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Sheep Blowfly Research VI.—The Treatment of Myiasis.*

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I. General Considerations.

The properties of an ideal dressing for the treatment of blowfly strikes have been enumerated by Lennox (1941) as follows:—

(i) It should be stable.
(ii) It should possess sufficiently low viscosity and surface tension to enable it to penetrate readily into a strike wound and into the surrounding fleece.
(iii) It should not damage the fleece and it should be easily removed in the industrial process of scouring.
(iv) It should resist atmospheric decomposition after application to the sheep and should not be readily removed by rain or urine.
(v) It should kill the maggots in a strike or so injure them that they can do no further damage.
(vi) It should be non-toxic to the sheep.
(vii) It should promote rapid healing of the strike wound.
(viii) It should prevent restrike both during the healing process and subsequently.
(ix) If an aqueous system, the dressing should be easily prepared by adding water to the solid components.
(x) It should be cheap.

These requirements are admirably stated and may serve as a basis for the search after an ideal dressing. However, point (v) requires modification, especially in view of the observations referred to in Article No. V of this series, from which the conclusion must be made that the breeding-place of *Lucilia cuprina* during the summer is on live sheep, at least in South Africa, although this would seem to be also largely the case in Australia. If the phrase "that they can do no further damage" is understood in the absolute sense, i.e. that they will also not become flies which may again strike sheep, it is in order. But if it refers only to damage in the maggot stage on the particular struck sheep, it is insufficient.

In the past most investigators laid more stress on the prevention of re-strike than on the killing of the maggots and all dressings with which the writer is acquainted suffer from this deficiency. The B. T. B. mixture described by Lennox falls in the same category. It is stated that "many of the maggots left the wound as soon as the dressing was applied and the majority of those which remained were killed within 10 minutes". The writer tested all blowfly dressings used in South Africa as well as a few

* See footnote to article I of this series.

others and found in practically all cases that the majority of the maggots left the wound very soon after the application, that these maggots would drop off the sheep and eventually develop into blowflies. In a few cases the maggots were stunned by the dressing and therefore readily dropped off the sheep as soon as the latter was released—when it usually shakes itself or stamps its hindlegs—and the majority recovered in 30-60 minutes, pupated and became flies.

It is obvious that if the fly can breed only on the sheep during several months of the year, the killing of all maggots in strike wounds should markedly decrease the incidence of blowflies or even exterminate them. It is therefore imperative that a dressing should kill 100 per cent. or very nearly that proportion of the maggots. For this purpose a stomach larvicide will not be satisfactory on account of the fact that the majority of the maggots are driven away and are not affected by such a poison, at least not by those so far used for this purpose. A contact larvicide from which the maggots cannot escape must consequently be used, and it should act rapidly before the maggots can get away from it or, if they are stunned, before they may drop off the sheep.

Point (x) of the properties, viz., that the dressing must be cheap, is very important in order to enable every farmer to use it, so that the killing of maggots could be generally and regularly carried out. In the investigations recorded in this paper the question of costs was, therefore, continually kept in mind.

Point (viii), that the dressing should prevent restrike both during the healing process and subsequently, is a high ideal which may be obtained by the inclusion in the dressing of stomach poisons, which would remain effective some time after healing has occurred. But this takes the dressing into the category of prophylactics and one might be satisfied with a dressing which prevents restrike until healing is completed, especially if extended protection should appreciably increase the cost of the dressing and so limit its use.

Protection against restrike can be effected in three ways: (1) by repellents, (2) by larvicides, especially stomach poisons such as boric acid and diphenylamine, or (3) by making the wound unattractive and unsuitable in other ways, based on a knowledge of the factors which tend to favour restrike. Repellents are limited in their effects and lately there seems to be a general tendency amongst investigators on this subject to look for other means of protection. In 1936 the writer reported on a dressing in which carbon tetrachloride was used as larvicide in an aqueous emulsion with woolgrease, to which Tagetes oil was added as a repellent. Tagetes oil was more effective than pine tar oil which, until then, had been considered the best blowfly repellent. But later—Mönnig (1940)—it was stated that even this oil was not sufficiently effective during a bad strike wave and " that it would be far better to get the wounds to dry and heal rapidly and also to make them unattractive and unsuitable for restrike in other ways than by means of repellents ". The above-mentioned emulsion also suffered from another defect which is common to all aqueous dressings but which was only realised at a later stage. This matter will be discussed presently.

