STUDIES ON A *EUSEIUS* SPECIES COMPLEX ON AVOCADO IN MEXICO AND CENTRAL AMERICA, WITH A DESCRIPTION OF A NEW SPECIES (ACARI : PHYTOSEIIDAE)

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SPECIES COMPLEX INTERBREEDING PHYTOSEIIDS

ABSTRACT : Slight morphological differences and reproductive isolation between some populations of *Euseius* indicated the existence of a complex of 3 species on avocado trees from southern California, USA, south through Mexico and Central America : *E. hibisci* in California and inland areas of Mexico south to Oaxaca ; *E. vivax* in the warmer, humid areas of southern Mexico and in Central America ; and *E. quetzali* n. sp. from the mountain areas of Guatemala and Chiapas, Mexico. Partial reproductive incompatibility (F_1 progeny all or mostly males) was observed between northern and southern populations of *E. hibisci* in Mexico and between California and Mexico populations.

COMPLEXE D'ESPÈCES CROISEMENTS PHYTOSEIIDES

RÉSUMÉ : De légères différences morphologiques et l'isolement reproducteur entre populations d'*Euseius* indiquent l'existence d'un complexe de 3 espèces sur avocatiers du sud de la Californie, U.S.A., à travers le Mexique et l'Amérique Centrale : *E. hibisci* en Californie et dans les régions intérieures du Mexique allant vers le sud jusqu'à Oaxaca ; *E. vivax* dans les régions plus chaudes et humides du sud du Mexique et Amérique Centrale ; *E. quetzali* n. sp. des régions montagneuses du Guatémala et du Chiapas au Mexique. Une incompatibilité partielle de la reproduction (toute la progéniture F_1 ou presque est composée de mâles) a été observée entre les populations d'*E. hibisci* du nord et du sud du Mexique et entre les populations de la Californie et celles du Mexique.

INTRODUCTION

Several surveys have been made in Mexico and Central America by the senior author, E. R. OATMAN and C. A. FLESCHNER, for natural enemies of *Oligonychus* species (Tetranychidae) on avocado. The objective of these surveys was to find and to introduce predaceous species which might enhance the biological control of the avocado brown mite, *Oligonychus punicae* (Hirst) on avocados in California. The predators encountered most frequently were phytoseiid mites in the genus *Euseius* (as redefined by McMURTRY, 1983) which were very close to *E. hibisci* (Chant). Laboratory cultures were established of some of the *Euseius* species from Guatemala and various regions of Mexico. As preliminary observations revealed slight morphological differences and also differences in behavioral characteristics among mites from different cultures, it was apparent that detailed biological and morphological studies would be necessary in order to establish the identity of these mites.

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MATERIALS AND METHODS

Cultures of *Euseius* species were established from mites collected on avocado trees from one location in Guatemala : Antigua, on 17-II-77 (GA) ; from three locations in Mexico : Ocozocoautla, near Tuxtla Gutierrez, Chiapas, on 30-III-81 (MT) ; near Oaxaca, on 9-II-81 (MO) ; and Alamos, Sonora, the type locality of *E. hibisci*, on 2-XII-82 (MA). Cultures of *E. hibisci* originating from mites collected from avocado in Riverside, California in 1977, and subsequently from citrus in Riverside in 1980, were also established (CR). Cultures were started with adult females ; initial numbers ranged from 11 to 33. Cultures GA, MT and MO were maintained in an insectary room at 24 ± 2°C on metal tile arenas surrounded by a water barrier (McMURTRY & SCRIVEN, 1975). Because of previous difficulties in rearing *E. hibisci* on artificial substrates, cultures MA and CR were maintained on excised avocado leaves (McMURTRY & SCRIVEN, 1964). The phytoseiids were fed twice weekly with pollen of *Malephora crocea* (Jacq.).

To assess reproductive compatibility among *Euseius* populations, hybridization tests were conducted in the laboratory at 23-25°C. Eggs or larvae from the stock cultures were isolated in 3.7 ml shell vials containing a layer of 2.5 % agar at the bottom (for provision of adequate humidity) and closed with ventilated stoppers (McMURTRY, 1980). Mites were reared to maturity on *M. crocea* pollen and the females isolated in clean vials with fresh pollen. Individual males from the appropriate cultures were then added to each vial to initiate the desired crosses. At least 15 pairings were made for each cross. Control crosses (♀ × ♂ from the same culture) were also made (5-8 pairs). After 2 days (the normal preoviposition period for phytoseiids), vials were inspected daily for 5 days. Any eggs resulting from heterogamic crosses were isolated in vials to determine mortality during development. The crosses between Guatemala and California populations were made in 1977, those between Oaxaca and California populations in 1981, and all other crosses were made in 1982-83.

