The sheep maggot-fly pest in Australia : an essay / by W.W. Froggatt, with notes and observations by W.F. Cooper.

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AN ESSAY
BY
W. W. FROGGATT

WITH NOTES AND OBSERVATIONS
BY
W. F. COOPER

THE COOPER LABORATORY
FOR ECONOMIC RESEARCH
WATFORD, ENGLAND

With W. F. Cooper's Compliments.

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PREFACE

IF the question were asked, "What is the most urgent problem which is engaging the anxious attention of Australian sheep-breeders at the present time?" the title of this treatise would be, in all probability, the answer returned by the majority of those interested in the subject.

The rapidly developing invasion of Australia by various species of maggot-flies, has become so serious as to threaten the principal industry of the Commonwealth. In spite of all efforts, both of the practical man and also of the scientist, very little has been achieved in the endeavour to find a remedy for the pest, or even to check it.

Partly in order to stimulate further efforts, partly to collate all practical information available, partly also to ascertain what views are held by the practical grazier, as well as to gain more intimate knowledge of the remedies adopted by him, Messrs. William Cooper and Nephews decided to offer prizes of £50, £25, and £10, for the three best essays on the maggot-fly, open to anyone in Australia. In response to this invitation seventy-nine essays were received.

Mr. J. Douglas Stewart, Professor of Veterinary Science at the University of Sydney; *Mr. S. McCall-McCowan*, Superintendent in Australia of the New Zealand and Australian Land Co., Ltd.; and *Mr. A. S. Barton*, of Polly Brewan Station, Walgett, New South Wales, very kindly offered to read the essays and to award the prizes. To them, the best thanks of the sheep-farmer and of the firm are due, for the task was most laborious, owing to the large number of essays sent in.

Preface

The three successful essays were those of :—*Mr. W. W. Froggatt*, Government Entomologist, Sydney; *Mr. J. L. F. Woodburn*, Cullingral Station, Merriwa, N.S.W.; and *Messrs. A. E. McLeod* and *J. B. Holme*, Canonbar Station, Miowera, N.S.W.; and to these competitors the prizes were awarded, in the order above.

Many of the essays contained matter of considerable interest; and, in view of the fact that no great amount of work has been published on the subject, and that such information as exists is not readily accessible to the general reader, it was decided to publish a short treatise on the subject, embodying the most useful information derived from the essays.

The present Bulletin is the outcome of this decision, and of the belief that the efforts of those whose observations have made such a publication possible, will be appreciated by all who are interested in the problem of the Maggot-fly pest.

Part I is a general summary of the scientific work on the subject, already published, but only so far as it applies to the Australian problem. With the exception of a few editorial alterations, Mr. Froggatt's essay is published *verbatim*, and forms the first section of Part II of this Bulletin. The second section of Part II consists of abstracts, with editorial comments and additions, from the essays of Mr. Woodburn and Messrs. McLeod and Holme. Part III gives a brief summary of the remedies recommended in the essays, and contains notes and suggestions from published works, on the same subject. Finally, Part IV consists of a collection of odd notes and details.

Up to now, no great amount of work has been published on the practical aspect of this subject; and it is worthy of note that even the extremely efficient and highly organised United States Department of Agriculture does not deal with the pest, *in this aspect*, in any of its Bulletins. A great amount of literature has been issued dealing with the *transmission of disease by flies*, more particularly the common house-fly; this, however, has but an indirect bearing on the *damage caused to the sheep and wool industry* of Australia. In the one case, the adult fly is the objectionable pest, the

larvæ being of little importance except that they are the precursors of the adults; and the diseases which the adult flies spread, are the cause of the harm done by them. In the other case, the adult fly is of very little importance except that it produces larvæ; the seriousness of the pest is due to the direct damage done to the wool; to the loss in condition of the sheep and consequent indirect damage to the wool; and, finally, to the actual death of many sheep and the loss in lambs, all caused by the larva or maggot.

I am indebted to Messrs. F. A. Shrimpton and J. A. Hill for assistance in reading and abstracting the essays; and to Messrs. W. S. Rogers, S. R. Timson and R. C. Timson for reading the proof-sheets.

W. F. COOPER.

The Cooper Laboratory
for Economic Research,
Watford, *April*, 1913.

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PART I

A GENERAL SUMMARY OF SCIENTIFIC INFORMATION ON BLOW-FLIES

IN England, the sheep maggot-fly pest is not very serious, inasmuch as the sheep are closely watched and any affected animals are promptly treated. MacDougall dealt with it in Scotland in 1899 and 1904; also Carpenter published some work on the subject in 1902. At the present time, the "blow-fly" or "maggot-fly" is becoming more serious to the British sheep-farmer, and further investigations are being initiated. A fairly complete list of the papers published on this subject is given in the bibliography.

A very detailed and exact study of the anatomy of *Calliphora erythrocephala*—the English Blue-bottle—was made by B. T. Lowne in 1890-5, published in two volumes. This, however, has no bearing on the practical problem as it exists, at present, in Australia, except in that it shows that the fly has special and peculiar sense organs. A series of papers by Hewitt upon the House-fly—*Musca domestica*—now published in book form (1910), contains observations of interest to the practical man. In his essay, Mr. Froggatt refers to most of the papers of any economic importance in relation to sheep.

Quite recently, a book has appeared, by L. O. Howard, of the United States Department of Agriculture, on the House-fly. This again, however, does not deal with *blow-flies*, but it considers the medical and sanitary aspects of House-flies, in so far as they transmit diseases. It is of great interest, however, and much of it may have a real bearing on the fly-pest, so that this book, and also that of Hewitt, are to be highly recommended to all who are seriously interested in the blow-fly problem.

BIOLOGY.

It is from a study of the biology of the flies and their larvæ that a solution of this difficult problem is to be sought, but, unfortunately, the accumulated knowledge of the subject is still very meagre.

Food. Several writers have shown that a variation in the food affects the rate of development and also the size of the adult. Herms (1907, p. 67, and 1911, p. 520) shows that in the case of *Lucilia cæsar* underfeeding of the larvæ gave rise to smaller flies.

Herms also states that, from unpublished data and from incomplete experiments, it appears, as a result of underfeeding, that males are chiefly produced. This is of importance, if correct. For it may be contended against the most necessary practice of making all refuse objectionable to the fly, that such measures do not make much difference to the actual number of flies ; but if, owing to insufficient food, the greater proportion of flies which are produced are males, then the difference will be very great ; since, with the smaller proportion of females, a very much smaller number of eggs will be laid, and the number of flies which can "blow" the sheep will be very greatly diminished.

An interesting observation was made also by Griffith (1908), who showed that when the larvæ are kept cool, the flies are all small, and that *such flies are incapable of reproduction.* It appears certain from Herms' work, that too little food produces small flies (1907 and 1911) ; and if these flies are incapable of reproduction—as well as being chiefly males—then attention to breeding-places, the burning of carcasses, spraying with cresylic fluids, etc., would have a great effect in diminishing the number of flies.

A suggestion which may be of value to those who seek for a remedy, is to be found in the results of Guyenot (1907) and Galli-Valerio (1910), who showed that, before ingesting the food, the maggot decomposes it, or breaks it down to a liquid state. If this is so, then it is not impossible that some substance may be found which would prevent the liquefaction of the flesh or food ; and if this

could be done, the maggot could not get sufficient nourishment. Several essayists point out that ashes, or any substance which keeps the maggots *dry*, will cause their death or make them drop off the sheep.

There is a suggestion, also, that putrefactive bacteria assist in preparing the food, so to speak, or in liquefying it for the maggot. In that case, disinfectant substances should assist in the control or killing of the maggot, by killing these bacteria.

Temperature. The influence of temperature has been ascertained in relation to the House-fly (*Musca domestica*) more particularly. According to Hewitt (1907), flies are able to withstand a temperature as low as – 5° C. (23° F.); but at – 10° C. (14° F.) they are killed in a few hours.

It is of interest to note that, in Australia, the flies are not active in the very hottest weather, but only in the cooler seasons. Apparently, the temperature of 100° to 120° F., in the shade, is too great for them. A pastoralist of considerable experience assures us that they seek shade at those times, particularly that of trees.

Light. The larvæ are affected by light, and strive to get away from it—as is obvious to the most casual observer. Hewitt has shown that, in the case of the House-fly (*Musca domestica*), the organ sensitive to light is situated on the "tubercles of the oral lobes of the larvæ." The colour of the light affects the rate of development, which is more rapid in blue or violet light than in red, yellow, or green.

Howard quotes statements which would show that flies have a preference for colours, and that they do not like blue. It is difficult to see, however, how any practical use could be made of this; and Howard doubts the conclusions drawn from the experiments.

Hibernation. That flies disappear, or hibernate, during winter, in cooler climates such as England, is very common knowledge. It takes place, to some extent, also, in warmer countries. The difference in degree of hibernation may account for the variation in the extent of trouble or inconvenience to which the flies may give

rise. In England, probably only a very few flies hibernate, the great majority dying on the approach of the cold weather; and for the few living flies to multiply and increase, a fair amount of time is necessary, so that it is difficult for them to increase to such an alarming extent as in more tropical countries. Where the semi-dormant forms are more numerous, very much less time is necessary for them to increase to such an extent as to become serious; but, in any case, every fly killed during the hibernating period must have a considerable effect later on, in reducing the number of flies existing during the warmer months.

This has given rise to attempts to deal with the fly during the less active periods of its life. If it were possible to reduce the number of flies at this period, some diminution of the damage done by them might be attained; at the same time, too much reliance cannot be placed upon this, for the numbers increase to an enormous extent in a very short time.

Hewitt, in his study of the House-fly, expresses the belief that it is the latest, or most recently hatched forms which hibernate. Evidently, either the hibernating forms are differently constituted to the ordinary forms, or else the change in climate, at the time when hibernation takes place, gives rise to a change in the fly. They become negatively heliotropic at this time of the year; that is to say, they object to light, and creep away into dark corners and crevices.

During hibernation, the digestive organs shrink and occupy a very small volume of the body; and the space which is usually occupied by the gut, is filled up with fat, upon which the flies are nourished during the winter months. In May or June, when the hibernating flies emerge (in England), there is very little fat left.

Hewitt found that in some hibernating flies the ovaries were well developed, and in others they were small; mature spermatozoa were found in the males.

Jepson (1909 a) carried out some experiments, but they are not of much interest in connection with this particular problem. The

larvæ are killed by cold, the adults hibernating; but Jepson carried some 200 larvæ through an English winter by keeping them warm.[1]

Distance of Flight. A matter of some importance is the distance to which flies will travel. The fact that the mosquito does not fly very far from the place of its origin is one of the factors which has made it possible to deal with it. With regard to the blow-fly in Australia, very little information is to be found on this point; and it might be of considerable assistance if some one would make experiments upon the matter. At the same time, it is not at all easy to do this. A very large number of flies must be caught; each of them must be marked,[2] and then liberated. Fly-traps must be placed at varying distances from the place where the flies are set free, and it should be pointed out that the farther the traps are placed from the spot where the flies are liberated, so is the chance of catching the flies lessened to an enormous extent; consequently, it would be necessary to mark and to liberate a very large number of them in order to catch a few only. Put very roughly, if one thousand flies are set free, and, at a distance of one hundred feet away, fifty flies are caught, then at two hundred feet away, the probabilities are that less than twelve would be caught. Nevertheless, if anyone would make a large experiment, the result might prove very useful.

Considering House-flies, Hewitt (pp. 123-124) observed that they were to be found a distance of some two and a half miles from any house or breeding-place. He mentions that Arnold set free three

[1] When fishing in Scotland, in January, an old shelter or "Arbour" was opened, in order to have lunch in it. It was well built, of wood, and fitted with windows; but the windows had been blocked up by thick and closely fitting shutters, placed outside. From inside, one could see a great number of flies between the shutters and the glass; they were clustered together, exactly like bees, as though to keep warm, and they were extremely sluggish in their movements, the greater number appearing to be dead. Perhaps the most curious fact was that the shutters fitted so closely that I could not see how any fly could have got between them and the glass.—W. F. C.

[2] A good general account of the method of doing this is to be found in Howard's book (p. 56). Jepson (1909 b) gives full details of his experiments.

If anyone is prepared to carry out some experiments on this matter, all available information and suggestions will be given, with the greatest readiness, on application to this laboratory. But it must be borne in mind that it will be a laborious and tedious experiment for a pastoralist to undertake.—W. F. C.

hundred flies, and captured five within a distance of two hundred feet from the house.

It must not be forgotten that even if flies travel only to a distance of a few feet, of their own accord, yet they may be carried very considerable distances by a wind, especially if they happen to go high up into the air.

