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# Idiosomal setae analysis in *Oligonychus peruvianus* and *Oligonychus perseae* (Acari: Tetranychidae) from different hosts

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## Abstract.

Sandoval MF, Aponte O, Vásquez C. 2011. Idiosomal setae analysis in *Oligonychus peruvianus* and *Oligonychus perseae* (Acari: Tetranychidae) from different hosts. Entomotropica 26(3): 127-136.

The phytophagous mites, *Oligonychus peruvianus* (McGregor, 1917) and *Oligonychus perseae* Tuttle, Baker and Abbatiello, 1976 are considered occasional pests in several tropical crops. Due to the morphological similarities between them, both species are difficult to differentiate. In this study, morphometrical and chaetotaxic analysis were made to discriminate *O. peruvianus* from *O. perseae*. Idiosomal length and width and idiosomal chaetotaxy were measured in *O. peruvianus* females collected on *Manihot esculenta* Crantz or *Persea americana* L. trees from Venezuela and then compared to *O. perseae* specimens from avocado trees from Costa Rica. Principal Components Analysis (PCA) of the idiosomal chaetotaxy showed existence of three distinct groups, the first group represented by *O. peruvianus* individuals collected in avocado trees; the second one by *O. perseae* individuals from avocado and the third one conformed by those *O. peruvianus* from cassava plants. Our results confirmed taxonomic value of chaetotaxy as a tool to discriminate these mentioned Tetranychidae species.

**Additional key words:** avocado; cassava; chaetotaxy; phytophagous mites; Venezuela.

## Resumen

Sandoval MF, Aponte O, Vásquez C. 2011. Análisis de las setas idiosomales en *Oligonychus peruvianus* y *Oligonychus perseae* (Acari:Tetranychidae) de diferentes hospederas. Entomotropica 26(3): 127-136.

Los ácaros fitófagos, *Oligonychus peruvianus* (McGregor, 1917) y *Oligonychus perseae* Tuttle, Baker y Abbatiello, 1976 son considerados plagas ocasionales en varios cultivos tropicales. Debido a las similitudes morfológicas entre ellas, frecuentemente ambas especies son difíciles de diferenciar. En este estudio fue realizado un estudio morfológico y quetotáxico para discriminar *O. peruvianus* de *O. perseae*. El largo y ancho del idiosoma y la quetotaxia idiosomal fueron evaluados en hembras de *O. peruvianus* colectadas sobre *Manihot esculenta* Crantz y *Persea americana* L. en Venezuela y posteriormente fueron comparados con especímenes de *O. perseae* colectados en arboles de aguacate en Costa Rica. El Análisis de Componentes Principales (ACP) de la quetotaxia idiosomal demostró la existencia de tres grupos distintos, el primer grupo estuvo representado por los individuos de *O. peruvianus* colectados en aguacate; el segundo por individuos de *O. perseae* colectados en aguacate y el tercero conformado por *O. peruvianus* provenientes de plantas de yuca. Los resultados confirman el valor taxonómico de la quetotaxia como una herramienta útil para discriminar estas especies de Tetranychidae.

**Palabras clave adicionales:** aguacate, yuca, quetotaxia, ácaros fitófagos, Venezuela.

## Introduction

Tetranychidae includes about 1 200 described species, some are considered pests in economically important crops (Jepsson et al. 1975, Bolland et al. 1998), mainly those species in the genera *Tetranychus* Dufour and *Oligonychus* Berlese (Jeppson et al. 1975). *Oligonychus* has some 213 species, which feed primarily on trees, shrubs and perennial grasses (Pritchard and Baker 1955, Bolland et al. 1998). Some are very similar morphologically, leading very often to species misidentifications. The phenotypic variation exhibited by some tetranychids may be partially due to environmental factors responses, leading to variations ranging from phenotypic plasticity, polymorphism, strain formation and even to speciation (Meyers and Bull 2002, Magalhães et al. 2007).

Several statistical tools have proved to be useful in distinguishing species and inter and intraspecific variation in different taxa of arthropods (Gettinger and Owen 2000, Moder et al. 2007). Studies on morphometric variation in phytophagous mite species associated with different host plants are necessary to improve our comprehension about the systematics of each group and thus better understand the relationship phytophagous mite-host plant (Skoracka et al. 2002).

In the field and in the laboratory, *Oligonychus peruvianus* and *Oligonychus perseae* are commonly confused. Some morphological features such as striae pattern between setae *e1*, dorsal setae and shape of the aedeagus have made possible to separate both species (Tuttle et al. 1976). Our intent in this study is the examination and analysis of morphological variations to provide new morphologic features to separate both *Oligonychus* species.

