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OVERWINTERING PHYTOSEIID MITES IN CENTRAL UTAH APPLE ORCHARDS[1]

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Predaceous typhlodromids[3] have been observed overwintering as adult females in fruit trees of northern temperate regions, but specific studies have been rather limited and no taxonomic or ecologic studies have been reported from Utah. Gilliatt (1935) and Garman and Townsend (1938) suggested that some adult phytoseiids overwintered under the bark of trees while others may seek shelter on the ground. Gilliatt (1935) further reported that adult *Seiulus pomi* Parrott (since divided into a number of *Typhlodromus* spp.) overwintered on twigs in Nova Scotia, concealed in such places as under rough bark, in old bud moth hibernacula, and in deserted oystershell scales (*Lepidosaphes ulmi* Linn.). Herbert (1953) found females of several species overwintering under bark scales of tree trunks and larger branches, in the empty hibernacula of eye-spotted bud moths (*Spilonota ocellana* D. and S.), in empty oystershell scales, and in empty codling moth (*Carpocapsa pomonella* Linn.) cocoons. Chant (1959) found *Typhlodromus bakeri* (Garman) overwintering in deep crevices around scars and wounds and in the splintered ends of dying twigs. Burrell and McCormick (1964) reported three species (*Typhlodromus longipilus* Nesbitt, *Typhlodromus rhenanus* (Oudemans), and *Typhlodromus occidentalis* Nesbitt) hibernating under loose bark of lower tree trunks and in debris around the bases of trees.

In a study of the overwintering sites in Ontario peach orchards large numbers of mites (mostly *T. rhenanus*) were found in bark crevices and deep protected cracks of cankers (Putman, 1959). Some were found in the splintered ends of broken or pruned branches, but none were found in superficially rough areas of living bark on the smaller limbs. Very few were found on twigs that were free of old Lecanium scales although large numbers were taken from twigs possessing old scales.

Only one investigation of the movement of mites from leaves to overwintering sites has been reported (Chant, 1959). He found no mites on leaves that had yellowed, but reported increases in the populations of *Typhlodromus finlandicus* Oudemans, *Typhlodromus tiliae* Oudemans (= *pyri* Scheuten of Chant, 1959), and *Typhlodromus umbricatus* Chant on the green leaves and twigs. Since mites were not found in the soil and cover, he concluded that they abandon

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[3]The nomenclature proposed by Chant (1965) was adopted for this study.

the yellowing leaves and move to the branches and trunk to overwinter.

Mortality rates of overwintering phytoseiids have been investigated only incidentally. Anderson and Morgan (1958) reported high winter mortality rates for several unidentified species of phytoseiids in British Columbia. Their calculations were made by comparing mite numbers on leaves in the fall and spring, the difference being attributed to winter mortality. Using similar methods, Chant (1959) found more than 90% mortality in overwintering *T. tiliae* in England. Putman (1959) found mortality of *Amblyseius fallacis* (Garman) in Ontario peach orchards to be "very high."

The purposes of this study were to identify the species of phytoseiids overwintering as adults in central Utah orchards, to determine their overwintering sites, and estimate winter mortality rates and fall movements of *Typhlodromus mcgregori* Chant and *T. occidentalis*—both of which are abundant in Utah apple orchards (Lee and Davis, 1968).

Methods

This study was made during three consecutive winters, 1965-1968, in Utah County, Utah. Eleven derelict apple orchards (Jorgensen, 1967) located throughout Utah County were qualitatively sampled during the first winter to determine the species of mites overwintering as adults and to locate their overwintering sites. Soil, ground cover, twigs and spurs, and bark were sampled extensively from each orchard. Berlese funnels were used to isolate mites from the collected materials. Occasional samples of crotch refuse, abandoned bird nests, and mummified fruit still clinging to the trees were collected. Twig-spur and bark samples were also collected from derelict orchards of other tree fruit varieties. Frequency charts were then developed to determine the primary overwintering sites of the most prevalent phytoseiid species.