Cobb (1906), in working on the spread of fungoid diseases of sugar-canes, found that he could not make the flies tired, even if they were kept on the wing for hours.

Period of Immature Adult. It is generally supposed that an adult fly can lay eggs (or larvæ) as soon as hatched. But it is shown by Hewitt and by Griffith (1908) that flies are not at first sexually mature, and are unable to breed, therefore, until some days after emerging from the pupal stage. This is very important, as pointed out by Howard (1912, p. 60). It is usually supposed that not much good may be done by catching flies ; but if they must live some ten days before being able to lay eggs or larvæ, then fly-traps of any sort should be very beneficial. The matter is dealt with fully by Howard.

NATURAL ENEMIES.

The natural enemies of the flies should form a very useful and interesting study, and this point has been considered in some of the essays, more particularly in that of Mr. Froggatt. A considerable amount of work has been done, but no great practical result has been achieved. At the same time, it is by no means improbable that a method of checking this pest would result from a more detailed study of its natural enemies. Very great benefits have resulted from the artificial breeding of the natural enemies of certain other pests ; so that this has become one of the recognised methods of dealing with them. Mr. Froggatt, however, in his essay, deprecates the probability of any valuable economic result issuing from a study of the natural enemies.[1]

[1] Whether or no Mr. Froggatt is too pessimistic, I cannot say ; but some work which was being carried out in the laboratory at Watford, was rendered almost useless because so many of the larvæ were infested with hymenopterous parasites ; so that I cannot help feeling that it would be worth while to give more attention to this point.—W. F. C.

Vertebrate Enemies A number of lizards are to be found in the homestead and buildings; also frogs abound in lagoons, swamps, and "tanks."[1] These animals are often killed, but it would be wiser to encourage them and to tolerate the croaking of the frogs, for they would eat a prodigious number of flies, if they had the opportunity. (See Howard, 1912, p. 95.)

The important problem of birds and their destruction, in this connection, is dealt with later (pp. 39 and 53).

Hymenopterous Parasites. The point is very fully dealt with by Howard (1912, pp. 62, *et seq.*). For the information of general readers, it may be pointed out that the insects, if any, which may be expected to be of value in this respect, are the hymenopterous parasites. (Howard, p. 88.) It is the "chalcidoid" group which is of particular interest in the control of other pests.

The observant pastoralist might be of some considerable assistance to the Government Entomologist, by examining pupa cases. Normally, the case is opened at one end for the emergence of the adult fly; but the hymenopterous parasites usually bore a small hole in the side of the case, so that where there is no second small hole in the empty pupa case, it may be presumed that no parasite has existed in it. Where, however, any such holes can be found, it would be advisable to communicate with the Government Entomologist, sending, at the same time, a number of the pupæ which have not yet developed into adult flies.

Chernes. Flies are infested with several parasites, amongst which may be mentioned the mites, and also the peculiar spider-like insects, called *Chernes*, a pseudo-scorpion. Periodically, the flies are found to be so heavily infested with these parasites that their movements are impeded and they can fly or move only very sluggishly. Yet there would not appear to be much probability that these parasites would relieve the situation very much. It would be well if observers would examine any flies they catch, to note if

1 A "tank," in Australia, corresponds to an English "pond"; though it is not the same thing.

2 The *Chalcididæ* form a family of parasitic *Hymenoptera*, the order of insects of which ants, bees, and wasps are familiar examples.

there are any of these tiny insects upon them. They are usually to be found attached to the bases of the legs, and can be seen with the naked eye.

Protozoa. Flies suffer, also, from protozoan parasites, of the same class as those which cause the diseases in cattle, such as *red-water*, *nagana*, etc.; though, of course, differing from them very materially. Any investigation on this must be left entirely to the scientist.

Fungi. Another important enemy is the fungus disease to which the flies are subject. A very excellent and concise account of this is given in Hewitt's book. Towards the end of summer, the time when the greater number of flies die (in England), large numbers may be found attached, in a rigid condition, to the ceilings, windows or walls of the houses. They have a very life-like appearance, but when they are touched they are found to be dead. These have been killed by the fungus named *Empusa muscæ*. In the later stages, a whitish ring of the spores of the fungus is to be seen surrounding the fly; the abdomen is swollen, and white masses may sometimes be seen on the body of the fly.

A considerable number of house-flies in this country die from this disease, but it is not recorded that it kills flies out of doors. It may be that the blow-flies of Australia die a natural death, from exhaustion; but it is quite likely that they also suffer from some such disease. It would not be easy for the ordinary pastoralist to give much assistance in this direction; but something might be done if attempts were made to find dead flies, lying about in the paddocks or elsewhere, and to observe whether they appeared to have been killed by a fungus. Any dead flies appearing to have died from this cause might be forwarded to the Government Mycologist, or to Mr. Froggatt, who would know how best to deal with them. In sending these flies, they should be put into a tube or matchbox; but no preservative should be used, as this might kill the spores of any fungus that may be present.

The spores of the fungus get on to the body of the fly, and develop, very much like the mould which may be seen on mouldy

bread. The spores germinate, penetrate the integument, and, developing within the body, finally penetrate every part so as eventually to kill the fly.

DISSEMINATION OF WORMS.

There is one point which it might be well to bring before the pastoralist, since it is most probable that the first actual indication of any serious trouble from this, will be noticed by him—*viz.*, that it is quite possible that flies play an important part in the increase of parasitic worm pests. The excreta of sheep or other animals suffering from tape-worms or round-worms contain the eggs of these parasites. Apart from the dung, the worms themselves, more especially the segments of tape-worms, are very attractive to flies—a point not without interest. It has been shown, as early as 1883,[1] that flies suck up the eggs and pass them out again in their excrement, without interfering with the vitality of the eggs. In an actual case, a human being was infected with tape-worms in this manner, the fly having laid the eggs on a lump of sugar. Nuttall (1899, p. 39) cites a case, noticed by Stiles, in the United States, where the *larvæ* of the fly, placed amongst the worms themselves (round-worms—*Ascaris lumbricoides*—not tape-worms), devoured the actual worms, and the eggs of these worms were found in the *adult* flies which developed from these larvæ. The matter has been dealt with by Nicoll (1911), who studied this point especially; and also more recently, by Graham-Smith (1911), who has given a very detailed and interesting account of the mouth parts of the English blow-fly (*Calliphora erythrocephala*), and the mechanism of sucking.

Any observations on this matter, therefore, should be noted and referred to the Government Entomologist or Veterinary Surgeon. The few facts brought to light, point to the possibility that the damage caused by the blow-fly pest may possibly assume proportions even greater than is considered likely at the present moment—and that is not small.

[1] See Nuttall, G. H. F., and Jepson, F. P., 1909, p. 28.

PART I

MAGGOT-FLY IN SHEEP

FIRST PRIZE ESSAY

By W. W. FROGGATT

(Government Entomologist, N.S.W.)

INTRODUCTION

THIRTY years ago, when the writer was personally interested in sheep on the Murray frontages, one could mark lambs at any time of the year and not even worry to dag the ewes, unless they were in a particularly bad state from too much young grass in a good season; one seldom found maggots on the lambs, and never in the wool. The only maggots one dealt with in sheep were in the heads of the rams, when they had injured their hard heads fighting, so that the broken skin had become blown; but that was a passing trouble, though dressing the rams' heads was not a job particularly run after by a station hand.

Though the rabbits were pretty thick in the early 'eighties on the Victorian side, they were comparatively an unknown quantity on the holdings of New South Wales, and Poisoning and Rabbit Acts were only being talked about. Still, we had had some big droughts, and dead sheep were scattered all over the plains and ranges, yet the flies had not then forsaken their natural rôle as scavengers, and become parasitic upon live sheep.

Flies of all kinds were pests in the bush, to the horses and travellers; but these flies were chiefly the cosmopolitan house and bush flies—*Musca domestica* and *Musca corvina*.

Blow-flies were the cook's and housewife's trouble in the summer time, but they were seldom seen in the interior in the winter months; in North Queensland and the tropics they were comparatively rare. In the bush, away from the waste and rubbish about town or homestead, blow-flies were not constant attendants to one riding or walking through the timber or scrub, as they

Fig. 1. The Common House-fly (*Musca domestica*).

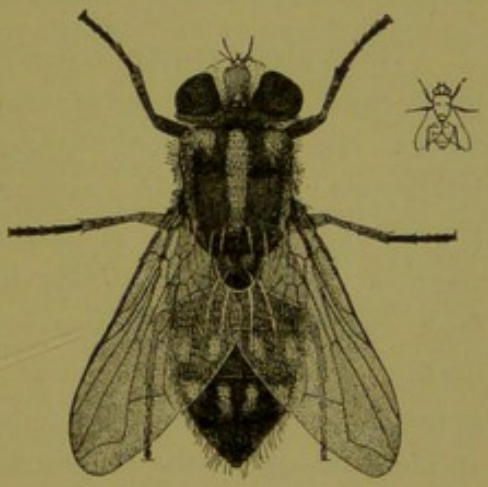

Fig 2. The Bush-fly (*Musca corvina*).

are at the present day. The writer first noticed the buzzing of blow-flies around one in the bush in abnormal numbers, during a visit to Gunnedah, when, during the drought of 1890-91, large numbers of pine trees began to die on the hill tops; going up the gullies, the large common blow-flies flew around and settled on one's back, just like the small house-flies.

Though blown wool may have been common before, in some holdings, it was not until 1903 that the writer had any record of it doing any noticeable damage to the wool and sheep. In the following year, it was recorded from a number of widely separated districts as a very serious trouble to the sheep-owners; and, in the last five years, it has become one of the most serious problems to fight and to control, in the working of sheep. At the present time,

there is hardly a district in which sheep are running where blown wool is not found; and, though perhaps the trouble is most intense in the south, west, north-west and Riverina districts of New South Wales, it has been found close to Sydney and all down the south coast. The trouble is still spreading, so that practically the whole of New South Wales is infested. Recent reports show that this trouble is extending through Queensland; and, as the blow-flies are not much affected by cold, it will probably be found, before long, infesting Victorian flocks in a similar manner.

The writer's practical observations in the paddocks have been made chiefly in the north-west and west of New South Wales, where the blown-wool trouble has been most constant and intense ever since it first appeared in our flocks. The last winter (1910) has been one of the mildest that the inhabitants of the west of New South Wales have known for many years, free from frost and cold winter rain-storms, which latter are more deadly to insect life than any amount of cold; the herbage and grass have in consequence remained green well into the spring—an ideal season for the propagation of such insects as flies. During the last six months of 1910, while making visits to the west and south of New South Wales, the writer found the open forest, and the flats along the creeks and billabongs, swarming with blow-flies; while, about any homestead, they simply clustered, like swarms of bees, round the wire doors—particularly those near the kitchen.

Though a comparatively new pest under altered conditions in Australian flocks, blown-wool flies have been known from a very early date in Great Britain; yet they are found hardly anywhere else on the continent of Europe, with the exception of a slight infestation in Holland some years ago, when the sheep in question were said to have been imported from England.

As far back as 1749 William Ellis published a work on the management of sheep, in which he devoted a chapter to the question of "maggots that breed in the bodies of sheep and lambs." He gives a very interesting account of the sheep-fly which is worth quoting, as it shows that something was known about the English

fly over a hundred and fifty years ago. "These sort of vermicular vermin are the death of many sheep and lambs, for as both these are very subject to breed maggots, by the blowing of several sorts of flies, and by the heat of the greasy wools in hot weather, if they are not carefully looked after by a judicious shepherd, they may be soon destroyed by maggots. . . . These insects are so prone to multiply, that from their first increase they will kill a sheep in three days' time. . . . A grievous malady indeed, that ought to be guarded against with the utmost vigilance, because part, or most of a flock, may, if neglected, be soon destroyed by maggots. And although this great evil is just touched on by ancient authors . . . I shall not so pass over the treating of these destructive vermin, but assure my reader, that sheep and lambs infected by them will infect others, by lying close in a fold or elsewhere to one another. Now the sheep and lambs that are most liable to the breed of maggots are those that carry the most and closest wool on their backs; and the more they are frequently heated by driving them out of their natural walk, the sooner they come under the misfortune." (From Professor Carpenter's Report.)

