New Report of Brevipalpus yothersi (Prostigmata: Tenuipalpidae) on Blueberry in Florida

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Source: Florida Entomologist, 100(4) : 731-739

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.100.0420

New report of *Brevipalpus yothersi* (Prostigmata: Tenuipalpidae) on blueberry in Florida

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Abstract

Brevipalpus yothersi (Baker, 1949) (Prostigmata: Tenuipalpidae) is newly reported on southern highbush blueberry, *Vaccinium corymbosum* L. X *V. darrowi* Camp (Ericaceae), in Florida, USA. The specimens were collected from a commercial southern highbush blueberry planting of Abundance, Emerald, and Meadowlark blueberry varieties from Sep to Nov 2016. The species is described based on morphological (light microscopy, scanning electron microscopy) methods. Information on its economic importance, host plants, and geographical distribution also is provided.

Key Words: false spider mite; flat mite; new record; *Vaccinium* spp.

Resumen

Brevipalpus yothersi Baker, 1949 (Prostigmata: Tenuipalpidae) es reportada por primera vez en arándano del sur *Vaccinium corymbosum* L. X *V. darrowi* Camp (Ericaceae), en Florida, Estados Unidos. Especímenes fueron colectados en una plantación comercial con tres variedades de arándano del sur (Abundance, Emerald y Meadowlark) entre Sep a Nov de 2016. La especie fue descrita con base en métodos de identificación morfológica (microscopía óptica y microscopía electrónica de barrido). Información sobre su importancia económica, plantas hospederas y distribución geográfica está incluida a continuación.

Palabras Clave: falsa araña roja, ácaro plano, nuevo reporte, *Vaccinium* spp.

The family Tenuipalpidae is known as false spider mites or flat mites. It contains over 1,100 valid species belonging to 38 genera (Vacante 2015). Members of the genus *Brevipalpus* Donnadieu, 1875, one of the dominant genera in the family, are considered as the most economically important group of species among the flat mites (Childers et al. 2003; Salinas-Vargas et al. 2016). These mites cause direct damage by inserting their mouthparts into plant tissues and sucking sap. They also inject their toxic saliva into the plant during feeding (Childers & Rodrigues 2011). Furthermore, several of these mites transmit viruses to host plants (Mesa et al. 2009; Salinas-Vargas et al. 2016).

Brevipalpus yothersi (Baker, 1949) (Prostigmata: Tenuipalpidae) is one of the more important flat mites, causing economic damage to many crop plants (Novelli et al. 2016). It was recently suggested to be the vector for cytoplasmic leprosis viruses (citrus leprosis virus C, citrus leprosis virus C2, and Hibiscus green spot virus 2) (Roy et al. 2015).

Brevipalpus yothersi was synonymized with *B. phoenicis* by Pritchard & Baker (1952) but Beard et al. (2015a) raised it again to species level and gave an extensive account of its distribution and host plants. But, so far, there have been no records of *B. yothersi* on blueberries grown in Florida. This paper reports blueberry as a new host of *B. yothersi* from Florida. Additionally, measurements (range in µm) of the Florida specimens, information regarding collection details, habitats, hosts, damage, and world distribution are also presented in this paper.

Material and Method

COLLECTION OF SAMPLES

Mites were collected from 3 different southern highbush blueberry varieties, Abundance, Emerald, and Meadowlark, from Sep to Nov 2016. Approximately 30 to 50 leaves per blueberry bush were collected every 2 weeks and samples were taken randomly from an organic commercial farm in Eustis, Florida, USA (28.8692°N, 81.63023°W; 38 masl). Samples were placed separately (according to variety) into 3.7 L zipper storage bags, labeled, and brought to the laboratory. There, the mites were collected from the leaves under a stereomicroscope. Specimens were preserved in vials containing 70% ethanol.

LIGHT MICROSCOPY

Mite specimens were cleared in Lacto-phenol, mounted in Hoyer's solution on microscope slides, and dried in an oven at 50 °C. Light microscopy photographs were taken with a JVC KY-F70B digital camera, and automontage pro software (version 5.02, Syncroscopy, Frederick, Maryland, USA) mounted on a Leica DMLB compound microscope. For identification, the following keys were used: Baker et al. (1975); Ghai & Shenhmar (1984); Baker & Tuttle (1987); Welbourn et al. (2003); Mesa et al. (2009); Beard et al. (2015a); and Çobanoğlu et al. (2016).

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All specimens were deposited in the mite collection of Ordu University, Agricultural Faculty, Plant Protection Department, Ordu, Turkey.

Photos of living mites were taken with a digital camera mounted on a stereoscopic microscope LEICA M205 C (Leica Microsystems Inc., Buffalo Grove, Illinois, USA) connected to a computer.

