CONTROL OF SOFT SCALES (HOMOPTERA: COCCIDAE) IN BRITISH COLUMBIA PEACH AND APRICOT ORCHARDS[1]

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Within the last eight years there has been a marked increase in numbers of soft scales on peach and apricot trees throughout the Okanagan Valley of British Columbia. *Pulvinaria* sp. is most frequently found on peach; one species of *Lecanium*, designated as *Lecanium* sp. A in this paper, evidently prefers apricot, whereas another species of *Lecanium*, designated as *Lecanium* sp. D, has been found only on peach. At least two other species of soft scales are present on tree fruits in the interior of British Columbia, but so far they have not been particularly troublesome.

The *Lecanium* scales overwinter as small nymphs, about three-fourths of a millimetre in length. They grow very rapidly during April and May, and commence egg-laying early in June. The eggs hatch during June and July, the date varying somewhat with the species, locality, and season. The young summer nymphs move to the leaves where they feed; they make very little growth during the remainder of the season. Just before the leaves fall in the autumn, the nymphs move to one- to three-year-old branches, where they pass the winter.

The life-history of *Pulvinaria* sp. is very similar to that of the *Lecanium* species. However, it begins egg-laying about two weeks earlier than the *Lecanium* scales, and the eggs commence to hatch about mid-June. Unlike the *Lecanium* scales, many of the summer nymphs of *Pulvinaria* sp. move from the leaves back to small branches during summer, and many of them are almost half-grown by autumn.

The scales devitalize the trees, and may kill one- and two-year-old twigs. They secrete copious quantities of honey dew, which makes the fruit sticky and sometimes unmarketable.

Field experiments were conducted from 1949 to 1955 on the chemical control of the scales on peach and apricot trees in the Okanagan Valley. A survey was also made to determine what species of insects parasitize or prey on these scales.

Materials and Methods

The following chemicals were used in the field experiments:

1. DDT, 50 per cent wettable powder; Pennsylvania Salt Manufacturing Company, Tacoma, Wash.

2. Demeton (Systox), 42.4 and 50 per cent liquids; Geary Chemical Company, New York, N.Y.

3. Diazinon, 25 per cent wettable powder of *O*, *O*-diethyl *O*-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate; Geigy Chemical Corporation, New York, N.Y.

4. Dieldrin, 50 per cent wettable powder; Shell Chemical Corporation, New York, N.Y.

5. Endrin, 18.5 per cent liquid; Shell Chemical Corporation, Julius Hyman Division, Denver, Colo.

6. Heptachlor, 25 per cent liquid (two pounds of heptachlor per U.S. gallon); Velsicol Corporation, Chicago, Ill.

7. Isolan, 25 per cent liquid of dimethyl 5-(1-isopropyl-3-methyl-pyrazolyl) carbamate; Geigy Chemical Corporation, New York, N.Y.

8. Lime-sulphur, liquid; specific gravity 1.28; Oliver Chemical Company, Penticton, B.C.

9. Lindane, two 25 per cent wettable powders, one from Pennsylvania Salt Manufacturing Company, Tacoma, Wash., and the other from California Spray-Chemical Corporation, Richmond, Calif.

10. Malathion, 50 per cent liquid; American Cyanamid Company, New York, N.Y.; 25 per cent wettable powder; Pennsylvania

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Salt Manufacturing Company, Tacoma, Wash.

11. Nicotine sulphate, 40 per cent liquid; The N. M. Bartlett Spray Works, Beamsville, Ont.

12. Parathion, 15 per cent wettable powder; Naugatuck Chemicals, Elmira, Ont.

13. Polyethylene glycol, 600 mono ester of refined tall oil, liquid; The Emulsol Corporation, Chicago. Ill.; 600 mono laurate, liquid; Glyco Products Company, Incorporated, Brooklyn, N.Y.

14. Pyrenone T-503, liquid containing (w/v) 0.4 per cent pyrethrins, two per cent rotenone, and four per cent piperonyl cyclonene; U.S. Industrial Chemicals, Baltimore, Md.

15. Pyrolan, 40 per cent liquid of dimethyl 5-(3-methyl-1-phenyl-pyrazolyl) carbamate; Geigy Chemical Corporation, New York, N.Y.

16. Soap, powder; Lever Bros., Montreal, Que.

17. Sodium lauryl sulphate, 42 per cent powder; Canadian Industries Limited, Montreal, Que.

18. Stove oil; 34 S.S.U. Vis. 100°F., over 75 per cent U.R., Shell Oil Company, Penticton, B.C.

19. Strobane, 42 per cent liquid of terpene polychlorinate with a chlorine content of approximately 66 per cent; B. F. Goodrich Chemical Company, Cleveland, Ohio.

