LOW-LEVEL FEEDING OF RONNEL IN A MINERAL SALT MIXTURE FOR AREA CONTROL OF THE FACE FLY, *MUSCA AUTUMNALIS* DEG. (DIPTERA: MUSCIDAE)

by

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INTRODUCTION

In 1953 a new Dipterous insect, Musca autumnalis Degeer, was reported in North America. Vockeroth (1953) reported the fly in Canada, but at the time it seemed to be only of passing interest. However, the insect spread rapidly across Canada and the United States and emerged as a major pest of the cattle industry. Musca autumnalis was first reported in Virginia in 1958 (Sabrosky, 1959), and became a cattle pest of major importance.

The fly's habits of clustering and feeding on secretions of the eyes and nostrils of cattle have proven to be a source of constant irritation to the animal and have led entomologists to give it the name, cattle face fly. The cattle congregate in shady areas where the flies seem to be less severe, resulting in less grazing and a loss of weight and milk production. McDaniel (1960) has reviewed this loss.

Hammer (1942) and Teskey (1960) studied and reviewed the literature on the life history and habits of the face fly. Briefly, the adult fly lays her eggs in fresh cow manure. The larvae develop within the droppings, and when fully grown most of them move into the nearby soil to pupate. Under field conditions, the complete cycle from egg to adult takes about two weeks.

The fact that the face fly breeds in the field droppings causes control of the larval stage to be difficult. Also,

since the adults are found throughout the pasture, residual spraying and dusting of cattle has not been successful.

The objective of this research is to evaluate a method of low-level feeding of ronnel (O,O-dimethyl O-(2,4,5-trichlorophenyl) phosphorothioate), in a mineral salt mixture as a larvicide over a large area for control of the face fly.

LITERATURE REVIEW

Soon after Musca autumnalis was observed to be a pest of cattle, various reports were published on how to achieve control of the fly. Bruce et. al. (1960) reported control using 0.1-0.2 percent DDVP in a syrup bait on the animal. This was later confirmed by Holdsworth (1962). Dorsey et. al. (1962) reported control using various organic phosphate insecticides applied as sprays or dusts.

Bodenstein and Fales (1962) and Treece (1961) found the face fly to be very susceptible to various insecticides in the laboratory, which led entomologists to believe that baits, sprays, or dusts would be effective in the field.

In areas of high concentration of flies it became evident that neither baits, sprays nor dusts would control the face fly. Fales et. al. (1961) reported poor results using DDVP baits. According to Cheng et. al. (1962) control of the face fly was harder to obtain than the stable fly, Stomoxys calcitrans L.. Granette et. al. (1961) (1962) failed to achieve control with baits, sprays, or dusts. Wallace and Turner, (1962) in Virginia, also failed to obtain control of face flies using various sprays and dusts applied to the head and shoulders of the animals. In those cases where entomologists (Dobson and Huber 1961, Dorsey et. al. 1962) reported a high level of control a heavy initial infestation of flies on the cattle did not exist.

Application of insecticides to animals for control of the face fly in the field is difficult. Davis (1961) mentioned that the fly's habit of breeding in open pastures is largely responsible for control difficulties. This widely dispersed breeding area allows the fly to breed in areas that aren't easily reached with insecticidal applications. According to Fales et. al. (1961) weather, time of application (the morning applications give higher control), nearby untreated animals, tall dew-laden brush which dilutes and removes insecticides from animals are other factors leading to poor control with insecticidal applications.

Knipling (1938) found that phenothiazine administered to cattle orally rendered the manure toxic to horn flys, Haematobia irritans L., which breed exclusively in fresh manure. Bruce (1939) reported essentially the same results. Bruce's findings indicated that dosages of 22 mg of phenothiazine per kg of animal body weight prevented growth of horn fly larvae in manure for 24 hours. Eddy et. al. (1954) reported control of horn fly and house fly larvae in manure by feeding lindane, aldrin and dieldrin to cattle.

In 1956 Crenshaw reported on the development of a new systemic insecticide, DOW-ET-57 (ronnel) for cattle grub control. He concluded that the compound had a low mammalian toxicity. McGregor and Bushland (1957) reported that ronnel given to cattle at a dose of 100 mg per kg of body weight resulted in control of blood-sucking stable flies as well as

control of cattle grubs. Raun and Herrick (1957), as well as numerous other workers, obtained 100 percent control of cattle grubs using ronnel at 100 mg per kg of body weight. Raun and Herrick observed symptoms of toxicosis in ronnel treated animals a few hours after treatment, but these animals recovered fully in 2 or 3 days.

Radeleff and Woodard (1957) studied ronnel toxicity in cattle and sheep and reported the following results: (1) dosages of 125 mg per kg of body weight or higher were toxic to yearling and older cattle; (2) dose levels of 100 mg per kg produced no symptoms of toxicosis for any cattle except one four month old calf which had mild diarrhea; (3) no deaths were reported in 250 cattle treated at dose levels of 100-120 mg per kg of body weight, and (4) one sheep had mild diarrhea at 400 mg per kg of body weight. They concluded that there was a large difference between minimum toxic dose and minimum lethal dose.