For morphological and taxonomic studies, specimens collected in various locations of Mexico and Central America were mounted on slides in Hoyer's medium and measurements made of dorsal shield setae and leg macrosetae. Measurements are given in micra. Setal nomenclature follows that proposed by ROWELL *et al.*, 1978.

RESULTS

Hybridization Tests

The Guatemala (GA) population was reproductively incompatible with all populations with which hybridization tests were made (Table 1). One California (CR) female paired with a GA male laid 5 eggs, 3 of which shriveled. The other 2 developed to male adults. No other females in these heterogamic crosses laid eggs, although some pairs were observed in the mating position.

The Tuxtla Gutierrez (MT) population was incompatible with that from Oaxaca (MO) as well as GA. In the MT-GA pairings, only 1 pair (MT ♀ × GA ♂) was observed in the mating position. Five females from the MT × GA (♀ × ♂) pairing and 5 from the GA × MT pairing were mounted in Hoyer's medium and examined, and only the one female observed in the mating position had an inflated spermathecal vesicle. However, there was no evidence of endospermatophores (AMANO & CHANT, 1978) in the vesicle. No GA ♀ — MO ♂ pairs were observed in the mating position. Five MO ♀ — GA ♂ pairs were observed in the mating position, and all 5 had 3-5 endospermatophores in the vesicles.

Some F_1 progeny were produced in the MO — CR pairings (Table 1). Only 20 % of the MO females paired with CR males produced progeny, although some of the non reproducing females appeared to be copulating with males. The rate

TABLE 1. — Results of laboratory crosses involving populations of *Euseius* from Guatemala (GA), Mexico — Tuxtla Gutierrez (MT), Oaxaca (MO), Alamos (MA), and California — Riverside (CR).

Cross	No.	♀'s ovipositing		
♀ × ♂	pairs	No.	%	Eggs/♀/day [a]
GA × MT	17	0	0	—
MT × GA	19	0	0	—
GA × GA	10	8	80	1.02
MT × MT	10	8	80	1.22
GA × MO	15	0	0	—
MO × GA	15	0	0	—
GA × GA	6	6	100	1.70
MO × MO	7	4	57.7	1.73
GA × CR	20	0	0	—
CR × GA	20	1	5	0.83
GA × GA	8	6	75	1.78
CR × CR	8	6	75	1.62
MT × MO	15	9	0	—
MO × MT	15	0	0	—
MT × MT	5	5	100	1.48
MO × MO	5	5	100	1.68
MO × CR	20	4	20.0	1.10
CR × MO	19	17	89.5	2.00
MO × MO	8	8	100	2.68
CR × CR	8	8	100	2.43
MO × MA	16	7	43.8	1.32
MA × MO	16	11	68.8	1.0
MO × MO	8	8	100	2.42
MA × MA	8	8	100	2.70

[a] Of ovipositing females for 5-day period.

of oviposition of the fertile females was lower than that of the CR females crossed with MO males and also the females in the control crosses. Thirty percent of these eggs laid by MO females paired with CR males were nonviable and 67 % of the eclosing mites reached maturity, all of which were males. Nearly 90 % of the CR females paired with MO males produced progeny, averaging 2 eggs/♀/day. Of 40 eggs isolated in vials, 5 (12.5 %) were nonviable and 9 (22.5 %) developed to adult males. The others died in the larval or protonymphal stage.

F_1 progeny also resulted from some of the MO-MA pairings, although the rate of oviposition of the fertile females was lower than that for the controls (Table 1). Seven of 16 MO females (44 %) paired with MA males produced a total of 46 progeny, of which 7 were nonviable eggs, 22 died as larvae or protonymphs and 17 (37 %) completed development (all males). Except for 1 female which had inflated but empty spermathecal vesicles, all had been inseminated (endospermatophores present in vesicles). Ovipositing MO females of this pairing contained an average of 3.14 endospermatophores and nonovipositing ones averaged 3.75 endospermatophores/female.

