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II. Population Dynamics of Mites on Three Species of Pines in the Forest Falls Area of the San Bernardino Mountains

III. Laboratory Studies on the Biology of the Phytoseiids *Metaseiulus validus* (Chant) and *Typhloseiopsis pini* (Chant)

Laurence D. Charlet and James A. McMurtry

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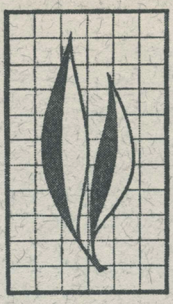

I. Survey of Mites on Native Pines, Including a Description of a New Species of Phytoseiidae

A survey was made to determine the mite species occurring on the foliage of 17 native species of pines in California. Mites were removed from the needles by an air-agitated water bath; 23 different families were recovered. The Phytoseiidae, Tetranychidae, and Tenuipalpidae were the most frequently recovered families. A new species of phytoseiid, *Amblyseius muricatus,* is described.

II. Population Dynamics of Mites on Three Species of Pines in the Forest Falls Area of the San Bernardino Mountains

Seasonal and annual changes were determined in species composition and population densities of phytophagous and predaceous mites on three species of native pines (*Pinus coulteri, P. lambertiana,* and *P. ponderosa*) in the San Bernardino Mountains. Population trends were recorded for the Phytoseiidae, Tetranychidae, and Tenuipalpidae. Four species of tetranychids of the genus *Oligonychus* were present, one species of phytoseiid, *Metaseiulus validus,* and the tenuipalpid, *Brevipalpus* sp. Mite numbers were generally lowest from January to March. Predaceous mites gave a positive numerical response to increases in tetranychid population.

III. Laboratory Studies on the Biology of the Phytoseiids *Metaseiulus validus* (Chant) and *Typhloseiopsis pini* (Chant)

Laboratory studies with the phytoseiid mites, *Metaseiulus validus* and *Typhloseiopsis pini,* were made to assess their potential as natural control agents. The *M. validus* mite developed from egg to adult in about six days at 35 C, and *T. pini* required about eight days at 29 C. With decreasing temperature, the developmental period increased. *Metaseiulus validus* had a maximum fe-

(Continued on inside back cover)

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Systematics and Bionomics of Predaceous and Phytophagous Mites Associated with Pine Foliage in California[1,2]

I. Survey of Mites Present on Native Pines, Including a Description of a New Species of Phytoseiidae

INTRODUCTION

CALIFORNIA IS DISTINGUISHED from all other states by extremes in physical conditions. Elevations range from 90 m below sea level to approximately 4,800 m at the summit of Mt. Whitney, about 125 km away. There are two major mountain ranges extending almost the entire length of the state. Rainfall is less than 5 cm in Death Valley and over 275 cm at certain points along the coast (Bright and Stark, 1973). These extremes in physical characteristics are reflected in the diversity of natural vegetation present. Trees dominate the flora in California on more than one-third of the state's land area (Griffin and Critchfield, 1972). Of all genera of trees in California, the genus *Pinus* is best represented, with a total of 19 species (Table 1). Three of these species occur only in California; eight more are mainly California species, but extend into other states (Griffin and Critchfield, 1972). This state probably has one of the greatest concentrations of the genus *Pinus* in the world with 19 native pine species (Little and Critchfield, 1969).

The 19 species of pines native to California are listed in Table 1, along with their altitude range in the state. They can be divided into two subgenera—*Strobus* (soft pines) and *Pinus* (hard pines)—based on the number and morphology of the needles, type of wood and cones, and persistence of the fascicle sheath. As indicated by the altitude ranges for each species, the subgenus *Strobus* contains no coastal species. Further, the species in the subgenus *Pinus*, except for two which have extremely broad altitude ranges, usually do not extend above 2,700 m. In the

[1] Accepted for publication August 16, 1976.

[2] This study is based on a dissertation submitted by the senior author in June, 1975, to the Graduate Division, University of California, Riverside, in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Entomology. Data were collected and observations made from 1972 to 1974. The research was supported in part by a predoctoral traineeship from the National Science Foundation.

TABLE 1

TAXONOMIC POSITION AND ALTITUDE RANGE OF SPECIES IN THE GENUS *PINUS* IN CALIFORNIA

Section	Subsection	Species	Common name	Altitude range
		Subgenus *STROBUS*		*Meters*
Strobus	Cembrae	*albicaulis*	Whitebark pine	2100–3700
	Strobi	*monticola*	Western white pine	1500–3100
		lambertiana	Sugar pine	1200–3100
		flexilis	Limber pine	2400–3400
Parrya	Cembroides	*edulis*	Nut pine	1200–1500
		quadrifolia	Parry pinyon	1100–1800
		monophylla	Singleleaf pinyon	600–2100
	Balfourianae	*balfouriana*	Foxtail pine	1500–3700
		aristata[1]	Bristlecone pine	2900–3500
		Subgenus *PINUS*		
Pinus	Ponderosae	*ponderosa*	Ponderosa pine	91–2700
		washoensis	Washoe pine	2100–2400
		jeffreyi	Jeffrey pine	1100–3100
	Sabinianae	*sabiniana*	Digger pine	150–1200
		coulteri	Coulter pine	900–2100
		torreyana	Torrey pine	0– 150
	Contortae	*contorta*	Lodgepole pine	0–3700
	Oocarpae	*radiata*	Monterey pine	0– 31
		attenuata	Knobcone pine	500–1800
		muricata	Bishop pine	0– 300

[1] Or *longaeva* Bailey (Bailey, 1970).

subgenus *Strobus*, two-thirds of the species grow above this elevation.

The forest habitat provides a variety of niches for arthropods, especially members of the Acari. The habitats include the forest floor, foliage, in or under the bark of trees, and bracket fungi (Lindquist, 1970). Of these, the most extensively studied have been the forest floor (Price, 1973; Metz and Farrier, 1969; Karg, 1968; Hayes, 1965; and Hartenstein, 1962), bark, and bark beetle burrows (Kinn, 1971; Moser and Roton, 1971; McGraw and Farrier, 1969; and Lindquist, 1969*a*, 1969*b*). Other studies have involved the mite fauna associated with fungi on pines (Powell, 1971; Stevens and Hawksworth, 1970). A recent study by Landwehr (1974) included sampling from the foliage of native *Pinus radiata* in central-coastal California. However, there has been no extensive study of the mite fauna associated with the foliage of pines. The purpose of this study was to provide background information on the acarine fauna associated with the needles of the pines native to California.

MATERIALS AND METHODS

To date, there has been little development of sampling procedures for mites of conifers. Kobayashi and Murai (1965, 1966), in their studies of the Cryptomeria red mite, *Paratetranychus* (*Oligonychus*) *hondoensis* Ehara, on *Cryptomeria japonica* D. Don, devised a method of removal using sodium hydroxide. They placed twigs 15 cm in length in tubes with the solution, stored them overnight, then shook them and poured the liquid through filter paper, which was then examined under a dissecting microscope. This method was also utilized by Condrashoff (1967), who stated that in tests with blackheaded budworm eggs, 96 percent of the eggs were recovered from the foliage of *Tsuga heterophylla* (Raf.) Sarg., compared with 47 to 70 percent counted

on the needles. He also mentioned that the extraction method required one-third to one-tenth the time spent in counting the eggs directly on the foliage. Fellin (1967, 1968) described the use of the mite-brushing machine developed by Henderson and McBurnie (1943) for sampling populations of the spider mite *Oligonychus ununguis* (Jacobi) on the foliage of Rocky Mountain Douglas fir, *Pseudotsuga menziesii* var. *glauca* (Beissn.) in western Montana. Landwehr (1974) used a knockdown and jarring method incorporating methyl isobutyl ketone, to sample mites on the foliage of ornamental and commercially grown *Pinus radiata* D. Don in central-coastal California.

The following criteria were considered important in devising a sampling technique: (1) The use of pine terminals that included both needles and branches, and that contained more than one year's growth. Shoots 15 cm in length were found to contain both old and new foliage, no matter what time of year the sample was collected. (2) Samples from as many trees as possible in each locality because of nonrandom distribution of mites. (3) Selection of a sample size that could be processed all at one time. (4) A removal method that was both effective and rapid. A washing method similar to that developed by Scriven and McMurtry (1971) and used successfully in removing mites from a few species of conifers (Scriven, unpublished data) seemed to offer the best overall qualities for the objectives of this study. Large volumes of material (15 terminals) could be processed at the same time, the procedure was easily replicated, the mites could be recovered alive for laboratory studies, no field examination was necessary (samples could be collected by others and shipped to the laboratory), and the mites recovered on filter paper could be stored in a refrigerator for subsequent counting and collecting.

Fifteen terminals of 15 cm each, were cut from each tree around the entire circumference. These shoots were placed in a paper bag which was then sealed inside a plastic bag and labeled. This unit had the advantage of keeping the sample from drying out and prevented the buildup of moisture and subsequent growth of mildew. Material handled in this manner was successfully shipped from northern California unrefrigerated. Samples were brought back to the laboratory at the University of California, Riverside, and stored in a cold room at approximately 10 C until washed. Samples stored in this way remained in good condition for more than 10 days, permitting washing and mounting as time was available.

A smaller version of the air-agitated water bath mite washer described by Scriven and McMurtry (1971) was used in this study. Overall dimensions of the tub were: 61 cm long, 30.5 cm wide, and 48 cm deep. When filled, the tub contained about 40 liters of water. A procedure was followed similar to that used by McMurtry et al. (1969). For this study, three plastic pots with screens were sufficient. The upper screen consisted of mesh openings of 1.41 mm and trapped the larger pieces of plant material, insects, and spiders. The middle screen had 0.68-mm openings which separated smaller insects, spiders, and the larger mites. The bottom screen had mesh openings of 0.15 mm, and recovered the majority of the mites and other small arthropods. The 15 pine terminals were placed in the filled tub, about 3 drops of liquid detergent were added to the water, and the air supply was turned on to agitate the material. The water was left on in order to keep the water continually flowing over into the screens. This procedure was continued for approximately 3 min; then the tub was drained and rinsed out into the series of screens. The material from the second and third screens was flushed into a bucket, and the entire contents were then slowly

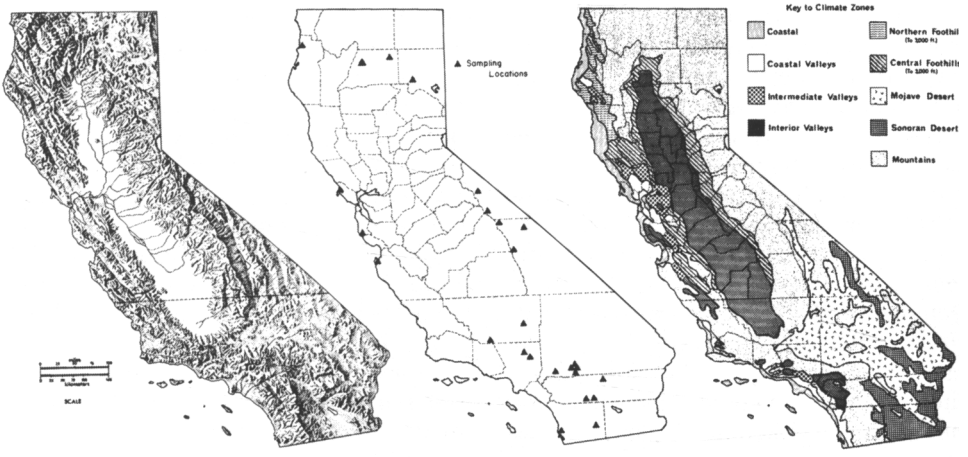

Fig. 1. Distribution of sampling locations in California

poured into a 12-cm Buchner funnel connected to a vacuum supply and containing paper cut to the correct size from coffee filters. This type of paper did not come apart when removed as did regular Whatman® filter paper. The funnel was kept full while pouring to ensure that the contents would be evenly distributed over the surface of the paper. A 20-liter can was used to hold the funnel. The filter paper was placed in a large Petri dish and stored in a small refrigerator until it was examined for mites. The samples could be kept for a few days without damage to the mites, but care was taken not to let the paper dry out.

