3, 16, 18
Lauro de Freitas	12°89'90" S, 38°32'63" W	Campus of UNEB**	4, 11
	12°53'38" S, 38°19'40" W	Urban area	4
Riachão das Neves	11°54'48" S, 44°52'49" W	Viveiro Biobrasil	16
Taperoá	13°33'52" S, 39°12'06" W	Fazenda Nossa Senhora Auxiliadora	21
Uruçuca	14°59'33" S, 39°28'02" W	Campus of IFBA**	25
	14°35'38" S, 39°16'56" W	Fazenda Guarani	2
	14°35'52" S, 39°19'55" W	Fazenda Liberdade	2, 9, 18, 26, 27
Valença	13°21'29" S, 39°10'27" W	Fazenda Barra	8, 28

\* Corresponding to plant species/scientific name numbered in the text.

\*\* CEPLAC (Comissão Executiva do Plano da Lavoura Cacaueira); EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária); IFBA (Instituto Federal da Bahia); UESC (Universidade Estadual de Santa Cruz); UNEB (Universidade do Estado da Bahia).

both the identifications in the published records and of the specimens identified in the present study, are provided under “Remarks”. To help identify all the species presented in the checklist, an illustrated identification key for females, partially based on Beard *et al.* (2015) and Castro *et al.* (2022b), is provided, with photographs of distinctive characters referred to in the text. The photographs used in the illustrated key were obtained from the material collected in the present study, and from the Universidade Estadual de Santa Cruz (UESC) and United States Department of Agriculture (USDA) reference collections.

## Results

Thirty-two papers to date have reported tenuipalpids from Bahia, and refer to a total of 11 species. Approximately 72% of those papers refer to the genus *Brevipalpus*, 16% to *Tenuipalpus*, 9% to *Raoiella*, and 3% to *Dolichotetranychus*. Five new species records were identified for the state, and are marked with an asterisk (\*) in the list below. A total of thirteen species in four genera were identified in the present study, with 8 of these having been previously recorded. There were 3 previously recorded species that were not recollected in the present study, *Brevipalpus obovatus*, *Tenuipalpus odoratus*, and *Tenuipalpus orchidofilo*. Both published and new records are provided in the checklist below. The distribution of the records in Bahia are presented in relation to the three biomes in Figure 1.

### Genus *Brevipalpus* Donnadieu, 1875

#### *Brevipalpus californicus* (Banks, 1904) sensu lato

Records in Bahia. Bondar, 1928: 39 (as *Tenuipalpus californicus*); Silva *et al.* 2022: 1; present study.

Specimens examined. UESC, ex. *H. brasiliensis*, Nov 2021 (2 ♀♀).

Remarks. The *californicus* group is composed of species of various morphological types identified as *B. californicus* sensu lato in Beard *et al.* (2013), and it has been accepted that this taxon name represents a species complex that is currently under revision (Tassi and Ochoa, personal communication). The morphology of the only two females collected in the present study is similar to the original description by Banks (1904) and to the photos of *B. californicus* sensu lato presented by Beard *et al.* (2013).

#### \**Brevipalpus feresi* Ochoa & Beard, 2015

Records in Bahia. Present study.

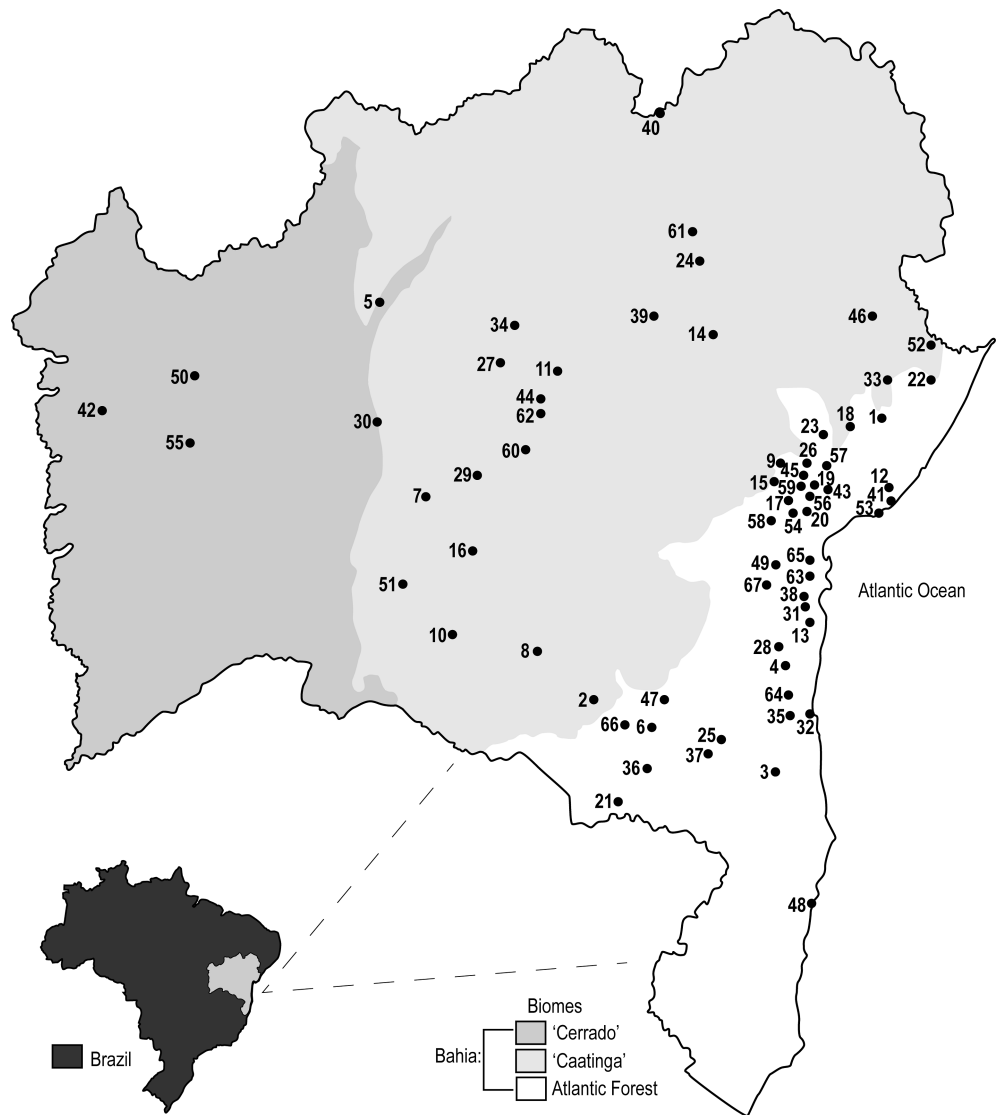
Specimens examined. Limeira, ex. *E. oleracea*, Jun 2017 (1 ♀); UESC, ex. *C. arabica*, Aug 2017 (2 ♀♀); UESC, ex. *H. rostrata*, Aug 2017 (2 ♀♀); UESC, ex. *C. arabica*, Nov 2017 (2 ♀♀); UESC, ex. *M. emarginata*, Nov 2017 (3 ♀♀); UESC, ex. *M. emarginata*, Jan 2018 (1 ♀).