MacDougall (1899) gives a general account of the damage caused by flies that blow wool in Great Britain. In his article, "Insect Pests of Domestic Animals," he briefly describes the two "Green Bottles," *Lucilia cæsar* and *Lucilia sericata*. He states that the latter is the most common blown-wool fly, but that both species have been bred from maggots in wool. This seems to be the general opinion among all English writers on the subject, that while *Lucilia sericata* is the most common, *Lucilia cæsar* has the same habit. "Both flies lay their eggs in putrefying matter; and they also lay in wounds." In a later volume of the same Journal (vol. xvi, 1904), the same writer deals with the sheep maggot-fly, in which he says: "A distinctly important point brought out in the inquiry relates not only to the wide-spreadness of maggot and its increasing frequency, but to its spread to high-lying hill pastures, where, until recently in many places, the attack seems to have been almost unknown."

Carpenter (1902, p. 132), under the heading of "Insects infesting Domestic Animals," gives an account of the history of the sheep-fly (*Lucilia sericata*); he gives some notes on the structure of the two different species of *Lucilia* by which *Lucilia sericata* can be distinguished from *Lucilia cæsar*, and a general account of the damage they do in Ireland. In conclusion, he makes the following statement which is applicable to sheep-breeders all over the world. "It seems that, over a limited area, one or two kinds of flesh-flies have forsaken the usual habit of their family, so that the maggots have become parasites instead of scavengers. There can be no doubt that this change of habit has been induced by the domestication of sheep by man. We have taken an originally alpine race of animals, crowded them on the plains, and by artificial selection increased the qualities—such as fat and thick wool—that tend to attract the fly."

Warburton, Zoologist to the Royal Agricultural Society of England, issued a report upon maggot in sheep in the Journal of that Society for 1902, in which he gives an account of the damage they cause in England. Regarding preventive measures, he does not throw much new light on the subject; but our conditions of sheep-breeding are so different from those of the old world, that the suggestions he offers have little application in Australia. The same applies to Sir G. T. Brown's notes in the same volume of that Society's Proceedings.

Professor J. A. Gilruth (1908), of the Veterinary Division of the Department of Agriculture of New Zealand, publishes a report (previously issued as Bulletin 12), entitled "Sheep Maggot," illustrated with a coloured plate of *Lucilia sericata*. In this report, he states that sheep maggot has been found in blown wool in many parts of New Zealand, and that he had bred this species of fly from maggots in blown wool. This identification of the New Zealand fly (if correct) as *Lucilia sericata* is very interesting, for we have this, and the allied species, *Lucilia cæsar*, in Australia and Hawaii; yet we can find no instance of their having adopted the parasitic habit in either of these countries, while the blow-flies (*Calliphora*) have developed such a keen taste for soiled wool on living sheep.

Though the sheep maggot-fly is unknown in the United States, or in any other part of America, this pest has appeared in the Hawaiian Islands within the last three years; there, as in Australia, it has been bred and identified as one of their common blow-flies, and not a green *Lucilia*. This fly is *Calliphora dux*, which, if not a native, has been established in the islands for many years without showing any partiality for live wool. An interesting report, "Abstract of a Preliminary Report upon Insects affecting Live Stock in Hawaii," by Van Dine and Norgaard was published in 1908. The writer, when in the Hawaiian Islands in 1907, had the pleasure of meeting these gentlemen, and, in company with them, visited the American Sugar Company's ranch on Molokai, and examined many infested sheep in their flocks. The climate and the conditions of sheep-raising in the territory of Hawaii are somewhat different from those in Australia. There were many sheep in the flocks badly infested with "scab." This was so much aggravated by the presence of swarms of the blood-sucking "horn-fly," that the scabs became open sores, and the sheep maggot-flies deposited their eggs and larvæ upon these, or else among the soiled wool round the sore.

Up to the present time, these are the only countries where flies have infested live wool, except that the writer has been informed on good authority that the sheep recently introduced into the New Hebrides have become infested this year (1910).

SYMPTOMS AND METHOD OF INFESTATION.

Warm showery winters are always the worst for sheep maggot flies, damp and warmth being the ideal conditions under which both plant and animal life flourish, and the season when all kinds of insect pests appear.

In different districts of this state, they vary in intensity at different times of the year; they appear in some localities as early as March, while in other localities they are not noticeable until April, May, and even right up to shearing time. In cold, stormy weather, the few blow-flies that survive are sheltering in hollow tree trunks

and other protective corners; and it is these flies that appear, after one or two bright sunny days, in the cold weather of midwinter. They are the survivors of last year's broods, though the main supply later on is from the pupæ hidden in the ground and produced from the maggots that transformed at the end of the warm weather.

At one time, sheep were not blown on the open plains anything like so badly as those running in forest scrub or hilly country; but, during the last few years, the flies infest and strike wool in all classes of country.

At the present acute state of the trouble, it is hardly necessary, as far as the sheep-man is concerned, to give an account of the symptoms that call attention to a blown-wool sheep, for the intelligent collie dogs can pick them out of the flock, after a little experience. However, as soon as a mob of sheep ring round in a drafting yard or stand at rest in the scrub, if one sheep is noticed standing apart, stamping its feet, and twitching its tail as if something was stinging or biting, you can be sure, even if there are no other outward signs, that it is infested with maggot. Usually, the flies lay their eggs upon the wool of the rump near the tail, but should the wool be accidentally soiled on the flank they may be deposited there. When the sheep is caught, it will be noticed that the wool is discoloured or dark on the surface, and quite hot to the hand, resulting from the decomposition, inflammation, and moisture caused by the swarms of maggots beneath. Opened out with a pair of sheep shears, a putrid, vile-smelling mass of wool is found beneath; if in an advanced stage, the maggots extend right down to the skin, which is red and inflamed. The whole mass of squirming maggots is in all stages of development, from great big fat creatures to some just hatched; for when once a sheep is blown and smelly, other flies are attracted, and these drop their eggs or living larvæ in clusters of a dozen to fifty, gummed together with a secretion that also glues them to the wool as they pass from the retractile slender ovipositor of the fly.

It is no wonder that the sheep is restless, stamps its feet, and flicks its tail, when the rump is covered with such a mass of maggots.

Neglected or blown sheep soon get into an awful state; the inflamed skin becomes broken and ulcerated, the blown wool is rubbed off or pulls off, and fresh swarms of maggots work along the back, until the best thing that can happen to the wretched animal is to die, which it often does, wandering away from the flock into the scrub.

The blowing of the freshly marked lambs after their tails have been docked is, of course, quite a different thing from the blowing of damp or dirty soiled wool. In freshly docked lambs, the blood naturally attracts the swarms of flies; and they have to be watched and dressed until the skin has healed over the severed joint.

The actual loss, in some of the best wool in the fleece, of the thousands of sheep that have been blown this last season in New South Wales alone, must run into thousands of pounds, without counting the even more serious loss of sheep and lambs from the fly pest.

THE FLIES THAT CAUSE THE DAMAGE.

In dealing with any insect pest, the first thing is to identify the particular insect responsible for the damage, so that we can study its habits and development, both before and since its becoming a pest. It is remarkable how little is often known about some of our commonest injurious insects; and the controversy carried on for years among sheep-men, ever since the blown-wool maggot appeared, is a case in point.

One of the greatest difficulties that the investigator has to deal with, is that the same common name is used for different insects, or that different common names are used for the same insect, and this, whether in other countries or in the same district. For example, what we commonly call "Blow-flies" in Australia, are known as "Blue-bottles" in England; and what we call "Blue-bottles" are known as "Green-bottles" with them; while in the United States, *Lucilia sericata* is called the "English Blue-bottle."

All these flies belong to the great family *Muscidæ*, which are remarkable for having the bristles on the antennæ feathered. This

family contains a number of large flies, known as Scavenger Flies, Meat-flies, Blow-flies, etc.; among them are many of the most serious pests that man has to deal with, such as the Horn-fly, the Screw-worm, the Tsetse Flies, and the cosmopolitan House-fly, as well as the Blow-flies and Blue-bottles that we have under consideration. The older entomologists called them scavengers and said they were useful; but latter-day investigation shows that they are the agents in spreading many of the most serious diseases that afflict man and animals. Therefore they should not be tolerated, and every means should be taken to keep them from contaminating our food.

The size and coloration has little to do with the generic and specific determination of the "Blow-flies" and "Blue-bottle flies"; for, though we have two large yellow-tinted "Blow-flies," other species of the same genus (*Calliphora*) are brilliant in bright metallic green, bronze, and blue tints, like the typical members of the genus *Lucilia*. As it is the flies belonging to the last group, which deposit their eggs upon live sheep and cause blown-wool in England, it was naturally thought to be the same fly when the pest appeared here. When the blown-wool trouble first appeared in Australian flocks, the sheep-breeders were quite positive that it was the "Green flies" that were the culprits, and not the larger common blow-flies of the house, which had been domestic pests ever since the country had been occupied.

Whenever a dead sheep, freshly-flayed skin, or offal was noticed in summer, the majority of the flies swarming over it were seen to be bright blue or green flies; the remainder were the larger blow-flies and a small shining black fly. The writer, knowing that blow-flies will deposit their eggs upon damp blankets or other woollen material in a camp, or upon bales of sheep, kangaroo, or opossum skins if there is any smell about them, believed, when he first took up the question of the identity of the "sheep maggot-fly," that blown wool was the work of the common blow-flies, in spite of all the testimony of sheep-owners that metallic blue and green flies were the culprits. In order to make sure, he obtained many samples of wool infested with maggots direct from the backs of living sheep; and from this wool, placed in jars with some damp earth, he soon

bred plenty of flies, and showed without doubt that, in nine cases out of ten, it was the two common yellow blow-flies that did all the damage to the sheep.

THE BLOW-FLIES.

All our typical blow-flies belong to the genus *Calliphora;* at one time, before the finer points of difference of classification had been worked out, the earlier naturalists placed them in the genus *Musca.* Their distinctive points have been well defined; and, though closely allied to the following genus *Lucilia*, a specialist can soon separate the members of the two divisions by close examination with a hand lens.

THE GENUS *CALLIPHORA.*

The *Calliphora* have the space in front of the eyes, below the prominent bristles on the top of the head, covered with fine hairs, so that the cheeks are hairy, and, generally speaking, they are clothed both with bristles and with fine silky hairs; the latter are wanting to a great extent in *Lucilia.* These flies are world-wide in their range, but none of the European or American species has been recorded from Australia. *Calliphora erythrocephala*, dull metallic blue, with a red face and black beard, and *Calliphora vomitoria*, with a black face and red beard, are the common species ranging over Europe and America, but they are rare in the Pacific Islands. One specimen of *Calliphora vomitoria* has been recorded by Howard from the Hawaiian Islands, where, however, *Calliphora dux* is the common species; it is doubtfully identified from New Zealand, and Frauenfeld has described it from New Caledonia.

A number of species have been described from the Malay Archipelago, the Pacific Islands, and Australia, some of which have a wide distribution over this region. The members of the genus *Calliphora*, in contradistinction to the "green-bottle" flies *Lucilia*, might be described as the "hairy" meat or blow-flies, for, though there are some bristly hairs on them, most of their vesture consists of fine soft hairs, which in the *Lucilia* are replaced with stout hairs or bristles.

The Mottled Blow-fly (*Calliphora oceaniæ*, Desv.).

This is the common blow-fly, both in the house and in the bush. It has a wide range over Australia, though it was originally described by the French naturalist, Robineau Desvoidy, from Timor, S.A.; and it and the following species (*Calliphora villosa*) are the parents of the smooth cylindrical maggots that destroy and breed in blown wool; they are also responsible for the blowing of meat, etc., in the

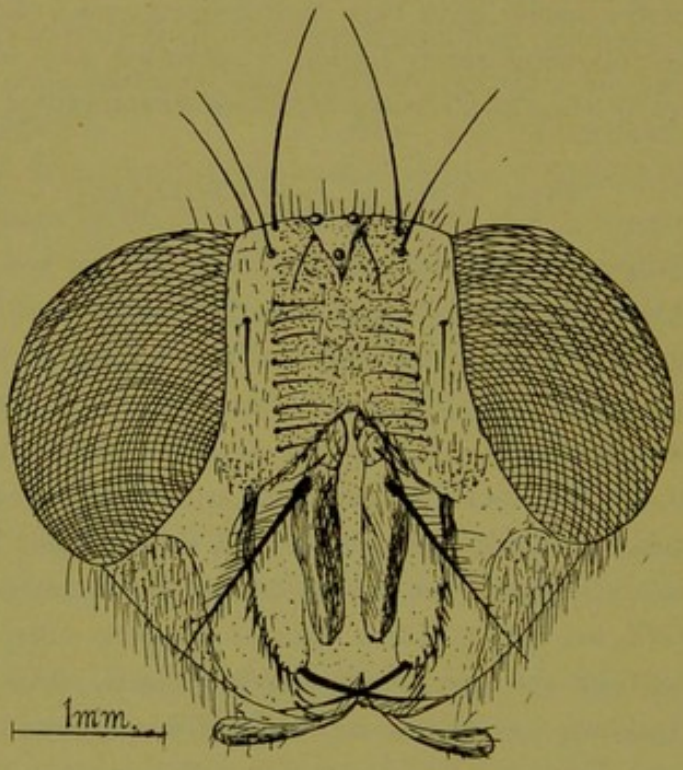

Fig. 3. The Mottled Blow-fly (*Calliphora oceaniæ*).
Head of female from front, ×15 diameters.

house. They are most plentiful in summer, but numbers hibernate through the winter months; and a few mild days, even in midwinter in New South Wales, will often bring a few out of their hiding-places. In the early part of summer, they deposit eggs; but in the height of summer, the eggs often hatch in the body of the mother before she can find a suitable food-supply, so that living maggots are deposited instead of eggs, which accounts for their rapid development. These eggs are slender and elongated, with the extremities

rounded, verging in colour from dull white to pale yellow. Taken from the ovaries of the fly, the shell or skin is so thin that the movements of the enclosed maggot can be observed within; but when laid in the ordinary way, the skin or shell hardens and becomes opaque. The average number of eggs taken from the body of one of these blow-flies was fifty, after a large series had been dissected.