SCANNING ELECTRON MICROSCOPY (SEM)

To prepare specimens for electron microscopy, the method of Çobanoğlu et al. (2011) was used. Briefly, the samples were fixed in 70% alcohol. After fixation, the samples were dehydrated in an alcohol series (70%, 80%, 90%, 100%, and 100%) for 30 m each. Dehydrated specimens were critical-point-dried, and mounted on SEM stubs. Mounted samples were coated with gold/palladium (20 nm). The specimens were examined with a scanning electron microscope (FEI Nova 430 w/EDS & CL, Nanoscale Research Facility, University of Florida, Gainesville, Florida, USA).

Results

Family Tenuipalpidae Berlese

Type genus—*Tenuipalpus* Donnadieu, 1875

Genus *Brevipalpus* Donnadieu 1875

Type species: *Brevipalpus obovatus* Donnadieu 1875

Brevipalpus yothersi Baker 1949

New synonymies (Beard et al. 2015a):

Brevipalpus mcbridei Baker 1949
Brevipalpus deleoni Pritchard and Baker 1958
Brevipalpus phoenicoides Gonzalez 1975
Brevipalpus amicus Chaudhri 1972
Brevipalpus recula Chaudhri 1972

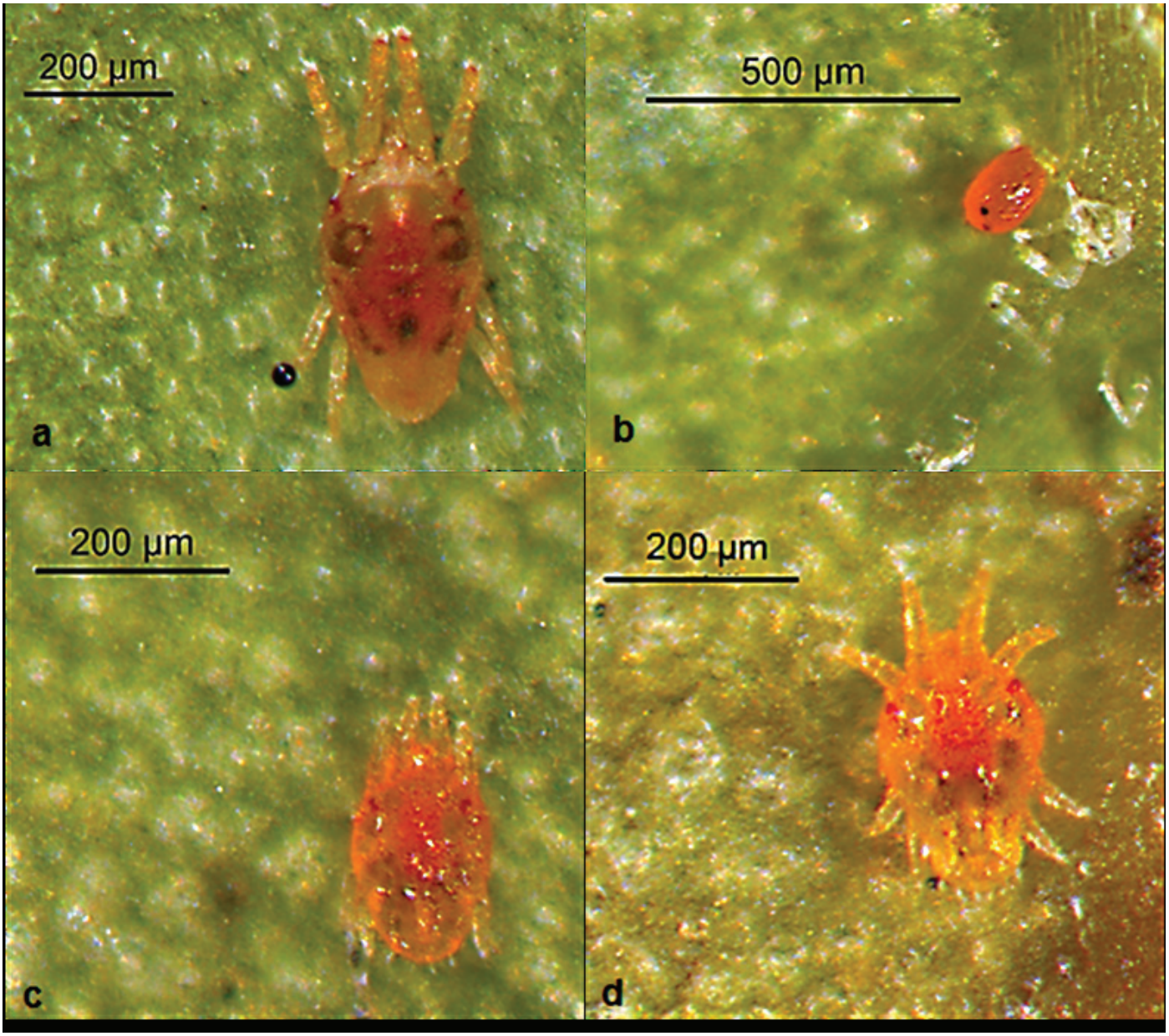

Fig. 1. *Brevipalpus yothersi* on blueberry (abundance) leaf - adult (a), egg (b), larva (c), protonymph (d).

