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Systematics and Bionomics of Predaceous and Phytophagous Mites Associated with Pine Foliage in California

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

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)

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

INTRODUCTION

MITES are not generally an economic problem in the coniferous forest ecosystems of the United States. However, there are a few documented cases of tree damage caused by mites. Johnson (1958) and Fellin (1968) reviewed epidemic infestations of the spider mite *Oligonychus ununguis* (Jacobi) in the Rocky Mountain Douglas fir forests. They suggested that these outbreaks were the result of destruction of the natural enemies of the mites following massive spray programs against forest insect pests.

In California, some cases of damage by spider mites have been reported on pines grown for Christmas trees and ornamentals, especially on *Pinus radiata*. These have been mainly from the central-coastal region (Koehler and Frankie, 1968; Landwehr, 1974).

In order to understand why mites are not usually a problem in forests, it is necessary to study the population dynamics of mites in native stands of conifers. The objective of this study was to determine seasonal and annual changes in species composition and population densities of phytophagous and predaceous mites on three species of native pines in the San Bernardino Mountains, and to gain some understanding of interrelationships.

MATERIALS AND METHODS

Study site

The sites chosen for the study were in the San Bernardino Mountains near Forest Falls, San Bernardino County, at an elevation of 1800–1860 m. The species selected were: *Pinus coulteri* D. Don (coulter pine), *P. lambertiana* Dougl. (sugar pine), and *P. ponderosa* Laws (ponderosa pine). There were two separate locations, with *P. coulteri* at 1800 m, and *P. lambertiana* and *P. ponderosa* about 1 mile away at an elevation of 1860 m. Both sites were near the head of Mill Creek Canyon, along the edge of the old river bed. A stream flowed along the far side of the canyon during most of the year. Other trees occurring in the same locations as the pines included: incense cedar, *Calocedrus decurrens* (Torr.); white fir, *Abies concolor* (Gordard Glend.); California black oak, *Quercus kelloggii* Newb.; and canyon live oak, *Quercus chrysolepis* Liebm. A discussion of the vegetation of this and surrounding areas has been presented by Horton (1960). Data on temperature and precipitation are given in Table 1 for the period of the study plus 6 months before sampling.

Sampling

The sampling and washing procedures were the same as described in Part I. The only exception was the use of a pole pruner to remove terminals on some of the sample trees that had insufficient foliage reachable by hand.

TABLE 1

TEMPERATURE AND PRECIPITATION DATA FOR FOREST FALLS, CALIFORNIA, FOR THE PERIOD SEPTEMBER 1971 TO NOVEMBER 1973*

Year	Month	Temperature (°C) Maximum	Minimum	Precipitation (cm)
1971	Sept	33	0	.03
	Oct	30	−8	6.88
	Nov	17	−3	1.32
	Dec	11	−11	38.02
1972	Jan	11	−10	.00
	Feb	16	−6	.38
	Mar	21	−5	.00
	Apr	21	−5	1.78
	May	28	−2	.56
	June	37	5	3.86
	July	36	10	Trace
	Aug	30	8	1.17
	Sept	28	4	.41
	Oct	24	−3	4.75
	Nov	16	−5	10.16
	Dec	13	−15	10.46
1973	Jan	11	−11	15.04
	Feb	11	−6	27.56
	Mar	10	−8	25.35
	Apr	21	−6	.58
	May	28	−2	1.09
	June	34	2	.00
	July	34	9	.25
	Aug	31	7	.00
	Sept	29	6	.00
	Oct	24	0	.05
	Nov	18	−6	8.99

* Data through the courtesy of the San Bernardino County Flood Control District.

To test whether there was any difference in the number of mites (Phytoseiidae, Tetranychidae, and Tenuipalpidae) at different levels in the tree, three different *Pinus ponderosa* trees were sampled at three separate heights, using various extensions of the pole pruner (1.5, 3.5, and 5.5 m). In each case, 15 terminals were cut from around the circumference of each tree, and the mites of the three families were counted after being washed and then collected on filter paper discs. An analysis of variance of the mite counts revealed no significant difference at the 5% level in the number of mites at the different heights in the tree.

