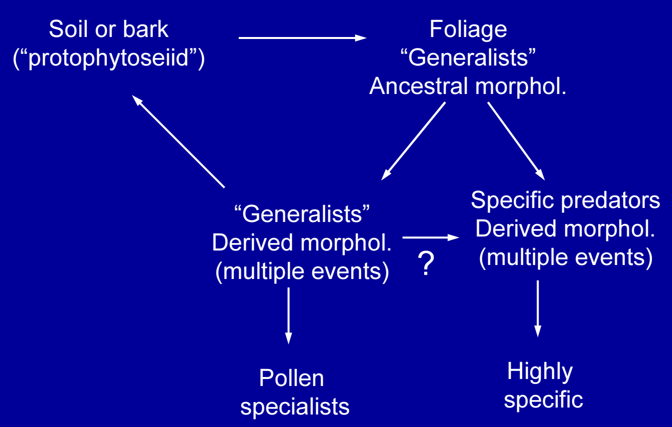
# Life Styles of Phytoseiid Mites: Implications for Rearing and Biological Control Strategies

J. A. McMurtry
Professor Emeritus, Univ. of California, Riverside
Present address: Sunriver, Oregon, USA

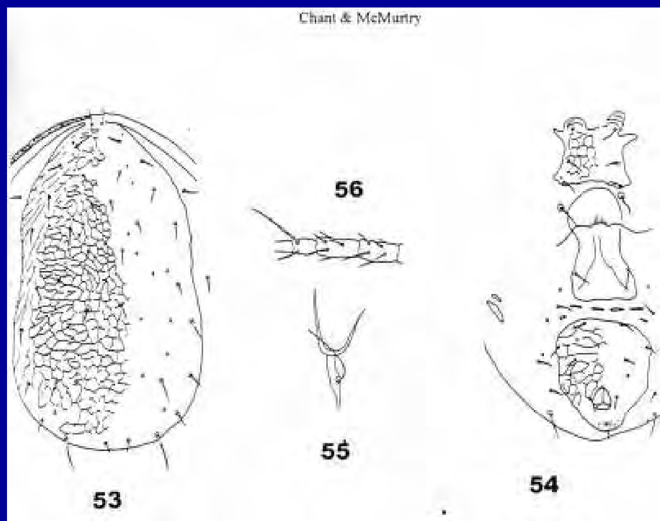
## Items for Consideration

- Evolution of feeding habits of the Phytoseiidae.
- Some associations of Phytoseiidae with different foods and plants (life styles).
- Relationships of life styles to rearing and biological control (examples).
- Some challenges at the species level in relation to biological control.
- Summary and Conclusions

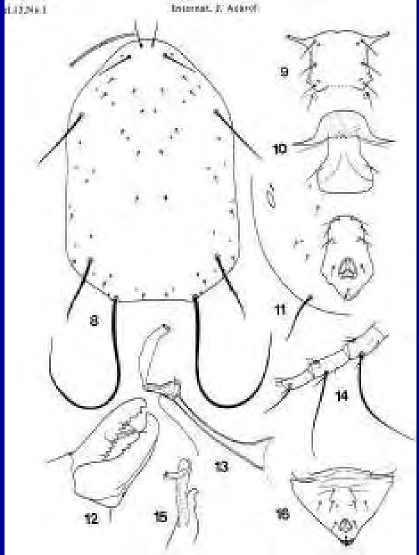
## Hypothetical pathways of evolution of phytoseiid food habits




*Neoseiulus ellesmerei*- ancestral morphology



*Amblyseius phillipsi*- highly derived morphology
(After Chant & McMurtry 2004)




## Life Styles of Phytoseiid Mites
(McMurtry & Croft 1997; Croft et al. 2004)

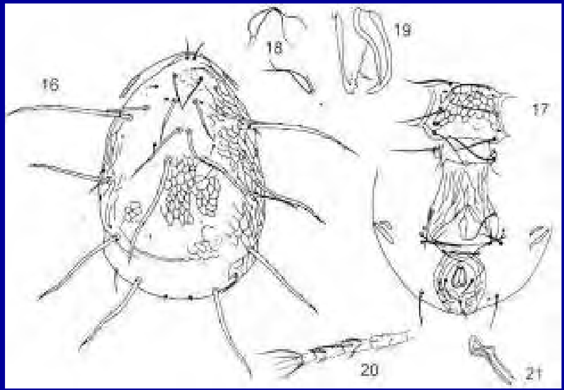
- Highly specific on *Tetranychus* spp. (Type I )
- Broadly specific, tetranychids most favorable (Type II)
- Generalists; wide array of foods acceptable (Type III)
- Specialized pollen feeders, general predators (Type IV)