After the cover was removed from the Petri dish, the entire filter paper was examined under a dissecting microscope at 15 × magnification. Any mites found on the plate were mounted directly in Hoyer's medium on a microscope slide, and placed on a slide warmer for 24 to 48 h. The mites were identified to family using a compound microscope. Genus and species determinations of Phytoseiidae and Tetranychidae were made under phase contrast. Slides of Bdellidae, Cheyletidae, Cunaxidae, Raphignathidae, Tenuipalpidae and Tydeidae were sent to various authorities for identification.

At least one sample was collected from all the native pine species in California except *Pinus washoensis* Mason and Stockwell, which is only found in isolated locations in northwestern California, and *Pinus edulis* Engelm., which only occurs in isolated portions of the New York mountains in southeastern California. A map showing the locations within the state where samples were collected is presented in Figure 1.

RESULTS AND DISCUSSION

During the study, 23 different families of mites were recovered from the foliage of 17 species of pines native to California (Table 2). This does not include mites in the suborder Cryptostigmata, which were not identified to family. Families of the suborder Prostigmata were the best represented of the Acari collected. The Phytoseiidae and the Tetranychidae were present in material taken from all but one species of pine, *Pinus monticola* Dougl. Table 3 shows the number of pine species from which the various mite families were collected, with the most frequently recovered families at the top.

TABLE 2

MITE FAMILIES ON THE FOLIAGE OF CALIFORNIA PINES

Species of *Pinus*	Acaridae	Anystidae	Ascidae	Bdellidae	Caeculidae	Caligonellidae	Cheyletidae	Cunaxidae	Eriophyidae	Erythraeidae	Eupalopsellidae	Johnstonianidae
Subgenus *Strobus*												
albicaulis										+		
monticola										+		
lambertiana							+		+			+
flexilis		+							+			+
monophylla		+		+			+					
balfouriana		+		+						+		+
aristata							+			+		
Subgenus *Pinus*												
ponderosa		+		+			+		+	+	+	
jeffreyi		+		+	+	+	+		+	+		
sabiniana				+			+					
coulteri		+		+		+	+		+	+		
torreyana							+		+			
contorta		+		+			+	+	+	+		
radiata	+	+	+	+			+					
attenuata						+					+	
muricata		+	+	+			+					

Species of *Pinus*	Neophyllobiidae	Oribatei*	Phytoseiidae	Raphignathidae	Saproglyphidae	Scutacaridae	Smarididae	Stigmaeidae	Tarsonemidae	Tenuipalpidae	Tetranychidae	Tydeidae
Subgenus *Strobus*												
albicaulis			+							+	+	
monticola		+								+		
lambertiana		+	+							+	+	
flexilis			+							+	+	+
quadrifolia	+	+	+							+	+	
monophylla		+	+							+	+	
balfouriana		+	+								+	+
artistata	+	+	+							+	+	+
Subgenus *Pinus*												
ponderosa	+	+	+					+		+	+	+
jeffreyi	+	+	+				+			+	+	+
sabiniana		+	+							+	+	
coulteri	+	+	+	+		+			+	+	+	+
torreyana			+						+		+	+
contorta	+	+	+					+		+	+	+
radiata		+	+		+				+	+	+	+
attenuata		+	+							+	+	+
muricata		+	+		+			+	+	+	+	+

* Suborder.

TABLE 3

NUMBER OF SPECIES OF PINES IN THE TWO SUBGENERA FROM WHICH THE DIFFERENT FAMILIES OF MITES WERE RECOVERED

Mite family	*Strobus*	*Pinus*	Total
Phytoseiidae	7	9	16
Tetranychidae	7	9	16
Tenuipalpidae	7	8	15
Oribatei*	6	8	14
Cheyletidae	3	8	11
Tydeidae	3	8	11
Anystidae	3	6	9
Bdellidae	2	7	9
Erythraeidae	4	4	8
Eriophyidae	2	5	7
Neophyllobiidae	2	4	6
Tarsonemidae	–	4	4
Caligonellidae	–	3	3
Johnstonianidae	3	–	3
Stigmaeidae	–	3	3
Ascidae	–	2	2
Eupalopsellidae	–	2	2
Saproglyphidae	–	2	2
Acaridae	–	1	1
Caeculidae	–	1	1
Cunaxidae	–	1	1
Raphignathidae	–	1	1
Scutacaridae	–	1	1
Smariididae	–	1	1

* Suborder.

Families that were collected from two or fewer species were all found on pines in the subgenus *Pinus*. This subgenus also had the best representation of mite families.

In the following treatment, the Phytoseiidae and Tetranychidae, the most frequently encountered families, are covered in greater detail. These, plus the family Tenuipalpidae, were usually recovered together from most of the pine material collected during the course of study (Table 3).

Phytoseiidae

There are three main systems of classification of the Phytoseiidae used by various workers. The system of Chant (1959) is the most conservative, recognizing the fewest genera; that of Muma and Denmark (1970) is the most liberal, and that of Schuster and Pritchard (1963) is intermediate. The classification system of van der Merwe (1968) uses the genera of Chant (1959), with further division into subgenera. In this paper, the senior author has chosen to follow the system of Schuster and Pritchard (1963), but replacing the genus name *Neoseiulus* with *Anthoseius*.

FAMILIES, TRIBES, AND GENERA OF PHYTOSEIIDAE

Family Phytoseiidae Berlese

Phytoseiini Berlese, 1916, p. 33.
Phytoseiinae Vitzthum, 1941, p. 767.
Phytoseiidae Baker and Wharton, 1952, p. 87.

A key to the genera and species collected is included in Key 1 (setal nomenclature after Schuster and Pritchard, 1963). The key is based on design of tabular keys proposed by Newell (1970, 1972).

Tribe Typhlodromini Karg

Typhlodromidae Karg, 1961, p. 441.
Typhlodromini Wainstein, 1962, p. 26.

Diagnosis: Sublateral setae I on membrane and proscutum with 6 pairs of prolateral setae or the absence of sublateral II.

Genus *Metaseiulus* Muma

Metaseiulus Muma, 1961, p. 295.
Type: *Typhlodromus validus* Chant, 1957.
Galendromus Muma, 1961, p. 298 (in part).
Typhlodromus (*Typhlodromus*) section *Menaseius* Wainstein, 1962, p. 21.
Galendromus (*Menaseius*) Muma, 1963, p. 27.
Galendromus (*Leonodromus*) Muma, 1963, p. 36.
Typhlodromus (*Metaseiulus*) Pritchard and Baker, 1962, p. 222.
Chanteius (*Eratodromus*) Wainstein, 1962, p. 20.

KEY 1

TABULAR KEY TO THE GENERA AND SPECIES OF PHYTOSEIID MITES FOUND ON NATIVE SPECIES OF PINES IN CALIFORNIA

Statement of Characters

1. Number of pairs of prolateral setae on the dorsal plate. (4 or 6)
2. Number of pairs of postlateral setae on the dorsal plate. (2–5)
3. Number of pairs of ventrolateral setae. (1, 2 or 3)
4. Number of pairs of preanal setae on the ventrianal plate. (3 or 4)
5. Length of prolateral setae V. =5–6 = sufficient in length to reach base of VI.
   <5–6 = shorter than interval between bases of V and VI.
   X = prolateral setae V absent.
6. Length of postlateral setae II. >2–3 = longer than the interval between the bases of II and III.
   =2–3 = to the interval between the bases of II and III.
   <2–3 = shorter than the interval between the bases of II and III.
   X = postlateral setae III absent.
7. Length of prolateral setae III relative to distance between III and IV, as a decimal.

Distribution of Variants

1	2	3	4	5	6	7	Genus and species
6	2	1,2	4	=5–6 <5–6	x	.50–1.00	*Typhloseiopsis*
6	2	2	4	<5–6	x	.50	*pini*
6	2	1	4	<5–6	x	.78	*citri*
6	2	2	4	=5–6	x	1.00	*eharai*
6	2	1	3,4	<5–6	x	.67–1.33	*Metaseiulus*
6	2	1	3	<5–6	x	.67	*validus*
6	2	1	4	<5–6	x	1.33	*flumenis*
6	4	3	3,4	<5–6	<2–3	.75–1.25	*Anthoseius*
6	4	3	3	<5–6	<2–3	.75	*singularis*
6	4	3	4	<5–6	<2–3	1.25	*rhenanoides*
4	5	3	3	x	>2–3 <2–3	.38–1.00	*Amblyseius*
4	5	3	3	x	<2–3	.38	*muricatus*
4	5	3	3	x	>2–3	1.00	*newelli*
4	5	3	3	x	<2–3	.87	*similoides*
4	3	3	1	x	=2–3	2.00	*Phytoseiulus macropilus*

Metaseiulus validus (Chant) (Fig. 2)

Typhlodromus (*Typhlodromus*) *validus* Chant, 1957, p. 290.
Metaseiulus validus (Chant). Muma, 1961, p. 295.

New Records: KERN CO.: Cuddy Valley, on *Pinus jeffreyi;* Cummings Valley, on *P. sabiniana.* RIVERSIDE CO.: Joshua Tree National Monument, on *P.*

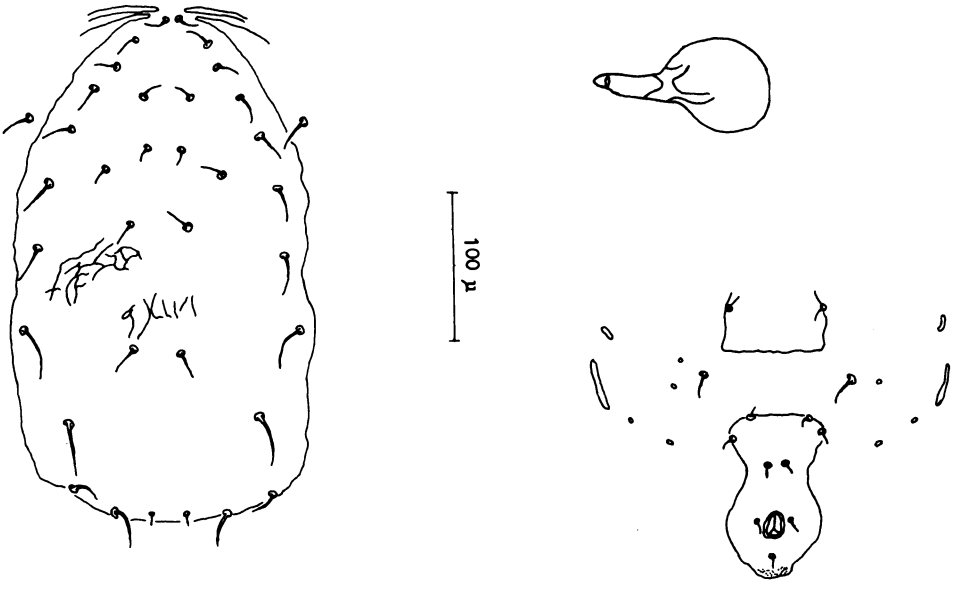

Fig. 2. *Metaseiulus validus* (Chant)

monophylla; Pinyon Flats, on *P. monophylla;* Thomas Mountain, on *P. quadrifolia.* SAN BERNARDINO CO.: Forest Falls, on *P. coulteri, P. lambertiana,* and *P. ponderosa;* Running Springs, on *P. attenuata;* South Fork Campground, on *P. jeffreyi.* SAN DIEGO CO.: Mt. Laguna, on *P. coulteri* and *P. jeffreyi.* SHASTA CO.: Hat Creek, on *P. sabiniana;* Shasta Lake, on *P. attenuata* and *P. jeffreyi.*

Table 4 indicates the pine species from which this mite was recovered during the study. Comparing these data with those for *Typhloseiopsis pini* reveals that, except for *P. jeffreyi,* the two mite species were not collected together on any pine in California, with *M. validus* not being found on any pines at high elevations (above 2100 m) or at coastal locations. It was collected in the same sample with the following phytoseiids: *Typhloseiopsis pini, T. citri,* and *Metaseiulus flumenis.*

The holotype of *M. validus* was collected from *Pinus ponderosa* in British Columbia. Other plants on which it was collected include black cottonwood and wild cherry, also from British Columbia (Chant, 1957; Anderson et al. 1958). Additional Canadian records for this species are given by Chant et al. (1974). Chant (1959) listed *M. validus* from California, and Kennett (1963) recorded it from dwarf mistletoe (*Arceuthobium campylopodum* Engelm.) on *Pinus sabiniana* in California. Schuster and Pritchard (1963) listed counties in California from which this mite was collected and reported it from Arizona and Nevada. Tuttle and Muma (1973) collected this phytoseiid from pines in many locations in Arizona. They also stated that *M. validus* is common on *Pinus* spp., and might be an effective agent for biological control of spider mites. *Metaseiulus validus* was one of the most numerous species of the phytoseiids collected in this study.

