Purchased by the Forest Service,
U. S. Department of Agriculture, for Official Use

Contact Toxicity of Twenty Insecticides Applied to *Symmerista canicosta*[1,2]

JACQUELINE L. ROBERTSON, ROBERT L. LYON, FAY L. SHON, and NANCY L. GILLETTE
Pacific Southwest Forest and Range Experiment Station, Forest Service, USDA, Berkeley, California 94701

ABSTRACT

Twenty insecticides were tested by topical application on mixed groups of 4th- and 5th-stage larvae of *Symmerista canicosta* Franclemont. Four exceeded DDT in toxicity at LD_{50}, but only resmethrin was significantly more toxic. Most of the compounds showed unusually high toxicities. Twelve, listed in decreasing order of toxicity, caused 50% mortality with <5μg/g body weight: resmethrin, methomyl, phoxim, pyrethrins, DDT, Zectran® (4-dimethylamino-3,5-xylyl methylcarbamate), chlorpyrifos, Landrin® (3,4,5- (93%) and 2,3,5-trimethylphenyl methylcarbamate (7%)), Gardona® (2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate), carbaryl, Imidan® (*O,O*-dimethyl phosphorodithioate *S*-ester with *N*-(mercaptomethyl) phthalimide), and aminocarb. Several were promising candidates for field testing.

Members of the genus *Symmerista* defoliate various species of oak, beech, elm, and maple in North America (Craighead 1950). *S. canicosta* Franclemont ranges from Nova Scotia to Virginia, and west to Manitoba and Minnesota (Franclemont 1946).

More than 300 miles[2] in lower western Michigan suffered heavy oak defoliation in 1970,[3] and the primary lepidopterous larva responsible was *S. canicosta*.[4] Although no tree mortality has been reported, defoliation by *S. canicosta* is a nuisance to home owners and recreational users of oak forests.[3]

Reported here are results of laboratory tests of 20 insecticides to find candidates for field testing against *S. canicosta*.[5] We know of no previous laboratory tests of insecticides on this insect nor of any attempts to rear it in the laboratory.

MATERIALS AND METHODS.—*Insect Culture*.—In rearing newly hatched larvae, we tried a wheat embryo diet modified after that of McMorran (1965) and Lyon et al. (1972); the gypsy moth, *Porthetria dispar* (L.), diet of Leonard and Doane (1966); and a forest tent caterpillar, *Malacosoma disstria* Hübner, diet modified after that of Addy (1969). No larvae survived on the wheat embryo diet, and few survived past the 3rd stage on either of the other 2 diets. Larvae which survived on diets, although not used for insecticidal tests, did provide useful information on characteristics of the larval stages.

At least 100 newly hatched larvae were reared individually in 9/16-oz plastic jelly cups with a 2×2×2-cm square of either the gypsy moth or forest tent caterpillar diet. Head-capsule width was measured to the nearest 0.05 mm after each molt by means of an ocular micrometer in a binocular dissecting microscope. Twenty measurements were obtained for each of the 1st 5 stages. These measurements (Table 1) provided the basis for selection of insects for testing.

Fourth and 5th instars were selected for testing from groups shipped from Wolf Lake, Manistee National Forest, Mich. These fed on the foliage of California black oak, *Quercus kelloggii* Newb. Branches were held with cut ends in water in closed sleeve cages 21 in. high, 17 in. deep, and 30 in. long. Survival under these conditions was excellent. Fresh foliage was provided every 2–4 days.

Insecticides.—Insecticides[6] which were tested for their contact toxicity were aminocarb, carbaryl, chorpyrifos, DDT, fenthion, malathion, methomyl, phoxim, propoxur, pyrethrins, resmethrin (ca. 70% trans and 30% cis isomers), trichlorfon, C_{12}-trichlorfon (dimethyl (2,2,2-trichloro-1-dodecanoyl oxyethyl) phosphonate), Dowco 214® (*O,O*-dimethyl *O*-(3,5,6-trichloro-2-pyridyl) phosphorothioate), Gardona® (2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate), Imidan® (*O,O*-dimethyl phosphorodithioate *S*-ester with *N*-(mercaptomethyl) phthalimide), Landrin® (3,4,5- (93%) and 2,3,5-trimethylphenyl methylcarbamate (7%)), Monitor® (*O,S*-dimethyl phosphoramidothioate), Sumithion® (*O,O*-dimethyl *O*-(4-nitro-