Fig. 2. *Brevipalpus yothersi* female - dorsal propodosoma (a), opisthosoma (b).

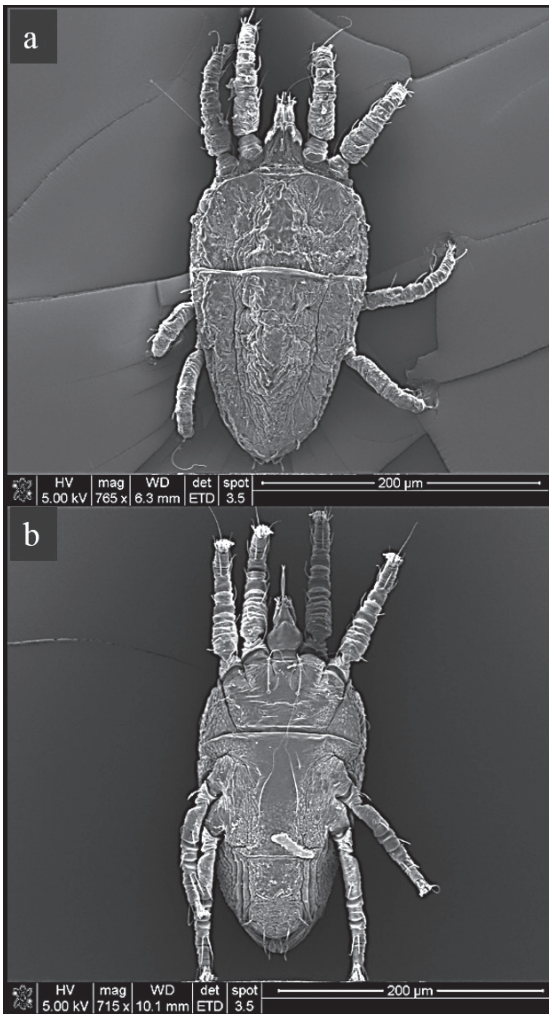

Fig. 3. *Brevipalpus yothersi* female - dorsal view (a), ventral view (b).

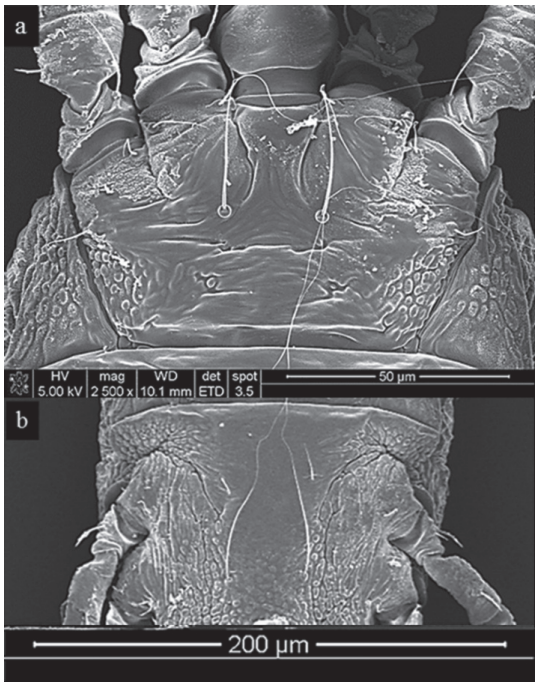

Fig. 4. *Brevipalpus yothersi* female - ventral view of propodosoma (a), the region between coxal fields of legs III and IV, and the bases of setae 3a and 4a, and the area between setae 3a and 4a, and the area posterior to the 4a setae (b).

Fig. 5. *Brevipalpus yothersi* female - ventral view of anal and genital regions (a), spermatheca (b), dorsal seta on palp femorogenu (c), distal part of palpus (d).

MATERIAL EXAMINED

One larva, 23.IX.2016; 1 deutonymph, 2♀, 10.X.2016 on Meadowlark blueberry variety. 1 larva, 1 deutonymph, 23.IX.2016; 1♀, 10.X.2016 on Emerald blueberry variety. 2 larvae, 3 protonymphs, 3 deutonymph, 4♀, 1♂, 23.IX.2016 on Abundance blueberry variety.

