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MORPHOMETRY OF *DIAPHORINA CITRI* (HEMIPTERA: LIVIIDAE) ON SIX RUTACEAE FROM VERACRUZ, MEXICO

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Abstract

The objective of this study was to characterize *Diaphorina citri* Kuwayama (Hemiptera: Liviidae) morphometrically, as well to determine whether the host has a relationship to a specific morphometric variation. The traits measured were body length, antenna length, lengths and widths of genal processes, and forewing length and width. Females and males were analyzed separately. The measures obtained were subjected to an analysis of variance and principal components analysis. The greatest morphometrical variation and smallest sizes were found in males collected from non-prefered hosts such as *Citrus limetta* Risso, *C. sinensis* (L.) 'Selection 8' and *C. paradisi* Macfad.; while, the least variations and largest sizes were found on *C. sinensis* (L.) Osbeck cv. 'Marrs', *C. sinensis* (L.) cv. 'Valencia' and *Murraya paniculata* (L.) Jack. The traits with notable variation were lengths and widths of forewings and genal processes. Greater morphometrical variations were found in males than in females. The results indicate that *D. citri* is a species with morphometrical variants and probably the host is a determinant in the definition of characters.

Key Words: Asian citrus psyllid, citrus, wing anomalies, genal processes

Resumen

El objetivo de este estudio fue realizar la caracterización morfométrica de *Diaphorina citri* Kuwayama (Hemiptera: Liviidae), así como conocer si el hospedero ejerce alguna influencia importante en la definición de variantes específicas. Los caracteres medidos fueron la longitud del cuerpo, longitud y amplitud de alas anteriores y procesos genales, y longitud de antenas. Los machos y hembras se analizaron de manera independiente. Las medidas obtenidas se sometieron a un análisis de varianza y a un análisis de componentes principales. La mayor variación morfométrica y menor talla se encontró en especímenes machos colectados en hospederos no preferenciales como *Citrus limetta* Risso, *C. sinensis* (L.) 'Selección 8' y *C. paradisi* Macfad.; mientras que los más grandes y menos variables en *C. sinensis* (L.) Osbeck cv. 'Marrs ', *C. sinensis* (L.) cv. 'Valencia' y *Murraya paniculata* (L.) Jack. Los caracteres con variación notable fueron la longitud y amplitud de las alas anteriores y de los procesos genales. Se encontró mayor variación morfométrica en machos que en hembras. Los resultados mostraron que *D. citri* es una especie con variantes morfométricas y probablemente el hospedante posee un efecto determinante en la definición de caracteres.

Palabras Clave: Psílido asiático de los cítricos, cítricos, anomalías en alas, procesos genales

Diaphorina citri Kuwayama (Hemiptera: Liviidae) (Burckhardt & Ouvrard 2012), the Asian citrus psyllid (ACP), is considered the most important arthropod pest of citrus (Sapindales: Rutaceae) in the world (Halbert & Manjunath 2004). The greatest danger of ACP is related to its transmission of the bacteria '*Candidatus* Liberibacter spp.', the putative agents associated with huanglongbing disease (HLB) (da Graca 1991; Garnier & Bové 2000; da Graca & Korsten 2004). HLB is one of the most devastating citrus diseases, responsible for the decline and death of millions of trees in tropical/subtropical Asia, Africa and the Americas (da Graca & Korsten 2004; Halbert & Manjunath 2004; Bové 2006). In Mexico, HLB was detected in July 2009 in commercial and backyard orchards in the state of Yucatán. From there, it has dispersed to other states, threatening the country's citrus industry (SENASICA 2012). Unlike HLB, the presence of *D. citri* was first registered in the state of Campeche in 2002 (López-Arroyo et al. 2005). Since then, it has been found in all the citrus-producing areas (SENASICA 2012).

