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REPELLENTS FOR PROTECTING ANIMALS FROM THE ATTACKS OF FLIES.[1]

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INTRODUCTION.

During the warm season of the year cattle, horses, and mules suffer a great deal of annoyance and more or less injury as the result of the attacks of various biting flies, and numerous requests are received in this department concerning methods of relieving the animals from these attacks. The flies that cause the greatest annoyance to domestic animals are the stable fly (*Stomoxys calcitrans* L.) and the horn-fly (*Lyperosia irritans* L.). The horseflies (Tabanidæ) are of some importance and individually their attacks are sanguinary, but they are not the cause of as much injury as either of the two species of muscids that have been mentioned. The bot flies (Œstridæ) affecting horses, cattle, and sheep are not biting flies and only visit these animals to deposit their eggs. The larvæ of these flies, however, are parasitic and are the cause of considerable annoyance and more or less loss, and for this reason repellents are sometimes applied to animals to prevent the adults from depositing their eggs. In the case of the horse and the ox, parasiticides are applied to the skin to destroy the eggs of bot flies that have already been deposited.

The screw worm (*Paralucilia macellaria* Fab.) likewise is not parasitic in its adult state, and visits animals only to deposit its eggs in wounds where the larvæ, when they emerge, may find nourishment and complete their growth. There are also various other species of flies that may deposit their eggs in wounds and whose larvæ become parasitic.

In the United Kingdom and Holland a bluebottle fly (*Lucilia sericata* Meig.) deposits its eggs on the soiled wool about the anus,

[1] The investigations reported in this paper were undertaken by the Bureau of Animal Industry incidentally during the progress of other investigations concerning stock dips. Although comparatively few repellents were tested, it is believed that the data obtained concerning substances which may be applied to live stock to protect them from flies are of interest and value to the live-stock industry.

[2] Resigned, April 16, 1914.

chiefly in young sheep, sometimes in adult sheep when badly kept, and the larvæ hatching from the eggs become parasitic in the skin. In Australia several species of blowflies (*Calliphora oceanicæ* Desv., *C. villosa* Desv., and *C. rufifacies* Desv.) produce a similar condition in sheep. Recently a cutaneous invasion of sheep with dipterous larvæ occurring at Cobham, Va., was reported to this department, but the fly responsible for the trouble has not been identified. The application of repellents and parasiticides is indicated in case sheep are subject to the attacks of such flies.

The house fly (*Musca domestica* L.) commonly visits wounds on animals to suck up the exudates that occur there. It is the cause of considerable annoyance to animals in this way; it prevents wounds from healing and may introduce into a wound agents of infection adhering to its body. Repellents are therefore indicated and are frequently used on wounds to keep house flies away and also to keep away such flies as may deposit their eggs in wounds, such, for example, as the screw-worm fly.

The use of fly repellents is resorted to largely for the purpose of relieving animals of the torment of biting flies or of preventing infestation with the larvæ of flies, without any reference to the control or eradication of such pests. In the case of such flies as the stable fly and the hornfly, the use of repellents can be of only secondary importance as an eradicative measure, since a much more effective means of getting rid of these pests lies in preventing them from breeding. This may be done by preventing access of the flies to materials such as manure, etc., in which they deposit their eggs, and by destroying the young stages that may be present in such materials. However, the eradication of these flies in most instances, or even a reduction in their numbers in many cases, is out of the question, so that it is necessary to resort to the use of repellents or other means to give relief to animals.

In the case of the horseflies, preventing them from biting is probably as important a factor as can be taken advantage of in bringing about control, yet it must be admitted that this means can be of only very little importance. In the case of the bot flies and the screw-worm flies, the use of repellents against the adults and of parasiticides against the eggs and larvæ is an important method of eradication as well as a valuable means of protecting animals.

INJURY CAUSED DOMESTIC ANIMALS BY BITING FLIES.

Aside from the transmission of various animal diseases by biting flies, a matter of much less importance in this country than in the Tropics, flies are generally assumed to be responsible for enormous losses to farmers and stockmen. Because of the great numbers in

which flies occur, the irritation they cause animals, the blood they abstract, the movements they cause animals to make in fighting them, and the unfavorable influence they have on the temper of dairy cows, it is believed by both scientist and layman that flies are responsible for very great financial losses.

According to Delamare (1908), a German professor named Lehmann is stated to have established that the supplementary expenditure of energy corresponding to the agitation caused horses by the attacks of flies amounts to a pound of oats a head per day. Moore (1903), of the South Dakota Agricultural Experiment Station, says: "When we consider the intimate relationship existing between the milk yield and the physical comfort of the cow, no question can be raised as to the benefit obtained by mitigating so far as possible the annoyances of these pests." Hopkins (1891) states that the hornfly so annoys cattle by its bite that the cows fail in milk and other cattle fail in flesh. Garman (1892) says: "The injury done to cattle has been greatly overestimated in some instances; yet there can be no doubt that the yield of milk from cows greatly worried by hornflies is much reduced, and growing and fattening stock are doubtless retarded by their attacks." Marlatt (1910) states: "During the first years of the hornfly, when it was a new and little understood menace to cattle, the losses occasioned by it were undoubtedly much exaggerated. Nevertheless, the loss when the fly is abundant is still very considerable, showing in reduced vitality, lack of growth, or lessened yield of milk, the production of milk often being cut down from one-fourth to one-half. In Canada the late Dr. James Fletcher estimated the loss in Ontario and Quebec at one-half the product of meat and milk." Bishopp (1913) describes an unusual outbreak of the stable fly in 1912 in northern Texas and refers to various other outbreaks that have occurred in the United States. In referring to the injury due to the fly he states that many horses and cattle became so weak that they gave up the fight against the pest. In a few cases in which the animals were not protected they succumbed in a short time. Texas fever was rekindled in an acute form in cattle that became weakened as a result of the flies, and in many cases death resulted. The influence of the flies on the milk production was marked, the reduction being from 40 to 60 per cent, and in some cases cows were completely dried up. Horses and mules lost 10 to 15 per cent in weight during the outbreak. Cattle likewise suffered a great reduction in weight. It is estimated that in northern Texas over 300 head of cattle, mules, and horses were killed directly or indirectly as the result of the fly attack. This loss is estimated at $15,000, and the loss in the milk production is placed at $10,000, and other losses are stated to surpass these.

Fuller (1913) has described an outbreak of the stable fly along the east coast of South Africa. All classes of animals are said to have suffered greatly from worry and anemia. Many cattle were killed, and horses and cattle stampeded into the sea and into rivers to obtain relief. The outbreak followed heavy rains.