Three trees of each pine species were sampled at monthly intervals for approximately 2 years, from March, 1972, to December, 1973. After the samples were washed, the mites on the filter paper discs were counted with the aid of a binocular dissecting microscope, and the number of individuals in each family, exclusive of eggs and larvae, was recorded. The mites were mounted in Hoyer's medium for further examination and identification. All tetranychid mites collected during the first 15 months of the study were mounted so that the species' composition during the year, and between the species of pines, could be determined for the first season of sampling. After May, 1973, no additional specimens were mounted, and the counts were recorded as either number per family, number per genus (all tetranychids were of the genus *Oligonychus*, or number per species (all phytoseiids were *Metaseiulus validus*).

Overwintering sites

Two different methods were used in an attempt to recover species of Tetranychidae and Phytoseiidae from overwintering habitats. The first was by removing bark from the trunks of the 3 species of pine, and the second was by sampling cones that were still attached to the trees. The cones were washed in the same manner as the foliage samples. Pieces of bark were pulled from the trunks of the trees (not sample trees) and placed in a Berlese funnel for approximately 7 days. The collected mites were mounted in Hoyer's medium for identification. No attempt was made to quantify the amount of bark collected.

RESULTS

The coulter pine had the greatest diversity of mite families with 14, followed by ponderosa with 11, and sugar pine with 6. The following sections describe the population dynamics of mites according to the different pine species.

Pinus ponderosa Laws

Phytophagous mites

Tenuipalpidae.—Tenuipalpids (*Brevipalpus* sp.) occurred in large numbers only on the *P. ponderosa* sample trees. Population densities on all 3 trees did not fall below 10 per 15 terminals (Fig 1). The low point of trees 2 and 3 occurred in March of the second year. The population of tree 1 declined to its lowest level in June, 1973. Trees 1 and 2 had the highest population peaks in the second year, but tree 3 had similar numbers in both years. The number of these mites was higher at all times than that of any other group on both trees 2 and 3; and on tree 1, the number of *Oligonychus* spp. exceeded that of *Brevipalpus* sp. only during the month of August, 1972.

Tetranychidae.—The spider mite populations (combined number of the 4 species of *Oligonychus* recovered) peaked at different times on each of the 3 sample trees; tree 1 in August, tree 2 in June, and tree 3 in July (Fig. 1). Both trees 1 and 2 exceeded 200 mites per 15 terminals the first year, but tree 3 had a high of only about 20 mites per sample. In the second year the situation changed, with tree 3 having a peak higher than on the first year, at over 160 mites per 15 terminals. Tetranychids on tree 2 peaked at about the same level, but the population on tree 1 reached only about one-third the level of that of the first year. The peaks for all 3 trees occurred later in 1973, in October or November, and populations quickly dropped off thereafter. The number of spider mites on all 3 trees remained below 5 mites per sample from December, 1972, to about May of 1973.

Species of Tetranychids recovered (Table 2).—On the ponderosa pines, *Oligonychus subnudus* was the most common species collected, but there were differences among trees. Tree 1 had more *O. cunliffei,* whereas trees 2 and 3 had more individuals of *O. subnudus.* Tree 1 had almost an equal number of *O. cunliffei* and *O. subnudus;* but in tree 2 there were 367 individuals of *O. subnudus* and only 55 of the other 3 species of *Oligonychus* combined, during the entire 15 months.

Predaceous mites

Phytoseiidae. — These predators showed a positive numerical response to increases in spider mites on all 3 trees in both sample years (Fig. 1). In the first year, phytoseiid populations peaked 1 to 3 months after the peak in the tetranychid population occurred. The increase in number began when the spider mite population reached a level of about 2 mites per terminal. The number of phytoseiids remained below 5 per