Remarks. The morphology of females collected in the present study is similar to the original description by Beard *et al.* (2015), except for the dorsal setae of the opisthosoma, which are slightly shorter than the original description.

#### *Brevipalpus obovatus* Donnadieu, 1875

Records in Bahia. Bondar, 1928: 39 (as *Tenuipalpus bioculatus*); Flechtmann, 1976: 59; Cavalcante *et al.* 2006: 1; Laranjeira *et al.* 2011: 17; Noronha and Cavalcante 2011: 453.

Remarks. Some works suggest that there is intraspecific variation between specimens previously classified as *B. obovatus*, as was found for the *B. phoenicis* and *B. californicus* species complexes, which could also indicate a complex of species (Mesa *et al.* 2009; Navia *et al.* 2013; Alves *et al.* 2019). This species was not collected in the present study.



**Figure 1** Map indicating the municipalities in the Bahia state territory according to the biomes where each record referred in the tenuipalpid checklist is located: (1) Alagoinhas; (2) Anagé; (3) Arataca; (4) Aurelino Leal; (5) Barra; (6) Barra do Choça; (7) Boquira; (8) Brumado; (9) Cabaceiras do Paraguaçu; (10) Caetité; (11) Cafarnaum; (12) Camaçari; (13) Camamu; (14) Capim Grosso; (15) Castro Alves; (16) Caturama; (17) Conceição do Almeida; (18) Coração de Maria; (19) Cruz das Almas; (20) Dom Macedo Costa (21) Encruzilhada; (22) Esplanada; (23) Feira de Santana; (24) Filadélfia; (25) Firmino Alves; (26) Governador Mangabeira; (27) Ibipêba; (28) Ibirapitanga; (29) Ibitiara; (30) Ibotirama; (31) Igrapiúna; (32) Ilhéus; (33) Inhambupe; (34) Irecê; (35) Itabuna; (36) Itambé; (37) Itororó; (38) Ituberá; (39) Jacobina; (40) Juazeiro; (41) Lauro de Freitas; (42) Luís Eduardo Magalhães; (43) Maragogipe; (44) Mulungu do Morro; (45) Muritiba; (46) Nova Soure; (47) Planalto; (48) Porto Seguro; (49) Presidente Tancredo Neves; (50) Riachão das Neves; (51) Riacho de Santana; (52) Rio Real; (53) Salvador; (54) Santo Antônio de Jesus; (55) São Desidério; (56) São Felipe; (57) São Felix; (58) São Miguel das Matas; (59) Sapeaçu; (60) Seabra; (61) Senhor do Bonfim; (62) Souto Soares; (63) Taperoá; (64) Uruçuca; (65) Valença; (66) Vitória da Conquista; and (67) Wenceslau Guimarães.

**\**Brevipalpus papayensis* Baker, 1949**

Records in Bahia. Present study.

Specimens examined. UESC, ex. *C. arabica*, Aug 2017 (2 ♀♀); UESC, ex. *H. rostrata*, Aug 2017 (2 ♀♀); IFBA, ex. *Citrus* sp., Sep 2017 (2 ♀♀); UESC, ex. *C. arabica*, Nov 2017 (1 ♀); UESC, ex. *M. emarginata*, Nov 2017 (2 ♀♀); UESC, ex. *M. emarginata*, Jan 2018 (2 ♀♀); UESC, ex. *M. citrifolia*, Jul 2021 (1 ♀).

Remarks. The morphology of the females collected in the present study is similar to the original description by Baker (1949) and to the redescription presented in Beard *et al.* (2015); however, some specimens showed slight variation in the bands with mixed orientation on the genital plate compared with that presented in the latter work.

### ***Brevipalpus phoenicis* (Geijskes, 1939)**

Records in Bahia. Flechtmann and Abreu 1973: 249; Flechtmann, 1976: 58; Moraes and Flechtmann 1981: 183; Flechtmann and Arleu 1984: 124; Noronha *et al.* 1997: 373; Santos Filho *et al.* 1999: 5; Ribeiro *et al.* 2001: 2022; Fiaboe *et al.* 2007: 9; Oliveira *et al.* 2007: 257; Almeida *et al.* 2010: 1; Laranjeira *et al.* 2011: 17; Noronha and Cavalcante 2011: 453; Silva *et al.* 2012a: 1; Silva *et al.* 2012b: 17; Navia *et al.* 2013: 6; Almeida and Figueira 2014: 1; Laranjeira *et al.* 2015: 1; present study.