The experimental evidence with regard to the losses due to flies that is available in this country does not seem to indicate that they are as a rule of such serious consequence as the foregoing statements would lead one to believe. The seriousness of such outbreaks as Bishopp and Fuller refer to can not be questioned. Carlyle (1899), at the Wisconsin Agricultural Experiment Station, conducted an experiment relative to injury due to flies in which two lots of seven cows each were used. Lot No. 1 was kept during the day in a paddock provided with shade trees, while lot No. 2 was protected from flies by being kept in a screened stable. The cattle in both lots were kept on the pasture during the night and taken off at 9 o'clock in the morning. The experiment was continued for a period of four weeks. The cattle in the lot protected from flies ate 835 pounds more green corn than those that were unprotected. All the cows lost in weight, but the protected cows lost nearly three times as much as the others. In comparing the milk and butter production of the first two weeks of the experiment with that of the two weeks just preceding the experiment it was noted that there was a decrease in both milk and butter. The milk reduction was greater for the protected animals and the butter reduction was greater for the unprotected animals. The conclusion reached was that the greater amount of butter yielded by the protected lot was not sufficient to pay for the increased trouble and expense entailed in stabling the cows during the greater part of each day.

Kent (1903), in an experiment at the Oregon Agricultural College and Experiment Station, used a proprietary repellent on four dairy cows. Four untreated cows served as controls. The treated cows gained a total weight of 265 pounds while the untreated ones gained 212 pounds. In comparing the milk and butter records of two cows from each lot that were in about the same stage of lactation with the records of the same cows during the two months just preceding the experiment it was found that the treated cows lost about 10 per cent less than the cows not treated.

Beach and Clark (1904), at Storrs Agricultural Experiment Station, Conn., tested a proprietary fly repellent which the manufacturers claimed would effect a tremendous saving during the fly season. The experiments covered a period of two seasons and the cows were sprayed thoroughly once a day. The conclusions reached by the authors are as follows: "1. The annoyance of cows by flies seems to be overestimated. 2. Certain proprietary ointments known

as 'fly removers' will protect the animal to a greater or less extent, but their use has little or no effect on the milk or butterfat secretion."

Eckles (1905) carried on experiments for two seasons at the Missouri Agricultural Experiment Station with a proprietary repellent for the purpose of determining whether the use of a repellent on dairy cows would have any influence on the amount of milk and butter produced. During the first season 16 cows were used and during the second season 22 cows were used. The fly season was divided into periods of two weeks, and the herd was sprayed each morning during alternate periods. A comparison was made between the sprayed and unsprayed periods. The conclusion reached by the author was that the use of the fly repellent was fairly effective in preventing the annoyance from flies if applied every morning, but that the yield of milk and fat was not appreciably affected by its use. The only advantage observed was that the cows stood more quietly during milking. With regard to the shrinkage in milk production during hot weather, the author has the following to say: "The rapid shrinkage that occurs in the yield of a cow during the hottest summer months is a well-established fact, but is probably not so much on account of flies as to failure to graze sufficiently, if on pasture, on account of the heat."

THE INFLUENCE OF COLOR ON FLIES.

Several years ago Dr. Schroeder, of the Bureau of Animal Industry, called my attention to some pictures of Holstein cattle he had taken in connection with some tuberculosis work, in which the flies on the animals were confined almost exclusively to the black-colored spots. Beach and Clark (1904) state that some animals suffer more from hornflies than others and that dark-colored animals suffer more than light-colored ones. Marlatt (1910) states that the hornfly exhibits a certain preference for red or other dark-colored cattle, and that such animals are more thickly infested has been frequently noted. He states, however, that when the flies are abundant this preference is not so strongly marked.

Marre (1908) refers to a discovery which a farmer in the vicinity of St. Cyr made relative to the influence of color on flies. The farmer had 170 cows in a number of stables and noted that flies had a marked aversion for blue. The idea came to him to add blue to the whitewash with which he coated the walls of his buildings each year. After doing this the flies left his cattle stables.

The formula used for the wash is as follows:

Water	100 liters (105.6 quarts, or 26.4 gallons).
Lime (slaked)	5 kilos (11 pounds).
Ultramarine blue	500 grams (1.1 pounds).

Two applications, one in June and one in August, are recommended. The present writer is not aware whether this observation has been corroborated or not.

INTERNAL REMEDIES FOR REPELLING FLIES.

It would hardly seem likely that a drug could be administered to animals that would prevent flies from making their customary attacks. However, Ochmann (1911) has recommended potassium tellurate for this purpose. According to him this chemical does not affect the general health of animals. The hair, however, becomes temporarily rougher, paler, and drier. The expired air, the perspiration, and the feces take on an intensely offensive garlic odor which persists for a long time.

Two dogs received on two successive days each 0.25 gram of potassium tellurate. The results appeared on the day of the first administration and lasted three to four weeks. The olfactory sense of one dog suffered considerably. One of the dogs formerly troubled with ticks was no longer affected. The dogs were protected from flies.

An ass was given 0.25 gram of the chemical in the feed for three days. The action was negative. Another ass received on three successive days 0.25 gram. On the second day the odor appeared in the breath and disappeared one day after the last dose.

A mule received on three successive days 1.5 grams. The odor appeared on the day following the first administration and gradually disappeared in 10 days. There were no unfavorable results. Another mule was given on three successive days 0.5 gram. The odor appeared on the day following the second dose and disappeared one day after the last dose. A mule received on two successive days 2 grams. An intense odor appeared on the second day and disappeared after six days.

The author states that flies lighting on the animals were repelled.

Mayer (1911) conducted experiments for the purpose of verifying Ochmann's results, and reached quite different conclusions. Ten experiments were carried out, nine on horses and one on a cow. Each animal received in all 10 grams in single doses of from 1 to 5 grams. The best method of administering the drug was to dissolve the salt in drinking water. Subcutaneous administration leads to dry necrosis. The drug was taken unhesitatingly and caused no ill results except occasionally a staring coat in fine-haired animals. The garlic odor of methyltellurid appeared in the breath of the cow and was present for a long time. The odor appeared to a very slight degree in the breath of three of the horses, but disappeared very soon.

The author states that the administration of potassium tellurate in all cases failed to protect animals from flies.