STEREOMICROSCOPE ANALYSIS OF DIFFERENT STAGES OF *BREVIPALPUS YOTHERSI*

Adult females are red-orange in color. They are flat, and oval in shape (Fig. 1a). Eggs are elliptical and bright reddish-orange color (Fig. 1b). Larvae are orange-red and have 3 pairs of legs (Fig. 1c) The protonymph stage (Fig. 1d) is similar in appearance and color pattern to the deutonymph stage, but smaller.

LIGHT MICROSCOPY AND SEM ANALYSIS OF DIFFERENT STAGES OF *BREVIPALPUS YOTHERSI*

FEMALE (N = 5) (FIGS. 2–6)

Dorsum: Central portions of prodorsum with strong areolae, usually longitudinally elongate, while the posterior cuticle of the sublateral prodorsum is reticulate with large cells and anterior to setae *v2* with weak reticulation, becoming broadly wrinkled to smooth posterior to *v2* (Fig. 2a). Opisthosoma with 6 pairs of lateral setae with setae *f2* absent (Fig. 2b, 3a). Ornamentation between setae *c1–c1* to *d1–d1* smooth to weakly reticulate. Area between the setae *d1–d1* and *e1–e1* with weak reticulations and wrinkles. The strong V-shaped folds from setae *e1–e1* to *h1–h1* is one of the characteristics of *B. yothersi*, but much weaker towards *h1* (Fig. 2b).

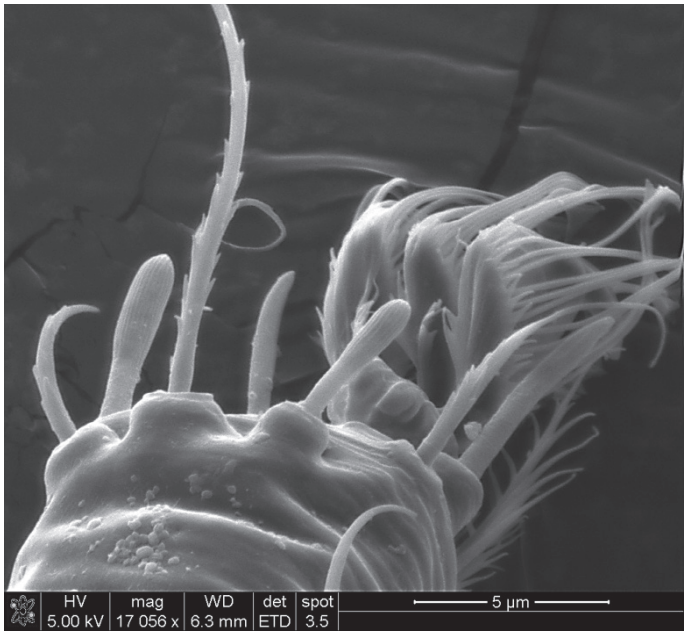

Fig. 6. Distal part of tarsus II of *Brevipalpus yothersi* female.

Measurements of setae as follows: length between setae *v2*–*h1* 217 to 222; width between setae *sc2*–*sc2* 138 to 144, *c3*–*c3* 149 to 179. Dorsal setae lanceolate, barbed: *v2* 9 to 12, *sc1* 8 to 11, *sc2* 10 to 11, *c1* 6 to 8, *c3* 6 to 9, *d1* 6 to 7, *d3* 8 to 9, *e1* 7 to 9, *e3* 8 to 10, *f3* 9 to 11, *h1* 9 to 11, *h2* 8 to 10.

Ventral: Base of coxal fields of legs I and II are finely verrucose (Fig. 4a). The region between coxal fields of legs III and IV and the bases of setae 3a and 4a is verrucose. Area posterior to the 4a setae is uniformly verrucose but between setae 3a and 4a is smooth to finely verrucose (Fig. 3b, 4b).

The ventral plates are uniformly verrucose, whereas the genital plate is verrucose-reticulate with large cells (Fig. 5a).

Spermathecal apparatus (Fig. 5b): The spermathecal duct is long, narrow and ending in vesicle. The spermathecal vesicle is oval-shaped with a thick distal stipe.

Palpus: Dorsal seta on palp femorogenu is barbed, narrow, setiform (Fig. 5c) and palp tibia with 2 setae and 1 omega (Fig. 5d).

Legs: *B. yothersi* has 2 solenidia (ω) on tarsus II (Fig. 6). Length of legs (base of coxae to tip of claws) as follows: leg I 149 to 179; leg II 156 to 173; leg III 140 to 150; leg IV 150 to 160.