Eleven of the 16 MA females paired with MO males produced progeny (Table 1). Of 59 total progeny, there were 4 nonviable eggs, 19 died in the nymphal stages and 36 (65.5 %) matured (33 ♂♂, 3 ♀♀). Ovipositing females contained an average of 6.2 endospermatophores and non ovipositing females contained an average of 6.0 endospermatophores. Thus failure to oviposit was not attributed to lack of insemination.

To determine if the F_1 progeny from the MA-MO crosses were fertile, F_1 males and females were backcrossed to the opposite sex of the same stock as the parent female. In the MAMO F_1 ♂ × MA ♀ backcrosses, 22 of 23 females produced progeny. The 3 MAMO F_1 females backcrossed with MA males produced no progeny, although all 3 pairs were observed in the mating position. Thirteen of 14 MO females paired with MOMA males produced progeny. Thus the MA — MO crosses produced numerous fertile males but only 3 hybrid MAMO females, which were infertile.

The results of the hybridization tests indicate that the GA, MT and MO populations are reproductively isolated from one another, although under laboratory conditions, occasional copulations occurred. The collection site of the MT population is only about 400 km from that of MO to the west, and also from that of GA to the southeast. The CR population was reproductively incompatible with the GA population and presumably with the MT population (which is more distinct morphologically) as well. The MO population hybridized to some extent with the MA and CR populations although the collection site of MO is approximately 1,600 km and 2,700 km from the sites of MA and CR, respectively. Some hybridization also occurred between the MA and CR populations (CONGDON and MCMURTRY, 1985). Presumably MA, which we consider to be the same species as MO (see

TABLE 2. — Setal measurements (means and ranges in μm) of female specimens of *Euseius* species from avocado in Guatemala, Mexico and California.

	Seta								
Locality	j6	J2	Z1	Z4	S2	S4	S5	SgeIV	StIV
MT [a]	12.2	13.2	13.5	15.2	19.0	23.2	27.7	55.1	74.2
(n = 14)	11-14	12-14	12-15	13-18	16-23	19-27	24-31	48-60	68-79
GA [b]	17.4	18.0	16.9	20.9	23.4	27.4	33.2	42.6	64.5
(n = 20)	14-21	14-22	14-19	18-26	21-26	24-32	30-41	40-47	59-67
MO [c]	18.5	19.8	19.8	23.3	30.0	35.9	40.2	52.6	75.7
(n = 21)	17-21	18-22	17-23	21-26	25-35	30-41	34-47	47-55	72-80
MA [d]	17.9	19.3	19.4	23.0	29.0	36.0	39.5	54.2	73.0
(n = 24)	16-19	17-21	16-22	19-27	25-32	33-40	37-42	49-58	62-78
CR [e]	17.9	20.3	22.9	23.9	34.5	37.7	40.6	56.2	74.1
(n = 22)	15-21	17-24	16-29	19-29	22-45	33-46	35-51	46-63	66-84

[a] Mexico, Ocozocoautla, near Tuxtla Gutierrez (Chiapas State).
[b] Guatemala : Antigua, 10 ♀♀ ; Patzicia (Chimaltinango), 2 ♀♀ ; Mixco (Guatemala), 1 ♀ ; Godinez (Sololá) 7 ♀♀.
[c] Mexico, Oaxaca, 13 ♀♀ ; Ixtlan de Juarez (Oaxaca State), 6 ♀♀ ; San Miguel Peras (Oaxaca), 2 ♀♀.
[d] Mexico, Alamos (Sonora).
[e] California, Riverside, various locations in southern region.

TABLE 3. — Setal measurements (means and ranges in μm) of *Euseius* species females from avocado in Central America and Mexico.