It would therefore seem likely that this internal remedy is not efficacious. If it or any other internal remedy were found efficacious, it is doubtful whether it could be administered to dairy cows without imparting an odor to the milk. On the whole, therefore, the use of internal remedies seems to be an extremely unpromising means of repelling flies.

EXTERNAL REMEDIES FOR REPELLING FLIES.

There are almost innumerable homemade and proprietary external remedies for repelling flies. They contain various substances that are distasteful to the insects. Many of them contain strongly odoriferous ingredients that have a repelling influence on flies. The qualities to be sought in a satisfactory repellent are: Absence of toxic and other detrimental properties when applied externally to animals; a marked repellent action on flies; and a duration of this action for a reasonable length of time. A common defect of many otherwise rather good repellents is the very short period during which they are effective. Some repellents are undoubtedly toxic and must be used with care.

METHODS OF APPLYING REPELLENTS.

Repellents as a rule are in the form of liquids and may be applied by means of a dipping vat, a pail spray pump, an atomizer such as that commonly used in gardens and greenhouses for applying insecticides to plants, or by means of a rag or a paint brush. The method employed necessarily depends to a very large extent on the number of animals to be treated, the physical character and toxicity of the preparation, its cost, and the individual preference of the farmer or stockman. Some preparations, either because of their cost or their toxicity, or for some other reason, are not adapted for use in a dipping vat or for application by means of a spray pump. Others may be applied by any one of the methods mentioned.

Marlatt (1910) describes a special splash board for vats, devised by J. D. Mitchell. By means of this board the splash caused when the animal plunges into the vat is thrown back into the vat in the form of a spray and many of the flies are wetted and carried down with the dip. It is said that with vats equipped with such splash boards from 75 to 80 per cent of the hornflies are killed.

EFFICACY OF PROPRIETARY REPELLENTS.

Lindsey (1903), at the Massachusetts Agricultural Experiment Station, tried out 10 proprietary fly repellents. He found that four were quite satisfactory, four others were less satisfactory, and two

were unsatisfactory. The chief defect of the second group seemed to be that they were not lasting. It is stated that these fly repellents are sold at retail from $1 to $1.50 a gallon.

POWDERS AS REMEDIES.

Smith (1889), of the New Jersey Agricultural Experiment Station, found by experiment that two powders were adapted for destroying hornflies and stable flies, namely, pyrethrum powder and tobacco powder. Pyrethrum acted promptly, but was objectionable from a practical standpoint because of its expense and because it lost its strength soon after application. Tobacco was found very much more satisfactory though the killing power was less. He recommended a proprietary powder having for its base tobacco dust and containing crude carbolic acid or creosote. The method of protecting cattle from the hornfly that he suggested was to apply carbolated fish oil to the belly, udder, and those parts of the animal where powder could not well be used, and to apply tobacco powder to the base of the horns, the back, and at the root of the tail. The effect of the oil is to repel and that of the tobacco to kill flies that attempt to feed.

OILS AS REPELLENTS.

Almost any kind of oil, whether it has a pungent or disagreeable odor or not, will repel flies to a certain extent. The mere physical condition of the hair and skin of an animal treated with oil seems to be repugnant to flies. Oils are used pure or in the form of an emulsion, or in combinations or mixtures. Crude petroleum, cottonseed oil, fish or train oil, and light coal-tar oil may be used pure.

Crude petroleum may be used in the form of an emulsion. The formula and method of preparing it so as to make 5 gallons of 80 per cent emulsion are as follows:

Hard soap	1 pound.
Soft water	1 gallon.
Beaumont crude petroleum	4 gallons.

In preparing the emulsion the soap should be shaved up and placed in a kettle or caldron containing the required amount of water. The water should be brought to a boil and stirred until the soap is entirely dissolved. Enough water should be added to make up for the loss by evaporation during the process. The soap solution and the required amount of oil are then placed in a convenient receptacle and mixed either by stirring or by means of a spray pump. If properly prepared the stock emulsion will keep indefinitely. When required for use the stock emulsion should be diluted, one part of the emulsion to three parts of water being used. The diluted emulsion does not remain uniformly mixed, so if allowed to stand it should be thoroughly mixed by stirring before using.

Jensen (1909) recommended the following mixture containing crude petroleum for dairy cows. He states that it remains on cattle for at least a week.

Common laundry soap	1 pound.
Water	4 gallons.
Crude petroleum	1 gallon.
Powdered naphthalin	4 ounces.

Cut the soap into thin shavings and dissolve in water by the aid of heat; dissolve the naphthalin in the crude oil, mix the two solutions, put them into an old dasher churn, and mix thoroughly for 15 minutes. The mixture should be applied once or twice a week with a brush. It must be stirred well before being used.

A mixture of cottonseed oil and pine tar in the proportion of two parts of the former to one part of the latter has been recommended to relieve cattle of flies.

Fish or train oil is generally rated as one of the best repellents. Its protective action is said to last from two to six days, depending on the temperature and humidity. A great many mixtures have been recommended in which fish oil occurs as an important ingredient. Moore (1903) recommended the following mixture for use on dairy cows:

Fish oil	100 parts.
Oil of tar	50 parts.
Crude carbolic acid	1 part.

The cost of the mixture was about 35 cents per gallon. The mixture was applied with a small hand spray pump. One application was effective for two days.

Bishopp (1913) gives the following formula for a mixture that is said to be very effective in keeping flies from live stock, when applied lightly:

Fish oil	1 gallon.
Oil of tar	2 ounces.
Oil of pennyroyal	2 ounces.
Kerosene	½ pint.

Parrott (1900), at the Kansas Agricultural College, found that repellents were not as effective in Kansas as they were said to be in other States. Fish oil was effective for less than two days.

The following formula is recommended by him as being as effective as fish oil, and at the same time cheaper and more lasting:

Pulverized resin	2 parts (by measure).
Soap shavings	1 part.
Water	½ part.
Fish oil	1 part.
Oil of tar	1 part.
Kerosene	1 part.
Water	3 parts.

Place the resin, soap shavings, the one-half part of water, and fish oil together in a receptacle and boil until the resin is dissolved. Then add the 3 parts of water, following with the oil of tar mixed with the kerosene. Stir the mixture well and allow it to boil for 15 minutes. When cool the mixture is ready for use and should be stirred frequently while being applied. Application should be made with a brush. One-eighth to half a pint is required for each animal. The cost of the mixture is given as 30 cents a gallon.

The present writer has not made or used the above repellent. Its formula and method of preparation seem too complex for wide use. It would appear that great caution should be exercised in boiling the mixture because of the inflammability of some of the ingredients.