Psylloidea species maintain a close, specific relationship with dicotyledonous angiosperms (Hodkinson 1988; Hollis 2004), and in the case of *D. citri,* the species has adapted through evolutionary time possibly modifying its physiognomy, physiology and phenology in concordance with host and environmental variations (Hollis 1987; Halbert & Manjunath 2004; Hodkinson 2009; Tsagkarakis & Rogers 2010) to exploit a host range that includes more than 25 species in the Rutaceae (Sapindales) as well as *Artocarpus heterophyllus* Lam. (Rosales: Moraceae) and *Ficus carica* L. (Rosales: Moraceae), and *Pithecellobium lucidum* Benth. (Fabales: Fabaceae) (Halbert & Manjunath 2004; Thomas & de León 2011). Development of ACP can be highly successful on certain hosts such as *Murraya paniculata* (L.) Jack (Sapindales: Rutaceae) (Tsai & Liu 2000; Tsai et al. 2002; Fernández & Miranda 2005b), *Citrus sinensis* (L.) Osbeck cv. 'Marrs' (Sapindales: Rutaceae) (Ortega et al. 2013) and *Citrus paradisi* Macfad (Liu & Tsai 2000), or it can be adversely affected on others like Cleopatra tangerine (*Citrus reshni* Hort. ex Tan) (Tsagkarakis & Rogers 2010). It has been observed that quality of the host plant can influence morphological and physiological variation. For example, in *Trioza erytreae* Del Guercio (Moran 1968) and *D. citri* (Wenninger et al. 2009) changes in body color have been related to differences in body mass and fecundity (Moran 1968, Wenninger et al. 2009). The biological significance of the morphological variation has not been totally understood because differences of the host plant and its influence can also be attributed to abiotic factors such as temperature, humidity and precipitation (Bomfim et al. 2011), photoperiod, and drought, among others (Hodkinson 2009). The fact that the morphs (polymorph variants) differ occasionally from the "normal" population type caused many to be described originally as different species (Mayr 1968).

In Mexico, ACP is the only reported vector of HLB (SENASICA 2012); however, recent studies in other countries have found that *Cacopsylla citrisuga* (Yang & Li) (Hemiptera: Liviidae) in *C. limon* (L.) Burm. (Cen et al. 2012) and *Diaphorina communis* Mathur on tangerine trees (*C. reticulata* Blanco) and curry (*Bergera koenigii* (L.) (Sapindales: Rutaceae) (Donovan et al. 2011) are potential vectors of HLB. This has led to detailed studies of psyllids associated with citrus. In the same vein, this study was conducted to characterize morphometrically *D. citri* in 6 rutaceous host species in Veracruz, Mexico, and to explore whether a given host influences morphometrical variations of ACP.

Materials and Methods

Diaphorina citri adults were collected from Feb 2010 to Feb 2011 in citrus plantations and orange jasmine (*M. paniculata*) plants growing in yards and urban areas in the region of Cazones, Veracruz, Mexico. The place is located in the northern part of the state at N 20° 42' W 97° 18' and at 10 m asl. The climate in the region is hot-humid (Am) with an average annual temperature of 25 °C, abundant summer rains and an annual precipitation of 2,000 mm, and average annual RH of 82%. Adult specimens were collected monthly in the following groves: 1) sweet lime (*C. limetta* Risso), 10-yr old, 2-ha with rows of 7 × 7 m with management consisting of chemical weed elimination, and applications of fertilizers and insecticides; 2) Marrs orange (*C. sinensis* cv. 'Marrs'), 12-yr old, planted in 1.7 ha on a hill in rows of 6 × 6 m, and regularly subjected to sanitation pruning and fertilizer applications; 3) Valencia orange (*C. sinensis* cv. 'Valencia') 15-yr old, planted in 3 ha on a hill in rows of 6 × 6 m; 4) 'Selection 8' orange (*C. sinensis* 'Selection 8'), 7-yr old, established in 3 ha in rows of 5 × 6 m, temporarily combined with corn; 5) grapefruit (*C. paradisi* cv. 'Rio Red') 9-yr old, planted in 1 ha on a plain in rows of 5 × 6 m, and regularly subjected to sanitation pruning and fertilization; and 6) Orange jasmine (*M. paniculata*), 6-yr old, growing in yards and urban areas without application of pesticides. At each site and on each date, leaves and shoots (when present) from 10 trees or plants were examined to collect the ACP adults with a mouth aspirator during a period of 30 minutes/plant. The collected specimens were labeled, preserved in 70% alcohol and classified with the dichotomous key for Psylloidea proposed by Yang (1984) and Burckhardt (2007); they were deposited in the reference collection of insect vectors of the Colegio de Postgraduados, Montecillo, Edo. de México, Mexico.