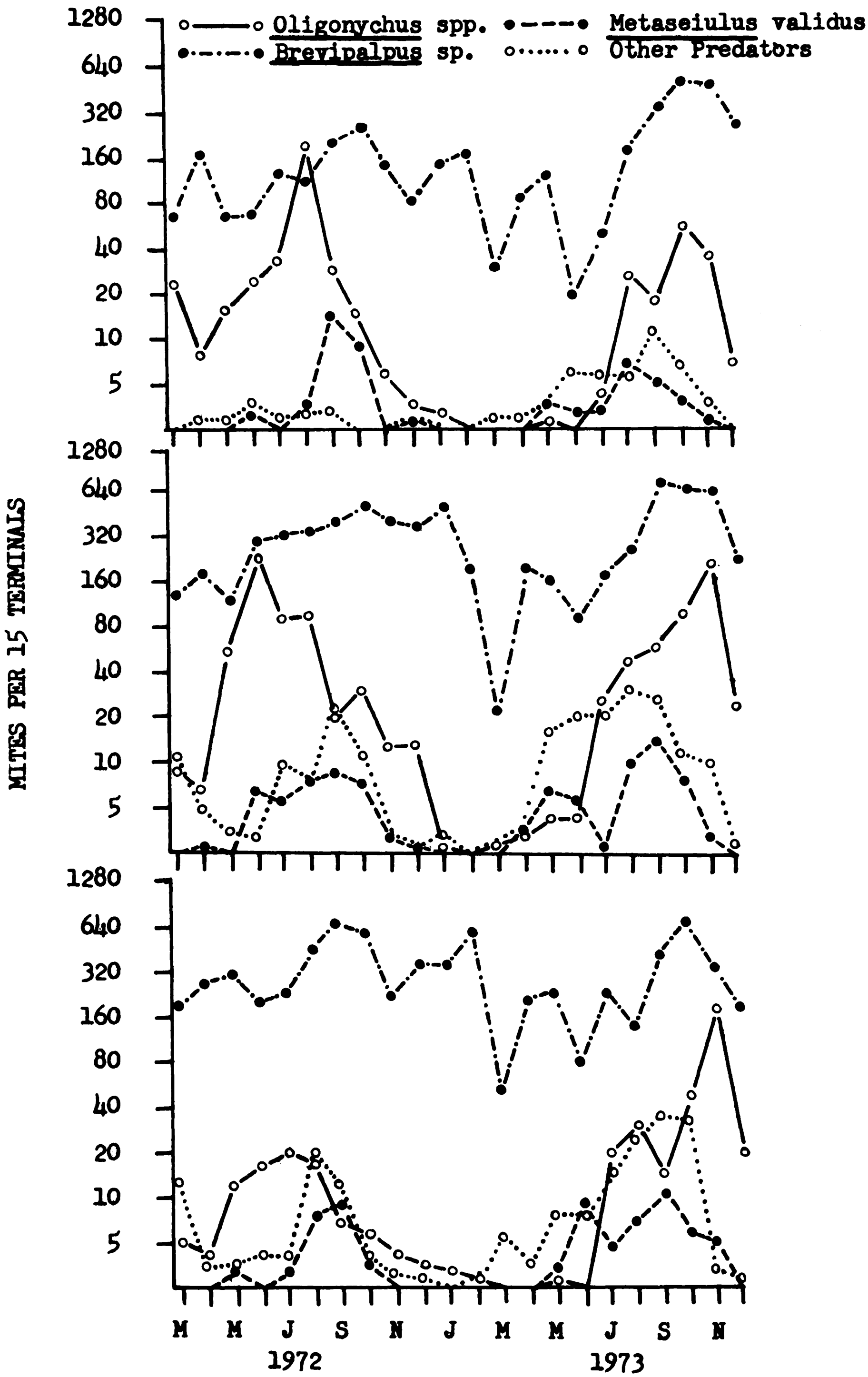

Fig. 1. Population fluctuations of phytophagous and predaceous mites on three trees of *Pinus ponderosa* at Forest Falls, California. Above, tree one; center, tree two; below, tree three.

TABLE 2

NUMBERS OF *OLIGONYCHUS** RECOVERED ON *PINUS PONDEROSA* NEEDLES DURING A FIELD STUDY AT FOREST FALLS, CALIFORNIA (TOTAL OF MALES AND FEMALES)

Date	*O. milleri* on Tree no. 1	2	3	Total	*O. cunliffei* on Tree no. 1	2	3	Total	*O. subnudus* on Tree no. 1	2	3	Total
1972												
March	10	1	–	11	5	1	–	6	2	5	5	12
April	–	–	–	–	2	1	–	3	5	5	7	17
May	–	–	–	–	4	1	3	8	5	20	12	50
June	1	–	–	1	5	11	–	16	5	124	10	139
July	2	–	2	4	10	7	–	17	18	74	19	111
Aug	8	–	12	20	84	12	4	100	48	56	28	132
Sept	–	–	–	–	11	–	2	13	9	15	4	28
Oct	1	–	–	1	5	8	–	13	5	16	5	26
Nov	–	–	–	–	3	4	1	8	3	7	2	12
Dec	–	–	–	–	1	–	–	1	–	12	2	14
1973												
Jan	–	–	–	–	–	–	–	–	–	1	–	1
Feb	–	–	–	–	–	–	–	–	–	–	–	–
March	–	–	–	–	–	1	–	1	–	–	–	–
April	–	–	–	–	–	–	–	–	–	1	–	1
May	–	–	–	–	–	1	–	1	1	1	1	3
Totals	22	1	14	37	130	47	10	187	101	367	95	563

* Tree No. 2 also had a total of 7 individuals of *O. ununguis* during this period (1, April, 72; 2, June, 72; 1, July, 72; 3, Oct., 72).

sample from about November, 1972, until May, 1973, on all 3 trees. In 1973, the phytoseiids began increasing earlier than the tetranychids, and began to decline when the number of spider mites was still high. Populations of these predators were higher on trees 2 and 3 in the second year, but tree 1 only had about one-half the population of the first year.