Larvicides as protectives have great possibilities, especially because their use would tend to extend protection beyond the healing stage. Manufacturers of proprietary dressings continue to incorporate arsenical compounds for this purpose, but they are undesirable on account of their

irritating and poisonous properties when used on a wound or a raw surface. In building up the blowfly spray described in this article, the writer seriously considered the incorporation of boric acid or other larvicides of this type and it may still be desirable to add such an ingredient, but under present international conditions the difficulty of obtaining the necessary chemicals and the increase in costs which would result led to the decision to do without them.

In 1940 the writer reported on tests carried out with wattle-bark extract (mainly tannates of catechol and pyrogallol) and discussed the reasons for attractiveness on which the use of this substance was based. Briefly the facts are that alkalinity and moisture are the main essential factors and consequently it was concluded that a wound should become unattractive to blowflies and unsuitable for young maggots if it was acidified and made to dry rapidly. Hence the use of an acid astringent.

In pursuance of this line of investigation further tests were made and several facts emerged on account of which the use of wattle-bark extract was suspended in favour of other substances. As previously reported, an emulsion of benzol in aqueous wattle extract solution attacks metal and, therefore, the two substances were applied separately and successively, which meant a double treatment against which several farmers, who carried out tests, raised objections. Moreover it was found that, in a certain percentage of cases, restrikes occurred, not on the site of the original strike but immediately next to it where none of the material had been applied. At first it was thought that this was due to failure to treat the whole strike, but it was soon realised that another factor was responsible and that this might be a defect inherent in all aqueous dressings, especially when it was recalled that similar restrikes had been reported after the use of the carbon tetrachloride-Tagetes oil emulsion referred to above. It now appears very probable that an aqueous dressing may provide a source of moisture, from which the suint in the immediate vicinity draws water and that in this way new attractive foci may be set up leading to strikes, just as happens in the case of soiling by diarrhoeic faeces. For these reasons the aqueous wattle extract was dropped, although further but unsuccessful attempts were later made to incorporate alcoholic solutions into other mixtures. It was decided to obtain the acid, astringent and drying effects by other means and alcohol was thought of particularly as a possible astringent and drying agent.

II. Tests for Larvicidal Efficacy.

A further fact which emerged from the work on wattle extract dressings was that *in vitro* tests of dressings for larvicidal value, at least where contact larvicides are concerned, are misleading and valueless. In the preliminary report referred to it has been recorded that emulsions of benzol in aqueous wattle extract solutions were 100 per cent. effective in killing maggots *in vitro* in 1 to 3 minutes. The further tests then reported on were mainly concerned with the efficacy of such emulsions in preventing restrikes. When tests of the larvicidal effect were subsequently carried out on actual strikes it was found that the results fell far short of what had been expected on the basis of *in vitro* tests. The average larvicidal efficacy obtained in several tests was only 63 per cent. Similar differences between the results of *in vitro* and *in vivo* tests were later noted with other mixtures and therefore the *in vitro* method was discarded. All tests of larvicidal efficacy recorded in this paper were made on artificial strikes. Three days after application of the first stage larvae, when the maggots were full-grown and almost ready to

leave the sheep, the strike area was clipped, the dressing to be tested was poured or sprayed on and time was kept by means of a stop-watch. From one to three minutes after application of the dressing maggots were removed and placed on clean sand in glass containers. The latter were covered with gauze and placed in an aquarium room with a moderately warm and moist atmosphere. About 14 days later, when all flies that would emerge had died, the content of the vessel was passed through a sieve and the results recorded as dead larvae, dead pupae and flies emerged. The reason for the difference in results obtained by the two methods is not clear; possibly the larvae in a wound are to some extent protected by a covering layer of the substances which surround them and very probably the alkalinity of the medium plays a part, as is indicated by the effect of acid ingredients in dressings to be mentioned later.

III. Selection of Larvicide.

On the basis of these general considerations an attempt was made to build up a dressing. The first requirement was a suitable larvicide. Pyrethrins, nicotine, paradichlorbenzene, and several other insecticides appeared to have no or very little effect on the maggots. Carbon tetrachloride is too expensive. Attention was, therefore, directed to coal-tar distillates of which some were known to be very effective.