Movements of *T. mcgregori* and *T. occidentalis* from leaves to their respective overwintering sites were investigated during October and November, 1967. Two apple orchards were used; a commercial orchard in Orem, Utah for *T. occidentalis*, and a derelict orchard north of American Fork, Utah for *T. mcgregori*. Samples of 500 leaves were taken from five selected trees in each orchard once a week. Samples of leaves falling from each tree were also taken to check for mites falling to the ground with the leaves. Collections of falling leaves were made by placing a drop cloth beneath the trees and gently shaking the branches to dislodge the leaves. These data were analyzed with a *t*-test to determine whether or not the mean numbers of mites on dropping leaves were significantly smaller than the numbers found on green leaves still adhering to the trees. Incidental collections of twig-spurs and bark were also taken from the commercial orchard in Orem.

The specific location of overwintering sites was investigated during the winters of 1966 to 1968. In 1966, about 300 twigs and spurs from a derelict orchard in Mapleton, Utah were dissected to determine the specific overwintering sites of phytoseiids. Five samples of 500 twig-spurs were collected during the winters of 1966-67 and 1967-68 and each twig cut into three sections based on years of growth as shown in Fig. 1. A year's growth was defined as the distance between two sets of terminal bud scars. Surface areas for the three terminal sections were estimated from 25 arbitrarily selected twig sections from each of the samples. The data were analyzed with an analysis of variance (Ostle, 1963) to check for significant variation in the number of mites among the sections.

A study was attempted to determine the winter mortality rates of *T. mcgregori*. The orchard (102 trees) was divided into five nearly equal size blocks, and five trees randomly selected within each block. One hundred twigs were taken from each tree once each month for five months (December-April, 1967-68). The data were than analyzed with an analysis of variance (Ostle, 1963) to detect possible variations among the months.

Results

Nine species of physoseiids were found overwintering in central Utah apple orchards. *Amblyseius cucumeris* Oudemans, *T. mcgregori*, and *T. occidentalis* were the most numerous and most frequently collected, while *Typhlodromus caudiglans* Schuster, *Typhlodromus columbiensis* Chant, *A. fallacis*, *Amblyseius floridanus* (Muma), *Amblyseius ovatus* (Garman), and *Amblyseius rosellus* Chant were collected incidentally. A frequency table was developed to indicate overwintering site preferences for the three major species among the four habitats most frequently inhabited (Table 1). *Typhlodromus mcgregori* was present in all twig-spur and bark samples although in much smaller numbers on the bark. On the other hand, *T. occidentalis* was most common in bark samples and *A. cucumeris* most frequently collected from cover samples. All of the incidentally collected species were taken from cover, except that *T. caudiglans* was taken from twig-spurs and *T. columbiensis* from bark. Although *T. mcgregori* was about the only species present in derelict pear, apricot, peach, plum, cherry, and apple orchards, they were present in

Table 1. Frequency of occurrence for the three most common phytoseiids among the habitats they most frequently inhabited.

Species	Frequency[a]			
	Twig-Spur	Bark	Cover	Soil
T. mcgregori	100.0	100.0	66.7	28.6
T. occidentalis	18.2	40.0	22.2	0.0
A. cucumeris	0.0	20.0	88.9	71.4

[a]Frequency was computed as a percentage of all samples taken for each habitat.