Others.—This heading includes the following families of mites: Cheyletidae, Bdellidae, Anystidae, Neophyllobiidae, Eupalopsellidae, and Stigmaeidae. The most common family was the Cheyletidae, composed entirely of *Cheletogenes ornatus* (Canestrini and Fanzago).

The response of these mites collectively was similar to that of the phytoseiids on all 3 trees (Fig. 1). On both trees 2 and 3, the number was greater than that of the phytoseiids in both years, with peaks either the same month or only 1 month different than those of the Phytoseiidae. On tree 1, the populations were very low the first year, with the number never above 5 per sample; however, in the second year, the population density exceeded that of the phytoseiids. The populations on all 3 trees dropped to low levels by November both years, and in 1973, the number of mites remained low until approximately May.

Pinus coulteri D. Don

Phytophagous mites

Tetranychidae.—The spider mites peaked at about 400 mites per 15 terminals on trees 1 and 3 in 1972 (Fig. 2). Tree 2 reached its highest point a month earlier and at a lower level. Populations dropped rapidly on both trees 1 and 3 after the peak, and by December were below 5 mites per sample. Numbers on tree 2 did not decline to this level until February of 1973. Mite numbers on all 3 trees were lower the second year, and the peaks occurred later in the season, in September or October.

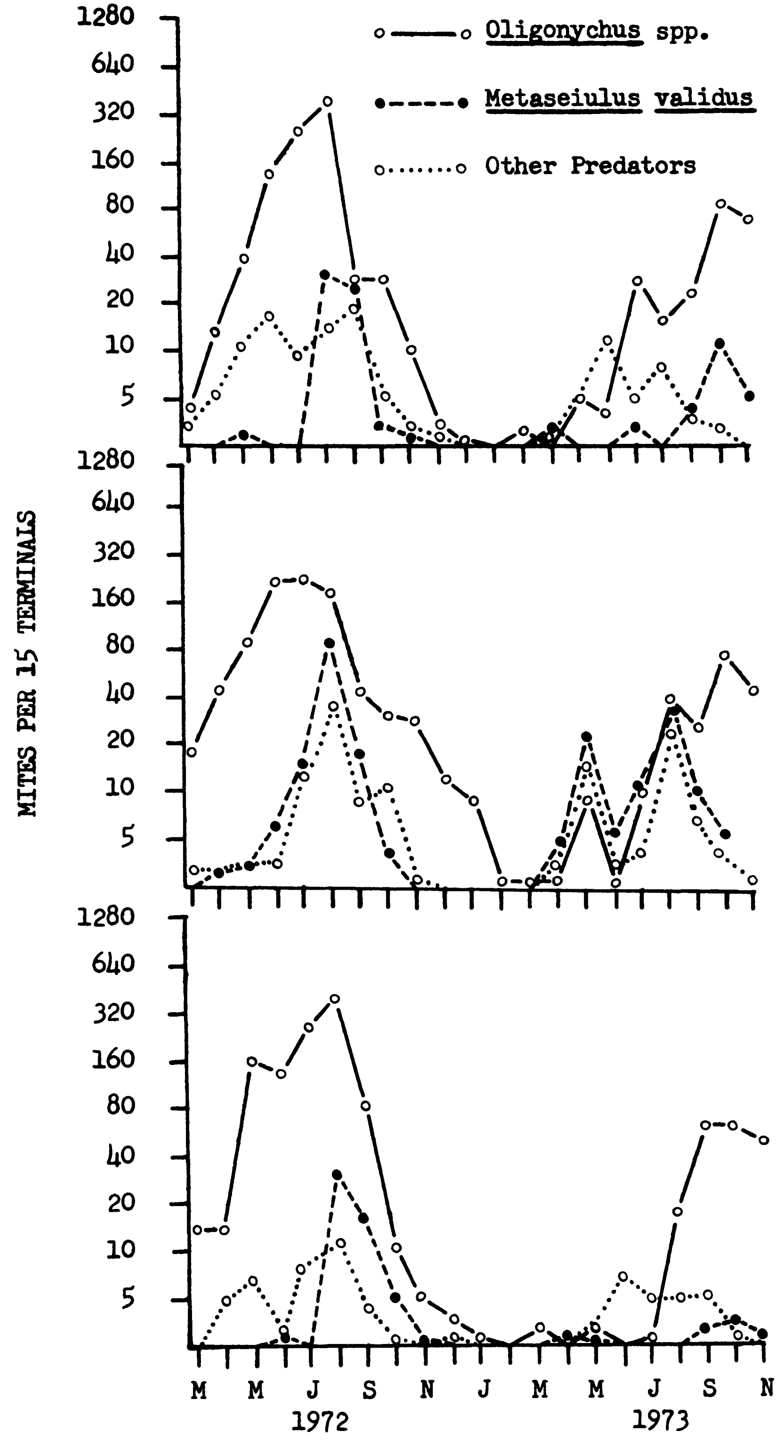

Fig. 2. Population fluctuations of phytophagous and predaceous mites on three trees of *Pinus coulteri* at Forest Falls, California. Above, tree one; center, tree two; below, tree three.

TABLE 3

NUMBERS OF *OLIGONYCHUS* RECOVERED ON *PINUS COULTERI* NEEDLES DURING A FIELD STUDY AT FOREST FALLS, CALIFORNIA (TOTAL OF MALES AND FEMALES)

Date	*O. milleri* on Tree no. 1	2	3	Total	*O. cunliffei* on Tree no. 1	2	3	Total	*O. subnudus* on Tree no. 1	2	3	Total
1972												
March	–	1	–	1	3	6	9	18	1	9	4	14
April	1	2	1	4	5	13	5	23	–	10	2	12
May	–	11	5	16	37	8	40	85	1	61	96	158
June	4	7	3	14	79	30	50	159	5	125	33	163
July	4	15	4	23	209	70	145	424	1	92	43	136
Aug	8	16	8	32	256	64	144	464	12	68	64	144