## Highly specialized predators of *Tetranychus* spp. (Type I)

- Very high reproductive potential
- Live in spider mite colonies
- Very long median dorsal (j-J) setae
- Plant habitat less important than prey species
- Require spider mites for mass production

Subfamily Amblyseiinae- *Phytoseiulus*- 4 spp., all highly derived, unrelated to other groups.
*P. persimilis* brought fame to the Phytoseiidae in the 1960's.

## *Phytoseiulus persimilis*
(after Chant & McMurtry 2006)




*Phytoseiulus persimilis*

Courtesy R. Cloid

Glasshouse cucumber production

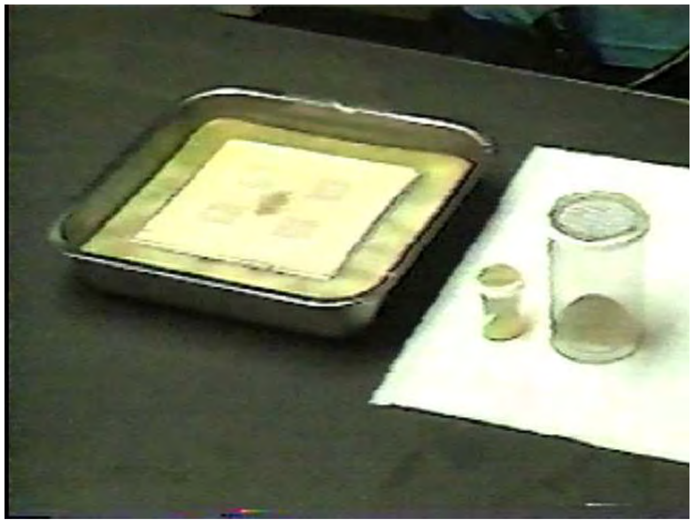
Releasing *Phytoseiulus persimilis* in strawberry field

Bean plants infested with *Tetranychus pacificus*

“Washing machine” for harvesting spider mites

Shaking spider mite eggs onto rearing unit

Techniques developed by G. Scriven (he later co-founded Biotactics)



## Broadly specific spider mite predators (Type II)

- Medium to high reproductive potential.
- Long median dorsal setae (j-J series).
- Thrive in highly webbed spider mite colonies; other types, e.g. *Panonychus spp*. not as favorable.
- Rust mites may be important alternate prey.
- Spider mites usually required for mass-rearing.

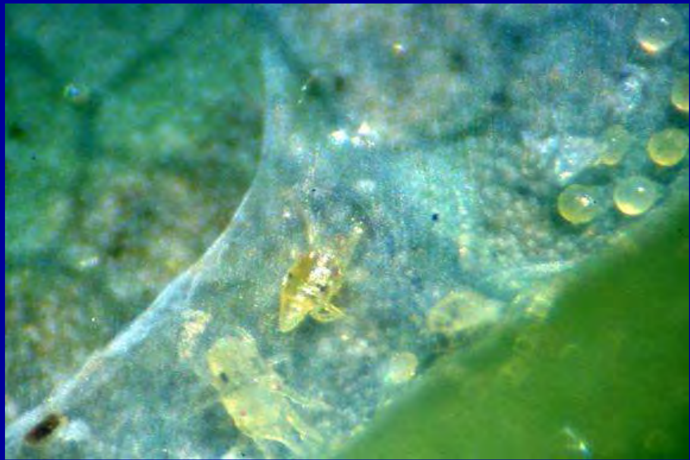
## Examples of broadly specific (Type 2) predators