	Seta								
Locality	j6	J2	Z1	Z4	S2	S4	S5	SgeIV	StIV
Costa Rica [a]	12.8	13.0	13.3	13.5	19.0	23.3	26.0	52.8	73.5
(n = 4)	12-14	12-14	12-14	13-14	16-23	20-26	23-29	46-60	70-79
El Salvador [b]	12.8	13.8	13.0	13.5	19.8	23.8	27.3	50.8	72.0
(n = 4)	12-14	13-16	12-14	13-14	19-23	20-28	24-32	48-57	66-76
Honduras [c]	11.3	12.5	12.5	14.3	18.0	20.8	25.3	50.8	72.3
(n = 4)	11-12	12-14	12-14	13-16	17-20	19-24	24-28	48-53	69-75
Mexico [d]	10.7	11.5	11.8	12.0	17.3	20.5	25.5	50.5	69.3
(Guerrero)	10-11	11-12	11-12	12	17-18	17-23	24-28	46-54	65-74
(n = 4)									
Mexico [e]	17.0	18.8	17.7	22.6	26.2	28.8	36.3	42.0	64.7
(Chiapas)	16-18	18-20	16-19	21-23	24-28	26-31	34-40	40-44	62-67
(n = 6)									
Mexico [f]	19.3	20.8	20.8	25.1	30.0	37.1	39.3	48.0	71.0
(Morelos)	17-22	19-22	18-23	22-26	24-34	32-42	35-46	46-50	66-76
(n = 7)									

[a] Tres Rios ; Esparta.
[b] San Salvador ; Acajutla.
[c] Zamarano.
[d] Acapulco.
[e] San Cristóbal de las Casas.
[f] Nepantla ; Cuatla ; Cuernavaca.

below), is also reproductively isolated from MT and GA populations.

The observations of endospermatophores in the spermathecae of females in crosses which resulted in only male progeny (or nearly so) indicate that lack of insemination of these females was not the reason for the absence of female progeny.

Morphological Comparisons

Table 2 shows setal measurements of specimens from areas of the 5 populations of *Euseius* on which cross-breeding tests were conducted. On the basis of setal lengths, the MT specimens can be separated from MO, MA, and CR specimens by shorter *j6, J2, Z1, Z4, S2, S4* and *S5*, and from GA specimens by longer *Sge IV* and *StIV*, and also shorter *j6, J2* and *Z4*. Ga specimens can be separated from MO, MA and CR by the shorter *SgeIV* and from MO also by shorter *StIV*. GA specimens usually can be separated from those of MO, MA, and CR also by shorter setae *S2* and *S4*. MO, MA, and CR specimens had very similar measurements.

Thus the populations which did not interbreed can be separated morphologically. Comparison of the MT specimens with the holotype of *Euseius vivax* (Chant & Baker) revealed that setal measurements as well as other characters corresponded very closely (setal measurements of *E. vivax* appear in the next section) ; therefore, the MT specimens are considered *E. vivax*. Comparison of specimens of MO, MA, and CR with the holotype of *E. hibisci* (collected from Alamos, Sonora, Mexico) indicated a close resemblance ; therefore, these populations are all considered *E. hibisci*. Complete setal measurements and a supplementary decription of *E. hibisci* were given by CONGDON and McMURTRY (1985). The Guatemala material represents a new species, *E. quetzali* n. sp. (described in the next section).

Table 3 shows measurements of specimens from avocado from other locations of Central America and Mexico. The data indicate that specimens from Costa Rica, El Salvador, Honduras and Acapulco, Mexico all have characteristically short setae on the dorsal shield similar to the MT specimens and the holotype of *E. vivax*, and therefore, are determined as *E. vivax*. Those specimens from San Cristóbal de las Casas are similar to the Guatemala material and are considered *Euseius quetzali* n. sp. The specimens from Morelos, Mexico resemble those from collection sites MO, MA, and CR and are considered *E. hibisci*.

A tabular key (Table 4) separates the 3 species on the basis of setal lengths.

TABLE 4. — Tabular key to females of species of the *Euseius hibisci* complex [1] on avocado in Central America, Mexico and California. Lengths of setae in μ.

J2	SgeIV	S4	S5	Z1	j6	Species
11-14	46-60	17-28	23-32	11-15	10-14	*vivax*
14-22	40-47	24-32	30-41	14-19	14-21	*quetzali*
17-24	46-63	30-46	34-51	16-29	15-22	*hibisci*

1. *Euseius* species having all leg macrosetae with sharp tips, *r3* and *R1* on membraneous cuticle near margin of dorsal shield, cervix of spermatheca relatively long (15-25 μm) and of uniform diameter throughout or slightly narrowing distally.

Euseius quetzali McMURTRY n. sp.