In order to determine the morphometric information of ACP specimens, each insect was dissected under a stereoscope to separate wings and antennae, which were placed individually in 0.2 mL Eppendorf tubes containing 70% alcohol. Representative series of antennae, wings and body were mounted on slides with hair gel and glycerin to prevent dehydration; later, photographs were taken of each structure/specimen. A total 4,719 adults (1,725 males and 2,994 females) were collected throughout the year. For the purpose of standardizing sample size for statistical analysis only 88 males and 124 females from each host species were considered; thus, we analyzed 27% adults of the total annual ACP collection. Six morphological measurements were found to be useful to determine the presence of morphometric variation among adults (Hollis 1987). The structures of interest were measured with the aid of Image Tool version 3 software (Wilcox et al. 2002). Body length (BL) of males was measured from the apex of the genal process to the end of the subgenital plate; in the case of females, BL was measured from the apex of the genal process to the distal part of the proctiger. Wing length (WL) was measured from the base to the distal part of the wing, and wing width (WW) was considered as the widest part. Length of genal process (LPG) was measured from the base to the tip of the apex; width of the genal process (WPG) was measured at the middle of the genal process at its widest part. Antenna length (ANT) was measured from the scape to the distal part of the flagellum. The male and female structures were analyzed independently since a preliminary analysis showed differences between the sexes.

The morphometric data were subjected to an analysis of variance (ANOVA) and comparison of means with the Tukey test ($P \leq 0.05$). In order to define which of the 6 studied traits contributed to the variability, we performed a multivariate analysis of principal components (PCA) using the software Minitab version 15 (Minitab Inc. 2007).

RESULTS

According to the key used, all of the specimens collected from the 6 hosts in the region of Cazones, Veracruz, were *D. citri*. The distinctive characteristics of the species were corroborated, i.e., “genal process > 1.0 times as long as vertex along mid-line, slender; forewing pattern consisting of a band of confluent brown spots along vein Rs and along outer margin, and these 2 areas well-separated by a white gap in the subapical region of Rs, and membrane whitish” (Burckhardt, 2007).

The largest population of ACP was found on *M. paniculata* and *C. sinensis* cv. ‘Marrs’; while, abundance on the sweet lime (*C. limetta*) and the orange *C. sinensis* ‘Selection 8’ was reduced ($F = 10.07$, df $= 5$ $P \leq 0.01$ for males; $F = 3.83$, df $= 5$ $P \leq 0.01$ for females). The samples contained specimens with anomalies. Of these, 2.65% were males, and 1.9% were females (Fig. 1). Moreover, maculation patterns and shape and size of the genal processes were different from the reported type in most of the collected specimens (Fig. 2). Differences in ab-