Sept	3	1	5	9	19	14	41	74	3	15	17	35
Oct	2	–	2	4	20	–	6	26	4	10	2	16
Nov	2	2	–	4	6	15	1	22	1	11	3	15
Dec	–	–	–	–	1	1	–	2	–	7	3	10
1973												
Jan	–	–	–	–	–	–	–	–	–	5	–	5
Feb	–	–	–	–	–	–	–	–	–	1	–	1
March	1	–	–	1	–	–	–	–	1	1	1	3
April	–	–	–	–	–	–	–	–	–	1	–	1
May	2	–	–	2	2	3	2	7	1	6	–	7
Totals	27	55	28	110	637	224	443	1304	30	422	268	720

Species of Tetranychids recovered (Table 3).—Three species of spider mites were collected during the first 15 months. *Oligonychus cunliffei* was the most common, with *O. subnudus* about half as frequent, and *O. milleri* least collected, but there were differences among trees. Tree 2 had more *O. subnudus* than did *O. cunliffei,* but tree 3 was just the opposite. During different times of the year, shifts in the species' composition were noted. In May, 1972, tree 3 had more *O. subnudus* than did *O. cunliffei;* but by July, the pattern had reversed. Tree 1 was different from the other trees in that the *O. cunliffei* population was over 20× that of the other 2 species.

Predaceous mites

Phytoseiidae. — *Metaseiulus validus* had a similar increase in numbers to rising tetranychid numbers on all 3 trees, with the peaks in August of the first year (Fig. 2). Peak numbers on tree 2 were about 2× higher than on the other trees, reaching about 90 mites per 15 terminals. On all trees, the populations started declining after the spider mites began to decline, and by November, 1972, were at about 1 mite per sample. In the next year, populations of these predaceous mites were lower on all trees, especially tree 3. This possibly was because the populations of the host spider mites were also lower in the second year. However, again in the second year, the phytoseiids did show a response to spider mite numbers, and in both trees 1 and 3, the peaks coincided with those of the spider mites.

Others.—This category includes the following families of mites: Cheyletidae, Bdellidae, Anystidae, Neophyllobiidae, Raphignathidae, Caligonellidae, Scutacaridae, and Erythraeidae. The most common predator recovered was the cheyletid, *Cheletogenes ornatus* (Canestrini and Fanzago).