Using radioactive phosphorus-32 as a tracer, Plapp and Cassida (1958) determined the distribution of metabolic pathways of ronnel. A holstein heifer in late lactation was given phosphorus-32 labeled ronnel at 100 mg per kg of animal body weight. They found that ronnel elimination in urine reached a peak at 18-24 hours and accounted for 49 percent of the total amount administered. The feces elimination accounted for 7 percent of the total dose and reached a peak 24 hours after treatment. Also at this time, cholinesterase

activity dropped to 40-50 percent of the pre-treatment level in the cow. Eight hours after treatment, milk residues reached a peak of 37 p. p. m. ronnel and declined to 0.4 p. p. m. one week later. This milk was fed to a young calf and no depression of cholinesterase activity was noted.

Eddy and Roth (1961) controlled larval development of the house fly Musca domestica L., stable fly, Stomoxys calcitrans L., and the horn fly Haematobia irritans L., by feeding newer organo-phosphorus insecticides to cattle at low levels. Anthony et. al. (1961) fed to cattle 0.5 mg ronnel per kg of body weight in a grain ration for 5 consecutive days. Face fly and house fly larvae that were introduced into the manure from these cattle were all killed. Ronnel fed at the rate of 2.5 mg per kg of body weight was effective in controlling face fly larvae, but was not effective in control of house fly larvae. Sherman and Ross (1959) fed chickens organophosphate insecticides and reported that the droppings were toxic to house fly larvae.

Rogoff and Kohler (1959) reported that they obtained control of cattle grubs by feeding ronnel in a mineral salt mixture. Wallace and Turner (1962) fed, free-choice, a 5.5 percent ronnel mineral salt mixture (Medicated Rid-Ezy[1]) as a

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[1]Medicated Rid-Ezy, Moorman Manufacturing Company, Quincey, Illinois, containing 5.5% ronnel active ingredient; Salt (NACL) 37-39%; and additional mineral ingredients.

larvicide for face fly control. Cattle fed at the rate of 3.04 mg ronnel per kg of body weight resulted in reduced larvae counts in the manure, but no adult fly control was observed. They concluded that the lack of adult control was due to the migration of adult flies from nearby untreated herds and that further evaluation of low-level feeding would be needed on an area basis.

MATERIALS AND METHODS

Location

This research was conducted on the farm of Mr. H. C. Stuart at Elk Garden, Virginia. Elk Garden is located in Russell County in southwest Virginia. The elevation varies from 2132 to 2480 feet above sea level. The topography consists of rolling hills bordered by mountains that attain a height of 3800 feet. Elk Garden is one section of a large valley containing numerous herds of cattle.

General

This experiment utilized approximately 1600 head of cattle. These cattle were divided into 23 different pastures consisting of approximately 2000 acres of land in one tract. The names of the pastures used in this thesis are the ones that were originally used by the owner.

The cattle in each of the pastures were offered free choice the 5.5 percent ronnel mineral salt mixture (Medicated Rid-Ezy) from May 1 to October 9, with the exception of two pastures on the perimeter of the area. These two herds received no ronnel and were used for control purposes.

The ronnel mineral salt mixture given to the treated herds was replenished weekly in the salt boxes. These salt boxes were the covered type and open on four sides. There was an upper trough for older cattle and a lower trough for calves.

The salt was stored in a centrally located building. A chart was kept there so that the weekly consumption records of each herd could be recorded by the farm manager, who placed the salt in the boxes.

Total consumption at the end of the test period was obtained by weighing the salt left in the boxes and subtracting this weight from the total amount of salt placed in the salt boxes during the entire period of the experiment. Consumption records were figured on the basis of milligrams of ronnel consumed per kilogram of animal body weight per day. The weight of the animals was obtained from Mr. John Barnes, manager of Elk Garden farms.

Larval Counts

Larval counts were made weekly from May 8 to September 13 on a total of nine fields. Seven of the treated herds and both of the check pastures were sampled.

Larval counts were made by taking a random core sample from 3-4 day old cattle droppings. Twenty-five such core samples were taken in each pasture by means of a coffee can five inches in diameter. A wooden handle was attached to the bottom of the can to make a "cookie-cutter" type of apparatus. The can was inserted into the dropping and a small shovel was pushed under the can (Figure 1). The core sample was transferred on the shovel (Figure 2) to galvanized metal trays 21" x 14" x 4" deep with small holes in the bottom. The author found the holes to be of value in letting water drain