Subfamily Tyhlodrominae

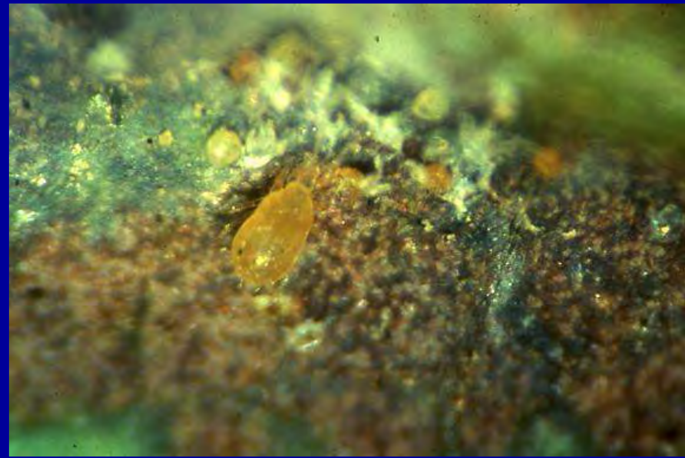
- *Typhlodromus rickeri* group- Asian origin. *T. rickeri* introduced to US; both spider mites and rust mites are favorable.
- *Galendromus*. All associated with tetranychids in heavily webbed colonies. *G. occidentalis*- brought fame to Phytoseiidae in 1960's. *G. helveolus* (introduced), *annectens*- live in webbed nests of persea mite and also in colonies of *Eotetranychus sexmaculatus* on avocado in California.


## "Nests" of persea mite on avocado leaf

Persea mite on avocado leaf



*Galendromus helveolus* (introduced to California)



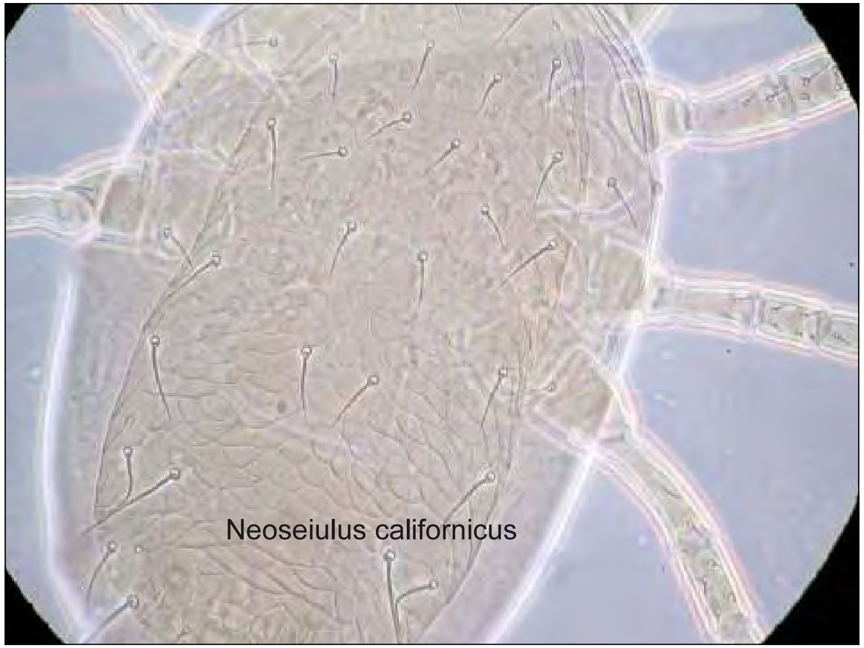
## Examples of broadly specific predators (cont.)

Subfamily Amblyseiinae

- *Neoseiulus* - A few spp., e.g. *fallacis* and *womersleyi*. If they have long median dorsal setae, they probably prefer spider mites. *N. californicus,* with intermediate- length setae, has some characteristics of Type III. Can be reared on foods that are cheaper to produce.

General comments

- Each of the Type II groups (4-5) probably evolved independently.
- Type II predators may be unable to compete with type III and IV (generalist) predators at low prey densities.




## General feeders (Type III)

- Feed on various groups of mites, small insects, honeydew, pollen, nectar, plant juices.
- Medium to low reproductive potential, sometimes lower on spider mites than other mites, e.g., eriophyoids.
- Often aggregate in protected areas of foliage (domatia), not in spider mite patches.
- Often dominant in stable ecosystems.
- Can be more cheaply mass-produced; spider mites not requred.