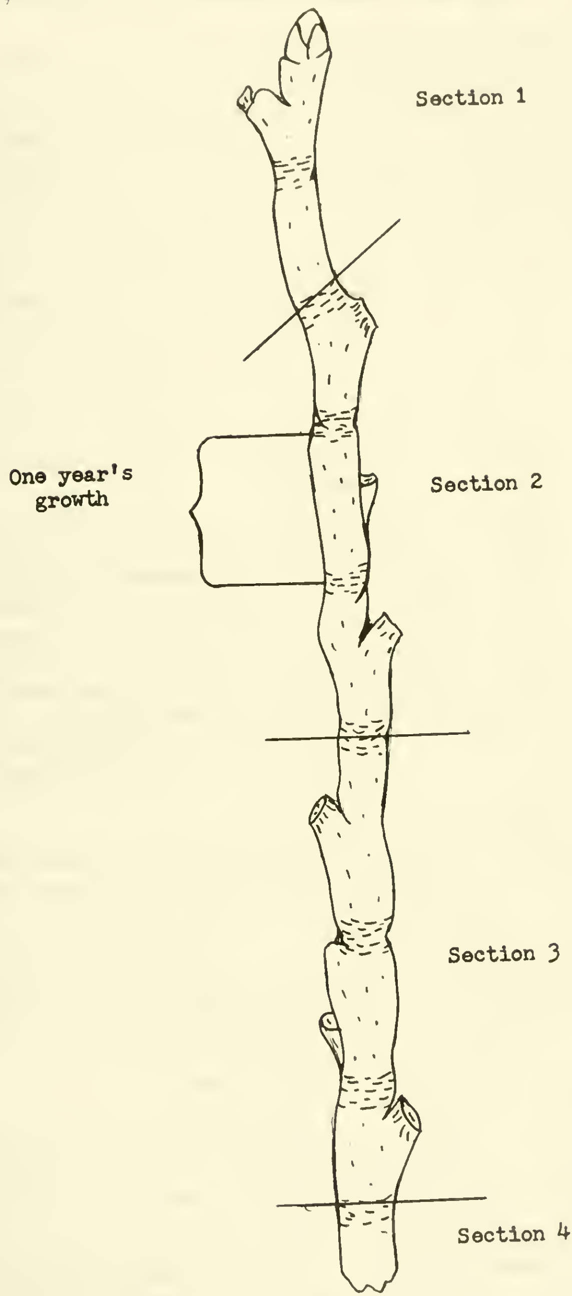

Figure 1. Division of the twig into growth sections: section 1 — terminal two years, section 2 — area 3-5 years old, section 3 — area 6-8 years old, and section 4 — area 9-15 years old.

almost all of them and were much more numerous in apple orchards than any of the other tree fruits.

The numbers of mites collected from green and falling leaves were contrasted in the fall of 1967. *Typhlodromus mcgregori* numbers on the falling leaves were not significantly smaller than those on the green leaves still adhering to the tree ($t = 1.40$, $t(21)(.95) = 2.08$). In this analysis the green leaves for October and November were pooled. A similar analysis for *T. occidentalis* resulted in the same conclusions, the numbers on the falling leaves were not significantly smaller than those on the green leaves still attached to the tree ($t = 1.40$, $t(13)(.95) = 2.16$). *Typhlodromus occidentalis* migrated from the leaves to their overwintering sites at about the same time *Tetranychus urticae* Koch migrated to the trunk and cover in 1968, and since *T. urticae* usually migrates earlier than the data were gathered for *T. occidentalis* in 1967, the few predators remaining on the leaves may have been merely incidental and not indicative of the behavior of most members in the population.

The few *T. mcgregori* observed on the twigs and spurs appeared to prefer sites beneath the corky abscission layers of the fruit stalks. The area of the twig that was 3 to 5 years old maintained the roughest portions of twigs, primarily because of the remaining corky abscision scars of former leaf petioles and fruit stalks. The twigs lost most of their corky material and became smoother after five years, reducing the available overwintering sites. The terminal two years of growth characteristically displayed dense pubescence, but few good hibernating sites. *Typhlodromus mcgregori* moved from the leaves into the abundant overwintering sites on the 3 to 5 year old portions of the twigs in the fall.

Twigs were sampled during the 1967-68 winter to test the hypothesis that *T. mcgregori* preferred the region from 3 to 5 years old for hibernating (Table 2). An analysis of variance was used to determine if there were significant differences among the three sections tabulated in Table 2 (Table 3). Since the variance was significant, the section means were tested (t-test) to find which sections had significantly higher numbers. The only ones which were determined to be significantly different were sections 1 and 3 ($t = 5.04$, $t(8)(.95) = 2.31$). It appears that the collection on February 3 in section 1 had a deciding influence on the significance tests.

Data for winter mortality rates of *T. mcgregori* were pooled each month for all five blocks, since the numbers of mites were too small to analyze the trees separately (Table 4). An analysis of variance suggested that there was no significant winter mortality within the orchard ($\alpha = .05$). If there were significant mortality of the summer populations during the winter, it would have been when they were finding their hibernacula or in the early spring after they had left there sites. When the mortality reported by Anderson and Morgan (1958), Chant (1959) and Putman (1959) occurred is yet to be determined.

Table 2. Number of *Typhlodromus mcgregori* per cm^2 in each twig section from a derelict orchard in Mapleton, Utah.