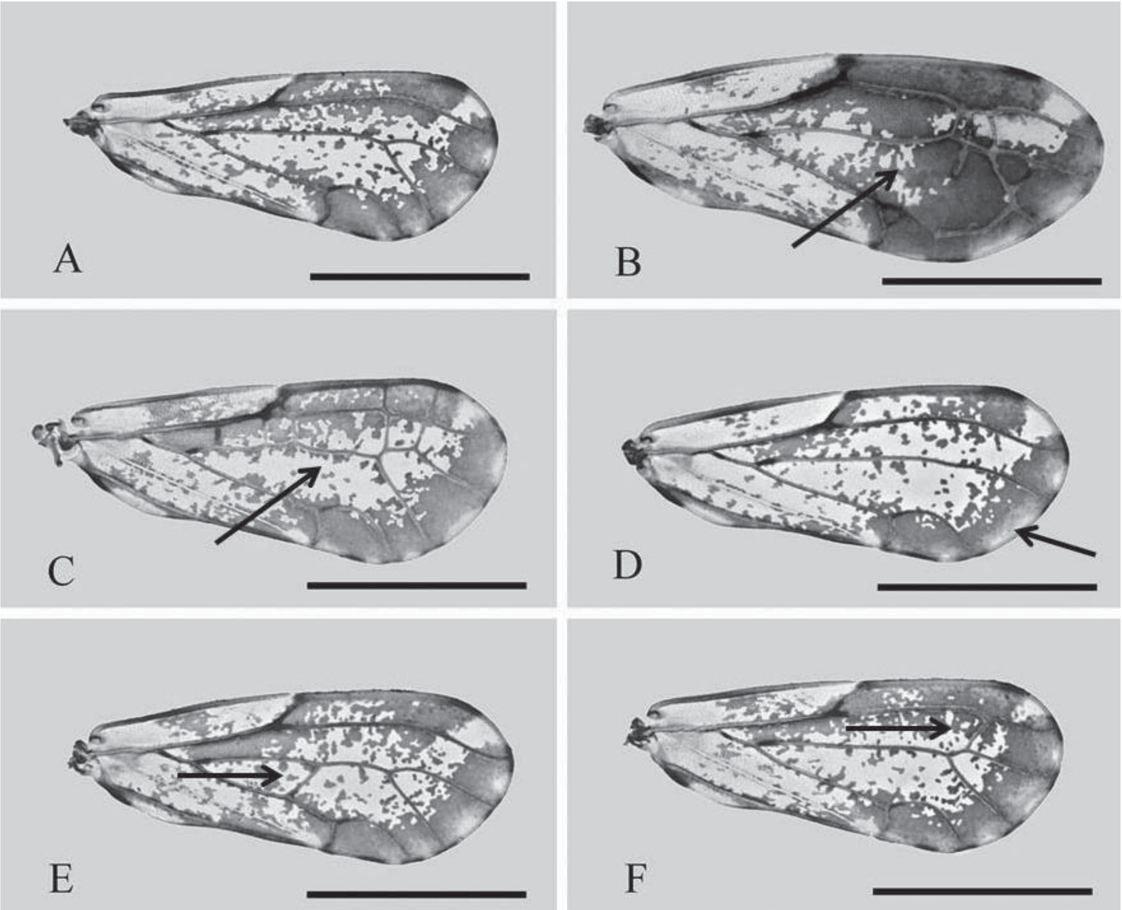

Fig. 1. Morphological variants of *Diaphorina citri* forewings collected from 6 species of Rutaceae in Cazones, Veracruz, México. 1A) Typical venation of the Psyllidae forewing. 1B) Male collected from sweet lime, Rs and M veins interrupted by transverse veins. 1C) Female collected from sweet lime, additional transverse veins. 1D) Male collected from *Citrus sinensis* cv. ‘Valencia’, M_{3+4} vein absent. 1E and 1F) Males collected from orange jasmine, additional transverse veins. Scale: 1 mm.

