

THE CONTROL OF EXTERNAL PARASITES OF DOMESTIC ANIMALS  
BY THE USE OF VOLCK, SPECIAL EMULSION NUMBER TWO

by

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## INTRODUCTION

The problem of the control of external parasites of domestic animals is a grave one and deserving of much more consideration than it has received in the past or is at present receiving. The actual annual losses due to these parasites are hardly realized because of the diverse ways in which these losses are incurred. The direct loss in death of animals resulting from attacks by external parasites, although greater than is generally realized, is only a minor item. Some more important ones are: Reduced production in dairy animals caused by such insects as the stable fly (Stomoxys calcitrans), the horn fly (Haematobia serrata), and several species of lice; less rapid increase in weight, or even loss of weight, in animals intended for market, caused by such parasites as those mentioned above and many others; and losses due to diseases transmitted by parasites, such as Texas fever which is transmitted by the Texas fever tick (Margaropus annulatus).

There are, for some of the external parasites, control measures which are really effective. On the other hand, there are many others for which no effective control has been discovered. The horn fly (H. serrata), stable fly (S. calcitrans) and the mange mites may well be mentioned as

examples of this latter group. Anything which gives promise of helping to cut down the losses caused by external parasites of domestic animals is well worth thorough investigation.

The data herein recorded were obtained as the result of studies made at the Kansas State College of Agriculture and Applied Science under a Fellowship provided by the California Spray Chemical Corporation and under the administration of the Crop Protection Institute. A committee with Dr. Roger C. Smith as chairman directed the work.

#### REVIEW OF LITERATURE

The only literature on the use of Volck special emulsion No. 2 as a control for external parasites of domestic animals is two theses and one report by graduate students here at Kansas State College as a result of research work under the Volck Fellowship. The work was begun June 1, 1927 by Mr. W. G. Bruce. His work consisted primarily of preliminary investigations on many parasites to determine the best research methods (Bruce 1928). His work showed that the oil would not readily harm the animals. The most extensive work was on the parasites of poultry. The results of this work showed that a 7 per cent solution of Volck special emulsion No. 2 when applied as a dip was an effective control for the common lice of poultry and that an 8 per

cent solution would control the tropical fowl mite (Liponyssus bursa). Bruce's work on cattle lice and fleas of cats and dogs formed a basis for future work.

The work was continued the following year by Mr. David G. Hall. He carried out some experiments to show that Volck, special emulsion No. 2 would not harm animals when taken internally in such amounts as might be expected when treating animals by spraying or dipping. Hall did considerable work on mange on dogs but got negative results. He continued the work on cat and dog fleas and carried out some work on hog lice.

Mr. Harry E. Skoog, continued the work during the third year of the project. He showed more conclusively that Volck special emulsion No. 2 would not harm the animals treated. He continued Hall's work on hog lice and showed that a 10 per cent solution of Volck, special emulsion No. 2 would kill eggs, nymphs and adults. Skoog tried to control the Sarcoptic mange of cats by use of Volck, special emulsion No. 2 but got negative results.

#### DESCRIPTION OF MATERIAL

The material used in this work is the product of the California Spray-Chemical Corporation. It has been described by H. E. Woodsworth, Assistant General Manager of the

company as, "An emulsion of white oil which differs from ordinary oil emulsions in the relative purity of the oil. The "Special emulsion is so called because the emulsifier has been changed in order to do away with any possible irritation." It has the consistency of thick cream and is dirty white in color. A solution of Volck can be made up with either hard or soft water. The emulsion is not very stable especially in low concentrations. If a container of 100 per cent Volck is allowed to remain open for a few days, the emulsion begins to disintegrate and a clear, brown oil separates out. Lower concentrations begin to break down more quickly.

#### EXPERIMENTAL DATA

##### Effect of Volck Special Emulsion No.2 on Animals

Volck special emulsion No. 2 has no detrimental effect on animals either externally or internally. When applied externally, it does not cause burning even though the animals are treated on a hot sunshiny day and turned out of doors immediately after treatment (Bruce 1928; Hall 1929). About 120 cattle have been treated by the writer, some of them twice and in no instance was any ill effects observed.