From a pound of blown-wool, the writer obtained 1,050 blow-flies; and allowing that half of these were females, and that all these females survived to deposit one batch of eggs, we would have in three generations 16,406,250 flies in about eight weeks in mid-summer, from the descendants of the flies from one pound of blown-wool.

Fig. 4. The Mottled Blow-fly (*Calliphora oceaniæ*). Larva.

Fig. 5. The Mottled Blow-fly (*Calliphora oceaniæ*). Head of larva, showing hooks.

Fig. 6. The Mottled Blow-fly (*Calliphora oceaniæ*). Anal segment.

The maggots, when full grown, measure slightly over half an inch in length, and are of a uniform dull white to semi-transparent tint. It is one of the typical cylindrical elongated maggots, with the head segment smallest, coming to a blunt cone-shaped point, containing a pair of black hooked retractile jaws, and a small brown

rimmed spiracle on either side, thirteen small tubercules forming the rim. The body consists of thirteen segments, broadest towards the hindermost extremity, which is sharply cut off (truncated) with a fringe of thorn-like, fleshy tubercules surrounding the depressed area in which are placed the anal spiracular apertures. The upper surface of the segments of the body is smooth and shining; each segment is marked on the under surface with a transverse band of fine blunt spines, and the anal segment is produced into two fleshy tubercules, like feet, on the under surface; so that by the aid of the retractile hooked jaws, the spines on the under surface, and the tubercules at the apex, these maggots can move about very quickly. A quarter of a pound of meat supplied sufficient nourishment to feed two hundred maggots, and these maggots took exactly six days to become full grown, when they pupated in the soil beneath the remains of the meat. It is probable that, exposed to the direct rays of the sun in midsummer in the bush, they would attain their full growth in a day less.

Fig. 7. The Mottled Blow-fly
(*Calliphora oceaniæ*).
Pupa.

The pupa is almost oval in shape, reddish brown, and measuring about a third of an inch in length, very small in comparison with the size of the fly compressed within its protection. Flies were obtained on the 1st of December from eggs laid on the

meat on the 14th of November, which changed into maggots on the following day. These maggots were full fed, and pupated on the 20th of November, so that their life cycle is about a fortnight or fifteen days. In another experiment, eggs laid on the 4th of December produced perfect flies on the 22nd.

The perfect fly measures one-third of an inch in length, from the front of the head to the tips of the closed wings. The eyes are dark brown, the space between them reddish brown, the rest of the head yellow, with a silvery pubescence near the eyes. The apical segment of the antennæ dull blue, and the proboscis black. The upper surface of the thorax slate blue, with the under surface of a lighter tint; the legs reddish brown, with the tarsi black; the wings semi-transparent, with black nervures. The abdomen is dull reddish yellow, with the centre of the upper surface of the segments broadly blotched with deep metallic blue which is broadest behind the thorax on the first segments, whence it runs out at the anal segment which has only a silvery tint over the yellow. From this very distinctive blue and yellow marking of the body, this fly can very easily be distinguished from all others of our species.

It probably has a wide range over Australia; but, as none of our museum collectors has ever gone into the question of collecting the common or household insects, it is difficult to find the range of many of our insects.

The Large Yellow Blow-fly (*Calliphora villosa*).

This is almost as common, all over Australia, as the last named species, and it has exactly the same habits; its development and life-history are identical, so that it is not necessary to repeat them.

It has a wide range over Australia; but the writer can find no record of it from any other country, except in Frauenfeld's account of the "Fauna and Flora of New Caledonia," published in 1867; there he describes it from New Caledonia, and states that this species, described by Macquart, is identical with the species afterwards described by Bois-Duval as *Musca australis*, from King George's Sound, W. Australia.

The perfect fly is somewhat variable in size, sometimes no larger than *Calliphora oceaniæ;* but a well-developed specimen measures half an inch from the front of the eyes to the tips of the folded wings. The eyes are dark brown, with the face and under surface of the head yellow. The thorax bluish slate colour on the upper surface, the under surface lighter, with the legs reddish yellow, and the tarsi black; the wings semi-transparent, with black nervures.

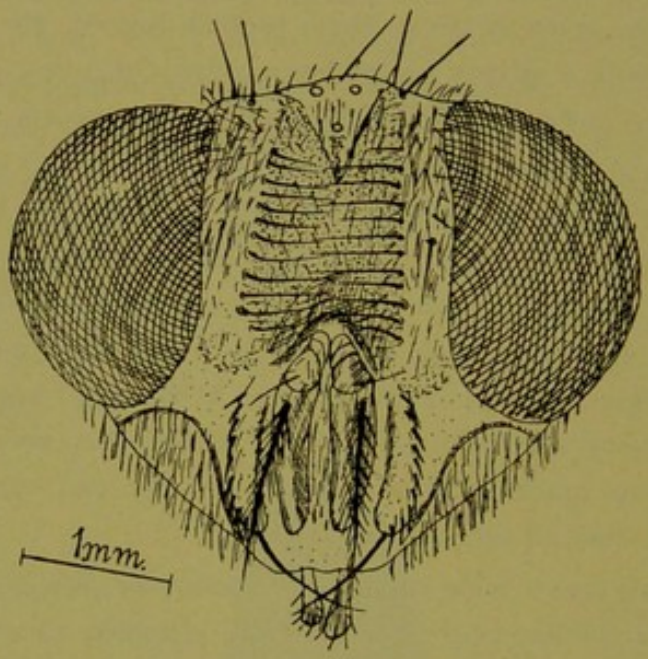

Fig. 8. The Large Yellow Blow-fly (*Calliphora villosa*).
Head of female from front, × 15 diameters.

The abdomen of a general dull greenish bronze tint, curiously marbled with golden yellow, and clothed on the upper surface with fine short black hairs, longer ones fringing the sides; the whole of the under surface and legs are golden yellow. Therefore the metallic tints of the abdomen are not so prominent, on account of this hairy and downy covering. The stouter hairs or bristles on the head and body are black.

It may be described briefly, as a downy, yellow-bodied blow-fly. A specimen taken in the house and placed upon some meat laid one hundred and eighty eggs, all of which were crawling maggots next morning.

THE METALLIC BLUE BLOW-FLY (*Calliphora rufifacies*).

This highly coloured blow-fly also has a wide range over Australia, and, though seldom coming into the house, it may be often observed feasting upon tainted meat, bones, and refuse in the yards and streets. It is abundant in the summer months in the bush, and it swarms over dead sheep; it is particularly noticeable around a sheep that has been freshly skinned in the bush and left to decay. It is the parent of the "hairy maggots," usually found alone, but more rarely mixed with the smooth maggots of other blow-flies in blown wool.

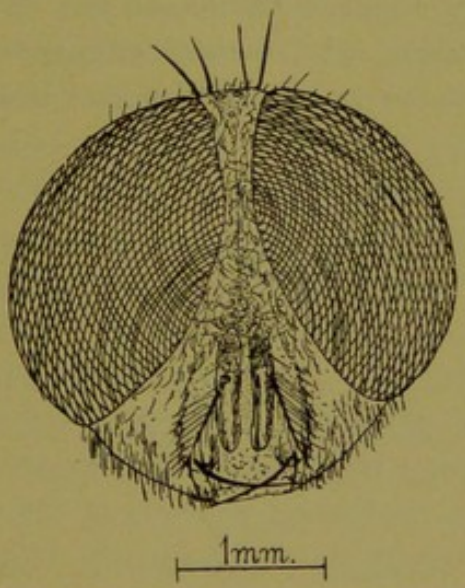

Fig. 9. The Metallic Blue Blow-fly (*Calliphora rufifacies*). Head of male from front, × 15 diameters.

The perfect fly, though measuring about one-third of an inch in length, is a much smaller fly than *Calliphora oceaniæ*, because the body is more slender and cylindrical; it can very easily be distinguished from the previous species by its uniform rich deep metallic blue colour, sometimes even shading into green on the abdomen. The space between the eyes is black, with the rest of the head dull yellow, but so thickly clothed with a white pubescence that it might be called the "white-faced fly." All the bristles are black, while the fine hairs are brown or grey to white on the under surface of the thorax and abdomen, forming a regular grey coat on the thorax and

on the first segment of the abdomen. The legs are black, the wings transparent, with the basal cells close to the thorax slightly clouded with brown, and the nervures black.

The maggots are of a general dirty white colour, with the centre of the back and head segment brownish, caused by the whole of the upper or dorsal surface of the segments being covered with fine black granulated spots. The head segment, forming a sheath for the characteristic curved black jaws, is slender; the next two segments are furnished with a fleshy tubercule on either side, and the following segments, 4-10, are furnished with a regular parallel band of eight fleshy angulate tubercules, two on the centre of the back and three on either side; the eleventh segment bears the pair of circular spiracles surrounded with a ring of twelve more rounded tubercules; the anal or last segment forms a blunt cone, with a tubercule on either side of the under surface. The whole of the under surface of the maggot is slightly flattened, and finely corrugated; the segments are furnished with transverse bands of fine warty spines, by means of which, with the aid of the retractile jaws and the false legs or tubercules at the tip of the hinder end of the body, the maggot can crawl very quickly, even over a smooth surface.

These maggots, when infesting the remains of a dead sheep, seem to prefer the fermenting contents of the paunch, and, when ready to pupate, usually do so among this decayed matter.

The pupæ are dark brown. Unlike those of the previously described species, they are flattened, but convex on either side, with the remains of the tubercules of the maggots forming a ragged fringe of filaments right round, and they are often clustered together in masses.

The exact time of the development of this fly, from the time the egg is deposited to the time of pupation and the final development of the perfect fly, has not yet been determined; but they develop very rapidly in breeding-jars, from very small maggots among the wool—less than a fortnight.

The maggots are more common in wool late in the year, and in many cases appear to prefer daggy dirty wool rather than simply damp or stained wool.

The Small Green Blow-fly (*Calliphora varipes*).

This little green fly is very common in the western country, in company with the larger species, about dead sheep and other decaying matter; but it is not so plentiful about the cities. As far as the writer knows, it has never been bred from blown wool.

It is about the size of a house-fly, but more cylindrical in form. Its general colour is bright metallic green, with a bronzy tint in the abdomen of some specimens; the face black between the eyes; and the lower part of the head more yellow than white. The wings clear, with black nervures; the legs brown mottled, with metallic tints on the thighs; the tarsi black. Besides the smaller size, it is easily distinguished from the other species by its variegated legs, which in the previously described flies are of a uniform black.

The Dark Blue Blow-fly (*Calliphora incisuralis*).

This species, allied to *Calliphora rufifacies*, has been identified from specimens obtained in Southern Queensland; nothing is known of its habits or range. Slightly larger than the last species, the coloration is as follows: front of head yellow, clothed with white pubescence; the antennæ reddish brown; eyes dark chestnut brown; the thorax dull metallic blue above, the hind portion of a much brighter purple to blue tint; the basal half of the abdomen of the same colour, the apical portion with a decidedly green tint. Legs dark brown, with dull metallic green tints on the thighs.

THE GENUS *LUCILIA*.