## Material and Methods

*Oligonychus peruvianus* specimens were collected from avocado (*Persea americana* Mill. [Lauraceae]) and cassava (*Manihot esculenta* Crantz [Euphorbiacea]) plants growing in La Ponderosa farm, Mario Briceño Iragorry municipality, Aragua state, Venezuela.

**Material examined:** Avocado cv. Criollo: 21/III/2002 (02); 18/IV/2005 (08); 04/IV/2002 (06); 02/V/2002 (05) and 16/V/2002 (01). Avocado cv. Choquette: 14/III/2002 (01); 21/III/2002 (01) and 04/IV/2002 (01). Cassava cv. Zulianita: 14/III/2002 (04); 21/III/2002 (04); 18/IV/2002 (05) and 02/V/2002 (02). Mites were collected by M. F. Sandoval and preserved in vials containing 70 % isopropyl alcohol.

*Oligonychus persea* specimens were collected from avocado trees at Estación Experimental Fabio Moreno Baudrit, Universidad de Costa Rica, Alajuela, Alajuela municipality, Costa Rica.

**Material examined:** Avocado cv. Reed: 07/X/2003 (10); 12/V/2004 (15). Specimens were preserved in isopropyl alcohol and sent by Dr. Hugo Aguilar.

Slides with males and females were prepared using Hoyer medium and examined in a phase-contrast microscope (Zeiss ICS standard 25). Species determination was made using the taxonomical keys of Tuttle et al. (1976) and comparisons with the original descriptions (McGregor 1917).

Dorsal and ventral setae *ve*, *sci*, *sce*, *c1*, *c2*, *d1*, *d2*, *e1*, *e2*, *f1*, *f2*, *h1*, *IC1*, *c3*, *c4*, *pg*, *g*, *h2*, *h3* were measured following Quirós-Gonzalez and Baker (1984). Distances from setae *v2* to setae *h1* and between bases of setae *sce* were measured. Voucher specimens were deposited in the Laboratorio de Acarología, Facultad de Agronomía, Universidad Central de Venezuela (UCV) under code numbers: INIAP-0034pv, INIAP-0125pv, INIAP-0142pv, INIAP-0063ps, INIAP-0012ps.

All morphological characters were measured in groups of 25 *O. peruvianus* and 25 *O. perseae* females from avocado (Venezuela and Costa

Rica), and in a group of 15 *O. peruvianus* males from cassava (*Oligonychus* group); and were subjected to an analysis of variance (Statistix version 8.0). *Oligonychus* specimens collected from avocado and cassava were initially considered as different groups to determine the association level between the three groups mentioned above. Significant morphological variables were subjected to Principal Component Analysis (PCA) using the statistical package CSTAT (Foucher 1989).

## Results

Females of *Oligonychus peruvianus* and *O. perseae* share some morphological features such as having the idiosoma and legs yellowish-green, with scattered dorsolateral dark green spots, meanwhile in males the idiosoma is dark yellow, and legs I and II are slightly reddish. Dorsal setae lanceolate, proximally widened and distally strongly tapered, shorter than interval between bases (Freitez 1974). Also, one pair of cuticular grooves (lyrifisures) with 7 µm in length located between *c2* and transversally oriented on the idiosoma is found in these two species (Figure 2). Lyrifisures have been found in *Tetranychus urticae* Koch, and although its role has not been established, is presumed to act on the pheromones emission (Penman and Cone 1974).

Hysterosomal dorsal striation transverse only interrupted for an irregular longitudinal design between the third pair of setae *e1* in *O. peruvianus*, while in *O. perseae* females show a transverse striation pattern in inverted V shape (Figure 1). Difference in striation pattern between *e1* constitutes one of the most useful morphological characteristic to separate both species.

