OCCURRENCE OF PHYTOSEIID MITES (*ACARINA: PHYTOSEIIDAE*) IN APPLE ORCHARDS IN SOUTH CENTRAL BRITISH COLUMBIA

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ABSTRACT

Sprayed and nonsprayed apple trees in the interior of British Columbia were sampled from 1967-70 for mites belonging to the family Phytoseiidae. **Typhlodromus occidentalis** Nesbitt and **T. columbiensis** Chant were the only species commonly found in sprayed orchards. **T. occidentalis** was more abundant. In nonsprayed orchards, **T. caudiglans** Schuster was practically the only phytoseiid found in the Okanagan and Similkameen valleys whereas it and **Phytoseius macropilis** (Banks) were the most common mites found in samples from higher rainfall districts bordering the Shuswap and Arrow Lakes. **T. pyri** Scheuten was less widely distributed than the above mites but was found in large numbers on nonsprayed trees in the Shuswap area and at Summerland in a dwarf apple orchard that is irrigated by overhead sprinklers. Five other species of phytoseiids were found but in very small numbers.

INTRODUCTION

During the past 2 or 3 years, predaceous mites belonging to the family Phytoseiidae have become important to the British Columbia fruit industry. These mites have controlled some species of phytophagous mites better and much more cheaply than acaricides. In 1968, a publication (Downing and Arrand 1968) outlining the procedures of integrated control including information on habits, recognition and conservation of phytoseiids, was made available to orchardists. Since then many British Columbia fruitgrowers, with the help of the provincial Department of Agriculture, have become familiar with the use of predaceous mites in apple pest control programs. During this time the population density of the phytoseiids increased to such an extent that many growers were able to omit most acaricidal sprays that were usually required.

Other apple growing areas of the world are having similar success with phytoseiid mites but often different species are involved. For example, in Missouri apple orchards, *Neoseiulus (=Amblyseius) fallacis* (Garman) and *Galendromus (=Typhlodromus) longipilis* (Nesbitt) according to Poe and Enns (1969) are the most important phytoseiids. *Typhlodromus occidentalis* Nesbitt (Hoyt 1969) is the predominant species in the State of Washington U.S.A. whereas in England *Typhlodromus pyri* Scheuten (Collyer 1964) is the most important phytoseiid.

Anderson *et al.* (1958) listed a total of 28 species of phytoseiids in British Columbia. Fourteen were found in orchards but only 3 occurred in relatively large numbers: *Typhlodromus occidentalis* Nesbitt, *T. caudiglans* Schuster (referred to as *T. rhenanus* by Anderson *et al.*) and *Phytoseius macropilis* (Banks). At this time, phytoseiid mites could not survive in sprayed orchards. Consequently their numbers were not sufficient to suppress populations of phytophagous mites. Now the situation has changed. This report describes the current status of phytoseiids in apple orchards in south central British Columbia.

METHODS

Most of the collections of phytoseiid mites were made from 1967-1970 in the dry Okanagan and Similkameen valleys (18-36 cm. annual precipitation) where the majority of apple orchards in British Columbia are located. Collections were also taken from locations with higher rainfall (50-100 cm. annual precipitation) such as the fruit growing areas near Shuswap, Arrow and Christina lakes. Samples were usually collected during the growing season when the majority of phytoseiids were on the leaves. When collections were made during the winter, spring or fall, overwintering sites such as twigs, bark, and sometimes duff at the base of the trees were sampled. Leaf samples were processed by the method of Henderson and McBurnie (1943) as modified by Morgan *et al.* (1955. Pieces of twig and bark were examined for mites under a binocular microscope. The duff samples were processed in a Berlese funnel using a glass plate collector. The perimeter of the plate was treated with a sticky substance to prevent the mites from escaping. Identification of the phytoseiid mites listed in this report was based on the generic concepts and keys of Chant (1957, 1959, 1965).

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RESULTS AND DISCUSSIONS

Major Species

Five species of phytoseiids were generally the most abundant in the collections and under certain conditions could play a prominent part in the control of phytophagous mites.

Typhlodromus occidentalis Nesbitt. At present this is without doubt the most important predaceous phytoseiid in sprayed orchards. In Okanagan and Similkameen apple orchards where spray programs have been adjusted to allow its maximum survival, this predator has been the main factor in control of McDaniel spider mite, *Tetranychus mcdanieli* McG., which was previously the most feared of all phytophagous mites. *T. occidentalis* is not so effective against the European red mite, *Panonychus ulmi* (koch). However, if oil is applied to apple trees at the half-inch green bud stage to kill most of the red mite winter eggs, *T. occidentalis* will usually hold the surviving mites under control so that a summer acaricide is seldom necessary. This predator also feeds on and suppresses population growth of the apple rust mite, *Aculus schlechtendali* (Nalepa). However, the apple rust mite is an excellent alternate food source for *T. occidentalis* as it is present during late May and early June when the other two phytophagous mites are scarce.