The same author recommends the following formula for horses. It is said to be effective for three to four hours and even longer:

Fish oil	2 quarts.
Carbolic acid (crude)	1 pint.
Pennyroyal	1 ounce.
Oil of tar	8 ounces.
Kerosene	[1] 1½ quarts.

The cost is given at about 80 cents a gallon. The mixture must be applied with an atomizer and not with a brush.

Carlyle (1899), of the Wisconsin Experiment Station, states that fish oil to which is added a little oil of tar and a little sulphur will serve to protect cows from hornflies for four to five days if the weather is fine. He states that none of the remedies seem to be effective against the stable fly an hour after being applied.

Otis (1904) recommends a repellent worked out by the entomological department of the Kansas station. The formula is as follows:

Resin	1½ pounds.
Laundry soap	2 cakes.
Fish oil	½ pint.
Water enough to make	3 gallons.

Dissolve the resin in a solution of soap and water by heating. Add the fish oil and the rest of the water. Apply with a brush. If to be used as a spray, add one-half pint of kerosene. The cost is 7 to 8 cents a gallon.

Fish oil containing a small admixture of carbolic acid has been used with good success as a repellent.

Lindsey (1903), at the Massachusetts Agricultural Experiment Station, found light coal-tar oil quite satisfactory. This oil is described as the lighter of two oils derived from tar. It is a dark, thin oil with a strong creosote odor. It was applied as a spray.

[1] Or enough to make 1 gallon of mixture.

Kerosene mixed with cottonseed oil or in the form of an emulsion may be used for repelling flies. Spencer (1904), at the Virginia station, used an emulsion of kerosene in a special spraying apparatus for destroying the hornfly. The formula and method followed in preparing the emulsion are given below:

Yellow soap	½ pound.
Soft water	1 gallon.
Kerosene oil	2 gallons.

Shave the soap fine and dissolve in water at boiling temperature. Place the kerosene in a barrel, add the hot-soap solution, and by means of a spray pump agitate for 15 to 20 minutes, or until emulsification is complete. One gallon of water is added to prevent the solution becoming thick. This is a stock solution and should be diluted in the proportion of 1 to 5 of water. The diluted emulsion tends to separate, so only the amount needed should be diluted each time.

It is stated that at the Virginia Agricultural Experiment Station daily sprayings for a period of two weeks reduced the hornflies to a point of insignificance. The flies were killed in passing through the spray.

A milk emulsion of kerosene may be made as follows: To 1 part of milk add 2 parts of kerosene and mix by means of a force pump, or in some other way. The creamy emulsion that results is to be diluted with 8 or 10 times the bulk of water.

Mayer (1911) found that laurel oil applied to the skin of cattle and horses repelled the flies. The oil produced an inflammation of the skin in some of the tests. The oil applied to bedsores of horses repelled the flies and produced no change in the sores.

Laurel oil and linseed oil in the proportions of 1 to 10 repelled flies from a bedsore on the foreleg of a horse for five days. The entire right side of a horse was rubbed with the oil. No flies were seen on the right side and great numbers were present on the left side. The action lasted for 12 days. A light application of oil to a horse was effective for only two days. This mixture produced no inflammation of the skin.

The following mixture was also tested by Mayer: Laurel oil, 1 part; dilute alcohol, 4 parts; and olive oil, 5 parts. In place of dilute alcohol denatured alcohol with water may be used, and in place of olive oil linseed oil may be used. The mixture was tried on horses, but the results were not so good, as the mixture did not stick. The action lasted five days.

Rancid oil should not be used on account of its irritating action.

REPELLENTS FOR APPLICATION TO WOUNDS.

Jensen (1909) gives three formulas of repellents for application to wounds:

Formula No. 1:

Oil of tar	8 ounces.
Cottonseed oil to make	32 ounces.

Formula No. 2:

Powdered naphthalin	2 ounces.
Hydrous wool fat	14 ounces.

Mix into an ointment.

Formula No. 3:

Coal tar	12 ounces.
Carbon disulphid	4 ounces.

Mix; keep in a well-stoppered bottle and apply with a brush.

Mixtures Nos. 2 and 3 are said to adhere to moist surfaces, and No. 3 is said, in addition, to form a coating over raw surfaces and protect from the screw-worm fly.

The editor at the close of the article in which the above formulas are given adds the following formula:

Oil of turpentine	1 dram.
Phenol	1 dram.
Cottonseed oil to make	4 ounces.

Mix and apply freely to wounds.

It is stated that this remedy is highly effective and is used widely in the South. It is said to induce healthy granulation of wounds.

EXPERIMENTAL TESTS OF VARIOUS SUBSTANCES AND MIXTURES FOR REPELLING FLIES.

For the purpose of determining the efficacy of various substances and mixtures for repelling flies, a number of tests were made by the present author at the Bureau of Animal Industry Experiment Station during the summers of 1912 and 1913. The results of these tests are given below. In making various mixtures for the purpose of trial the plan adopted was to combine a pungent or odoriferous substance with an oil which served mainly as a vehicle.

CRUDE CARBOLIC ACID.[1]

The following tests were made with 10 per cent crude carbolic acid in cottonseed oil:

On July 22, 1912, a calf was sprayed with a mixture of 10 per cent crude carbolic acid in cottonseed oil. About 2 quarts of the mixture were applied. The calf was discovered down about 7 to 10

[1] A sample of the crude carbolic acid used in these tests was examined in the Biochemic Division of the Bureau of Animal Industry, and was found to contain 21.8 per cent phenols.

minutes later with symptoms of carbolic-acid poisoning. There was salivation, dyspnea, trembling, paralysis, inability to rise, rapid breathing, and rapid and irregular beating of the heart.

Another calf was sprayed on the same date with about 1½ quarts of the mixture. The calf showed distinct symptoms of carbolic-acid poisoning in 6 minutes. It showed a tendency to fall in 8 minutes, and fell in 14 minutes. The symptoms in the order in which they occurred were: Salivation, dyspnea, muscular tremors, loss of muscular control, and finally motor paralysis. The breathing was rapid and shallow.

It was necessary to destroy both of the animals.

July 15, 1913, applied the mixture to a calf by means of a brush. Used 2⅔ ounces of the mixture. The repellent action was very marked. July 16, about 18 hours later, the animal was worried as much by flies as were the controls. Oil was present only along the back. There was only a very faint odor of carbolic acid. The protection was practically nothing. There were no symptoms of poisoning.