Mites in these families of predators also showed an increase in numbers in response to an increase in number of spider mites on all 3 trees in 1972 (Fig. 2). Populations on trees 1 and 3 started increasing earlier than on tree 2, but the reverse was the case the next year.

These predators responded earlier than the phytoseiids on trees 1 and 3 in both years, but the curves of both the phytoseiids and other predators were extremely close together on tree 2. Numbers were generally low from November, 1972, to at least April of the following year.

Pinus lambertiana Douglas

Phytophagous mites

Tetranychidae.—The spider mites on these 3 trees were all *Oligonychus ununguis*. The levels were much lower on this species of pine, compared to the other pine species, never exceeding 150 mites per 15 terminals (Fig. 3). On all 3 trees, the peaks occurred at approximately the same time each year, in contrast to the coulter (Fig. 2) and ponderosa (Fig. 1) pines in which the peaks occurred later in the second year. In both trees 2 and 3, the peaks were higher the second year (Fig. 3), which was the opposite of the other 2 pine species (Fig. 1, Fig. 2). There was only a single peak in 1973, whereas in the previous year there were as many as 3 distinct peaks on all 3 trees. However, since the numbers in all cases were very small, this could have been due to sampling variation. Populations of spider mites remained at low levels from about December, 1972, to about May of the next year.

Predaceous mites

Phytoseiidae.—Phytoseiids were recovered only on tree 1, and the numbers were very low both years, never exceeding 5 per 15 terminals (Fig. 3). The mites did peak at the same time as the spider mites, in October, 1972, and 1973. By November of both years, they had dropped to 1 or less per sample. In 1972, phytoseiids were collected for only 3 months; but in 1973, they were recovered from monthly samples for 6 consecutive months.

Overwintering Habitats

No mites were recovered from the cones of *Pinus ponderosa* that were washed in the same manner as the foliage samples. The results of the bark collections are shown in Table 4. No tetranychids were collected. These species probably overwinter as eggs on the branches, as is the case for the closely related *O. ununguis* (Johnson, 1958). Closer examination of the pine branches needs to be done. All the species of phytoseiids recovered were different from those collected from the foliage during this field study. According to MacPhee (1964), arthropods in orchards overwinter in either the tree, the organic material on the ground, or in the soil. Putman (1958) found phytoseiids in fungal cankers, insect cocoons, the bodies of dead insects, and under old *Lecanium* scales. Therefore, it is likely that much more searching of the trunk and other habitats will be necessary before the overwintering habitats of the phytoseiids from the pine foliage can be determined.

The phytoseiids collected may have been overwintering fauna from the litter under the trees, or from other nearby plants, or possibly were permanent residents under the bark. Of the phytoseiid species recovered, *Metaseiulus occidentalis* has perhaps the widest host range, *Amblyseius aurescens* next, and *Typhloseiopsis citri* the most restricted. *Metaseiulus occidentalis* was recorded from 16 genera of trees and other plants by Schuster and Pritchard (1963), including species of *Quercus* and various herbaceous plants which do occur in the area. It is therefore possible that the mites could have come from other plants in the surrounding area. *Amblyseius aurescens* has been collected from the foliage of 7 different genera of plants in California, and from the

