Calocalpe undulata:[1] Contact Toxicity of Ten Insecticides to the Larvae[2]

Jacqueline L. Robertson, Marion Page, and Nancy L. Gillette

Pacific Southwest Forest and Range Experiment Station, Forest Service, USDA, Berkeley, CA. 94701

ABSTRACT

Ten insecticides were tested against larvae of *Calocalpe undulata* (L.). The decreasing order of toxicity at LD_{50} was: bioethanomethrin, phenothrin, pyrethrins, phoxim, tetrachlorvinfos, mexacarbate, carbaryl, phosmet, DDT, and malathion. At LD_{90}, the decreasing order of toxicity was the same, except that phoxim and tetrachlorvinfos switched positions. Malathion was not toxic at the highest dose level tested (500 µg/g body weight). When the response of *C. undulata* was compared with that of 4 other forest geometrid species, the data showed that pyrethroids were always the most toxic candidates whereas malathion was always the least toxic.

Calocalpe undulata (L.) larvae defoliate wild and choke cherries over much of eastern North America (Baker 1972). A severe infestation in 1973 on black cherry, *Prunus serotina* Ehrh., in the Allegheny National Forest, PA.,[3] prompted the tests reported herein. We determined the relative contact toxicity of 10 insecticides applied to the larvae.

Other forest pests in the family Geometridae have been subjected to similar screening tests in our laboratory. We compared the responses of *C. undulata* to certain insecticides to those of the elm spanworm, *Ennomos subsignarius* (Hübner), fall cankerworm, *Alsophila pometaria* (Harris), spring cankerworm, *Paleacrita vernata* (Peck), and western hemlock looper, *Lambdina fiscellaria lugubrosa* (Hulst).

Methods and Materials.—*Insects*.—Test insects were collected in the Allegheny National Forest near Kane, Pa., and shipped to Berkeley, Calif., in July 1973. They were held at 45°C until used (1–5 days). During this time they fed on black cherry foliage.

Insecticide Formulations.—Ten insecticides were tested[4]: 4 were organophosphorous: malathion, phosmet, phoxim, and tetrachlorvinfos; 3 were pyrethroids: bioethanomethrin, phenothrin, and pyrethrins; 2 were carbamates: carbaryl and mexacarbate; and 1 was a chlorinated hydrocarbon: DDT. DDT was included as a standard for comparison because of its common and effective use in forest insect control in the past.

Each insecticide was formulated in reagent grade acetone on the basis of wt/vol concn of AI. Fresh formulations were prepared for each of 4 replicates. Four to 5 concn/insecticide were used to compute ld-p lines (Daum 1970).

Treatment Procedure.—Last and penultimate stage larvae were segregated in groups of 10 in classes from 30–110 mg body weight. The average weight of all insects tested with each chemical was 70 mg. During and after treatment, insects were held in sterile plastic petri dishes (15×100 mm) lined with filter paper.

Topical application on the thoracic dorsum of test insects at the dose rate of 1 µliter/100 mg body weight was performed with an ISCO model M microapplicator equipped with a ¼-cc tuberculin syringe and a 27-gauge hypodermic needle. Control insects were treated with acetone only. Test insects were not anesthetized.

After treatment, larvae were fed black cherry foliage. The filter paper lining the test dishes was saturated with water to maintain the turgidity of the foliage. Mortality was tallied after 1 day. Mortality of control insects was 0.7% (3/453).

Results and Discussion.—All chemicals were more toxic than DDT, except malathion, which was not toxic at the highest dose level tested (500 µg/g body weight) (Table 1). In decreasing order of toxicity at LD_{50}, these were bioethanomethrin, phenothrin, pyrethrins, phoxim, tetrachlorvinfos, mexacarbate, carbaryl, and phosmet. The decreasing order of toxicity at LD_{90} was the same except for a switch in position of phoxim and tetrachlorvinfos. This change in order was a result of the low slope of phoxim compared to the slopes of mexacarbate and tetrachlorvinfos (1.9 vs. 2.7 and 3.4).

The relative order of toxicity of candidate insecticides to *C. undulata* and 4 other forest geometrid species—*E. subsignarius* (Robertson and Lyon 1973), *A. pometaria* (Lyon and Brown 1970), *L. fiscellaria lugubrosa*,[5] and *P. vernata* (Page et al. 1974)—using the same test methods showed substantial similarities (Table 2). The pyrethroids were the most toxic; malathion was least toxic in all cases.

The variation in sensitivity among the 5 geometrids was, however, rather broad. A comparison of LD_{50} values (Table 3) showed that *E. subsignarius* was in general a highly susceptible species, and that *L. fiscellaria lugubrosa* differed from it by a factor of less than 10. *C. undulata* was the least susceptible to 5 of the insecticides; it had LD_{50} values ranging from 34 to >417 times greater than those for the least susceptible species. *P. vernata*, which was least susceptible to 3 of the insecticides, had LD_{50} values 38–128 times greater than those of the most susceptible species.

The large differences in LD_{50} values, sometimes over 100×, clearly show the risk involved in predicting insecticide activity on 1 insect species from data obtained on a different species which is a member of the same

[1] Lepidoptera: Geometridae.

