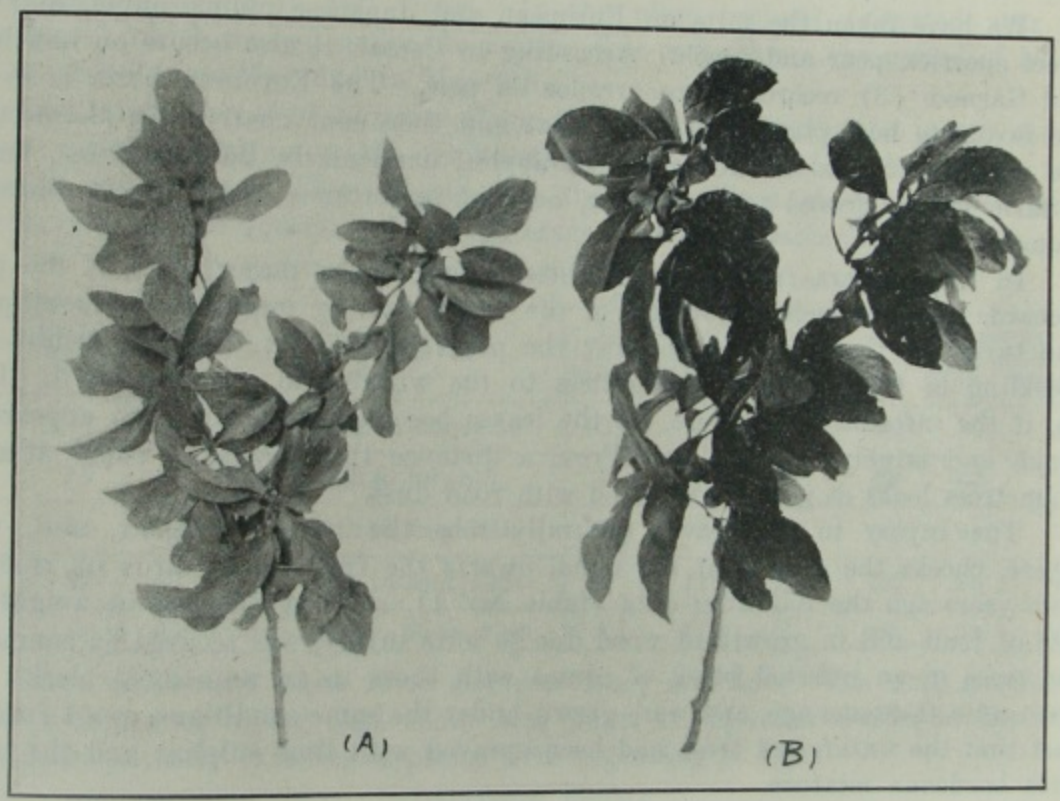
first generation of flies oviposited. On this information we laid down the following plan which has been followed now for three years on commercial plantations of from eight to ten acres and results have been checked against the poisoned bait experiments. At the time the seed is being sown in the main plantation or following the seeding operations, plant a row of cull onions, held over from the previous year's crop, every 100 feet through the plantation, setting them about four inches deep and about six inches apart in the row. Allow these culls to sprout and grow so that when the seedlings are an inch high, the volunteer growth is 6 to 8 inches. Pull up and burn these volunteers about June 15th or at the time when the greatest number of first generation larvæ are present in them and before pupation occurs.

Time and space does not allow us to present the data covering this "trap crop" method of control or the records on the poisoned bait measure as obtained at Vernon, B.C., but we hope at some later time to do so.



(A) Showing pallid, sickly appearance of mite-injured plum foliage;
(B) Normal plum foliage. (Reduced)

NOTES ON THE PLUM SPIDER MITE OR EUROPEAN RED MITE.

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The following paper on the Plum Spider Mite is largely based on orchard observations made from 1914 to 1921, and on life history studies conducted during 1921 by the junior writer.

History and Distribution.

The Plum Spider Mite or European Red Mite (*Paratetranychus pilosus* Can. and Fanz.) is an European species which doubtless was introduced into Canada on imported nursery stock. It was first noticed in Ontario in 1912 by Caesar (1),

and this appears to be the earliest record of its appearance in North America. Since then, it has been reported from Pennsylvania and Connecticut (2) and last summer (1921) specimens of the mite were forwarded to us from Vernon, B.C.

