BACKRUBBERS AS A METHOD OF CONTROLLING HORN FLIES ON CATTLE IN VIRGINIA

by

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I. INTRODUCTION

The horn fly, Siphona irritans (L.), is a small blood sucking fly about 4 mm. long which belongs in the family Muscidae of the order Diptera. This fly is an obligate parasite of cattle, remaining on the host constantly leaving only to deposit its eggs on fresh dung.

This insect has been a serious pest on beef and dairy cattle since it was introduced into the United States near Philadelphia between the years 1886 and 1888. By 1890 it had become a serious pest on cattle in Virginia. Herds averaged as many as 600 or more flies per animal, and individual animals were infested with as many as 2,000 of these insects.

Baker (1918) reported that the control of biting flies on dairy cattle may result in a four to six per cent increase in milk production. Freeman (1925) found that horn flies, feeding once a day, take an average of 3.2 milligrams of blood from an animal per meal. Under controlled conditions he found that cows infested with horn flies produced 1.4 per cent less milk than those protected from the pest. Bruce (1947) obtained an increase of 1 to 32 per cent in milk production of the treated herds over the untreated herds. The best managed herds were found to exhibit the least increase in production. Laake (1946) obtained average weight gains of 30 to 70 pounds per animal in beef cattle treated with DDT compared with untreated cattle. Cutkomp (1958) reported average weight gains up to .69 pounds per day per treated animal compared with untreated animals.

The purpose of this research is to evaluate the use of backrubbers as a method for controlling horn flies on cattle in Virginia. The

experiments were designed to accomplish three major objectives: (1) to determine if backrubbers treated with different insecticides would provide good control of horn flies on cattle, (2) to obtain information as to the residual effect of the insecticides, and (3) to compare the effectiveness of backrubbers treated with insecticides diluted with inert dust or number two fuel oil.

II. REVIEW OF LITERATURE

A. Nomenclature

The horn fly, Siphona irritans (L.), was first described by Carolus Linnaeus (1758) who placed it in the genus Conops and gave it the species name irritans. Robineou-Desvoidy (1830) described the horn fly in Southern France and gave it the scientific name Haematobia serrata. Rondani (1856) described this insect in Italy and placed it in the genus Lyperosia. Williston (1889) was the first to describe the horn fly in the United States. Although he gave it the scientific name Haematobia cornicola he said it was probably synonymous with H. serrata.

McLintock (1954) in a review of the life history of the horn fly, gave an incomplete summary of its nomenclature. Eldridge (1957) gave the following synonymous genera and their authority: Siphona Meigen, Haematobia Le Peletier de Saint-Fargeauet et Audinet-Serville, and Lyperosia Rondani. He stated that there was considerable disagreement concerning the correct generic name of this insect among dipterists. Rather than attempting to decide the issue he accepted the usage of the authorities at the United States National Museum, which is Siphona Meigen.

The following synonyms of Siphona irritans (L.) were encountered by the author:

1. Conops irritans L.
2. Lyperosia irritans (L.)
3. Haematobia irritans (L.)
4. H. cornicola Williston
5. H. serrata Robineau-Desvoidy
6. H. stimulans Eldridge-James.

The synonyms which appeared most often in the literature are Conops irritans L., Lyperosia irritans (L.), Haematobia irritans (L.) and H. serrata R-D.

B. Life History

Smith (1889) was apparently the first to study extensively the life history of the horn fly, even though it was described many years earlier in Europe. He observed that this insect spent most of its time on cattle, leaving only to deposit eggs on freshly dropped cow manure. He also observed that this fly appeared in early spring and disappeared after the first frosts. The complete life cycle, according to Smith, takes place in about two weeks. He found that this pest over-wintered in the pupal stage. This work was corroborated by Riley (1889) during the same year.

Fernald observed that the eggs of the horn fly hatch in about twenty four hours after being deposited on freshly dropped manure. The maggots pupate in the ground in about seven days. (Fernald 1894). A more precise study was made by Melvin (1931) who found that the eggs hatched in 19 hours and 39 minutes at a constant temperature of 25 degrees centigrade and in 14 hours and 25 minutes at a constant temperature of 30 degrees centigrade. The egg, larval and pupal period required 238.5 hours or 9.92 days at a constant temperature of 30 degrees centigrade. McLintock (1954), gave an excellent review of the life history and habits of the horn fly. He also observed that the horn fly over-wintered in Canada as a pupa or a third instar larva. These forms were found within the manure and either in or on the soil beneath the manure.

C. Horn Fly Control

1. Dairy Cattle: Soon after the introduction of the horn fly into the United States between 1886, and 1888, stockmen became very concerned over the tremendous number of these insects on their cattle and the terrible rumors circulating about the harm they did. Probably the most wide-spread rumor was that these flies actually ate the base of the horns of cattle causing them to fall off. Many deaths of cattle were attributed to this insect. John B. Smith, (1889) was the first person in this country to do extensive research on the life history, control and damage caused by the horn fly. He checked out many stories where this fly was said to be the cause of deathto cattle and found conclusive evidence in nearly every case that death was actually caused by other factors. He also discredited rumors about the horn fly feeding on the horns of cattle and causing them to fall off. Smith tested several materials for their effectiveness in controlling horn flies. These were pyrethrum and tobacco dust, both of which gave good fly control. At that time, the cost of pyrethrum was prohibitive, therefore he recommended only the use of the tobacco dust. To prevent larval development he suggested that a boy be sent out into the pasture to spread the manure.

Howard (1889), of the Federal Division of Entomology, recommended the use of smears of various oils such as fish oil and axle grease as repellents to keep cattle free of horn flies. Fernald (1894) also recommended these smears and stated that they were effective for two to five days.

John Spencer (1904), of the Virginia Agriculture Experiment Station, devised an effective spray system similar to the ones in use today. This consisted of a spray room in which was located a system of spray nozzles arranged so that the cattle passed under it when entering the milk parlor. The insecticide he recommended for use in this sprayer consisted of an emulsion of yellow soap, soft water and kerosene. The cattle were to be sprayed daily with this solution. Marlatt (1910) suggested the use of a spray similar to Spencer's, and also recommended the use of traps, dips and the spreading of the manure as supplemental measures. Ranck (1913) reported good horn fly control by the use of a spray containing cotton seed oil, kerosene, carbolic acid, oil of tar and pennyroyl. Using a spray containing fish oil, kerosene, sour milk, oil of citronella and water, Baker (1917) obtained successful horn fly control with an application every second day. Cory (1917) obtained control with a spray formulated from pine tar, creosote and caustic soda. Cleveland (1926) reported that an emulsion of crankcase oil and oil of tar, applied with an atomizer or compressed air sprayer, would control the horn fly for twenty four hours. Marlatt (1928) obtained good control of this pest using a dust containing powdered derris root and also with a pyrethrin-kerosene spray.

Howell (1944) successfully repelled the horn fly from cattle for ten hours by applying a pyrethrin-thiocyanate oil spray at the rate of 2 cc per 3.23 square feet of surface area to the animal. Excellent horn fly control was also obtained by Peairs (1946) by spraying cattle with DDT at the rate of two pounds per 100 gallons. This material controlled the horn fly from July the 11th through early October, it was not stated how many

applications were necessary to obtain control during this period. McAlister (1947) using a spray containing 2% piperonyl butoxide, 0.2% pyrethrins and 12.5% DDT, applied at the rate of 12 ounces per animal, obtained four days of effective control. Testing various chlorinated hydrocarbon insecticides, Smith (1948) reported that 5% DDT protected dairy cattle for 29 days; 5% methoxychlor for 20 days; 5% DDD for 24 days; 5% toxaphene for 31 days, and 5% chlordane for 32 days after treatment. McGregor (1949), Morrison (1950) and DeFoliart (1954) obtained similar results using chlorinated hydrocarbons. Lindquist (1954) found that good control could be obtained for three weeks by sprinkling a tablespoon of 50% methoxychlor dust on cattle.

Bruce (1952) developed a treadle sprayer which applied insecticides to cattle as they stepped on a treadle. Garnett (1955) using the Bruce treadle sprayer which dispensed a spray containing 0.5% pyrethrins and 5% piperonyl butoxide, obtained good biting fly control on cattle. Cheng (1957) devised an electric eye sprayer which applied a spray to the cattle as they broke the light beam. When used with a spray containing 6% butoxypolypropylene glycol and 0.035% synergized pyrethrins, this device gave excellent horn fly control.