Specimens examined. F. Terra Nova, ex. *H. rostrata*, Sep 2007 (1 ♀); UESC, ex. *Z. spectabile*, Sep 2007 (1 ♀); F. Barra, ex. *E. elatior*, Nov 2007 (2 ♀♀); UESC, ex. *E. elatior*, May 2007 (1 ♀); F. Frupical, ex. *Musa* sp., Apr 2007 (2 ♀♀); UESC, ex. *Heliconia* sp. var. Irish Red, Sep 2007 (1 ♀); UESC, ex. *T. grandiflorum*, Jul 2021 (1 ♀).

Remarks. All the published records under the taxon name *B. phoenicis* in Bahia were provided before the publication of Beard *et al.* (2015), and should be considered questionable due to synonymies and historic misidentifications. In this way these records should be considered as *B. phoenicis* sensu lato. All the females collected in the present study have similar morphology to the redescription of *B. phoenicis* sensu stricto provided by Beard *et al.* (2015).

### ***Brevipalpus tuberellus* De Leon, 1960**

Records in Bahia. Alves *et al.* 2019: 2184; present study.

Specimens examined. CEPLAC, ex. *Musa* sp., Nov 2017 (1 ♀); UESC, ex. *L. lurida*, Mar 2018 (16 ♀♀, 1 DN, 11 PN, 7 LV).

Remarks. All the specimens of *B. tuberellus* included in the molecular phylogenetic analysis of Alves *et al.* (2019) and identified in the present study were collected from the municipality of Ilhéus by Kaélem S. Sousa. The morphology of the females is similar to the original description by De Leon (1960) and the redescription by Baker and Tuttle (1987).

### ***Brevipalpus yothersi* Baker, 1949**

Records in Bahia. Arena *et al.* 2016: 27; Ramos-González *et al.* 2016: 14; Mineiro *et al.* 2018: 4; Silva *et al.* 2022: 1; present study.

Specimens examined. F. Santo Antônio, ex. *Citrus* sp., Mar 2007 (2 ♀♀, 1 DN, 1 PN, 2 LV); F. Frupical, ex. *T. cacao*, Apr 2007 (1 ♀); F. Liberdade, ex. *A. purpurata* verm., Apr 2007 (1 ♀, 1 DN, 1 PN); F. Liberdade, ex. *A. purpurata* rosa, Apr 2007 (1 ♀, 1 DN); F. Liberdade, ex. *H. psittacorum* x *H. Spathocircinada* cv., Apr 2007 (2 ♀♀); F. Olho D'Água, ex. *E. elatior*, May 2007 (2 ♀♀, 1 DN); F. Terra Nova, ex. *T. cacao*, May 2007 (1 ♀); F. Liberdade, ex. *Musa* sp., May 2007 (1 ♀); F. F. N. S. Auxiliadora, ex. *A. carambola*, Jul 2007 (1 ♀); F. Monte Alegre, ex. *P. guajava*, Oct 2007 (3 ♀♀, 2 DN); UESC, ex. *Citrus* sp., Sep 2011 (4 ♀♀); UESC, ex. *T. cacao*, Apr 2012 (1 ♀); A. Point, ex. *E. oleracea*, May 2016 (1 ♀); UESC, ex. *C. nucifera*, Aug 2017 (5 ♀♀, 5 DN, 2 PN); UESC, ex. *Citrus* sp., Aug 2017 (17 ♀♀); UESC, ex. *E. elatior*, Sep 2017 (1 ♀); IFBA, ex. *Citrus* sp., Sep 2017 (4 ♀♀); Jacuba (Itamarati), ex. *Citrus* sp., Sep 2017 (6 ♀♀); CEPLAC, ex. *Musa* sp., Nov 2017 (1 ♀); UESC, ex. *H. rostrata*, Nov 2017 (1 ♀); UESC, ex. *C. trichotoma*, Jan 2018 (11 ♀♀); UESC, ex. *M. emarginata*, Jan 2018 (1 ♀); A. Serra de Areia, ex. *P. edulis*, Jan 2018 (3 ♀♀); UESC, ex. *L. lurida*, Mar 2018 (1 ♀); UESC, ex. *P. edulis*, Mar 2018 (15 ♀♀); Urban area (Barra), ex. *Citrus* sp., May 2019 (48 ♀♀, 7 DN); UESC, ex. *P. edulis*, Jan 2021 (4 ♀♀, 3 DN, 5 PN, 5 LV); CEPLAC, ex. *T. cacao*, Apr 2021 (3 ♀♀, 2 LV); Rod. BR-415, ex. *Heliconia* sp., Jun 2021 (3 ♀♀, 1 DN, 2



LV); UESC, ex. *M. arboreus*, Jul 2021 (8 ♀♀); F. Sossego, ex. *Citrus* sp., Nov 2021 (1 ♀); V. Biobrasil, ex. *T. cacao*, Nov 2021 (15 ♀♀, 8 DN, 6 PN, 5 LV).

Remarks. The morphology of females collected in the present study is similar to the original description by Baker (1949) and to the redescription presented by Beard *et al.* (2015).

## **Genus *Dolichotetranychus* Sayed, 1938**

### ***Dolichotetranychus floridanus* (Banks, 1900)**

Records in Bahia. Sanches and Flechtmann 1982: 151; present study.

Specimens examined. EMBRAPA, ex. *A. comosus*, Aug 2016 (15 ♀♀).

Remarks. The morphology of the females collected in the present study is similar to the redescription presented in Baker and Pritchard (1956).

## **Genus *Raoiella* Hirst, 1924**

### ***Raoiella indica* Hirst, 1924**

Records in Bahia. Melo *et al.* 2018: 148; Nuvoloni *et al.* 2021: 1769; Nuvoloni *et al.* 2022: 1; present study.

