

Theobroma cacao, a new host for *Brevipalpus yothersi* (Acari: Tenuipalpidae) in Peru

Hector Alonso Escobar-García ^a, Daniel Júnior de Andrade ^b, Daniel Carrillo ^c, Ronald Ochoa ^d

^a Facultad de Agronomía, Universidad Nacional de Piura (UNP), Urb. Miraflores S/N, Castilla, Piura, Perú.

^b College of Agricultural and Veterinary Sciences, São Paulo State University (FCAV/UNESP), Jaboticabal, São Paulo, Brazil.

^c Tropical Research and Education Center, University of Florida, 18905 SW 280th Street, Homestead, FL 33031-3314, USA.

^d Systematic Entomology Laboratory, United States Department of Agriculture, Agricultural Research Service, Beltsville, MD, USA.

Short note

ABSTRACT

Brevipalpus yothersi Baker (Acari: Tenuipalpidae) is reported for the first time on cocoa, *Theobroma cacao* L. (Malvaceae) in northwestern Peru. Mites were collected from organic cocoa smallholdings from September to December 2020 in eight localities (three Provinces) of the Piura Department. The highest mite population density was found on peduncle and epicarps of fruits of different phenological stages, and the lowest density on the leaves.

Keywords Acarofauna; cocoa beans; emerging pest; flat mites; Tetranychoidae

Introduction

Phytophagous mites of the genus *Brevipalpus* (Acari: Tenuipalpidae), commonly referred to as flat mites or false spider mites, are an emerging pest of agricultural and ornamental crops. Currently, about 318 species of the genus *Brevipalpus* have been described (Castro *et al.* 2020). Some *Brevipalpus* species are major plant pests because of their ability to transmit viruses to several economically important fruit trees, including citrus (Kitajima *et al.* 2010; Freitas-Astúa *et al.* 2018), passion fruit (Kitajima *et al.* 2003), and coffee (Chagas *et al.* 2003). *Brevipalpus yothersi* Baker (Acari: Tenuipalpidae) is reported from 33 countries (Castro *et al.* 2020). It was first described by Baker (1949) from females and nymphs collected on privet, *Ligustrum* sp. (Oleaceae) collected by M. A. Yothers in Orlando, Florida, USA. Since then, it has been reported on various plant species around the world. *Brevipalpus yothersi* is widely distributed, and in South America it has been reported in Argentina, Brazil, Colombia, Ecuador, Venezuela (Beard *et al.* 2015) and Peru (present study). It is associated with the transmission of cytoplasmatic Cileviruses causing citrus leprosis (Roy *et al.* 2015). Ochoa *et al.* (1994) recorded *Brevipalpus phoenicis* s.l. (Geijskes) (Acari: Tenuipalpidae) on cocoa *Theobroma cacao* L. (Malvaceae) in Central America, and five Tenuipalpidae species have been reported on cocoa (Castro *et al.* 2020).

In Peru, cocoa beans are an important economic product, including several derivatives such as cocoa butter, cocoa paste, and cocoa powder, sold domestically and internationally (MINAGRI 2018). The Department of Piura has a total of 1,748 ha with 5,678 associated producers (APPCACAO 2020). There are no previous records of *B. yothersi* in Peru and not on cocoa either. This article reports *T. cacao* as a new host plant for *B. yothersi* in Peru. The finding of *B. yothersi* affecting cocoa is of considerable concern and it is essential to determine

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Corresponding author

Hector Alonso Escobar-García 

hescobarg@unp.edu.pe;

hescobar1990@gmail.com

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the potential pest status on this important crop. Our research objective was to determine the presence of the mite and the damage caused to cocoa trees in organic smallholding production and contribute to Integrated Pest Management programs' strategies.

Materials and methods

In this study, cocoa tree flat mites were collected in smallholdings under the organic production system from September to December 2020 (Table 1). The collection areas are of a tropical and subtropical desert climate and were surveyed during the spring season. Five cocoa trees were randomly selected at each locality and 25 leaves and five fruits of different phenological stage were collected randomly, packed in separate paper bags, and sent to the Entomology Laboratory, Facultad de Agronomía, Universidad Nacional de Piura, Perú. The mites were observed and counted under a stereomicroscope (ZEISS Stemi 508 with Aixocam ERc 5s digital camera) and mounted on slides in Hoyer's medium (Krantz and Walter 2009). The identification of the species was based on morphological identification using an Omax 40x -2500x phase contrast trinocular microscope with an OMAX S35180U3-18Mp camera, and taxonomic keys provided by Beard *et al.* (2015). Voucher specimens were deposited in the Acarology collection of the aforementioned institution.