Soon after treatment, as soon as the excess oil has disappeared, the hair of the treated animals has a smooth

glossy appearance which greatly enhances the general appearance of the animals. The skin texture is also better.

Volck special emulsion No. 2 taken internally in normal doses is practically harmless. Two dogs weighing 12 pounds and 55 pounds were given doses of one-half ounce Volck special emulsion No. 2 and two ounces respectively. Food was withheld for 12 hours previous to and following treatment. At no time during the next three days did the temperature of the dogs vary more than two degrees Fahrenheit from that previous to the treatment, which was normal. The dogs were killed three days after treatment and post mortem showed only a slight gastritis in one dog with none in the other, and a slight enteritis in both dogs. There was not enough to harm the dogs in any way though.

#### Methods of Application

The usual method of application is by dipping or spraying. A few large dogs were treated by giving them a bath in the oil solution. In nearly all cases, the hair was vigorously rubbed or brushed to insure full penetration to the skin.

The animals treated by dipping were simply dipped into the solution so that all parts of the body except the head were under and held in that position for several minutes.

During this time the head was plunged under three or four times and the hair ruffled so that the solution could penetrate more readily.

A 14 quart compressed air sprayer was used in spraying animals. At first a nozzle giving a wide spray cone was used but later one giving a very narrow spray cone was tried and proved to be more effective although using a little more material per animal.

#### External Parasites of Cats and Dogs

Fleas (Ctenocephalis spp). Previous experiments by Bruce, Hall, and Skoog had determined that a 10 per cent solution of Volck would give a 100 per cent control of fleas on cats or dogs if applied thoroughly and the animals kept in flea free quarters. Skoog (1930) stated that the hair of cats and dogs was matted after a treatment with Volck and that he had not found a successful method of removing the excess oil. Experiments were therefore carried out to find some method of removing this excess oil.

In these experiments, the larger animals were bathed in the solution and the smaller animals dipped. Previous workers had sprayed the larger animals but it was found that under practical conditions, the owners seldom had the proper facilities for treatment by spraying and preferred the bath method which was found to be at least as effective as spray-



ing if not more so. The solution was always applied at a temperature of about 90°F.

Five heavily infested cats were dipped in an eight per cent solution of Volck special emulsion No. 2 and held in for about three minutes. The heads were dipped under several times. It was observed that the fleas were not quickly killed. It was 30 minutes before any appreciable number had died and many did not succumb until one hour after treatment. Two hours after dipping, a few live fleas were found on the animals.

Five days later the cats were found to have a few fleas so they were dipped again, this time in a 10 per cent solution of Volck. They were held in the solution for three minutes and the heads immersed several times. Two days later, they were examined and no fleas found. They were also examined at intervals of two-three weeks for four months, and at no time could any fleas be found on them.

When the cats were examined two days after the second treatment, the hair was badly matted and dirty so they were given a bath in soap and water. Soap flakes were used, a lot of suds worked up and worked well into the fur of the animals. This was found to remove the dirt and excess oil and to leave the fur soft and fluffy.

Several more dogs and cats were treated and in all

cases except two a 100 per cent control was obtained with a 10 per cent solution of Volck. The two cases where 100 per cent control was not secured were with animals which had never been bathed before and had very thick, dirty, matted hair, preventing full penetration of the Volck solution.

A Spitz dog having the long, thick, white coat of hair characteristic of that breed and heavily infested with both fleas and lice was treated with a 10 per cent solution of Volck. As usual a 100 per cent control was secured. But the interesting part of the experiment was the effect on the hair and the reaction of the dog. Previous to the treatment the dog had not been feeling well and "had no life", would not play, etc. About a week after the treatment, one of the several examinations was made and the dog was looking and feeling much better. It was playful and active and, just to show the improvement, the owner put it through its tricks. The dog had been given a bath in soap and water and the owner said that it looked much better than it ever had before after giving it a bath. This was undoubtedly due to the Volck. The owner was very well pleased with the results of the treatment.