An entirely new approach to the problem of horn fly control was tried by Knipling (1938). He found that phenothiazine administered orally to cattle at the rate of 0.1 grams per kilogram of body weight would prevent the development of the horn fly larvae in the manure of the treated animals. The manure still retained its insecticidal activity up to ninety hours after being eliminated. Cattle given a

subcutaneous injection of 25% lindane were observed to be free of horn flies, (Lindquist 1953). Eddy (1954) reported that lindane fed to cattle at the rate of 100 parts of lindane to a million parts of feed kept them free of horn flies for 21 days and prevented larval development in the manure for up to six days. Aldrin and dieldrin mixed in the feed and fed at the rate of 100 p.p.m., prevented the larvae of the horn fly from developing in the manure for up to 55 days after the last treatment.

The methods and materials previously mentioned were for the most part applicable only for the control of horn flies on dairy cattle or small lots of beef cattle. At the present time the only insecticides recommended for use on dairy cattle are methoxychlor dust and various formulations of pyrethrins.

2. Range Cattle: Until Wells (1944) obtained seven days of good horn fly control on range cattle, there had been no practical means of controlling the pest on these animals. He used a 5% DDT aerosol and also a 0.2% DDT spray applied with a pressure sprayer. Bruce (1946), Peairs (1946), Matthysse (1946), Laake (1946), DeFoliart (1954) and others followed with similar results. Laake (1948) found that by spraying beef cattle with wettable powder formulations of various chlorinated hydrocarbon insecticides, good horn fly control could be obtained. The treatments, and the days of good control (i.e. 25 or less flies per animal), obtained were as follows: 0.5% DDT, 30-45 days; 0.5% methoxychlor, 20-47 days; 0.5% DDD, 20-50 days; 0.5% toxaphene, 27-42 days, and 0.25% chlordane, 17 days.

DeFoliart (1956) reported that the following dust formulations gave good horn fly control on beef cattle when applied with a rotary duster; 50% DDT, 23.5 days; 1% dieldrin, 15 days, and 25% dieldrin, 15 days.

A major contribution to the control of horn flies was made by Rogoff (1952). He reported that cable-type backrubbers treated with various chlorinated hydrocarbons would give excellent horn fly control. These self treating devices which were saturated with 5% DDT, methoxychlor, dilan or toxaphene resulted in good control for fifteen days after treatment. The backrubber, as a method of controlling horn flies, was equally as effective as spraying cattle and it had the additional advantages of requiring much less time and labor. It also resulted in less residue appearing in the tissue of the treated animals than a comparable spray treatment (Rogoff and Moxon 1952). Backrubbers saturated with 5% DDT or chlordane resulted in 30-70 days of good horn fly control (Lindquist 1954). Raun (1956) reported excellent horn fly control for up to five weeks using backrubbers treated with 8% butoxypolypropylene glycol plus 4% methoxychlor and 4% methoxychlor plus 50% butoxypolypropylene glycol. Goodwin (1956) also reported that backrubbers treated with 5% malathion or 5% perthane gave excellent horn fly control when retreated every ten days.

Based on the results of these and other experiments, the backrubber is now recommended for the control of horn flies on beef cattle by the United States Department of Agriculture and many state agriculture experiment stations.

III. THE INVESTIGATION

The difference in the manner of handling and treating beef and dairy cattle has necessitated the division of the investigation into two distinct areas. These may be classified as the control of horn flies on beef cattle and the control of horn flies on dairy cattle. The problem of insecticidal residue is also quite different between the two classes of animals. The dairy animals are brought into the milk parlors at least twice daily and, consequently, are readily available for treatment. Beef cattle, on the other hand, are seldom handled, remaining in the pasture or on the range almost constantly. Milk from dairy cattle constantly goes for human consumption whether the cattle are under treatment or not. Beef, however, is usually not available for human consumption until after control for horn flies has ceased. This enables the cattle to dispose of a large part of any toxic residue which might have accumulated during the treatment period.

A. Horn Fly Control on Beef Cattle

Two preliminary experiments were conducted during the summer of 1956 to test several methods of controlling horn flies on beef cattle. The first experiment was designed to determine if various type back-rubbers treated with several widely used insecticides would give horn fly control when used in Virginia. The second experiment was designed to evaluate backrubbers treated with a dust diluted insecticide. During the summer of 1957, a third experiment was designed to determine: (1) the effectiveness of backrubbers treated with dust diluted insecticides

and oil diluted insecticides; (2) the effect of rain on dust type backrubbers, and (3) the length of time the backrubbers would retain their insecticidal activity.

1. An Experiment Testing Various Types of Backrubbers and Insecticides

The following experiment was conducted to determine specifically if backrubbers would give horn fly control in Virginia. The experiments were conducted under many conditions which might be encountered in this state. These conditions are summarized briefly in Table 1. Four types of backrubbers using three different insecticides were used in this test in order to find out which combination, if any, would give the best control.

a. Procedure: Nine herds of beef cattle and three herds of dairy heifers were chosen for this experiment. Three backrubbers of each of the four types were placed in separate pastures. One of each type was treated with chlordane, toxaphene and Toxowick.*

The insecticides used were oil emulsions diluted to five per cent by the addition of number two grade fuel oil. Number one grade fuel oil was also tried as a diluent; however, it was found that it evaporated too readily for effective use. The insecticides and fuel oil were mixed and applied to the backrubbers until saturation was achieved. All backrubbers were saturated at the time pretreatment counts were taken. They were then retreated every other week thereafter.

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* Toxowick: 25% DDT; 0.3% Lindane; 35% Crag Fly Repellent (Butoxy Polypropylene Glycol).

Table 1.-Field observations for testing various type backrubbers and insecticides in Montgomery County, Virginia, Summer 1956.

Herd No.	Size of Herd	Breed of Cattle	Size of Pasture	Type* Backrubber	Insecticide** Used
1	20 hd.	10 Angus 10 Hereford	one acre	A	5% Chlordane
2	20 hd.	10 Angus 10 Hereford	one acre	B	5% Chlordane
3	25 hd.	20 Holstein 5 Jersey	100 acres	C	5% Chlordane
4	50 hd.	Hereford	100 acres	D	5% Chlordane
5	20 hd.	Hereford	40 acres	A	5% Toxaphene
6	25 hd.	20 Holstein 2 Jersey 3 Guernsey	30 acres	B	5% Toxaphene
7	30 hd.	Hereford	30 acres	C	5% Toxaphene
8	25 hd.	Aberdeen Angus	25 acres	D	5% Toxaphene
9	40 hd.	Hereford	60 acres	B	5% Toxowick
10	20 hd.	10 Holstein 5 Jersey 5 Guernsey	40 acres	C	5% Toxowick
11	40 hd.	Hereford	75 acres	D	5% Toxowick
12	70 hd.	Hereford	60 acres 20 acres 20 acres 25 acres	A	5% Toxowick

* See pages 18 and 28.
** Diluted in number two fuel oil.

The backrubbers were placed near salt licks, water holes, beneath shade trees, or a combination of these locations. These sites were chosen because cattle have been found to loaf frequently near them. Placement near water sources alone was not tried because cattle usually had access to all parts of a stream or pond.

The total number of horn flies were estimated on ten animals chosen at random in each herd. The flies on each animal were estimated by two people. In instances where the animals were easily frightened, field glasses were employed to aid in making the estimates. Pretreatment estimates were taken, followed by post-treatment counts which were made every seven days.

The four types of backrubbers were constructed and installed in the following manner.

Type A backrubber (Figure 1) was made by placing two poles, which were about six feet long, firmly in the ground and about twenty feet apart. Three strands of barbed wire were strung from the top of one pole to the top of another, leaving enough sag so that the center portion was about eighteen inches from the ground. These three strands were combined by wrapping another strand of barbed wire around them or tying them together with heavy baling twine to form a core. Burlap sacks were then wrapped around the barbed wire core, each sack overlapping the next one by six inches. These sacks were secured to the wire every six inches by means of heavy baling twine.

Type B (Figure 2) is a commercial backrubber manufactured by the Tatge Chemical Company.* It consists of a coil spring about four feet

* The Tatge Chemical Company, Herington, Kansas.