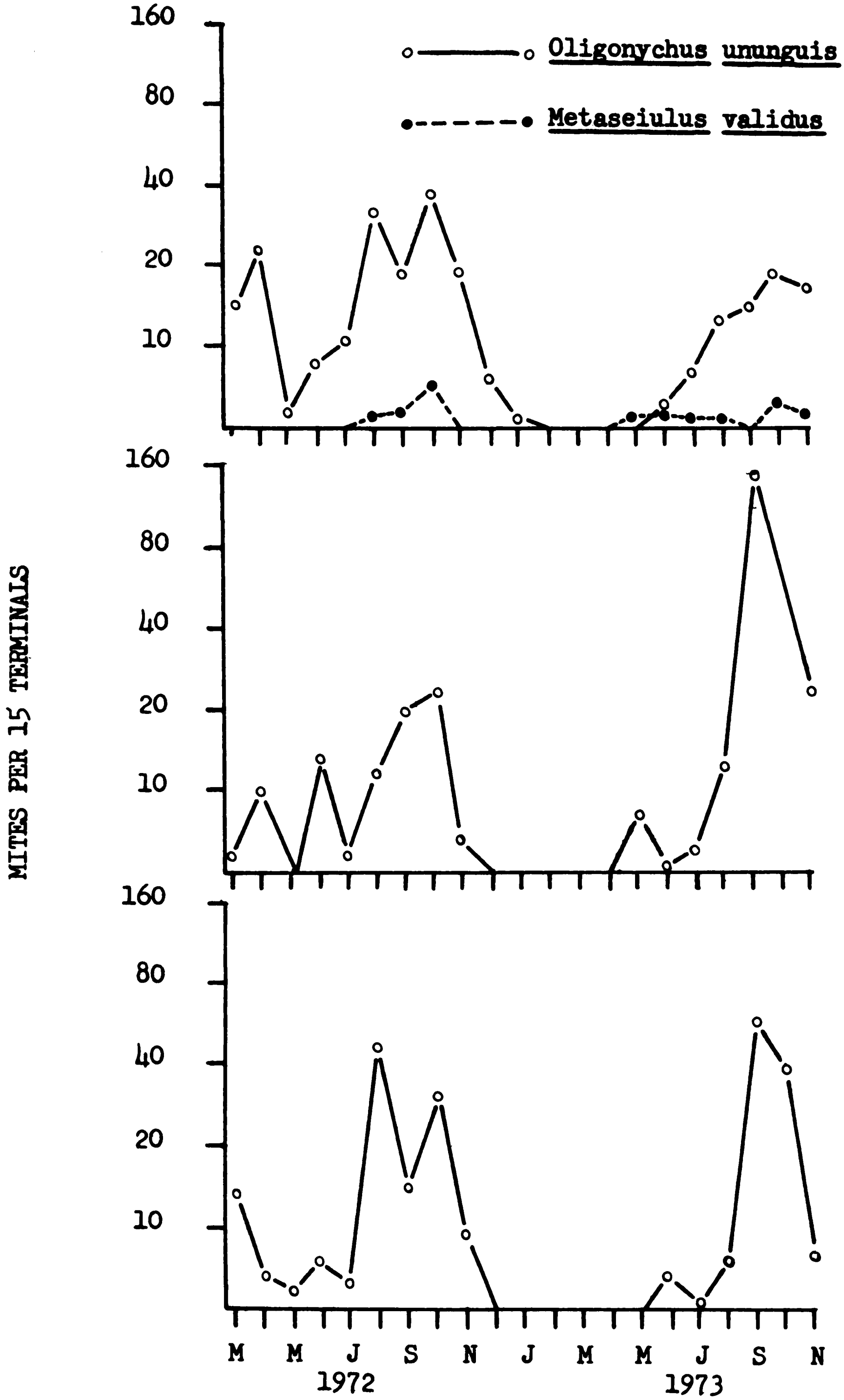

Fig. 3. Population fluctuations of phytophagous and predaceous mites on three trees of *Pinus lambertiana* at Forest Falls, California. Above, tree one; center, tree two; below, tree three.

TABLE 4

PHYTOSEIIDS COLLECTED ON THE BARK OF THREE SPECIES OF PINES AT FOREST FALLS, CALIFORNIA

Date of sample	Pine species	Phytoseiid species recovered*
November, 1972	*Pinus coulteri*, *P. lambertiana*, and *P. ponderosa*	none recovered
January, 1973	*P. ponderosa*	*Metaseiulus occidentalis* (3 females) *Typhloseiopsis citri* (3 females)
January, 1973	*P. lambertiana*	*Amblyseius aurescens* (1 female)
March, 1973	*P. coulteri*	*T. citri* (2 females) *M. occidentalis* (2 females)

* Determined by Dr. E. E. Lindquist, Biosystematic Research Institute, Ottawa, Ontario, from Berlese funnel sample.

litter of 5 others (Schuster and Pritchard, 1963). This included the litter of cypress, a conifer; so they could be inhabitants of the litter of these conifers as well. During the survey portion of this study (Part I), specimens of *T. citri* were collected from pine foliage, but during the period of sampling when slides were made, no mites of this species were collected. Thus, either it was present on other conifers in the area, or merely was not recovered.

DISCUSSION

It was evident that there was considerable variation in mite populations among the 3 species of pines studied—the greater diversity of families in the coulter pines, the presence of large populations of tenuipalpids on the ponderosa pines (Fig. 1), the low number of predators on the sugar pines (Fig. 3), and the presence of only 1 species of tetranychid on the sugar pines (Fig. 3). Even between-tree differences were notable.