The results obtained with crude carbolic acid may be summarized as follows: In the case of the first two calves treated it shows that carbolic acid in cottonseed oil is absorbed through the skin. It is well known that carbolic acid, when combined with oil, loses its caustic properties, but its toxic properties still remain, as evidenced by the above cases of poisoning. It seems certain that in the case of any such mixture, no matter how small the content of carbolic acid, a certain amount of the same must be absorbed. The amount absorbed will depend, other things being equal, on the amount of the mixture applied. In the third test that was made, the same strength (10 per cent) mixture was used, but it was applied with a brush and only to the amount of 2⅔ ounces. There were no symptoms of poisoning. It is therefore evident that a 10 per cent mixture of crude carbolic acid (21.8 per cent phenols) in cottonseed oil may be used with safety if the application is very light. It is undoubtedly true that a very much weaker mixture of carbolic acid if applied liberally would produce toxic symptoms.

The repellent action of this mixture, however, does not endure. Its action was very marked at first, but lasted less than 18 hours. It would be necessary therefore to apply this mixture every day. In order to ascertain whether daily applications of the mixture could be made without danger to the animal, a calf was treated with this mixture on October 2, 3, 4, 6, 7, 8, 9, 10, 11, and 13. The mixture was applied with a brush. There were no symptoms of poisoning or other untoward results.

PINE TAR.

TEN PER CENT PINE TAR IN COTTONSEED OIL.

July 29, 1912, sprayed a cow with 10 per cent of pine tar in cottonseed oil. Used 3½ quarts of the mixture.

July 30, the cow was looking droopy. The ears were hanging.

July 31, the hair was still oily. There was no odor of tar. The animal was bright and perfectly normal. No hornflies were observed. A few stable flies were present on the legs and body. The animal was not fighting the flies, whereas unsprayed animals were constantly switching their tails.

August 1, some oil was still present. Some stable flies were present, especially on the legs. Animal does not fight flies as much as do the untreated animals.

August 3, oil still present on the back, croup, and thighs. It is very sticky. There is little or no protective action.

TWENTY PER CENT PINE TAR IN COTTONSEED OIL.

July 15, 1913, treated a cow with 20 per cent pine tar in cottonseed oil. Used 5⅓ ounces of mixture. It was applied with a brush. The protection was marked but not quite so effective as either 10 per cent crude carbolic acid or 10 per cent oil of tar in cottonseed oil. July 16, about 18 hours later, the cow fought flies as much as did the controls. There was some oil present on the neck, back, and on the fore legs. There was no odor of tar. There was little or no protective action evident at this time.

A HALF-AND-HALF MIXTURE OF PINE TAR AND COTTONSEED OIL.

July 31, 1912, sprayed a calf with a half-and-half mixture of pine tar and cottonseed oil. Used about 2 quarts of fluid. The mixture was too thick to spray well in pump. The animal was sprayed very unevenly and some spots were not covered. Two types of nozzles were used, but a satisfactory spray was not developed.

August 1, there was plenty of oil present and also an odor of tar. Tar was visible here and there on the hair. No flies were observed.

August 3, some oil was still present. There was a slight odor of tar. A repellent action was still noticeable on the back, croup, and thighs.

July 31, a second calf was sprayed. Used about 2 quarts, which was not enough to cover the animal properly.

August 1, there was plenty of oil present, and there was a strong odor of tar. No flies were observed.

August 3, the oil and tar odor still present. A distinct repellent action on stable flies was still noticeable.

FIFTY PER CENT PINE TAR IN BEAUMONT OIL.

August 19, a cow was treated with 50 per cent pine tar in Beaumont oil. The mixture was applied with a brush.

August 20, the mixture had been rubbed off the sides and abdomen. The odor of tar was still present. The hair was rather untidy. Flies were present only on underside of abdomen.

August 21, the cow was stiff. The mixture was still present on the back. There was no repellent action.

SUMMARY OF RESULTS WITH PINE TAR.

It is noted from the first test made that a liberal application of 10 per cent pine tar in cottonseed oil caused the animal to look droopy. It is probable that this was due to a toxic action of the tar. The odor of the tar had disappeared on the second day following the treatment. The repellent action lasted for three days. Some oil was present five days after the treatment.

In the test in which 20 per cent of pine tar was used, the mixture was applied with a brush and only $5\frac{1}{3}$ ounces were used. The repellent action was marked, but not so great as in the case of 10 per cent crude carbolic acid or 10 per cent oil of tar. The repellent action lasted less than 18 hours. The odor of tar had disappeared at that time.

In the third test in which a half-and-half mixture of pine tar and cottonseed oil was used, the mixture was applied liberally by means of a spray pump. The repellent action lasted more than three days in the case of both animals treated. The mixture is too thick to be used in a spray pump.

In the last test, in which a half-and-half mixture of pine tar and Beaumont oil was used, the repellent action lasted less than two days. This mixture had a detrimental effect in that it caused the animal to become stiff.

There seems to be no danger to animals in applying tar in cottonseed oil for the purpose of repelling flies. In the first test there were slight symptoms of poisoning, but the amount of 10 per cent mixture applied ($3\frac{1}{2}$ quarts) was much more than would ever be applied to an animal to protect it from flies.

It is evident from the second test that when a pine-tar-cottonseed-oil mixture of moderate strength is applied in quantities such as it is economical to use, the applications will have to be made every day in order to provide protection.

OIL OF TAR.[1]

TEN PER CENT OIL OF TAR IN COTTONSEED OIL.

July 22, 1912, sprayed a calf with 10 per cent oil of tar in cottonseed oil. Used about 2 quarts of the mixture.

July 23, the oil was still evident. No hornflies were observed. Stable flies were seen to light on the hair but left immediately. Some stable flies were seen on the legs of the animals.

July 25, the odor of the oil of tar had entirely disappeared. The hair was still oily but flies were seen to light on the oily spots.

July 29, there was no oil present.

July 15, 1913, applied 3⅔ ounces of the mixture to a calf by means of a brush. The repellent action was very marked.

July 16, about 18 hours later, the calf did not fight the flies quite so much as did the controls. There was no odor of tar. There was a very slight evidence of oil on the sides and back but no repellent action could be observed.

HALF-AND-HALF MIXTURE OF OIL OF TAR AND COTTONSEED OIL.