## Examples of general feeders (Type III)

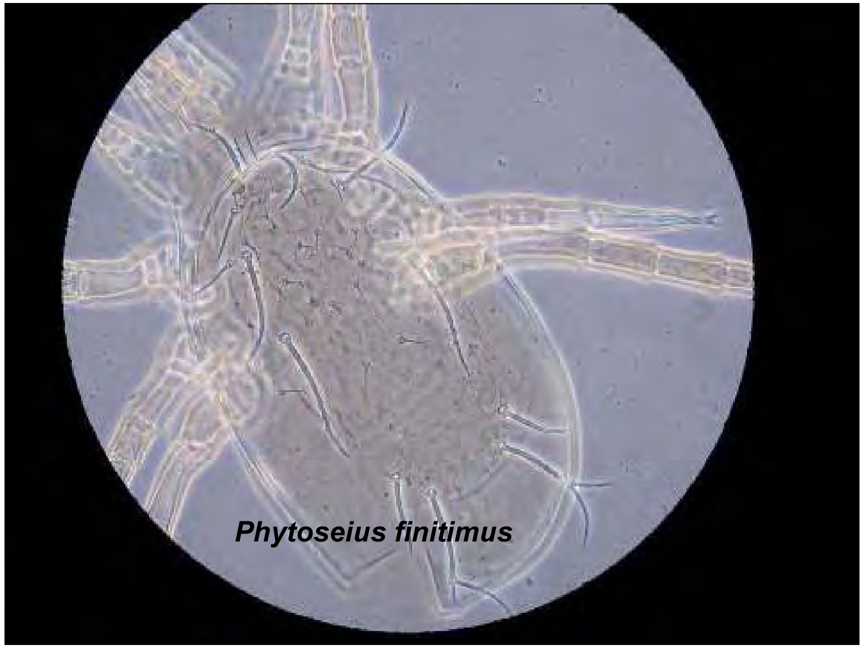
Subfamily Typhloldrominae

- *Typhlodromus* *pyri*- cosmopolitan- impact on *Panonychus ulmi;* rust mites are favorable prey.
- *Metaseiulus*- mostly N. America- Eriophyoids (rust/bud mites) appear more favorable than spider mites.

These have mostly unmodified morphologies.

## Examples of general feeders (cont.)

- Subfamily Phytoseiinae- *Phytoseius* spp.- All highly derived.
- Potential mostly unknown.
- Adaptations to host plant features- small, laterally compressed, movement through dense leaf hairs.