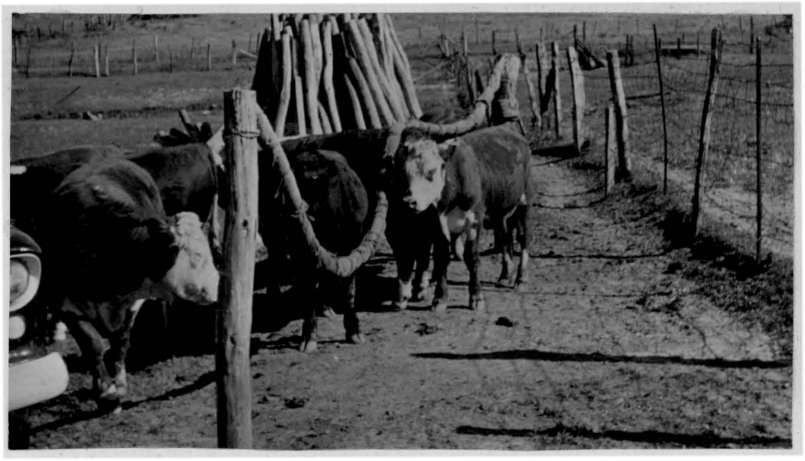


Figure 1. Type A Backrubber

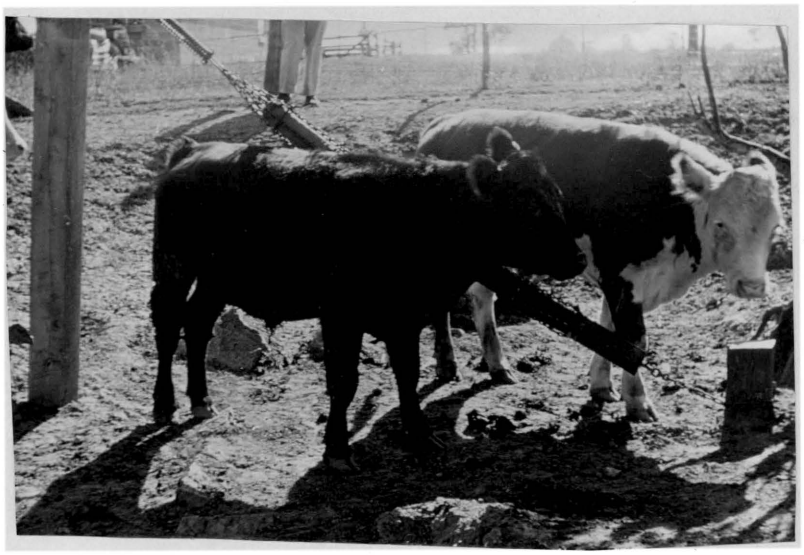


Figure 2. Type B Backrubber

long, wrapped with cotton and covered with canvas. At the lower end is a container which retains the excess insecticide. This core acts in the same manner as the wick in oil lamps which draws the oil from the reservoir. At the upper end of the core is a heavy coil spring which keeps the applicator tight while the cattle rub against it. Three heavy chains run parallel to the wick and are joined together by metal holders. These serve to protect the cotton wick from wear.

The type C or "tent type" backrubber (Figure 3) was made by placing two poles about ten feet from a center pole. Barbed wire was run from the bottom of one pole to the top of the center post and to the bottom of the third pole. The three strands of barbed wire were joined and the sacks were wrapped around them in the same manner as was described previously for the type A backrubber (page 1[illegible]). One of the end posts was covered with burlap sacks which were folded into quarters and stapled to it.

Type D (Figure 4) was constructed by placing a long and a short post about fifteen feet apart. The barbed wire was strung from the top of the four-foot post to the top of the one-foot post. The barbed wire was then joined together and the sacks were wrapped around it as previously described for type A backrubber. The four-foot post was covered in the same manner as described for the end post of type C backrubber. The lower end of the backrubber always sagged six or eight inches after several days of use by the animals.

The following material was used to construct the homemade backrubbers: barbed wire, fence posts, staples, burlap sacks, and binding twine. The

Figure 3. Type C Backrubber

Figure 4. Type D Backrubber

only tools required were: a post hole digger, wire cutters, a digging bar, a shovel and hammer. The approximate cost of the materials for constructing the nine homemade backrubbers was $24.30 or $2.70 per unit. The commercial type backrubbers used in this experiment sold for $39.95 per unit at retail stores.

b. Results: The results of this experiment are given in tables two, three and four. The results are presented in average number of flies per animal and also in per cent reduction based on the pretreatment counts. It will be noted that excellent horn fly control was obtained on all herds except herd 12.

c. Discussion of Results: Good horn fly control was consistently obtained on all herds of cattle where the four types of backrubbers treated with the mentioned insecticides were installed. The evidence, therefore, indicated that these types of backrubbers may be used effectively to control horn flies on cattle in Virginia.

The probable reason for the reduced effectiveness of the backrubber in herd 12 was that the cooperator rotated this herd to different pastures seven times during the season. Although the backrubber was moved to the new pastures at the same time the herds were moved, excellent horn fly control was not always obtained. It is felt that some of the locations chosen for the backrubbers were not suitable and also that cattle could not become accustomed to using them when moved so frequently.

The results from herds six and nine (Table 3 and 4) indicated that the type B or "commercial type" backrubber might not result in as effective control in large pastures as the other type backrubbers. In small

Table 2.-Control of horn flies by the use of backrubbers treated with chlordane. Montgomery County, Virginia. July - September 1956.

Herd number	Type backrubber	Average number flies per animal before treatment		Weekly observations 1	2	3	4	5	6	7	8	9	10	11
1	A	194.5	a*	-	-	-	0.6	6.3	1.3	1.6	0.0	1.5	0.8	0.0
			b**	-	-	-	99	95	99	99	100	99	99	100
2	B	234.0	a	-	-	-	0.5	0.0	1.7	5.6	0.0	0.4	4.2	0.0
			b	-	-	-	99	100	99	98	100	99	98	100
3	C	318.5	a	-	-	2.3	10.4	3.2	1.0	1.6	1.5	11.4	1.9	8.1
			b	-	-	99	97	99	99	99	99	96	99	98
4	D	216.5	a	-	-	2.6	20.0	8.8	23.3	2.9	8.7	5.3	26.1	0.6
			b	-	-	99	91	96	89	99	96	97	88	99

* Average number of horn flies per animal (based on ten animals) per observation.
** Per cent reduction of horn flies on ten animals per observation.

Table 3.-Control of horn flies by the use of backrubbers treated with toxaphene. Montgomery County, Virginia. July - September 1956.

Herd number	Type backrubber	Average number flies per animal before treatment		Weekly observations 1	2	3	4	5	6	7	8	9	10	11
5	A	267.0	a*	-	-	-	12.0	2.2	3.9	5.3	17.9	1.7	2.8	3.0
			b**	-	-	-	96	99	99	98	93	99	99	99
6	B	289.0	a	-	-	-	-	7.1	11.7	10.1	6.2	30.4	42.0	36.3
			b	-	-	-	-	98	96	97	98	90	86	87
7	C	302.5	a	-	-	-	-	-	7.9	5.5	4.3	1.7	1.6	0.5
			b	-	-	-	-	-	97	98	99	99	99	99
8	D	132.0	a	3.3	3.4	6.4	4.2	7.7	3.4	8.7	10.3	1.5	3.6	1.2
			b	98	97	95	97	94	97	93	92	99	97	99

* Average number of horn flies per animal (based on ten animals) per observation.
** Per cent reduction of horn flies on ten animals per observation.

Table 4.-Control of horn flies by the use of backrubbers treated with Toxowick.* Montgomery County, Virginia. July - September 1956.