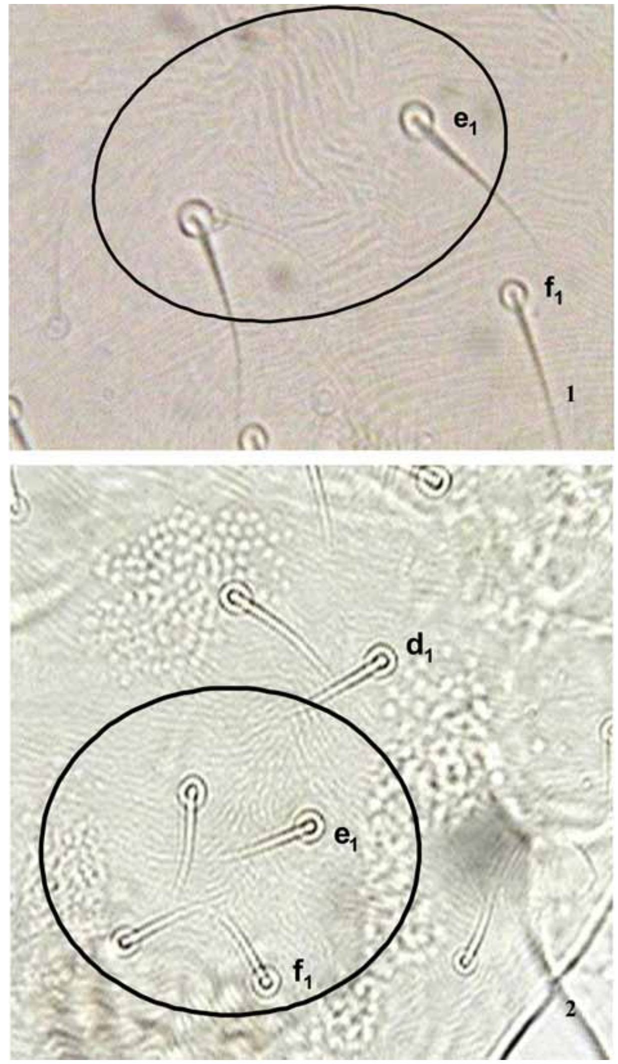


**Figure 1.** Cuticular striation pattern between setae *e1* in *O. peruvianus* (1) and *O. perseae* from avocado (2).

### Morphological comparison between *O. peruvianus* and *O. perseae*

In all *Oligonychus* groups differences were detected in the idiosomal length and width, in most of dorsal setae, except for *sce*, and also in most of ventral setae, except for *ic4* and *h2* (Table 1). In general, larger idiosomal ventral and dorsal setae were observed in *O. peruvianus* specimens collected from avocado, except for *ve* and *sce* setae. However, ventral setae were consistently shorter when compared with specimens collected in cassava.

When *O. perseae* and *O. peruvianus* specimens from avocado trees were compared, both species share similar idiosomal width and length ($P \leq 0.05$) (Table 1), but differences in dorsal setae