■ *Female* (Figs. 1-4) : Dorsal shield length 341 (312-355), width at *s4* 225 (211-237) (based on 10 specimens), with light striations anterolaterally and light reticulations on most of the posterior portion, with prominent pores in locations shown in Fig. 1. Setal lengths (based on 20 specimens) as follows : *j1* 31 (30-35), *j3* 34 (31-40), *j4* 17 (16-19), *j5* 16 (14-19), *j6* 17 (14-21), *J2* 18 (14-21), *J5* 6 (5-6), *z2* 28 (25-33), *z4* 29 (25-35), *z5* 16 (13-18), *Z1* 17 (14-19), *Z4* 21 (18-25), *Z5* 62 (59-68), *s4* 43 (40-51), *S2* 24 (20-26), *S4* 27 (24-32), *S5* 33 (29-41). Setae *r3* 20 (18-22) and *R1* 13 (12-14), on membraneous cuticle. Peritremes 146 (125-166) extending to level of seta *j3*.

Sternal shield lightly sclerotized, margins indistinct but with lateral lobes and an apparent median lobe posteriorally, shield bearing 3 pairs of setae ; metasternal setae on platelets ; genital shield width 89 (84-96) ; ventrianal shield 106 (99-111) long, 56 (51-60) wide at level of preanal