20. Toxaphene, 40 per cent wettable powder; Hercules Powder Company, Wilmington, Del.

21. Trithion 4E, liquid containing four pounds of *S*-(*p*-chlorophenylthio) methyl *O*, *O*-diethyl phosphorodithioate per U.S. gallon; Stauffer Chemical Company, Mountain View, Calif.

22. Washing soda, crystalline sodium carbonate ($10H_2O$); Church and Dwight Company, Montreal. Que.

Sprays were applied by high-pressure, hand-gun equipment, by air-blast, concentrate sprayers, and, in one instance, by bucket-pump sprayer. As a rule, there were at least eight trees per treatment, but treatments were replicated in only a few instances. Experiments were conducted when the insects were in various stages of development: over-wintered nymphs, mature and almost mature scales, and summer nymphs. Control was determined by one of the following methods: (1) As soon as the spray deposits were dry, scale-infested twigs were taken to the laboratory and the cut ends of the twigs immersed in water. Scale mortalities were recorded two to three weeks later. (2) Two to three weeks after spraying, scale-infested twigs were pruned from the trees, and scale mortalities immediately recorded. (3) The number of scales per leaf was recorded before, and about two weeks after, spraying. Later, when it was found that dead scales remained attached to the leaves, the pre-spraying count was omitted and both living and dead scales were recorded in the post-spraying count. (4) As a rule, no counts were made of living and dead scales where the chemicals gave almost perfect control or very little or no control. In such instances, degree of effectiveness was estimated in the field by visual observation.

The species of parasites and predators present were determined by collecting, throughout the growing season, scale-infested twigs from peach and apricot orchards in the interior of British Columbia. The twigs, their cut ends immersed in water, were kept in battery jars in an insectary. Adult parasites that emerged from the scales were removed from the jars every day, and mounted on points for subsequent identification.

Results and Discussion

Chemical Control of *Lecanium* sp. A

Overwintered Nymphs—Mortalities of small, overwintered nymphs of *Lecanium* sp. A one month after apricot trees in the dormant stage were sprayed with lime-sulphur, or with lime-sulphur plus nicotine sulphate, were:—

Material	Gallons per acre	Average scale mortality, %
Lime-sulphur Nicotine sulphate, 40%	20 1	43
Lime-sulphur	20	33
Check	—	7

Mortality for each treatment was based on 500 scales; one twig was sampled from each of five trees.

When Diazinon or malathion was applied to peach trees showing ten

per cent full bloom, mortalities of overwintered nymphs of *Lecanium* sp. A two weeks later were:—

Material	Pounds per acre	Average scale mortality, %
Diazinon, 25%	12	97
Malathion, 25%	15	95
Check	—	23

Mortality for each treatment was based on 1000 scales; one twig was sampled from each of ten trees.

Despite the fairly high mortality in the Diazinon and malathion plots, the trees became moderately sticky with honey dew during the last week in May. Evidently, where the initial scale infestation is severe, the rating for satisfactory commercial control should be greater than 97 per cent scale mortality.

Mortalities of overwintered nymphs of *Lecanium* sp. A were estimated to be between 30 and 60 per cent ten days after apricot trees had been sprayed at the calyx stage with various chemicals. Mortality was highest with 42.4 per cent demeton at 0.25 pints per 100 gallons and lowest with a mixture of 40 per cent nicotine sulphate at one pint plus washing soda at 0.5 pounds. Intermediate in effectiveness were 25 per cent Lindane at one pound, 15 per cent parathion at one pound, and a mixture of 40 per cent nicotine sulphate at one pint plus polyethylene glycol ester of tall oil at one quart. At the time of spraying, the scales were about twice as large as they were during the winter, and probably they were more difficult to control than earlier in the season.

Mature and Almost Mature Scales —A summer spray of 25 per cent Lindane at 1.5 pounds per 100 gallons was ineffective against mature and almost mature scales of *Lecanium* sp. A on apricot. The addition of one quart of stove oil to the spray mixture gave no improvement.

In another apricot orchard, several chemicals failed to give satisfactory control of *Lecanium* sp. A when about 75 per cent of the scales had started to lay eggs. Twenty-five per cent malathion at one pound per 100 gallons killed many of the adult scales, but was innocuous to the eggs. Twenty-five per cent Lindane at one pound per 100 gallons, 50 per cent demeton at 0.5 pints, 15 per cent parathion at 1.5 pounds, a mixture of 40 per cent nicotine sulphate at one pint plus polyethylene glycol mono laurate at one quart, or a similar dosage of nicotine sulphate plus 2.5 pounds of soap had no ovicidal value, and evidently killed fewer adults than the malathion spray.