TABLE 4

PHYTOSEIIDAE ON FOLIAGE OF CALIFORNIA PINE SPECIES

Pinus spp.	*Metaseiulus*		*Typhloseiopsis*		
	validus	*flumensis*	*eharai*	*citri*	*pini*
Subgenus *Strobus*					
albicaulis					+
lambertiana	+	+			
flexilis				+	+
quadrifolia	+	+			
monophylla	+				
balfouriana					+
aristata					+
Subgenus *Pinus*					
ponderosa	+				
jeffreyi	+			+	+
sabiniana	+				
coulteri	+				
torreyana					+
contorta				+	+
radiata			+	+	+
attenuata	+				
muricata			+		+

Pinus spp.	*Anthoseius*			*Amblyseius*		*Phytoseiulus*
	singularis	*rhenanoides*	*newellii*	*similoides*	*muricatus*	*macropilis*
jeffreyi	+					
torreyana		+	+	+		
contorta	+					
radiata		+	+			
muricata			+		+	+

Metaseiulus flumenis (Chant) (Fig. 3)

Typhlodromus (*Typhlodromus*) *flumenis* Chant, 1957, p. 290.
Galendromus (*Menaseius*) *flumenis* (Chant). Muma, 1963, p. 34.
Metaseiulus flumenis (Chant) Schuster and Pritchard, 1963, p. 225.
New Records: RIVERSIDE CO.: Thomas Mountain, on *P. quadrifolia*. SAN BERNARDINO CO.: Forest Falls, on *P. lambertiana*.

Discussion. This phytoseiid was collected from only 2 species of pine (subgenus *Strobus*) in the southern part of the state (Table 4). Both in number of specimens collected and number of species of pine from which they were taken, this species was far less common than *Metaseiulus validus*. This was just the opposite of the observations of Tuttle and Muma (1963) in Arizona. They reported this species to be the most common phytoseiid in the state, abundant on a wide variety of plants. In the present study, this mite was found in the same samples as *M. validus*, in both instances.

Metaseiulus validus was collected from soopolallie (*Shepherdia canadensis*) and *Pinus monticola* in British Columbia (Chant, 1957; Anderson et al., 1958; and Chant et al., 1974). Schuster and Pritchard (1963), Specht (1968), and Tuttle and Muma (1973) list additional records for this species.

Genus *Typhloseiopsis* DeLeon

Typhloseiopsis DeLeon, 1959, p. 150.
Type: *Typhloseiopsis theodoliticus*.

Typhlodromus (*Typhloseiopsis*) Pritchard and Baker, 1962, p. 222.
Chanteius (*Typhloseiopsis*) Wainstein, 1962, p. 20.
Paraseiulella Muma, 1961, p. 294.
Amblydromus Muma, 1961, p. 297.
Typhlodromina Muma, 1961, p. 297.
Chanteius (*Evanseius*) Wainstein, 1962, p. 20.

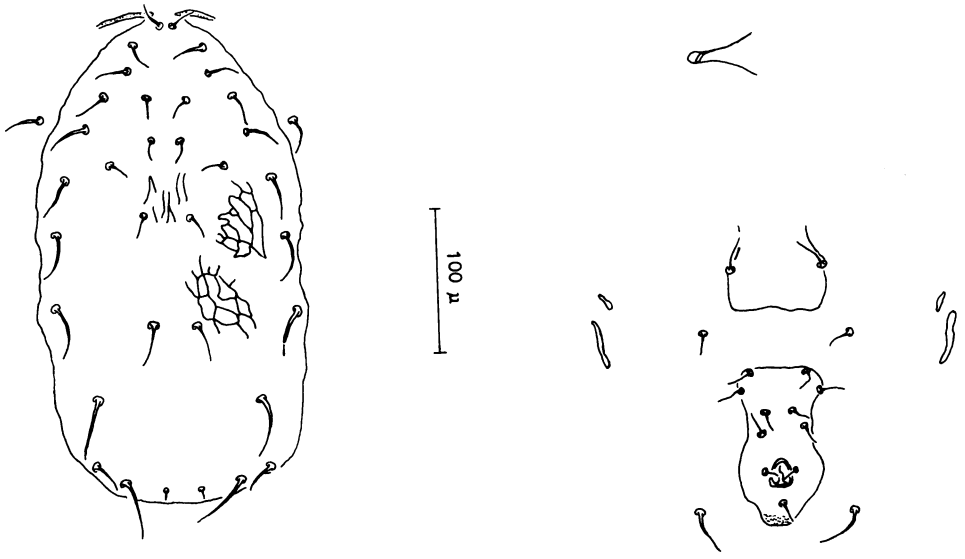

Fig. 3. *Metaseiulus flumenis* (Chant)

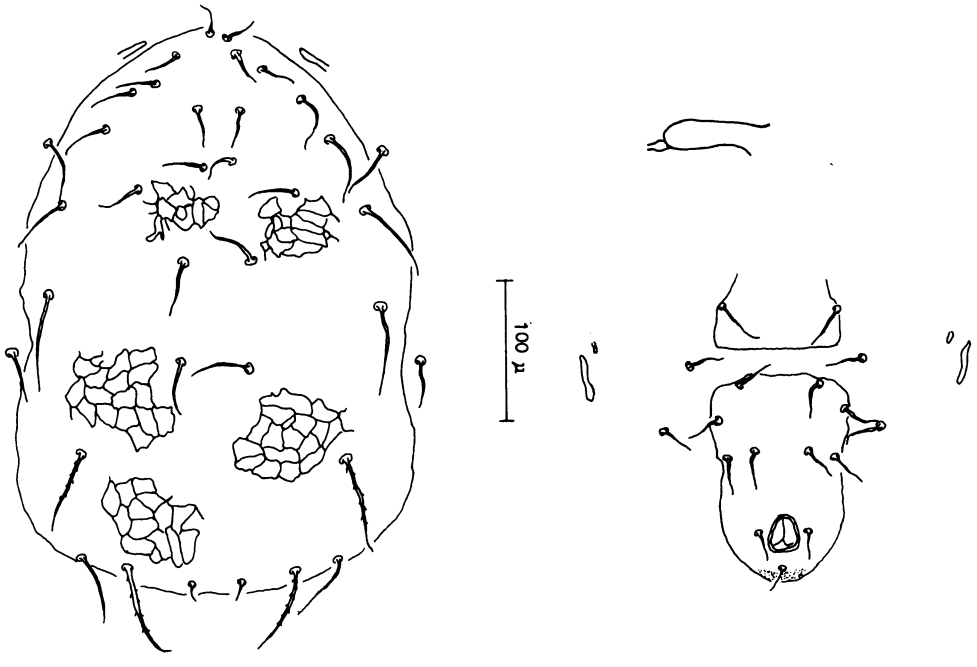

Fig. 4. *Typhloseiopsis eharai* (Muma and Denmark)

Typhloseiopsis eharai (Muma and Denmark), New Combination (Fig. 4)

Typhloseiopsis conspicuus (Garman), Schuster and Pritchard, 1963, p. 207.

Typhlodromina eharai Muma and Denmark, 1969, p. 412.

Typhlodromus eharai (Muma and Denmark), McMurtry, Oatman, and Flechner, 1971, p. 405.

New Records: SAN MATEO CO.: Pt. Ano Nuevo, on *P. radiata.* MARIN CO.: Inverness, on *P. muricata.*

Discussion. This mite was collected from two species of coastal pines less than 160 km apart (Fig. 4). Only 8 ♀ ♀ were recovered during the study. It was found in the same sample with *T. pini, Amblyseius newelli, A. muricatus,* and *Phytoseiulus macropilis.*

The type specimen of this mite was found on prune at Napa, California (Muma and Denmark, 1969). Schuster and Pritchard (1963) recorded this species from 6 California counties. McMurtry et al. (1971) added 4 southern California counties to the distribution data of *T. eharai.* Muma and Denmark (1969) divided the former *Typhloseiopsis conspicuus* into several species, leaving *T. eharai* as a strictly California species. The data given by Specht (1968) for *Typhlodromus conspicuus* probably refers to *T. conspicua* (Garman).

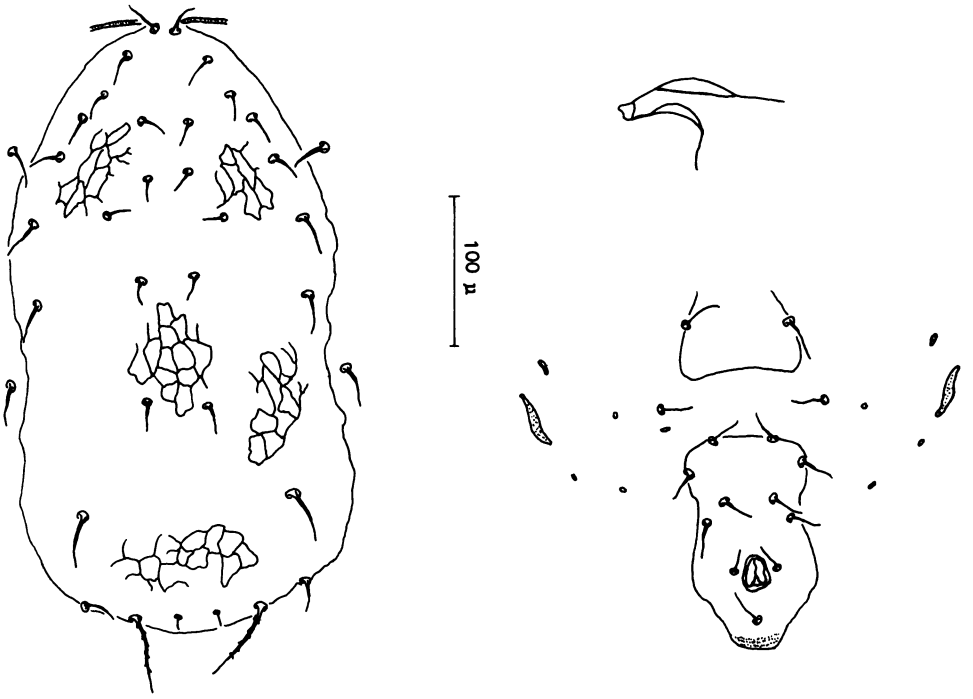

Fig. 5. *Typhloseiopsis citri* (Garman and McGregor)

Typhloseiopsis citri (Garman and McGregor) (Fig. 5)

Typhlodromus citri Garman and McGregor, 1956, p. 8.
Typhlodromus pacificus McGregor, 1956, p. 8.
Typhloseiopsis citri (Garman and McGregor), Schuster and Pritchard, 1963, p. 210.
New Records: INYO CO.: Rock Creek Lake, on *P. contorta.* LASSEN CO.: Hog Flat Res., on *P. jeffreyi.* MONTEREY CO.: Monterey, on *P. radiata.* SAN BERNARDINO CO.: Dollar Lake, on *P. flexilis.* SHASTA CO.: Shasta Lake, on *P. jeffreyi.*

Discussion. This mite occurred over the entire length of the state and on pine species (Table 4) from high elevations (*P. flexilis* at over 2700 m) to coastal pines (*P. radiata* at Monterey). It was somewhat more common than *T. eharai,* but much less so than *T. pini,* both in number of specimens recovered and in number of pine species collected from (Table 4). It does not occur on the drier mountain or desert slopes, as does *M. validus. T. citri* was collected in the same sample with *T. pini, M. validus, Anthoseius singularis,* and *A. rhenanoides.*

Typhloseiopsis citri was collected from citrus in southern California (Garman and McGregor, 1956; McGregor, 1956). Other host records and locations are given by: McGregor (1956); Schuster and Pritchard (1963); McMurtry et al. (1971); and Landwehr (1974).

Typhloseiopsis pini (Chant), New Combination (Fig. 6)

Typhlodromus pini Chant, 1955, p. 501.
Typhlodromus (*Typhlodromus*) *pini* Chant, 1960, p. 53.

Typhlodromina pini (Chant), Muma, 1961, p. 297.

Typhloseiopsis citri (Garman and McGregor), Schuster and Pritchard, 1963, p. 210 (in part).