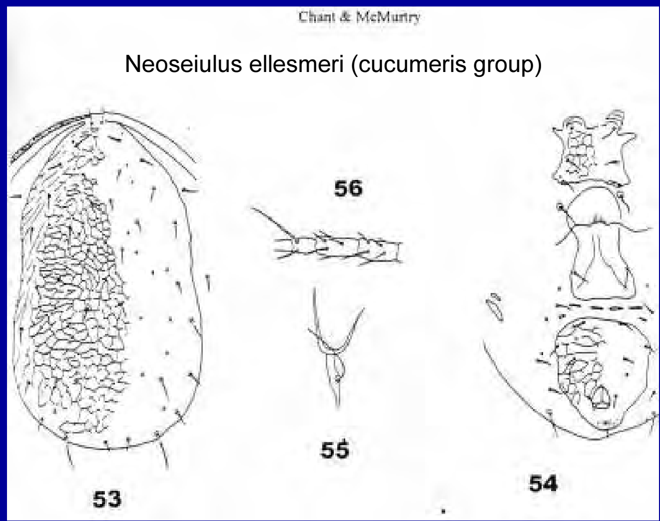


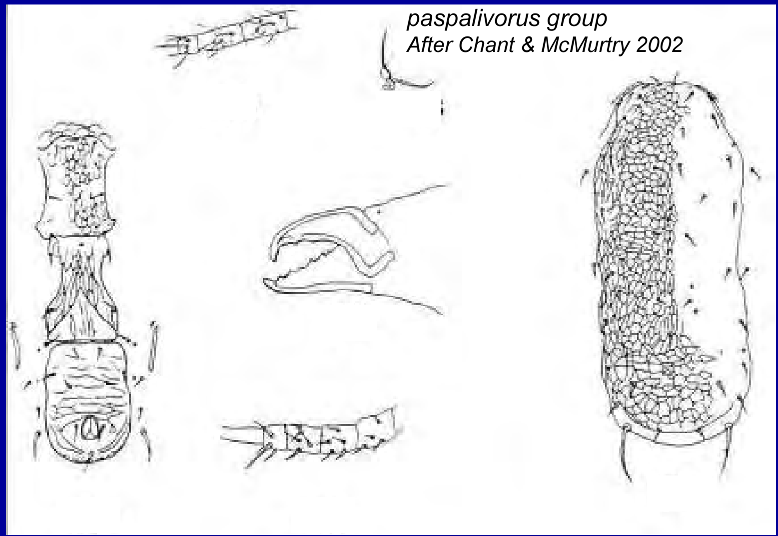

## Examples of general feeders (cont.)

Subfamily Amblyseiinae

Tribe Neoseiulini- *Neoseiulus-*

- *barkeri* group, e.g. *barkeri*
- *cucumeris* group, e.g. *cucumeris-* both spp. used commercially in biological control (thrips, etc.).
- *paspalivorus* group- elongate, flat body, mainly on grasses. *N. paspalivorus* and *baraki* associated with the coconut mite *Aceria guereronis* on coconut palm (Moraes et al. 2004).





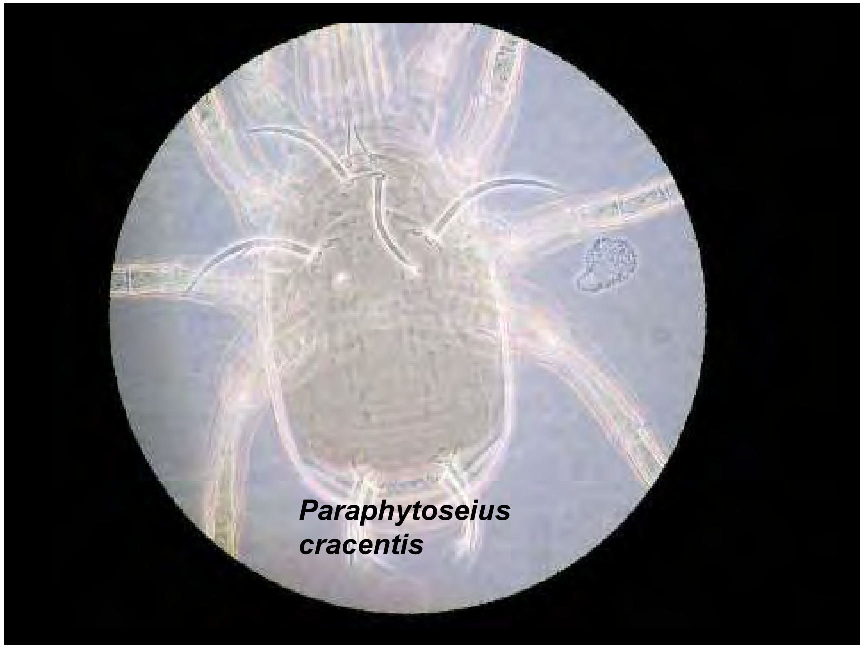

*Neoseiulus baraki.* Courtesy M. Guedes

Coconut damaged by *Aceria guerreronis* (Eriophyidae)
Courtesy F.R. da Silva

## Examples of general feeders (Cont.)

Tribe Kampimodromini- highly derived body plans- often thick setae, small size, laterally compressed.

- *Kampimodromus- aberrans*- effective biological control agent, best on hairy leaves? Benefit from pollen and mildew.
- *Paraphytoseius*- Superficially resembles *Phytoseius* (convergence). On hairy leaves; associations with prey largely unknown.