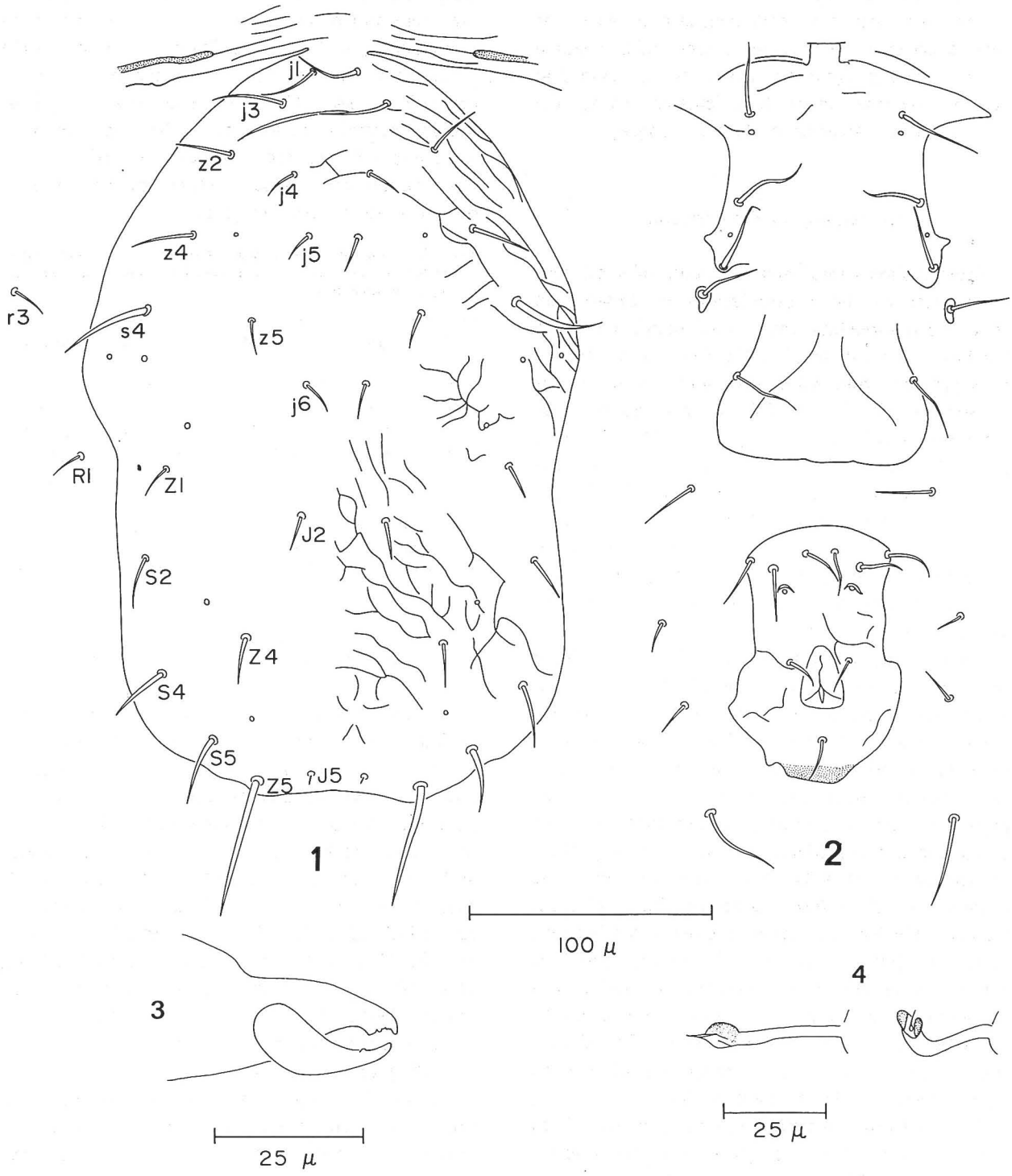

FIG. 1-4 : *Euseius quetzali* n. sp., female :
1. — Dorsal shield ; 2. — Ventral surface ; 3. — Chelicera ; 4. — Spermatheca.

setae, 71 (64-78) wide at level of anus. Seta *JV5* 37 (35-38).

Fixed digit of chelicera 23-25 long with 2 relatively large and 3 minute subapical teeth, movable digit 21-24 long with 1 tooth.

Cervix of spermatheca tubular, 21 (16-25) long.

Distinct macrosetae present on genua of legs II, III, IV and on ti and tIV ; that on leg I (*pd 1*) somewhat longer but no thicker than seta *ad. 1*. Lengths (n = 10) : *SgeI* 25 (23-29), *SgeII* 25 (23-27), *SgeIII* 29 (27-30), *SgeIV* 43 (40-47), *StiIV* 35 (32-39), *StIV* 65 (59-67). All macrosetae ending in sharp tips. Chaetotactic formula of geII 2-2/0-2/0-1 ; geIII 1-2/1-2/0-1 ; geIV 1-2/1-2/0-1.

■ *Male* (Figs. 5-7) : Dorsal shield length 256 (250-264), width at *s4* 207 (192-216), with striations anterolaterally and reticulations on most of posterior portion, with prominent pores in locations as shown in Fig. 5. Setal lengths (based on 12 specimens) as follows : *j1* 26 (23-29), *j2* 34 (33-37), *j4* 18 (17-20), *j5* 18 (16-19), *j6* 20 (18-22), *J2* 18 (17-20), *J5* 4, *z2* 28 (24-31), *z4* 31 (27-35), *z5* 17 (16-19), *Z1* 18 (17-21), *Z4* 23 (21-28), *Z5* 53 (49-56), *s4* 40 (37-42), *S2* 24 (21-29), *S4* 25 (23-28), *S5* 33 (29-34) ; *r3* 22 (20-23), and *R1* 15 (14-17), both on dorsal shield. Peritreme length 98 (92-102), extending nearly to level of seta *z2*.

Sternogenital shield with anterior margin indistinct, first pair of sternal setae appear to be on membrane ; 4 additional pairs of setae on shield. Ventrianal shield 107 (99-116) long, reticulated, with preanal setae in transverse row ; shield connected to posterior portion of peritremal plate. Spermatodactyl as in Fig. 7.

Lengths of leg macrosetae as follows : *SgeII* 21 (20-21), *SgeIII* 23 (22-25), *SgeIV* 34 (32-36), *StiIV* 32 (29-33), *StIV* 55 (52-57), all ending in sharp tips.

■ *Material Examined*. Holotype ♀ and 4 paratype ♀♀, *Guatemala* : Jocotenango, near Antigua Guatemala, Sacatepéquez, 17-II-77, on *Persea americana*, deposited in U.S. National Museum of Natural History. Five paratypes, same data, in Division of Biological Control, University of California, Riverside (UCR). Additional paratypes as follows : 5 ♀♀, Godinez, Sololá, 15-III-77 ; 2 ♀♀, Patzicia, Chimaltenango 18-II-77 ; 1 ♀, Mixco, Guatemala, 17-II-77, 2 ♀♀, Chichicastenango, Quiché, 16-III-77, all from *Persea americana* ; 12 ♂♂, from laboratory culture (original stock from Chichicastenango, 1(-II-77), all deposited in UCR.

Additional material as follows :

Mexico : 9 ♀♀, El Callejon, near San Cristobal de las Casas, Chiapas, 7-II-81 from *P. americana* ; Guatemala : numerous females from various locations in provinces of Guatemala, Sacatepequez, Chimaltenango, and Sololá, from *P. americana*.

Diagnosis : *E. quetzali* is distinguished from *E. hibisci* and *E. vivax* by the shorter macroseta on genu IV, and from *E. vivax* also by longer setae *J2*.