The spider mite occurs in all the fruit growing districts of Ontario, but is especially troublesome in the Niagara district. In view of its wide-spread occurrence in this province, it appears to the writers that it must have been introduced many years before its discovery, and that it must have a much wider distribution in North America than that recorded in literature. It is highly probable that in many cases *P. pilosus* has been mistaken for the common red spider *T. telarius* or for the clover mite *Bryobia pratensis* and has been reported under one or the other name.

Host Plants and Nature of Injury.

We have taken the mite on European and Japanese plums, apple, sour and sweet cherries, pear and peach. According to Caesar, it also occurs on hawthorn, and Garman (3) records its occurrence on rose. The European plum is by far the favourite host plant with apple next and then sour cherry. In Connecticut the mite has caused severe injury to apples, particularly Baldwin trees, but in Ontario it has proved to be, so far, only of importance as a pest of European plums.

In the Niagara fruit belt, the mite is one of the major pests of the plum orchard. It attacks both surfaces of the leaves and, by means of its mouthparts, punctures the tissues and withdraws the plant juices. At first this results in a speckling of the leaves, due doubtless to the withdrawal of chlorophyll. Later on, if the infestation is severe, all the leaves become pallid, sickly in appearance, tough and largely functionless. From a distance the foliage on badly attacked plum trees looks as if it were coated with road dust.

The injury to the leaves naturally robs the trees of vigour, and, when severe, checks the growth of the wood, dwarfs the fruit and retards its ripening. Two years ago the following data (table No. 1), showing the loss in weight and size of fruit and in growth of wood due to mite injury, was secured by comparing the trees in an infested block of plums with those in an uninfested block. The trees were the same age, and were grown under the same conditions, apart from the fact that the uninfested trees had been sprayed with lime sulphur and the others with bordeaux mixture.

TABLE No. 1—Showing Loss in Weight and Size of Fruit and in Growth of Wood Due to Mite Infestation

Variety	Loss in Weight of Fruit	Loss in Size of Fruit	Loss in Terminal Growth of Wood
Gueii	41.5%	40.3%	23.9%
Pond's	20.6%	24.3%	45.6%
Lombard	27.3%	19.1%	22.3%
Reine Claude	28.7%	24.8%	35.0%

On apple trees, according to Garman, the infested foliage becomes brownish or assumes a dull leaden appearance, and later in the summer many of the leaves drop. The same author reports a marked reduction in the size of the fruit on infested Baldwin trees.

Life History.

The Egg.

Description: The egg is flattened spherical in shape, and measures .15 mm to .16 mm in diameter. When newly laid, it is pearly to pink in colour, and later on becomes a dull dark red. At the apex there is a hair-like process about as long as the diameter of the egg.

The overwintering and summer eggs are similar in size, shape and colour.

Location: The overwintering eggs are located on the bark anywhere from the tips of the twigs to the trunk, usually on rough bark and in the axles of shoots and spurs.

The summer eggs, in the early part of the season, are laid on any part of the upper or lower surface of the leaves and on the petioles. Later on, some of them are deposited on the bud scales and on the bark.

Hatching of Overwintering Eggs. The eggs commence to hatch at the time European plums are in full bloom. In the plum orchard (situated near the lake shore) which we had under observation this past season, the period of hatching extended from May 2nd to May 9th.

Incubation Period of Summer Eggs: The period of incubation in our experiments varied according to the temperature, from 13 days in the spring, to 6 days in midsummer. The average for the season was about 9 days. More precise data on the duration of the egg stage is given in table No. 2: -

TABLE No. 2—Showing Duration of Incubation

Brood	No of Exp's	No of Eggs	Time of year	Incubation Period			Temperature		
				Min.	Max.	Aver.	Min.	Max.	Mean
2nd	10	72	May 23rd. to June 10th	10	13	10.5	40	85	61
3rd	13	81	June 19th to July 8th	7	8	7.5	48	97	74
4th	13	134	July 11th to July 26th	6	8	7.0	60	91	77
5th	16	110	July 30th to Aug. 19th	8	11	9	52	85	69
6th	14	89	Aug. 24th to Sept. 12th	8	11	10	48	92	60

Stage of Growth when First Summer Eggs are Laid: The first generation adults commenced laying eggs about May 25th, or, in other words, at the time the calyces on early varieties of plums were beginning to fall.