Figure 1. Method of collecting core samples

Figure 2. Transferring core sample to metal tray

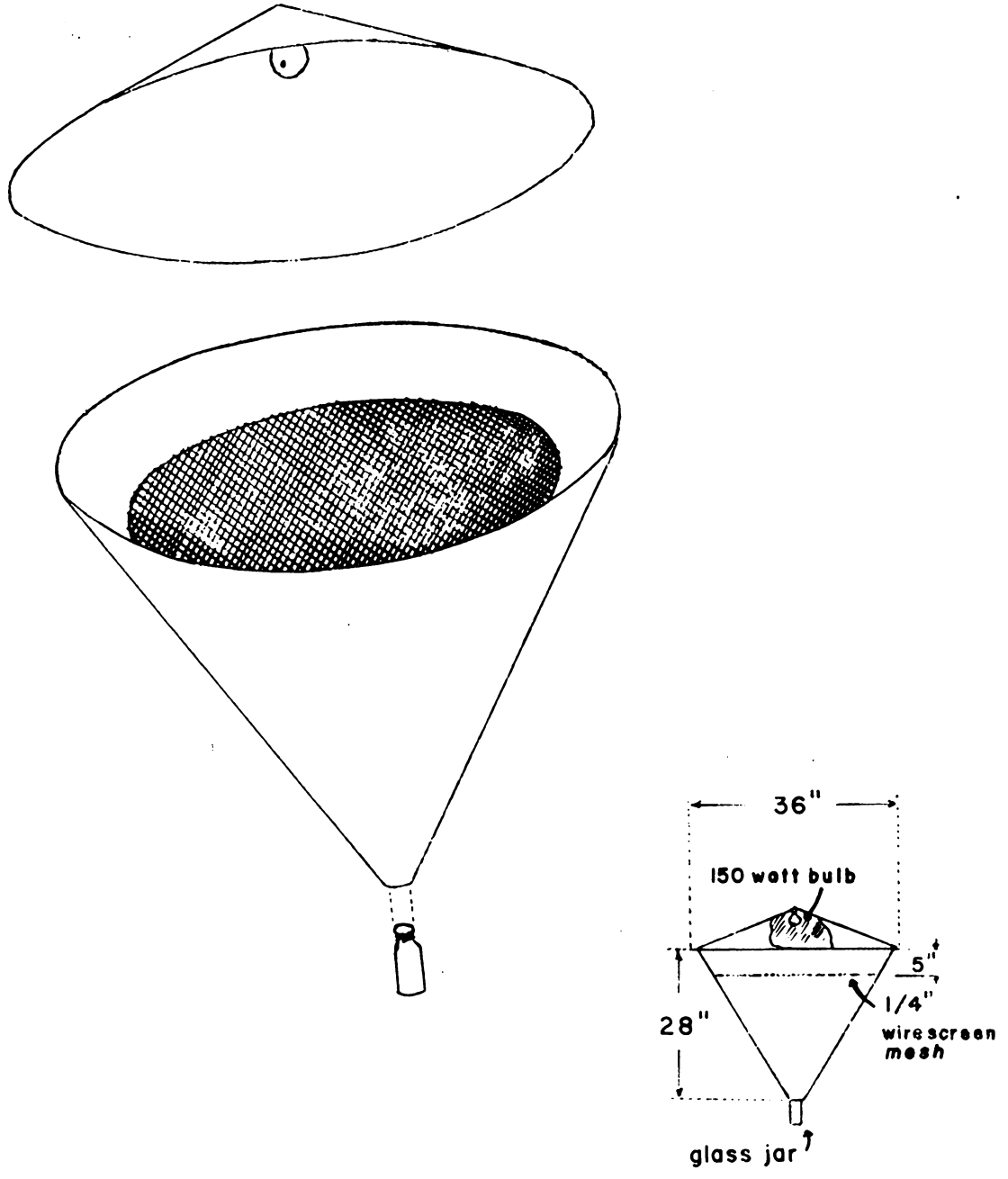
from the tray, especially when the droppings had a high moisture content. A standard mesh screen wire was placed in the tray before adding the manure. The screen wire served a double purpose of preventing the larvae from escaping through the holes in the bottom of the tray and adding ventilation to the tray.

Separate trays containing twenty-five manure samples each were used for each of the nine fields. A small white stake with the name of the field and the date of collection was placed in each tray after a field was collected.

The trays were brought to Blacksburg, Virginia the same day the collections were made, and the contents from each tray were placed in a Berlese funnel, (Figure 3). The manure was spread over a 1/4 inch mesh wire in the Berlese funnels and a jar of 95 percent ethanol was attached at the base of the cone of each funnel. The lids of the Berlese funnels contained a 150 watt light bulb. The combination of heat and light caused the larvae to migrate to the wire screen. The larvae then fell through the wire, into the jar containing the alcohol. The manure was allowed to remain in the Berlese funnels for 4 to 5 days. At the end of this period, the jars were removed.

The contents of each jar were emptied into a white enamel baking pan and the face fly larvae were separated from other species and counted. The weekly collections from each field were preserved in pint Mason jars containing 95 percent ethanol for future reference.

Figure 3. Berlese funnel



Adult Counts

Adult face fly counts were made in each of the nine fields where larvae counts were made. Ten animals were selected at random in each of the nine pastures and the total number of face flies on the head of each animal was counted by means of binoculars. Counts were made between 10:00 a.m. and 3:00 p.m. since fly infestation on the animals was highest at this time. Abbott's formula was used to figure percent control for both larval and adult counts.

RESULTS AND DISCUSSION

The results for each field are presented separately since pasture conditions were different for each of these fields. A short discussion is also included in the results for clarity of interpretation. The location of each field should be referred to on the map on page 19. Data presented in the results may be found in Tables 1 and 2 on pages 20 and 21.