August 22, 1912, sprayed a calf with a half-and-half mixture of oil of tar and cottonseed oil. Used about 2 quarts of the mixture. The animal almost immediately began to show signs of sickness. The eyes were half closed. The skin about the eyes, on the face, and at the corners of the mouth was wrinkled. There was slight salivation. These symptoms were followed by a slight swaying in the hind quarters when the animal walked. Finally the gait became staggering and the animal fell from time to time and arose again only with the greatest difficulty.

August 26, when the next observation was made, the animal had entirely recovered. There was no repellent action noticeable.

TEN PER CENT OIL OF TAR IN BEAUMONT OIL.

July 22, 1912, sprayed a calf with 10 per cent oil of tar in Beaumont oil. Used about 2 quarts of the mixture.

July 23, oil was present on the hair. There were a very few stable flies on the legs. No hornflies were observed.

July 25, more oil was present on the hair than in the case of a calf sprayed on the same date with a mixture in which cottonseed oil served as the base.

July 29, oil was present on the back and rump. No hornflies were observed.

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[1] A sample of the oil of tar used in these experiments was examined in the Biochemic Division of the Bureau of Animal Industry and was found to contain phenols, volatile with steam, 14 per cent.

August 7, 1913, a calf was treated with 10 per cent oil of tar in Beaumont oil. The mixture was applied with a brush. The repellent action was marked.

August 8, no odor of tar was noticeable. The oil was rubbed off the abdomen, the sides, and outside of the thighs. Some stable flies were present on the legs. Only a very few hornflies were present.

FIFTY PER CENT OIL OF TAR IN BEAUMONT OIL.

August 19, 1913, a cow was treated with a mixture of 50 per cent oil of tar in Beaumont oil. The mixture was applied with a brush. There was a slight salivation, and the cow remained rather quiet following the treatment. It seems certain that there were symptoms of phenol poisoning.

August 20, the odor of the oil of tar was still present. Only a few stable flies were present on the legs. Other animals in the same pen were covered with flies. The mixture had disappeared from the sides and abdomen.

August 21, the cow was a little stiff. Oil was still present on the back. The cow was protected very little from the flies.

SUMMARY OF RESULTS WITH OIL OF TAR.

In the first test with 10 per cent oil of tar in cottonseed oil the mixture was applied with a spray pump. About 2 quarts of the liquid were applied. The repellent action lasted less than three days.

In the second test the mixture was applied by means of a brush, and $3\frac{2}{3}$ ounces were used. The repellent action, which was very marked at first, had nearly disappeared at the end of 18 hours.

In the third test a half-and-half mixture of oil of tar and cottonseed oil was applied with a spray pump. About two quarts of the mixture were used. There were symptoms of poisoning. The next observation was made four days later, at which time there was no repellent action.

In the fourth test 10 per cent oil of tar in Beaumont oil was applied with a spray pump. About 2 quarts of the mixture were used. There were no symptoms of poisoning.

In the fifth test 10 per cent oil of tar in Beaumont oil was applied with a brush. On the following day the odor of tar had entirely disappeared and the repellent action had almost entirely ceased.

In the last test 50 per cent oil of tar in Beaumont oil was applied with a brush. The protection lasted about two days. There were mild symptoms of poisoning and the animal became slightly stiff.

The repellent action of 10 and 50 per cent of oil of tar in cottonseed oil or in Beaumont oil is very marked, but when applied in

such quantities as it is economical to use the action lasts less than a day when cottonseed oil is used, and about two days when Beaumont oil is used. As shown by the third test, 50 per cent oil of tar is dangerous when applied in large quantities.

The last test shows that 50 per cent oil of tar in Beaumont oil when applied in small quantities with a brush is also dangerous. The increase of the content of oil of tar from 10 to 50 per cent does not seem to increase the duration of the repellent action materially, as indicated by tests 1 and 3, but the 50 per cent Beaumont oil mixture protected twice as long as the 10 per cent mixture.

For the purpose of determining whether daily applications of 10 per cent oil of tar in cottonseed oil would produce poisoning or other untoward results, a calf was treated with the mixture on October 2, 3, 4, 6, 7, 8, 9, 10, 11, 13, and 14. The mixture was applied with a paint brush. No symptoms of poisoning resulted, and the skin remained unaffected.

THE MOORE FORMULA.

October 4, 1912, a calf was sprayed with the following mixture:

Fish oil	100 parts.
Oil of tar	50 parts.
Crude carbolic acid	1 part.

About three quarts of the mixture were used. The animal appeared sick after being sprayed. It was restless and there was salivation.

October 7, the animal was very oily. There was present an odor of tar and fish oil. Flies were still repelled.

July 16, 1913, a bull calf was treated with the above mixture, which was applied with a brush, and 6 ounces were used. The repellent action was marked. There were no symptoms of poisoning.

It is noted from the first of the above tests that the application of the Moore mixture in large quantities is dangerous. Such a liberal application, however, would never be made in practice. The repellent action was still evident on the third day. In the second test a small quantity of the mixture was applied to a calf by means of a brush and no symptoms of poisoning resulted.

TEN PER CENT OIL OF CITRONELLA IN COTTONSEED OIL.

June 19, 1913, a calf was treated with 10 per cent oil of citronella in cottonseed oil, applied with an atomizer. A few hours later all protection had ceased.

July 2, 1913, the above calf was again sprayed. An hour or so later a repellent action was still noticeable. The calf was not troubled much with flies as compared with the untreated animals.

July 3, 1913, a cow was sprayed. Used 1½ ounces. There was a very marked repellent action, but an hour or so later this had become

greatly reduced. There was a very slight odor of citronella at that time.

July 10, 1913, applied the mixture to a cow by means of a brush. Used about 6 ounces of oil. July 11, about 22 hours after application, oil was present on the neck and along the back. There was no odor of citronella. There was little or no protection as indicated by the presence of many hornflies on the underside of the abdomen, and the presence of many stable flies on the legs.

It is noted from the above tests that the mixture used is a powerful repellent, but that its effect does not last more than a few hours.

TEN PER CENT OIL OF SASSAFRAS IN COTTONSEED OIL.

June 19, 1913, a mixture of 10 per cent oil of sassafras in cottonseed oil was applied to a calf by means of an atomizer. There was a pronounced repellent action which, however, had disappeared at the end of a few hours.

July 2, 1913, the same calf was again treated. An hour or so later a repellent action was still present. The calf was troubled very little with flies as compared with the other animals. July 3, there was no odor or protective action noticeable.

July 3, 1913, treated a cow with the mixture. Used about 3 ounces. The repellent action was marked. An hour or so later the repellent action was greatly reduced and there was no odor of sassafras.