New Records: HUMBOLDT CO.: Trinidad, on *P. muricata.* INYO CO.: Matlock Lake, on *P. balfouriana;* Rock Creek Lake, on *P. albicaulis;* and Schulman Grove, on *P. aristata.* MARIN CO.: Inverness, on *P. muricata.* MONTEREY CO.: Monterey, on *P. radiata.* SAN BERNARDINO CO.: Dollar Lake, on *P. flexilis;* South Fork Campground, on *P. jeffreyi;* and South Fork Meadow, on *P. contorta.* SAN DIEGO CO.: Del Mar, on *P. torreyana.* SAN MATEO CO.: Pt. Ano Nuevo, on *P. radiata.*

Discussion. Chant (1959) did not consider the presence of a second pair of ventrolateral setae to be a specific character; therefore, he synonomized *T. pini* and *T. citri* (*T. pini* has 2 and *T. citri* has only 1). However, in this study it was evident from the examination of 193 females that the presence of 2 ventrolateral setae is very stable; therefore, the authors agree with Tuttle and Muma (1973) that *T. pini* is a distinct species.

Typhloseiopsis pini, like *T. citri,* was found throughout the state, but was present on twice as many pine species as was *citri* (Table 4). This species seemed to be mainly restricted to pines at higher elevations or along the coast (Table 4). *Typhloseiopsis pini* was recovered from species of pines and in locations where *M. validus* was not collected; it was found in the same sample with all the other phytoseiids except *M. flumenis* and *A. singularis.*

The type material of *T. pini* was collected from the bark of *Pinus contorta* and *P. strobus* in British Columbia

(Chant, 1955). *T. pini* has been reported from British Columbia, Washington, Montana (Fellin, 1968), Arizona (Tuttle and Muma, 1973), California, Mexico (Chant, 1959), Alaska, Canada (Chant et al., 1974), and Hawaii (Prasad, 1968). Landwehr (1974) listed *T. arboreus* from *P. radiata* in central California. However, he was following the key of Schuster and Pritchard (1963), who considered *T. pini* a synonym of *T. citri*. In their paper, *T. pini* would key out to *T. arboreus*. The senior author examined many of these slides and they conform to what is here called *T. pini*.

Genus *Anthoseius* DeLeon

Anthoseius DeLeon, 1959, p. 258; Wainstein, 1972, p. 1477.

Type: *Anthoseius hebetis* DeLeon.

Neoseiulus Hughes, 1948, p. 141.

Typhlodromus (*Neoseiulus*) Nesbitt, 1951, p. 34.

Amblydromella Muma, 1961, p. 294.

Clavidromus Muma, 1961, p. 296.

Paraseiulus Muma, 1961, p. 299.

Typhlodromella Muma, 1961, p. 299.

Neoseiulus Schuster and Pritchard, 1963.

Mumaseius DeLeon, 1965a, p. 23.

Typhlodromus (*Anthoseius*), Ehara, 1967, p. 67.

Typhlodromus (*Anthoseius*), van der Merwe, 1968, p. 20.

Orientiseius Muma and Denmark, 1968, p. 238.

Discussion. DeLeon (1965a), Ehara (1967), and van der Merwe (1968) recognized that the genus *Neoseiulus* was used incorrectly by many workers. The discussion by van der Merwe should be consulted for the reasons for the change of status of *Neoseiulus*. The senior author agrees with the statements presented, but regards *Anthoseius* as a discrete genus, to replace the name *Neoseiulus* as used by Schuster and Pritchard (1963) in the generic classification of the species *A. rhenanoides* and *A. singularis*.

This genus was represented in this study by the species *A. singularis* and *A. rhenanoides*. These species were recovered only from pines in the subgenus *Pinus*, and occurred on both coastal and inland species (Table 4).

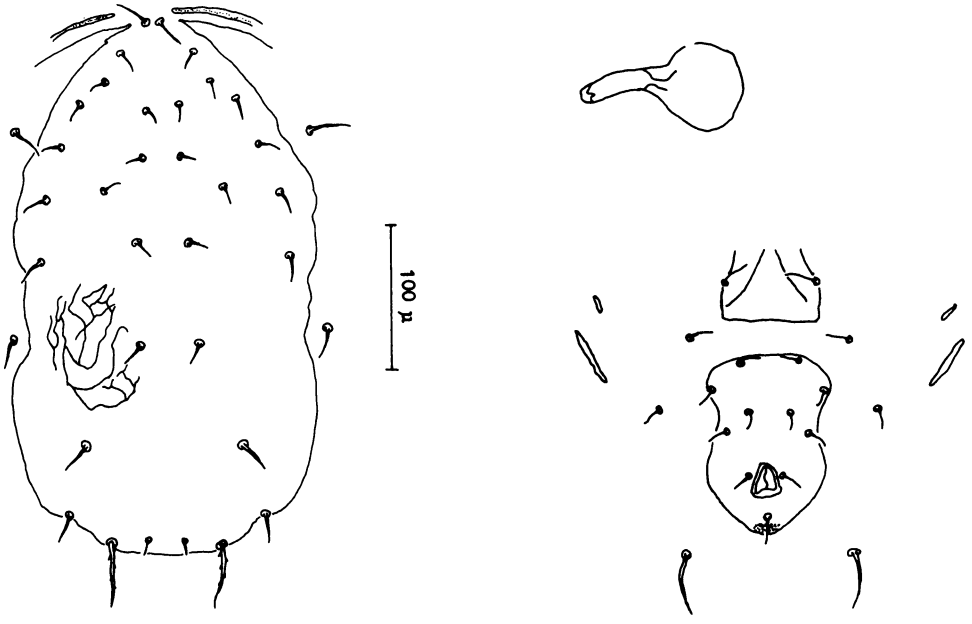

Fig. 6. *Typhloseiopsis pini* (Chant)

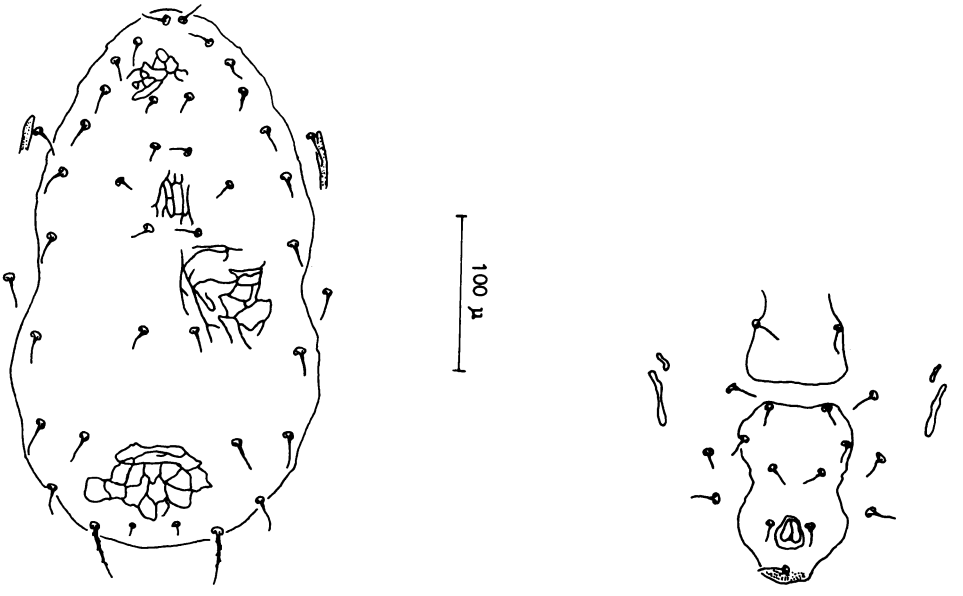

Fig. 7. *Anthoseius singularis* (Chant)

Anthoseius singularis (Chant), New Combination (Fig. 7)

Typhlodromus singularis Chant, 1957, p. 289.
Neoseiulus singularis (Chant) Schuster and Pritchard, 1963, p. 201.
New Records: INYO CO.: Rock Creek Lake, on *P. contorta*. LASSEN CO.: Hog Flat Reservoir, on *P. contorta* and *P. jeffreyi*.

Discussion. This species was collected only from northern and central California, and only from the subgenus *Pinus* (Table 4). In this study, *P. contorta* was sampled in 3 different areas of California (northern, central, and southern), and *A. singularis* was recovered from only the northern and central areas. Although large samples were taken from *P. contorta* in southern California (collections were made for insectary cultures of *T. pini* and are not included as collection records), no *A. singularis* was found. It appears that the distribution of this species does not extend to lower latitudes. Chant (1957) collected the type from Douglas fir in British Columbia, and gave additional host records there. He mentioned that this species was relatively common in western North America. Schuster and Pritchard (1963) collected a single specimen from California and Fellin (1968) collected *A. singularis* in Montana. *A. singularis* was found in the same sample with *T. citri*.

Anthoseius rhenanoides (Athias-Henriot), New Combination (Fig. 8)

Typhlodromus rhenanoides Athias-Henriot, 1962, p. 85.
Neoseiulus rhenanoides (Athias-Henriot), Schuster and Pritchard, 1963, p. 205.
New Records: MONTEREY CO.: Monterey, on *P. radiata*. SAN DIEGO CO.: Del Mar, on *P. torreyana*.

Discussion. This species was also not very common, being recovered from

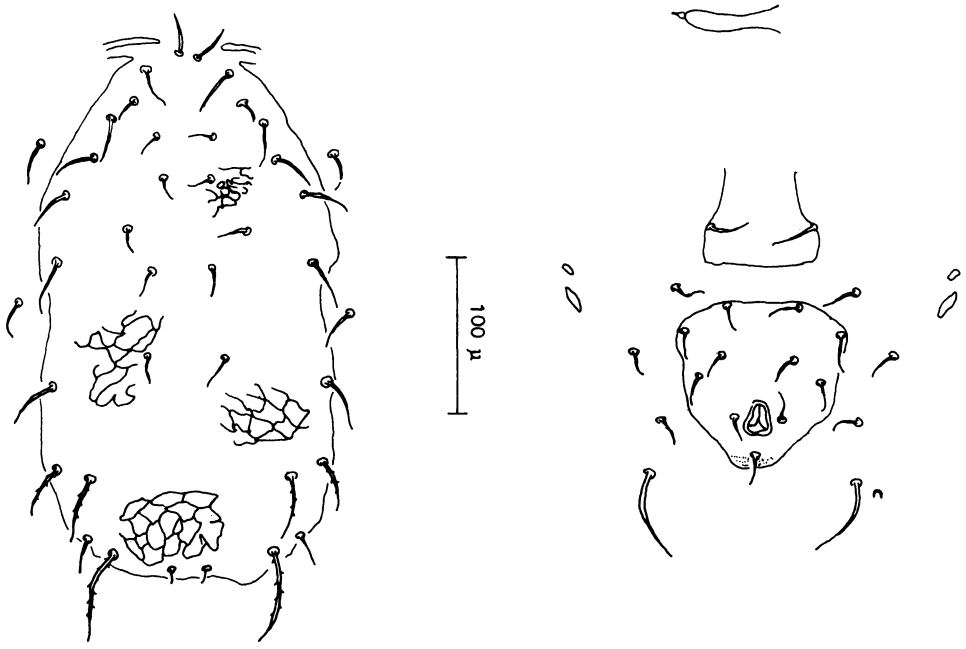

Fig. 8. *Anthoseius rhenanoides* (Athias-Henriot)

only 2 species of pines (Table 4), and only in coastal locations. It is one of the 2 species in this survey that has been recorded outside the United States. The type was recorded from Algeria on a wide variety of hosts (Athias-Henriot, 1962). Athias-Henriot stated that this species was one of the most widespread and common of the species collected there. *A. rhenanoides* has also been recorded from California (Schuster and Pritchard, 1963; Landwehr, 1974) and Hawaii (Prasad, 1968). It was found in the same sample with *T. pini, T. citri, A. similoides,* and *A. newelli.*

Tribe Amblyseiini Muma

Amblyseiinae Muma, 1961, p. 273.

Amblyseiini Wainstein, 1962, p. 26.

Amblyseiini Muma, Schuster and Pritchard, 1963, p. 225.

Diagnosis: Sublateral setae I is on the membrane and there are only 4 pairs of prolateral setae on the dorsal plate.

Discussion. The genera recovered during this study include *Amblyseius* Berlese and *Phytoseiulus* Evans.

Genus *Amblyseius* Berlese

Amblyseius Berlese, 1914, p. 143.