Check Pastures

Coal Pit

This pasture was located on the perimeter of the treated area and was used as a control. A standard mineral salt without ronnel was used here. The average face fly count per animal was 26.3. The average face fly larval count per twenty-five core samples was 550.

Upper Burk

This herd was used as a second check herd and was located on the perimeter of the treatment area on the opposite side of the treated area from the Coal Pit. These cattle also received a standard mineral salt containing no ronnel. The average face fly count per animal was 34.2 with an average larval count of 752 per twenty-five core samples.

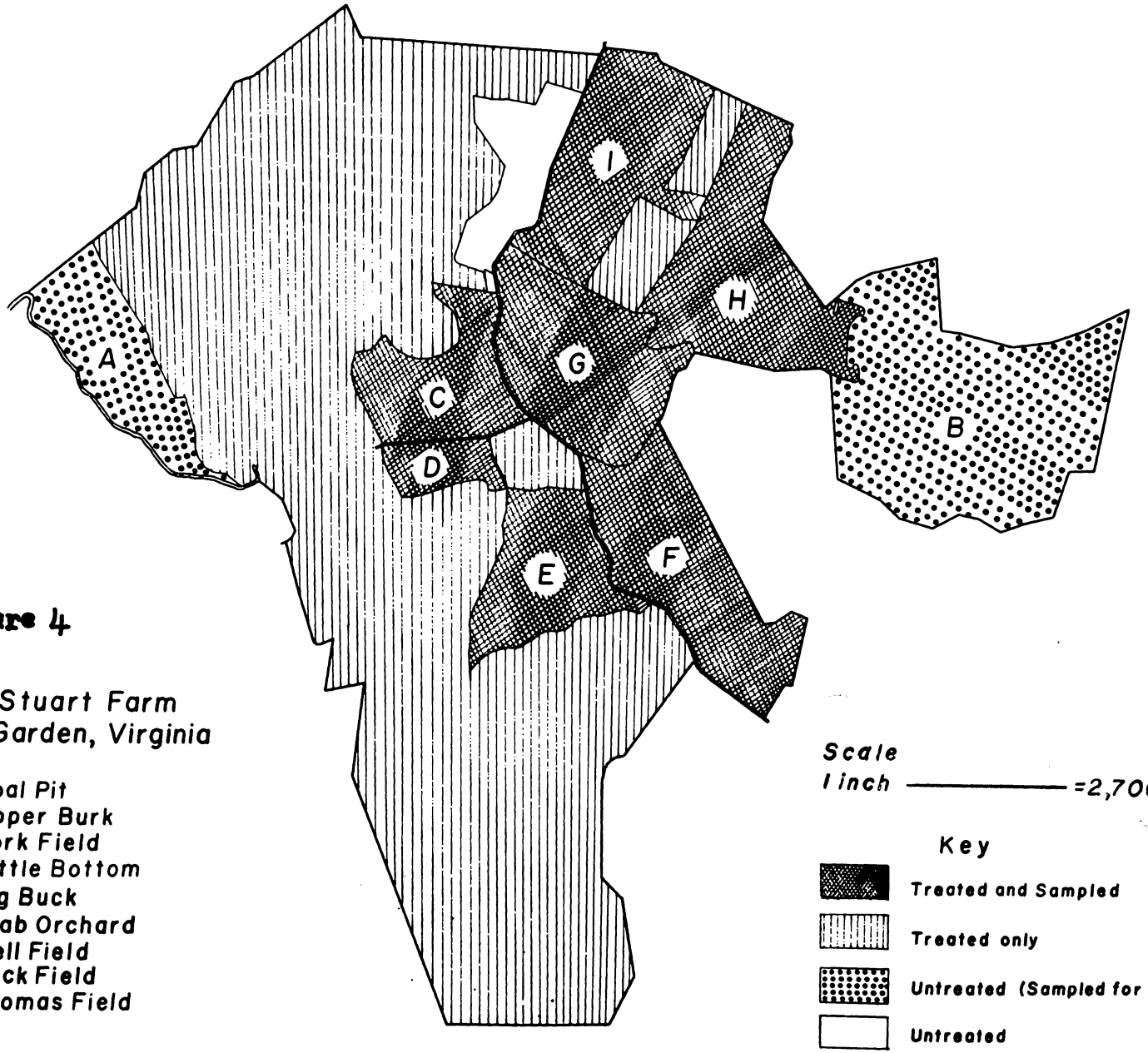


Figure 4

H.C.Stuart Farm
Elk Garden, Virginia

A Coal Pit
B Upper Burk
C Fork Field
D Little Bottom
E Big Buck
F Crab Orchard
G Well Field
H Rock Field
I Thomas Field

Table 1. Summary of Adult Face Fly Counts for the Period of May 17 to September 18 From Pastures in Which the Cattle Were Treated With Ronnel in Mineral Salt. Elk Garden, Virginia. 1962