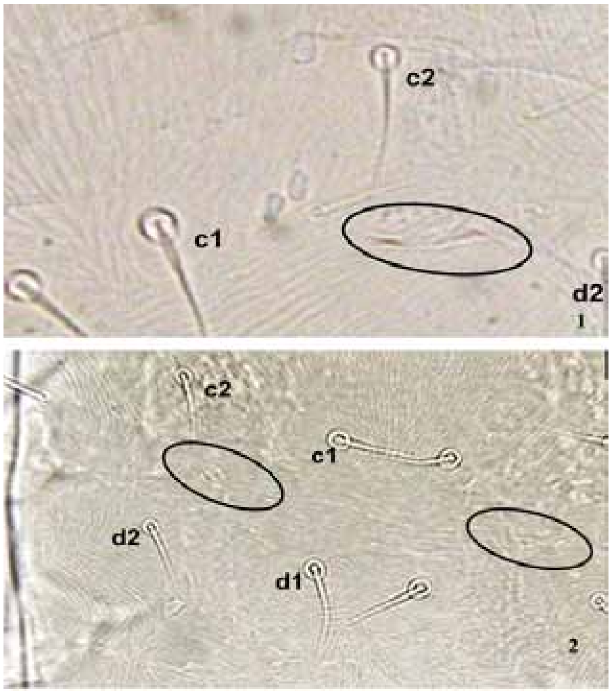


**Figure 2.** Detail of lyrifisures in *O. peruvianus* (1) and *O. perseae* (2).

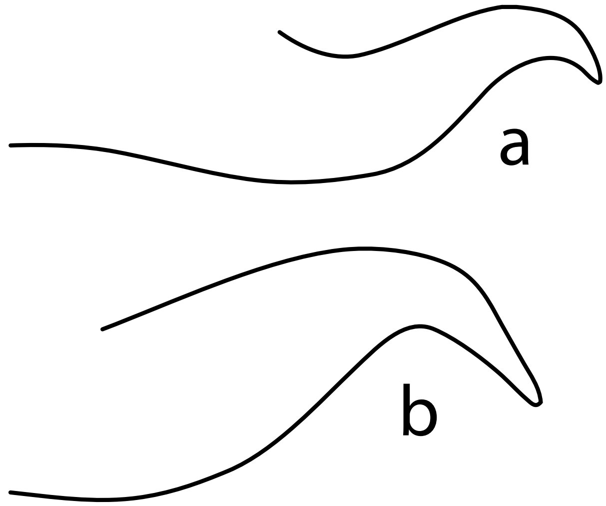


**Figure 3.** Aedeagus in *O. peruvianus* (a) and *O. perseae* (b)

*sci*, *c1*, *c2*, *c3*, *d1*, *d2*, *e1*, *f1*, *f2*, *h1* and in ventral setae *IC1*, *IC3*, *pg*, *g*, and *h3* were detected. However, both species differ in over 72 % of the characters considered in the study. In addition, differences in dorsal setae *v2*, *sci*, *c1*, *c2*, *c3*, *d2*, *e1*, *e2*, *f1*, *h1*, ventral *IC1*, *IC3*, *pg* and *g* were found, as well as in the width and length of idiosoma in specimens of *O. peruvianus* from both avocado and cassava ($P \leq 0.05$). Finally, similarities in the dorsal setae *sci*, *sce*, *c1*, *c2*, *c3*, *d1*, *d2*, *e1*, *e2*, *f2* and *h1*, in ventral setae *IC1*, *c4*, *g*, *h2*, and in idiosoma length and width between *O. perseae* from avocado and *O. peruvianus* from cassava were found.

## Shape of the aedeagus

*Oligonychus peruvianus* male aedeagus is small in size, with a curvature toward ventral region (Baker and Pritchard 1962). Moreover, we found that the aedeagus is sigmoid, tapering progressively towards the tip, which bends toward venter (Fig. 3a). In *O. perseae*, aedeagus is also ventrally directed, but curvature is slightly longer than in *O. peruvianus* (Fig. 3b).

## Principal Component Analysis (PCA)

The PCA performed on those significant different variables showed that the first three components accounted for only 58.65 % of variability found in all of the 21 evaluated variables in the two *Oligonychus* species from avocado or cassava (Table 2).

Width and length of idiosoma, length of setae *e2*, *h1* and *h2* showed low quality (<40) to account for the observed variability (Table 3). When a second analysis was performed ignoring the group of variables mentioned above, percentage of variability (70.09 %) observed in two *Oligonychus* species was accounted for the first three axes (Table 4). Nonetheless, *pg* showed lower quality (<50) (Table 5), so that a third analysis was performed in which more than 70 % of the total variability observed was account for the three first principal components (Table 6), which may be considered appropriate for this kind of study. The first linear combination showed variation in *e1*, *c3*, *f1* and *c1* in two *Oligonychus* species collected in avocado and cassava, being variability accounted for more than 70 % for component 1. Also variables *c2*, *sc1*, *IC1*, *d1* and *c3* were account for the first

**Table 1**. Morphometric values (µm) in two *Oligonychus* species from avocado and cassava trees.

| | | *O. peruvianus* | | *O. perseae* |
|---|---|---|---|---|
| | | avocado | cassava | avocado |
| Idiosoma | width | 171.13 a | 163.46 b | 172.79 a |
| | length | 304.78 b | 324.95 a | 318.63 ab |
| Ventral setae | $ic_1$ | 24.17 b | 26.79 a | 26.52 a |
| | $ic_3$ | 22.57 c | 23.75 b | 25.38 a |
| | $ic_4$ | 22.08 a | 23.12 a | 23.26 a |
| | *ag* | 21.19 c | 22.17 b | 23.03 a |
| | *g* | 19.99 b | 21.15 a | 21.28 a |
| | $h_3$ | 21.80 b | 21.28 b | 24.55a |
| | $h_2$ | 35.91 a | 35.85a | 36.56 a |
| Dorsal setae | *ve* | 21.05b | 25.78a | 21.89b |
| | *sci* | 33.71a | 32.05b | 31.50b |
| | *sce* | 45.03a | 45.35a | 45.07a |
| | $c_1$ | 34.05a | 30.08b | 30.44b |
| | $c_2$ | 27.28a | 23.43b | 23.90b |
| | $c_3$ | 66.61 a | 61.62 b | 60.95 b |
| | $d_1$ | 33.14a | 31.86ab | 30.70b |
| | $d_2$ | 24.62a | 22.17b | 22.95b |
| | $e_1$ | 34.77a | 31.35b | 30.63b |
| | $e_2$ | 23.60a | 22.29b | 23.22ab |
| | $f_1$ | 32.53a | 30.02b | 26.37c |
| | $f_2$ | 41.27a | 39.52ab | 36.33b |
| | $h_1$ | 38.61a | 37.05b | 37.32b |

Values in a column with the same letter did not show significant differences (Tukey´s test P<0.05).