Herd number	Type backrubber	Average number flies per animal before treatment		Weekly observations 1	2	3	4	5	6	7	8	9	10	11
9	B	192.5	a**	-	17.7	11.0	8.5	15.5	10.6	15.9	8.0	2.5	24.8	23.3
			b***	-	91	94	96	92	95	92	96	99	87	88
10	C	418.5	a	-	-	4.0	7.8	2.3	1.8	2.5	2.1	0.7	3.8	8.1
			b	-	-	99	98	99	99	99	99	99	99	98
11	D	350.0	a	-	-	-	-	-	-	1.9	2.6	1.5	8.5	1.1
			b	-	-	-	-	-	-	99	99	99	98	99
12	A	209.0	a	-	-	-	24.5	25.9	20.1	31.2	2.2	12.3	47.5	6.1
			b	-	-	-	88	88	90	85	99	94	77	97

* Toxowick: 25% DDT; .3% lindane; 35% Crag Fly Repellent (Butoxy Polypropylene Glycol).
** Average number of horn flies per animal (based on ten animals) per observation.
*** Per cent reduction of horn flies on ten animals per observation.

pastures, however, it seemed to be equally as effective. Apparently terrain, number of trees and size of herd and pasture had little effect on the control obtained by the use of these backrubbers for horn fly control.

2. An Experiment Testing Backrubbers Charged with Dust Diluted Insecticide

A preliminary experiment was designed and conducted during the summer of 1956 to test the effectiveness of backrubbers charged with dust diluted insecticides for controlling horn flies. This experiment was conducted under rugged mountainous pasture conditions.

a. Procedure: Three herds of Hereford cattle having very similar pasture conditions in Giles County were chosen for this experiment. The pastures ranged in area from 50 to 75 acres. Each pasture was located on the side of mountains which were covered with rocks, trees and underbrush. A dust backrubber was placed in each of the three pastures in a clearing within ten feet of a salt lick. The backrubbers were installed and charged the same day.

Pretreatment estimates were taken the same day that the backrubbers were installed and charged. Post-treatment counts were made every seven days until the end of the season. These counts were made on ten randomly chosen animals in each herd by two observers using field glasses.

The dust backrubber was constructed using the basic frame of the "triangle" or type D backrubber (page 23). Before the burlap sacks were wrapped around the barbed wire, approximately one fourth pound of dust

diluted insecticide was poured into the top of each sack. Most of the dust fell to the bottom of the sacks. Thus when the open end of the sacks was fastened to the barbed wire core and the sacks were wrapped around it, most of the dust was located in the outer layer. When half of each sack had been wrapped around the core, approximately one eighth of a pound of additional insecticide was poured into the crease formed between the core and the unwrapped portion of the sacks. The sacks were then wrapped completely around the core. Binding twine was wrapped around the cable every six inches to secure the burlap sacks to it, (Figures 5-10).

b. Results: The results are presented as average number of horn flies per animal (Table 5). The number of horn flies found during the pretreatment counts were very similar, ranging from an average of 237.5 to 268.0 per animal for each herd. This would indicate that the horn fly infestation on each herd was approximately equal at the time the backrubbers were installed and charged. Excellent horn fly control was obtained on each herd for the three week period of observations. A noticeable increase in the number of flies was observed during the second week on all herds. During the third week an increase in the control of horn flies was observed for all herds.

c. Discussion of Results: The three backrubbers treated with 10 per cent toxaphene dust resulted consistently in excellent horn fly control on the cattle in the herds where they were installed. Exposure to the natural elements apparently had little influence on the effectiveness of the backrubbers during this experiment.

A possible explanation as to why there appeared to be an increase in the horn fly population during the second week of the experiment and a

Table 5.-The average number of horn flies per animal before and after installation of backrubbers treated with 10% Toxaphene dust. Giles County, Virginia. Summer 1956.

Herd number	Average number horn flies per animal before treatment	Average number horn flies per animal after treatment		
		Weeks		
		1	2	3
1	268	3.8	11.6	4.6
2	233	1.0	35.7	3.8
3	238	0.1	16.7	3.6

Figure 5. Constructing core and frame for backrubber which is to be charged with a dust-diluted insecticide.

Figure 6. Pouring dust-diluted insecticide into bottom of burlap sacks.

Figure 7. Pouring dust-diluted insecticide into crease formed between sacks and core.

Figure 8. Wrapping charged sacks around core.

Figure 9. Securing sacks to core.

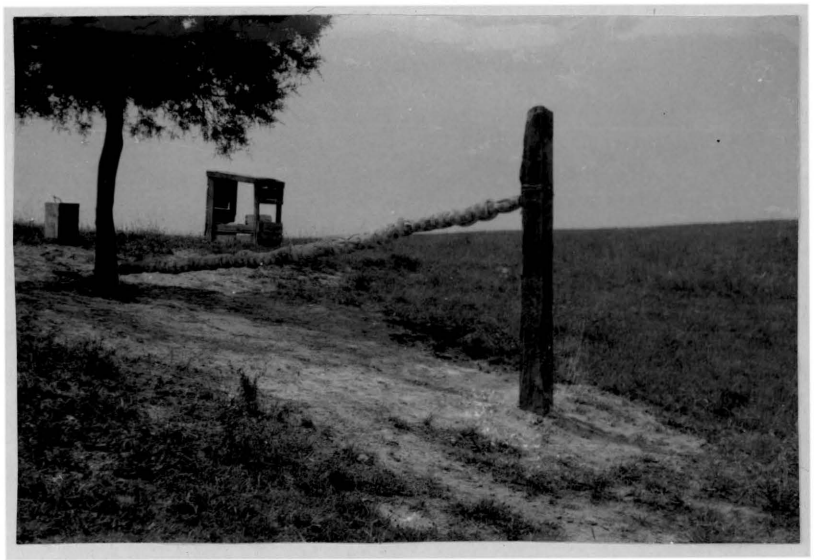


Figure 10. Completed dust backrubber.

decrease during the third week might be the frequency with which the cattle used the backrubber. The cattle might cease to use the device after the initial control had been obtained and resumed using it when there were sufficient flies to irritate them. More research, however, is needed to determine if this is actually the case.

There were several heavy rains during the three weeks this experiment was in progress. Contrary to what might have been expected, the backrubbers continued to emit dust. It was found that one of the backrubbers still discharged dust a year after its initial installation. To determine if the dust still retained any insecticidal activity the backrubber was installed in a new pasture in Montgomery County, Virginia, August, 1957. The following per cent reduction in the horn fly population was observed on this herd: 62% the first week; 86% the second week; 91% the third week, and 80% the fourth week.

3. An Experiment Comparing Backrubbers Treated with Oil and Dust Diluted Insecticides.

The first experiment gave conclusive evidence that the use of backrubbers may be an effective method of controlling horn flies on cattle in Virginia. The second experiment illustrated that dust diluted insecticides could be successfully used in cable-type backrubbers for horn fly control. Several important questions arose as a result of these experiments, 1. How long after charging would the backrubbers continue to give horn fly control? 2. Do backrubbers treated with dust diluted insecticides give control comparable to that given by the ones treated with

oil diluted insecticides? 3. What effect does rain have on the horn fly control given by dust-type backrubbers?

It was the purpose of this experiment to obtain an answer to these questions.

a. Procedure: Fourteen herds of Hereford cattle located in Montgomery County were selected to be used in this experiment. Seven of the herds were located in the Riner area and seven were located in the Blacksburg area. One herd in each area was maintained as a check herd. Because the cooperators treated the original check herds, new ones in the same area had to be used.

The design of this experiment is given in Table 6.

Fly estimates were made weekly by two observers. Most of the herds were docile enough for the observers to make the counts while walking among the animals. When this was not the case, field glasses were used to help in making the estimates. An average of 60 or less horn flies per animal was considered satisfactory control, whereas an average of 20 or less flies per animal was considered excellent control.

The backrubbers were located where it was thought that they would be used frequently. All were placed beneath shade trees or near salt licks, or if possible, both factors were incorporated into the chosen site. Chain swivels were used to attach the core of the backrubbers to the supporting posts. This was done in order to prevent the barbed wire from breaking at the point of attachment and also to allow the core to rotate.

Table 6.-Design of the experiment comparing backrubbers treated with oil and dust diluted insecticides. Montgomery County, Virginia. Summer 1957.