Benzol is rather irritating to sheep or, at least, causes pain on application and it was thought that fractions with higher boiling points and larger molecules may be less irritating. Preliminary tests of such fractions showed that the irritating effects of some of them were due mainly to tar acids (phenol and cresols), ta bases (quinoline and isoquinoline) and naphthalene which they contained. Therefore, these fractions were obtained free of acids and bases for further tests. It was also found that the addition of naphthalene did not increase the efficacy of any of these fractions, but that the larvicidal properties were indeed lowered by a naphthalene content of over 5 per cent. and consequently the naphthalene was removed from fractions containing it. The tar fractions used in all the following tests were, therefore, neutral and free of naphthalene. The results obtained with the various fractions alone are given in Table 1.

Table 1.

Fraction.	B.P. (°C.).	L.	P.	F.
Benzol	± 80	70	24	6
Xylol	133–134	11	—	89
Naphtha A	120–160	31	34	35
Naphtha 11A	143–160	12	58	30
Naphtha 11	143–167	15	36	49
Naphtha 4	160–180	35	27	38
Naphtha 4, free of cumarone	±160–180	24	39	37
Heavy naphtha	160–200	20	18	62
Naphtha 3	180–200	8	28	64
Creosote oil 6	200–240	68	10	22
Creosote oil 7	240–300	55	14	31
Naphtha 11A : 50 Creosote oil 6 : 50	—	33	23	44

Explanation.—L. P and F are the percentages of dead larvae, dead pupae and flies emerged as obtained by the technique described above. As a rule three strikes were treated with each substance tested, but frequently a larger number of tests were made and the results here given are the averages of all such tests and usually refer to well over 100 maggots.

If a graph is drawn from these figures it will be seen that there are three apices, one produced by benzol, another by the light naphthas boiling at about 140 to 160° C. and a third by the creosote oils boiling at about 200 to 240° C.

IV. Addition of Cresols.

In previous tests made with the same substances which had not been purified of tar acids and bases, it had been noted that the larvicidal effect was better than now obtained. Since a reasonable quantity of tar acid in a dressing would add the advantage of a disinfectant, tests were now made with the same fractions to which the phenol or cresols were added in definite quantities. The results are given in Table 2:—

Table 2.

Fraction.	B.P. (°C.).	Percentage Tar Acid Content.	L.	P.	F.
Benzol	± 80	2·5 Phenol	89	9	2
Benzol	± 80	5 Phenol	82	5	13
Naphtha A	120–160	2·5 Phenol	77	22	1
Naphtha A	120–160	5 Phenol	91	6	3
Naphtha 4	160–180	2·5 Phenol	66	28	6
Naphtha 4	160–180	5 Phenol	55	25	20
Naphtha 3	180–200	5 Phenol	23	60	17
Naphtha 3	180–200	10 Phenol	85	10	5
Creosote oil 6	200–240	2·5 Phenol	25	15	60
Creosote oil 6	200–240	5 Phenol	53	26	21
Benzol	± 80	2·5 Cresol (crude).	52	20	28
Benzol	± 80	5 Cresol (crude).	90	5	5
Naphtha A	120–160	2·5 Cresol (crude).	54	30	16
Naphtha A	120–160	5 Cresol (crude).	98	1	1
Naphtha 11A	143–160	5 Cresol (crude).	24	56	20
Naphtha 11	143–167	5 Cresol (crude).	44	47	9
Naphtha 10	158–170	5 Cresol (crude).	39	46	15
Naphtha 4	160–180	5 Cresol (crude).	49	42	9
Naphtha 3	180–200	5 Cresol (crude).	39	46	15
Creosote oil 6	200–240	5 Cresol (crude).	36	21	43

It seems strange that 5 per cent. phenol tends to make some of the fractions less effective than 2·5 per cent. phenol while cresol has the opposite effect. The results are definitely in favour of light naphtha while creosote oil does not show up well at all.

V. Addition of Drying Agent.

The addition of other ingredients, viz., the drying and astringent agent and the acid were now considered. As previously stated, alcohol had been thought of as a possible astringent and drying agent and its use had meanwhile been more strongly suggested by rather unexpected effects produced by a proprietary dressing which contained alcohol. Mr. M. C. A. Nolte had

also drawn my attention to the articles by Hurst (1940), Trim (1941) and Wigglesworth (1941) in which mention is made of the penetration of oil-alcohol mixtures through the cuticle of maggots, but the significance of this was not realised at the time and the articles were read later when this realisation came through the results of the tests now to be recorded.