Section and Date	Mites per Section	Mites per (sq cm) Surface Area	Sample Mites per 1800 sq cm[a]
Section 1			
March 15, 1967	1800.30	1	1.00
February 3, 1968	1493.12	34	40.97
March 2, 1968	1452.84	4	4.94
March 23, 1968	1649.30	11	11.96
March 29, 1968	1776.74	9	9.09
Mean			13.59
Section 2			
March 15, 1967	2689.82	26	17.45
February 3, 1968	2648.72	39	26.53
March 2, 1968	2669.98	24	16.22
March 23, 1968	2287.74	29	22.83
March 29, 1968	2105.94	13	11.11
Mean			18.83
Section 3			
March 15, 1967	2860.44	5	2.34
February 3, 1968	2610.64	9	4.48
March 2, 1968	3754.24	10	4.78
March 23, 1968	3273.26	13	7.14
March 29, 1968	2373.26	7	5.11
Mean			4.77

[a]The number of mites in each sample is determined as the number of mites per 1800 cm^2 of twig surface area.

Table 3. Summary of the analysis of variance of the data from Table 2, based on mites per 1800 cm^2 of twig surface area.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean	Square F-Ratio
Mean	1	173.80	173.80	
Twig sections	2	10.32	5.16	3.68*
Experimental error	12	16.84	1.40	
Total	15	200.96		

*Significant at $\alpha = .05$.

Table 4. Numbers of *Typhlodromus mcgregori* collected from twigs and spurs of a derelict apple orchard near American Fork, Utah.

Month	Mites per 500 Twigs *in* each Block					
	1	2	3	4	5	Total
December	8	11	4	1	12	36
January	7	22	7	2	7	45
February	8	9	5	1	4	27
March	14	5	3	4	1	27
April	13	15	11	0	8	47

Discussion and Conclusions

Mites of the genus *Typhlodromus* have been observed overwintering as adult females in the northern temperate fruit orchards, although there is some question of the location of their overwintering sites. Different species seem to prefer different habitats: *T. mcgregori* on the twigs and bark, *T. occidentalis* on bark, and *A. cucumeris* in the cover (Table 1). These results supported the observations of Anderson and Morgan (1958), Putman (1959), and Burrell and McCormick (1964), who found that *Typhlodromus* species were generally arboreal in winter and summer while *Amblyseius* remained primarily in the ground cover. The only arboreal species found in high numbers in the cover was *T. mcgregori* and it has been found rather commonly in the cover during the summer also (Jorgensen, unpublished data). *Amblyseius cucumeris* was occasionally collected from the bark, but it was only incidental and probably not in its preferred overwintering site.

Chant (1959) found that nearly all *T. finlandicus*, *T. tiliae*, and *T. umbricatus* moved to the twigs and branches before the leaves fell in the autumn months. He reported an increase in the number of mites on green leaves as other leaves began to turn yellow, but mites were not found on yellow falling leaves or on the ground cover. The number of *T. mcgregori* on green leaves in central Utah did not increase as other leaves turned yellow, but there were many collected from falling leaves and in the ground cover. It appears that substantial numbers of *T. mcgregori* fell to the ground cover with dropping leaves, although it is likely that the data from the yellowed falling leaves would have been misrepresentative if the major mite movement to twigs and bark had occured before the sampling began.

Typhlodromus occidentalis moved from the leaves to the bark at about the same time as *T. urticae*. The lack of change in the numbers of predators on the leaves during October and November is likely due to the fact that the major movement had already occurred and only incidental specimens remained — the fate of which is probably not indicative of the population as a whole.

Putman (1959) suggested that arboreal phytoseiids are guided in seeking overwintering sites by two responses — thigmotactic and chemotactic (seeking objects of animal origin). The thigmotactic response was suggested when he found hibernating mites primarily in protected crevices; and the chemotactic when large numbers were found in strips of cardboard containing oriental fruit moth (*Grapholitha molesta* Busck) cocoons placed on the trees, as opposed to few mites in similar strips without the cocoons. The twig dissections in this study confirm Putman's (1959) findings since overwintering *T. mcgregori* were found primarily in protected crevices and spent insect egg cases. The thigmotactic response in locating overwintering sites was supported by the predominance of mites on portions of the twigs from 3 to 5 years old where crevices are more numerous. Thigmotaxis seems to be more influential than chemotaxis in the searching behavior for overwintering sites by *T. mcgregori*.