Immature Forms.

During its growth the spider mite moults three times and thus passes through three immature stages. The newly hatched mite is termed the larva, after the first moult it is the so-called first nymph or protonymph and after the second moult the deutonymph.

Description: The larva is oval in shape, sparsely clothed with long bristles delicate, pearly pink to dull red in colour and measures about .16 mm by .088 mm. It has only three pairs of legs.

The protonymph has four pairs of legs and is somewhat darker in colour than the larva. It measures .198—.270 mm. x .162—.198 mm.

The deutonymph in shape and colour resembles the other immature forms. The legs are translucent and sparsely covered with hairs. Like the larva and first nymph, the deutonymph is very delicate and soft-bodied. In size it is .32 mm. —.36 mm x .23 mm.

Habits of Immature Forms: The larvæ and nymphs feed principally on the lower surface of the leaf, generally close to the veins. They may remain feeding in one spot for several hours.

Each moult is preceded by a quiescent period of one or two days during which time the larva or nymph remains attached to the leaf and shows indication of life.

Length of Larval-nymphal Period: In our studies this period varied from 17 days in the spring to 7 days in June and July, the average being 10.7 days. Fuller data covering the six generations are shown in Table No. 3.

(*a*) Fellenburg plum severely injured by mite. (Reduced)

TABLE No. 3—Showing Duration of Larval-nymphal Period

Brood	No. of Exp's	No. of Nymphs	Time of year.	Nymphal Period			Temperature		
				Min.	Max.	Aver.	Min.	Max.	Mean
				Days	Days	Days			
1st	11	48	May 3rd. to May 21st	16	18	17	34	75	53
2nd	12	60	June 5th to June 20th	8	11	9	42	87	64
3rd	13	72	June 20th to July 13th	7	10	8	48	98	77
4th	12	82	July 18th to Aug. 3rd	7	10	9	52	91	76
5th	15	58	Aug. 7th to Sept. 29th	8	13	11	46	86	66
6th	13	35	Sept. 1st to Sept. 23rd	11	15	13	48	90	66

The Adult.

After the third and final moult the mite reaches the adult stage.

Descriptions: The female is oval in shape and rather stout; carmine in colour with dark red to black blotches on the abdomen; and measures .36—.46 mm x .25—.28 mm. The legs are cream to dusky yellow in colour. On the dorsal surface there are 26 setose bristles, each of which is set in a conspicuous white tubercle.

The male is considerably smaller than the female and measures about .20 mm. —.28 mm x .14 mm—.16 mm. The cephalothorax is pearly pink to reddish with a median crimson eye-spot; the abdomen is dark red to purplish black and the legs are translucent.

Egg Laying Activities of the Female: In our insectary studies, the female mites commenced to deposit eggs 2 to 5 days (the average was three days) after reaching maturity. Each female laid from 11 to 90 eggs with an average of 38.6, (table No. 4). The daily rate of deposition per female varied from 1 egg to 12 eggs, and the egg-laying period ranged from 3 to 29 days. (Table No. 5).