The members of the genus *Lucilia* might be described as brilliant metallic green or bronze-tinted scavenger flies. This group, unlike the *Calliphora*, contains neither brown nor yellow blow-flies. Earlier naturalists, who considered colour as a main point of difference, were misled in several instances in describing new species, so that they placed them in the wrong genus; consequently, several of the *Calliphora* were described as *Lucilia* on account of their metallic tints. The members of this genus are easily separated from the

genus *Calliphora*, for, instead of being clothed with fine hairs and a few scattered bristles like the latter, they have a coat of short scattered bristles on the head and thorax, with very little fine hair. The other distinctive characters are, that the space in front of the eyes, below the prominent bristles on the top of the head, is naked; the thorax is of one tint—shining metallic, with fine whitish down on the front of the thorax; the upper surface of the abdominal segments is covered with scattered short stiff hairs or bristles.

There are a large number of species of the genus *Lucilia*, ranging all over the world, and they are much more numerous in tropical countries than the members of the genus *Calliphora*. In Van der Wulf's Catalogue of the Described Diptera of South Asia, published in 1896, there are seventy-one species of *Lucilia* listed and eight species of *Calliphora*.

The European Sheep Maggot-fly (*Lucilia sericata*).

The European sheep maggot-fly (*Lucilia sericata*) is the common bright metallic-green fly in the gardens, back-yards, and streets of Sydney, where it may be seen resting upon offal or scraps; it comes round the meat-safe when hanging outside in the shade of a tree, but it does not commonly come into the house. Though it has a wide range over Australia, it has not been bred from blown wool in this country.

Yet it is the common "Green-bottle" of Great Britain that, together with the allied species (*Lucilia cæsar*), lays its eggs in the wool of sheep in Great Britain. Professor Carpenter (1902) says: "She lays her eggs, in clusters of about fifty, on the wool of the sheep, attaching them to the hairs half-way between the root and the tip. The eggs hatch out within twenty-four hours, or less, and grow to their full size in about fourteen days. The maggots resemble those of *Calliphora erythrocephala* rather closely. In the *Lucilia* larva, however, the small fan-like spiracle on the prothorax has ten prominences, instead of thirteen present on the corresponding organ of the *Calliphora* maggot; also, the short anal feet of the maggot are not so distinct."

In Australia, this fly is very quickly attracted to meat hung up outside the house; and, crawling over it, it deposits its slender yellowish white eggs in masses in the crevices, working its slender ovipositor with a regular pump-like motion. These eggs hatch within the day, and the maggots are full-fed upon meat in six to

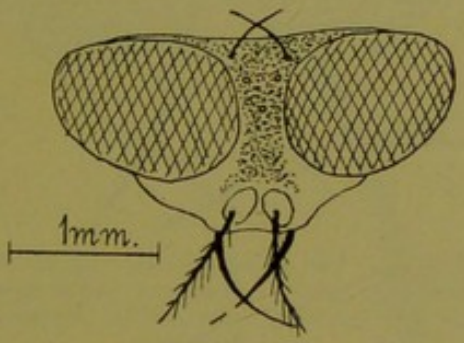

Fig. 10. The European Sheep Maggot-fly (*Lucilia sericata*). Head of male from above, showing well-separated eyes, × 15 diam.

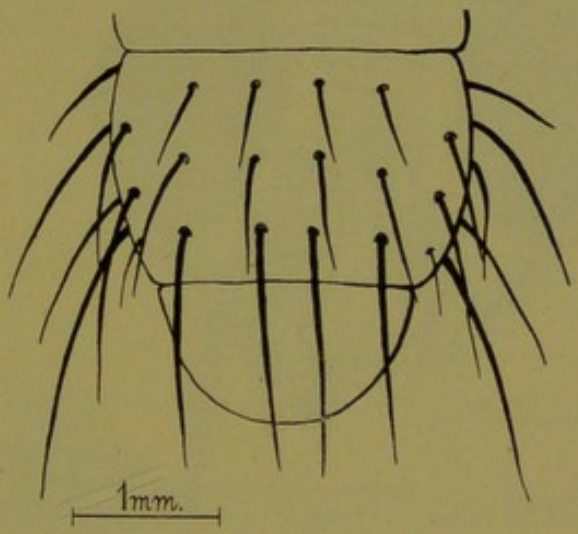

Fig. 11. The European Sheep Maggot-fly (*Lucilia sericata*). Arrangement of hairs on the mesothorax.

seven days; these pupate in the soil beneath, forming the usual oval brown pupa-case, from which the perfect flies emerge upon the sixth day after pupation. This fly has almost a world-wide range; it is common in North America and Africa.

It measures slightly over one-fourth of an inch in length; is of the usual stout form; of a rich dark metallic-green tint, with the abdomen of a much more brilliant colour, sometimes with a bronzy tint.

According to Professor J. R. Bos, who studied the life-history of this fly in Holland, a single female can lay five hundred eggs in the course of her life.

The Bronzy Green Maggot-fly (*Lucilia cæsar*, Linn.).

This fly is closely allied to the last species, and it is also known to deposit its eggs in the wool of sheep in Great Britain, where they have been bred out from wool in a similar manner. It is almost

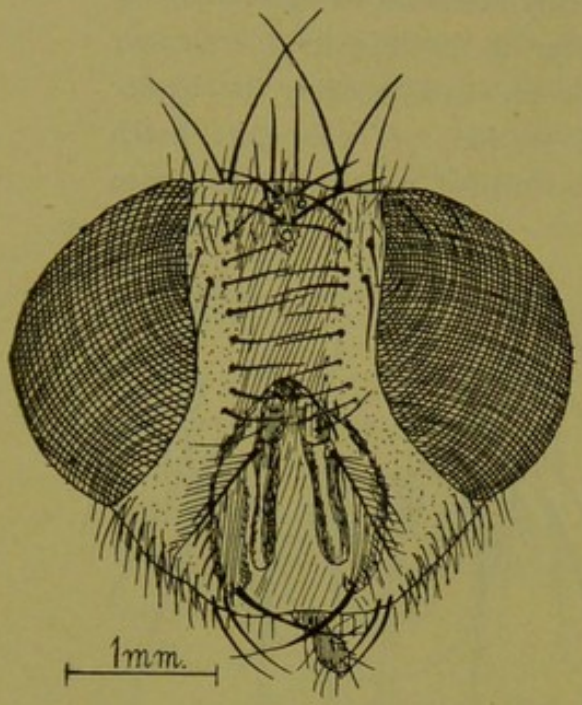

Fig. 12. The Bronzy Green Maggot-fly (*Lucilia cæsar*). Head of female from front, × 15 diameters.

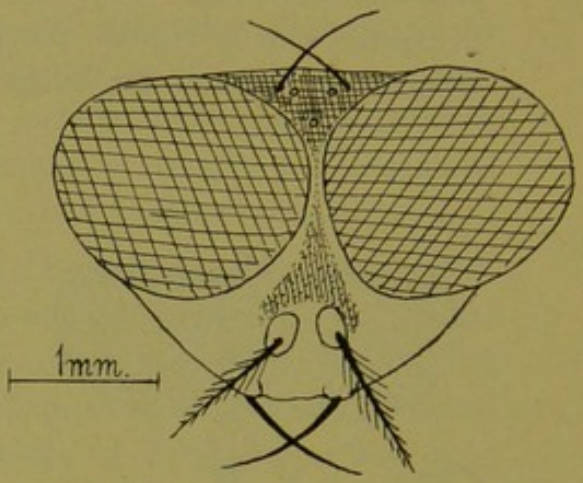

Fig. 13. The Bronzy Green Maggot-fly (*Lucilia cæsar*). Head of male from above, showing eyes nearly touching, × 15 diameters.

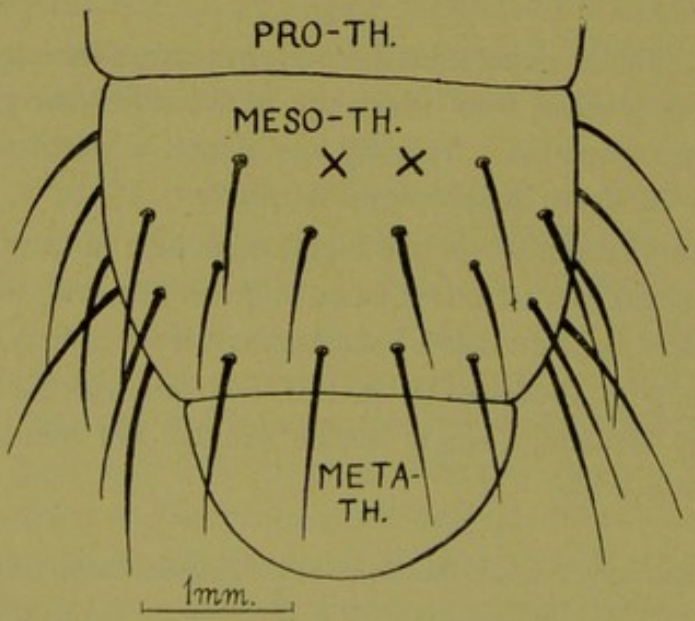

Fig. 14. The Bronzy Green Maggot-fly (*Lucilia cæsar*). Arrangement of large hairs on mesothorax. Note absence of hairs at × ×. These are present in *Lucilia sericata*, as shown in Fig 11.

cosmopolitan in its range, and the writer has received specimens from Southern Queensland, which were identified as this species by Coquillet, of Washington, U.S.A. Its life-history and habits are similar to those of the previous species. It is about the same size, with the eyes reddish brown ; the face grey, clouded with blackish brown; the thorax deep metallic green, with the abdomen more brightly tinted with bronzy green.

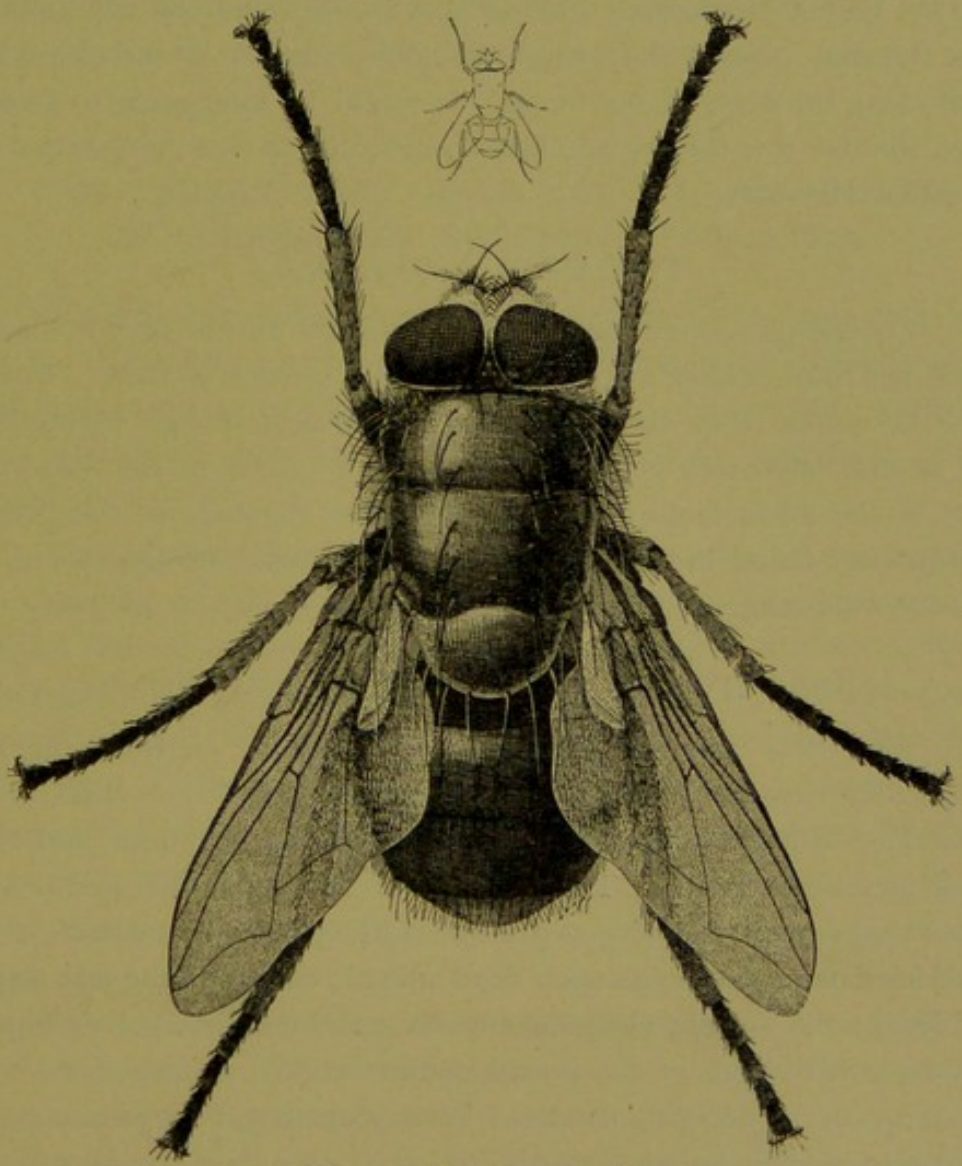

Fig. 15. The Large Lucilia
(*Lucilia tasmaniensis*).