All preceeding studies on winter mortality of phytoseiids have reported rather high mortality rates. Chant (1959) and Anderson and Morgan (1958) both reported mortality rates over 90%; but since both studies were based on comparisons of fall and spring mite populations on green leaves, an error could have been introduced if a large number of mites fall to the ground with the autumn leaf drop and do not move back onto the tree in the spring. Chant (1959) reported that almost all of the mites left the leaves before they began to fall, so the reported high mortality was likely, but a more precise measurement is possible by periodically sampling the overwintering population. *Typhlodromus mcgregori* did not appear to suffer any winter mortality between December and April, thus whatever mortality occurred must have been before December or after April, and these two periods may result in mortality as severe as those reported by Chant (1959) and Anderson and Morgan (1958).

If predaceous mites are to be considered for use in integrated control of phytophagous mites, their overwintering sites and mortality rates must be known. Their usefulness is determined, in part, if high spring populations can be provided to counteract an early spring build-up of the pest species. By knowing the principal overwintering sites a grower could manage his trees to provide abundant sites for the predators and direct pesticide treatments to avoid them. Gilliatt (1935) and Chant (1959) reported that dormant sprays reduced phytoseiid populations in addtion to the eggs of phytophagous species. Since most of the *T. mcgregori* overwinter on the twigs, they are extremely vulnerable to dormant sprays. On the other hand, *T. occidentalis*, which overwinter primarily in bark of the trunk and scaffold limbs, is less vulnerable since the deeper bark crevices provide better protection from pesticides. This is supported by the fact that *T. mcgregori* is seldom found in commercial orchards of central Utah (Duke, Croft, and Jorgensen; 1968) where *T. occidentalis* is frequently abundant. Based on these observations, it appears that *T. mcgregori* would be difficult to manage in an integrated control program since it is vulnerable to dormant sprays, which are usually an integral part of an integrated control program in tree fruit orchards. The overwintering habits of *T. occidentalis* make it a more promising predator in integrated orchards.

Literature Cited

Anderson, N. H. and C. V. G. Morgan. 1958. The role of *Typhlodromus* spp. (Acarina: Phytoseiidae) in British Columbia apple orchards. Proc. Internatl. Cong. Entomol. 10:659-663.

Burrell, R. W. and W. J. McCormick. 1964. *Typhlodromus* and *Amblyseius* (Acarina: Phytoseiidae) as predators on orchard mites. Ann. Entomol. Soc. Amer. 57:483-487.

Chant, D. A. 1959. Phytoseiid mites (Acarina: Phytoseiidae) Part I. Bionomics of seven species in southeastern England. Part II. A taxonomic review of the family Phytoseiidae. with descriptions of 38 new species. Can. Entomol. 91, Suppl. 12. 64 pp.

———. 1965. Genetic concepts in the family Phytoseiidae (Acarina: Mesostigmata). Can. Entomol. 97:351-374.

Duke, D. M., B. A. Croft, and C. D. Jorgensen. 1969. Distribution and searching behavior of *Typhlodromus mcgregori* Chant (Acarina: Phytoseiidae). Unpublished manuscript.

Garman, P. and S. F. Townsend. 1938. The European red mite and its control. Bull. Conn. Agric. Expt. Sta. 418. 34 pp.

Gilliatt, F. C. 1935. Some predators of the European red mite, *Paratetranychus pilosus* C. & F., in Nova Scotia. Can. J. Res. 13:19-38.

Herbert, H. J. 1953. Progress report on predaceous mite investigations in Nova Scotia (Acarina: Phytoseiidae). Rep. Entomol. Soc. Ontario. 1952:27-29.

Jorgensen, C. D. 1967. Ecology of Utah apple mites: A statement of the problem. Proc. Utah Acad. of Sci., Arts, and Letters. 44:265-274.

Lee, M. S. and D. W. Davis. 1968. Life history and behavior of the predatory mite *Typhlodromus occidentalis* in Utah. Ann. Entomol. Soc. Amer. 61: 251-155.

Ostle, B. 1963. Statistics in research. 2nd Ed. Iowa State Univ. Press. Ames. 585 pp.

Putman, W. L. 1959. Hibernation sites of Phytoseiids (Acarina: Phytoseiidae) in Ontario peach orchards. Can. Entomol. 91:735-741.