Pasture	Reinfestation a/ Pressure	Adult Counts b/ (Flies/Animal)	Percent Control
Fork Field	Light	16.0	46.7
Little Bottom	Light	18.3	39.0
Big Buck	Light	23.8	20.7
Well Field	Medium	20.5	31.6
Crab Orchard	Medium	22.2	26.0
Thomas Field	Heavy	22.8	24.0
Rock Field	Heavy	32.2	0
Checks c/	-	30.0	-

a/ Light-Surrounded by treated pastures; Medium-almost surrounded by treated pastures; Heavy-partially surrounded by treated pastures

b/ Representing the average of 10 animals per pasture

c/ The check counts from untreated pastures (Coal Pit and Upper Burk) were combined and averaged

Table 2. Summary of Face Fly Larval Counts for the Period May 8 to September 13 Using Ronnel in Mineral Salt. Elk Garden, Virginia. 1962

Pasture	Treatment (Ronnel-mg/kg/day)	Larval Counts[a/]	Percent Control
Fork Field	6.15	4.4	99.2
Little Bottom	8.12	12.4	98.1
Big Buck	5.25	50.7	92.1
Well Field	5.65	19.0	97.0
Crab Orchard	8.08	26.5	95.8
Thomas Field	4.88	79.1	87.7
Rock Field	7.01	29.4	95.4
Checks [b/]	none	643	-

a/ Represents the average number of larvae found in 25 core samples (5" diameter) per pasture during the time of treatment.

b/ The check samples from untreated pastures (Coal Pit and Upper Burk) were combined and averaged.

Treated Pastures

All of the beef cattle in the remaining 21 pastures were offered ronnel treated mineral salt from May 1 to October 9, 1962. Seven pastures were selected for face fly adult and larval counts depending on their location in the overall treatment area.

Fork Field

This pasture was surrounded by pastures containing ronnel mineral salt treated herds and was located in the center of the treatment area. As indicated by Table 1, there was an average overall face fly population of 16 flies per animal in the Fork Field as compared to an average of 30 flies per animal in the check fields (Coal Pit and Upper Burk). This was a reduction of 46.7 percent.

The average face fly larval count in the Fork Field was 4.4 larvae per twenty-five core samples as compared to an average of 643 larvae per twenty-five core samples in the two untreated pastures. The percent of control was 99.2.

Adult fly counts were lowest in this pasture. Reinfestation pressure was light here due to the pasture's location near the center of the treatment area. The low reinfestation pressure probably accounts for the effective larval control since the consumption of ronnel (6.15 mg per kg of animal body weight per day) was not as high as found in some of the other pastures. However, the larval control was highest in

this pasture probably as a result of reduced adult population in this field.

Little Bottom

This pasture was also located in the center of the treatment area. An average face fly count of 18.3 flies per animal was observed in Little Bottom as compared to an average of 30 flies per animal observed in the two untreated herds. This was a 39.0 percent reduction in flies.

The average face fly larval count in this pasture was 12.4 larvae per twenty-five core samples as compared to an average of 643 larvae per twenty-five core samples from the two check fields. Thus, larval control was 98.1 percent.

Fly control here was much better than in the adjacent pasture (Big Buck). This was probably due in part to the higher rate of consumption (8.12 mg ronnel per kg of body weight per day) of the Little Bottom herd compared to the others. There was also very light reinfestation pressure in this pasture because of its location in the center of the treatment area.

Big Buck

This pasture was surrounded by treated herds although somewhat closer to untreated animals than the Fork Field and Little Bottom. The adult face fly count here averaged 23.8 per animal, and was a 20.7 percent reduction of face flies.

The larval counts in this pasture averaged 50.7 per

twenty-five core samples. This was an effective larval control of 92.1 percent.

The salt consumption (5.25 mg ronnel per kg of animal body weight per day) was lower than other fields, therefore, the larval control was not as good as observed in some treated pastures. Also it was noted that the lower salt trough for calves in the double-decked covered mineral salt box was empty on several occasions. Thus, a high larval count was obtained in core samples taken from calf droppings that probably contained no ronnel. Approximately 5 of the twenty-five core samples from each pasture were calf droppings. The author observed a very high larval count in these droppings on at least two occasions.

Crab Orchard

This pasture bordered two pastures of treated cattle and one pasture of untreated cattle. The average face fly count was 22.2 per animal. This was shown to represent a 26 percent reduction in face flies when compared to the checks.

The average larval count per twenty-five core samples was 26.5. This gave a control effectiveness of 95.8 percent. The effective larval control was probably a result of the relatively high salt consumption (8.08 mg ronnel per kg animal body weight per day) of the animals in this herd. The larval count in this field increased in August and September when the salt box was moved further away from the

source of water. As a result a sizable reduction of salt consumption by the animals occurred during the duration of the experiment.

Thomas Field

This field bordered treated cattle on two sides and untreated cattle on the other two sides. The face fly count on the Thomas Field Cattle averaged 22.8 per animal, a reduction of 24 percent.

The larval counts in the Thomas Field were observed to average 79.1 per twenty-five core samples, a reduction of 87.7 percent when compared with check samples.

The larval control in this field was not as good as seen in other treated herds. This was probably due to a combination of factors: (1) the salt box was not located in areas often frequented by the animals, such as the source of water and shade; (2) this field, due to its location, was subjected to fairly high reinfestation pressure, and (3) the 4.88 mg ronnel per kg of body weight was the lowest consumption rate recorded.