MALE (N = 1) (FIG. 7A)

The adult males are more wedge-shaped than females. They have same ventral pattern as female.

DEUTONYMPH (N = 4)

Dorsum: Length between setae *v2*–*h1* 171 to 222; width between setae *sc2*–*sc2* 110 to 129, *c3*–*c3* 117 to 145. Dorsal setae: *v2* 5 to 6, *sc1* 5 to 12, *sc2* 9 to 14, *c1* 4 to 5, *c3* 4 to 8, *d1* 3 to 4, *d3* 4 to 6, *e1* 3 to 4, *e3* 3 to 6, *f3* 13 to 17, *h1* 10 to 16, *h2* 10 to 16.

Legs: Length of legs (base of coxae to tip of claws) as follows: leg I 104 to 127; leg II 96 to 108; leg III 85 to 88; leg IV 82 to 94.

PROTONYMPH (N = 2)

Dorsum: Length between setae *v2*–*h1* 146 to 173; width between setae *sc2*–*sc2* 104 to 110, *c3*–*c3* 107 to 122. Dorsal setae: *v2* 4, *sc1* 6 to 7, *sc2* 9 to 11, *c1* 3, *c3* 3 to 7, *d1* 2, *d3* 3, *e1* 3, *e3* 3, *f3* 11 to 13, *h1* 11 to 12, *h2* 10 to 12.

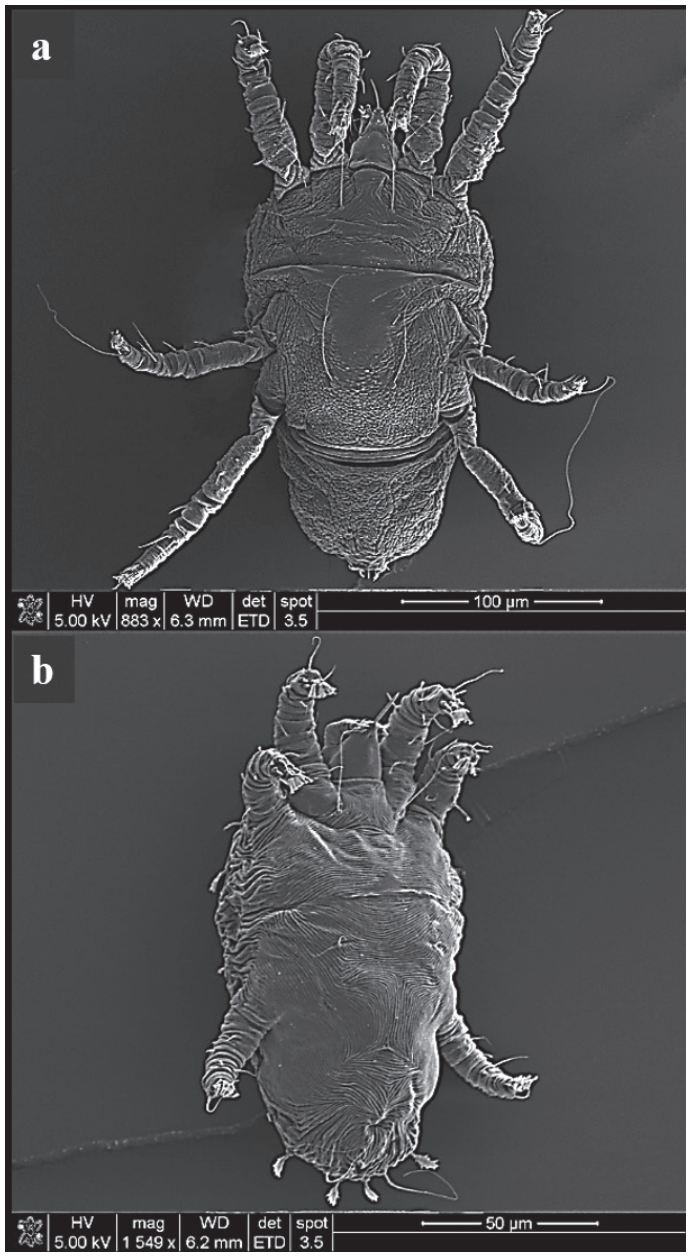

Fig. 7. Ventral view of *Brevipalpus yothersi* male (a) and *Brevipalpus yothersi* larva (b).

Legs: Length of legs (base of coxae to tip of claws) as follows: leg I 83 to 85; leg II 71 to 72; leg III 62 to 64; leg IV 60 to 62.