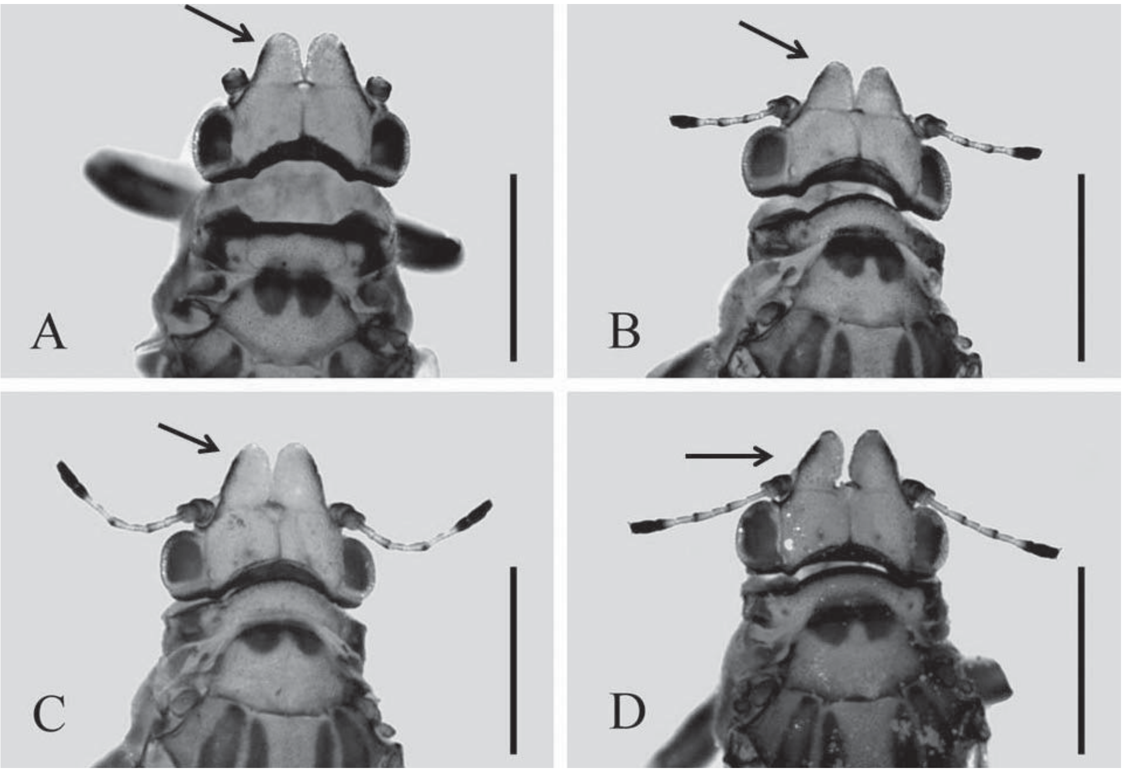

Fig. 2. Morphological variants found in *Diaphorina citri* genal processes collected from 6 species of Rutaceae in Cazones, Veracruz, México. 2A) Male collected from *Citrus sinensis* cv. 'Valencia', genal processes conical with rounded apices. 2B) Male collected from *Citrus sinensis* 'Selection 8', genal processes conical. 2C) Male collected from *Citrus sinensis* 'Selection 8', genal processes partially separated. 2D) Male collected from sweet lime, genal processes strongly separated. Scale: 500 µm.

dominal color were also observed: gray-brown, blue-green and orange-yellow.

The analysis of variance indicated significant differences in the observed variables (F = 16.99 GL = 5 $P < 0.0001$). All females traits were larger than those of males (Table 1). In males, statistically significant differences were observed in each of the variables with respect to the host ($P < 0.05$). Male body length (BL) of ACP specimens had similar values on the different hosts (Tukey test $P < 0.05$). On average, male BL was $\bar{x}$ = 2.46, SE = 0.020. Grapefruit was the host with the shortest male BL values ($\bar{x}$ = 2.34 ± 0.018 SE), but these were not significantly shorter than those on sweet lime. The males with the longest BL were found on 'Marrs' orange and 'Valencia' orange, but these were not significantly longer than those on orange jasmine and "Seletcion 8' (Tukey test $P < 0.05$).

Wing widths (WW) were similar in males collected on sweet lime, 'Marrs' orange, and grapefruit. The narrowest WW were found on males on orange jasmine and these were statistically different from males on orange 'Selection 8' and 'Valencia' orange. Wing length (WL) varied by host somewhat similarly to WW; the main differences were that WL were shortest on males on orange jasmine and 'Marrs' orange. The longest wings were on males on sweet lime and 'Valencia' orange, but these were not significantly longer than those on 'Selection 8' (Table 1).

The lengths and widths of the genal process (Table 1) were largest on males on grapefruit, and they were statistically different from those on sweet lime, which were the smallest. The antennae of males were the longest on 'Valencia' orange, but not significantly longer than on 'Selection 8', and they were significantly the shortest on orange jasmine (Table 1).

In females, there were significant differences for hosts in relation to all the variables considered in the study ($P < 0.05$). BL of females on sweet lime, grapefruit and Valencia orange differed significantly from each other with the longest BL on 'Valencia orange and the shortest on grapefruit. However, female BL on 'Valencia' orange was not significantly longer than on 'Marrs' orange (Table 1).

Wing widths of females on orange jasmine and grapefruit were significantly the narrowest. Wing widths were the widest on females on 'Selection

TABLE 1. SIZES (MM) (± SE) OF 6 MORPHOLOGICAL TRAITS IN MALE AND FEMALE *DIAPHORINA CITRI* COLLECTED FROM 6 DIFFERENT RUTACEOUS HOST SPECIES AT CAZONES DE HERRERA, VERACRUZ, MÉXICO.