**Table 2.** Cumulative percentage of total variation in 20 morphometric variables in *Oligonychus peruvianus* and *Oligonychus perseae*.

| Component | Eigenvector | Percentage | Cumulative percentage |
|---|---|---|---|
| 1 | 7.79 | 37.08 | 37.08 |
| 2 | 2.55 | 12.14 | 49.22 |
| 3 | 1.98 | 9.43 | 58.65 |
| 4 | 1.45 | 6.90 | 65.55 |
| 5 | 1.18 | 5.64 | 71.18 |
| 6 | 0.95 | 4.54 | 75.72 |
| 7 | 0.87 | 4.16 | 79.88 |
| 8 | 0.76 | 3.61 | 83.49 |
| 9 | 0.61 | 2.91 | 86.39 |
| 10 | 0.48 | 2.28 | 88.68 |
| 11 | 0.43 | 2.06 | 90.74 |
| 12 | 0.38 | 1.83 | 92.56 |
| 13 | 0.31 | 1.50 | 94.06 |
| 14 | 0.25 | 1.17 | 95.23 |
| 15 | 0.21 | 1.01 | 96.24 |
| 16 | 0.20 | 0.94 | 97.18 |
| 17 | 0.17 | 0.83 | 98.01 |
| 18 | 0.14 | 0.68 | 98.69 |
| 19 | 0.13 | 0.61 | 99.30 |
| 20 | 0.10 | 0.46 | 99.76 |

component, but contribution to total variation was lower (Table 7).

The second component included variables *v2*, *h3* and *f2*, being *v2* the variable with the greatest contribution to this component (73 %). Meanwhile, in the third component, variables *c4*, *d2*, *g* showed the highest contribution to the total variation. In this study, variables included in the first and second principal components showed the greatest variability observed (Table 7). According to correlation between variables in the two first components, more correlated setae were *v2*, *sci*, *c1*, *c2*, *c3*, *e1*, *f1*, *f2*, *h1* and *IC1*. Conversely lesser correlated were *d1*, *d2*, *c3*, *c4*, *g* (Figure 4). Based on our results, these components were selected to build the figure of association between the three groups of individuals studied (Figure 5). The analysis allowed detecting three distinct groups: the first group consisting of individuals of *O. peruvianus* collected from avocado, the second group represented by all individuals of *O. perseae* in avocado and, finally, the third group consisting of *O. peruvianus* from cassava. In the latter group, two individuals were similar to *O. peruvianus* from avocado.

## Discussion

Morphometrical differences found in *O. peruvianus* and *O. perseae* could be related to the host plant effect (Mattos and Feres 2009),

Table 3. Total variation and variable quality in three principal components

| Variable | Quality | PC-1 | PC-2 | PC-3 |
|---|---|---|---|---|
| *Idiosoma width* | 38.9 | 0 | 34.35 | 4.50 |
| *Idiosoma length* | 18.2 | 4.13 | 0.02 | 14.04 |
| $v_2$ | 83.1 | 16.88 | 65.14 | 1.06 |
| *sci* | 63.0 | 59.17 | 0.16 | 3.70 |
| $c_1$ | 77.0 | 73.38 | 1.48 | 2.19 |
| $c_2$ | 68.1 | 64.36 | 3.11 | 0.64 |
| $c_3$ | 79.0 | 77.68 | 1.36 | 0.01 |
| $d_1$ | 52.1 | 39.72 | 1.05 | 11.37 |
| $d_2$ | 59.3 | 26.59 | 4.22 | 28.51 |
| $e_1$ | 77.3 | 76.39 | 0.67 | 0.27 |
| $e_2$ | 32.8 | 4.36 | 23.53 | 4.91 |
| $f_1$ | 82.8 | 71.08 | 9.21 | 2.48 |
| $f_2$ | 73.8 | 37.06 | 36.7 | 0.09 |
| $h_1$ | 25.1 | 13.43 | 6.95 | 4.70 |
| $ic_1$ | 70.3 | 61.10 | 6.90 | 2.33 |
| $ic_3$ | 61.5 | 32.52 | 6.50 | 22.51 |
| $ic_4$ | 64.0 | 23.93 | 0.83 | 39.23 |
| *pg* | 44.9 | 41.50 | 0.14 | 3.26 |
| *g* | 49.2 | 18.63 | 0.20 | 30.41 |
| $h_3$ | 72.1 | 23.63 | 42.61 | 5.86 |
| $h_2$ | 38.9 | 13.09 | 9.83 | 15.96 |

PC-1: Principal Component 1; PC-2: Principal Component 2 and PC-3: Principal Component 3

which may lead to the formation of mite races as consequence of haplodiploid reproduction system (Helle and Overmeer 1973). Comparatively, *O. perseae* is smaller with dorsal setae longer except for *ve*, *sce* and *e2*. Moreover, setae *sce*, *c3*, *f2* and *h1* are pilose-shaped in *O. peruvianus* and *O. perseae*.