Summer Nymphs — A post-harvest application of 40 per cent nicotine sulphate at 1.5 pints, plus stove oil at one pint, per 100 gallons killed exposed, summer nymphs of *Lecanium* sp. A on apricot trees, but did not kill nymphs that were protected by the shells of the mother scales, and had no effect on the eggs. After all eggs had hatched, and the nymphs had moved from under the mother scales, an additional spray of nicotine sulphate plus stove oil (the dosage of nicotine sulphate reduced to one pint) gave very good control. No counts were made, but living scales were found only after prolonged search.

In another apricot orchard (Table I), a post-harvet spray of malathion gave excellent control of summer nymphs. However, a nicotine sulphate-stove oil mixture did not give as good control as in the previous experiment. This mixture has very poor residual properties, and was probably ineffective against most of the nymphs that moved from under the mother scales after spraying. With the possible exception of parathion, the other chemicals that were applied were not promising.

In another experiment in the same orchard (Table II), a post-harvest spray of malathion once again gave excellent control of summer numphs. As in the previous experiment, control with nicotine sulphate was not satisfactory, presumably because many of the nymphs were protected by the mother scales. The addition of stove

oil to nicotine sulphate evidently did not increase the effectiveness of the latter.

In a third apricot orchard, mortalities of summer nymphs were greater than 99.8 per cent 19 days after a post-harvest spray of 25 per cent Diazinon at two pounds, 25 per cent malathion at two pounds, or 25 per cent Trithion at one pint per 100 gallons. Mortality in the check plot was five per cent.

TABLE 1.—Average Numbers of Living Nymphs of *Lecanium* sp. A before, and Two Weeks after, a Post-harvest Spray of Various Chemicals to Single Apricot Branches by Bucket-pump Sprayer.

Material	Amount per 100 Gal.	Nymphs per Leaf[1]	
		Before Spraying	After Spraying
Malathion, 50%	1.3 pints	27	0.05
Parathion, 15%	1.0 lb.	12	0.9
Demeton, 42.4%	0.5 pints	21	8
Nicotine Sulphate, 40%	2.0 pints		
Stove oil	2.0 pints	17	11
Sodium lauryl sulphate, 42%	2.0 oz.		
Isolan, 25%	1.0 pints	14	9
Heptachlor, 25%	1.5 pints	27	15
Dieldrin, 50%	1.0 lb.	35	27
Endrin, 18.5%	0.5 pints	10	11
Strobane, 42%	2.0 pints	40	50
Pyrolan, 40%	0.5 pints	32	41
Check	—	33	44
Pyrenone T-503	1.0 pints	16	22

[1]Based on 20 leaves.

Chemical Control of *Lecanium* sp. D

Overwintered Nymphs—Mortalities of overwintered nymphs of *Lecanium* sp. D 15 days after peach trees were sprayed with Diazinon or malathion at the pink stage of blossom development were:—

Material	Pounds per 100 gallons	Average scale mortality, %
Diazinon, 25%	2	99.8
Malathion, 25%	2	99
Check	—	10

Mortality for each treatment was based on 500 scales; one twig was sampled on each of ten trees.

Another section of the same orchard was sprayed by a concentrate machine. Mortalities of slightly larger nymphs of *Lecanium* sp. D one month after a "calyx" spray of Diazinon plus DDT, or malathion plus DDT, were:—

Material	Pounds per acre	Average scale mortality, %
Diazinon, 25%	16	98
DDT, 50%	12	
Malathion, 25%	16	82
DDT, 50%	12	
Check	—	3

Mortality for each treatment was based on 1000 scales; one twig was sampled on each of 20 trees.

TABLE II.—Average Numbers of Living Nymphs of *Lecanium* sp. A before, and Two Weeks After, a Post-harvest Spray of Various Chemicals to Single Plots of Apricot Trees by Hand-gun Sprayer.

Material	Amount per 100 Gal.	Nymphs per Leaf[1]	
		Before Spraying	After Spraying
Malathion, 50%	1 pint	25	0.04
Nicotine sulphate, 40%	1 pint	28	10
Stove oil	2 pints		
Sodium lauryl sulphate, 42%	2 oz.		
Nicotine sulphate, 40%	1 pint	45	17
Washing soda	8 oz.		
Lindane, 25%	1 lb.	40	25
Check	—	37	38

[1]Based on 20 leaves from each of four trees.

Malathion plus DDT in the "calyx" spray did not give as good control of *Lecanium* sp. D as malathion alone in the earlier, "pink-bud" spray, even though the per-acre dosage of malathion was approximately 50 per cent greater (dosage at the pink-bud stage was approximately ten pounds per acre). Evidently the nymphs become more difficult to kill as they increase in size; at the calyx stage they were about 50 per cent larger than at the pink-bud stage.