## Examples of general feeders (cont.)

Tribe Amblyseiini- Most species highly derived, long "caudal" setae Z5

- *Transeius*-

  *montdorensis* (= tetranychivorus?)- potential for thrips control in Australia (Steiner et al. 2003).
- *Amblyseius*-

  e.g. *andersoni*- important on tetranychids on deciduous fruits, vines.

  *swirskii*- citrus (Middle East) and commercial production for greenhouse crops.


## Examples of general feeders (cont.)

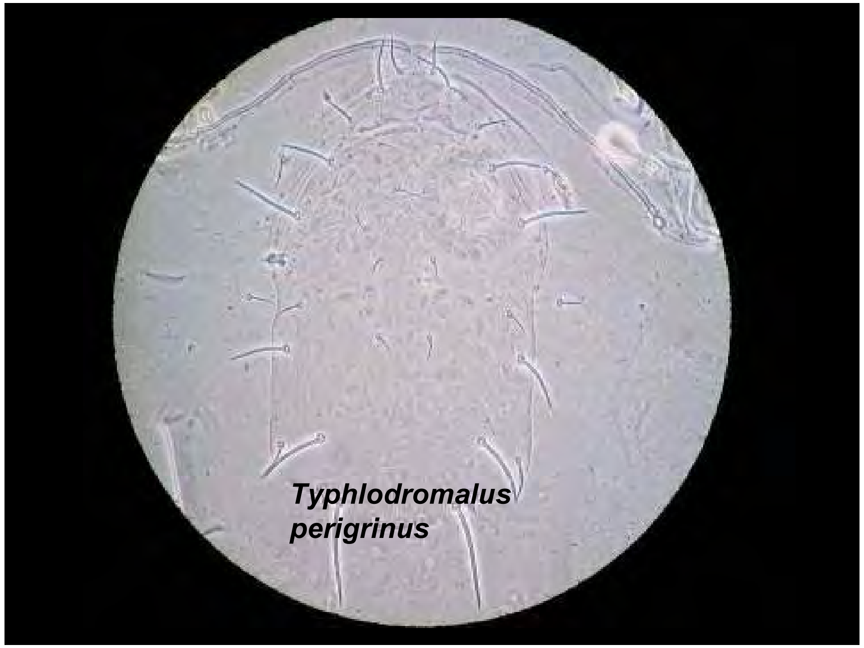
Tribe Euseiini

- *Typhlodromalus*-

  *aripo*- on cassava green mite (CGM); established in Africa.
- *Amblydromalus*-

  *manihoti*- successful establishment in Africa on CGM.

  *limonicus*- apparent impact on spider mites on avocado, citrus in California, USA coastal areas. Might have promise for biological control programs.





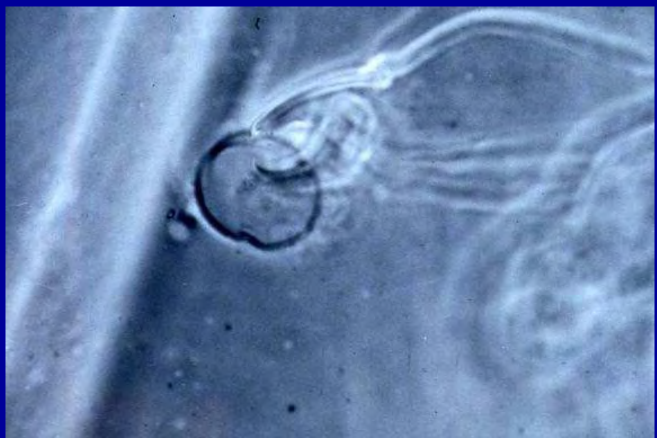

## Specialized pollen feeders (Type IV)

Tribe Euseiini *Euseius, Iphiseius*

- Medium reproductive potential, usually highest on pollen.
- Populations may reach highest peak during bloom periods of crop (e.g. avocado) or adjacent trees (e.g. *Eucalyptus*).
- Specialized mouthparts- short stubby chelicerae, wide deutosternum.
- Potentially valuable on tetranychids forming light webbing; on thrips.
- Can be cheaply mass-produced on pollen; leaves may be required.
- Underutilized!