T. occidentalis was found in all areas sampled except those with a very high rainfall. It was found in extremely small numbers in nonsprayed orchards presumably because of competition from other predators including different species of phytoseiids and its inability to survive on foods such as pollen (Laing 1959), when animal prey is not available. This species survives in sprayed orchards because it has developed strains with a high degree of tolerance to organic phosphate insecticides, such as azinphosmethyl, that are used for control of the codling moth, *Laspeyresia pomonella* (L).

The overwintering habits of *T. occidentalis* play a significant role in its survival. If its preferred prey, the McDaniel spider mite is present and wintering on the trunks of apple trees, *T. occidentalis* will also winter there and probably be protected from freezing by snow cover. If, on the other hand, the European red mite is the main prey, then *T. occidentalis* will spend the winter in the aerial parts of the tree on twigs etc. near red mite winter eggs. These locations offer little or no protection from cold weather. This was well demonstrated after the winter of 1968-69 when temperatures in the Okanagan Valley dropped to -25° C or lower. *T. occidentalis* suffered almost complete mortality where it wintered in the aerial parts whereas it survived with little mortality where it wintered on the trunks.

In apple orchards where integrated control is practised, European red mite and apple rust mite are generally present whereas the McDaniel spider mite is not. This is because *T. occidentalis* is highly efficient as a predator of the McDaniel spider mite but much less effective against the other two mites. In such orchards *T. occidentalis* therefore winters mainly in the aerial parts of the tree and consequently is subject to periodic kills by cold winters.

T. caudiglans Schuster is the most abundant and often the only phytoseiid in nonsprayed orchards in the Okanagan, Similkameen and Arrow Lake regions. It has been collected from all the areas sampled including the high rainfall area of Seymour Arm on Shuswap Lake.

T. caudiglans is much more tolerant of cold than *T. occidentalis*. Where the two mites wintered together in the aerial parts of apple trees during periods of -25° to -35° C there was almost 100% survival of *T. caudiglans* but almost 100% mortality of *T. occidentalis*. Live *T. caudiglans* were also collected from the North Thompson area after a winter during which a temperature of -43° C was recorded. This species, unlike *T. occidentalis*, survives during periods of low prey density because it is able to feed on pollen (Putman 1962). Probably the greatest weakness of this predator is its inability to survive the pesticides used in orchards. Unlike *T. occidentalis*, it is very susceptible to the organic phosphate insecticides that are used for codling moth control.

T. columbiensis Chant. Chant (1959) described this species from a specimen he collected in 1956 from wild cherry at Hedley, B.C. in the Similkameen Valley. Since then *T. columbiensis* has been found in most areas of the Okanagan and Similkameen valleys. It is present but less common in the Shuswap and Arrow lake districts. Very few specimens have appeared in samples from non-sprayed orchards. After the extremely cold winter of 1968-69 which severely reduced populations of *T. occidentalis*, large populations of *T. columbiensis* were found in some orchards. In some instances they comprised close to 50% of the phytoseiid population. However, in 1970 when *T. occidentalis* had recovered from the cold winter and was at a high population density, *T. columbiensis* accounted for only about 3% of the phytoseiids in those orchards. The apparent competition from *T. occidentalis* may explain the rise and fall of *T. columbiensis* populations. However, because this rise of *T. columbiensis* took place in sprayed orchards there is good reason to suspect that organophosphate resistant strains of this mite may be developing. Resistant strains would assist integrated control.

Laing (1969) and Lee and David (1968) showed

that *T. occidentalis* does not feed on pollen, leaves, or fungus spores as alternate food sources when prey mites are not available. Our experiments showed that *T. columbiensis* is able to survive and lay eggs when fed a diet of pollen and therefore should be able to survive during the early part of the growing season when numbers of prey mites are low.

Phytoseius macropilus (Banks). This was the most common phytoseiid collected in the Shuswap region where the annual precipitation is 50-65 cm. It was also found in the Arrow Lake district. It has not been taken in samples from sprayed orchards or from any orchard in the Okanagan or Similkameen valleys except from a nonsprayed orchard west of and 500 m. above Oliver.