Chemical Control of *Pulvinaria* sp.

Overwintered Nymphs — Lime-sulphur at 20 gallons per acre, used alone or with 40 per cent nicotine sulphate at one gallon, did not give satisfactory control of overwintered nymphs of *Pulvinaria* sp. on apricot trees in the dormant stage. Thirty-nine days after spraying the percentage mortalities were: Lime-sulphur, 89; lime-sulphur plus nicotine sulphate, 65; check, 5. The low mortality in the lime-sulphur-nicotine sulphate plot was doubtless partly due to poor spray coverage. A moderately strong wind was blowing when most of the trees in that plot were sprayed.

Mature and Almost Mature Scales — A mixture of 40 per cent nicotine sulphate at one pint, plus washing soda at 0.5 pounds, per 100 gallons, applied to peach trees at the calyx stage, had no observable effect on mature and almost mature scales of *Pulvinaria* sp. A similar quantity of nicotine sulphate, plus polyethylene glycol ester of tall oil at one quart, was equally ineffective. Fifty per cent malathion at 1.3 pints per 100 gallons, applied to apricot trees at about 90 per cent petal-fall, was also ineffective against these scales.

Summer Nymphs—Fifteen per cent parathion at 0.75 pounds per 100 gallons gave good control of *Pulvinaria* sp. nymphs on peach trees during June. Forty per cent nicotine sulphate at one pint plus soap at three pounds was not quite so effective. The sprays were applied when about 75 per cent of the eggs had hatched. Evidently parathion was sufficiently persistent to continue killing nymphs that emerged some days after spraying, whereas this was not so with nicotine sulphate. Very few scales were killed by 25 per cent Lindane at one pound per 100 gallons, or by 40 per cent toxaphene at 2.5 pounds.

Parasites and Predators

Parasites reared from *Pulvinaria* sp. and *Lecanium* spp. in the Okanagan Valley include *Coccophagus scutellaris* (Dalm.), *Aphycus kincaidi* (Timb.), and *Aphycus* sp. near *californicus* How. *Lecanium* spp. were also parasitized by *Coccophagus lycimnia* (Wlkr.) and *Microterys* sp.[3] Larvae of a predacious fly, *Leucopis* sp.[4], were found devouring large numbers of *Lecanium* eggs. Unfortunately, this predator was sometimes parasitized by *Pachyneuron eros* Gir. Various coccinellids (species not determined) attack soft scales in the Okanagan Valley, and anthocorids were seen feeding on *Lecanium* spp. in the laboratory. In the spring, birds of the finch family were observed feeding on overwintered nymphs of *Lecanium* spp.

Summary

In experiments from 1949 to 1955 in British Columbia peach and apricot orchards, a post-harvest spray of malathion, Diazinon, or Trithion gave excellent control of summer nymphs of *Lecanium* sp. A on apricot trees. Diazinon or malathion, at the pink-bud stage of peach, also gave good control of small, overwintered nymphs of *Lecanium* sp. D, but was not quite so effective against slightly larger nymphs of *Lecanium* sp. A at ten per cent full bloom. A summer spray of malathion, parathion, nicotine sulphate plus soap, nicotine sulphate plus polyethylene glycol mono laurate, lindane, lindane plus stove oil, or demeton did not give satisfactory control of mature and almost mature scales of *Lecanium* sp. A. Summer nymphs of *Pulvinaria* sp. were controlled in June by one application of parathion; both Lindane and toxaphene were ineffective. At least five species of Hymenoptera and one species of Diptera attack soft scales on peach and apricot trees in the Okanagan Valley.

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A NOTE ON SEXING LIVE SPECIMENS OF *SCOLYTUS UNISPINOSUS* LEC. (SCOLYTIDAE, COLEOPTERA)[1]

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A method for rapid, accurate determination of insect sex is often a valuable asset in field studies. Several sex differences, including one common to many species of *Scolytus*, and the results of testing their validity for field use, are presented here for *Scolytus unispinosus* Lec., the Douglas-fir engraver beetle.

In recent work it was necessary to determine the sex of a number of Douglas-fir engraver beetle adults in the field without injuring them. This led to an examination of adults under the microscope which revealed three differences in the external morphology of the sexes.

The first difference noticed in the attacking adults, was that the frons of the male bore a denser crown of setae than that of the female. This characteristic was used to sex 60 adults with a 10x hand-lens and then under 40x with a stereoscopic microscope. Subsequent dissections revealed that 14 errors were made with the hand lens, while only one was made using the microscope. The value of this characteristic is reduced after the beetles have been engaged in gallery construction, as the head setae become considerably worn.

A stable and reliable difference was found in the shape of the head as described for most members of this genus (Blackman, 1934). When viewed laterally, the front of the female's

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