[2] Received for publication June 3, 1974.

[3] David Holland, U. S. For. Serv., Delaware, Ohio (personal communication, June 1973).

[4] This paper reports research involving chemical insecticides. It does not include recommendations for their use nor does it imply that uses discussed here have been registered. All uses of insecticides must be registered by appropriate State and Federal agencies or both before they can be recommended.

[5] Lyon, Robert L. Unpublished data on file at Pacific SW For. and Range Exp. Stn., P. O. Box 245, Berkeley, CA 94701.

Table 1.—Toxicity of 10 insecticides topically applied to *Calocalpe undulata* larvae.

Insecticides	No. treated	Slope ± SE	LD_{50}[a]	95% fiducial limits	LD_{90}[a]	95% fiducial limits	Toxicity ratio at LD_{90}[b]
Bioethanomethrin	321	3.08±0.29	0.2	0.17– 0.22	0.51	0.44– 0.63	1333.0
Phenothrin	320	3.83±0.97	1.0	0.68– 1.8	2.2	1.4 – 16	309.
Pyrethrins	349	2.90±0.41	3.3	2.8 – 4.0	9.2	7.0 – 14	74.
Tetrachlorvinfos	320	3.39±0.60	9.0	6.6 – 14	22	14 – 84	31.
Phoxim	319	1.89±0.54	5.6	[c]	27	15 –>1000	25.
Mexacarbate	320	2.73±0.28	9.8	8.7 – 11	29	24 – 39	23.
Carbaryl	270	3.14±0.70	59	48 – 73	150	110 – 330	4.5
Phosmet	269	3.16±0.65	120	100 –170	320	220 – 730	2.1
DDT	320	2.17±0.51	170	82 –330	680	350 –>1000	1.0
Malathion	70	—	>500				

[a] ug/g body weight.
[b] Toxicity relative to DDT = LD_{90} DDT/LD_{90} candidate.
[c] Data too heterogeneous to give useful 95% fiducial limits.

Table 2.—Decreasing order of toxicity at LD_{50} of insecticides topically applied to 5 forest geometrid species.

C. undulata	*E. subsignarius*	*A. pometaria*	*P. vernata*	*L. fiscellaria lugubrosa*
bioethanomethrin	bioethanomethrin	pyrethrins	bioethanomethrin	pyrethrins
pyrethrins	pyrethrins	mexacarbate	pyrethrins	mexacarbate
phoxim	mexacarbate	DDT	phoxim	DDT
tetrachlorvinfos	phoxim	tetrachlorvinfos	mexacarbate	malathion
mexacarbate	tetrachlorvinfos	malathion	malathion	
phosmet	DDT			
DDT	phosmet			
malathion	malathion			

Table 3.—Decreasing order of susceptibility at LD_{50} of forest geometrids to 8 insecticides.

Insecticide	Most susceptible[a]	Times less susceptible 1.3–12	30–60	128–>417
Bioethanomethrin	E	—	P(50)[b]	C(167)
DDT	L	E(1.3)	A(32)	C(142)
Malathion	L	E(7.0)	P(>29)	A(152), C(>417)
Mexacarbate	E	L(2.0)	A(30), C(47)	P(128)
Phosmet	E	—	C(34)	—
Phoxim	E	C(12)	P(38)	—
Pyrethrins	E	L(2.0), P(7.0)	A(40), C(60)	—
Tetrachlorvinfos	E	C(6.9)	A(38), P(38)	—

[a] A = *A. pometaria*.
C = *C. undulata*.
E = *E. subsignarius*.
L = *L. fiscellaria lugubrosa*.
P = *P. vernata*.
[b] Value in parenthesis indicates LD_{50} less susceptible species/LD_{50} most susceptible species.

family. Large differences in response also have been shown to occur between species in the same genus and even between subspecies (Robertson and Gillette 1973).

ACKNOWLEDGMENT.—Technical grade insecticide samples were provided by the American Cyanamid Co., Chemagro Corp., Dow Chemical Co., McLaughlin Gormley King Co., Shell Chemical Co., Stauffer Chemical Co., Sumitomo Chemical Co., and Union Carbide Corp. We thank Porter Garhardt, Allegheny National Forest, for collecting and shipping the insects.

REFERENCES CITED

Baker, W. L. 1972. Eastern forest insects. USDA, Misc. Publ. 1175, 642 pp.

Daum, R. I. 1970. Revision of two computer programs for probit analysis. Bull. Entomol. Soc. Am. 16: 10–15.

Lyon, R. L., and S. J. Brown. 1970. Contact toxicity of insecticides applied to fall cankerworm reared on artificial diet. J. Econ. Entomol. 63: 1970–1.

Page, M., R. L. Lyon, and L. E. Greene. 1974. Contact toxicity of eleven insecticides to the spring cankerworm. Ibid., 67: 460–1

Robertson, J. L., and R. L. Lyon. 1973. Elm spanworm: contact toxicity of ten insecticides applied to the larvae. Ibid., 66: 627–8.

Robertson, J. L., and N. L. Gillette. 1973. Western tent caterpillar: contact toxicity of ten insecticides applied to the larvae. Ibid., p. 629–30.