Herd number	Treatment	Retreatment interval	Size of pasture in acres	Size of herd
1	5% Toxaphene dust	4 weeks	20	14 hd.
2	5% Toxaphene oil	4 weeks	20	20 hd.
3	5% Chlordane dust	4 weeks	100	30 hd.
4	5% Chlordane oil	4 weeks	15	10 hd.
5	5% Toxaphene dust	8 weeks	30	20 hd.
6	5% Toxaphene oil	8 weeks	100	50 hd.
7	5% Chlordane dust	8 weeks	100	30 hd.
8	5% Chlordane oil	8 weeks	20	20 hd.
9	5% Toxaphene dust	not retreated	100	50 hd.
10	5% Toxaphene oil	not retreated	20	16 hd.
11	5% Chlordane dust	not retreated	75	30 hd.
12	5% Chlordane oil	not retreated	100	30 hd.

b. Results: Toxaphene dust gave 7.3 weeks of satisfactory horn fly control, for an average of 1.6 weeks longer than the toxaphene oil (Table 7). It will be noted that chlordane dust and chlordane oil gave 16 weeks of satisfactory horn fly control each. The backrubbers were not retreated at any time between the initial treatment and the time the horn fly counts reached an average of 60 flies per animal.

Based on a total of 45 observations for each treatment the various formulations of insecticides gave a definite number of weeks of excellent horn fly control (Table 8). Toxaphene dust and toxaphene oil gave excellent control for 24 and 21 weekly observations respectively. Chlordane oil gave excellent control for 29 weekly observations. On the other hand chlordane dust gave almost twice as many weeks of excellent control as the other treatments.

Rainfall, seemed to have some effect on the control observed from the backrubbers treated with dust diluted insecticides and oil diluted insecticides. The graph (Figure 11) clearly illustrates that the rainfall did not have a greater effect on the control given by the dust-diluted insecticides than it did on the oil diluted insecticides. The toxaphene dust and oil was apparently influenced to a greater extent than was the chlordane dust and oil.

c. Discussion of Results: Toxaphene dust seems to give almost two weeks more control than the toxaphene oil. Both formulations of toxaphene are apparently much inferior to the two formulations of chlordane in regard to their residual effect in the backrubbers. It would therefore

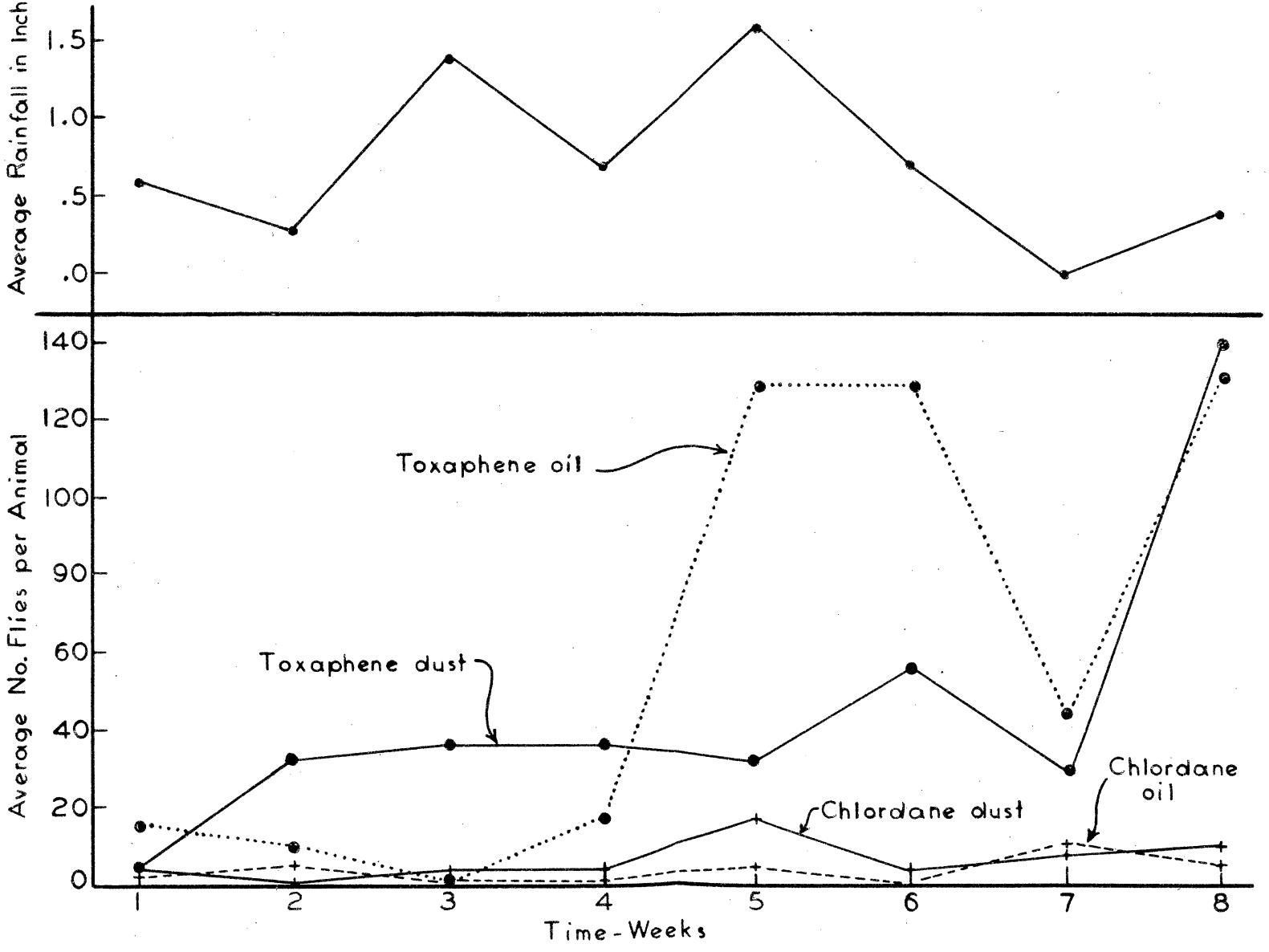
Table 7.-The number of weeks observed after treatment that the horn fly population averaged 60 or less flies per animal. Montgomery County, Virginia. Summer 1957.

Material	Diluent	Weeks	Replicates
5% Toxaphene	dust	7.3	3
5% Toxaphene	oil	5.7	3
5% Chlordane	dust	16.0	0
5% Chlordane	oil	16.0	0

Table 8.-The number of weeks that the horn fly population was observed to average 20 or less flies per animal. Montgomery County, Virginia. Summer 1957.

Times treated	5% Toxaphene		5% Chlordane	
	dust	oil	dust	oil
	weeks		weeks	
4	13	14	14	15
2	10	3	14	1
1	1	4	13	13
Total out of 45:	24	21	41	29

Figure 11. The effect of rainfall on the control of horn flies obtained by the use of backrubbers.



seem that chlordane in either the dust or oil formulation would be an ideal insecticide to use in backrubbers for the control of horn flies.

