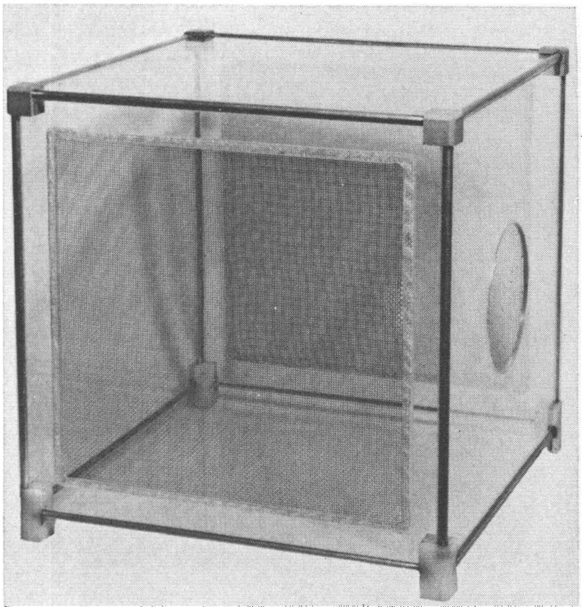

FIG. 1.—Sample cage built up to show a combination of plastic and mesh sides, with double modular corners acting as leg.

and (4) stackable or collapsible, i.e. easy to store or transport. These conditions are satisfied by the modular cage described here.

The cage consists of 8 molded ABS corner pieces which each take three 1/4-in. aluminium tubes, which are simply pushed into the corners. The corner pieces are slotted to receive material 1/16 in. thick, such as hardboard, perspex, glass, mesh, or any combination of these (Fig. 1).

It is possible to wrap the whole cage in nylon mesh (Fig. 2), together with any number of solid sides to suit particular requirements. Plastic connectors are available which can be used either as feet for the cage (Fig. 1) or to allow extension of the cage to double the size. Extension is possible only in 1 direction.

The cage is very light but solid. It can be assembled or dismantled in a few minutes.

It is easily envisaged that the units could be used for lightweight shelving or diverse construction for particular experimental purposes.

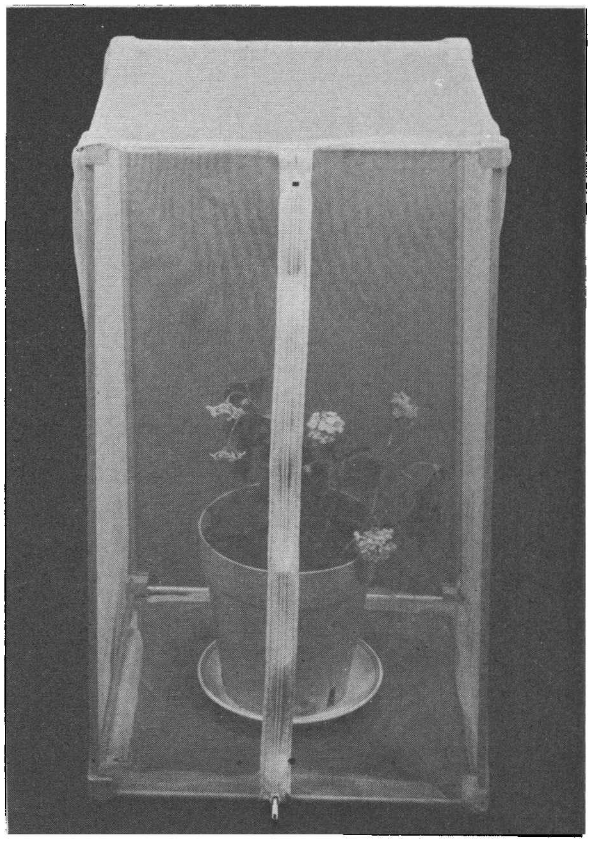

FIG. 2.—Simple frame construction to support covering of nylon mesh.

The corners, which cost about 3 cents each, are made by plastic-injection technique. If desired, we can supply further information on their production.

ACKNOWLEDGMENTS.—We acknowledge the considerable assistance given by R. O'Connel and S. Jackson on the design and construction of the plastic corners.