First it was desired to determine whether 96 per cent. Ethyl Alcohol alone or in combination with the distillates had any effect on the maggots and the following tests were made:—

TABLE 3.

96 Per Cent. Alcohol.	Tar Distillate.	L.	P.	F.
—	Naphtha 10 : 100	31	38	31
10	Naphtha 10 : 90	15	56	29
20	Naphtha 10 : 80	40	43	17
30	Naphtha 10 : 70	77	10	13
40	Naphtha 10 : 60	96	—	4
50	Naphtha 10 : 50	98	1	1
60	Naphtha 10 : 40	98	1	1
70	Naphtha 10 : 30	97	1	2
80	Naphtha 10 : 20	85	8	7
90	Naphtha 10 : 10	52	19	29
100	—	0	26	74

Although alcohol has little effect on the maggots, it is obvious that it increases the efficacy of the naphtha and that the most effective mixture lies about the 50:50 mark or even a higher proportion of alcohol.

Tests were then made with combinations of equal parts of 96 per cent. alcohol and various neutral tar fractions. Results are shown in Table 4.

TABLE 4.

Fraction.	B.P. (°C.).	L.	P.	F.
Benzol	± 80	98	1	1
Naphtha A	120–160	96	1	3
Naphtha 11A	143–160	74	5	21
Naphtha 11	143–167	88	3	9
Naphtha 10	158–170	98	1	1
Naphtha 4	160–180	87	4	9
Naphtha 3	180–200	88	7	5
Creosote oil 6	200–240	86	5	9

If these results are compared with those given in Table 1 a marked improvement along the whole series is evident.

Combinations of neutral tar fractions with 96 per cent. alcohol and Cresol were now made. The proportions were in each case respectively 47·5 per cent., 47·5 per cent., and 5 per cent; the results are given in Table 5.

TABLE 5.

Fraction.	B.P. (°C.).	L.	P.	F.
Benzol	± 80	94	5	1
Naphtha A	120–160	85	3	12
Naphtha 11A	143–160	95	4	1
Naphtha 11	143–167	97	2	1
Naphtha 10	158–170	97	2	1
Naphtha 4	160–180	92	7	1
Naphtha 3	180–200	99	—	1
Creosote oil 6	200–240	99	—	1

In the case of Creosote oil 6 only 1 maggot out of 144 (total of three tests) was not killed and it appeared to have escaped contact with the mixture. The result given by Naphtha A is unexpected, although this is the average of three tests which all gave similar results. The other fractions all show up well, but the 100 per cent. efficacy mark has not yet been reached, while 5 per cent. Cresol is probably too high for practical purposes.

VI. ADDITION OF ACID.

At this stage indications had been obtained from "feeler" tests that the addition of an acid, which would neutralise the medium around the maggots, may assist a contact larvicide and consequently acids were incorporated in the mixtures in subsequent tests. It was considered desirable to use an acid which is normally in the solid phase and will dissolve in the alcohol-tar oil mixture, in order that it should remain on the surface of the wound when the liquid has evaporated and maintain an acid reaction there. A list of possible acids was considered. Many of them would be irritating and others appeared to have other disadvantages. Eventually tartaric, citric and boric acid were selected for testing.

At the same time an oil was incorporated to prevent too hard and brittle a crust from forming on the wound. It was found that only a limited quantity of oil would mix with the alcohol-tar oil mixture. The only oil which mixes with the alcohol appeared to be castor oil, while all other vegetable, animal and mineral oils tried would not, although they readily mixed with the tar oils. The larger the quantity of oil incorporated the less alcohol had to be used in order to obtain a clear, homogeneous mixture. The addition of cresol improved matters, while the acids again had the opposite effect. It was, therefore, now a matter of balancing the ingredients in such a way that the desired result would be obtained. Since vegetable and animal oils definitely reduced the larvicidal efficacy of the mixture, only mineral oils could be used and further tests were made with liquid paraffin of S.G. 0·85. It was found that too large a proportion of mineral oil promoted the growth of bacteria and the formation of pus in the wound, while 10-15 per cent. of oil was sufficient to have the desired soothing and softening effect. The results obtained with some of the mixtures tested can best be presented in tabular form.