Type: *Zercon obtusus* Koch, 1939.

Amblyseius (*Seiopsis*) Berlese, 1923, p. 255.

Amblyseius (*Amblyseiopsis*) Garman, 1948, p. 17.

Neoseiulus Hughes, 1948, p. 141.

Amblyseiopsis Garman. Muma, 1955, p. 264.

Typhlodromus (*Amblyseius*) Chant, 1957, p. 530.

Phyllodromus DeLeon, 1959, p. 260.

Typhlodromus (*Typhlodromopsis*), DeLeon, 1959, p. 113.

Amblyseius (*Amblyseius*) Muma, 1961, p. 287.

Amblyseius (*Typhlodromopsis*) Muma, 1961, p. 288.

Amblyseius (*Amblyseialus*) Muma, 1961, p. 288.

Amblyseius (*Typhlodromalus*) Muma, 1961, p. 288.
Phytoscutella Muma, 1961, p. 275.
Amblyseiulus Muma, 1961, p. 278.
Cydnodromus Muma, 1961, p. 290.
Phytodromus Muma, 1961, p. 291.
Paraamblyseius Muma, 1962, p. 8.
Amblyseius (*Arrenoseius*) Wainstein, 1962, p. 12.
Amblyseius (*Neoseiulus*) DeLeon, 1965a, p. 23.
Amblyseius (*Typhlodromips*) DeLeon, 1965a, p. 23.
Amblyseius (*Amblyseius*) van der Merwe, 1968, p. 112.

Discussion. The genus *Amblyseius* Berlese was represented in this study by *A. newelli* (Chant), *A. similoides* Buchelos and Pritchard, and a new species. All the *Amblyseius* spp. were relatively rare in pine foliage, and were found only in coastal areas and only on pines of the subgenus *Pinus* (Table 3).

Amblyseius newelli (Chant) (Fig. 9)

Typhlodromus (*Amblyseius*) *newelli* Chant, 1960, p. 135.
Amblyseius newelli (Chant) Schuster and Pritchard, 1963, p. 252.
New Records: MARIN CO.: Inverness, on *P. muricata*. SAN DIEGO CO.: Del Mar, on *P. torreyana*. SAN MATEO CO.: Pt. Ano Nuevo, on *P. radiata*.

Discussion. *Amblyseius newelli* was the most abundant species of this genus recovered during the study, but was collected from only 3 locations and 3 pine species (Table 4), all in coastal area habitats. It was found in the same sample with the following phytoseiids: *T. pini, T. eharai, A. rhenanoides, P. macropilis,* and *Amblyseius muricatus.*

The type was collected in a coastal area (Los Angeles Co.) from litter (Chant, 1960). Schuster and Pritchard (1963) recorded *A. newelli* from Marin County, California.

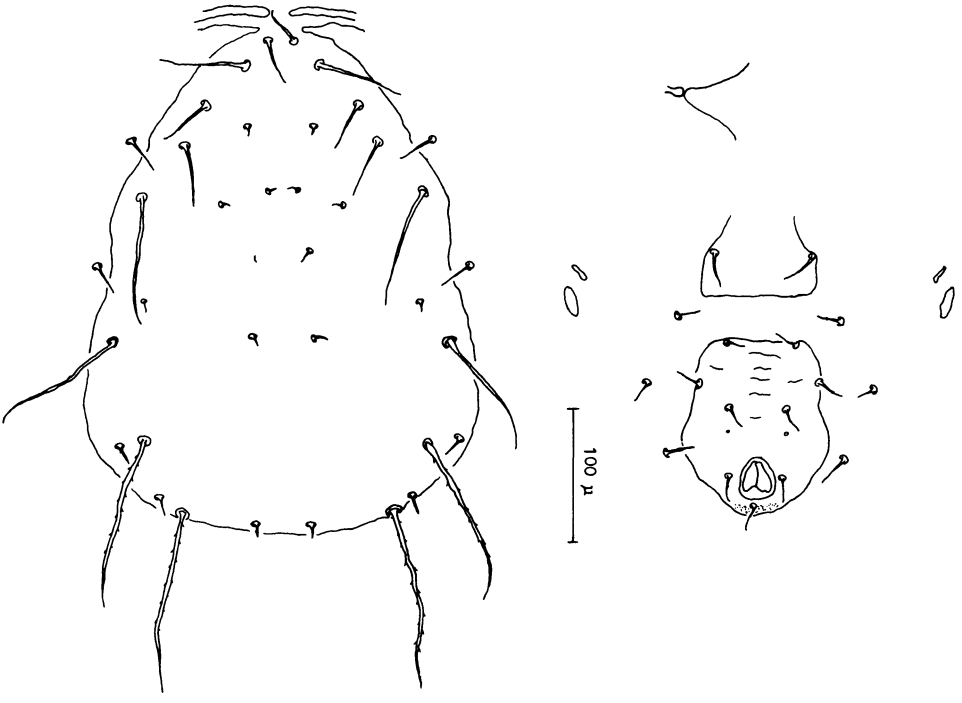

Fig. 9. *Amblyseius newelli* (Chant)

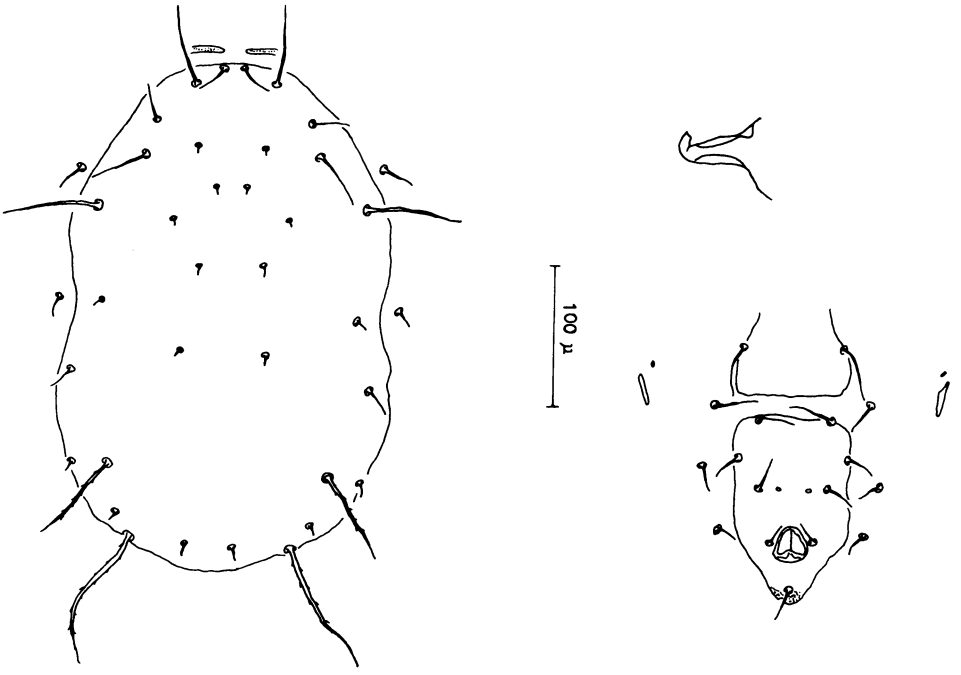

Fig. 10. *Amblyseius similoides* Buchelos and Pritchard

Amblyseius similoides Buchelos and Pritchard (Fig. 10)

Amblyseius similoides Buchelos and Pritchard, 1960, p. 179.

New Records: SAN DIEGO CO.: Del Mar, on *Pinus torreyana.*

Discussion. This species was rare. Only 1 ♀ was collected during this study, and that from *P. torreyana* (Table 4). The holotype was collected in Redwood City, San Mateo County (Buchelos and Pritchard, 1960). Schuster and Pritchard (1963) and Landwehr (1974) listed localities and hosts where *A. similoides* has been collected in California. McMurtry et al. (1971) noted that this mite is not found in the hotter interior areas of southern California but is found mainly in the coastal and intermediate areas. They said it is important in suppressing the spider mite *Panonychus ulmi* in walnut orchards in San Diego County. *Amblysieus similoides* was recovered in the same sample as *T. pini, A. newelli,* and *A. rhenanoides.*

Amblyseius muricatus, New Species (Fig. 11)

Diagnosis: This phytoseiid resembles the species *Amblyseius exopodalis* Kennett from California. It differs in that prolateral II and postlateral II are shorter in length, the cervix of the spermatheca is shorter, and *A. muricatus* has 3 pairs of macrosetae on leg IV and *A. exopodalis* only 2. This species is also similar to *Typhlodromus* (*Amblyseius*) *britannicus* Chant, but the latter is smaller and has been recorded only from England (Chant, 1959). The differences between this new species and other phytoseiids collected during the

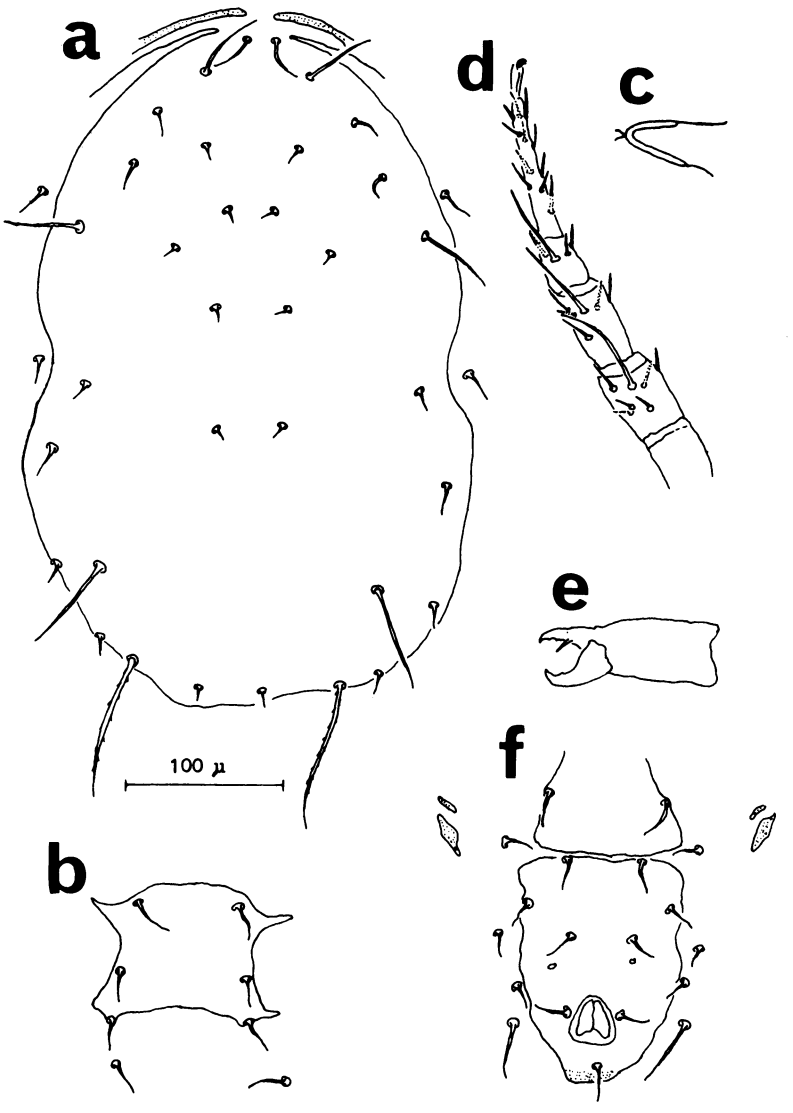

Fig. 11. *Amblyseius muricatus,* n. sp.: a, dorsal plate; b, sternal plate; c, spermatheca; d, leg IV; e, chelicera; f, ventrianal plate.

study are presented in the tabular key in Key 1.