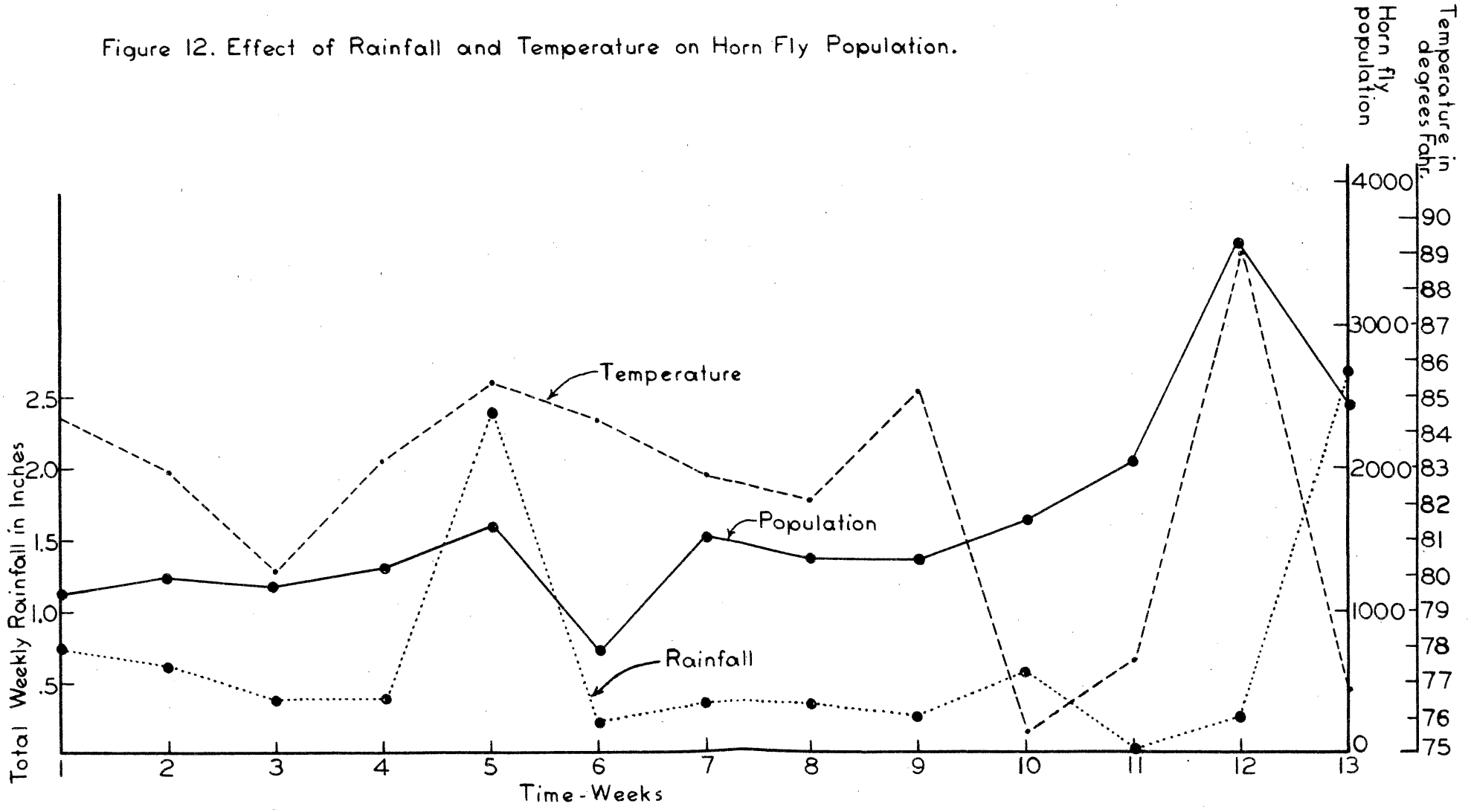
The reason that chlordane oil gave only 29 weeks of excellent horn fly control compared to 41 for chlordane dust might be that one of the herds had an extremely high initial horn fly population. A second possibility might be that the backrubber was not used sufficiently by the cattle to give the expected control.

Rainfall did not appear to be a limiting factor in the control of horn flies by the use of backrubbers treated with either the dust diluted or oil diluted insecticides. The horn fly population increased on the treated herds as well as the untreated check herds following rains and rise in temperature. This would indicate that rainfall and temperature might have an effect on the life cycle of the horn fly rather than the effectiveness of the backrubbers (Figure 12). There probably was some effect on the control given by backrubbers due to rainfall and temperature, however, this does not appear to be significant in light of this information.

B. Horn Fly Control on Dairy Cattle

The need for a simple, economical method for controlling horn flies on dairy cattle has long been apparent. Until recently there were only a few methods of controlling this pest available to the dairyman. One method was to spray the cattle with either a hand operated or power sprayer. A second method was to install a backrubber in a pasture used by the cattle. A third method was to sprinkle a measured amount of

Figure 12. Effect of Rainfall and Temperature on Horn Fly Population.



methoxychlor dust on the animal's back. Some dairymen did not favor the first and third method because it required handling the cattle. The second method was not practical because most dairymen rotated their pastures quite often. The installation of a cable-type backrubber (hereafter referred to as a dairy backrubber) across a pathway used daily by the cows seemed like a possible solution to this problem.

The following experiments were conducted to see if this would be a practical method of controlling horn flies on dairy cattle.

1. A Preliminary Experiment Testing the Dairy-Type Backrubber

a. Procedure: Three grade-A dairy farms, one in Giles County and two in Montgomery County, Virginia, were chosen as the locations for the dairy backrubbers. Each barn had a fenced cattle walk leading to it. The backrubbers were adjusted to make them a little too high for the cattle to step over and yet low enough to cause the animals to lower their heads and go under them. When the cows walked under the dairy backrubber, insecticide was applied to their backs and upper sides. The cattle were supposed to use the backrubbers twice a day, once at each milking. Fly counts were made on ten animals randomly selected in each herd once a week.

A piece of half-inch chain was hung from one side of a cattle walk to the other side, so that the center of the chain was about 32 inches from the ground. Burlap sacks were folded into lengthwise quarters and wrapped around the chain. The sacks were then individually tied at each end. They did not overlap each other but were placed side by side so

that they could turn freely on the chain. The chains were fastened at each end to a screw hook placed in a board about three feet from the ground (Figure 13).

The dairy backrubbers were saturated with Toxowick Dairy Spray,* diluted to five per cent by the addition of number two fuel oil. The concentration was increased to ten per cent on backrubber number one on the day the second post-treatment count was made and on backrubbers two and three the day the first post-treatment counts were taken.

b. Results: The results of this experiment are given in Table 9. When treated with five per cent Toxowick, none of the backrubbers gave effective control. In fact there was an increase in the average number of flies per animal the week after the initial treatment rather than a decrease. Good horn fly control was obtained on all herds when the concentration was increased to ten per cent.

c. Discussion of Results: There is no positive explanation as to why the five per cent concentration failed to give adequate horn fly control. A possible reason might be that it took the dairyman a week or so to learn to adjust the backrubber properly. This was found to be the case with one herd and it could easily have been the same with the other two herds. A second possibility could be that the cows failed to obtain enough insecticide to be toxic to the horn flies.

The cattle became accustomed to using the dairy backrubber within several days after they had been installed. They lowered their heads and went under the backrubbers without any hesitation.

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* Toxowick Dairy Spray: 25.5% Methoxychlor, Technical; 25% Crag Fly Repellent. (Butoxy Polypropylene Glycol).

Table 9.-Results of an experiment testing dairy backrubbers treated with Toxowick Dairy Spray.* Montgomery and Giles Counties, Virginia. August 29 - September 29, 1956.

Herd number	Average number of flies per animal before treatment	Average number of flies per animal after treatment**			
		Weeks			
		1	2	3	4
1	102.0	27.3	34.5	1.6	7.7
2	120.0	-	134.0	4.5	23.3
3	69.0	-	52.2	1.8	8.8

* Toxowick Dairy Spray: 25.5% Methoxychlor, Technical; 25% Crag Fly Repellent (Butoxy Polypropylene Glycol).

** The backrubbers were saturated with 5% Toxowick the 1st and 2nd weeks and with 10% the 3rd and 4th weeks.

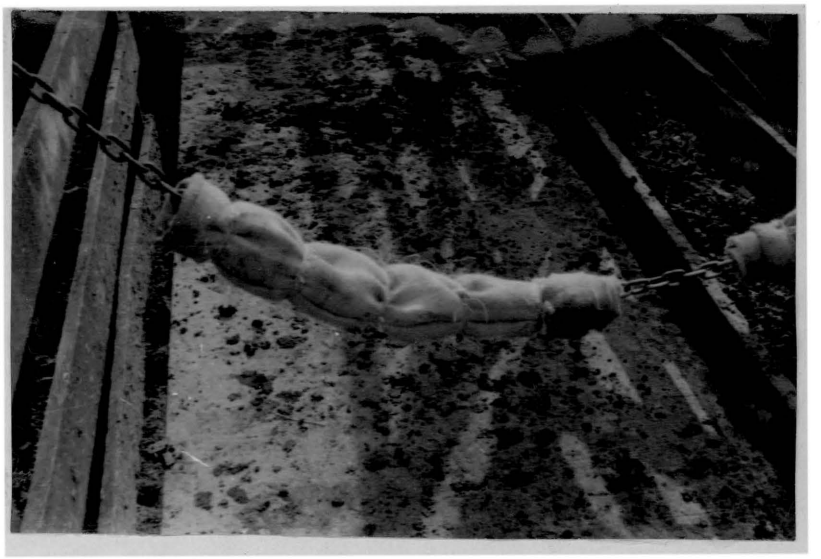

Figure 13. Completed dairy backrubber treated with oil.

Figure 14. Charging dairy backrubber with dust: Step 1.