In these investigations some 700 tests were made, but it is unnecessary to record many of them, as they are of no direct interest.

TABLE 6.

96 Per Cent. Alcohol.	Tar Fraction.	Liquid Paraffin.	Cresol.	Acid.	L.	P.	F.
55	Naphtha 11 : 35.....	10	2·5	Citric 2...	97	2	1
55	Naphtha 11 : 35.....	10	2·5	Tartaric 2.	100	—	—
55	Naphtha 11 : 35.....	10	2·5	Tartaric 3.	100	—	—
55	Naphtha 11 : 35.....	10	2·5	Tartaric 4.	100	—	—
55	Naphtha 11 : 35.....	10	2·5	Tartaric 5.	100	—	—
55	Naphtha 11 : 35.....	10	2·5	Boric 2...	91	7	2
55	Naphtha 11 : 35.....	10	2·5	Boric 3...	100	—	—
55	Creosote oil 6 : 35...	10	2·5	Citric 2...	93	6	1
55	Creosote oil 6 : 35...	10	2·5	Tartaric 2.	100	—	—
55	Creosote oil 6 : 35...	10	2·5	Tartaric 3.	100	—	—
55	Creosote oil 6 : 35...	10	2·5	Tartaric 4.	100	—	—
55	Creosote oil 6 : 35...	10	2·5	Tartaric 5.	100	—	—
55	Creosote oil 6 : 35...	10	2·5	Boric 3...	100	—	—
50	Creosote oil 6 : 30...	20	3	Boric 3...	97	2	1
50	Creosote oil 6 : 30...	20	3	Tartaric 3.	100	—	—
40	Creosote oil 6 : 40...	17	3	Tartaric 3.	100	—	—

While tartaric acid in concentrations of 2, 3, 4 and 5 per cent. reduces the pH of the strike wound, which is usually about 8·4 before treatment, to 4·5, 4·3, 3·3 and 2·6 respectively, 2 per cent. citric acid produces a pH of approximately 4 and 3 per cent. boric acid only a pH of about 6·8. Apparently it is not the pH alone that is important. The results obtained with tartaric acid were consistently satisfactory, also in other tests not recorded here, and it was therefore finally selected as suitable.

Owing to the international complications it soon became difficult to obtain tartaric acid and its price rose above reasonable limits. Another readily available acid had, therefore, to be found and renewed attempts were made to incorporate wattle extract into the mixture. The tannates contained in this substance readily dissolve in alcohol, but all attempts to obtain a stable mixture failed owing to the fact that such a solution appears to be incompatible with some ingredient in the tar fractions. Eventually sulphuric acid was tried. Two difficulties had been expected, viz., that this acid would tend to cause polymerisation of parts of the tar fractions and that it might affect metal containers in which such a dressing would have to be supplied. Besides, there was the fact that such an acid would probably not remain on the surface of the wound as long as tartaric acid which would crystallise out there. At first diluted sulphuric acid was used in order to prevent polymerisation but a homogeneous mixture could not be made unless the proportion of alcohol was reduced below effective limits. However, if the concentrated acid was first diluted in the 96 per cent. alcohol it proved to have no further polymerising effect on the tar fractions. Moreover, a homogeneous mixture obtained in this way does not affect metal. This is probably due to the small quantity of water contained in the mixture being physically bound in such a way that the acid is unable to dissociate in it and therefore it remains inactive. It is again a matter of balancing the ingredients, with the tar fraction, liquid paraffin and cresol on one side and the alcohol with its water content and the acid on the other. Within certain narow limits the proportions of the various ingredients can be varied. The results obtained with such mixtures are given in Table 7.

TABLE 7.

96 Per Cent. Alcohol.	Tar Fraction.	Liquid Paraffin.	Cresol.	H_2SO_4.	L.	P.	F.
42	Naphtha 10 : 40.....	15	2·5	0·5	100	—	—
40	Creosote oil 6 : 44·5...	12·5	2·5	0·5	100	—	—
72·5	Creosote oil 6 : 25.....	—	2	0·5	100	—	—
72·5	Creosote oil 6 : 20.....	5	2	0·5	100	—	—
25	Creosote oil 6 : 72·5...	—	2	0·5	86	8	6
40	Creosote oil 6 : 42.....	15	2·75	0·25	100	—	—
43	Creosote oil 6 : 43.....	11·25	2·5	0·25	100	—	—

A concentration of 0.·25 per cent sulphuric acid produces a pH of about 4·5 in the strike wound immediately after treatment. A few hours later the pH has usually risen to 5·5-6, but then the surface of the wound becomes dry and, if it is moistened with distilled water 24 hours after treatment a pH of approximately 7 is usually obtained.