[1] Lepidoptera: Notodontidae.
[2] Received for publication Feb. 18, 1972.
[3] Biology and Sampling of Oakworms in Michigan 1971-3. June 1971. (Unpublished report on file in Field Office, Division of Forest Pest Control, Northeastern Area State and Private Forestry, U.S. Forest Service, St. Paul, Minn.)
[4] I. Millers and G. Erickson. Oak Defoliation in Manistee National Forest 1970. (Unpublished report on file in Field Office, Division of Forest Pest Control, Northeastern Area State and Private Forestry, U. S. Forest Service, St. Paul, Minn.)
[5] This paper reports research involving pesticides. It does not report recommendations for their use nor does it imply that any uses described have been registered. All use of pesticides must be registered by appropriate State or Federal agencies or both before they can be recommended.

[6] Technical grade insecticide samples were provided by American Cyanamid, Chemagro, Chevron, Dow, duPont, MGK, Shell, Stauffer, and Union Carbide. C_{12}-trichlorfon was synthesized by Dr. Melvin Look and Larry White, U. S. Forest Service, Berkeley, Calif.

Table 1.—Head-capsule measurements of *S. canicosta*.[a]

Instar	Head capsule width (mm)	
	Avg	Range
1	0.49	0.45–0.53
2	.75	.68– .83
3	1.25	1.00–1.40
4	2.03	1.50–2.30
5	2.52	2.15–3.00

[a] 20 larvae measured for each stage.

m-tolyl) phosphorothioate), and Zectran® (4-dimethylamino-3,5-xylyl methylcarbamate).

Serial dilutions were made in acetone from stock solutions prepared fresh daily. Five concentrations were tested for each chemical and replicated at least 3 times.

Testing Procedures.—A mixture of 4th and 5th instars, anesthetized with CO_2, were treated topically on the thoracic tergum in groups of 10. An ISCO Model M microapplicator with a ¼-ml tuberculin syringe and a 27-gauge hypodermic needle was used for treatment at 1 μliter/100 mg body weight. Average weights of 4th and 5th instars tested with each chemical ranged from 23.4 to 34.3 mg. Fourth instars treated separately with resmethrin averaged 16.9 mg, and 5th instars so treated averaged 42.3 mg.

Insects were held after treatment at 22–24°C and ambient humidity in 100×20-mm plastic petri dishes lined with water-saturated filter paper. They were fed California black oak foliage. Dead and moribund insects were tallied after 3 days. Data were analyzed by probit analysis.

RESULTS AND DISCUSSION.—*S. canicosta* was highly susceptible to most of the 20 candidate insecticides. Twelve compounds caused 50% kill at a dosage level of $<5\mu g/g$ body weight (Table 2). In decreasing order of toxicity, they were resmethrin, methomyl, phoxim, pyrethrins, DDT, Zectran, chlorpyrifos, Landrin, Gardona, carbaryl, Imidan, and aminocarb. The 1st 6 required $<2\mu g/g$ for an LD_{50}.

Because of the high toxicity of DDT, the standard in the study, few candidates were more toxic. Only the pyrethroid resmethrin was substantially more toxic (12.3×) at LD_{50}. This compound was significantly more toxic to 5th than to 4th instars. This finding appears to be an exception to the general rule that the dosage needed to give a particular level of kill increases with advancing larval stages (Busvine 1971).

These tests suggest that several compounds are promising candidates for field testing. Resmethrin appears to be an excellent candidate because of its unusually high toxicity to larvae. Pyrethrins recently were stabilized (Miskus and Andrews 1972). Tests against the western hemlock looper, *Lambdina fiscellaria lugubrosa* (Hulst), showed that the stabilization substantially improved prospects for using pyrethrins outdoors (Bogaard 1969, Mason 1970). Another promising candidate, Zectran, was registered for use against the western spruce budworm, *Choristoneura occidentalis* Freeman, and thus is available for testing against other insects. Phoxim, Landrin, Gardona, carbaryl, and Imidan also are promising candidates because of their relatively low mammalian toxicities (Kenaga and Allison 1969).

ACKNOWLEDGMENT.—We thank Tom Eiber and Dr. Imants Millers of the Forest Pest Control Division, Northeastern Area, State and Private Forestry, U.S. Forest Service, St. Paul, Minn., for supplying insects and technical assistance, and Gerald W. Walton, Northeastern Area, State and Private Forestry, U.S. Forest Service, Upper Darby, Pa., for supplying the computer program used in the probit analysis.

Table 2.—Toxicity of insecticides topically applied to 4th and 5th instars of *S. canicosta*.