Contact and Residual Toxicity of Selected Acaricides and Insecticides to a Ladybird Beetle, *Stethorus punctum*[1,2]

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The ladybird beetle, *Stethorus punctum* (LeConte), is an important natural predator of the European red mite, *Panonychus ulmi* (Koch), in south-central Pennsylvania. Marshall (1963) found some pesticides to be highly toxic to certain pests, but only moderately toxic to certain beneficial species when applied at moderate dosages. However, when heavily applied, these compounds were indiscriminately lethal. With the objective of utilizing *S. punctum* in future integrated-control programs, data on the toxicity of compounds commonly used for control of apple pests were collected.

Ripper (1956) summarized previous research on the effect of various chemicals on *S. punctum*. He stated that applications of DDT, chlordane, and parathion resulted in complete elimination of *S. punctum*. Materials tolerated to varying degrees by the predator were nicotine, petroleum oil, lead arsenate, and methoxychlor.

Madsen (1968) reported azinphosmethyl WP, when used at a rate of 2½ to 3 lb/acre, gave good codling moth control and resulted in only minimal toxicity to predators.

[1] Coleoptera: Coccinellidae.
[2] Authorized for publication Feb. 19, 1970, as paper no. 3739 in the journal series of the Pennsylvania Agricultural Experiment Station. This research was supported in part by USDA, Agr. Res. Serv. grant no. 4023. Received for publication Mar. 5, 1970.
[3] Graduate assistant and Professor of Entomology respectively, Department of Entomology.
[4] Acknowledgment is made of the valued assistance of Vincent W. Spangler.

Table 1.—The percent mortality from treatment of 6 pesticides on adults of the predaceous coccinellid *S. punctum*.[a]

Treatment	Dosage/ 100 gal spray (lb)	Treatment dates (1969)	Mortality at hours after treatment: Contact[b] 1	Contact[b] 24	Contact[b] 48	Residue[b] 1	Residue[b] 24	Residue[b] 48
Imidan WP 50%	0.50	6/17	0	3	67	0	0	40
	.75	6/17	0	3	30	0	0	17
Gardona WP 75%	.25	6/2	0	0	26	0	0	11
	.50	6/2	0	0	24	0	0	2
Azinphosmethyl WP 50%	.25	5/19	0	0	38	0	0	13
Galecron 4 EC[c]	1.00[c]	6/24	0	0	33	0	0	8
Fundal SP 95%	.25	5/30	0	0	63	0	0	13
	.50	5/30	0	0	67	0	0	29
Lovozal WP 20%	1.00	8/11	0	0	35			
40%	.50	8/11	0	0	12			

[a] % mortality based on Abbott's (1925) formula.
[b] 30 beetles exposed to each type test at each dosage level for all treatments.
[c] Tested at 16 fl. oz.

MATERIALS AND METHODS.—Adult *S. punctum* were collected from 3 apple orchards in south-central Pennsylvania. The beetles were collected from trees by placing a styrofoam cup beneath the leaf where the beetles were present. With a camels'-hair brush the beetles were brushed into the cup. The beetles were taken to the laboratory in the styrofoam cups. All beetles were 1st-generation adults with the exception of those used in the Lovozal test; those were of the 3rd generation.

The materials to be tested were then weighed and the solutions were mixed in the appropriate amount with water. The acaricides and insecticides tested, their formulations, active ingredients, and sources were:

Imidan® WP 50%; *O,O*-dimethyl *S*-phthalimidomethyl phosphorodithioate; Stauffer Chemical Co.;
Gardona® WP 75%; 2-chloro-1- (2,4,5-trichlorophenyl) vinyl dimethyl phosphate; Shell Chemical Co.;
azinphosmethyl WP 50%; Chemagro Chemical Co.;
Galecron® 4 EC; *N'*- (4-chloro-*o*-tolyl) -*N,N*-dimethylformamidine; Ciba Corp.;
Fundal SP® 95%; *N'*- (4-chloro-*o*-tolyl) -*N,N*-dimethylformamidine, hydrochloride; Morton Chemical Co.;
Lovozal® WP 20% and 40%; phenyl 5,6-dichloro-2- (trifluoromethyl) -1-benzimidazolecarboxylate; Fisons Corp.

The capture cups as well as the test cups were 8 oz no. 320 styrofoam cups.[5] Holes 1 in. square were cut in 2 opposite sides of the cup, about in its center. The holes were covered with white Dacron Ninon screening[6] which was glued in place with Elmer's Glue-All®.[7] A lid was made by cutting a cup in half horizontally and then covering the upper half with white Dacron Ninon screening which was also glued in place.