The mixture mentioned last in Table 7 was finally selected as the most suitable. Under field conditions it has given excellent results both against sheep blowflies and cattle screw worm (*Chrysomyia bezziana*). Restrikes were rare and limited to cases of continued scouring or soiling by urine and fighting rams.

VII. EFFECTS ON THE SKIN.

The testing of larvicidal efficacy on artificial strikes enables one at the same time to observe the effects of such mixtures on the sheep. The sheep's skin is very delicate and frequently the undamaged skin next to a strike area is affected more severely by an irritant mixture than is the damaged skin in the strike area.

The neutral naphthas and creosote oil do not damage the healthy skin, nor does the addition of cresols, even up to 5 per cent., cause undue irritation. With over 3 per cent. cresol the skin will show a slight reddening after 24-48 hours, but this is transitory. Strong alcohol usually produces a slight hyperaemia of short duration, not followed by any other changes. The addition of cresol to alcohol has no more marked effect, but the further addition of 0·25 per cent. sulphuric acid enhances the hyperaemia and in some cases a very thin, light-brown scab is formed and cast off. Tartaric acid does not produce any such effect. Just as the alcohol-tar distillate combination has strong penetrating properties as far as the maggots are concerned, it also appears to have such properties in relation to the superficial layers of the sheep's skin. The damaged skin in the strike area does not appear to suffer, since the result of treatment in this area is not worse than that obtained by washing the area with water after mechanical removal of the maggots. In both cases the area becomes dry, the surface hardens and forms a thin scab which is cast off after about a week. The healthy skin, treated with the same mixture, shows moderate hyperaemia and turns dark-brown within 24 hours. The surface becomes dry and unpliable and after about a week a thin scab is cast off, leaving healthy skin below. The addition of liquid paraffin reduces the hardening of the surface. The complete mixture produces the same results and, although this effect is superficial, it is the one remaining undesirable quality of this dressing. However, of a

number of farmers who have tested the dressing not one has complained about or even remarked on this effect. Other species of animals which have been treated show little or no skin reaction. A number of young white pigs, about 6 weeks old and badly affected with sarcoptic mange, were thoroughly sprayed all over. They showed a slight reddening of the skin, but this soon disappeared without any after-effects and the mange was cured by two applications. In cattle there was no skin reaction, not even in the ears when treatment was applied against ear-ticks. On the human skin the dressing has no adverse effect. The creosote oil (B.P. 200-240° C.) was selected as being slightly less irritant to the sheep's healthy skin than the light naphthas, while equal proportions of creosote oil and alcohol appeared to be better than a higher proportion of alcohol. The quantity of liquid paraffin that can be incorporated is limited by the proportions of alcohol and creosote oil.

VIII. General Remarks.

The cost of the sulphuric acid (commercial quality) is very low, but it remains to be seen whether it may not be preferable to replace it by tartaric acid in order to reduce irritation and to give better protection. As stated above, it may further prove desirable to incorporate a suitable stomach larvicide in order to extend protection against restrikes, but under present conditions this is not feasible without a great increase in costs.

As a matter of interest it may be mentioned that butyl alcohol does not produce the results obtained with ethyl alcohol and that combinations of pyrethrins in oil, naphthalene and paradichlorbenzene respectively with alcohol and acid gave as unsatisfactory results as these insecticides had previously given in other vehicles.

Summary.

An attempt was made to prepare a blowfly dressing which would be rapidly lethal to the maggots and cause the strike wounds to become unattractive to blowflies and to dry and heal quickly.

In vitro tests of contact larvicides on blowfly maggots were found to be unreliable. Tests were, therefore, made on artificial strikes.

The larvicidal efficacy of neutral tar oils is greatly increased by the addition of alcohol.

The further addition of a suitable acid increases larvicidal efficacy, makes wounds unattractive and promotes rapid healing.