Our results showed that dorsal setae *sce*, *h1*, ventral setae *c4*, *h2* and idiosomal values do not seem to be appropriate features to be used in separating this two species, since those showed high variability. Baker and Pritchard (1962) found that dorsal setae of specimens from

Table 4. Cumulative percentage of total variation in 16 morphometric variables in Oligonychusperuvianus and *Oligonychus perseae*..

| Component | Eigenvector | Percentage | Cumulative percentage |
|---|---|---|---|
| 1 | 7.48 | 46.77 | 46.77 |
| 2 | 1.97 | 12.29 | 59.06 |
| 3 | 1.77 | 11.03 | 70.09 |
| 4 | 0.90 | 5.61 | 75.70 |
| 5 | 0.83 | 5.19 | 80.89 |
| 6 | 0.51 | 3.16 | 84.05 |
| 7 | 0.46 | 2.90 | 86.94 |
| 8 | 0.44 | 2.77 | 89.71 |
| 9 | 0.34 | 2.12 | 91.83 |
| 10 | 0.27 | 1.68 | 93.51 |
| 11 | 0.24 | 1.48 | 94.99 |
| 12 | 0.22 | 1.35 | 96.34 |
| 13 | 0.20 | 1.25 | 97.59 |
| 14 | 0.15 | 0.93 | 98.52 |
| 15 | 0.14 | 0.84 | 99.36 |
| 16 | 0.10 | 0.64 | 100.00 |

**Table 5.** Total variation and variable quality in three principal components

| Variable | Quality | CP-1 | CP-2 | CP-3 |
|---|---|---|---|---|
| $v_2$ | 86.7 | 13.47 | 73.14 | 0.08 |
| *sci* | 62.9 | 60.37 | 0.02 | 2.48 |
| $c_1$ | 78.4 | 73.18 | 3.03 | 2.16 |
| $c_2$ | 72.6 | 62.73 | 6.5 | 3.35 |
| $c_3$ | 80.4 | 77.24 | 3.16 | 0.01 |
| $d_1$ | 50.5 | 40.38 | 0.77 | 9.36 |
| $d_2$ | 69.0 | 26.17 | 5.24 | 37.54 |
| $e_1$ | 77.1 | 76.48 | 0.3 | 0.29 |
| $f_1$ | 84.4 | 73.94 | 8.49 | 1.96 |
| $f_2$ | 78.3 | 39.19 | 39.04 | 0.03 |
| $ic_1$ | 69.7 | 58.5 | 9.39 | 1.82 |
| $ic_3$ | 65.9 | 35.2 | 3.18 | 27.49 |
| $ic_4$ | 69.8 | 24.47 | 0.07 | 45.22 |
| *pg* | 47.8 | 41.43 | 0.11 | 6.29 |
| *g* | 54.4 | 18.62 | 1.03 | 34.72 |
| $h_3$ | 73.8 | 26.97 | 43.18 | 3.69 |

PC-1: Principal Component 1; PC-2: Principal Component 2 and PC-3: Principal Component 3

Table 6. Cumulative percentage of total variation in 15 morphometric variables in two Oligonychus species.

| Component | Eigen value | Percentage | Cumulative percentage |
|---|---|---|---|
| 1 | 7.10 | 47.36 | 47.36 |
| 2 | 1.97 | 13.11 | 60.47 |
| 3 | 1.72 | 11.48 | 71.94 |
| 4 | 0.88 | 5.88 | 77.83 |
| 5 | 0.69 | 4.62 | 82.45 |
| 6 | 0.48 | 3.18 | 85.63 |
| 7 | 0.45 | 2.99 | 88.63 |
| 8 | 0.34 | 2.26 | 90.88 |
| 9 | 0.27 | 1.80 | 92.69 |
| 10 | 0.24 | 1.61 | 94.30 |
| 11 | 0.24 | 1.57 | 95.87 |
| 12 | 0.20 | 1.33 | 97.20 |
| 13 | 0.17 | 1.15 | 98.34 |
| 14 | 0.14 | 0.96 | 99.30 |
| 15 | 0.11 | 0.70 | 100.00 |

Central America are slightly longer than those Peruvian species.