July 10, 1913, applied the mixture with a brush to the above cow. Used about 5⅓ ounces. July 11, about 22 hours later, a little oil was present on the neck, withers, and just behind the withers. Many hornflies were present on the front legs and on the underside of the abdomen.

The above tests show that the mixture has a marked repellent action, but that this only lasts for a few hours.

TEN PER CENT OIL OF CAMPHOR IN COTTONSEED OIL.

June 19, 1913, a mixture of 10 per cent oil of camphor in cottonseed oil was applied to a calf by means of an atomizer. A few hours afterward some protective action was still noticeable.

July 2, 1913, the same calf was again treated. An hour or so later the calf was still protected from flies.

July 3, 1913, no protection was noticeable in the case of the above calf. A cow was sprayed with the mixture. Used 2⅓ ounces. There was a marked protective action. An hour or so later the protective action was greatly reduced. There was no odor of camphor.

July 10, 1913, applied the mixture to the above cow with a brush. Used 5 ounces. July 11, about 22 hours after application, a little oil was present on the neck and along the back. There was no odor

of camphor. Some hornflies were present and many stable flies were on the legs.

The immediate protection rendered by the above mixture is marked, but its action lasts only for a few hours.

HALF-AND-HALF MIXTURE OF KEROSENE AND COTTONSEED OIL.

August 7, 1913, a cow was treated with a half-and-half mixture of cottonseed oil and kerosene. The mixture was applied with a brush. The flies were repelled.

August 8, the oil was rubbed off the sides, abdomen, and the outside of the thighs. Very few flies were present.

KEROSENE EMULSION.

August 21, 1913, treated a cow with kerosene emulsion made according to the formula on page 11, diluted 1 to 8. The emulsion had only a very slight repellent action.

BEAUMONT OIL.

August 7, 1913, a calf was treated with Beaumont oil. The oil was applied with a brush. The repellent action was marked. August 8, the oil had been rubbed off the abdomen, the sides, and the outside of the thighs. Stable flies were present on the legs. There was plenty of oil present on the neck, shoulders, and back. There were no hornflies on the animal, although they had been numerous the day before.

FISH OIL.

July 22, 1912, a calf was sprayed with fish oil. About 2 quarts of the oil were used. July 23, the oil was present on the hair. Flies frequently lit on the animal but left almost immediately. A few stable flies were noted on the legs. No hornflies were observed.

July 25, considerable oil was still present. Some flies were seen to light on and crawl over the greasy hair. There was a very slight fishy odor.

July 29, oil was present on the back and rump. No hornflies were observed. Stable flies were observed on the legs.

August 6, rear portion of body very sticky and dirty. There was a loss of hair in spots on the back and sides.

July 15, 1913, applied fish oil with a brush. The protection was very marked. July 16, about 20 hours later, there was an abundance of oil present on the upper half of body, and a repellent action was noticeable in this region. There was still a very slight amount of oil on the legs, but it was not sufficient to keep the flies off.

In the first test with fish oil the oil was applied by means of a spray pump. Two liters were used. The repellent action lasted between one and three days. The liberal application of the oil caused

the hair to become sticky and dirty in places. There was also a loss of hair. These unfavorable results were not noted in the second test, in which a light application of oil was made with a brush.

LAUREL OIL.

June 19, 1913, a calf was rubbed with laurel oil. The protection was very marked.

July 2, 1913, the oil was applied to a calf with a paint brush. There was a very marked repellent influence on both the hornflies and the stable flies. An hour or so later the repellent action was only very slightly reduced.

July 3, 1913, the same calf was treated. Used about 2 ounces. The mixture was applied with a paint brush. The repellent action was marked.

July 10, 1913, applied the oil with a brush to all parts of the body except the head. Used 5 ounces. July 11, about 22 hours later, there was an abundance of oil present on body and neck. There were no flies on the body and neck. Some stable flies were present on the legs.

July 15, 1913, a severe exfoliation was noted on the shoulders and neck. There was a slight exfoliation on the head. A similar exfoliation was noted on the withers shortly after the first treatment on June 19.

August 19, 1913, a calf was treated all over with laurel oil. Application was made by means of a brush.

August 20, there was an abundance of oil present. It was rubbed off the abdomen. The repellent action was marked, but the odor of the oil was not as strong as at first.

August 21, some oil was present on the back and sides. There was a repellent action still evident.

August 7, 1913, a cow was treated with 10 per cent laurel oil in cottonseed oil. The mixture was applied with a brush. The repellent action was marked.

August 8, oil was present on the neck, shoulders, and back. It was rubbed off the sides and abdomen. There was no odor of laurel oil. Stable flies were present on the legs. Hornflies were present on the abdomen where the oil had been rubbed off.

Laurel oil has a very marked repellent action on both hornflies and stable flies. No observations were made to determine the limit of the duration of the repellent action, but it undoubtedly as a rule continues for several days. On account of the fact that the oil has a tendency to produce an exfoliation of the skin it should be applied very lightly to the hair. As indicated by the last test, in a 10 per cent mixture of laurel oil and cottonseed oil the laurel oil disappears by evaporation in less than 24 hours.

PYRETHRUM POWDER.

July 25, 1912, a cow was dusted with pyrethrum powder along the neck and back. Used about 2½ ounces of powder. Flies were observed to light frequently on the treated portions of the body and remain for a time.

July 26, an attendant reported that there was plenty of powder still present and that it seemed to repel the flies.

August 9, 1913, pyrethrum powder was applied to the skin of a cow. The repellent action was very marked. August 10, only a very slight protective action was noted.

Pyrethrum powder when applied to the skin of cattle has a very marked repellent action, but this lasts only for about a day.

SUMMARY OF EXPERIMENTAL TESTS.

The experimental tests are summarized in the following table:

Summary of experimental tests.