Results and discussion

We report *B. yothersi* for the first time in Peru and also its first report on cocoa, *T. cacao*. *Brevipalpus yothersi* was found in all eight localities surveyed. The following morphological characteristics were used to identify *B. yothersi*: prodorsum centrally rugose, lateral sections with strong areolae (usually longitudinally elongate), large sublateral cells and becoming broadly wrinkled to smooth anterior to setae v2 (Figure 1A). The opisthosoma with strong "V"-shaped folds from setae e1 to h1 (Figure 1B) and with six pairs of lateral setae. The ventral plate is uniformly verrucose with small rounded warts. The genital plate is verrucose-reticulate with large cells (Figure 1C). Spermathecal apparatus has a long, narrow duct which fuses with an oval vesicle that has a small distal stipe (Figure 1D). Gnathosoma with a lanceolate dorsal seta on the femurogenu palp and leg II with two solenidia on the tarsus (Beard *et al.* 2015). Adult females are orange-red, flat, oval in shape and were observed on leaves and fruits (Figure 2B). The eggs are elliptical and bright reddish-orange in color. The larvae are orange-red in color. The nymphal stages are weak reddish-orange color with green and hyaline spots.

Table 1 Localities where flat mites were sampled in the Department of Piura, Peru.

Location	Collection date	Latitude	Longitude	Altitude	Average mites/leaf	Average mites/cm ² fruit surface
Chililique	05-IX-2020	5°2'0.91" S	80°4'18.06" W	237 m	1.24	13.67
El Olguín	04-IX-2020	5°16'39.20" S	79°56'21.25" W	127 m	1.2	5
Francisco Bolognesi Bajo	21-IX-2020	4°41'14.44" S	80°15'46.36" W	214 m	1.52	15.14
Lalaquiz	19-XI-2020	5°13'38.42" S	79°39'9.23" W	698 m	0.2	2.83
La Quemazón	08-X-2020	5°18'30.00" S	79°42'45.01" W	257 m	1.24	6.33
Palo Blanco	12-XII-2020	5°2'21.23" S	80°4'43.17" W	208 m	1.36	13.57
Puerta Pulache	20-X-2020	4°44'37.82" S	80°12'11.25" W	236 m	1.44	19.5
San Juan de Bigote	08-X-2020	5°18'55.54" S	79°46'36.93" W	187 m	1.48	6.67