	Males					
Variable	BL[a]	WW	WL	LPG	WPG	ANT
Host*						
Sweet lime	2.425 ± 0.01 bc[b]	0.907 ± 0.004 ab	2.157 ± 0.009 a	0.135 ± 0.002 b	0.103 ± 0.001 c	0.504 ± 0.002 bc
Marrs	2.509 ± 0.01 a	0.900 ± 0.004 ab	2.105 ± 0.008 c	0.142 ± 0.001 ab	0.110 ± 0.001 ab	0.499 ± 0.002 c
Murraya	2.453 ± 0.01 ab	0.890 ± 0.004 b	2.091 ± 0.007 c	0.137 ± 0.001 ab	0.107 ± 0.008 abc	0.489 ± 0.002 d
Grapefruit	2.342 ± 0.01 c	0.896 ± 0.004 ab	2.108 ± 0.008 bc	0.143 ± 0.001 a	0.112 ± 0.001 a	0.506 ± 0.002 bc
Selection 8	2.451 ± 0.02 ab	0.911 ± 0.003 a	2.141 ± 0.006 ab	0.137 ± 0.002 ab	0.106 ± 0.001 bc	0.510 ± 0.002 ab
Valencia	2.493 ± 0.02 ab	0.908 ± 0.004 a	2.148 ± 0.008 a	0.142 ± 0.001 ab	0.110 ± 0.001 ab	0.517 ± 0.002 a
	Females					
Sweet lime	2.795 ± 0.01 c	0.971 ± 0.003 ab	2.272 ± 0.006 a	0.153 ± 0.001 a	0.116 ± 0.001 ab	0.506 ± 0.002 abc
Marrs	2.886 ± 0.01 ab	0.957 ± 0.004 bc	2.232 ± 0.008 bcd	0.149 ± 0.001 ab	0.117 ± 0.009 a	0.500 ± 0.004 bc
Murraya	2.766 ± 0.01 c	0.955 ± 0.003 c	2.223 ± 0.007 d	0.145 ± 0.001 b	0.113 ± 0.001 b	0.496 ± 0.002 c
Grapefruit	2.674 ± 0.01 d	0.953 ± 0.004 c	2.225 ± 0.008 cd	0.150 ± 0.001 ab	0.116 ± 0.001 ab	0.509 ± 0.002 ab
Selection 8	2.823 ± 0.02 bc	0.972 ± 0.003 a	2.261 ± 0.006 ab	0.150 ± 0.001 a	0.113 ± 0.001 ab	0.515 ± 0.001 a
Valencia	2.953 ± 0.02 a	0.967 ± 0.003 bc	2.252 ± 0.005 abc	0.148 ± 0.001 ab	0.117 ± 0.008 a	0.517 ± 0.002 a

n = 88 males and 124 females per each host.

[a] Morphological traits: BL = body length, WW = wing width, WL = wing length, LPG= genal processes length, WPG= genal processes width, ANT = antenna length.

[b] Means with the same letter within each variable are statistically equal (Tukey, $P \leq 0.05$).

*Hosts: Sweet lime (*C. limetta*), Marrs orange (*C. sinensis* cv. 'Marrs'), Orange jasmine (*M. paniculata*), Grapefruit (*C. paradisi*), Selection 8 (*C. sinensis* 'Selection 8'), Valencia (*C. sinensis* cv. 'Valencia').

8' orange, but these were not significantly wider than those on sweet lime. The longest wings were on females on sweet lime, but these were not significantly longer than those on 'Selection 8' or 'Valencia orange. The shortest wings were on females on orange jasmine, but these were not significantly shorter than those on grapefruit or on 'Marrs' orange (Table 1).

Genal cones were the longest on females on sweet lime and 'Selection 8' orange, but these were not significantly longer than those of females on grapefruit, 'Marrs' orange and 'Valencia' orange. Genal cones were the widest on females on 'Marrs' orange, but these were not significantly wider than on those on sweet lime, grapefruit and 'Selection 8' orange. Genal cones of females were narrowest on orange jasmine, but these were not significantly narrower than those on sweet lime, grapefruit and 'Selection 8' orange. Antenna lengths of females were the longest on 'Valencia' orange and 'Selection 8' orange, but these were not significantly longer than those on sweet lime or grapefruit. The shortest antennal lengths were found on females on orange jasmine, but these were not significantly shorter than those of females on sweet lime and 'Marrs' orange (Table 1).