Well Field

This field was bordered on three sides by pastures containing treated cattle and on one side by untreated cattle. The average adult fly count per animal was 20.5, which was 31.6 percent lower than the fly counts in the check fields.

The face fly larval counts averaged 19.0 per twenty-five core samples, a larval control of 97 percent.

The larval and adult control achieved here was much higher in the earlier part of the summer (June and July) than in the middle of August and the first of September. During the latter period it was hot and dry and the animals reduced their salt consumption. The average salt consumption (5.6 mg ronnel per kg of body weight per day) was not as high as in some of the other fields. Even though this field was bordered by a field of untreated cattle, the reinfestation pressure was not extremely heavy since the two fields were separated by a very rocky hill which formed a natural barrier.

Rock Field

This field was located adjacent to pastures containing untreated cattle on three sides. As seen in Table 1, the face fly count per animal was 32.2; therefore, no adult fly control was obtained.

The average larval count in the Rock Field was 29.4 per twenty-five core samples, a 95.4 percent reduction. This effective larval control can be explained by noting the relatively high consumption rate of salt (7.01 mg ronnel per kg body weight per day) by the animals in this field. The failure to control adult face fly populations is probably due to high reinfestation pressure from adjacent untreated herds.

Discussion

In spite of effective larval control in all treated fields that were sampled, appreciable adult control was never obtained. This was apparently due to fly migration into the treatment area from surrounding untreated areas. The highest adult control was observed in the Fork Field and Little Bottom, as seen in Table 1. These two herds were located in the center of the treatment area, and were not subjected to high reinfestation pressures, as were some of the herds located near the edge of the treatment area. The Rock Field, is an example of a herd subjected to this heavy reinfestation pressure. Counts from this field showed a larval control of 95.4 percent, but no adult control. Adjacent to the Rock Field was a check herd, Upper Burk, with a face fly count of 34.2 flies per animal and a larval count of 752 larvae per twenty-five core samples. The few larvae that were breeding in the Rock Field would not account for the high adult count there (32.2 flies per animal). Apparently, most of the face flies in the Rock Field were moving from the Upper Burk pasture where they were breeding in large numbers as evidenced by the high larval count from the Upper Burk herd. The face fly appears to have a strong tendency to disperse.

The ronnel consumption must be maintained above 5.5 mg per kg of body weight per day to assure adequate larval

control. An example of this is the comparison of the consumption of ronnel in the Thomas Field which was 4.88 mg ronnel per kg of body weight per day with the consumption of ronnel in the Rock Field, which was 7.01 mg ronnel per kg of body weight per day. The Rock Field averaged approximately 10 more flies per animal than did the Thomas Field. However, the larval counts in the Rock Field (29.4 per twenty-five core samples) were much less than larval counts in the Thomas Field (79.1 per twenty-five core samples). This difference in larval counts is probably due to the lower salt consumption of the Thomas Field herd.

There are several explanations for the variations in salt consumption between various pastures. One factor was the location of the salt box in regard to the source of water and shade. For example, the salt box in the Thomas Field was located the greatest distance from the source of water (two-fifths of a mile), and the lowest salt consumption was recorded in this field.

The number of salt boxes in each pasture was important in salt consumption. The Little Bottom pasture contained two boxes, and the highest salt consumption was recorded from this field.

The design of the covered salt boxes were the double-decked type trough with a lower trough for calves and an upper trough for cows. Since all animals had a tendency

to eat out of the lower trough, this trough sometimes became empty, and the salt was unavailable to the calves.

The hot, dry weather in July and August caused some pastures to suffer from drought. This resulted in less available grazing for the animals and a lower salt consumption. The reduced water content of the grass during this period may have accounted for this.

The high larval and adult counts during the latter part of July and August in all treated herds were probably a result of: (1) the hot, dry weather during this period (as discussed in the preceeding paragraph), and (2) during this hot, dry period adult and larvae populations were at a peak in check fields. This probably brought on increased reinfestation pressure from these areas.

CONCLUSIONS

The primary objective of this work was to evaluate the effectiveness of low-level feeding of ronnel in a mineral salt mixture for control of the face fly over a large area. On the basis of data collected, the following conclusions are given:

1. In spite of good larval control, adult fly counts remained high, especially in treated pastures near the untreated areas. Apparently the face fly has a natural tendency to disperse.
2. In pastures where the consumption of ronnel was above 5.5 mg per kg of animal body weight per day, larval control was above 95 percent.
3. During hot, dry periods animals reduced their salt consumption and this resulted in decreased larval control.
4. When salt boxes were placed in areas where cattle were seldom seen to frequent, salt consumption was lowered, as was larval control.

In the author's opinion, the results of this experiment indicate that the low-level feeding of ronnel to control the face fly is impractical for an area the size of that utilized in this research.

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LITERATURE CITED

1. Anthony, D. W., N. W. Hooven, and Otelia Bodenstein. 1961. Toxicity to face fly and house fly larvae of feces from insecticide fed cattle. J. Econ. Entomol. 54:406-8.