Specimens examined. UNEB, ex. *V. merrillii*, Sep 2017 (16 ♂♂, 11 ♀♀); Urban area (L. de Freitas), ex. *V. merrillii*, Sep 2017 (18 ♂♂, 41 ♀♀); UNEB, ex. *Heliconia* sp., Sep 2017 (13 ♂♂, 36 ♀♀); Machadinho, ex. *Musa* sp., Sep 2017 (15 ♂♂, 18 ♀♀, 1 DN); Machadinho, ex. *C. nucifera*, Sep 2017 (31 ♂♂, 83 ♀♀, 5 DN, 6 PN); Urban area (Barra), ex. *C. nucifera*, May 2019 (1 ♂, 3 ♀♀).

Remarks. The morphology of the females collected in the present study is similar to the redescription presented by Beard *et al.* (2018).

## **Genus *Tenuipalpus* Donnadieu, 1875**

### **\**Tenuipalpus coyacus* De Leon, 1957**

Records in Bahia. Present study.

Specimens examined. F. Frupical, ex. *E. oleracea*, Apr 2007 (1 ♀); F. Liberdade, ex. *C. nucifera*, May 2007 (1 ♀); F. Bela Vista, ex. *C. nucifera*, Aug 2007 (23 ♀♀); C. Japonesa, ex. *C. nucifera*, Nov 2008 (3 ♀♀); F. Guarani, ex. *C. nucifera*, Jun 2016 (2 ♀♀, 2 DN, 2 PN); Limeira, ex. *C. nucifera*, Jun 2017 (2 ♀♀).

Remarks. The morphology of the females collected in the present study is similar to the redescription presented by Castro *et al.* (2019).

### ***Tenuipalpus heveae* Baker, 1945**

Records in Bahia. Castro *et al.* 2013: 95; Castro *et al.* 2017: 421; Castro *et al.* 2018: 1578; present study.

Specimens examined. CEPLAC, ex. *H. brasiliensis*, Mar 2021 (1 ♂, 5 ♀♀, 1 LV).

Remarks. The morphology of the females collected in the present study is similar to the redescription presented by Castro *et al.* (2017).

### ***Tenuipalpus odoratus* Souza, Castro & Oliveira, 2019**

Records in Bahia. Souza *et al.* 2019: 544. This species was not collected in the present study.

### ***Tenuipalpus orchidofilo* Moraes & Freire, 2001**

Records in Bahia. Silva *et al.* 2022: 1. This species was not collected in the present study.

**\**Tenuipalpus pacificus* Baker, 1945**

Records in Bahia. present study

Specimens examined. Urban area (Ilhéus), ex. *Phalaenopsis* sp., Apr 2019 (8 ♂♂, 36 ♀♀, 12 DN, 12 PN, 20 LV).

Remarks. The morphology of the females collected in the present study is similar to the original description by Baker (1945) and to the redescrptions presented by Meyer (1993) and Beard *et al.* 2013.

***Tenuipalpus panici* De Leon, 1965**

Records in Bahia. Nascimento *et al.* 2022: 2196.

**\**Tenuipalpus uvae* De Leon, 1962**

Records in Bahia. Present study.

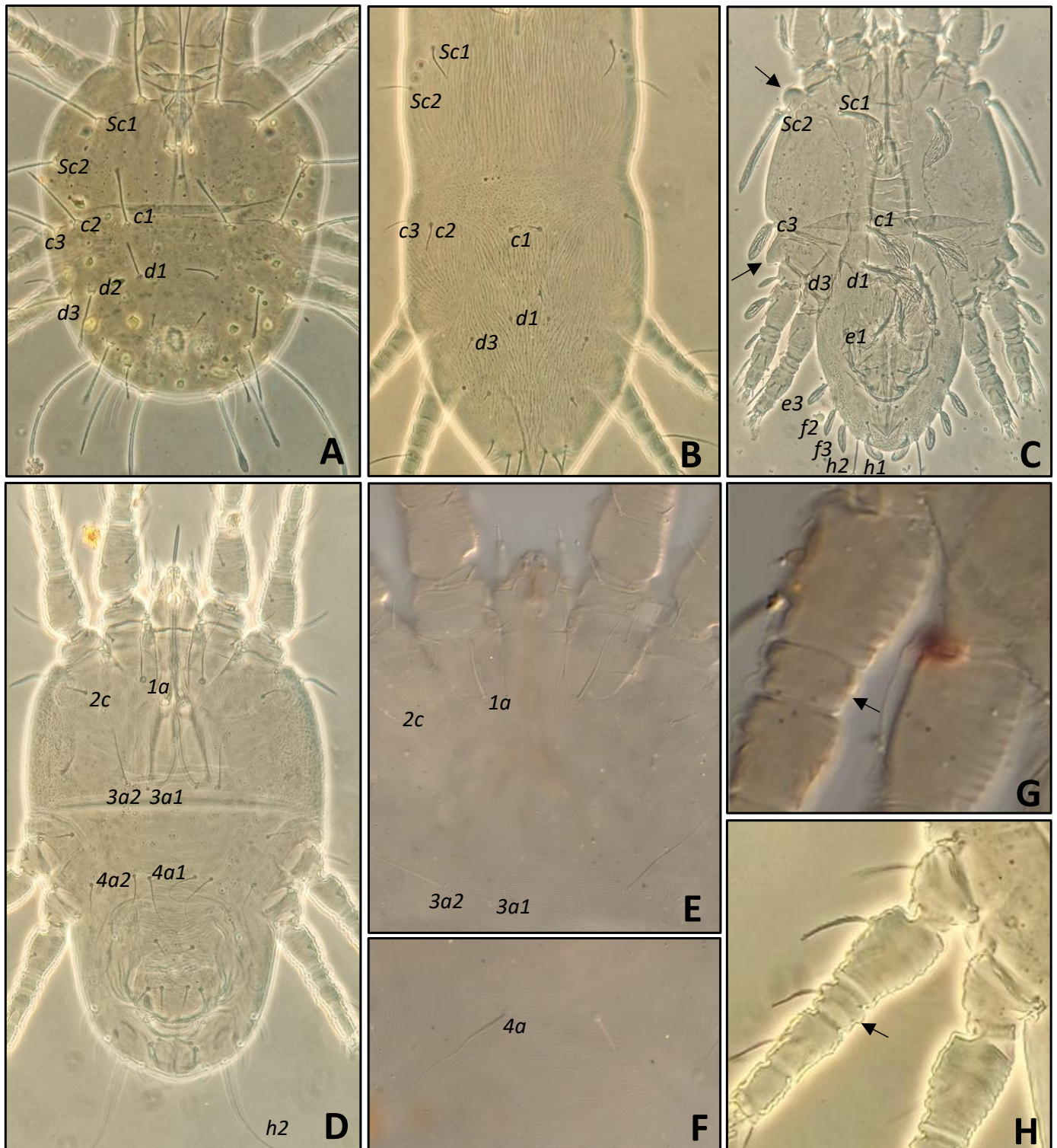
Specimens examined. F. Bela Vista, ex. *S. mombin*, Apr 2007 (2 ♂♂, 2 ♀♀, 2 DN, 1 LV); F. Barra, ex. *H. bihai*, Aug 2007 (1 ♀); UESC, ex. *S. mombin*, Aug 2017 (1 ♂, 5 ♀♀, 1 DN).