Multivariate analysis of principal components (Table 2) showed an accumulated explained variance of 58.2% in males and 51.1% in females using the first 2 principal components. The analysis indicates that wing length and wing width are the main variables that contribute to the first principal component (PC1); whereas the lengths and widths of genal processes were the main contributors of the PC2 (Table 2). Both components can be interpreted as an index of wing size (PC1) and an index of genal process size (PC2), respectively. The third principal component can be an indicator of body length. Altogether, the three components explain 74.5% of the total variability in males, and 68.3% in females; males were more variable than females.

The analysis of the morphometric variables in males showed atypical values in the parameters evaluated; these differences occurred mainly in insects collected from sweet lime and *C. sinensis* 'Selection 8'. In females, such differences occurred in females collected from *C. sinensis* cv. 'Marrs', grapefruit and orange jasmine.

TABLE 2. PRINCIPAL COMPONENT ANALYSIS* (PCA) OF MORPHOLOGICAL TRAITS OF MALES AND FEMALES OF *DIAPHORINA CITRI* COLLECTED FROM 6 DIFFERENT RUTACEOUS HOST SPECIES AT CAZONES, VERACRUZ, MEXICO.

	Males					
Variable	PC1	PC2	PC3	PC4	PC5	PC6
BL[a]	0.156	0.316	0.685	0.634	0.000	-0.069
WW	0.599	-0.244	0.243	-0.214	-0.108	0.682
WL	0.583	-0.336	0.102	-0.163	0.044	-0.713
LPG	0.357	0.547	-0.253	-0.081	0.707	0.059
WPG	0.286	0.594	-0.243	-0.114	-0.696	-0.098
ANT	0.262	-0.275	-0.582	0.711	-0.053	0.094
Absolute value	1.8362	1.6545	0.9813	0.8171	0.4037	0.3073
Proportion	0.306	0.276	0.164	0.136	0.067	0.051
Accumulated	0.306	0.582	0.745	0.882	0.949	1.000

	Females					
Variable	PC1	PC2	PC3	PC4	PC5	PC6
BL	0.247	-0.190	0.676	0.662	0.057	0.061
WW	0.636	0.173	-0.217	-0.027	-0.044	0.718
WL	0.608	0.157	-0.312	0.209	-0.122	-0.67
LPG	0.187	-0.652	-0.22	-0.089	0.695	-0.035
WPG	0.094	-0.691	-0.035	-0.139	-0.702	0.025
ANT	0.348	0.081	0.59	-0.7	0.071	-0.171
Absolute value	1.6272	1.4383	1.0301	0.8529	0.5697	0.481
Proportion	0.271	0.24	0.172	0.142	0.095	0.080
Accumulated	0.271	0.511	0.683	0.825	0.92	1.000

[a] Morphological traits: BL = body length, WW = wing width, WL = wing length, LPG = genal process length, WPG = genal process width, ANT = antenna length.

*The PCA was performed using the correlation matrix. PC1 to PC6 are the principal components estimated by the PCA.

Discussion

The results of this study reveal the presence of morphometrical variants of *D. citri*, which are possibly determined in part by the host plant taxon as well as abiotic factors (García-Barros 1999; Bomfim et al. 2011). Berlocher & Feder (2002) mention that such changes may originate as a result of the insect migration, because they have to adapt to a geographic change, a new host or both. The plant taxa that hosted individuals with greater morphometrical variants were *C. limetta* and *C. sinensis* 'Selection 8'. Variability was more evident in males. Hodkinson (2009) pointed out that some psyllid species exhibit polymorphism, which involves differences in color or size, variations in shape, venation, presence or intensity of coloring pattern, distribution and density of forewing spinules, slight changes in the shape of terminalia and antenna length. It should be mentioned that in the specimens collected for this study, the most evident morphometrical changes were manifested in wing venation, i.e., in 2.65% in males and 1.9% in females. However, variations in forewing venation also can be attributed to environmental stresses that lead to alterations in normal development (Badyaev 2005), and which could involve temperature (Santos et al. 2006) and a possible relationship between interspecific hybridization and fluctuating asymmetry (Rego et al. 2006).