Euseius vivax (CHANT & BAKER)

Amblyseius vivax : CHANT & BAKER, 1965 : 23.
Euseius vivax : DENMARK & MUMA, 1973 : 260.

■ *Previous records* : Holotype female, in U.S. National Museum of Natural History, from *Camelia* leaf, San Jose, Costa Rica. Other collection records from various parts of Costa Rica, Nicaragua, El Salvador (CHANT & BAKER, 1965), El Salvador (DENMARK & ANDREWS, 1981) and Brazil (DENMARK & MUMA, 1973).

■ *Measurements of holotype* : Setae : *j1* 31, *j3* 32, *j4* 12, *j5* 13, *j6* 12, *J2* 12, *J5* 4, *z2* 25, *z4* 30, *z5* 10, *Z1* 12, *Z4* 13, *Z5* 58, *s4* 48, *S2* 16, *S4* 20, *S5* 23, *r3* 16, *R1* 11. Genital shield 86 wide ; peritreme length ca. 144. Fixed digit of chelicera 23 long, movable digit 24. *SgeI* (*pd 1*) 24 (barely discernable from ad 1), *SgeII* 24, *SgeIII* 28, *SgeIV* 52, *StiIV* 42, *StIV* 70 ; all leg macrosetae with sharp tips.

■ *Notes* : DENMARK & MUMA (1973) listed *E. vivax* from a wide variety of host plants from the state of São Paulo, Brazil. No records of *E. hibisci* were included in their paper, although EHARA (1966) listed collections from São Paulo State. In view of the present study, Brazilian specimens should be reexamined.