Remarks. The morphology of the females collected in the present study is similar to the original description by De Leon (1962).

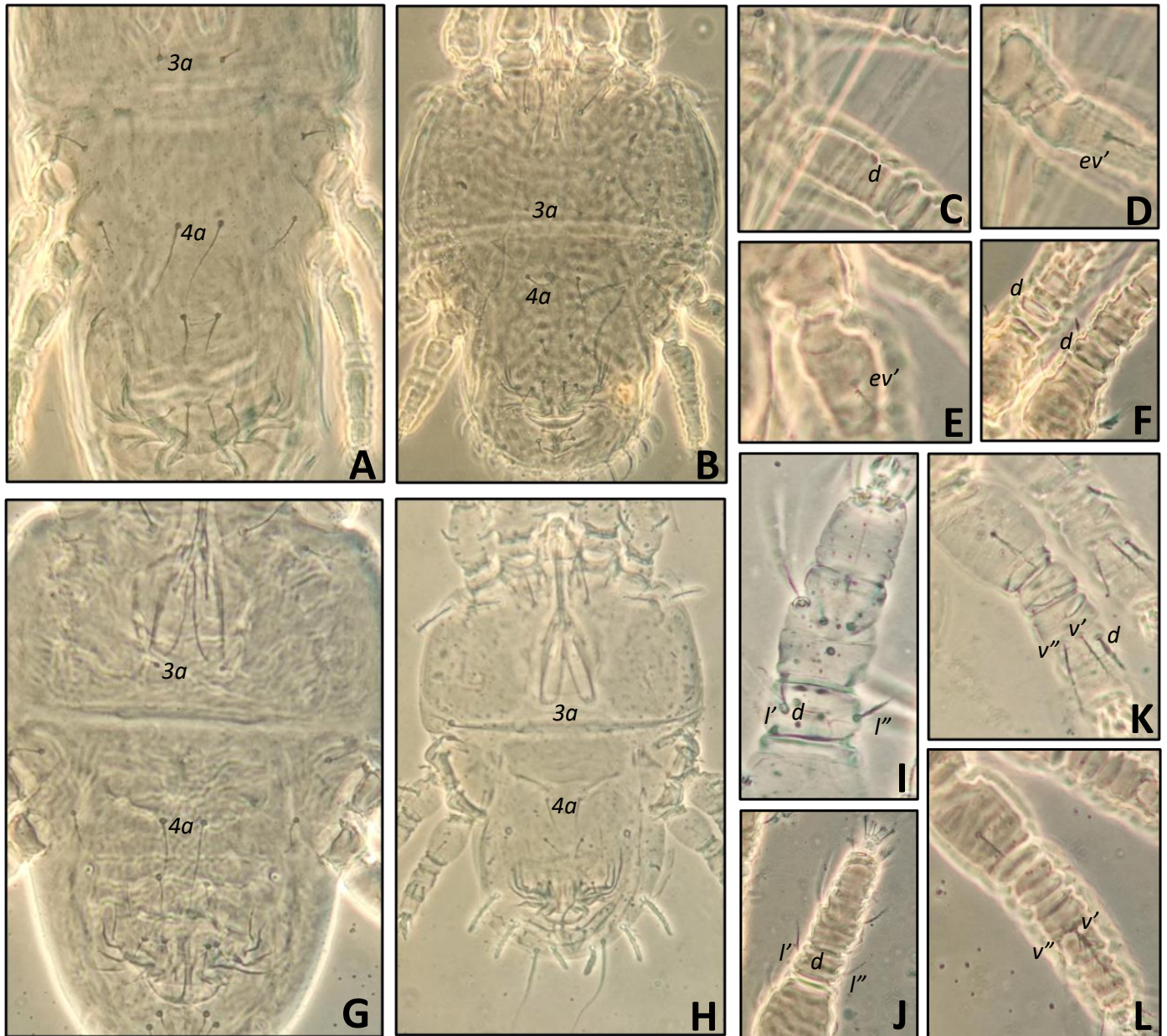
**Key to the 16 tenuipalpid species reported from Bahia state territory**

Based on adult females.