2. An Experiment Testing Several Formulations of Insecticides with Dairy Backrubbers

This experiment was designed to verify the preliminary experiment testing the dairy backrubber. It was also desired to determine if dust diluted insecticides could be successfully used in the dairy backrubber. Another purpose was to find out how long the dairy backrubber would give successful horn fly control without retreatment.

a. Procedure: Seven grade-A dairy herds in Montgomery County were chosen for this experiment. The dairy backrubber, as described in the previous experiment (page 41), was installed for two of the herds. Dairy backrubbers treated with dust diluted insecticides were installed for the remaining five herds. They were charged with dust diluted insecticides in the following manner. One pound of the prepared insecticide was poured into the bottom of each of the sacks to be used. The sacks were placed side by side. The chain was then placed at the top of the sacks and they were rolled around it. One fourth pound of additional insecticide was poured into the crease formed by the core and the remaining half of the sacks. Next, the sacks were secured to the chain by tying them at each end and the center (Figures 14-16). The charged backrubbers were then installed in the same manner as that described in the previous experiment (page 42).

Horn fly counts were made on ten animals in each herd every seven days. Counts were also made on ten animals in a nearby herd of dairy heifers which was used as a check herd. The herds were predominately Holstein cows. Horn flies were only counted on the darker cows in order

Figure 15. Charging dairy backrubber with dust: Step 2.

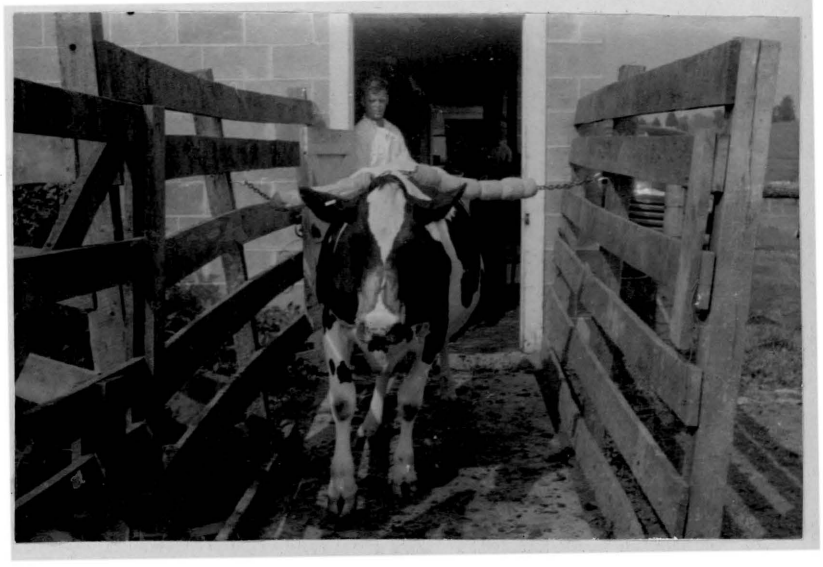

Figure 16. Completed dairy backrubber charged with dust-diluted insecticide.

to minimize any error which might have been introduced in the fly counts due to color of the animal. Horn flies seemed to prefer the darker animals.

Two backrubbers were treated with ten per cent methoxychlor dust, two with five per cent methoxychlor emulsion, two with one per cent Bayer 21/199* and one with 25 per cent methoxychlor dust. All of the treatments except the 25 per cent methoxychlor dust were replicated four times. The backrubbers were retreated whenever the horn fly population averaged fifty or more per animal. An average of 50 or less flies per animal was considered satisfactory control.

b. Results: The average number of weeks of satisfactory horn fly control is given in Table 10. It will be noticed that twenty-five per cent methoxychlor dust gave eight weeks of satisfactory control. The other insecticides and formulations gave from 2.5 to 4.5 weeks less of satisfactory horn fly control.

c. Discussion of Results: The concentration of the insecticide rather than the type of formulation was probably the most important factor in determining the period of effective control. The cooperators were very pleased with this method of horn fly control for dairy cattle. Many indicated a desire to continue using this method.

If any of these insecticides should present a residue problem there is a possibility that this method could be used to apply pyrethrins or

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* O, O-Diethyl O-(3 chloro-4-methyl-7-coumarinyl) phosphorthioate. Manufactured by the Chemagro Corporation, 437 Fifth Avenue, New York 16, New York.

Table 10.-Average number of weeks of horn fly control given by dairy backrubbers. Montgomery County, Virginia. Summer 1957.

Insecticide	Diluent	Replicates	Weeks of control*
25% Methoxychlor	dust	0	8.0
10% Methoxychlor	dust	4	5.5
5% Methoxychlor	oil	4	4.5
1% Bayer 21/199**	dust	4	3.5

* 50 or less flies per animal.
** 0, 0-Diethyl 0-(3 chloro-4-methyl-7-coumarinyl) phosphorthioate.

repellents to dairy cows. This phase of the dairy backrubber should be more fully explored.

Rainfall apparently had little effect on the horn fly control obtained. The backrubbers were found to dry out and continued to emit dust within a day after rain.

IV. SUMMARY

A preliminary experiment was conducted during the summer of 1956 to determine the effectiveness of cable-type backrubbers for controlling horn flies on beef cattle in Virginia. Backrubbers were placed with 12 herds of beef and non-lactating dairy cattle. Four types of backrubbers and three insecticides were tested. These backrubbers treated with the three mentioned insecticides gave good horn fly control to all herds of cattle.

Two additional preliminary experiments, which were conducted during the summer of 1956, indicated that several other methods might also control horn flies on cattle. Dust diluted insecticides showed promise of giving successful horn fly control when used in cable-type backrubbers. A modification of the cable-type backrubber was used with some success for controlling horn flies on dairy cattle.

Two final experiments were conducted during the summer of 1957. The first experiment was designed to compare backrubbers treated with dust and oil diluted insecticides; to determine the residual effectiveness of the backrubbers, and to determine what effect rain had on the effectiveness of the backrubbers. Fourteen herds of Hereford cattle were used for this experiment. Backrubbers treated with dust diluted insecticides gave as good horn fly control as those treated with oil diluted insecticides. Up to sixteen weeks of satisfactory control was obtained as a result of the installation of backrubbers treated with dust or oil diluted insecticides. Rainfall and temperature had little influence on the effectiveness of the backrubbers.

The second experiment was conducted to test further the dairy backrubber. Dust and oil diluted insecticides were used in the dairy backrubbers at various concentrations. This experiment was conducted with seven herds of grade A dairy cattle. Dairy backrubbers treated with the various formulations of insecticides gave up to eight weeks of satisfactory horn fly control.

V. CONCLUSIONS

All types of backrubbers used in these experiments gave good horn fly control when used with the specified insecticides. In all cases backrubbers treated with dust diluted insecticides gave as good control of horn flies as those treated with oil diluted insecticides. Backrubbers treated with toxaphene dust actually gave longer control than the ones treated with toxaphene oil. Size of pasture, herd or the type of terrain apparently had little influence on the effectiveness of the backrubbers.

Rainfall had very little effect on the horn fly control obtained by the use of backrubbers treated with either the dust or oil diluted insecticides. Temperature and rainfall, however, had considerable effect on the over-all horn fly population. Generally when the temperature and rainfall increased the horn fly population increased.

The dairy backrubber offers an excellent method of controlling horn flies on dairy cattle. It eliminates the need of annoying cattle by spraying them or otherwise handling them to control horn flies. It also reduces the amount of labor required to control this pest on dairy cattle.

Backrubbers are an easy, economical, time-saving method of controlling horn flies on beef and dairy cattle which may be used under a wide range of conditions.

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VII. BIBLIOGRAPHY

A. Literature Cited

Baker, A. W. 1917. Preliminary notes on the use of repellents for horn flies and stable flies on cattle. 47th Ann. Rept. Ent. Soc. Ontario for 1916, Toronto 1917, 52-56.

Baker, A. W. 1918. Effect of stable and horn fly attack on milk production. Ont. Ent. Soc. R. 48: 91.

Bruce, W. G., and E. B. Blakeslee. 1946. DDT to control insect pest affecting livestock. Jour. Econ. Ent. 39: 369-371.

Bruce, W. N., and G. C. Decker. 1947. Fly control and milk flow. Jour. Econ. Ent. 40: 530-536.