The Large Lucilia (*Lucilia tasmaniensis*).

This is a much larger species, measuring half an inch from the front of the head to the tips of the folded wings. It is of a uniform deep metallic green tint; the base of the abdomen is darkest, and the two following segments are barred with purple along the hind margin. The legs are black, and the wings slightly clouded with brown, which is darkest around the basal areas.

Originally described from Tasmania, it has an extended range up the Queensland coast; and during a recent collecting trip among the Solomon Islands, the writer obtained a number in the clearings and along the edge of the forest. It would be interesting to ascertain whether it is this, or an allied species, that is blowing the wool in the New Hebrides.

THE GENUS *OPHYRA*.

The genus *Ophyra* contains medium-sized flies of brown, black, or dingy tints, seldom metallic, clothed with bristles or hairs. Some are not unlike house-flies in general appearance, though they differ in several important points. They are not placed in the *Muscidæ* but in the allied family *Anthomyidæ*. The members of the genus *Ophyra* are found in most parts of the world, and some species have a very wide range.

The Shining Black Fly (*Ophyra nigra*, Meign.).

This fly is very abundant round dead sheep, anywhere in the bush. It can easily be distinguished from the "Blow-flies" and "Green-bottles" by the shining black tints of the back and the dull metallic abdomen. The members of this genus are said to lay their eggs upon decaying vegetable matter; but in Australia, this species deposits her eggs upon dead animal remains in the last stage of decay; the slender, elongate, smooth, and somewhat yellow tinted larvæ, crawl about in the putrid matter on the surface of the soil underneath the decaying carcass. When pupating, they form a more elongate reddish brown chrysalid or pupal case than the blow-flies, buried just beneath the surface of the soil.

The perfect flies are about the size of a house-fly, of a uniform black tint, with the bristles and finer hairs black also; the centre of the back is shining black, with the upper surface of the abdomen dark blue-black, with deep metallic tints; the wings semi-transparent, with the nervures black. This fly has a wide range through China, the Malay Archipelago, and Australia; and is doubtfully recorded from England by Walker.

Though these flies have never been bred from blown or dead wool, they are noted and described with them because they are so often associated with the flies that cause the damage.

THE CAUSES THAT HAVE LED TO SCAVENGER OR FLESH FLIES BECOMING PARASITES.

Blow-flies are indigenous to Australia; specimens were collected by the naturalists who visited our shores in exploring expeditions as far back as the early part of the last century, before there could be any chance of their having been introduced by man from other countries.

Now, under natural conditions, blow-flies confined their attention to decaying animal and vegetable matter festering round camps. When settlers came into the country, they were, at the worst, what we might call "casual domestic pests," attracted into the house and larder by their keen sense of smell to food upon which they deposited their eggs. Sometimes, it happened that they obtained access to a neglected wound on a farm animal, and it became maggoty; but this was soon rectified.

There is always some cause for the abnormal increase of any pest, be it animal or vegetable, if we look deep enough; either altered conditions of living, or suitable climatic conditions, such as have caused the rabbit for instance, and also the prickly pear, to become such widespread pests in Australia.

The naturalist Gilbert, when collecting birds in 1848, on the Hautmann's Abrolhis Islands on the West Australian coast, found

the ground under the low scrub where the Noddy Terns nested swarming with the Larder beetle (*Dermestes lardarius*). These beetles multiplied and throve because the island swarmed with a small lizard that climbed up to the nests and killed the young terns in hundreds, feeding upon a portion while the beetles devoured the remains upon the ground. A similar instance was brought under the writer's notice in Western Queensland at the end of the last great drought, when a lady on one of the Never Never Stations sent him a packet of these beetles. She stated that whenever the hands, out mustering the stock, camped for a meal, these insects swarmed out from under every stick and stone to pick up the scraps that fell to the ground.

They had increased abnormally, owing to the thousands of dead animals that had covered the land during the great drought. Now this drought was remarkable for the fact that, unlike many of the previous and more local ones, it was felt over the greater part of the pastoral country in Australia. Then, flocks had to be shifted all over the country, leaving in their wake thousands of dead sheep clothed with wool that was not worth collecting. The scavenger or blow-flies deposited their eggs among this wool, and thus apparently acquired the habit of detecting foul wool. This sharpened sense, which we might say is now inherited, has become intensified, so that it requires very little moisture, mucus, or blood upon the wool to attract the flies; thus, wool, under these conditions, has become a regular food supply to large numbers of these fly-maggots.

Next, given this acquired habit, the modern methods of sheep-breeders have also been to the advantage of the blown-wool flies. The aim of all sheep-men is to get every inch of skin covered with a thick dense fleece. The old-fashioned, clean-legged, bare-bellied ewe of the plains—common thirty years ago—with her loose open fleece, has vanished; and the larger, close-wooled ewe, with wrinkled neck and wool down to the toes, has replaced her. The modern Australian sheep, as bred for wool, is simply a medium for turning our pasturage into commercial wool of the finest staple, just as the dairy-man breeds cows to produce the greatest quantity of butter-fat

from a given quantity of fodder for commercial butter. The semi-wild hairy-wooled sheep of the alpine regions was naturally a more hardy animal than the modern sheep, which has been bred through ages of domestication with careful selection, just as the modern dairy-man's cows are very different from the wild scrub cattle of old bush days. The dense heavy wool, full of yoke, growing closely round the tail, crutch, and legs is very much more easily soiled, particularly with urine, or at lambing, than in old times; and when once blown, it forms an impenetrable cover for the maggots against all outside enemies.

DOCKING THE TAILS OF LAMBS.

Sheep are distinguished from goats by the possession of long tails; and in the East, where there are scores of varieties of goats and sheep about the villages, goats and sheep are so much alike that the traveller can only be certain to which group they belong by the possession or absence of the caudal appendage. If you watch a goat with her apology for a tail, you will notice how sharply she can flick it and disturb any fly that settles on her rump.

The tail of the sheep, most noticeable in the pet lambs about the homestead, is a most useless appendage, covered with wool to the tip, which swings about in a helpless manner. It simply collects dirt and burrs, and messes all the wool on the rump. The docking of lambs' tails seems a very cruel operation to the onlooker; but, under ordinary conditions, as soon as the blood drains out of the small blood vessels, the wound heals very rapidly, and from the stockman's point of view the look of the adult sheep is improved.

There is, however, no uniformity in the standard of docking lambs' tails, and the careless operator often cuts them off so that there is not even a stump left. Now, though the sheep has little or no control over the long woolly tail, yet, when several of the basal joints are left at the docking, it can flick this remnant of a tail in exactly the same manner as the goat does when anything settles on its rump. It also protects the bare skin from any injury, and from the bite or sting of an insect.

One of our well-known pastoralists of West Wyalong, Mr. W. Thompson, of Caroon, thinks that he has solved the difficulty of keeping flies off the sheep and depositing their eggs or maggots in the wool, by the common-sense method of cutting the lambs' tails longer than is the usual fashion. He has written the following letter to the newspapers :—

"Three years ago I had a small flock of stud ewes (about thirty), and though I tried several kinds of dressing, only one of the number escaped being blown. This was a ewe with about four inches of tail, or about double the allowance. I noticed that while the flies were able to harass the other sheep, and cause them to run about excitedly, this long-tailed sheep stamped its hind feet and shook its tail vigorously from side to side, and thus kept the flies off its hind quarters. I further noticed that the wool on the breech of the sheep was kept in a 'brushed aside' condition, not in the straggling and often upward lay of the wool on short-tailed sheep, with the obvious consequences. Again, the exposure caused by the removal of too much tail is often responsible for injuries, such as fly stings, etc., which seriously interfere with the natural functions of the sheep, and which assist the blow-fly in its work. . . . Two years ago I docked 2,000 lambs, cutting the tails well below the butt of the bulb. Fourteen months ago, I docked 3,200 in the same way, and without an exception they escaped being blown. Early in July of this year (1910), I also docked 3,000, using searing irons, and of these not one has yet been found suffering from fly-blowing. The sheep in adjoining holdings suffered heavily ; also some short-tailed sheep on my own place. Therefore I think that a fair case has been made for leaving the lamb when docking a length of tail sufficient to be of use to it in the various ways mentioned."

THE QUESTION OF DEALING WITH SHEEP MAGGOT-FLY.

The methods to be adopted for dealing with this pest have to be studied from all points of view, both by the stockman and by

the naturalist. One of the first things to be done is to establish the identity of the species of the flies that blow wool. When we have done this, we can study their life-histories and their habits under both normal and altered conditions; thus, we can obtain data upon which to work with some reasonable hope of keeping them in check. It has now been proved that at least three distinct species of "meat or blow flies," indigenous to Australia, have acquired the habit of depositing their eggs or living maggots upon soiled or smelly wool upon the backs and flanks of healthy sheep. These are the two common yellow blow-flies, *Calliphora oceaniæ* and *Calliphora villosa*, and one of the metallic blue flies *Calliphora rufifacies*. The first two species are the parents of the stout cylindrical maggots, and the last species of the "hairy maggots." Usually only one species infests the same sheep; but sometimes both kinds of maggots are found in the same mass of soiled blown wool. It is difficult to say how many eggs an individual fly will lay in the course of its life, which in many flies may be several months; but it is known, from actual experiment, that a blow-fly lays from forty to one hundred and forty eggs at one time if undisturbed, and may lay at this rate several times. The natural food of all these flies is decomposing animal, or fermenting vegetable matter.

REMOVAL OF REFUSE AND CARCASSES.

A quarter of a pound of meat is sufficient food for the development of from two hundred to two hundred and fifty large blow-fly maggots, from the egg to the pupa; and specimens bred in captivity have developed from the egg to the perfect flies in fifteen days, in November. Therefore, the carcass of every sheep, horse, or bullock, is food for countless numbers of blow-fly maggots. The writer, in September, 1910, found the half-dried paunch of a bullock that had been partially burnt, a seething mass of blow-fly maggots; the dried skin of the paunch had effectually protected them from the crows then feeding on the burnt flesh. A few pounds of offal in the pigsty, or around the homestead, will be sufficient breeding ground

to infest the whole place. Poisoned rabbits, both above ground and dead in their burrows, are popularly supposed to be the breeding grounds of maggots; but though probably a factor in their generation, very little evidence has been brought forward regarding the actual infection. The trappers' camps and places where the trapped rabbits are cleaned and gutted, are, as a rule, infested with flies; but this kind of offal soon dries in the sun, and it is exposed to the birds and ants, so that it is not likely that it has much to do with the increase of blow-flies. The first and most important step in the reduction of the blow-fly pest is the destruction of their breeding grounds; clean up all offal, and burn every dead animal in the paddocks as quickly as possible—*and burn thoroughly*. A reduction in their numbers will not come about in a day, perhaps not in a year; but, just as with fruit-flies in the orchards, a diminution will soon be noticeable to the most sceptical sheep-owner.

This cleaning up may be difficult on a large holding, but nothing is impossible; nor can it be neglected with a pest that has become such a source of loss, both in wool and in sheep and lambs. The importance of destroying offal and dead beasts is well known in other countries; swarms of street dogs have been tolerated and protected for centuries in Constantinople because they are the street scavengers. In India and the East, the jackals are never molested because they hunt through the villages at night and clean up the offal and waste scraps.

Over a large part of the United States, Mexico, and the West Indies, the Turkey buzzard (*Gallinazo aura*—one of the vultures) is protected by law, despite their offensive smell and unclean habits. They swarm round and strip every dead beast to the bone, and thus clean up the ranges. They sit about the back-yards in the Mexican villages, and at nightfall fly in from all quarters to roost on the roof of the cathedral or public buildings in the centre of city squares; they are quite a feature of Vera Cruz and other large towns in Mexico and Cuba.

When the sheep maggot-fly appeared in the Hawaiian Islands, where there are no carnivorous birds, the ranch-owners wanted the

authorities to import Turkey buzzards from Texas; but Professor Van Dine, who visited Texas for the purpose of seeing whether this should be done, reported against the proposal on account of their habit of roosting around habitations and fouling the water, and also on account of a grave suspicion that they sometimes are responsible for the spread of anthrax. In Australia, we have many carnivorous birds, such as the much abused crow (which, not without reason, is hated by every bushman), the many hawks, and the wedge-tailed eagle, all of which feed upon both living and dead animals.