The proportion of spider mite species varied between the ponderosa and coulter pines (Tables 2 and 3). *Oligonychus cunliffei* was twice as abundant on the coulter pines, compared to *O. subnudus;* but on the ponderosa pines, *O. subnudus* was 3× more abundant than *O. cunliffei*. In both pine species, *O. milleri* ranked third in numbers recovered. *Oligonychus ununguis* occurred in significant numbers only on the sugar pines, and was the only species of tetranychid recovered from this pine during the period of sampling.

The presence of relatively high populations of tenuipalpids on *Pinus ponderosa* at most times during the season may have influenced the densities of the predator populations. In the second year, both the phytoseiids and the other groups of predators increased earlier in the season, before the tetranychids, on all 3 trees. This early buildup may have been induced by the presence of tenuipalpids as an alternate food source. Pine pollen was generally present in early spring, and pollen has been suggested as an alternate food source for certain species of phytoseiids (McMurtry et al., 1970). It has been shown that alternate hosts enable predators to survive periods of low host density, and to maintain better dispersion patterns in the ecosystem (Flaherty, 1969; Flaherty and Huffaker, 1970).

Data from all 9 sample trees indicated that populations of all species tended to peak later the second year. A possible reason for this shift can be noted in the weather data (Table 1). A comparison of the precipitation totals for the first 4 months of the year in 1972 and 1973 reveals a large amount of snowfall in 1973, but less than 2.5 cm in the previous year for the same period. Also, there was a delayed increase in the maximum temperatures in 1973 as compared to 1972 (Table 1). This information may indicate a later and more severe winter in the second year, which could account for the later peak of populations of mites that season.

It is probable that the phytoseiids and tetranychids have a winter diapause. The populations of predators, including the phytoseiids, declined to low levels by November of both years of the study, and did not appear in the samples again until March or later. In 1973, they declined before the spider mites had declined. This fact indicates the possible occurrence of a diapause induced by photoperiod.

Although there is a positive correlation between decline in the number of spider mites and increase in phytoseiids, a cause and effect relationship cannot be proved because of a complex of variables associated with increases or declines in mite numbers. As discussed by Huffaker et al. (1970), they include the intrinsic features of the mite itself (food requirements, developmental times, fecundity rates, movements), meteorological effects, the host plant, and the action of natural enemies. Fleschner (1958) also demonstrated the effects of the genetics of the host plant and the nature of the soil. Koehler and Frankie (1968) concluded that on ornamental plantings of *Pinus radiata,* the natural enemies were ineffective in controlling populations of *Oligonychus subnudus* to any appreciable degree. However, unlike in our study, their graphs indicated little if any response by the predators to increase in mite numbers.

Some authors (van den Bosch and Messenger, 1973; DeBach, 1974) have emphasized the need to evaluate the effectiveness of natural enemies by the exclusion or check method. Although there are dangers inherent in some of these methods (insecticidal check may not only destroy the mite predators, but may also act to stimulate the reproduction of the spider mites [Huffaker et al., 1970]), only by removing the natural enemies and monitoring the populations of the pest, and comparing them with control populations, can the effectiveness of the natural enemy be verified.

Paired comparisons with and without the predators are not possible with full-grown pine trees; therefore, only indirect evidence is available. One fact indicating control of tetranychid populations by predation is that the spider mites never reached high numbers. Even at the point of highest populations of these mites, the pine needles showed little feeding damage, indicating that food was not a limiting factor. As weather was still favorable, the populations could have continued to rise. The highest number of tetranychids on the coulter pines was 404 mites per sample on tree 3, and this represents only about 27 mites per terminal. Multiplying the number of needle fascicles ×3 needles per fascicle for this species only results in 1 mite for every 12 needles. This may be an oversimplification, and laboratory tests would be needed to determine what the food requirements are for the tetranychid species, but it serves to illustrate that much higher populations were possible.

Personal observations indicated that the phytoseiids tend to congregate in the same areas (at the base of needle fascicles on the shoot) as the spider mites. This is also where the mite eggs are laid. Fleschner (1950) and Putman (1955, 1962) concluded that predators of mites located their prey only by contact. Therefore, if the predator is in the same area as the prey, the chances of contact are increased; and more effective predation should result. This information, along with the fact that the phytoseiids and other predators respond numerically to spider mite increases, indicates that phytoseiids, and possibly other predators such as the Cheyletidae, may be important in the natural control of the tetranychids, and in holding them at endemic levels in the forest ecosystem.

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(Continued from inside front cover)
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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