Substance used.	Duration of odor.	Duration of repellent action.	Duration of presence of substance.	Method of application.	Effect on animals.
	Days.	*Days.*	*Days.*		
10 per cent crude carbolic acid in cottonseed oil.	.....	.....	.....	Spray pump.	Phenol poisoning.
Do	.....	.....	.....	.....do.....	Do.
Do	1+	1−	1+	Brush.....	None.
10 per cent pine tar in cottonseed oil	2−	3+	5−	Spray pump.	Caused depression.
20 per cent pine tar in cottonseed oil	1−	1−	1+	Brush.....	None.
50 per cent pine tar in cottonseed oil	3+	3+	3+	Spray pump.	Do.
Do	3+	3+	3+	.....do.....	Do.
50 per cent pine tar in Beaumont oil	2−	2−	2+	Brush.....	Caused stiffness.
10 per cent oil of tar in cottonseed oil	3−	3−	3+	Spray pump.	None.
Do	1−	1+	1+	Brush.....	Do.
50 per cent oil of tar in cottonseed oil	.....	4−	.....	Spray pump.	Phenol poisoning.
10 per cent oil of tar in Beaumont oil	.....	.....	7+	.....do.....	None.
Do	1−	1+	1+	Brush.....	Do.
50 per cent oil of tar in Beaumont oil	1+	2	2+	.....do.....	Slight symptoms of poisoning. On second day animal was stiff.
The Moore formula	3+	3+	3+	Sprayed.....	Phenol poisoning.
Do	.....	.....	.....	Brush.....	None.
10 per cent oil of citronella in cottonseed oil.	.....	1−	.....	Atomizer....	Do.
Do	1−	1−	1+	Brush.....	Do.
10 per cent oil of sassafras in cottonseed oil.	.....	1−	.....	Atomizer....	Do.
Do	1−	1−	.....	.....do.....	Do.
Do	.....	1−	1+	Brush.....	Do.
10 per cent oil of camphor in cottonseed oil.	.....	1−	.....	.....	Do.
Do	1−	.....	.....	Atomizer....	Do.
Do	1−	1−	1+	Brush.....	Do.
50 per cent kerosene in cottonseed oil	.....	1+	.....	.....do.....	Do.
Beaumont oil	1+	1+	1+	.....do.....	Do.
Fish oil	3+	3−	7+	Spray pump.	Slight loss of hair.
Do	.....	.....	.....	Brush.....	None.
Laurel oil	1+	1+	1+	.....do.....	Severe exfoliation.
Do	2+	2+	2+	.....do.....	None.
10 per cent laurel oil in cottonseed oil	1−	1+	1+	.....do.....	Do.
Pyrethrum powder	.....	1+	1+	.....	Do.
Do	.....	1+	1+	.....	Do.

GENERAL SUMMARY.

The biting flies that annoy domestic animals most in this country are the stable fly, *Stomoxys calcitrans*, and the hornfly, *Lyperosia irritans*. The bot flies are not biting flies, but are a menace to domestic animals because of the parasitic habits of their larvæ. This is also the case with the screw-worm fly, *Paralucilia macellaria*, which deposits its eggs in wounds, and a bluebottle fly, *Lucilia sericata*, occurring in the United Kingdom and Holland, and certain species of Calliphora occurring in Australia, the larvæ of which invade the wool and skin of sheep.

Repellents are more or less effective against all of these flies.

Opinions differ with regard to the injury by biting flies. The common opinion seems to be that these flies are responsible for great losses. However, a limited amount of experimental evidence relating to cattle seems to indicate that the losses, when they occur, are not great.

The repellent action of certain colors has been noted by various investigators. Light-colored animals suffer less from flies than dark-colored ones. One author (Marre, 1908) has recorded the observation of a farmer in France who found that a blue color applied to the inside of stables repelled flies. This observation seems to have remained uncorroborated.

Potassium tellurate has been recommended by Ochmann (1911) as an internal remedy for repelling flies. However, Mayer (1911) failed to obtain results with the remedy, and it seems safe to assume that internal remedies will never prove practicable in repelling flies.

Liquid repellents may be applied by means of a dipping vat, a pail spray pump, an atomizer, or by means of a rag or a paint brush. The method to be employed depends on the individual preference of the farmer and the nature and cost of the preparation used.

The powder remedies that have been used are pyrethrum powder and tobacco powder.

Various oils, emulsions of oils, and mixtures of oils are used in repelling flies. Crude petroleum, cottonseed oil, fish or train oil, and light coal-tar oil may be used pure. Jensen (1909) recommends for dairy cows an emulsion of crude petroleum containing an admixture of powdered naphthalin.

Fish oil is rated as one of the best repellents and has been used alone and in combination with various other substances. Other substances that have repellent qualities and that have been used in various mixtures are pine tar, oil of tar, crude carbolic acid, oil of pennyroyal, and kerosene.

Jensen's formula is said to protect cows for a week. The protective action of fish oil is stated to range from less than two days

(Parrott, 1900) to six days. Moore's formula is said to protect for two days. This mixture is safe when applied lightly with a brush, but not when applied liberally with a pail spray pump.

Laurel oil is a very effective repellent. Mayer (1911) found that the protection lasted from 2 to 12 days. The oil when used pure has an irritating effect unless it is applied lightly. According to Mayer the irritating effect may be overcome by combining it with linseed oil in the proportion of 1 to 10. The present author found that 10 per cent of laurel oil in cottonseed oil was active for less than a day.

A number of formulas for repellents for application to wounds have been recommended by various authors.

In experimental tests carried out by the present author the following results were obtained:

A 10 per cent mixture of crude carbolic acid (21.8 per cent phenols) in cottonseed oil has a very strong repellent action on flies, but this lasts less than a day, in consequence of which it is necessary to apply the mixture every day. The mixture should be applied lightly with a brush, since a heavy application with a spray pump is likely to cause phenol poisoning.

Mixtures consisting of 10, 20, and 50 per cent of pine tar in cottonseed oil have marked repellent qualities. They should be applied lightly and it is necessary to apply them every day. A liberal application of a 10 per cent mixture is deleterious to animals. This is also the case with a half-and-half mixture of pine tar and Beaumont oil when applied lightly with a brush.

A mixture of oil of tar (14 per cent phenols, volatile with steam) in cottonseed oil and in Beaumont oil has a very marked repellent action. A 10 per cent mixture of oil of tar in cottonseed oil is safe. A half-and-half mixture of oil of tar and cottonseed oil when applied liberally with a spray pump and 50 per cent oil of tar in Beaumont oil applied with a brush are not safe. Ten per cent oil of tar in Beaumont oil is safe. When applied lightly it is necessary to apply 10 per cent oil of tar in cottonseed oil or 10 per cent oil of tar in Beaumont oil every day.

Mixtures of 10 per cent of oil of citronella, oil of sassafras, or oil of camphor in cottonseed oil are powerful repellents, but they are active for less than a day.

A heavy application of fish oil causes the hair to become sticky and fall out. A light application did not produce these results.

Pyrethrum powder is an effective repellent, but its action lasts only for about a day.

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