1. Opisthosoma with three setae in setal row C (*c1*, *c2* and *c3*) (Figures 2A, B) ..... 2
  - Opisthosoma with two setae in setal row C (*c1* and *c3*) (Figure 2C) ..... 3
2. Opisthosoma with three setae in setal row D (*d1*, *d2* and *d3*) (Figure 2A) .....
  - ..... *Raoiella*: *R. indica*
  - Opisthosoma with two setae in setal row D (*d1* and *d3*) (Figure 2B) .....
    - ..... *Dolichotetranychus*: *D. floridanus*
3. Opisthosoma with setae *h2* long and whip-like, at least four times longer than other dorsal opisthosomal setae (Figures 2D, 3H) ..... *Tenuipalpus* 4
  - Opisthosoma with setae *h2* not whip-like, similar in form to other dorsal opisthosomal setae (Figures 4A, E, H) ..... *Brevipalpus* 10
4. Dorsal idiosoma with a pair of lateral projections anterior of prodorsal seta *sc2* and lateral to anterior opisthosomal seta *c3* (Figure 2C) ..... *T. coyacus*
  - Dorsal idiosoma without lateral projections anterior of prodorsal seta *sc2* and lateral to anterior opisthosomal seta *c3* (Figure 2D) ..... 5
5. Coxisternal region with two pairs of setae *3a* (*3a1* and *3a2*) (Figures 2D, E) ..... 6
  - Coxisternal region with a single pair of setae *3a* (Figures 3A, B, G, H) ..... 7
6. Coxisternal region with two pairs of setae *4a* (*4a1* and *4a2*) (Figure 2D); genu III with one seta (Figure 2H) ..... *T. pacificus*
  - Coxisternal region with a single pair of setae *4a* (Figure 2F); genu III nude (Figure 2G) .....
    - ..... *T. orchidofilo*
7. Femur IV with two setae (*d* and *ev'*) (Figures 3C, D) ..... *T. panici*
  - Femur IV with one seta (*ev'*) (Figure 3E) ..... 8



**Figure 2** Diagnostic characters of adult female flat mites referred to in the identification key of the tenuipalpid species reported from Bahia: A – *Raoiella indica* (dorsum, PC); B – *Dolichotetranychus floridanus* (dorsum, PC); C – *Tenuipalpus coyacus* (dorsum with lateral projections indicated by the arrows, PC); D – *T. pacificus* (venter, PC); E – *T. orchidofilo* (venter, DIC); F – *T. orchidofilo* (venter, DIC); G – *T. orchidofilo* (genu III indicated by the arrow, DIC); H – *T. pacificus* (genu I indicated by the arrow, PC).