Three leaves infested with European red mites were placed in each test cup. Leaf turgor was maintained by wrapping the petioles with water-moistened cotton and sealing the cotton with parafilm.[8]

For the contact test, a small amount of each test material was placed in a 50-ml beaker. The field-collected beetles were then taken from the capture cup and placed in the solution, immersed, and allowed to remain in the solution 15 sec. The beetles were removed, while still wet, from the solution with a probe and placed on the leaves in the test cups. Three lots of 10 beetles each were placed in individual cups; mortality was recorded after 1, 24, and 48 hr.

Two control cages were maintained for each type of treatment for each test day. For the contact test the beetles were placed in clean untreated cups with mites for food. For the residue tests paper liners were wet with water and placed into the cups, then the mites and the beetles were introduced.

Residue tests were conducted in test cups of the same size and description using techniques similar for contact tests except that paper liners of 400 white 100% sulphite[9] were dipped into the test solutions. The liners were air dried for 15 min, placed into the cups, and fastened with a straight pin at the top. Three lots of 10 adult beetles were then placed in each of 3 cups and mortalities were recorded after 1, 24, and 48 hr.

The beetles were very active when placed in the cups and as a result did not remain solely on the leaves to feed. This factor assured frequent contact with the treated paper liners that were in the cups for the residue tests.

A small desk fan, 0.1 amp, catalog no. FR-10,[10] was used to assure air circulation in the cups during the test period. Relative humidity was kept at 50%; the temperature was 26°±2°C.

Abbott's formula (1925) was used to correct mortalities when the control mortality exceeded 5%.

DISCUSSION AND CONCLUSIONS.—None of the chemicals tested killed all of the beetles exposed to it, but direct contact with the chemicals was more toxic than the residual action of the chemicals (Table 1). These mortalities are only an indication of relative toxicity of the chemicals, but they yield valuable information, since the beetle in the orchard is likely to come into contact with these chemicals in one of these two ways. It is probable that these tests yielded higher mortalities than are likely to occur in the orchard.

In our judgment 48 hr is perhaps too long to attempt to hold the beetles in the cups, since at 48 hr there was considerable mortality among the control beetles. For the 6 days of the contact tests there were 220 control beetles held, with no mortality occurring from 1 to 24 hr. However, from 24 to 48 hr control mortality ranged from 4 to 43%. For the 5 days of the residue tests 200 control beetles were tested, and again no mortality occurred from 1 to 24 hr. From 24 to 48 hr control mortality ranged from 4 to 20%.

All the chemicals tested could be used in an integrated-control program for orchard pests with minimal toxicity to *S. punctum*. However, there always will remain the need for more chemicals which are harmless to beneficial arthropods but are still capable of bringing pest species to a level which causes no or only slight economic damage.

[5] Mars Cup Co., Northport, L. I., N. Y. 11768.
[6] Dodgeville Finishing Co., Attleboro, Mass. 02703.
[7] Borden Chemical Co., New York, N. Y. 10017.
[8] Scientific Products, Evanston, Ill. 60201.
[9] Gates Paper Co., Kalamazoo, Mich. 49001.
[10] Emerson Electric Co., St. Louis, Mo. 63100.

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Horn Fly[1] Control with Dichlorvos-Impregnated Strips[2]

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Sustained release of dichlorvos from resin strips and collars provides a practical means of dispensing vapor to control many insect pests and has been used widely to control flying insects in buildings where strong ventilation can be avoided. However, short-nosed cattle lice, *Haematopinus eurysternus* (Nitzsch), were controlled on cattle confined less than 24 hr to a shed containing strips (Harvey and Ely 1968), and cat fleas, *Ctenocephalides felis* (Bouché), were controlled for 3 months on cats wearing impregnated collars in a well-ventilated building (Fox et al 1969).

We attempted to determine how well dichlorvos-impregnated tags, strips, blocks, and collars attached to cattle in pastures controlled horn flies, *Haematobia irritans* (L.).

METHODS.—Collars, tags, and blocks were cut from standard resin strips (6×25 cm) containing 20% dichlorvos supplied by Shell Chemical Co., Princeton, N. J. Sections (5×6 cm) for ear tags used in test 1 were cut from the strips and riveted or stapled to modified rubber ear tags procured from Ritchey Mfg. Co., Ft. Lupton, Colo. (Fig. 1). A rubber washer, cut from the portion removed from the ear tag, was used on the upper part of the ear to support the added weight (20 g) of the attached section of dichlorvos-impregnated resin.