Insecticide	Insects treated (no.)	Slope ± SE	LD_{50}[a]	95% fiducial limits	LD_{90}[a]	95% fiducial limits
Resmethrin	791	3.08±0.27	0.09	0.08– 0.10	0.23	0.18– 0.35
	300[b]	2.44± .25	.11	.10– .15	.38	.26– .83
	451[c]	3.74± .38	.08	.07– .09	.17	.14– .26
Methomyl	442	2.08± .35	.70	.39– 1.10	2.88	1.63– 14.12
Phoxim	426	2.29± .51	.72	.26– 1.65	2.62	1.16– 68.59
Pyrethrins	391	1.92± .22	1.05	.68– 1.52	4.90	2.73– 13.01
DDT	399	2.85± .30	1.11	.80– 1.38	3.14	2.31– 4.98
Zectran	432	2.20± .32	1.59	.96– 2.26	6.06	3.71– 14.39
Chlorpyrifos	432	4.37± .95	2.12	1.12– 3.06	4.16	2.27– 20.06
Landrin	408	2.60± .20	2.87	2.33– 3.36	8.93	7.21– 11.67
Gardona	433	2.20± .63	3.58	.04–85.59	13.69	[d]
Carbaryl	470	1.74± .27	3.67	1.53– 4.74	19.95	11.08– 41.59
Imidan	432	2.87± .54	3.69	2.10– 5.53	10.32	6.03– 32.94
Aminocarb	436	1.54± .44	4.27	.05– 8.70	29.1	5.46–2503.71
Dowco 214	429	2.97± .74	5.77	1.03–10.55	15.55	5.20– 492.21
C_{12}-trichlorfon	372	1.28± .11	6.88	4.67– 9.14	69.57	43.27– 144.13
Propoxur	381	1.63± .32	8.04	3.15–15.87	49.19	21.01– 918.37
Sumithion	431	2.52± .30	8.13	6.22–11.16	26.22	18.70– 52.16
Malathion	449	2.47± .39	8.48	6.95–12.93	28.00	18.81– 91.28
Trichlorfon	439	1.79± .31	12.63	6.10–19.94	65.52	30.67– 234.79
Monitor	379	3.21± .35	14.65	11.12–16.68	36.71	28.89– 48.56
Fenthion	380	2.30± .29	35.56	22.37–49.70	128.14	78.97– 300.19

[a] μg/g body weight.
[b] 4th instar.
[c] 5th instar.
[d] Data too heterogenous to provide useful 95% fiducial limits.

REFERENCES CITED

Addy, N. D. 1969. Rearing the forest tent caterpillar on an artificial diet. J. Econ. Entomol. 62: 270–1.

Bogaard, T. A. 1969. A comeback for pyrethrum? Agric. Chem. 24 (12): 23.

Busvine, J. R. 1971. A Critical Review of the Techniques for Testing Insecticides. Commonwealth Institute of Entomology, London. 345 p.

Craighead, F. C. 1960. Insect Enemies of Eastern Forests. USDA Misc. Publ. 657. 679 p.

Franclemont, J. G. 1946. A revision of the species of *Symmerista* Hübner known to occur north of the Mexican border (Lepidoptera, Notodontidae). Can. Entomol. 78: 96–103.

Kenaga, E. E., and W. E. Allison. 1969. Commercial and experimental organic insecticides (1969 revision). Bull. Entomol. Soc. Am. 15: 85–148.

Leonard, D. E., and C. C. Doane. 1966. An artificial diet for the gypsy moth, *Porthetria dispar* (Lepidoptera: Lymantriidae). Ann. Entomol. Soc. Am. 59: 462–4.

Lyon, R. L., C. E. Richmond, J. L. Robertson, and B. A. Lucas. 1972. Rearing diapause and diapause-free western spruce budworm (*Choristoneura occidentalis*) on an artificial diet. Can. Entomol. 104: 417–26.

Mason, R. R. 1970. Controlled field test of stabilized pyrethrins against the western hemlock looper. U.S. For. Serv. Res. Note PNW-120. 9 p.

McMorran, A. 1965. A synthetic diet for the spruce budworm, *Choristoneura fumiferana* (Clem.) (Lepidoptera: Tortricidae). Can. Entomol. 97: 58-62.

Miskus, R. P., and T. L. Andrews. 1972. Stabilization of thin films of pyrethrins and allethrin. J. Agric. Food Chem. 20 (2): 313–5.

Reprinted from the
JOURNAL OF ECONOMIC ENTOMOLOGY