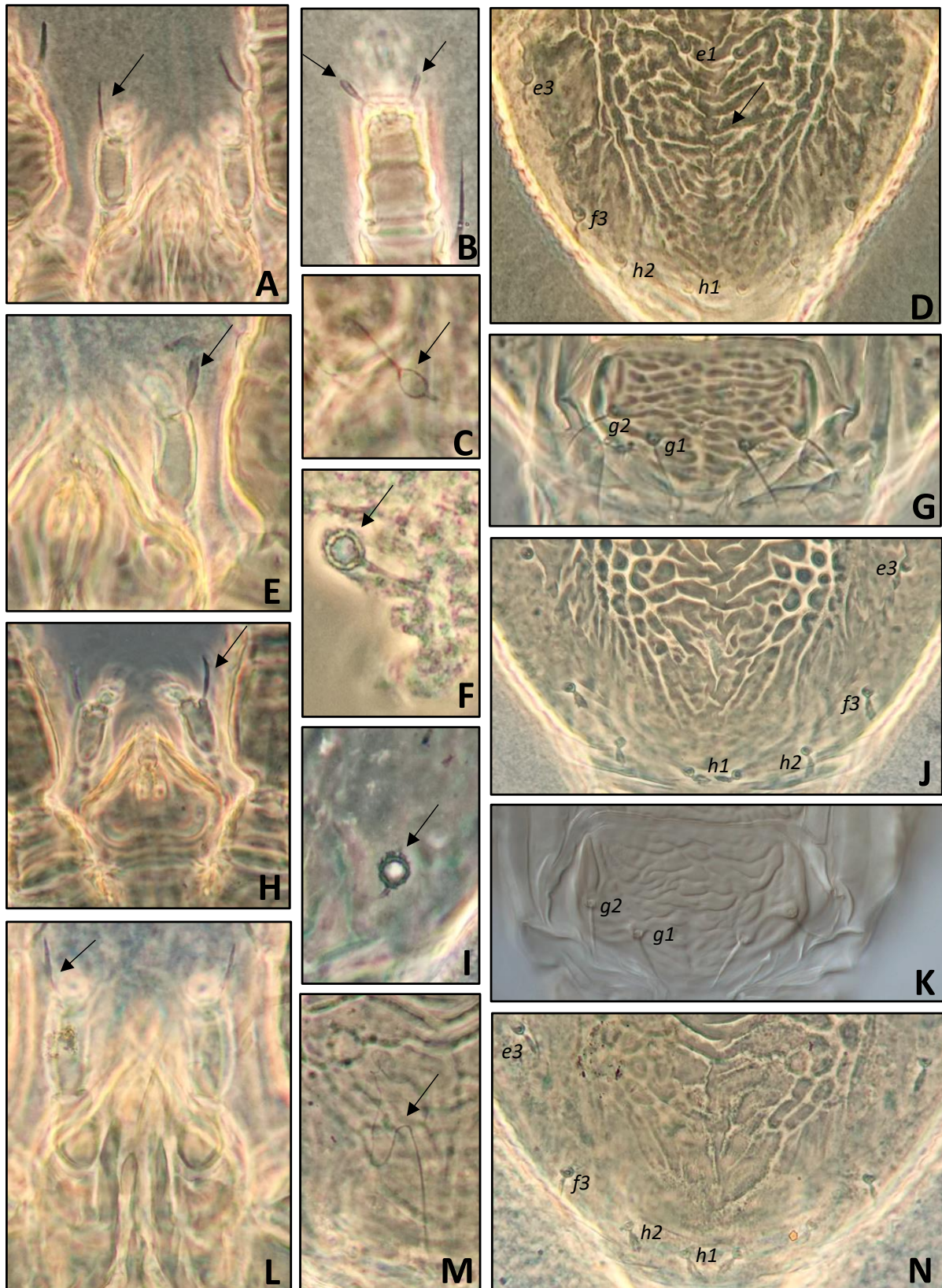


**Figure 3** Diagnostic characters of adult female flat mites referred to in the identification key of the tenuipalpid species reported from Bahia: A – *Tenuipalpus panici* (venter, PC); B – *T. heveae* (venter, PC); C – *T. panici* (femur IV dorsum, PC); D – *T. panici* (femur IV venter, PC); E – *T. heveae* (femur IV, PC); F – *T. heveae* (genua I and II, PC); G – *T. odoratus* (venter, PC); H – *T. uvae* (venter, PC); I – *T. uvae* (genu I, PC); J – *T. odoratus* (genu II, PC); K – *T. uvae* (tibia IV, PC); L – *T. odoratus* (tibia IV, PC).

- 8. Genua I and II with one seta each (*d*) (Figure 3F)..... *T. heveae*  
 — Genua I and II with three setae each (*d*, *l'* and *l''*) (Figures 3I, J) ..... 9
- 9. Tibia IV with three setae (*d*, *v'* and *v''*) (Figure 3K)..... *T. uvae*  
 — Tibia IV with two setae (*v'* and *v''*) (Figure 3L)..... *T. odoratus*
- 10. Opisthosoma with two setae in setal row F (*f2* and *f3*) (Figures 4A, E) ..... 11  
 — Opisthosoma with one seta setal row F (*f3*) (Figures 4H, 5D) ..... 12



**Figure 4** Diagnostic characters of adult female flat mites referred to in the identification key of the tenuipalpid species reported from Bahia: A – *Brevipalpus californicus* (dorsum, PC); B – *B. californicus* (tarsus II, PC); C – *B. californicus* (spermatheca, PC); D – *B. tuberellus* (spermatheca, PC); E – *B. tuberellus* (dorsum, PC); F – *B. tuberellus* (tarsus II, PC); G – *B. tuberellus* (seta v2, PC); H – *B. obovatus* (dorsum, DIC); I – *B. obovatus* (tarsus II, DIC); J – *B. obovatus* (spermatheca, DIC); K – *B. obovatus* (seta of the palp, DIC).



**Figure 5** Diagnostic characters of adult female flat mites referred to in the identification key of the tenuipalpid species reported from Bahia: A – *Brevipalpus yothersi* (seta of the palp, PC); B – *B. yothersi* (tarsus II, PC); C – *B. yothersi* (spermatheca, PC); D – *B. yothersi* (dorsum, PC); E – *B. papayensis* (seta of the palp, PC); F – *B. papayensis* (spermatheca, PC); G – *B. papayensis* (genital plate, PC); H – *B. feresi* (seta of the palp, PC); I – *B. feresi* (spermatheca, PC); J – *B. feresi* (dorsum, PC); K – *B. feresi* (genital plate, DIC); L – *B. phoenicis* (seta of the palp, PC); M – *B. phoenicis* (spermathecal duct, PC); N – *B. phoenicis* (dorsum, PC).

11. All dorsal setae (*v2*, *sc1*, *sc2*, *c1*, *c3*, *d1*, *d3*, *e1*, *e3*, *f2*, *f3*, *h1* and *h2*) with similar size and shape (Figure 4A); tarsus II with two solenidia (Figure 4B); spermatheca vesicle rounded, with thick walls, a series of fine finger-like projections along the distal margin, and a bubble internally (Figure 4C) . . . . . ***B. californicus* s.l.**  
 — Dorsocentral setae flattened (*c1*, *d1*, *e1* and *h1*) and much larger than dorsolateral seta (*c3*, *d3*, *e3*, *f2*, *f3* and *h2*) (Figures 4E, G); tarsus II with one solenidion (Figure 4F); spermatheca vesicle oval, with fine walls, without distal projections, and no internal bubble (Figure 4D) . . . . . ***B. tuberellus***
12. Tarsus II with one solenidion distally (Figure 4I) . . . . . ***B. obovatus***  
 — Tarsus II with two solenidia distally (Figure 5B) . . . . . 13
13. Palp femorogenu with a narrow dorsal seta (Figure 5A); spermatheca vesicle oval, with a strong distal stipe (Figure 5C); cuticle on dorsal opisthosoma between setae *e1-e1* to *h1-h1* usually with strong chevrons (V-shaped folds), becoming much weaker towards *h1-h1* (Figure 5D) . . . . . ***B. yothersi***  
 — Palp femorogenu with a broad flat dorsal seta (Figure 5E); spermatheca vesicle rounded, without stipe, or spermatheca often not developed (Figures 5F, I, M); cuticle on dorsal opisthosoma between setae *e1-e1* to *h1-h1* without strong chevrons (Figure 5J) . . . . . 14
14. Genital plate with mostly transversely aligned elements, with “warts” or cell elements fused to form transverse bands (Figure 5G) . . . . . ***B. papayensis***  
 — Genital plate not as above, with “warts” or cell elements fused to form large cells (Figure 5K) . . . . . 15
15. Opisthosoma with setae *e3*, *f3*, *h1*, *h2* broad, 9–13 µm long (Figure 5J); spermatheca vesicle rounded (Figure 5I) . . . . . ***B. feresi***  
 — Opisthosoma with setae *e3*, *f3*, *h1*, *h2* moderately broad, 7–10 µm long (Figure 5N); spermatheca vesicle not visible, spermathecal duct ends in a membranous bulb (Figure 5M) . . . . . ***B. phoenicis* s.s.**