2. Bodenstein, O. F. and J. H. Fales. 1962. Residual tests on face flies. Soap and Chem. Spec. 38:125-28.

3. Bruce, W. G. 1939. The use of phenothiazine in the medication of cattle for the control of horn flies. J. Econ. Entomol. 32:704-6.

4. Bruce, W. N., S. Moore, III, and G. C. Decker. 1960. Face fly control. J. Econ. Entomol. 53:450-1

5. Cheng, T. H.,D. E. H. Frear, and H. F. Enox, Jr. The use of spray and aerosol formulations containing R-1207 and dimethoate for fly control on cattle and the determination of dimethoate residues in milk. J. Econ. Entomol. 55:39-43

6. Crenshaw, C. L. 1956. DOW-ET-57 a systemic animal insecticide. Down to Earth. 12:4-7.

7. Davis, D. A. 1961. Face fly poses threat to both livestock and wildlife. Ag. Chemicals. 16:39.

8. Dobson, R. C. and D. A. Huber. 1961. Control of face flies (Musca autumnalis) on beef cattle in Indiana. J. Econ. Entomol. 54:434-6.

9. Dorsey, D. K., and H. E. Kidder, and C. J. Cunningham. 1962. Face fly control studies in West Virginia during 1960 and 1961. J. Econ. Entomol. 55:369-74.

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

11. _____, and A. R. Roth. 1961. Toxicity to fly larvae of the feces of insecticide fed cattle. J. Econ. Entomol. 54:408-11.

12. Fales, J. H., J. C. Keller and O. F. Bodenstein. 1961. Experiments on control of the face fly. J. Econ. Entomol. 54:1147-51.

13. Granette, P., and E. J. Hansens. 1961. Tests against face flies on cattle in New Jersey during 1960. J. Econ. Entomol. 54:562-6.

14. _____, _____, and A. J. Forgash. 1962. Tests against face flies on cattle in New Jersey during 1961. J. Econ. Entomol. 55:655-9.

15. Hammer, O. 1942. Biological and ecological investigations on flies associated with pasturing cattle and their excrement. Vidensk. Medd. Dansk. Naturh. Foren., Kbh. 105:141-393.

16. Holdsworth, R. P. 1962. Control of face flies attacking commercial dairy herds. J. Econ. Entomol. 55:146-7.

17. Knipling, E. F. 1938. Internal treatment of animals with phenothiazine to prevent development of horn fly larvae in the manure. J. Econ. Entomol. 31:315-6.

18. McDaniel, I. N. 1960. New fly is troublesome pest of cattle. Maine Farm Res. 8:11-13.

19. McGregor, W. S. and R. C. Bushland. 1957. Tests with DOW-ET-57 against two species of cattle grubs. J. Econ. Entomol. 50:246-9.

20. Plapp, F. W. and J. E. Cassida. 1958. Bovine metabolism of organophosphorus insecticides. Metabolic fate of O,O-dimethyl O-(2,4,5-trichlorophenyl) phosphorus thirate in rats and a cow. J. Agr. Food Chem. 6:662-7.

21. Radeleff, R. D. and G. T. Woodard. 1957. Toxicological studies of DOW-ET-57 in cattle and sheep. J. Econ. Entomol. 50:249-51.

22. Raun, E. S. and J. B. Herrick. 1957. Feedlot tests on the efficacy of DOW-ET-57 (trolene) for control of cattle grubs. J. Vet. Med. Assoc. 131:421-2.

23. Rogoff, W. M. and P. H. Kohler. 1959. Free-choice administration of ronnel in a mineral salt mixture for the control of cattle grubs. J. Econ. Entomol. 52:958-62.

24. Sabrosky, C. W. 1959. Musca autumnalis DeGeer in Virginia. Proc. Entomol. Soc. Wash. 61:6.

25. Sherman, M. and E. Ross. 1959. Toxicity of house fly larvae to insecticides. J. Econ. Entomol. 52:719-23.

26. Teskey, H. J. 1960. A review of the life history and habits of Musca autumnalis Deg. (Diptera:Muscidae). Canadian Entomol. 92:360-7.

27. Treece, R. E. 1961. A comparison of the susceptibility of the face fly, Musca autumnalis and the house fly, M. Domestica to insecticides in the laboratory. J. Econ. Entomol. 54:803-5.

28. Vockeroth, J. R. 1953. Musca autumnalis DeGeer in North America (Diptera:Muscidae). Canadian Entomol. 85:422-23.

29. Wallace, J. B. and E. C. Turner, Jr. 1962. Experiments for control of the face fly in Virginia. J. Econ. Entomol. 55:415-6.