Female (mean of 10 measurements): Chelicera 118μ with about 4 subapical teeth on the fixed digit and 1 on the movable digit. Dorsal shield 452μ long, 264μ wide, not reticulated. Vertical setae 29μ; dorsocentrals I 13μ, II and III 9μ, IV 13μ; clunals 11μ; prolaterals I 49μ, II 18μ, III 22μ, and IV 56μ; postlaterals I 13μ, II 22μ, III and IV 18μ, and V 104μ; mediolaterals I 9μ and II 73μ; sublaterals I and II 20μ; postlaterals V serrate. Peritreme extending to base of vertical setae. Ventrianal plate 142μ long, 100μ wide, with 3 pairs of preanal setae and a pair of pores posterior to the third pair of setae. Three pairs of ventrolateral setae laterad of the plate. Preanal setae I, II and III 20μ;

paranal setae 20μ; postanal setae 24μ; ventrocaudal setae 51μ; ventrolateral setae I 18μ, II and III 16μ. Primary metapodal platelets 31μ long, 9μ wide; accessory platelets 18μ by 3μ. Genital plate 151μ long, 73μ wide at anterior, and 98μ at posterior; sternal plate 75μ long. Sternal setae I 31μ, II and III 27μ; metasternal setae 27μ; genital setae 27μ. Leg IV with macrosetae on tibia 73μ, genu 60μ, and basitarsus 61μ. Cervix and atrium of spermatheca 27μ long and 16μ wide at base.

Male: Dorsal shield 394μ long, 268μ wide. Four pairs of preanal setae on the ventrianal plate, with a pair of pores behind 4th pair of setae.

Holotype: ♀, Inverness, Marin Co., California, November 10, 1974, V. Landwehr, from foliage of *Pinus muricata* D. Don.

Allotype: same locality, August 31, 1975, V. Landwehr, same host.

Paratypes: 9♀♀, same locality, August 31, 1975, V. Landwehr, same host.

Primary types are deposited in the Canadian National Collection, Biosystematics Research Institute, Ottawa, Ontario (Type No. 14055). Paratype specimens are in the collection of the authors, the U.S. National Museum, Washington, D.C., and the Canadian National Collection.

This species is named for the host plant from which it was recovered.

Discussion. This phytoseiid is rare on pine, with only 10 ♀♀ and 1 ♂ being collected during the study, and that from a coastal species of pine (Table 4). It was found in the same sample with *T. pini, T. eharai, P. macropilis,* and *A. newelli.*

Genus *Phytoseiulus* Evans

Phytoseiulus Evans, 1952, p. 397.
Type: *Laelaps macropilis* Banks, 1905.
Amblyseius (*Phytoseiulus*) Pritchard and Baker, 1962, p. 294.
Phytoseiulus (*Phytoseiulus*) Wainstein, 1962, p. 17.

Discussion. This genus was represented by 2 specimens of a single species in this study, *Phytoseiulus macropilis* (Banks).

Phytoseiulus macropilis (Banks)

Laelaps macropilis Banks, 1905, p. 139.
Hypoaspis macropilis (Banks) Banks, 1915, p. 85.
Phytoseiulus speyeri Evans, 1952, p. 397.
Phytoseiulus macropilis (Banks). Cunliffe and Baker, 1953, p. 23.
Phytoseiulus macropilis (Banks). Schuster and Pritchard, 1963, p. 279.
Phytoseiulus chanti Ehara, 1966, p. 135.
New Records: MARIN CO.: Inverness, on *Pinus muricata.*

Discussion. This predaceous species was rare in the collections of this study, being recovered only from a single pine species, *Pinus muricata* (Table 4) from the coastal part of central California. This is the first record of this species from pines. All other records have been from low-growing herbaceous plants in coastal or humid situations. It was collected in the same samples as were *T. pini, T. eharai, A. newelli,* and *A. muricatus.*

This species is the most cosmopolitan of all the phytoseiids collected during this survey. Smith and Summers (1949) stated that the types were recorded from water hyacinth at Eustis, Florida, and in strawberry plantings in Santa Cruz Co., California. They also included earlier records of this mite from Texas, Florida, and California. The following localities are listed for *P. macropilis:* United States, British West Indies, Hawaii, Panama Canal Zone, and the Canary Islands (Chant, 1959); Puerto Rico (DeLeon, 1965*b*); and

KEY 2

TABULAR KEY TO THE SPECIES OF THE GENUS *OLIGONYCHUS* IN FAMILY TETRANYCHIDAE FOUND ON NATIVE SPECIES OF PINES IN CALIFORNIA

Statement of Characters

1. Length of dorsocentral hysterosomal setae 1, as a decimal, relative to the interval between the first and second setae.
   - >1.00 = Dorsocentral hysterosomal seta 1 greater than the interval between setae 1 and 2.
   - =.50–.90 = Dorsocentral hysterosomal seta 1 greater than one-half, but less than 1, times the interval between setae 1 and 2.
   - <.45 = Dorsocentral hysterosomal seta 1 less than one-half the interval between setae 1 and 2.
2. Relative length of anterior dorsocentral hysterosomal setae.
   - simil = all pairs similar in length.
   - short = anterior pair much shorter than posterior pair.
3. Number of tactile setae on tibia I.
   - (5, 6, or 7)

Distribution of Variants

1	2	3	Species
>1.00	simil	7	*ununguis*
=.50–.90	simil	6	*pityinus*
<.45	simil	6	*subnudus*
<.45	short	6	*milleri*
<.45	simil	5	*cunliffei*

Brazil (Denmark and Muma, 1973). *Phytoseiulus macropilis* was collected from more than 30 genera of plants in Florida (Muma and Denmark, 1970). The biology of this mite in Hawaii was investigated by Prasad (1967).

Family Tetranychidae Donnadieu

Tetranychides Donnadieu, 1875, p. 9.
Tetranychidae Murray, 1877, p. 97.

Subfamily Tetranychinae Berlese

Tetranychini Berlese, 1913, p. 17.
Tetranychinae Reck, 1950, p. 123.

Tribe Tetranychini Reck

Tetranychinae Reck, 1950, p. 123.
Tetranychini Pritchard and Baker, 1955, p. 124.

Diagnosis: Members of this tribe can be separated from others in the subfamily on the basis of a well-developed empodium and 2 pairs of closely associated duplex setae on tarsus I, and a single pair on tarsus II.

Genus *Oligonychus* Berlese

Oligonychus Berlese, 1886, p. 24. Type *Heteronychus brevipodus* Targioni Tozzetti.
Paratetranychus Zacher, 1913, p. 39.

Diagnosis: Members of this genus can be recognized by the absence of the caudal pair of paranal setae, the well-developed empodial claw, and the presence of 6–12 proximoventral hairs (Pritchard and Baker, 1955).

Discussion. This genus was represented by 5 different species: *O. milleri* (McGregor), *O. subnudus* (McGregor), *O. cunliffei* Pritchard and Baker, *O. pityinus* Pritchard and Baker, and *O. ununguis* (Jacobi). Collections ranged from coastal areas to elevations over 3000 m in the Sierra Nevada Mountains.

A key to the species found on pines during this study (Key 2) is based on the design for tabular keys described by Newell (1970, 1972). Table 5 shows the relationship between tetranychid species and the pines from which they were collected.

TABLE 5

TETRANYCHID SPECIES PRESENT ON THE FOLIAGE OF CALIFORNIA PINE SPECIES

Pinus spp.	*Oligonychus*				
	subnudus	*ununguis*	*cunliffei*	*milleri*	*pityinus*
Subgenus *Strobus*					
albicaulis	+				
lambertiana	+	+			
flexilis	+	+			
quadrifolia				+	
monophylla	+	+			+
balfouriana	+	+		+	
aristata		+		+	
Subgenus *Pinus*					
ponderosa	+	+	+	+	
jeffreyi	+	+	+		
sabiniana	+	+	+		
coulteri	+		+	+	
torreyana	+				
contorta	+		+		
radiata	+		+		
attenuata			+	+	
muricata	+		+		

Oligonychus milleri (McGregor)

Paratetranychus milleri McGregor, 1950, p. 343.
Oligonychus milleri (McGregor), Pritchard and Baker, 1955, p. 280.
New Records: INYO CO.: Independence, on *Pinus balfouriana,* and Schulman Grove, on *P. aristata.* RIVERSIDE CO.: Thomas Mountain, on *P. quadrifolia.* SAN BERNARDINO CO.: Forest Falls, on *P. coulteri* and *P. ponderosa.* SHASTA CO.: Shasta Lake, on *P. attenuata.*

Discussion. This mite was collected on 3 species in each of the pine subgenera (Table 5) at 1800 to over 3000 m from southern to northern California. It was found associated with all the other 4 species except *O. pityinus,* which was collected only from *P. monophylla.* It was the only species recovered from *P. quadrifolia* (Table 5).

The type was collected from California on *Pinus ponderosa* by McGregor (1950), who also reported it from Arizona and Virginia. Pritchard and Baker (1955) listed *O. milleri* from various species of pines from the following additional localities: Idaho, Utah, Wisconsin, Louisiana, Florida, North Carolina, and Delaware. Reeves (1963) listed this species from both pines and spruce in New York. Tuttle and Baker (1964) gave additional host plants in Arizona. This mite has been reported damaging *Pinus caribaea* in Jamaica (Muma and Apeji, 1970). The authors have also collected this species on the ornamental plantings of *P. radiata, P. coulteri, P. pinea,* and *P. halepensis* on the grounds of the University of California, Riverside.

Oligonychus subnudus (McGregor)

Paratetranychus subnudus McGregor, 1950, p. 355.
Oligonychus subnudus (McGregor), Pritchard and Baker, 1955, p. 281.
New Records: HUMBOLDT CO.: Trinidad, on *Pinus muricata.* INYO CO.: Independence, on *P. balfouriana;* Rock Creek Lake, on *P. albicaulis* and *P. contorta;* and Schulman Grove, on *P. flexilis.* KERN CO.: Cuddy Valley, on *P.*

jeffreyi and *P. monophylla;* Cummings Valley on *P. sabiniana.* MARIN CO.: Inverness, on *P. muricata.* MONTEREY CO.: Monterey, on *P. radiata.* RIVERSIDE CO.: Thomas Mountain, on *P. jeffreyi.* SAN BERNARDINO CO.: Forest Falls, on *P. coulteri, P. lambertiana,* and *P. ponderosa;* South Fork Campground, on *P. jeffreyi;* South Fork Meadow, on *P. contorta.* SAN DIEGO CO.: Del Mar, on *P. torreyana;* Mt. Laguna, on *P. coulteri* and *P. jeffreyi.* SAN MATEO CO.: Pt. Ano Nuevo, on *P. radiata.* SHASTA CO.: Hat Creek, on *P. sabiniana,* and Shasta Lake, on *P. jeffreyi.*

Discussion. This was the most common species encountered during the study, being collected from all but 4 of the species of pines sampled (Table 5). It was recovered from the length of the state and from both coastal and high elevations and was found associated with 4 of the other species of *Oligonychus* collected during the study.

McGregor (1950) listed the type from *Pinus* sp. at Oxnard, California, and Pritchard and Baker (1955) added additional localities in California and Washington. Tuttle and Baker (1964) stated that *O. subnudus* in Arizona either consists of a complex of species, or is quite variable. Length of the dorsal setae of individuals collected in this study varied from one to another, even in the same locality. This mite has been a problem to growers of young Monterey pines (Koehler and Frankie, 1968) in central-coastal California. Landwehr (1974) also included information on this mite in his study.

Oligonychus cunliffei Pritchard and Baker

Oligonychus cunliffei Pritchard and Baker, 1955, p. 284.

New Records: HUMBOLDT CO.: Trinidad, on *Pinus muricata.* INYO CO.: Rock Creek Lake, on *P. contorta.* KERN CO.: Cummings Valley, on *P. sabiniana.* LASSEN CO.: Hog Flat Res., on *P. contorta.* LOS ANGELES CO.: Pinyon Ridge, on *P. coulteri.* MONO CO.: Lee Vining, on *P. jeffreyi.* MONTEREY CO.: Monterey, on *P. radiata.* RIVERSIDE CO.: Thomas Mountain, on *P. jeffreyi.* SAN BERNARDINO CO.: Forest Falls, on *P. coulteri* and *P. ponderosa;* Running Springs, on *P. attenuata;* South Fork Campground, on *P. jeffreyi;* and South Fork Meadow, on *P. contorta.* SAN DIEGO CO.: Mt. Laguna, on *P. coulteri* and *P. jeffreyi.* SHASTA CO.: Shasta Lake, on *P. jeffreyi.*

Discussion. This mite was recovered from all but 1 pine species in the subgenus *Pinus,* but from none of the species in the subgenus *Strobus* (Table 5). *O. cunliffei* was found throughout the state on coastal as well as on inland pine species, but was not found in pines above 2400 m.

The type was collected on *Pinus palustris* in Florida, and the species, until recently, had been known only from pines in that state (Landwehr, 1974).