T. pyri Scheuten. *T. pyri* is probably the best known and has the greatest world wide distribution of all members of the family Phytoseiidae. However, its distribution in the interior of British Columbia is very limited. It has been taken from nonsprayed apple trees near Christina Lake and in the Shuswap region, particularly around Sicamous and Mara Lake where it was the main species present. It, along with *T. caudiglans*, is the main mite predator in a dwarf apple orchard that is irrigated by overhead sprinklers at the Summerland Research Station. Perhaps overhead sprinkling is creating conditions similar to those in high rainfall areas where *T. pyri* is more common. If so, this predator may become more widespread, as overhead sprinkling becomes more widely practised. According to Collyer (1964), and from observations here, *T. pyri* is an effective predator. It could be very useful for control of phytophagous mites in British Columbia apple orchards if organic phosphate resistant strains of the mite could be developed.

Minor Species

The following five phytoseiids were found only in certain collections and in very limited numbers and do not appear very promising as predators in apple orchards.

T. soleiger (Ribaga) has been found only in nonsprayed orchards at Silverton, Christina Lake and at a high elevation (800 m.) in the Okanagan Valley.

T. arboreus Chant is very similar in appearance to *T. columbiensis* but has been found only once in a sample from a semi-neglected apple orchard in Summerland.

T. smithi Schuster was found on twigs from a nonsprayed apple tree near Vavenby.

Amblyseius cucumeris Oudemans is usually found on low growing plants including grape vines but was taken once from a leaf sample of apple trees in Kelowna.

A. fallacis (Garman) is one of the most important phytoseiids in the eastern United States and is able to survive in sprayed orchards in Missouri (Poe and Enns 1969). It is comparatively scarce in apple orchards of the interior of British Columbia but a few have been taken from semi-neglected apple trees in Summerland.

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THE PSYLLIDAE OF BRITISH COLUMBIA WITH A KEY TO SPECIES

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ABSTRACT

A list is presented of the 38 plant-lice or Psyllidae recorded from British Columbia. Keys to the species are given with locality records, together with an additional 28 species recorded from adjacent areas of Alberta, Washington and Alaska. The keys are adapted from those given in monographs by Crawford (1914), Caldwell (1938a) and Tuthill (1943) with the addition of ten species not included in their keys.

INTRODUCTION

The Psyllidae (=Chermidae) of British Columbia have been neglected as a group and no comprehensive check-list has been published since Downes' (1927) list which consisted of eight species only. Two monographs on the group for the whole of North America have been produced, namely those of Crawford (1914) and Tuthill (1943), but the latter work covered the sub-families Triozinae and Psyllinae only. Other writers, notably Klyver (1932b), Caldwell (1936, 1937, 1940), Strickland (1938, 1939) and Jensen (1956), have described species and published records of the occurrence of psyllids from British Columbia and adjacent areas and the list of Hemiptera of North America by Van Duzee (1917) also contains some records for the region. The list given below is based upon these works and upon the collection of the late W. Downes preserved in the Spencer Entomological Museum of the University of British Columbia and brought to my attention by Dr. G. G. E. Scudder.

CHECK-LIST OF THE PSYLLIDAE RECORDED FROM BRITISH COLUMBIA

In this list the nomenclature follows Crawford (1914) and Tuthill (1943) and, therefore, conflicts to some extent with that of Caldwell (1938a). I base this choice on what appears to be the most common modern usage both in North America and among European workers (eg. Kloet and Hincks, 1964). The reference following the author and date of each species gives the source of my record which is a published work except when drawn from the Downes' collection ('Downes coll.') or from the notes of Downes preserved with the collection ('Downes notes'). I have given the oldest reference I could find in each case although I do not claim that these are the earliest records of the occurrence of each species in the province.

Subfamily:	LIVIINAE	
Genus:	*Livia* Latreille	
Species:	*caricis* Crawford 1914	Crawford 1914
Genus:	*Aphalara* Förster	
Species:	[2]*calthae* (Linnaeus 1861)	Downes coll.
	rumicis Mally 1894	Klyver 1932b
	angustipennis Crawford 1911	Downes 1927
	veaziei Patch 1911	Downes coll.
	nebulosa kincaidi Ashmead 1910	Klyver 1932b
	vancouverensis Klyver 1932	Klyver 1932b
	[2]*persicaria* Caldwell 1937	Waddell 1952

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[2] **Calthae** is not accepted by Caldwell (1937) as a North American species and he has described several further species including **persicaria** from North American material previously ascribable to **calthae** (see keys and notes below).