Several of the dogs lapped up some of the solution and one bulldog, apparently liking the oil, consumed at least 50 cc of the 10 per cent solution. Neither this animal nor any of the others showed any ill effects from the Volck.

Lice (Trichodectes latus). Some of the dogs treated for fleas also had lice and one dog which was treated had only lice. A 100 per cent control was secured on all of these with a 10 per cent solution of Volck.

#### External Parasites of Hogs

Lice (Haematopinus suis L.). Twelve hogs infested with the hog louse Haematopinus suis were sprayed with a 10 per cent solution of Volck. The infestation was about eight lice per square inch. These occurred principally on the head and neck of the animals. There were also many eggs in the folds of the neck. It was not necessary to handle these animals as they were merely fed a shovelful of corn and sprayed as they were eating. With the compressed air sprayer, which has a long combination rubber tube and rod attachment with a curve at the end, it was possible to reach all parts of the animals while they were feeding. The 10 per cent solution was used at the rate of about one pint per animal. Three days later the animals were examined with the assistance of Professor Geo. A. Dean and Dr. R. C. Smith and no live lice could be found. Nine days after treatment they were examined again and no live lice found. The treatment apparently gave a 100 per cent control of eggs, all stages of nymphs, and adults. The owner especially remarked on the fine condition and appearance of the hair.

## External Parasites of Cattle

Lice (Linognathus vituli, Bovicula bovis, Haematopinus eurysternus). The cattle lice rank among the major external parasites of domestic animals. Various substances can be used to control cattle lice but the majority of these are also dangerous to the animals often causing severe burning. Volck has the advantage that it is entirely harmless and leaves the hair in a fine condition.

A herd of 30 cattle at Latimer, Kansas was treated with Volck February 15. These cattle were infested with the biting louse, Bovicula bovis, the short nosed ox louse, Haematopinus eurysternus, and the long nosed ox louse, Linognathus vituli. The older animals were infested with the biting lice B.bovis and the short nosed ox lice H.eurysternus but had few of the long nosed ox lice L.vituli. The biting lice B.bovis occurred all over the bodies of the animals, but the short nosed ox lice, H.eurysternus, occurred in the greatest numbers around the heads of the animals and especially around the base of the horns and over the eyes. The degree of infestation varied widely, some animals having as many as twenty lice per square inch, and others only five per square inch.

The animals were treated by spraying with a compressed air sprayer. A 10 per cent solution of Volck special emul-

sion No. 2 was used. About one and one-fourth quarts of solution were used per animal. Especial effort was made to reach all parts of the head as the lice were thickest there. As soon as treated, the animals were turned out of doors in the sun to dry. It was noticed that, although the sun was bright, there was positively no burning or ill effects from the treatment.

Three days after treatment, the results were checked. The assistance of Professor Geo. A. Dean and Dr. R. C. Smith was available for this work. Of the main herd treated, there were about six animals older and more easily handled than the others. On these a satisfactory control (95 per cent) was secured. With the younger animals, it was estimated that a 70 per cent control was secured.

On March 16, this herd was given a second treatment. At this time it was noticed that there were no sucking lice present but the infestation of biting lice was greater than had been observed three days after the first treatment.

The same spraying apparatus was used as in the previous treatment. A 10 per cent solution of Volck was used and about two and one-fourth quarts of the solution used per animal. During this second application, the animals were brushed vigorously with stiff brushes.

Twenty-five days after the second treatment, the animals were examined. At that time there were many young

lice present, but few old lice. With these observations and those of the owner, it is believed that the second treatment gave a 90 per cent kill of the lice but failed to kill many eggs. The owner was well pleased with the results of the treatments and stated that the animals had been doing better since the treatments. Several other herds of range cattle were treated and controls of 85 per cent to 90 per cent obtained.