Oligonychus pityinus Pritchard and Baker

Oligonychus pityinus Pritchard and Baker, 1955, p. 290.

New Records: KERN CO.: Cuddy Valley, on *Pinus monophylla.* LOS ANGELES CO.: Little Rock Canyon, on *P. monophylla;* and Pinyon Ridge, on *P. monophylla.*

Discussion. This mite was found only on *Pinus monophylla* in this study (Table 5). Of the 5 species recovered, it was the most limited in host range and locality. The type was also recorded from the same host plant, although farther north in the state than was sampled during this survey. It was found in the same sample with *O. ununguis* and *O. subnudus.*

Oligonychus ununguis (Jacobi)

Tetranychus ununguis Jacobi, 1905, p. 239.
Paratetranychus ununguis, Zacher, 1913, p. 39.
Oligonychus ununguis, Hirst, 1920, p. 59.
Tetranychus uniunguis Ewing, 1917, p. 497.
Neotetranychus uniunguis, McGregor, 1919, p. 647.
Paratetranychus uniunguis, McGregor, 1950, p. 356.
Oligonychus americanus Ewing, 1921, p. 660.
Paratetranychus americanus, McGregor, 1950, p. 333.
Paratetranychus alpinus McGregor, 1936, p. 770.
Paratetranychus pini Hirst, 1924, p. 526.
Oligonychus ununguis (Jacobi), Pritchard and Baker, 1955, p. 319.

New Records: INYO CO.: Independence, on *Pinus balfouriana;* and Schulman Grove, on *P. aristata* and *P. flexilis.* KERN CO.: Cuddy Valley, on *P. jeffreyi.* LASSEN CO.: Hog Flat Res., on *P. jeffreyi.* LOS ANGELES CO.: Little Rock Canyon, on *P. monophylla.* MONO CO.: Lee Vining, on *P. jeffreyi.* RIVERSIDE CO.: Joshua Tree National Monument, on *P. monophylla;* and Pinyon Flats Campground, on *P. monophylla.* SAN BERNARDINO CO.: Forest Falls, on *P. lambertiana* and *P. ponderosa;* and South Fork Campground, on *P. jeffreyi.* SHASTA CO.: Hat Creek, on *P. sabiniana;* and Shasta Lake, on *P. jeffreyi.*

Discussion. *Oligonychus ununguis* was collected from both subgenera of pines (Table 5) throughout the length of the state. However, it was not recovered from any coastal pines. It was well represented in the samples from high elevations (over 3000 m) and also from pines growing in desert areas. It was collected in the same samples as *O. milleri, O. subnudus, O. cunliffei,* and *O. pityinus.*

The type of *O. ununguis* was described from specimens on spruce in Germany (Jacobi, 1905). Garman (1923) reported this mite in Connecticut and Canada. Cunliffe and Ryle (1923) recorded this species in England, Sweden, and Holland. An early account of the biology of this species in England was given by Ryle (1925). This species has been listed from Connecticut, Georgia, Maine, Maryland, North Carolina, Illinois, Pennsylvania (McGregor, 1950), and California (McGregor, 1936). Matthysse and Naegele (1952) reported this mite to be one of the 2 most common and damaging mites of evergreens in New York State. Neiswander (1952) studied the control of this tetranychid on juniper in Ohio. Pritchard and Baker (1955) noted that members of the Cupressaceae seem to be favored hosts for *O. ununguis.* Johnson (1958) studied this mite on Douglas fir in Montana. This species of *Oligonychus* has been reported by Ehara from Japan (1964) and Hokkaido (1962). Von Scheller (1962) studied the bionomics of *O. ununguis* and listed the natural enemies associated with this mite in northwestern Germany. Reeves (1963), in his treatment of the Tetranychidae of New York, gave a good account of the previous work done on this mite and its reported hosts and distribution. It has also been recovered from Brazil (Ehara, 1966), Bermuda, New Zealand, Queensland (Browne, 1968), and Arizona (Tuttle and Baker, 1964, 1968).

Mesostigmata

Family Ascidae Voigts and Oudemans, 1905

Asca pini Hurlbutt, 1963

New Records: HUMBOLDT CO.: Trinidad, on *Pinus muricata.* MARIN CO.: Inverness, on *P. muricata.* MONTEREY CO.: Monterey, on *P. radiata.* SAN MATEO CO.: Pt. Ano Nuevo, on *P. radiata.*

This was the only genus collected from this family, and the only other family in the suborder Mesostigmata other than the phytoseiids. These mites were collected only from coastal species of pines, and then only those of the subgenus *Pinus* (Table 2). Hurlbutt (1963) mentioned finding this species on pine in Mexico; and Lindquist and Evans (1965) referred to this genus as "cosmopolitan," containing approximately 25 species. Metz and Farrier (1969) reported many specimens of this genus in their study of the litter in a pine and hardwood forest. In Alberta, Canada, the genus *Asca* was recovered from cankers of the comandra blister rust, *Cronartium comandrae* Peck, on lodgepole pine (Powell, 1971).

Prostigmata (Trombidiformes)

Family Anystidae Oudemans, 1902

Anystids were recovered from over one-half of the pine species sampled (Table 2) from a wide variety of climatic areas, including coastal, desert, and high elevation regions. They were more prevalent (2 to 1) in the subgenus *Pinus* (Table 3), and were seldom collected in numbers of more than 1 per sample or location. The predaceous habits of anystids were discussed by McMurtry et al. (1970). Apparently they are usually not numerous enough in tetranychid infestations to be important in control. Price (1973) recorded this family in his study of the arthropods in the surface layers of California pine forest soil. Anystids were recorded from Monterey pine foliage by Landwehr (1974).

Family Bdellidae Duges, 1834

Bdella longicornis (Linnaeus), 1758

New Records: KERN CO.: Cuddy Valley, on *P. jeffreyi* and *P. monophylla.* LASSEN CO.: Hog Flat Res., on *P. jeffreyi.* MARIN CO.: Inverness, on *P. muricata.* RIVERSIDE CO.: Thomas Mountain, on *P. jeffreyi.* SAN BERNARDINO CO.: Forest Falls, on *P. coulteri* and *P. ponderosa;* and South Fork Meadow, on *P. contorta.* SAN DIEGO CO.: Mt. Laguna, on *P. jeffreyi.* SAN MATEO CO.: Pt. Ano Nuevo, on *P. radiata.*

Spinibdella cronini (Baker and Balock), 1944

New Records: INYO CO.: Independence, on *Pinus balfouriana;* and Rock Creek Lake, on *P. contorta.* KERN CO.: Cummings Valley, on *P. sabiniana.* LASSEN CO.: Hog Flat Res., on *P. jeffreyi.* MONO CO.: Lee Vining, on *P. jeffreyi.* SAN BERNARDINO CO.: Forest Falls, on *P. coulteri* and *P. ponderosa.*

Spinibdella depressa (Ewing), 1909

New Records: MONTEREY CO.: Monterey, on *Pinus radiata.* SAN BERNARDINO CO.: Forest Falls, on *P. coulteri* and *P. ponderosa.*

Cyta latirostris (Hermann), 1804

New Records: HUMBOLDT CO.: Trinidad, on *Pinus muricata.*

This family was also collected from more than one-half of the pines sampled during the study, and was more common in the *Pinus* subgenus by almost 4:1 (Tables 2 and 3). *Bdella longicornis* and *S. cronini* were the most frequently recovered, from 7 and 6 species of pines, respectively. Price (1973) also found these species to be among the most common of the bdellids he collected from the pine soil litter. He also recovered specimens of *C. latirostris.* Snetsinger (1956) reported *S. depressa* as an important predator of the clover mite on the bark of trees and in grassy areas in Illinois. *Cyta latirostris* and *S. depressa* were both reported by Moser and Roton (1971) in bark samples of pine bark beetle. The taxonomy of this family, and a listing of the localities where these species have been collected, has been presented by Atyeo (1960).

Family Caeculidae Berlese, 1894

This family of heavily armored, slow-moving predaceous mites (Krantz, 1970) was represented in this study by a single individual from jeffrey pine in southern California (Table 2).

Family Caligonellidae Grandjean, 1944

Molothrognathus crucis Summers and Schlinger, 1955

New Records: SAN BERNARDINO CO.: Forest Falls, on *Pinus coulteri.* SHASTA CO.: Shasta Lake, on *P. jeffreyi.*

Another unidentified species was collected from Shasta Lake, Shasta Co., on *P. attenuata.* All of these specimens were collected from the subgenus *Pinus* (Table 3). Summers and Schlinger (1955) recorded the type *M. crucis* from oak mulch in Riverside County, California, and other specimens from juniper and *Salix* litter in Nevada and California, respectively. Smiley and Moser (1968) listed a species from this genus from pines in Mexico.

Family Cheyletidae Leach, 1815

Cheletongenes ornatus (Canestrini and Fanzago), 1876

New Records: INYO CO.: Schulman Grove, on *Pinus aristata.* KERN CO.: Cuddy Valley, on *P. jeffreyi* and *P. monophylla;* and Cummings Valley, on *P. sabiniana.* RIVERSIDE CO.: Thomas Mountain, on *P. jeffreyi.* SAN BERNARDINO CO.: Forest Falls, on *P. coulteri, P. lambertiana,* and *P. ponderosa;* South Fork Campground, on *P. jeffreyi;* and South Fork Meadow, on *P. contorta.* SAN DIEGO CO.: Mt. Laguna, on *P. coulteri* and *P. jeffreyi.* SHASTA CO.: Hat Creek, on *P. sabiniana.*

Acaropsellina anarsia Summers, 1976

New Records: MARIN CO.: Inverness, on *Pinus muricata.* MONTEREY CO.: Monterey, on *P. radiata.*

Cheletomimus berlesei (Oudemans), 1904

New Records: SAN DIEGO CO.: Del Mar, on *Pinus torreyana.*

Prosochela oaklandia (Baker), 1949

New Records: SAN DIEGO CO.: Del Mar, on *Pinus torreyana.*

This was the fourth most commonly encountered family during this survey. It was only surpassed by the Phytoseiidae, Tetranychidae, and Tenuipalpidae, as far as number of species of pine from which they were collected (Table 3). As with many other families, it was most common in the subgenus *Pinus,* being present on all but one species (Table 2). Collections of cheyletids on pines ranged from coastal locations to those at high (over 3000 m) elevations. Cheyletidae is a family of essentially predaceous mites (Krantz, 1970), and has been seen feeding on spider mites (McMurtry et al., 1970). Volgin (1969) and Summers and Price (1970) should be consulted for more in-depth treatment. Muma (1964) listed *Cheletogenes ornatus* and *Cheletomimus berlesei* from citrus in Florida. Yunker (1961) recorded *C. berlesei* from a large variety of plants in the United States, Mexico, Italy, and the Middle East. Moser and Roton (1971) and Kinn (1971) reported finding this family in association with bark beetles on various species of the genus *Pinus.* Landwehr (1974) listed *C. ornatus* from Monterey pine in central-coastal California. Price (1973) noted finding members of this family in his study of forest soil litter.

Family Cunaxidae Thor, 1902

Cunaxoides biscutum (Nesbitt)

New Records: SAN BERNARDINO CO.: South Fork Meadow, on *Pinus contorta.*

Only one specimen of this family was recovered during this study (Table 2). Cunaxids are predaceous and are found in humus, leaves, straw and moss (Krantz, 1970). Both Metz and Farrier (1969) and Price (1973) collected cunaxids in forest litter. Moser and Roton (1971) collected the genus *Cunaxoides* from bark samples of *Pinus taeda* in Louisiana.

Family Eriophyidae Nalepa, 1898

This family is probably more numerous than the collection record would indicate, for the members are exceedingly small and undoubtedly many passed through the 0.15-mm openings in the screen when the samples were being washed. The individuals that were recovered came from a variety of habitats, from coastal to high elevations (Table 2).

This family is highly host specific, feeding almost exclusively on perennials. Some species severely damage crops or other plants (Keifer, 1952), and some have been shown to be vectors of plant virus diseases (Oldfield, 1969). Keifer (1952) listed 8 species of native California pines from which eriophyids were collected. This study added 3 additional host pines to this list, but undoubtedly they will be found on the other pines also. A new species of eriophid was recorded from *Pinus sylvestris,* which is used as Christmas trees in the Pacific Northwest (Keifer and Saunders, 1972).