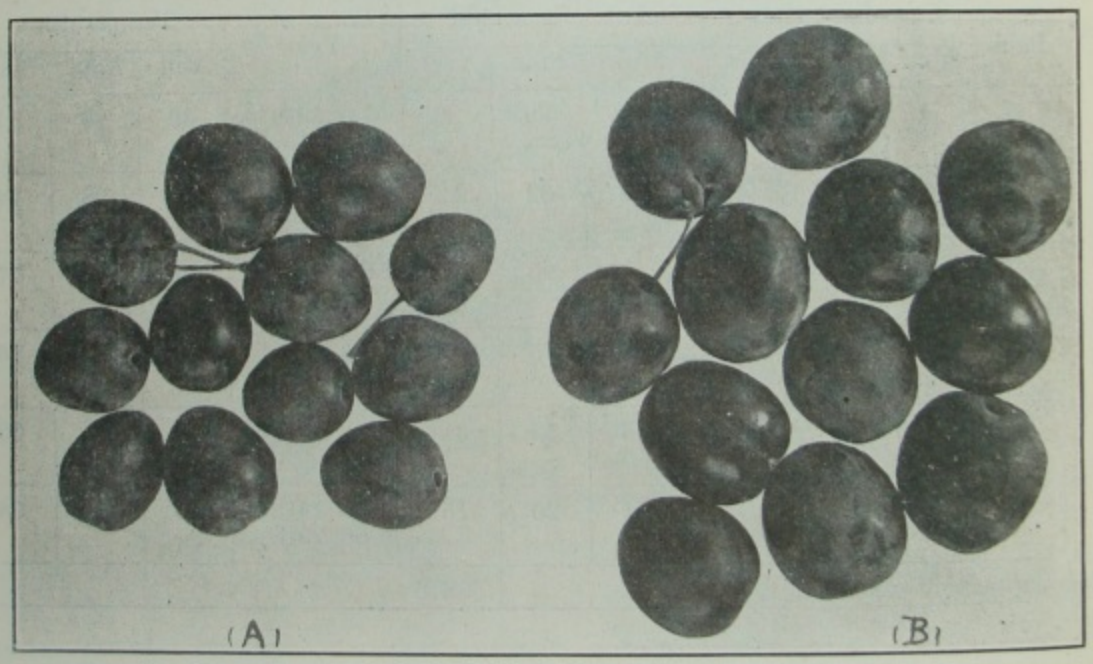
TABLE No. 4—Showing Daily Number and Total Number of Eggs Laid per Female

Brood	No. of Pairs	Eggs Laid Daily			Total Eggs Laid			Time of Year	Temperature		
		Min.	Max	Aver.	Min.	Max.	Aver.		Min.	Max.	Mean
1st	6	1	12	3	12	39	29	May 19th to June 14th	38	90	1
2nd	7	1	9	4	11	62	42	June 15th to July 14th	48	98	74
3rd	7	1	9	3	41	90	66	July 7th to Aug. 6th	52	95	77
4th	7	1	9	3	38	75	52	July 26th to Aug. 30th	46	92	75
5th	7	1	8	3	13	52	31	Aug. 19th to Sept. 16th	46	92	60
6th	8	1	8	3	11	20	15	Sept. 14th to Sept. 29th	45	80	58
Average throughout season:				3.4			38.6				

Length of Adult Life of Female: As shown in table No. 5, the adult females lived from 6 to 33 days, with an average covering the six generations of 17.7 days.

TABLE No. 5--Showing Egg Laying Period and Length of Adult Life of Female

Brood	No. of Pairs	Egg Laying Period			Length of Life			Time of Year	Temperature		
		Min.	Max.	Aver.	Min.	Max.	Aver.		Min.	Max.	Mean
		days	days	days	days	days	days				
1st	6	3	13	9	8	25	18	May 19th to June 14th	38	90	61
2nd	7	4	20	12	6	25	16	June 15th to July 14th	48	98	74
3rd	7	6	24	19	19	27	23	July 7th to Aug. 6th	52	95	77
4th	7	12	29	19	18	33	24	July 26th to Aug. 30th	46	92	75
5th	7	6	17	12	10	29	18	Aug. 19th to Sept. 16th	46	92	50
6th	8	3	9	5	7	12	9	Sept. 14th to Sept. 29th	45	80	58
Average throughout season:				12.5			17.7				



(*a*) Typical Gueii plums from mite-infested trees compared with (*b*) plums from uninfested Gueii tree. (Reduced)

Habits of Male and Length of Adult Life: The males are active, and appear to be engaged most of the time running nimbly over the leaf surface in search of females. They are occasionally found attending quiescent female deutonymphs.

In mating, the male crawls under the female, extends his genital parts upward and curving slightly forward engages with the female. Several males may gather around a female, and each may in turn mate with her.

The male is short-lived. In our studies, the average length of life was 3 days, the maximum 5 days and the minimum 2 days.

Parthenogenesis. In order to determine whether this species is parthenogenetic, six female deutonymphs were placed in separate cages and were kept isolated during their entire life. Four days after reaching maturity, all the females commenced to lay eggs, and each deposited from 10 to 41 eggs, the average being 25 eggs. All the progeny proved to be males.