A dressing is described which has given good results in field tests and which is also effective for treatment against screw-worm in cattle. The dressing readily kills ticks on animals and has given good results in a few cases of sarcoptic mange.

Acknowledgement.

The writer is greatly indebted to Dr. T. Jorden and Mr. C. v. d. M. Brink, of the chemical laboratory of Iscor (South African Iron and Steel Industrial Corporation, Pretoria), who prepared and supplied the various tar distillates used in these investigations, as well as to Mr. P. A. Cilliers,

technical assistant, who carried out large-scale field tests on sheep. A number of farmers in various parts of the Union also carried out tests on sheep and cattle and made very useful remarks on the mixtures submitted to them.

Addendum.

When production of the blowfly remedy was started on a large scale (over 20,000 gallons were sold during the first seven months) it soon became evident that a sufficient quantity of neutral creosote oil would not be available in the Union if the demand increased according to the indications. Moreover, the extraction of the tar bases and naphthalene, as carried out under present conditions in the large-scale production of the oil, was incomplete, leaving varying amounts of both, with the result that the remedy sometimes caused undesirable irritation.

Tests were therefore made with mixtures of benzol and creosote oil, instead of the latter alone, and finally a mixture of equal parts of these substances was decided on. This would allow the production of the remedy to be doubled with the same quantity of creosote oil and reduce the irritant ingredients in the latter to one half in the mixture.

The addition of benzol further allows the addition of more mineral oil as well, although, as noted previously, this should not be pushed too far. Supplies of mineral oil presented a further difficulty, as liquid paraffin became practically unobtainable. Various mineral oils were tested and satisfactory results were eventually obtained with a mixture of one part second grade motor oil (S.A.E. 60) and two parts of a light fuel oil (C.1. Fuel).

The varying amounts of tar bases remaining in the creosote oil made it necessary to adjust the amount of sulphuric acid incorporated in the mixture. Tests on this point indicated that the original quantity of neutral creosote oil used in previous experiments must have contained some tar bases and that 0·15 per cent. commercial sulphuric acid in the final mixture is sufficient to give a pH of 4·3—4·5 if the oil contains no bases. This degree of acidity is satisfactory and should be aimed at by adding the required quantity of acid according to the percentage of bases present.

The mixture as now made has the following composition:—

96% alcohol	40% volume
Mineral oil (S.A.E. 60)	5·0
Mineral oil (C.1. Fuel)	10·0
Cresol	2·5
Sulphuric acid	0·15
Benzol	21·175
Neutral creosote oil (B.P. 200—240° C.) ...	21·175

In practice the creosote oil is washed free of cresols only so far as to leave about 12 per cent., which gives the correct proportion in the final mixture, and therefore no cresol is added.

The efficacy of the mixture against maggots and ticks remains as high as before and no apparent pain is caused by its applications to strike wounds.

As previously noted such mixtures are irritant to the healthy skin of sheep, although they cause much less irritation to the affected parts in the strike area and none at all to the skins of cattle, pigs, horses and dogs. In the course of these additional tests it was noted that the same mixture did not affect all sheep equally and further observations indicated that it is the amount of wool grease which causes the variation, sheep with a relatively dry fleece being less affected than those with much yolk. Since the remedy dissolves wool grease it is very probable that the latter promotes absorption and in this way produces the particular sensitiveness of the sheep's skin.

REFERENCES.

HURST, H. (1940). Permeability of insect cuticle. *Nature*, Vol. 145, No. 3676, pp. 462-463.

LENNOX, F. G. (1941). Some experiences in the preparation of Sheep Blowfly dressings and a description of a new boric acid mixture. *J. Counc. Sc. Ind. Res.*, Vol. 14, No. 2, pp. 77-87.

MONNIG, H. O. (1936). A new fly repellent and a blowfly dressing. Preliminary Report. *Onderstepoort J.*, Vol. 7, No. 2, pp. 419-430.

IDEM. 1940). Blowfly strike in sheep—a new line of treatment and prevention. (Preliminary note). *J. S.A. Vet. Med. Ass.*, Vol. 11, No. 4, pp. 142-150.

TRIM, A. R. H. (1941). The protein of insect cuticle. *Nature*, Vol. 147, No. 3717, p. 115.

WIGGLESWORTH, V. B. (1941). Permeability of insect cuticle. *Nature*, Vol. 147, No. 3717, p. 116.