*Euseius hibisci* on avocado leaf


*Euseius stipulatus* chelicera and pollen grain
(from Flechtmann & McMurtry 1992*)*



Flowers of “ice plant”, *Malephora crocea*

## Other types?

- *Typhlodromus bambusae* on *Schizotetranychus celarius* on bamboo (Saito, 1990). Apparent example of coevolution in a stable habitat.
- Specialists on eriophyoids? Or generalists exploiting certain habitats?
- Specialists on tenuipalpid (flat) mites?
- Specialists on certain insects?
- Specialists on tydeid mites? *Paraseiulus* spp.
- Subtypes of Type III (generalists)? This awaits study!

## Sorting out closely related species- example: *Euseius* species in California, USA

1. *hibisc*i- avocado (widespread); citrus (coastal, a few other pockets).
2. *tularensis*- citrus (widespread), grape, avocado (rare).
3. *quetzali*- many wild plants (*Quercus, Rubus*), deciduous fruits, nuts.
4. *obispensis*- avocado, only 1 county in California.
5. *stipulatus* (introduced 1971)- citrus (coastal S. Calif.), can displace native *Eueius*. New records (2006-7)- avocado, raspberry, grape. Initially didn’t colonize avocado.

- Coexistence? Apparently uncommon.
- Based on morphology (large series) and cross-breeding.

## Cryptic species, biotypes/strains DNA techniques

Today we have DNA/molecular techniques to characterize species and biotypes/strains. For example:

- *Amblydromalus manihoti, tenuiscutus and limonicus*- molecular studies confirmed morphological studies (Edwards et al. 1998).
- *Euseius concordis, citrifolius*- molecular data consistent with morphological studies (Noronha et al. 2003).
- Distinguishing and assessing survival and dispersal of resistant strain of *Euseius finlandicus* (Yli-Matilla, et al. 2000)

## Tomato plants infested by *Tetranychus evansi*

(courtesy G. de Moraes)

*Phytoseiulus longipes*

## Cassava green mite damage

Courtesy G. de Moraes

## Importance of detecting biotypes in biological control programs: examples

- *P. longipes from S. Africa* showed reduced feeding and no potential for biological control of *T. evansi*; *longipes* from Brazil fed readily on *T. evansi* and preferred it to *T. urticae* (Furtado et al. 2007).
- *Typhlodromalus aripo, Amblydromus manihoti* on cassava green mite- These spp. from Colombia failed to establish in Africa; Biotypes from NE Brazil readily established and spread in many countries across Africa (Yaninek & Hanna 2003) .

## Variation within populations- example: *Kampimodromus aberrans*

- *K. aberrans* shows seasonal variations in setal lengths (Chant 1955, Swirski & Amitai 1965, Tixier et al. 2000).
- Molecular data suggested that populations may be highly structured, with little gene flow between females on a crop and those in adjacent surrounding vegetation (Tixier et al. 2002).
- Such findings have obvious implications in biological control and systematics.

## Classification System of Chant & McMurtry for the Phytoseiidae

- 1994 Typhlodrominae, Phytoseiinae- 6 tribes, 23 genera.
- 2003- 2006 Amblyseiinae, parts I-IX- 9 tribes, 61 genera.
- Total- 15 tribes, 84 genera.
- 2007- "Illustrated keys and diagnoses for the genera and subgenera of the Phytoseiidae of the world". 220 pp., Indira Publishing House. Culmination of 15+ yrs. work.

Why is this important to biological control? It has helped us to proceed from chaos to some degree of order.

## Summary and Conclusions

- Our life-style system does have some relevance to mass-rearing and control potential.
- There is increasing use of generalist (Type III) species.
- Species in Type IV (pollen specialists) are underutilized.
- Cultures must be consistently monitored for contaminant species. Some, e.g. *N. fallacis* and *N. californicus*, are notorius contaminants.
- We must not assume that studies on one population of a species will apply to other populations as well.

## Summary and Conclusions (cont.)

- Detection of cryptic species, biotypes and population variants is essential.
- Storage of predators and food needs greater research emphasis.
- Evaluation is all-important. Industry will play an increasingly important role.

## Finally

- We will always need collectors in the field in order to maintain viable "banks" of species and biotypes for biological control trials.
- We will always need more biological information on phytoseiids in order to refine rearing methods and biological control strategies.