DESTRUCTION OF BIRDS AND ANIMALS.

Now, it has always been the habit of the sheep-men to destroy everything that eats the sheep's grass, or kills lambs and sheep, irrespective of the value of these creatures in other ways; and in carrying out this policy, they have destroyed other useful birds which came to the same baits and which were not enemies. Thus, the balance of power in the animal life of the bush has been altered. In fact, the active enemies of the squatter, such as the crows and eagle hawks, kill also a great number of noxious things; while the smaller hawks, in spite of the small birds they often destroy, must be classed as useful birds from the numbers of caterpillars and insects they devour, and for the scavenger work they carry on about the sheep camps and homesteads.

As an example, Gould, in "Birds of Australia," writing in 1846, says of the brown hawk—now a rare bird in New South Wales—"By the settlers, this bird is considered one of the pests of the country; but it was clear to me that whatever injury it may inflict by now and then pilfering the newly hatched chickens from the poultry yard, is amply compensated for by the havoc it commits among the countless myriads of the destructive caterpillar. To give an idea of the numbers of this bird to be met with at one time, I may state that I have frequently seen from ten to forty on a single tree, so sluggish and indisposed to fly that any number of specimens might have been secured."

Though the poisoning of dead sheep and the spreading of baits for dingoes and wild dogs has caused a great decrease in the hawk life of the plains, it was nothing to the havoc caused from the wholesale poisoning carried out during the last decade since the advent of the rabbit pest. Not only have all kinds of poisoned baits been used, but the poisoning of water in the dry west has killed hundreds of harmless and useful creatures.

The main supply of food for the bulk of our birds is insects. These feathered police have been killed out; so that the blow-flies and their maggots have lost their most serious enemies, and have increased like the locusts and caterpillars, in consequence. The more birds, the fewer flies.

The wholesale destruction of bird and animal life in Australia has reacted upon the pastoralist and agriculturist in many ways, and we are only just beginning to awake to the value of our vanishing fauna.

EFFECT OF FOREST RING-BARKING.

Not only is this destruction of our feathered friends the birds, the lizards, and the more humble creatures—the carnivorous insects—caused by shooting, trapping, and poisoning, but also by the removal or ring-barking of the forest and scrub that gives both shelter and food to our wild life—"The little creatures of the forest."

This has been studied in other parts of the world: in the United States, under the Biological Survey of the Federal Government, and in the kingdom of Hungary, under the Ornithological Division of the Department of Agriculture. In the great agricultural country of Hungary over 1,300 State foresters record the movements and migration of the birds of Central Europe; and where forestry is carried out so carefully that all dead and hollow decayed trees have been removed, it was found that nesting-places were wanted by the birds. Artificial nesting-boxes were so necessary to the birds which nest in holes in trees, that a factory was started for making them; and four years ago (1906) the Minister ordered the Hungarian Central Office for Ornithology to present a scheme to supply these

artificial nesting-boxes to the State forests, comprising 5,000,000 acres; and that scheme is now in operation.

The birds that have suffered most, are the most useful. The magpie, even, one of our very best insectivorous birds, not only held its own upon the advent of the farmer but increased in numbers in all open forest country, until the poison cart came round. Like the laughing jackass, the magpie is an inquisitive, busy bird, turning over every bit of loose rubbish on the ground, and picking up anything that looks eatable; and the nice-looking pollard and phosphorus baits were just a nice morsel lying on the track in all districts where rabbit poisoning prevails. Except just round the township commons, one sees very few magpies at the present time. The Laughing Jackass has similar habits, and has suffered in a similar manner. The poisoning of water, as it is carried out in the Cobar district of New South Wales and other places, should certainly not be allowed. If poisoned water is necessary, it should be placed under such cover that no birds and other animals can get to it. The writer has been credibly informed that not only are scores of kangaroos killed, but that wild pigeons, quail, and many little birds, parched with thirst, fall victims to the enticing poisoned water. Another correspondent had seen many lizards dead around the poisoned water; and while the large monitor lizard, commonly called the "gohanna" in the bush, is one of the best killers of young rabbits, many of the smaller ones, such as the geckos, "Stump tails," and "Blue tongues" feed almost entirely upon flies and other noxious insects.

It may be necessary to scatter poison all over the land, but it is a deplorable state of things: and this method will some day be looked upon as having been a grave mistake, when so many useful checks upon insect life have followed the rabbit. There are insects that devour the larvæ of the sheep maggot-flies, such as the "devil's coach horse" (*Creptophilos erythrocephalus*), a black beetle with short wings and bright red head, often found under the remains of dead sheep; and also many ground carabs with similar carnivorous habits: but it is doubtful whether they have any practical value as a check upon the increase of fly maggots.

DESTROY THE MAGGOTS WHEN DRESSING THE SHEEP.

When blown sheep are being dressed in the paddock or sheep-yards—and the latter is the place where this operation generally takes place—the writer has noticed that, in nearly all cases, the operator, when he has shorn off the matted infested wool, throws it down upon the ground and there it is left. The more or less developed maggots in this infested wool crawl out and immediately bury themselves in the loose soil; there, they pupate within a few days; a week later, perfect flies will swarm out, ready to follow and reinfest the next flock that comes along from the paddocks to the drafting yard. When dressing blown sheep, **all maggoty wool should be carefully collected and thrown into a tin or bag, and scalded, burnt, or treated with some chemical solution,** such as Cooper's Dip, carbolic wash, or kerosene oil. It would be wise if all the sheep were placed upon a sheet or bag while being dressed, so that no escaping maggots would reach the soil, in which, by means of their curved jaws, they can very soon get under cover away from the ants and other enemies.

This is a very important matter in the control of sheep maggot-fly; for, under the prevailing conditions of most sheep-yards, where many sheep are handled and drafted, the soft soil of the yards protects swarms of escaped pupating-larvæ and pupæ: therefore, every time a flock of sheep is left standing in a station yard, it is at the mercy of the locally bred sheep maggot-flies.

KILLING THE MAGGOTS.

The question of finding some chemical, or combination of chemicals, that will kill the maggots in the wool by contact, or that will cause them to drop out and die, has been much discussed. The numerous experiments carried out, show that if it were advisable to kill the maggots in the wool, it is very doubtful whether any mixture has yet been discovered which will deal with them effectually, as a contact poison.

The dipterous maggots of this group, though they look so soft and helpless, are very tenacious of life; and even when soaked in

liquids, or smothered in poisonous mixtures that would kill many other insects almost immediately, these compounds have little or no effect upon the smooth chitinous skin of the blow-fly maggots. Many experiments have been carried out with various oils and other mixtures sent in for report and trial, and have been used under much more drastic conditions than would be the case when they were applied in the ordinary manner in the paddock. Fully developed maggots, given five to ten minutes' total immersion in most of these oils, have shown that, if the maggots are then removed and placed upon clean damp wool or damp earth, most of them will be found next morning clean and healthy, having worked all the oil off by contracting the segments of their bodies; and if further fed with food, they will develop into pupæ and finally produce flies.

Turpentine killed the maggots in seven minutes; but after remaining in kerosene for six minutes, and then being placed on clean earth, one out of the five maggots was alive next morning but did not live long enough to pupate. As might be expected, carbolic killed them in a few minutes. Placed in a solution of Cooper's Dip, at the strength of one ounce of powder to a pint of water, five out of ten maggots were alive the following morning, though they had been immersed for ten minutes before they were removed to the tin of clean earth. Another lot of ten maggots were placed in a dish of the same powder dry, and they simply crawled round and round in the glass dish all day; next morning it was found they had transformed into pupæ among the powder, but these pupæ subsequently dried up and produced no flies. A similar number were then placed on a dish of white arsenic, where they acted in exactly the same manner, and the only effect it seemed to have upon them was to hurry up the act of pupation. It might be noted that maggots placed and left under wool soaked in Cooper's Dip all night (of the same strength of solution) were all dead next morning.

It is evident, therefore, that it is a very difficult matter to kill well-developed fly-maggots with a contact poison, in the wool, upon the sheep. Even when they have been thoroughly wetted with the mixture, if they can work their way down into the untouched wool, they can get rid of the poison on their bodies in the same way as

when they wriggle out of the wool and drop to the ground. The eggs and freshly hatched maggots[1] are much more easily killed, as they cannot get away from their surroundings like the large maggots, nor is their skin so thick and tough. Therefore some mixture, such as carbolic wash or Cooper's Dip, is effective in the early stages of infestation, though of doubtful utility later.

CHEMICALS OR MIXTURES THAT WILL REPEL FLIES AND KEEP THEM AWAY FROM BLOWN WOOL.

We shall have to find a preventive mixture, therefore, fluid or powder, that will either keep the flies from dropping their eggs and larvæ upon the wool, or will destroy them before entering it. This is a question that will yet have to be perfected in the paddocks and sheep-yards, in conjunction with the chemist's laboratory and the naturalist's insectarium.

Nearly every pastoralist and farmer has some mixture that he swears by, but which the man in another district considers is not equal to his own specific. The same opinion applies to most of the oils, etc., placed on the market by business firms. The ideal mixture that we all want, is one that will not injure the wool nor yet be difficult to remove from the shorn fleece; one that will penetrate through the wool down to the skin, and while drying and driving out the taint, and smell, and maggots, will at the same time act as an ointment or salve to reduce the inflammation or heal the broken skin.

Many squatters, now, instead of dipping off the shears, let the sheep go for several months before dipping, in order that the fresh growth of wool may be sufficient to retain the residue, and protect the sheep from fly infestation for a much longer period. Dips containing arsenic and sulphur as the active poison, or mineral oils containing some form of carbolic as the active constituent, are most in demand; and these retain their virtues for a longer or shorter period, according to the climatic conditions of the district.

[1] It has been our experience that the eggs are extremely difficult to kill.—W. F. C.

In the southern coastal districts of New South Wales, a mixture of turpentine and Stockholm tar met with great favour, and is still extensively used. Mr. Rogers, of Berridale, thoroughly mixes two bottles of Stockholm tar, a kerosene tinful[1] of rendered fat, and a bottle of turpentine, applying it warm with an old paint-brush.

In the Riverina district of New South Wales, many use a strong solution of bluestone, a simple and easily made mixture which, they claim, dries up the soiled wool, removes the tainted smell, and is shunned by the flies; but it does not seem to improve the wool with which it comes into contact. Whale-oil and sulphur was much in vogue when the fly first made its appearance; but experience has shown that animal oils are not so good as mineral oils, and in some cases have an attraction for flies instead of keeping them away.

CRUTCHING.

Opinions are divided as to the crutching of sheep to protect them from flies; but while a great many of the sheep-men advocate and carry out crutching before shearing, Mr. H. H. Kelly, of Garrawilla, in a letter to the *Pastoralists' Review*, says that where dips are used, crutching should not be done. He says:—

"In the month of June in this year (1908), a number of my sheep were suffering from the attentions of the fly, and as it was a good many months since the ordinary dipping, and the protective qualities of the dip must necessarily have been becoming exhausted, I put into operation a plan which I had thought out. I had the ewe and wether hoggets treated in the following way (the breeding ewes were lambing at the time, and could not be so dealt with):—

"I had a trough prepared with a mixture of Cooper's Powder Dip, at the same strength as for ordinary dipping, and each sheep was taken hold of (much in the same manner as for shearing) and sat in the mixture for a few seconds till it had time to soak into the

[1] The kerosene tin holds 4⅛ gallons; and a "bottle" contains 1½ pints.—W. F. C.

wool covering the hind quarters. The sheep were then turned out without any further handling, and the result was that, in the case of those that had been blown, the maggots were poisoned and fell off, and those that had escaped being blown showed no signs of subsequent fly attack. The sheep were not crutched before being treated in the way I have described, so that there was plenty of wool to 'hold' the dip, nor did they need any special attention afterwards.

"At shearing, the wool that had been soaked with dip was found to have sustained no injury from discoloration or otherwise, although there was six or seven months' growth as compared with a month's or six weeks' growth at ordinary dipping. In the coming season, I intend to treat my breeding ewes in the same way, as near their lambing time as it is safe to put them through such a process.

"A wooden trough was used, and of course such can be made of any length, according to the number of sheep one wants to treat and the number of men one wants to employ at the work."

As the labour of dressing and re-dressing hundreds of sheep, all through the season, means a great deal more work and worry than running the sheep through a race and dipping trough, where each sheep is simply flopped down to wet its hind quarters, Mr. Kelly's method seems as though it could be adopted with advantage on many sheep stations.