Family Erythraeidae Robineau-Desvoidy, 1828

The larvae of this cosmopolitan family are parasitic on a variety of insects and other arthropods. The nymphs and adults are predaceous on small arthropods (Southcott, 1961). Smiley (1964, 1966) described 2 new erythraeids as predators of cotton bollworm eggs. Krantz (1970) suggested from evidence in the literature that members of the genus *Balaustium* may be gen-

eral feeders that are also capable of predation, phytophagy, parasitism, and hematophagy. Newell (1963) reported on 4 cases of members of the genus *Balaustium* attacking man in the United States and Canada. The biology and behavior of *B. putmani* Smiley were studied by Putman (1970). He found all stages attacking European red mite, San Jose scale, and apple aphid.

The family Erythraeidae was equally represented in both pine subgenera (Table 3), and occurred in samples from pines from a variety of habitats, from coastal to high elevations.

These mites have been found associated with bark beetles in pines in Louisiana (Moser and Roton, 1971), in forest litter in the southeastern United States (Metz and Farrier, 1969; Price, 1973), and on comandra blister rust on *Pinus contorta* in Canada (Powell, 1971).

Family Eupalopsellidae Wilmann, 1952
Eupalopsellus sp., Sellnick, 1949[3]

New Records: SHASTA CO.: Shasta Lake, on *Pinus attenuata.*

Saniosulus nudus Summers, 1960

New Records: SAN BERNARDINO CO.: Forest Falls, on *Pinus ponderosa.*

These genera were the only representatives of this family collected during the study, and both pines from which they were collected belong in the subgenus *Pinus* (Table 3).

Species of this little known family have been found in such habitats as juniper, sage, heather, pine bark and citrus (Summers, 1960). Summers (personal communication) reported *S. nudus* to be fairly well distributed on citrus, and predaceous on scale insects. The type of *S. nudus* was recovered from orchid plants being shipped from Mexico to the United States (Summers, 1960). Other members of this family have been collected from the bark of *Pinus taeda* in Louisiana (Moser and Roton, 1971; Smiley and Moser, 1968).

Family Johnstonianidae Newell, 1957

The collections of this family were not very numerous, but this was the only family recovered that was represented only from pines in the subgenus *Strobus* (Table 3). In all other cases, even if the family was found only on 1 species of pine, it was from the subgenus *Pinus.* Johnstonianids were present in pine samples from high elevations, but not from any coastal areas, which are only represented in the other subgenus.

Family Neophyllobiidae Southcott, 1957

This family was recovered from both of the pine subgenera (Table 3) and mostly from southern California species. Species in this family are probably predaceous on other mites and scale insects (DeLeon, 1958). They have been recovered from such habitats as oak, peach, moss, tree bark, and incense cedar (McGregor, 1950). Smiley and Moser (1968) described a new species associated with bark beetles on *Pinus taeda* in Louisiana.

Family Raphignathidae Kramer, 1877
Raphignathus cometes Atyeo

New Records: SAN BERNARDINO CO.: Forest Falls, on *Pinus coulteri.*

[3] Dr. F. M. Summers (personal communication) stated that this could be an undescribed species.

Raphignathus gracilis Rack

New Records: SAN BERNARDINO CO.: Forest Falls, on *Pinus coulteri.*

Only 4 individuals of both of these species were recovered during the approximately 1½ yrs the trees in Forest Falls (see Part II and Table 2) were sampled, which would indicate that this family is relatively rare on pines.

This is another monogeneric family according to Summers (1966), who included only the genus *Raphignathus.* Atyeo et al. (1961), recorded members of this family as often occurring on or under tree bark. They are probably predaceous on other small arthropods (Krantz, 1970). Price (1973) recorded *R. gracilis* in forest soil samples, and Smiley and Moser (1968) found a member of this family under the bark of *P. taeda.*

Family Scutacaridae Oudemans, 1916

This little known mite family seems to be relatively rare, for in the sampling only 1 specimen was collected (Table 2).

Family Smarididae Vitzthum, 1929
Sphaerotarsus sp., Womersley, 1936

New Records: LASSEN CO.: Hog Flat Res., on *Pinus jeffreyi.*

This is another family that was represented by only a single specimen (Table 2). The taxonomic and biological information is covered in papers by Womersley and Southcott (1941), Southcott (1961), and Grandjean (1947).

Family Stigmaeidae Oudemans, 1931
Eupalopsis acus Summers, 1960

New Records: LASSEN CO.: Hog Flat Res., on *Pinus contorta.*

Two other unidentified individuals were collected from Marin County (Inverness) on *Pinus muricata* and from San Bernardino County (Forest Falls) on *P. ponderosa.*

This family is another example of those which were only represented in the subgenus *Pinus* (Table 3), being recovered from 1 coastal and 2 inland species of pines. *Eupalopsis acus* was described by Summers (1960) from apple collected in British Columbia, and another specimen was reported from *Prunus* in Iran in the same paper. Other species in this family are predators of the Tetranychidae (McMurtry et al., 1970) in Europe and the United States, and are considered beneficial (e.g., *Zetzella mali*). Metz and Farrier (1969) and Price (1973) have all reported this family in forest litter, and Moser and Roton (1971) listed it from the bark of *Pinus taeda* in Louisiana.

Family Tarsonemidae Kramer, 1877

The tarsonemids collected during this study came from the subgenus *Pinus* and, except for the 1 recovered from *P. coulteri,* came from strictly coastal species of pines (Table 2).

This family includes 10 to 12 genera of mites that are phytophagous, fungivorous, or insectophilous (Krantz, 1970). Much work has been done in recent years on the members of this family associated with different species of bark beetles, especially in the genera *Tarsonemoides, Tarsonemus,* and *Iposemus* (Lindquist and Bedard, 1961; Lindquist, 1964, 1969a, 1969b; and Kinn, 1971).

Family Tenuipalpidae Berlese, 1913

Brevipalpus sp.[4]

New Records: INYO CO.: Rock Creek Lake, on *Pinus contorta;* Schulman Grove, on *P. aristata.* KERN CO.: Cummings Valley, on *P. sabiniana.* LASSEN CO.: Hog Flat Res., on *P. contorta.* RIVERSIDE CO.: Joshua Tree National Monument, on *P. monophylla;* Pinyon Flats Campground, on *P. monophylla;* and Thomas Mountain, on *P. jeffreyi.* SAN BERNARDINO CO.: Forest Falls, on *P. coulteri, P. lambertiana,* and *P. ponderosa;* Running Springs, on *P. attenuata;* South Fork Campground, on *P. jeffreyi;* and South Fork Meadow on *P. contorta.* SAN DIEGO CO.: Mt. Laguna, on *P. jeffreyi.*

The Tenuipalpidae were the third most frequently encountered family during the course of this survey. They were collected on all but 2 species of pine, 1 each in *Strobus* and *Pinus* subgenera (Table 2). They seemed to be present in large numbers at most times of the year, even winter (see Part II), ranging from coastal areas to high elevations in the Sierra Nevada Mountains.

The Tenuipalpidae are plant feeders that often occur on the lower surface of leaves, on the bark, on heads of flowers, under the leaf sheaths of grasses, or in plant galls (Pritchard and Baker, 1958). This family also contains members that damage citrus and ornamentals in many parts of the world (Tuttle and Baker, 1964). Species on pine in the United States included *Brevipalpus porce,* which has been recorded from mistletoes on *P. edulis* and *P. ponderosa; B. pini* from *P. radiata;* and *B. pinicola* from pine in Florida (Pritchard and Baker, 1958). DeLeon (1960) listed a new species from pine in Mexico.

Landwehr (1974) reported *B. pini* from *P. radiata,* and described what he believed to be 2 geographic forms of this mite in California. He thought the forms could be separated morphologically.

Family Tydeidae Kramer, 1877

Tydeus kochi Oudemans, 1937

New Records: HUMBOLDT CO.: Trinidad, on *Pinus muricata.* SAN BERNARDINO CO.: Forest Falls, on *P. coulteri* and *P. ponderosa.*

Tydeus caudatus

New Records: SAN BERNARDINO CO.: South Fork Meadow, on *Pinus contorta.*

Paralorryia ferula (Baker), 1944

New Records: SAN DIEGO CO.: Del Mar, on *Pinus torreyana.*

This family was recovered from over one-half of the pine species sampled (Table 2). As with many other mite families, it was more widely represented in the subgenus *Pinus,* the ratio being almost 3:1 (Table 3). Tydeids were recovered from all pine habitats except those on the drier desert slopes.

The biology of this family is not well known. Some members, such as *Tydeus californicus,* are plant feeders (Fleschner and Arakawa, 1952); other species are predaceous on mites (Baker, 1965). Some tydeids may be beneficial as al-

[4] Dr. E. W. Baker (personal communication) stated that these mites were similar to *B. pini,* but were almost certainly a new species.

ternate hosts for predaceous mites when the preferred host is absent (Flaherty and Hoy, 1971). Baker (1965) reported this family to be common on mosses and lichens on trees, in stored foods, and even in soils. Price (1973) recovered mites of this family from pine forest soil in northern California. Moser and Roton (1971) found this family associated with bark beetles on *Pinus taeda,* and Powell (1971) collected tydeids from blister rust on lodgepole pine in Canada. *Paralorryia ferula* (Baker), was reported from California, Oregon, Mexico, Peru, Poland, Egypt, Morocco, Spain, Italy, and Libya (Baker, 1968). The biology was investigated by Brickhill (1958) along with that of another species, *Tydeus bakeri,* also from California. The latter species was the most common tydeid collected from Monterey pine by Landwehr (1974).

Astigmata (Acaridei)

Family Acaridae Ewing and Nesbitt, 1942

Only 1 specimen of this family was recovered from the collections during this study (Table 2). It is not surprising to find a member of this family on a coastal species of pine, since, within this diverse group, many species are found in extremely wet habitats, generally feeding on organic debris of some kind (Krantz, 1970). Powell (1971) found 3 species of this family on cankers of blister rust from Canadian lodgepole pines. Kinn (1971) recorded members of this family as bark beetle associates in California.

Family Saproglyphidae Oudemans, 1924

This family was also rare in the collections of this survey, being recovered only from 2 species of coastal pine (Table 2). Members of the Saproglyphidae are fungivorous or saprophytic, and may be found associated with insects (Krantz, 1970). Kinn (1971) found representatives of this family associated with bark beetles of 5 genera.

Cryptostigmata (Oribatei Duges, 1834)

This group was found on all but 3 species of native pines (Table 2). It was found in high elevations, desert areas, and coastal habitats.

This large group of families was not identified other than to suborder. This cosmopolitan group of "beetle mites," as they are sometimes called, contains approximately 5000 species that are common inhabitants of forest humus and soil, and are primarily saprophagous, algivorous, or fungivorous (Krantz, 1970). Accounts of the taxonomy and biology of these mites can be found in the following sources: Balogh, 1961, 1965, 1972; Wooley, 1958, 1960; Wooley and Baker, 1958; and van der Hammen, 1952.

Hayes (1965) studied the distribution of some Oribatei in coniferous soil in the British Isles, Hartenstein (1962) studied the decomposition of conifer needles by members of the Phthiracaridae, and Price (1973) collected 33 species of Cryptostigmata in the surface layers of pine forest soil. Eight families of this suborder have also been found in bark samples containing pine bark beetles (Moser and Roton, 1971) and 3 families were collected from *Cronartium comandrae* cankers taken from *Pinus contorta* in Alberta, Canada (Powell, 1971).

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cundity rate of 1.08 eggs/♀ per day at 29 C, and *T. pini* had a maximum of 0.95 at 24 C. Both species could feed, develop, and oviposit on three tetranychid species, but not on scale crawlers or tenuipalpids. Only *T. pini* could feed, develop, and oviposit on pollen. *Metaseiulus validus* consumed 2.77 eggs/♀ per day of *Oligonychus punicae,* and 0.81 adult ♀♀; *T. pini* consumed 1.89 and 1.11, respectively. At an 8-h photoperiod, 88.3 percent of the ♀♀ of *M. validus* and 71.43 percent of the ♀♀ of *T. pini* entered reproductive diapause. At a 16-h photoperiod, neither species entered diapause. The ratio of ♀♀ to ♂♂ of both species was about 1:1. At 24 C, the preovipositional period for *T. pini* was 4.33 days, the reproductive longevity was 18.75 days, and 17.70 eggs were laid per ♀.

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