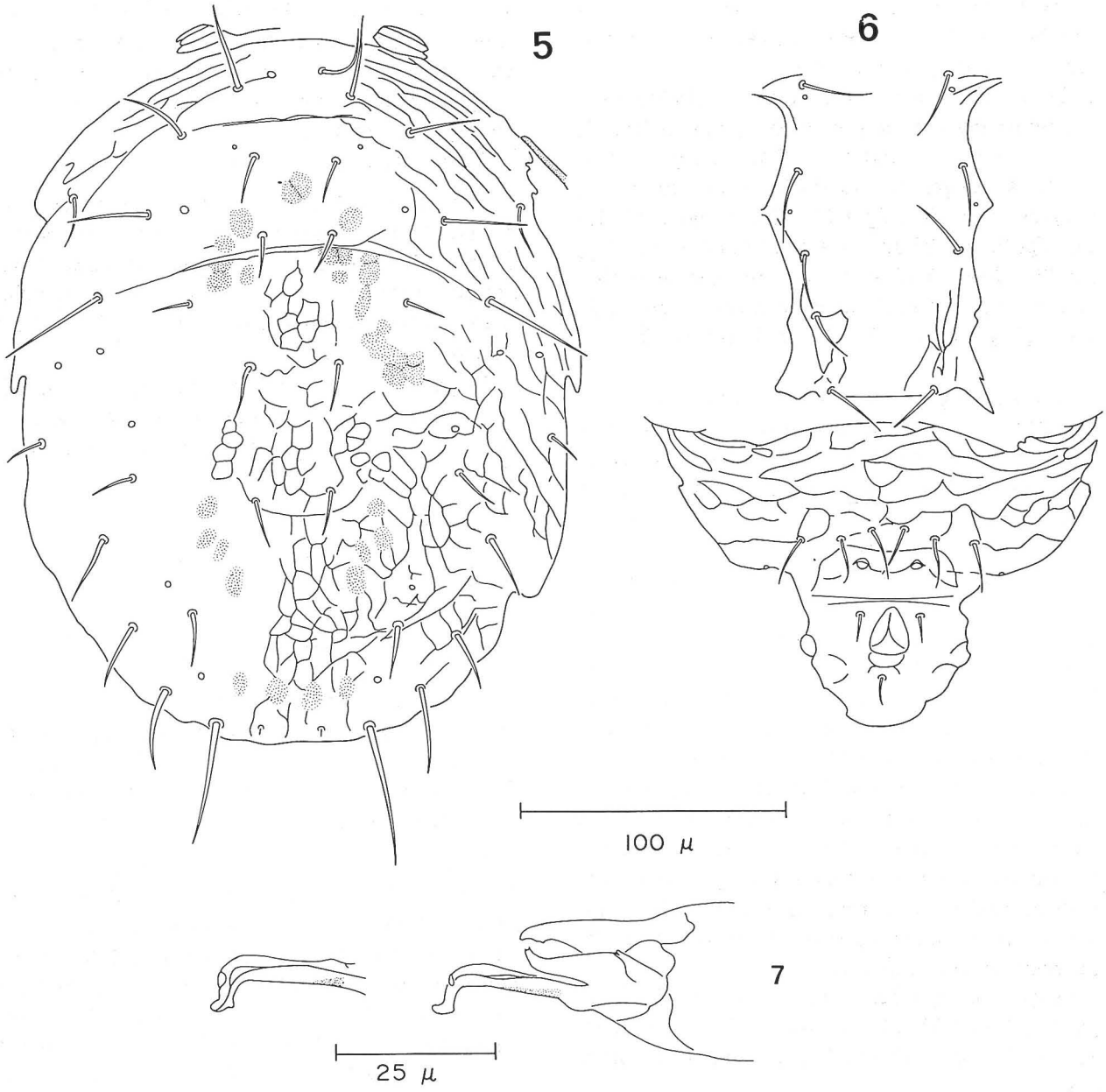

FIG. 5-7 : *Euseius quetzali* n. sp., male :
5. — Dorsal shield ; 6. — Ventral surface ; 7. — Chelicera and spermadactyl.

DISCUSSION

The morphological and biological evidence from this study indicates the existence of a *Euseius* complex of 3 species on avocado from southern California, through Mexico and Central America (not including the Atlantic coastal areas, from which sufficient collections have not been made). Analysis of various series of specimens indicates that *E. hibisci* is the common species on avocado in California and inland areas of Mexico, south to the state of Oaxaca. *E. vivax* is common in the warm, more humid areas of southern Mexico and Central America. *E. quetzali* thus far is known only from the mountain areas of Chiapas state, Mexico, and in Guatemala, where it was found to be the dominant species on avocado in the highlands, where native *Persea* trees also occur (McMURTRY, 1983). There are no records of overlap of the 3 species, but additional collecting is needed in southern Mexico in transition areas between tropical, subtropical and mountain biotopes.

Consistent differences in lengths of certain setae (sometimes an overlap of 1-2 $\mu\mu$ in the ranges), and total reproductive isolation in laboratory tests were the two criteria used for declaring validity of species. Although *E. quetzali* is more or less intermediate between *E. hibisci* and *E. vivax* in lengths of setae on the dorsal shield, the degree of incompatability of *quetzali* with the other 2 species was as high as that between *hibisci* and *vivax* in laboratory tests.

Both pre mating and post mating isolation properties were involved between the 3 species. In some series of pairings, few matings were observed, while in others, some females were inseminated but no progeny were produced.

Some post mating isolating properties were also present between populations of *E. hibisci*. Although nearly all pairings resulted in production of F_1 progeny, the progeny were all males except in a few cases. Populations from southern California, Alamos (Sonora), Mexico and Oaxaca, Mexico are isolated from on another by areas of desert and/or mountains ; therefore some degree of incompatibility between demes might be expected to have evolved, and eventual differentation into separate species is conceivable.

In detailed morphological and biological studies of phytoseiids, we can expect many instances in which it will be difficult to make decisions about validity of species. There seems to be no definitive way of determining if two or more demes have diverged sufficiently to be considered evolutionary species, as defined by WILEY (1981).

Incompatibility between populations was also shown in another *Euseius* species, i.e., *E. addoensis* from the eastern and western cape provinces of South Africa. In this instance, however, crosses resulted in the production of fertile F_1 and F_2 females, although reproductive rates were lower and percentage of nonviable eggs higher than in control crosses (McMURTRY, 1980). Similar results were obtained in crosses involving *Typhlodromus occidentalis* Nesbitt from different areas of the western USA (CROFT, 1970). On the other hand, in some species of Phytoseiidae, widely separated populations have been found to be fully reproductively compatible, e.g. *Typhlodromus annectens* Deleon from Chiapas, Mexico and southern California, *Phytoseiulus macropilus* from Cook Islands and southern California (unpublished data), *A. potentillae from the Netherlands and southern Italy* (McMURTRY *et al.*, 1976), and *Phytoseiulus persimilis* Athias-Henriot from Chile and Italy (KENNETT & CALTAGIRONE, 1968).

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