Hollis (1987) states that the original host of *D. citri* was a species of *Murraya*; however, *D. citri* adapted to other rutaceous taxa leading to its success on *C. sinensis* and *C. paradisi* (Tsai & Liu 2000). Moran (1968), based on a study on *T. erytreae*, indicated that such adaptation also brought changes in the sizes of the organisms that derived from the quality of the nutrients in the host plant. Several studies have considered the role of gene flow in relation to local adaptation of a new host (Butlin 1990). The morphometrical differences among the individuals collected from *C. limetta* and *C. sinensis* 'Selection 8' were possibly caused by adaptation to new hosts, as Moran (1968) proved when he found that *T. erytreae* developed better on its original hosts, *Vepris undulata* Verdoorn & C. A. Sm. (Sapindales: Rutaceae) and *Clausena anisata* Willd. (Sapindales: Rutaceae), than on *C. limon* (L.), because the psyllid had to readapt to the later host when citrus were introduced in southern Africa.

In our study it was notable that *D. citri* is a species with morphometrical variation, which could be attributed to its adaptation to the study region as a result of geographic isolation from its center of origin and that the host taxa could have repercussions on variation of *D. citri*. *Murraya paniculata* and *C. sinensis* 'Marrs' were the hosts that supported the largest *D. citri* populations, an aspect that coincides with reports of several authors who commented that this is because these rutaceous taxa grow new shoots and leaves continuously, and thereby provide food and oviposition sites for the insect (Tsai et al. 2002; Fernández & Miranda 2005b; Ortega et al. 2013). In contrast, on *C. limetta*, *C. sinensis* 'Selection 8', and *C. paradisi* trees, adult densities were low despite the availability of shoots (Ortega et al. 2013). The non-preference of the insect for *C. sinensis* 'Selection 8' probably is attributed to the fact that it is a late cultivar and that its large, dark leaves that have a dry and wilted appearance were unattractive to the insect. Mature leaves are considered as a poor source of quality food since soluble nutrients are not readily available (Moran 1968; Tsagkarakis & Rogers 2010).

In general, females were longer ($\bar{x}$ = 2.81mm ± 0.019 SE) than males ($\bar{x}$ = 2.45 mm ± 0.020 SE), an aspect that coincides with reports by several authors in different countries such as Argentina (3.3 mm and 2.7 mm for females and males, respectively) (Hall 2008), Reunion (2.8 to 3.2 mm) (Étienne et al. 2001), Cuba (2 to 3 mm) (Fernández & Miranda 2005a) and Venezuela (3.1 and 2.5 mm) (Fonseca et al. 2007); though, Mathur (1975) and EPPO (2005) report shorter lengths of both males (1.53 -1.7) and females (2.06 - 2.4 mm). Female WL and WW were greater ($\bar{x}$ = 2.24 mm ± 0.007 SE and 0.96 mm ± 0.003 SE) than those of males ($\bar{x}$ = 2.12 ± 0.008 SE and 0.90 mm ± 0.004 SE). This coincides with Mathur (1975) and Chetry et al. (2012) who reported an average of 2.17 mm for WL and 0.84 mm for WW. They point out, that there may be slight variations in function of differential environmental factors.

To corroborate if morphometric variations are related to the host, it is necessary to study *D. citri* populations on each particular plant species over time, to investigate whether variations are heritable and to determine if the frequency of the morphs are stable or fluctuate among generations (Svensson & Abbot 2005). Other feasible experiments could be bioassays for rearing the progeny of specimens with anomalies and studying if the F1 retains the presumed parental variation. Also, rearing a monomorphic population on diverse host taxa to find out if the predicted variations occur should yield data to complement the findings in the present study. Additionally, molecular analysis should be performed in order to see possible changes at genome level (Peña-Carrillo et al. 2012).

We conclude that *D. citri* in the region of Veracruz, Mexico is a species with morphometrical variations and that the host taxon and environmental factors could affect variation. Males were more variable than females. In both sexes we observed that the determining variables for the morphometric characterization of *D. citri* were wing lengths and widths as well as genal process lengths and widths. García-Barros (1999) asserted that there is a functional relationship of body size to wing beats and wing morphological characteristics: the larger the body size, the larger the wing surface area; nonetheless, the movements are slow. The function of the genal process is known without accuracy; Kristoffersen (2006) indicates that the proximity of such structures with antennal lobes suggests that genal processes probably have an olfactory function, and that this may have a significant impact on host location.

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