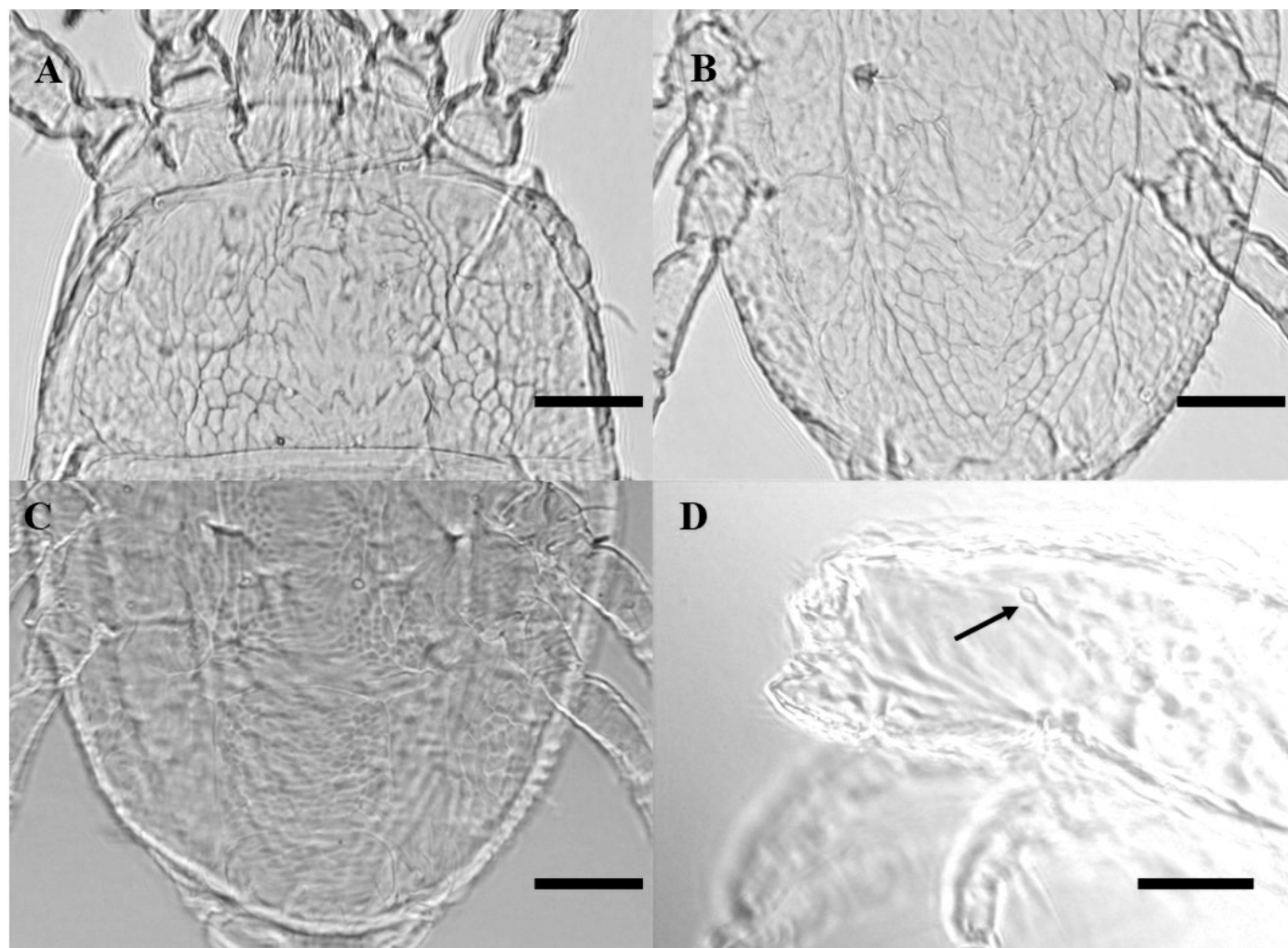


Figure 1 Morphological characteristics of *Brevipalpus yothersi*, female: A – dorsal propodosoma; B – opisthosoma; C – ventral view of the anal and genital regions; D – adult female spermatheca (indicated by arrow). Scale bars = 30µm.

Brevipalpus yothersi was observed and collected on the leaves, peduncle, and epicarp of fruits of different phenological stages. The mite's presence was noticed on mature fruits close to harvest. The symptoms associated with the lesions caused by these mites were more representative on fruits where population densities were higher (mean 10.3 mites/cm²) compared to the populations found in leaves (mean 1.21 mites/leaf). The large number of adult and immature mites were located in the groove between the ridges of the epicarp of the fruit (Figure 2A). During the survey, brown spots were observed on the epicarp of fruits in the eight localities (Figure 2A and 2C). Some fruits had large areas of dark brown epicarp and abundant exuviae (Figure 2D). *Brevipalpus yothersi* was observed in lignified areas on the epicarp resulting from damage caused by several species of *Tuckerella* (Acari: Tuckerellidae), taking advantage of the crevices for protection and to lay eggs.

There are few studies about the mite diversity in cocoa. Several species of fungivorous Tarsonemidae mites were reported from cocoa trees in Brazil and Costa Rica (Ochoa *et al.* 1995; Ochoa and OConnor 1998; Rezende *et al.* 2015; Sousa *et al.* 2018). Six species of Eriophyoid mites have been reported associated with *Theobroma* spp. *Aceria reyesi* (Nuzzaci) (Acari: Eriophyidae) is the only mite species known to cause serious damage and its importance as a cocoa pest is recognized in some Central and South American countries (Carvalho *et al.* 2018).