APPENDIX A

Table I. Total Face Fly Larval Counts for the Period From May 8 to July 10. Elk Garden, Virginia. 1962

Pasture	Larval Counts a/							
	May 8	May 17	May 26	June 8	June 16	June 22	June 29	July 10
				Treated				
Little Bottom	5	14	2	2	3	0	4	0
Fork Field	-	3	0	0	2	0	1	0
Crab Orchard	-	-	0	0	2	0	0	70
Big Buck	-	-	1	3	0	7	27	0
Well Field	-	20	0	2	0	2	0	0
Thomas Field	-	-	8	0	0	4	23	4
Rock Field	-	-	-	-	-	7	1	0
				Untreated				
Coal Pit	256	320	89	9	610	325	446	367
Upper Burk	-	-	45	57	207	261	273	642

a/ represents the number of larvae found in 25 core samples (5" diameter) in each pasture

Table I. (Continued) Total Face Fly Larval Counts for the Period From July 18 through September 13. Elk Garden, Virginia. 1962

Pasture	Larval Counts [a] July 18	Aug. 1	Aug. 8	Aug. 22	Aug. 31	Sept. 31	Total	Average
			Treated					
Little Bottom	2	8	15	85	5	29	174	12.42
Fork Field	3	10	29	1	5	3	57	4.38
Crab Orchard	201	17	1	7	10	10	318	26.5
Big Buck	12	27	30	96	132	274	609	50.75
Well Field	54	10	131	24	0	1	247	19.0
Thomas Field	73	107	91	458	50	132	950	79.1
Rock Field	4	2	40	131	7	73	265	29.44
			Untreated					
Coal Pit	1661	753	993	809	882	181	7701	550.1
Upper Burk	1018	332	1808	1472	1602	1312	9029	752.4

[a] represents the number of larvae found in 25 core samples (5" diameter) in each pasture

Table II. Summary of Adult Face Fly Counts for the Period of May 17 to July 17 From Pastures in Which Cattle Were Treated With Ronnel in Mineral Salt. Elk Garden, Virginia. 1962

Pasture	Face Flies Per Animal [a]							
	June 8	June 13	June 22	June 29	July 5	July 9	July 12	July 17
			Treated					
Little Bottom	11.3	9.2	15.6	2.1	16.3	7.4	19.0	28.1
Fork Field	9.8	4.8	9.8	1.6	4.8	6.0	19.4	22.4
Crab Orchard	16.5	9.6	13.0	5.0	12.2	8.9	28.5	23.3
Big Buck	15.2	6.6	9.5	7.1	14.4	10.4	45.0	20.6
Well Field	5.2	15.3	9.7	9.8	7.1	6.6	19.0	16.4
Thomas Field	6.9	6.0	13.2	7.9	20.3	9.9	35.0	26.6
Rock Field	-	-	35.0	11.6	24.6	25.6	46.5	28.7
			Untreated					
Coal Pit	20.5	17.5	25.0	5.6	14.5	23.4	31.8	26.5
Upper Burk	14.0	18.6	21.0	20.8	24.0	22.5	41.0	47.3

[a] Each number represents an average of 10 animals per pasture

Table II (Continued) Summary of Adult Fly Counts for the Period of July 27 through September 18 From Pastures in Which Cattle Were Treated With Ronnel in Mineral Salt. Elk Garden, Virginia. 1962

Pasture	Face Flies Per Animal [a] July 27	July 31	Aug. 7	Aug.21	Aug.30	Sept. 12	Sept.18	Average
				Treated				
Little Bottom	4.9	24.3	40.0	32.5	28.5	34.0	4.8	18.3
Fork Field	9.0	16.8	25.0	25.5	45.0	23.5	17.0	16.0
Crab Orchard	11.6	27.0	44.5	43.5	48.0	30.0	11.8	22.2
Big Buck	24.7	35.0	28.0	67.5	35.5	-	13.6	23.8
Well Field	14.7	26.5	51.0	42.7	45.5	33.0	5.3	20.5
Thomas Field	13.9	31.7	56.0	28.5	44.0	37.0	5.1	22.8
Rock Field	26.3	28.2	41.0	45.5	52.0	41.5	12.3	32.2
				Untreated				
Coal Pit	30.5	24.5	41.5	33.5	36.0	53.0	11.3	26.3
Upper Burk	39.0	33.5	57.5	62.0	63.0	35.0	14.2	34.2

a/ Each number represents an average of 10 animals per pasture

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ABSTRACT

Preliminary experiments in Virginia by Wallace and Turner (1961) on face fly control indicated that there was some promise using low-level feeding of a chemical such as ronnel in a mineral salt mixture as a larvicide.

In cooperation with the Moorman Manufacturing Company and Mr. H. C. Stuart of Elk Garden, Virginia, a large scale experiment was initiated in the spring of 1962.

Approximately 1600 head of cattle in 23 pastures were utliized in this experiment. All of the pastures received a mineral salt mixture containing 5.5 percent ronnel with the exception of two pastures on the perimeter of the treated area that received no ronnel and were used as checks.

Adult and larval counts were made on 7 of the 23 treated pastures and both of the untreated pastures.

Results indicated that: (1) In spite of good larval control adult fly counts remained high, especially in treated pastures near untreated areas. Apparently the face fly has a natural tendency for dispersion, and, therefore, area control by low-level feeding of salt containing a larvicide is difficult. (2) When the consumption of ronnel remained above 5.5 mg per kg of animal body weight per day, larval control was above 95 percent. (3) During hot, dry periods animals reduced their salt consumption and this

resulted in decreased larval control. (4) When salt boxes were placed in areas where cattle were seldom seen to frequent, salt consumption was lowered, as was larval control.