May 7, a herd of young dairy cattle was treated. They were infested mainly with the long nosed ox louse L.vituli but had some biting lice B.bovis. The infestation averaged about three lice per square inch. A 10 per cent solution of Volck was used applying about two quarts per animal. A different nozzle was used on the sprayer which gave a nearly solid stream spray. This seemed to be more efficient in getting penetration but it also used more material.

It was observed that most of the lice were dead one and one-half hours after treatment. One day after treatment, there were no live lice present. Three days after treatment, the hair became very soft and fine and the skin was in excellent condition.

Some experiments were carried out to determine the toxicity of Volck special emulsion No. 2 to adult lice. Two hundred adult lice, B.bovis were collected and one hun-

dred of them dipped for twenty seconds in a 10 per cent solution of Volck. The other 100 lice were dipped in distilled water for twenty seconds and kept as a check. The lice dipped in Volck evidently died very quickly, as most of them never moved at all after being taken from the dip. Within fifteen minutes after treatment, all of the lice were dead.

The check lice were kept in a constant temperature incubator at 37.5°C. Of these, 90 lived 48 hours, 6 lived 72 hours, 3 lived 96 hours and 1 lived 125 hours.

One hundred L.vituli adults were treated as above and proved to be much more resistant as shown by the following table.

Table I. Toxicity of Volck Special Emulsion No. 2 to 50 Adult Lice (L.vituli)

Number of minutes after treatment  
(divided into periods)

	0-15	15-30	30-45	45-60	60-75	85
	Minutes	Minutes	Minutes	Minutes	Minutes	Minutes
No. of lice which died in each period	5	15	18	9	2	1

This table shows that these lice are much more resistant to Volck special emulsion No. 2 than B.bovis.

The results of the check on this experiment are shown in the following table:

Table II. Length of Life of the Check Lice (50)

Number of days after treatment  
(divided into periods)

	0-2 days	2-3 days	3-4 days	4-5 days
No. of lice which died during each period	25	6	17	2

One hundred B.bovis eggs were collected. Fifty of these were dipped in a 10 per cent solution of Volck special emulsion No. 2 for one minute. The other fifty were dipped in distilled water for one minute. The eggs were then placed on a blotter to remove the excess moisture, placed in vials and put in a constant temperature incubator at 37.5°C. None of the eggs treated with Volck hatched but 76 per cent of the check eggs hatched.

Flies (Musca domestica, Stomoxys calcitrans, Haematobia serrata). Cattle were sprayed with a 10 per cent Volck solution and it was found that it had no inherent repellent qualities. Many substances were then combined with Volck in an endeavor to find some combination which would make an effective fly repellent. These fly sprays were first



applied with a compressed air sprayer and later with a fairly large hand sprayer. Check animals were used in each experiment, most of which were sprayed with tap water. To check the results of each spray, either the number of flies on the animal or the number of times it switched its tail per unit of time were counted, or a combination of both methods were used. Unless otherwise stated all other applications were made between 3 P.M. and 5 P.M.

Some of the substances which were tried out and the results obtained are:

1. Fish oil.

This was combined with Volck as follows:

1 part fish oil  
10 parts 10% Volck  
2 parts concentrated soap solution\*

This mixture was applied to cattle and the following results were obtained:

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\* The "concentrated soap solution" used in these mixtures was made by cutting up laundry soap and dissolving it in hot water to saturation.

Table III. Showing the Number of Times the Animals Switched their Tails in Three-Minute Periods

Observation number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sprayed animal	5	4	5	5	6	5	6	8	6	5	6	10	8	10
Check animal	56	50	57	54	59	50	55	54	61	57	55	47	54	57

Observations 1-11, inclusive, were made at ten-minute intervals, beginning fifteen minutes after spraying.

Observations 12-14, inclusive, were made at ten-minute intervals, beginning four hours after spraying.

The results given above are typical of several experiments with this mixture.