Proportion of Males to Females: At no time, during the past season, did our observations in various orchards show a preponderance of males over females. Counts made in the orchard at different times gave an average ratio of about 1 male to 10 females. In the insectary, the ratio was 1 to 4. This would indicate that, under normal conditions, most of the females are fertilized.

Number of Generations.

The activities of the mite extended this past year from May 2nd when the overwintering eggs commenced to hatch, to mid-October, when the last eggs were laid. During this period—5½ months—a maximum of six ("first hatched series") and a minimum of three generations ("last hatched series") developed in the insectary. This, of course, means that under our conditions, there are three full generations and three additional partial generations.

Overlapping of Broods.

Except for two weeks in the spring, namely, from May 11th to 25th, when only immature forms were found, all stages from eggs to adults were present in the orchard throughout the season. The overlapping of the different generations is shown in table No. 6.

TABLE No. 6—Showing Number, Duration and Overlapping of Generations.

Winter 1920-21	May	June	July	Aug.	Sept.	Oct.	Winter 1921-22
1st Gen.	2	23					
2nd. Gen.	25			3			
3rd Gen.		19				14	
4th Gen			11			14	
5th Gen.			30			14	
6th Gen				24		14	

Period of Maximum Infestation.

From the first appearance of the mite in early May until the middle of June, the degree of infestation was very light. However, during the month of July the mites increased marvellously, at this time as many as 800 to 1,200 eggs being found on a single plum leaf. The mites spread throughout the trees and attacked every leaf. From the third week in August to the end of the season their numbers fell even more rapidly than they had increased. The explanation of this is noted under the heading of Natural Control.

Comparative Susceptibility of Varieties of Plums.

Notes made on the comparative susceptibility of over fifty varieties of European plums are presented herewith in tabular form.

TABLE No. 7—Showing Comparative Susceptibility of European Plums to Mite Injury.

Severe	Moderate	Light	Very Light
Smith Orleans	Arch Duke	Duane	Reine Claude
German Prune	Victoria	Quackenboss	
Shipper's Pride	Gueii	Lombard	
Shropshire Damson	Washington	Grand Duke	
McLaughlin	Hand	Diamond	
Pond	Monarch	Tennant Prune	
King Damson	Yellow Egg	Warner's Late	
Moore's	Imperial Gage	Latchford	
French Damson	Kingston	Bleeker's Gage	
Ancaster	Bradshaw	Hulling's Superb	
Emerald	Fellenburg		
Riley Damson	John A.		
Belgium	Field		
Wyedale	Lawson		
Pearl	Klondyke		
	Early Rivers		
	Moyer		
	Blue Prolific		
	Early Transparent Gage		
	Canada Orleans		
	Hudson		
	Large Golden Prolific		
	Curlew		
	Sugar Plum		
	Pacific Prune		
	Improved Lombard		

Control.

Natural Control.

Depletion of Food Supply: The depletion of the food supply was undoubtedly the most important natural check on the multiplication of the spider mite this past season. The leaves of severely attacked trees became tough and dry in mid-summer, and ceased to provide the mites with sufficient nourishment, consequently most of them on such trees perished. Trees, which in July had been infested with countless numbers of mites, became almost free towards the end of August. Thus it happened that the smallest number of overwintering eggs were deposited on the most severely infested trees.

Weather: The mites, feeding as they do on the upper and lower surfaces of the foliage, are not afforded very much shelter by the leaves during the storms. Rains wash them off the upper surface, and heavy rains accompanied by strong winds, wash them from the lower surface. Immediately after a heavy rain storm last summer, infested trees were examined and it was found that approximately 90% of the mites had been washed off the upper surface, and approximately 70% from the lower. The eggs, of course, remained attached to the leaves.

Predaceous Enemies: In view of the fact that the mite was so very abundant this past season, it was very surprising to find that predaceous enemies were remarkably scarce. The minute, black ladybird beetle, *Stethorus punctum* Lec. was found in small numbers feeding on the mites. The well-known two-spotted ladybird beetle, *Adalia bipunctata* Linn. was also observed on infested foliage apparently attacking the mites. But so far as we could judge, no predaceous enemies had any appreciable effect in reducing the numbers of the spider mite.