LARVAE (N = 2) (FIG. 7B)

Dorsum: Body measurements: length between setae *v2*–*h1* 131 to 170; width between setae *sc2*–*sc2* 85 to 107, *c3*–*c3* 99 to 111. Dorsal setae: *v2* 3 to 4, *sc1* 5, *sc2* 9 to 10, *c1* 3, *c3* 3 to 4, *d1* 2, *d3* 4, *e1* 3, *e3* 4 to 5, *f3* 10 to 13, *h1* 9 to 12, *h2* 12 to 65.

Legs: Length of legs (base of coxae to tip of claws) as follows: leg I 83 to 85; leg II 71 to 72; leg III 62 to 64; leg IV 60 to 62.

HOST PLANTS AND DISTRIBUTION

Brevipalpus yothersi seems to have a cosmopolitan distribution and a very broad host range, with a strong association with *Citrus* spp.

Table 1. Geographical distribution and host records of *Brevipalpus yothersi* (based on examined material by Beard et al. (2015a).

Country	Host
Argentina	*Citrus sinensis* (Rutaceae), *Poncirus trifoliata* (Rutaceae), *Citrus x sinensis* (Rutaceae)
Australia	*Cupaniopsis anacardioides* (Sapindaceae), *Caryota* sp. (Arecaceae), *Dendrobium conothum* (Orchidaceae), *Macroptilium atropurpureum* (Fabaceae), *Citrus* sp. (Rutaceae), lime *Citrus x aurantiifolia*, *Citrus lemon* fruit and leaves (Rutaceae), *Lenwebbia* sp. (Myrtaceae), *Tecomaria capensis* (Bignoniaceae), *Tabebua* sp. (Bignoniaceae), *Alstonia actinophylla* (Apocynaceae), *Hymenocallis littoralis* (Amaryllidaceae), leaves of *Hibiscus* sp. (Malvaceae), *Passiflora* sp. leaves (Passifloraceae), *Gardenia* sp. leaves (Rubiaceae), *Citrus* sp., *Passiflora edulis* Sims (Passifloraceae), *Punica granatum* (Lythraceae), *P. edulis*, native shrub, various ornamental shrubs
Bangladesh	*Psidium guajava* fruit (Myrtaceae) (Intercepted in Chicago, USA)
Belgian Congo	*Carica papaya* (Caricaceae), *C. sinensis* (Rutaceae)
Brazil	Coffee leaves (Rubiaceae), *Citrus aurantiifolia* (Rutaceae) (Intercepted in New York)
Burma	*Citrus* sp.
China	*Citrus* sp., luggage (Intercepted in New York, USA)
Colombia	*C. aurantiifolia* (Intercepted in New York, USA), *Citrus tangerina* (Rutaceae) (Intercepted in Charleston, South Carolina, USA)
Costa Rica	*Hibiscus* sp. flower (Intercepted in Texas, USA), *C. sinensis* (Rutaceae)
Cuba	*C. sinensis* (Intercepted in Houston, Texas, USA)
Dominican Republic	*C. sinensis* (Rutaceae), mixed plants (Intercepted in New York, USA), *P. guajava* fruit (Intercepted in New York, USA), *Citrus* sp. (Intercepted in USA)
Ecuador	*Citrus latifolia* (Rutaceae) (Intercepted in New York, USA)
El Salvador	*Simarouba glauca* (Simaroubaceae), *Fernaldia* sp. (Apocynaceae) (Intercepted in Texas, USA)
Ethiopia	*Citrus reticulata* (Rutaceae)
France	*Locasia cucullata* leaf (Araceae) (Intercepted in Washington DC, USA)
Guatemala	*Fernaldia* sp. (Intercepted in Texas, USA)
Honduras	*Acalypha hispida* (Euphorbiaceae), *Acalypha wilkesiana* (Euphorbiaceae), *Musa* sp. (Musaceae)
India	*Citrus* sp., *C. sinensis*, *C. medica* (Rutaceae), *C. reticulata* (Intercepted in Texas, USA), Rutaceae (Intercepted in New York, USA)
Indonesia	*Camellia sinensis* (Theaceae)
Israel	*Psidium guajava* (Myrtaceae) (Intercepted in Washington DC, USA), *P. guajava* fruit (Intercepted in Chicago, USA)
Malaysia	*Hevea* sp. seedlings (Euphorbiaceae)
Mexico	*Persea americana* Mill. (Lauraeae) (Intercepted in California, USA), *Hibiscus* sp. leaf (Intercepted in Texas, USA), *Fraxinus* sp. leaf (Oleaceae) (Intercepted in Texas, USA), *Cocos nucifera* (Arecaceae), *C. nucifera* (Intercepted in Brownsville, Texas, USA)
Nigeria	*Musa* sp. (Musaceae), *C. sinensis* (Intercepted in New York, USA)
Pakistan	*Eriobotrya japonica* (Rosaceae), *Peganum harmala* (Nitrariaceae), *Helianthus annuus* (Asteraceae), *Citrus* sp., *P. guajava* fruit (Intercepted in New York, USA)
Philippines	*P. guajava* (Intercepted in California, USA), Orchid leaf (Orchidaceae) (Intercepted in Chicago, USA)
Puerto Rico	*Ficus* sp. leaf (Moraceae)
Spain	*C. sinensis* (Intercepted in New York, USA)
Sri Lanka	*Camellia sinensis* (Theaceae)
Thailand	*Pandanus* sp. (Pandanaceae), *Hibiscus esculentus* (Malvaceae), *Cannabis sativa* (Cannabaceae), *P. guajava* (Intercepted in New York, USA), Cucurbitaceae (Intercepted in New York, USA)
USA	Grape, *Vitis* sp. plants (Vitaceae) (USA), *Citrus* sp. (Orlando, Florida), *Juglans regia* (Juglandaceae) (Orlando, Florida), *C. nucifera* leaf (Arecaceae) (Fort Lauderdale, Florida), *P. guajava* fruit (Maryland), *Maranta* sp. (Marantaceae) (Bradenton, Florida), *Petrea* sp. (Verbenaceae) (Miami, Florida), *A. alexandrae* (Arecaceae) (Gainesville, Florida), *Citrus* sp. (with Leprosis) (Rutaceae) (Lake Alfred, Florida), *Haya* sp. (Caryophyllaceae) (Guadalcanal)
Venezuela	*P. guajava* (Intercepted in New York, USA), *Citrus lemon* fruit