## 2. Oil of Tar.

This was mixed with Volck and soap in the same proportions as the preceding, but was not at all satisfactory, due largely to the failure to get the oil of tar thoroughly emulsified.

Later, some oil of tar was saponified with  $N_2OH$  in an endeavor to get it in an emulsion with Volck, but although superior to untreated oil of tar, it was not at all satisfactory, either as a spray solution or as a repellent because it did not go readily into an emulsion and was irritating to the throat of the animals.

## 3. Amyl Acetate.

This was mixed with Volck emulsion as follows:

1 part amyl acetate  
10 parts Volck Special Emulsion No.2

It was not at all effective as a repellent.

## 4. Asafetida.

A mixture was made up as follows:

2 parts asafetida  
30 parts 10% Volck Special Emulsion No.2.

This made a very good emulsion and was fairly effective as a fly repellent, as shown by the following table.

Table IV. Showing the Number of Times the Animals Switched their Tails  
in Three-Minute Periods. Observations Taken at  
Ten-Minute Intervals

Observation number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sprayed animal	5	2	2	6	6	3	4	9	11	11	14	44	47	30
Check animal	30	54	36	30	32	37	43	39	46	33	38	51	49	32

5. Naphthalene.

A mixture was made up as follows:

- 25 parts alcoholic solution of naphthalene
- 25 parts Volck Special Emulsion No.2
- 25 parts carbon tetrachloride
- 25 parts water

This did not make a good emulsion and was so volatile that it retained its repellent qualities for only two-three hours.

6. Pyrethrum extract.

A mixture was made as follows:

- 25 parts pyrethrum extract
- 50 parts 10% Volck Special Emulsion No.2
- 25 parts concentrated soap solution

The results are shown in Table V.

Table V. Showing the Number of Times the Animals Switched Their Tails in Three-Minute Periods. Observations taken in Ten-Minute Intervals

Observation number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Sprayed animal	2	4	4	2	3	6	4	6	8	10	10	12	11	13	14	32	34	37
Check animal	24	28	25	22	25	29	24	27	25	30	28	24	29	26	23	35	36	36

The above table does not bring out all the facts, however. For the first 45 minutes after spraying, the flies would not come anywhere near the animal and the tail switching was caused by mere force of habit. But after the first hour, the repelling action of the mixture rapidly decreased.

#### 7. Pine tar oil.

This repellent gave the best results.

The first mixtures used were weak, but finally the following was made up and gave good results:

1 part pine tar oil  
10 parts 10% Volck Special Emulsion No.2  
2 parts concentrated soap solution

This was very effective, as shown by the following table:

Table VI. Showing the Number of Times the Animals Switched Their Tails  
in Three-Minute Periods. Observations made at  
Ten-Minute Intervals

Observation number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sprayed animal	0	1	2	2	3	3	2	4	3	5	9	11	9	32	41	30
Check animal	28	32	27	40	42	55	48	52	34	28	84	56	44	27	35	33

Observations 1-13, inclusive, were made beginning 15 minutes after spraying.

Observations 11-13, inclusive, were made after the animals were turned outdoors.

Observations 14-16, inclusive, were made indoors and 16 hours after spraying.



In an endeavor to get the pine tar oil more thoroughly into emulsion, it was saponified with  $\text{NaOH}$ . This gave a good emulsion but subsequent experiments with it and with untreated pine tar oil proved that the untreated pine tar oil is a more effective repellent. The saponified pine tar oil is also irritating to the throat and nose of animals and man, causing severe coughing.

Experiments were also carried out to find out if the addition of pyrethrum extract to the pine tar oil spray increased its efficiency. The tests proved that pyrethrum extract does not increase the repellent powers of the pine tar oil spray.

The mixture which was found, after much experimentation to give the best results, was as follows:

- 1 part Volck Special Emulsion No.2
- 2 parts pine tar oil
- 1 part concentrated soap solution
- 1 part water.