Strips and blocks were suspended from neck chains in tests 2 and 3, respectively. In test 2 standard, uncut 25-cm strips weighing 108 g were evaluated (Fig. 2), and in test 3, a 50-g block (6×6×1 cm) was attached to each neck chain (Fig. 3).

The collar used in test 4 was made by cutting a standard 25-cm strip in 5 strands (1×25 cm), joined end to end by rivets, and the strands formed an adjustable collar (up to 110 cm long) weighing about 100 g (Fig. 4).

Before treatment, horn fly numbers were estimated on the cattle confined in small holding pens. Post-treatment counts were made from a truck driven among the cattle in pastures. Estimates were made from both sides of each animal. Horn fly counts on untreated cattle in the same vicinity also were recorded during time of tests.

RESULTS.—Numbers of horn flies on untreated Hereford cattle on native-grass pasture at Hays, Kans., ranged from 100 to 1000/head during the period of tests (July to September 1969).

Test 1.—Twenty-two heifers (avg ca. 100 horn flies/head) were tagged in the left ear (Fig. 1) on July 18 and returned to a 30-acre pasture. One day after treatment, all animals except one were free of horn flies. Populations remained low (fewer than 50/head) for the next 30 days but increased to 200/head after 45 days and 350/head after 65 days.

Test 2.—Ten cows (avg ca. 150 horn flies/head) were each fitted with a 108-g strip attached to a neck chain (Fig. 2) on July 24 and returned to a 60-acre pasture. The next day (July 25) all cows were free of horn flies. Populations remained below 50/head for 3 weeks after treatment but increased to 150/head after 40 days and 250/head after 65 days.

Test 3.—Twelve steers (avg ca. 200 horn flies/head) were each fitted with a 50-g block attached to a neck chain (Fig. 3) on Sept. 25. Horn fly numbers were 10, 75, and 200/head on days 1, 7, and 14, respectively, after treatment. There appeared to be no control after 14 days.

Test 4.—Two bulls (avg ca. 1000 horn flies/head) were held in a 5-acre pen. A 3rd bull, similarly infested, was held in a 2nd pen, separated from the 2-bull pen by a 15-m roadway. On Aug. 25, 1 of 2 bulls held in the same pen was fitted with a 100-g collar (Fig. 4); the next day both bulls in that pen were free of horn flies, while the untreated bull in the other pen remained infested. The collar then was transferred to the segregated infested bull; 1 day later it also was free of horn flies. No attempt was made to determine how long the collar provided horn fly control.

DISCUSSION.—Dichlorvos-impregnated resin attached to cattle controlled horn flies for periods ranging from about 1 week to 1 month. The treatments during July and August controlled the flies for a longer time than did the one in September, possibly because the release rate of dichlorvos was slower at the lower temperature in September. Dichlorvos spray is recommended for horn fly control on dairy cattle, so apparently no residue problems would result from attaching impregnated resin to cattle.

Ear tags are being used increasingly to mark cattle; hence, a tag made of dichlorvos-impregnated resin, if effective for horn fly control, could serve a dual purpose. Neck-chain tags could also serve a dual purpose. Chains are more expensive and not so permanent as ear tags. A collar similar to those used on dogs and cats but large enough to accommodate cattle would seem to be the most promising, but it probably would not be practical to make frequent tag or collar changes. Since season long fly control was not achieved with a single application in these tests, it probably would be necessary to develop a collar having a longer dichlorvos-release period.

We do not know the reason dichlorvos vapor can affect horn flies outdoors, where conditions are seemingly unfavorable for effective vapor concentration. However, it may be similar to the initial control of horn flies reported when only 6–33% of the cattle within several herds were treated with Ciodrin in wax-bars (Harvey and Ely 1970).

There were few opportunities to note effects of treatments on other insects, but it generally appeared that stable flies, *Stomoxys calcitrans* (L.), were not controlled. In 1 instance partial control of short-nosed cattle lice was observed on a carrier animal.

Use of dichlorvos-impregnated resin on cattle for insect control appears promising enough to justify further investigations.

[1] Diptera: Muscidae.

[2] Contribution no. 1022, Department of Entomology and no. 247, Fort Hays Branch, Kansas Agricultural Experiment Station, Kansas State University, Manhattan 66502. Received for publication Mar. 20, 1970.

[3] Associate Entomologist and Associate Animal Husbandman, respectively.