(Rutaceae) (Beard et al. 2015b). Because *B. yothersi* was considered to be *B. phoenicis* (Geijskes) since 1952, when it was synonymized with the latter (Pritchard & Baker 1952), its hosts and geographic distribution are given here based on material examined by Beard et al. (2015a) in Table 1.

DAMAGE

Brevipalpus spp. are economically important plant-feeding mite species. These species damage plants directly by feeding on the epidermal cells of the stems, leaves, and fruits (Peña et al. 2015; Salinas-Vargas et al. 2016). They feed by inserting their chelicerae into the host plant tissue. During feeding, toxic saliva is injected into the cells. The sap is then mixed with saliva and sucked up by the mite. *Brevipalpus* spp. usually feed on twigs, leaves, and fruit (Childers et al. 2011). The symptoms associated with injury caused by these mites vary from necrotic brown spots on leaves, resinous leaf patches with opposing leaf, stem browning, gall formation, brownish patches on the fruit surface, corky ring-like bands around the fruit to defoliation and die back depending on the host plant species (Childers et al. 2003).

Brevipalpus mites also can act as vectors of viruses. Their role as vectors of citrus leprosis virus (CiLV) has greatly increased their worldwide importance as quarantine pests (Peña et al. 2015).

Fig. 8. Blueberry leaves infested with *Brevipalpus yothersi* and the bacterial plant disease *Xylella* sp. (Bacteria: Xanthomonadales).

In this study, necrotic brown spots were observed together with the symptoms of *Xylella* sp. (Bacteria: Xanthomonadales) on blueberry leaves infested with *B. yothersi* (Fig. 8).

Recently, it has been shown that *B. yothersi* has a strong association with the citrus leprosis virus complex and it has been suggested to be a vector of the cytoplasmic leprosis viruses (Roy et al. 2015). These viruses induce localized necrotic or chlorotic lesions around the mite-feeding sites (Ramos-Gonzalez et al. 2016).

Remarks

Brevipalpus yothersi was originally described as a separate species in 1949 (Baker, 1949). It was later considered as a synonym of *B. phoenicis* together with *B. papayensis* in 1952 (Pritchard & Baker, 1952). However, *B. yothersi* differs from *B. phoenicis* in having a narrowly lanceolate dorsal seta on palp femorogenu (Fig. 5c) instead of broad as in *B. phoenicis*. The spermatheca vesicle is round without stipe or not developed in *B. phoenicis*, whereas the spermatheca vesicle is oval with a strong distal stipe in *B. yothersi*. Furthermore, the cuticle on the dorsal opisthosoma between setae *e1–e1* to *h1–h1* is without strong chevrons, usually with more or less transverse folds in *B. phoenicis*, whereas the cuticle on the dorsal opisthosoma between setae *e1–e1* to *h1–h1* is usually with strong chevrons (V-shaped folds), becoming much weaker towards *h1–h1* (Beard et al. 2015a). *Brevipalpus yothersi* differs from *B. papayensis* as shown in Table 2.