A typical table showing the results obtained with this spray is as follows:

Table VII. Number of Flies on Animals. Observations Taken at One-half Hour Intervals

Time after spraying in hours	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6
Sprayed animal	0	0	0	0	2	3	2	6	8	9	7	9
Check animal	30	35	30	38	42	32	40	36	45	52	48	45

To determine the accumulative effect of the spray, the following experiment was carried out. An animal was sprayed twice a day for one week and once a day for the two succeeding weeks. The results of an observation 24 hours after spraying taken at the end of the first week were as follows:

Number of flies on animals. Results of six observations taken at ten-minute intervals beginning 24 hours after spraying.

Total number of flies on sprayed animal	-	126
" " " " " check "	-	480
Average " " " " sprayed animal	-	21
" " " " " check "	-	80

Number of times animals switched tails in three-minute periods. Six observations taken at ten-minute intervals, beginning 24 hours after spraying.

Total number of times sprayed animal switched tail	-	18
" " " " check " " "	-	165
Average " " " sprayed " " "	-	3
" " " " check " " "	-	27.5

It was also observed that the sprayed animal stood very quietly while the check animal was continuously making twitching movements of its skin, shaking its head, stamping its feet, and turning its head to lick and bite itself.

Results at the end of the second week, during which the animal was sprayed only once a day, were as follows:

Number of flies on animals. Results of six observations taken at ten-minute intervals beginning 24 hours after spraying.

Total number of flies on sprayed animal	-	92
" " " " " check "	-	402
Average " " " " sprayed "	-	15.3
" " " " " check "	-	67

During the third week of the experiment (second week of spraying once a day), the results were much the same as those of the previous week.

The results of an observation taken beginning directly after spraying at the end of the last week are given below.

Table VIII. Number of Flies on Animals. Observations taken at One-Half Hour Intervals, Beginning One-Half Hour After Spraying

Time after spraying in hours	$\frac{1}{2}$	1	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5
Sprayed with repellent	0	0	0	0	0	3	1	5	2	3
Check (sprayed with tap water)	75	70	86	78	65	75	82	74	72	66
Check*	0	0	0	3	1	5	9	7	11	14

#### Effect of this spray on the Animals

During the first week of the above experiment, the animals were sprayed at about 8:30 a.m. and 4:30 p.m. Directly following these sprayings, the animals were turned out of doors. Although often the sunlight was very strong and the temperature high, no harmful results could be observed.

The spray gives a yellowish tinge to white hair, but imparts a lustre to it which is characteristic of Volck. The lustre is especially noticeable on animals with dark hair.

\*An animal never before sprayed with a repellent was sprayed to use as a check against the animal which had been sprayed for three weeks.

### External Parasites of Horses

Lice (Trichodectes parumpilosus). Two horses which had been out on range all winter, were found to be heavily infested with lice. The infestation was at least 15 lice per square inch. These animals were sprayed with a 10 per cent solution of Volck and the solution rubbed in with brushes. Eight quarts of the solution were used per animal. Four days later, they were examined and no lice could be found on one animal but a few lice were found on the other. At least a 95 per cent control was secured on this second animal. The hair of both animals appeared very much better after the treatments. It was smooth and soft where before it had been rough and harsh. The animals were in the barn during the treatment and for one and one-half days afterward.

### External Parasites of Humans

Chiggers (Trombidium spp.). Chigger bites on the writer and other students were treated with various concentrations of Volck. A 20 per cent solution was applied to some affected areas on one student, and some other affected areas left as checks. The student reported immediate and permanent relief from the irritation where the Volck had been applied, but the untreated areas continued to irritate.

Another student used 100 per cent Volck and got relief from chigger bites but failed to keep any areas as checks. The writer used 100 per cent Volck on chigger bites which were in a more advanced stage and found that the treated bites persisted as long as the untreated, but were not so irritating.