Both pattern of female dorsal striation and shape of aedeagus showed to be important as diagnostic features due to differences were consistently observed in all specimens, thus they are valuable in separation of both species (Ochoa et al. 1994). In Tetranychinae, aedeagus has evolved to a more complicated structure than in Bryobiinae, being formed of a shaft and a knob which probably become a critical key-lock system and an effective mating barrier between species living on the same host plant (Gutierrez and Helle 1985). According to Alberti and Storch (1976), the shape of aedeagus is a critical diagnostic character for determining many species, especially in Tetranychinae genera. Based on aedeagus and some other morphological characters, Pritchard and Baker (1955) recognized five major species groups in genus *Oligonychus*, with *O. peruvianus* forming a separated group having the aedeagus bent ventrad. Other studies have shown value of aedeagus to separate species, mainly in *Tetranychus* and *Oligonychus* species (Gutierrez

Table 7. Total variation and variable quality in three principal components analysis

| Variable | Quality | CP-1 | CP-2 | CP-3 |
|---|---|---|---|---|
| $v_2$ | 86.50 | 13.29 | 73.19 | 0.00 |
| *sci* | 63.80 | 62.30 | 0.00 | 1.51 |
| $c_1$ | 79.00 | 74.92 | 2.78 | 1.34 |
| $c_2$ | 72.50 | 63.20 | 6.18 | 3.11 |
| $c_3$ | 80.40 | 77.22 | 3.09 | 0.05 |
| $d_1$ | 50.70 | 39.78 | 0.89 | 10.06 |
| $d_2$ | 69.00 | 27.63 | 4.51 | 36.84 |
| $e_1$ | 78.30 | 77.89 | 0.36 | 0.03 |
| $f_1$ | 85.10 | 75.15 | 8.88 | 1.03 |
| $f_2$ | 77.80 | 38.64 | 39.21 | 0.00 |
| $ic_1$ | 70.40 | 58.64 | 9.41 | 2.35 |
| $ic_3$ | 62.90 | 32.79 | 2.73 | 27.37 |
| $ic_4$ | 70.30 | 23.20 | 0.01 | 47.11 |
| *g* | 58.60 | 18.37 | 1.26 | 38.94 |
| $h_3$ | 73.90 | 27.42 | 44.07 | 2.39 |

PC-1: Principal Component 1; PC-2: Principal Component 2 and PC-3: Principal Component 3 PC-1: Principal Component 1; PC-2: Principal Component 2 and PC-3: Principal Component 3

and Schicha 1983, Zhang and Jacobson 2000).

Although length of setae seems to have significant importance in a morphometrical analysis to separate both species, these show to have a relative value to recognize populations from different host plants. On the other hand, the Principal Component Analysis showed setae *v2*, *sci*, *c1*, *c2*, *c3*, *e1*, *f1*, *f2*, *h1* and *IC1* to be important to distinguish *O. perseae* from *O. peruvianus*. Similarly, Vásquez et al. (2011) showed relative value of setae *sc1* and *sca2 v2*, *sc1*, *c1*, *d1*, *e1* and *f1* to separate *Oligonychus punicae* (Hirst) or *Oligonychus biharensis* (Hirst) populations, respectively. Additionally, Mattos and Feres (2009) demonstrated the value of length of setae *v2*, *sc2*, *c1*, *c3*, *e1* and *h1* to separate *Eutetranychus banksi* populations (McGregor) collected on different host plants (*Citrus* sp., *Hevea brasiliensis* and *Pachira aquatica*).