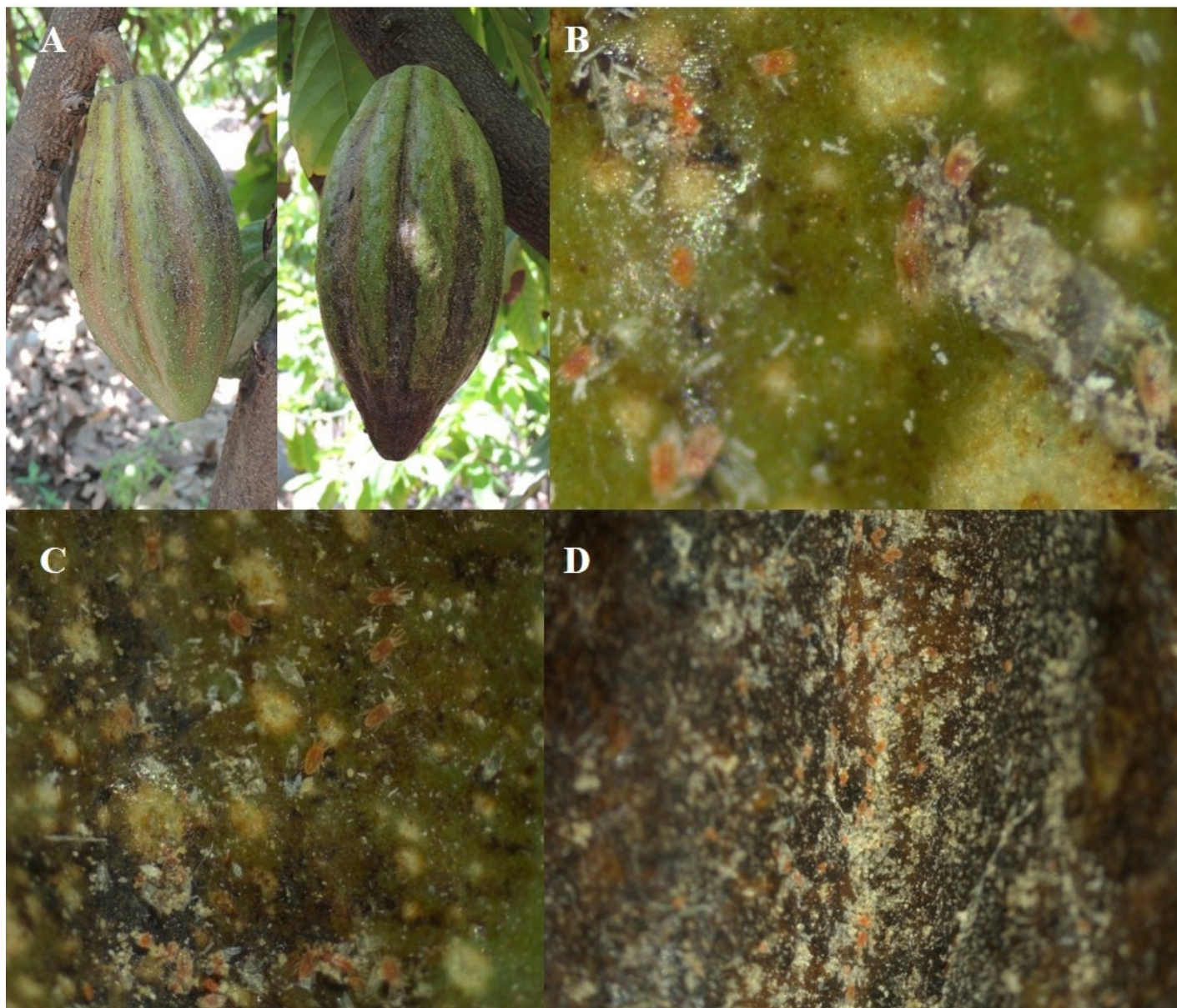


Figure 2 Population of *Brevipalpus yothersi* in fruits: A – Fruit with dark brown epicarp infested by high populations; B – All forms of development of *B. yothersi* in the epicarp; C – Females and immatures mobiles of *B. yothersi* in fruits; D – General view of multiple exuvia (white skins) of *B. yothersi* from the epicarp of the same fruit.

The mite attacks the terminal buds of cocoa branches, causing atrophy, premature leaf drop, and shortening of the internodes (Doreste *et al.* 1975). Eleven species of phytophagous mites of the family Tetranychidae have been reported in association with *Theobroma* spp. (Migeon and Dorkeld 2006-2020). Flechtmann (1979) reported for the first time *Tuckerella ornata* (Tucker) (Acari: Tuckerellidae) on the woody stem and stem cracks of cocoa plants in Belém, State of Pará, Brazil. In Peru, three species of *Tuckerella* associated with cocoa have been observed (Escobar-Garcia *et al.* 2021). In addition, in the location of Lalaquiz (Table 1), a population of *Brevipalpus californicus* s.l. (Banks) (Acari: Tenuipalpidae) was recently collected and its presence is being investigated. Furthermore, worldwide two Phytoseiidae species (Demite *et al.* 2020) have been reported on cocoa.

The presence of *B. yothersi* in Peru is of concern as it is a vector of several plant viruses

affecting economically important crops, such as citrus and passion fruit (Freitas-Astúa *et al.* 2018). This species is the principal vector of *Citrus leprosis virus* (CiLV) (Roy *et al.* 2015; Ferreira *et al.* 2020) and as such is considered a quarantine pest (Peña *et al.* 2015). Recently the first draft of the genome sequence of *B. yothersi* has been reported, which is also the first mite vector of the plant virus to be sequenced (Navia *et al.* 2019). This report emphasizes the importance of carrying out studies of biology, ecology, geographical distribution and economic impact on the production of cocoa by mites, as well as to determine the potential role of *Brevipalpus* species as a vector of diseases in cocoa trees.

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