Mortality Due to Location of Overwintering Eggs: In cases where the overwintering eggs were located a considerable distance from the leaves, for example, near the crotch or on the trunk, it was observed that quite a number of the minute, newly-hatched larvæ perished before reaching the leaves.

Artificial.

Lime Sulphur: It is very fortunate that, in order to successfully combat the spider mite on plum trees, it is not necessary to make any special applications or to use any special spray material. Our experiments have shown definitely that the pest can be controlled by spraying twice with commercial Lime Sulphur 1-40,

Overwintering eggs on plum twig. X 10.
Plum Spider Mite; male and female. X. 10. (Inset)

at the times recommended for the control of Brown Rot, Curculio, etc. viz: (1) when the fruit is set and most of the calyces have dropped and (2) two weeks later. Needless to say the spraying must be done very thoroughly.

The results secured in a Vineland orchard in 1920 were very striking. One large block of plum trees was sprayed with Lime Sulphur and another adjoining block, with the same varieties in it, was sprayed with Bordeaux mixture. By midsummer the foliage on the trees sprayed with Bordeaux mixture was pallid, largely functionless and stood out in very marked contrast to the healthy, green foliage in the blocks sprayed with Lime Sulphur.

Sulphur Dust: Preliminary experiments indicate that heavy applications of sulphur dust will control the mite.

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INSECTS OF THE SEASON IN ONTARIO.

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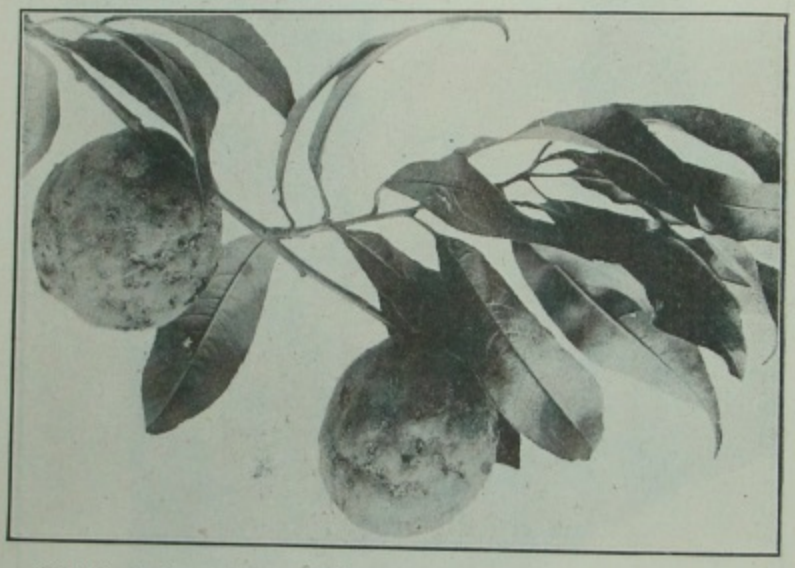
ORCHARD INSECTS.

CODLING MOTH (*Carpocapsa pomonella*). The very hot weather throughout July aroused fears that there would be an abnormally large percentage of second brood larvæ and consequently a much greater amount of injury to apples and pears.



Lygus injury on peaches. Note the unsightly scars.

Fortunately these fears were not realized to any marked extent, apparently because the weather became comparatively cool in early August and remained moderately cool throughout that month.

PLUM CURCULIO (*Conotrachelus nenuphar*). In some localities this pest did much harm, but in most parts of Ontario it was not more troublesome than usual.

CIGAR AND PISTOL CASE-BEARERS (*Coleophora fletcherella and C. malivorella*). These two insects, usually considered minor orchard pests, were remarkably abundant in the Newcastle district. Almost every apple orchard which had not been well-sprayed the previous year, or which had only received the post-blossom application, was badly infested. In June many of the trees were almost completely defoliated and what foliage was left was brown and ragged. In one case about 30 acres of Stark trees were so severely damaged that the brown, blighted appearance of the trees was conspicuous a mile away. A cursory examination this fall of affected trees indicated that the outbreak was over.

BUD MOTH (*Tmetocera ocellana*). In the Newcastle apple orchards, infested with case-bearers, the bud moth was also quite abundant and contributed its share of injury to the foliage. In other parts of the province it was not especially conspicuous.