Conclusively, the striation pattern between setae

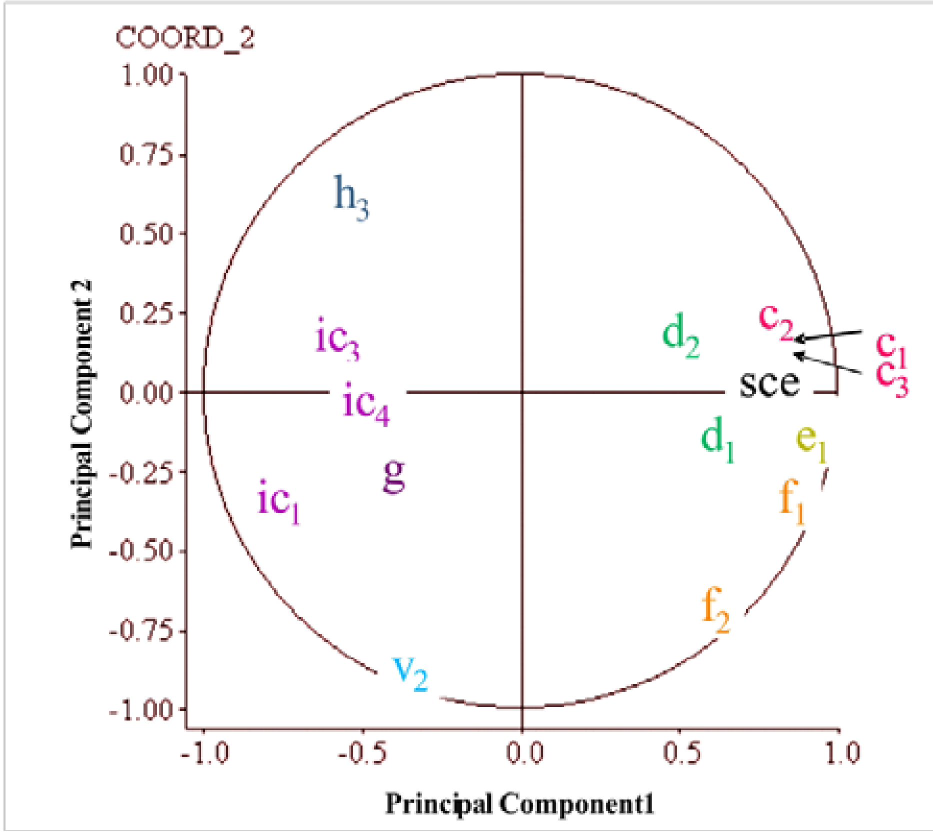


**Figure 4.** Clustering of *O. peruvianus* and *O. perseae* according to arrangement in two principal components

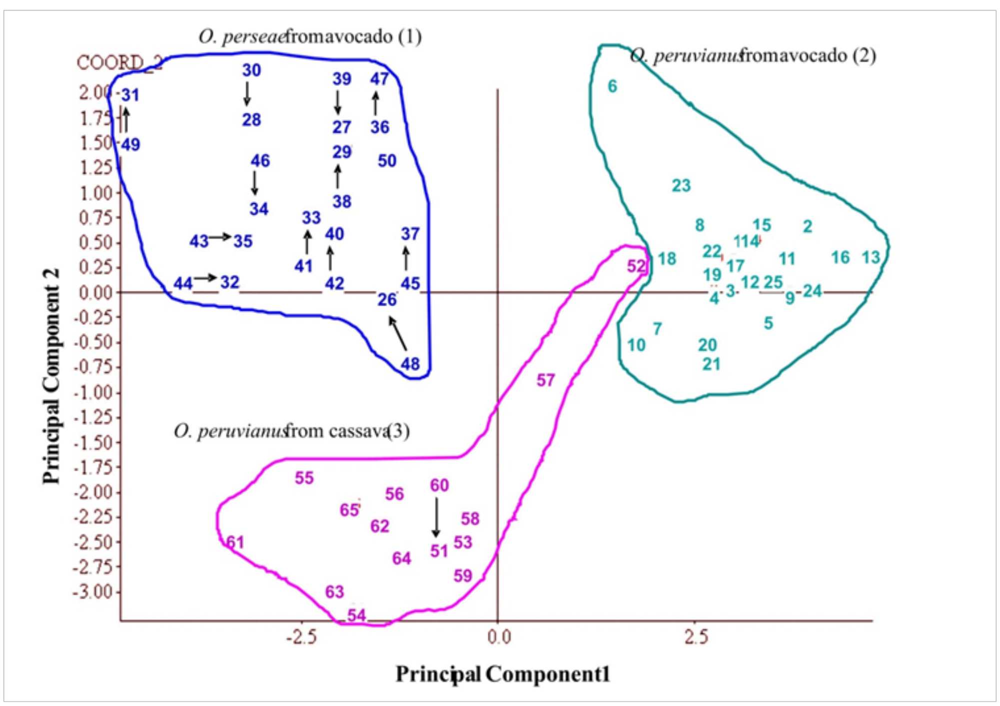


**Figure 5.** Representation of the idiosomal dorsal and ventral setae in *O. peruvianus* and *O. perseae* in the first and second principal component

*e1* on idiosomal dorsum in *O. peruvianus* and *O. perseae* females and shape of the aedeagus seem to be the most important morphological characters for separating these species.

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