Later an infestation of chiggers was obtained by the writer and noticed at an early stage. One leg was bathed in a 20 per cent Volck solution and the other in warm water. The check leg itched very much during the following night, but the treated leg did not bother at all or at any time after. The next day, certain affected spots on the check leg were treated with 100 per cent Volck. This acted as a palliative, but did not entirely stop the itching.

#### INCIDENTAL OBSERVATIONS

##### Toxicity of Volck Special Emulsion No. 2 to Dipterous Larvae

It was desired to find the effect of Volck special emulsion No. 2 on screw worm larvae, but as none were available, it was decided to try some other species of Dipterous larvae.

Dipterous larvae were collected from damp straw and treated with Volck oil at concentrations ranging from 5

per cent to 50 per cent. The larvae were immersed in the Volck oil about 15 seconds and then placed in salve boxes. Check larvae were used for each concentration and were dipped in distilled water. Four hours after treatment, no larvae were dead. At this time several larvae were placed in a salve box with a little straw. The larvae and straw were soaked in 50 per cent Volck and enough added so that the bottom of the box was covered.

The next morning, none of the larvae were dead, but four of the treated larvae had pupated. The larvae placed in the can with the 50 per cent Volck had a complete coating of oil around them, but were not affected. Fifty hours after treating, eight of the treated larvae had pupated and only two had died. One check larva had died also.

#### Toxicity of Volck Special Emulsion No. 2 to Fleas

Live fleas were collected from infested cats and experiments carried out to determine the length of time necessary for various concentrations of Volck to kill the fleas. Concentrations of Volck ranging from 4 per cent to 20 per cent were made up. The fleas, four to each concentration were dipped under for 15 seconds. They were then removed and placed in clean vials and the length of time necessary to kill them observed. The "time to kill" in the following table was calculated as the average for the four fleas,

except for concentration 5, which was calculated for the average of the three that died. The results were as follows:

Table IX. Toxicity of Volck to Fleas at Various Concentrations

Concentration	Time dipped	Time dead	Length of Time to kill		Number revived
			Hours	Minutes	
4%	5:37	8:12	2	35	0
5%	5:41	8:07	2	26	1
6%	5:44	7:47	2	3	0
7%	5:49	7:74	1	35	0
8%	5:54	7:15	1	21	0
9%	6:19	7:27	1	8	0
10%	6:25	7:48	1	23	0
12%	6:35	7:30		55	0
15%	6:38	7:36		58	0
20%	6:47	7:54	1	12	0
Check			81	26	0

This experiment was repeated later and much the same results obtained.

In both experiments, the fleas were examined individually under the high power of a binocular microscope to determine when they were dead. They were rendered inactive



and apparently dead in about 29-30 minutes after dipping.

#### CONCLUSIONS

1. A 10 per cent solution of Volck, special emulsion No. 2 when applied as a spray and thoroughly worked into the hair, controlled the lice on cattle.

2. A 10 per cent solution of Volck, special emulsion No. 2, thoroughly applied as a dip or wash to dogs and cats, eliminated all fleas from the animals. The animals should be bathed in soap and water one day after treatment to remove the excess oil.

3. A 10 per cent solution of Volck, special emulsion No. 2, when applied as a spray controlled the lice on dogs.

4. A mixture of one part Volck, special emulsion No. 2, two parts pine tar oil, one part concentrated soap solution in water, and one part water, was a very effective repellent spray for Musca domestica, Stomoxys calcitrans, and Haematobia serrata.

5. Volck, special emulsion No. 2, in solutions as high as 50 per cent was not toxic to certain dipterous larva. (Probably stable fly and house fly larva ).

6. Volck, special emulsion No. 2, when taken internally by animals in such concentrations and amounts as might be expected of an animal being treated, was not harmful to

the animals.

7. Volck, special emulsion No. 2, apparently has some value as a treatment for chiggers on man.

8. A 10 per cent solution of Volck, special emulsion No. 2, applied as a spray controlled the lice on two horses.

9. Volck, special emulsion No. 2, as applied externally did not cause any burning or other harmful effects.

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