Bruce, W. N. 1952. Automatic sprayer for control of biting flies on cattle. Ill. Nat. Hist. Surv. Div. Biol. Notes 27: 2-11.

Cheng, T. H., R. E. Patterson, B. W. Avery, and J. P. Vanderberg. 1957. An electric eye controlled sprayer for application of insecticides to livestock. Penn. Agr. Expt. Station Bull. 626: 14pp.

Cleveland, C. R. 1926. Repellent sprays for flies attacking dairy cattle. Jour. Econ. Ent. 19: 529-536.

Cory, E. N. 1917. The protection of dairy cattle from flies. Jour. Econ. Ent. 10: 113.

Cuthomp, L. K., and A. L. Harvy. 1958. The weight responses on beef cattle in relation to control of horn and stable flies. Jour. Econ. Ent. 51: 72-75.

DeFoliart, G. R. 1954. Horn fly control with chlorinated insecticides. Jour. Econ. Ent. 47: 266-268.

DeFoliart, G. R. 1956. Dusting for horn fly control on beef herds. Jour. Econ. Ent. 49: 393.

Eddy, G. W., W. S. McGregor, D. E. Hopkins, and J. M. Dreiss. 1954. Effects on some insects of the blood and manure of cattle fed certain chlorinated hydrocarbon insecticides. Jour. Econ. Ent. 47: 35-38.

Eldridge, B. F., and M. T. James. 1957. The typical muscid flies of California. Calif. Ins. Survey Bull. 6: 6-7.

Fernald, C. H. 1894. The horn fly. Mass. Hatch Sta. Bull. 24: 15pp.

Freeman, S. B., W. M. Regan, and A. H. Folger. 1925. The relation of flies and fly sprays to milk production. Jour. Econ. Ent. 18: 779-790.

Garnett, P., E. J. Hansens, and C. T. O'Connor. 1955. Automatic cattle sprayers for fly control in New Jersey. Jour. Econ. Ent. 48: 386-389.

Goodwin, W. J. 1956. Control of horn flies on cattle with treated rubbing devices. Jour. Econ. Ent. 49: 407-408.

Howard, L. O. 1889. The horn fly. Annual Report Dept. of Agr. 1889: 345.

Howell, D. E., and F. A. Fenton. 1944. The repellency of a pyrethrum-thiocyanate oil spray to flies attacking cattle. Jour. Econ. Ent. 37: 677-680.

Knipling, E. F. 1938. Internal treatment of animals with phenothiazine to prevent development of horn fly larvae in manure. Jour. Econ. Ent. 31: 315-316.

Laake, E. W. 1946. DDT for the control of the horn fly in Kansas. Jour. Econ. Ent. 39: 65-68.

Laake, E. W. 1948. Chlorinated hydrocarbon insecticides for the control of horn flies on beef cattle in Kansas and Missouri. Jour. Econ. Ent. 42: 143-144.

Linnaeus, C. 1758. Systema Naturae Ed. 10: 604. (Original not seen) Eldridge, B. F., and M. T. James. 1957. The typical Muscid flies of California. Calif. Ins. Survey Bul. 6: 6-7.

Lindquist, A. W., A. R. Roth, R. A. Hoffman, W. W. Yates, and P. O. Ritcher. 1953. Chamotherapeutic use of insecticides for control of bloodsucking insects. Jour. Econ. Ent. 46: 613-614.

Lindquist, A. W., and R. H. Hoffman. 1954. Effectiveness of cattle rubbing devices and hand dusting for horn fly control. Jour. Econ. Ent. 47: 79-81.

McAlister, L. C. Jr., H. A. Jones, and D. H. More. 1947. Piperonyl butoxide with pyrethins in wettable powders to control certain agriculture insects. Jour. Econ. Ent. 40: 908-909.

McGregor, W. S. 1949. Field tests of insecticides and spraying methods to control horn flies in dairy herds. Jour. Econ. Ent. 42: 641-643.

McLintock, J., and K. R. Depner. 1954. A review of the life history and habits of the horn fly. Canadian Ent. 86: 20-33.

Marlatt, C. L. 1910. The horn fly. U. S. Dept. Agr. Cir. 115: 1pp.

Marlatt, C. L. 1928. Report of the Entomologist. U. S. Dept. Agr. Washington, D. C.

Matthysse, J. G. 1946. DDT to control horn flies and gulf coast ticks and range cattle in Florida. Jour. Econ. Ent. 39: 62-65.

Melvin, R., and D. E. Beck. 1931. Length of the developmental stages of the horn fly at constant temperature. Jour. Econ. Ent. 24: 330-331.

Morrison, H. E., R. W. Lauderdalei, H. H. Crowell, and D. C. Mote. 1950. Jour. Econ. Ent. 43: 847-849.

Pearis, L. M. 1946. DDT and horn fly populations. Jour. Econ. Ent. 39: 91-92.

Ranck, E. M. 1913. Horn flies and other insects. Miss. Agr. Station Cir. 13pp.

Raun, E. S., and D. J. Casey. 1956. A comparison of backrubber formulations for controlling horn and stable flies in Iowa. Jour. Econ. Ent. 49: 395-397.

Riley, C. V., and L. O. Howard. 1889. The horn fly. Insect Life. 2: 93-103.

Robineau-Desvoidy, J. B. 1830. Myod 389 (Original not seen) Cited from: Williston, S. W. 1889. A new species of Haematobia. Entomological Americana 5: 81.

Rogoff, W. M. 1952. Cable type backrubbers for horn fly control on cattle. South Dakota Agr. Expt. Station Bull. 418: 12pp.

Rogoff, W. M., and A. L. Moxon. 1952. Cable type backrubbers for horn fly control on cattle. Jour. Econ. Ent. 45: 329-334.

Rondani, C. 1856. Dipt. Ital. Prodr., 1: 93 (Original not seen) Cited from: Eldridge, B. F., and M. T. James. 1957. The typical Muscid flies of California. Calif. Ins. Survey Bull. 6: 6-7.

Smith, C. L. 1948. Chlorinated hydrocarbon insecticides for control of the horn fly on dairy cattle in Texas. Jour. Econ. Ent. 41: 981-982.

Smith, J. B. 1889. The horn fly. New Jersey Agr. Expt. Station Bull. 62: 40pp.

Spencer, J. 1904. The horn fly. Va. Agr. Expt. Station Bull. 153: 7pp.

Wells, R. W. 1944. DDT as a fly spray on range cattle. Jour. Econ. Ent. 37: 136-137.

Williston, S. W. 1889. A new species of Haematobia. Entomological Americana 5: 181.

B. Literature Not Cited

Bruce, W. G. 1940. The horn fly and its control. U. S. Dept. Agr. Leaf. 205: 5pp.

Bruce, W. G., and E. B. Blakeslee. 1948. Factors affecting test with DDT sprays to control horn flies. Jour. Econ. Ent. 41: 39-42.

Carter, R. H., et al. 1949. The chlorinated hydrocarbons content of milk from cattle sprayed for control of horn flies. Jour. Econ. Ent. 42: 116-118.

Garnett, P., H. L. Haynes, and R. W. Helm. 1951. Further evaluation of butoxypolypropylene glycol as a fly repellent for dairy cattle. Jour. Econ. Ent. 44: 97-102.

Garnett, P., and E. J. Hansens. 1957. Further observations on the effecto of biting fly control on milk production cattle. Jour. Econ. Ent. 50: 332-336.

Hadwen, S. 1914. Notes on the life history of blood sucking Diptera of British Columbia, with special reference to Tabanidae. Proc. Ent. Soc. Br. Columbia, Victoria Br. Columbia. 4, N. S. 46-49.

Lindquist, A. W. 1936. Parasites of horn flies. Jour. Econ. Ent. 29: 1154-1158.

McDonald, R. E. 1919. The stable fly. Tex. Dept. Agr. Mo. News Bull. 23.

Morris, H. 1918. Blood-sucking insects as transmitters of anthrax or charbon. La. State Univ. Agr. Expt. Station Bull. 163: 15pp.

Towsend, C. H. 1912. Proceedings of Entomological Society of Washington. 14: 47.

Wilhelmi, J. Zur. 1920. Veberwinterung von musciden. Zeitschr. Angew. Entom. Berlin, Vi, No. 2.

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