## Discussion

With the 5 new species records of *B. feresi*, *B. papayensis*, *T. coyacus*, *T. pacificus* and *T. uvae* presented in the present study, the number of Tenuipalpidae species reported from Bahia state is raised to 16. The majority of published flat mite records in the checklist referred to *B. phoenicis*. As highlighted in the remarks for that species record, literature prior to Beard *et al.* (2015) should be considered to be *B. phoenicis* sensu lato until vouchers are examined to confirm the specific identification. On the other hand, females collected in the present study were able to be confirmed as *B. phoenicis* sensu stricto. Among the specimens collected in the present study, the most frequently identified species were (in descending order): *B. yothersi*, *B. papayensis*, *B. feresi*, *R. indica* and *T. coyacus*. The species *Brevipalpus yothersi*, *B. papayensis* and *R. indica*, together with *D. floridanus*, *T. heveae*, *T. pacificus*, *B. phoenicis* s.l., *B. californicus* and *B. obovatus* are all considered to be pests around the world (Hoy 2011; Vacante 2015; Beard *et al.* 2013, 2015, 2018; Kitajima 2020; Lillo *et al.* 2021).

The red palm mite, *R. indica*, is an important pest of bananas, coconut and other Arecaceae worldwide (Flechtmann and Etienne 2004; Hoy 2011; Kane *et al.* 2012; Vacante 2015), and has been reported causing damage to the açai palm *Euterpe oleracea* in southern Bahia (Nuvoloni *et al.* 2021). Among the samples collected in the present study, damage to coconut *Cocos nucifera* and manilla palm *Veitchia merrillii* were also observed. Coconut leaves were observed with large numbers of chlorotic points, necrosis, dryness and even death of the basal leaves,

while young leaves appeared completely browned on the ornamental palm *V. merrillii* due to the removal of cell contents by *R. indica*, and caused the plant to enter into premature senescence.

Although *D. floridanus*, an important pest of pineapple in several countries (Hoy 2011; Beard *et al.* 2013; Vacante 2015; Seeman *et al.* 2016), has been reported from pineapple in Bahia by Sanches and Flechtmann (1982) in association with leaf necrosis, samples collected in the present study did not show any obvious damage produced by the mite. Likewise, the flat mite *T. heveae*, an important pest of *Hevea brasiliensis* (see Pontier *et al.* 2000), was not observed to be causing significant damage in the present study, even though damage to some rubber tree clones has previously been reported in Bahia (Castro *et al.* 2013). On the other hand, severe damage by *T. pacificus*, a pest of orchids worldwide (Pritchard 1951; Krantz and Walter 2009), was observed on *Phalaenopsis* sp. in the present study, with leaves presenting a large number of chlorotic points. Damage to the orchid *Dendrobium phalaenopsis* were recently reported in the state of Bahia, and was probably caused by the flat mites *T. orchidofilo*, *B. yothersi* and *B. californicus* (see Silva *et al.* 2022).

There are known or implicated vectors of plant viruses among the *Brevipalpus* species reported in the present study. *Brevipalpus yothersi* is a vector of CiLV-C (Ramos-González *et al.* 2016) and PFGSV (Ramos-Gonzalez *et al.* 2020); *B. papayensis* is considered a vector of CiLV-C and CoRSV (Nunes *et al.* 2018); *B. phoenicis* s.l. is implicated in the possible transmission of Zoned chlorosis in citrus trees (Kitajima 2020); *B. californicus* is considered a vector of Orchid fleck virus (OFV) (Garcia-Escamilla *et al.* 2018; Beltran-Beltran *et al.* 2020; Fife *et al.* 2021); and finally *B. obovatus* is considered a vector of Solanum violifolium ringspot virus (SvRSV) (Ramos-Gonzalez *et al.* 2022).

The State of Bahia is located in the Northeast of Brazil and includes three natural Brazilian biomes, the “Cerrado”, “Caatinga” and Atlantic Forest, each characterized by different physical and biological characteristics including soil, rain and vegetation (Santos *et al.* 2018). Although tenuipalpid mites were found in all three biomes in Bahia state territory, the number of records was much higher in the Atlantic Forest, with 61% of all reports from this biome, followed by the “Caatinga” (33%) and the “Cerrado” (6%). Based on that irregular distribution, the importance of more studies in the “Cerrado” and “Caatinga” biomes becomes clear, especially as these latter biomes have a warm climate that could be favorable to tenuipalpid species (Baker and Tuttle 1987; Laranjeira *et al.* 2015).

This study presents an overview of the tenuipalpid species reported from the Bahia state territory, expanding the known records and host plants for this family of mites. Given the importance of this family as phytophagous pests and disease vectors, further collections that include ornamentals, fruit, and commercial plantations, should be undertaken to understand the effect of environmental factors present in each biome on the frequency and abundance of tenuipalpid species, especially in the “Cerrado” and “Caatinga”.

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## ORCID

Renata S. Nascimento  <https://orcid.org/0009-0008-8235-0261>

Kaélem S. Souza  <https://orcid.org/0009-0007-5762-5609>



Elisângela A. S. F. Melo  <https://orcid.org/0000-0001-8849-7311>  
 Aline D. Tassi  <https://orcid.org/0000-0002-8622-5977>  
 Elizeu B. Castro  <https://orcid.org/0000-0002-8056-6893>  
 Denise Navia  <https://orcid.org/0000-0003-3716-4984>  
 Renata S. de Mendonça  <https://orcid.org/0000-0002-0514-6442>  
 Ronald Ochoa  <https://orcid.org/0000-0003-1680-3601>  
 Anibal R. Oliveira  <https://orcid.org/0000-0001-8313-9953>

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