Brevipalpus yothersi is listed as *B. phoenicis* group species B (Beard et al. 2015b). However, it was raised to species level again. It was also confirmed that *Brevipalpus amicus* Chaudhri, *B. recula* Chaudhri, *B. mcbridei* Baker, and *B. deleoni* Pritchard and Baker are junior synonyms of *B. yothersi* (Beard et al. 2015a).

Discussion

The family Tenuipalpidae Berlese includes more than 1,100 species in 36 genera (Beard et al. 2015; Çobanoğlu et al. 2016). *Brevipalpus* Donnadieu, 1875 is the largest genus in the Tenuipalpidae (Welbourn et al. 2003) and includes more than 300 species worldwide.

Within the genus *Brevipalpus*, *B. yothersi* was not detected during previous surveys carried out in Florida, USA, on blueberry. In this study, during surveys carried out in 2016 in Florida, it was reported on southern highbush blueberry (*Vaccinium corymbosum* L. × *V. darrowi* Camp (Ericaceae)). *Brevipalpus yothersi* was initially described from specimens collected on privet (*Ligustrum* sp.: Oleaceae) in Orlando, Florida, USA (Baker 1949). It was subsequently synonymized with *B. phoenicis*

Table 2. Morphological characteristics used to separate *Brevipalus yothersi* and *Brevipalpus papayensis* (Sanchez-Velazquez et al. 2015).

Morphological characteristic	*B. yothersi*	*B. papayensis*
Dorsal palp femur seta	Setiform and barbed (Fig. 5c)	Broadly setiform and barbed
Sublateral region of propodosoma	Posterior region forming large cells, anterior region smooth (Fig. 2a)	Reticulations and large cells only posteriorly
Opisthosoma	Reticulation between setae e1 and h1 with "V" shaped folds (Fig. 2b)	Reticulation between setae e1 and h1 starting with transverse folds abruptly becoming longitudinal folds towards h1
Ventral region posterior to setae 4a	Rounded reticulations (Fig. 4b; Fig. 3b)	Elongate reticulations forming transverse bands
Spermatheca	With a long narrow duct, which merges to an oval vesicle with small distal stipe (Fig. 5b)	With a long moderately thick duct, which ends in a spherical vesicle with a crown of small projections

by Pritchard & Baker (1952). The mite was recently resurrected and redescribed (Beard et al. 2015a; Novelli et al. 2016). According to Beard et al. (2015a), it was collected from *Citrus* sp. (Orlando), *Juglans regia* (Juglandaceae) (Orlando), *Cocos nucifera* (Arecaceae) (Fort Lauderdale), *Maranta* sp. (Marantaceae) (Bradenton), *Petrea* sp. (Verbenaceae) (Miami), *Archontophoenix alexandrae* (Arecaceae) (Gainesville), *Citrus* sp. (with leprosis) (Rutaceae) (Lake Alfred) in Florida.

Within the group of *Brevipalpus* species that transmit plant viruses, *B. yothersi* is the principal vector of viruses causing the cytoplasmic type of leprosis (Rodrigues & Childers 2013; Roy et al. 2015; Arena et al. 2016; Ramos-Gonzalez et al. 2016). Previously, it was thought that all leprosis viruses could be transmitted only by *B. phoenicis,* but recently, the species status of *B. phoenicis* has been revised, and 4 species previously considered as synonyms of *B. phoenicis* have been confirmed as separate species.

Blueberry necrotic ring blotch virus (BNRBV) was reported from Florida by Quito-Avila et al. (2013). It is closely related to the viral plant diseases citrus leprosis virus and Hibiscus green spot virus (HGSV), which are transmitted by *Brevipalpus* species (Robinson 2013). In the future, it also will be necessary to elucidate the potential role of *B. yothersi* as a vector of blueberry necrotic ring blotch virus.

Like viruses, other plant pathogens including bacteria also are transmitted or spread by mites from different families such as Tenuipalpidae, Acaridae, Eriophyidae, Siteroptidae, Tarsonemidae and Tetranychidae (Sarwar 2015). Unlike viruses, most bacterial diseases of plants do not require vectors. However, vectors contribute to the spread of some bacterial pathogens of plants (Purcell 2009). We observed that leaves heavily infested with *B. yothersi* also were infected with the bacterial plant disease *Xylella* sp. (Fig. 8). Thus, further study may be necessary to determine the role of *B. yothersi* in the development and spread of *Xylella* in *Vaccinium* spp.

Acknowledgments

We thank Dr. Phillip Harmon and the Universityof Florida/IFAS Plant Disease Diagnostic Center for the identification of *Xylella* sp. We also thank the Interdisciplinary Center for Biotechnology Research (ICBR) at the University of Florida for providing technical assistance with the use of the electron microscope. Finally, we thank an organic grower in central Florida for allowing collection of samples from his farm. The research was supported by private funding from a Florida blueberry grower group.

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