In the case of a solution of chemicals which is wanted to remain in the wool as long as possible, to repel flies and keep them from striking the wool, such materials as arsenic and sulphur in combination under a hot sun would scorch any eggs, or any young maggots before they could get under shelter into the clean wool that has grown up from the skin.[1]

We have shown that the well-grown maggots, a week old, just before pupating, can stand almost any contact poison against their hard, stout skin; and that the smaller and more immature the

[1] I doubt whether arsenic or any feasible substance would "scorch" the *eggs*, or have any effect on them. I think that the ideal to be sought is to obtain a material which, remaining in the fleece, will kill the young maggots as soon as they hatch—for in that condition they are quite weak and easily killed. This opinion is based on a very large number of experiments carried out on the eggs of other insects.—W. F. C.

maggots are, the quicker they die and the less able they are to get away from the chemicals.

KILLING THE FLIES.

Catching and killing the adult flies is advisable, particularly about the homestead buildings; and a simple method of trapping them outside the windows has been suggested by Mr. G. A. Thorby, of Geurie, in the *Agricultural Gazette* of New South Wales (November, 1909):—"Make a trough of any light metal, such as zinc, tinned iron, etc., about 1½ inches wide and ½ inch deep, of a length sufficient to fill the width of a window, with the ends soldered in. Kerosene water and soapsuds[1] are poured into this trap, which is fixed along the bottom of the window outside, so that the flies buzzing against the glass or wire gauze drop into the mixture." Outside the closed kitchen and dining-room windows, this would kill numbers; but the writer is sure that in many places the width and depth are not sufficient. In fact, a section of ordinary tinned guttering, as used along verandas, with both ends soldered up, would not be any too large. The only trouble would be unhooking and emptying the trough whenever necessary—probably every morning in the summer.

Another correspondent suggested placing bits of meat in bottles, with some liquid in the bottom, and hanging them about among the fly-area spots; but he found a difficulty afterwards in cleaning out his bottles. Poisoned meat might be placed under a wire screen, so that the flies could get through but no birds or animals reach it; but here again, a dish of soapy or oiled water below any tainted meat, would kill more than poisoned meat, and be more certain and lasting; as, in summer, the meat would soon dry, and it would be difficult to keep the meat-ants away. We know that certain strong-smelling oils attract other kinds of flies; therefore, if we can find an oil attractive to blow-flies that could be put out in shallow tins, it would be a great factor in their destruction, and would not destroy anything else.

[1] One would expect that the soapsuds are unnecessary if the paraffin is there. Kerosene alone is used for other flies, particularly mosquitoes (see p. 67). It is the very thin layer on the water which prevents the flies from being able to get out of it, and which kills them. Or the soapy water alone might suffice.—W. F. C.

CONCLUSION.

In this report, the writer has gone into the matter from all points of view, and, while it is impossible to give a *cure* for the evil, suggestions may have been thrown out that can be acted upon by the sheep-owners that will to some extent mitigate the pest.

The following are the points under consideration:—Certain scavenger flies have acquired the parasitic habit of blowing the wool on live and otherwise healthy sheep.

We have found out the particular species of flies that have acquired this habit, and know something of their habits and life-history under their natural conditions as offal feeders.

Preventive methods are the first consideration. Keep the sheep as clean as possible, so that there is no tainted or dirty wool to attract the flies from the surrounding bush.

Secondly; clean up and destroy all the dead animal offal and fermenting matter, in which the maggots of these flies can feed and develop.

Thirdly; by experiment, find the best chemical, or combination of chemicals, that will keep the flies from coming near the sheep; or that will kill eggs and young maggots before they enter the wool; and that will retain its virtue for the longest time, without injuring the quality of the wool.

Among such an able body of practical men as the sheep-breeders of Australia, all on the trail of the blow-fly, aided by scores of chemical investigators all working towards the same end, a solution of the difficulty will surely follow. Now that our enemies have been defined, their habits understood, and we have some idea how to fight them, the blowing of wool has been taken in hand—a serious trouble, but one that can be attacked and conquered, just as in the early history of sheep-breeding in Australia sheep scab was taken in hand when it threatened to paralyse the industry and wipe out our flocks. Australia, in the present day, is one of the very few sheep-growing countries in the world where sheep scab has been eradicated.

WALTER W. FROGGATT.

SECOND PRIZE ESSAY

(ABSTRACTED)

By J. L. F. WOODBURN,

Cullingral Station, Merriwa, N.S.W.

THIS writer considers that the fly trouble has been *consequent* upon the destruction of rabbits, and not *coincident* with it; that the wholesale poisoning of a large number of rabbits one year would not aggravate the fly trouble in the *same* year, but only in a year or two subsequent to it, since it would take that time for the flies to multiply to the extent necessary to cause them to be an actual menace to grazing. This may account for some of the discrepant statements on the relation of poisoned rabbits to the increase in flies.

Special attention is drawn to the "hairy" maggot, and it is pointed out that this is one of the worst; it is more active, and, eating its way into the flesh, it gives rise to sores which are very attractive to other flies.

On this station, the fly trouble is worst in August to October, if the sheep are not shorn by then; but it is bad from March to June. Sheep that are badly cut in shearing are sure to be blown; such sheep are almost certain to die unless they receive careful and prompt attention.

Attention is drawn, also, to the effect of green pasture, causing scouring and making the sheep more attractive to the fly.

The fly attacks ewes, lambs, and weaners, and merino sheep especially. A case is cited where on one station, running merino wethers only and no ewes, the fly trouble does not exist; on an adjoining station, running breeding ewes, the fly is a constant source of trouble.

Wrinkly sheep are more liable to attack than plain-bodied sheep. Wethers are affected less than ewes, as is evident by the following figures:—

	Merino wethers (3,000), showed loss of...	1 per cent.
6,000 weaners, consisting of	Merino ewes, showed loss of	40 ,,
	Merino wethers, showed loss of	3 ,,
	Cross ewes (Lincoln-merino), showed loss of	15 ,,
	Cross wethers, showed loss of	None.

Cross-breds are more intelligent and more able to resist attack; they are less liable, also, the wool being more open and not retaining the urine to the same extent.

A matter of very considerable importance is contained in the following paragraph:—"A sheep that has been badly attacked by flies will often strip its wool as completely as though it had had wool fever. Even if it does not strip its fleece, a break in the fibre shows the bad time that the animal has passed through, and tender wool is less valuable than sound."[1]

If the sheep are not attended to, the maggots travel away from the crutch, spreading over the body of the animal. The wool where they have worked becomes hard and useless, and, if not removed, usually falls away in time.

Dressings. The measures adopted "have been numerous and the failures many." Carbolic and turpentine have been found most effective dressings.

The dressing usually applied is:—

Carbolic	1 part.
Stockholm Tar	2 parts.
Kerosene	3 parts.
Castor or Whale Oil... ...	4 parts.

This is applied with a mop to the shorn parts.

1 Some samples of Australian wool show a very serious break; in some cases this is so great that the wool parts entirely when the dirt surrounding the weak place is removed. In other cases, the break is not so great; but an examination shows that the fibre becomes thinner, and has the character termed "tender." The effect upon the wool is being considered by us, and will doubtless be the subject of another communication at a later date. Reference is made to this same point in several of the essays.

An article on "Faults in Wool," by a Bradford correspondent, appears in *Dalgety's Review*, 1910, p. 104, where the weakness is mentioned; but this cause of trouble is not mentioned, though it is generally recognised by the essayists.

Information is given on the use of sixteen mixtures, the chief of which seem to be the following:—

No. 1. *Kerosene* will kill the maggots and is a good healing agent; but it does not cling to the wool long enough to kill the maggots if the sheep is blown again.

No. 2. *A Saturated Solution of Copper Sulphate* has the same good qualities and the same defects.

No. 3. *Turpentine* will kill speedily, but it is too severe when used alone.

No. 4. The same applies to *Carbolic*.

No. 5. *Stockholm Tar*, if used alone, causes a hard scab on the part, and ulcerous matter forms beneath.

No. 6. A mixture of *Turpentine* 1 part, and *Castor* or *Fish Oil* 5 parts, is a good dressing for killing the maggots and healing the wound; but from experience here it will not hold long enough to prevent the fly blowing the spot again.

No. 8. Any kind of *Fluid Dip* used in a dilute form, 1 part to 25 or 30 parts water, will kill the maggots and disinfect the wound, but here again the same difficulty arises:—the fly will blow the same part again, and the maggots will live.

No. 9. *Powder Dips* used according to directions have the same result.

No. 10. ———'s *Fly-Blow Oil* has been tried, but has not proved effective.

No. 11. The use of ———'s *Fly-Blow Oil* has been attended with similar unsatisfactory results.

No. 12. A neighbour in this district has adopted the use of a fluid dip in the above-mentioned strength, followed by a dressing of *Castor Oil* and *Kerosene in equal parts*, together with sufficient *Lamp-black* to give the mixture a honey-like consistency. It was argued that the maggots would not live in lamp-black, but that where it was applied in a mixture they would work their way out at once. It was found to be quite ineffective, however.

In the course of numerous experiments, it was found that something was needed, that would remain in the wool for a time and kill any maggots that might be deposited after the animal had been dressed.

No. 14. The substitution of *Sulphur* for *Tar*, in the above mixture, produces a very good dressing.

No. 16. *Tobacco*—1 lb. to 4 or 5 gallons of water—has been used, but has not been given sufficient trial to make any definite statement as to its efficacy.

The best plan of meeting the trouble, is by **Crutching** during March. Stress is laid upon the necessity of doing this thoroughly and properly. The track of the maggots must be followed up, "*even if it means, as at times it does, that the sheep has to be nearly half shorn.*" The use of the machine is better than hand shears.

Early Shearing is advocated in this essay, as in most of the others. This commenced on September 6, 1909, on this station, and "it is intended to make an earlier start next year."

Dipping is widely advocated for the prevention of the trouble. It is certainly a precautionary measure, and its beneficial effect upon the wool is undisputed; but its effect in warding off the attacks of the fly, do not appear to be very great. From the writer's experience, it cannot be claimed that it is worth while to dip *solely* for the relief of the fly trouble; its value from the wool point of view is quite a different question.

The Burning of Carcasses is especially mentioned as being a necessary and essential operation on all stations. It is, also, pointed out that the offal-tip near the slaughter-yard often serves as an admirable place for breeding.[1]

The Poisoning of Rabbits is considered as follows:— It is essential that the rabbits should be checked. Poisoning is the only practical method; therefore poison. But do it so thoroughly that the rabbit is practically exterminated; then the necessity for continual

1 This is a matter which should receive careful attention, and reference is made to it on pp. 37, 38. It is a simple matter to treat such places, without any trouble.

use of the poison cart is removed. In short, *united, determined, and thorough action by the whole of the country*—laws being passed to force united co-operation—is the first step towards the solution of the fly trouble.

Mr. Woodburn considers that the poisoned rabbits which return into their burrows and die there become an inaccessible breeding-place for flies.

The breeding of **Plain-bodied Sheep** is advocated as being less attractive to the fly.

As to the **Destruction of Birds** and other enemies, Mr. Woodburn points out that whereas, on the one hand, there are districts in Victoria where the starlings are numerous, and where the fly trouble does not exist; yet, on the other hand, there are districts where this bird abounds, and where the fly is a serious pest.[1]

[1] An aspect of the question which appears to be of considerable importance is considered in this essay, namely, the enormous destruction of forests which has taken place in Australia. With some knowledge of the extraordinary alteration in climate and fertility which occurred in Russia, Norway and Sweden, America, and other places, it is a matter of no surprise that Australia suffers so much from droughts.

For general information, attention may be drawn to two of the best known instances. In Russia, certain areas of the Steppes were renowned for their fertility. The hills bounding these areas were covered with large forests, but the trees were felled for timber, so that the hills were made bare. As soon as this happened, the land which was so fertile previously, became barren and useless; but the Government insisted upon replanting the hills, with the consequence that the plains gradually recovered their fertility.

Again, the Mississippi River was not known in the old days to be very erratic in its floods; but, as time went on, the character of the river seemed to change, the floods became so excessive as to break down the banks, causing tremendous damage and loss of life. Investigation showed that this was due to the enormous and excessive felling of trees which had taken place around the sources of the river. The Government insisted upon reafforestation of this land, with consequent improvement in the conditions of the river. This point of the question alone is one which should engage the earnest attention of the pastoralist and the Government.

But the effect of this elimination of the forest-lands upon the insect life is one of very great importance also. Unfortunately, however, it is one which does not appear to have been so closely studied. Upon its effect on the climate, and the fertility of the soil, a very great amount has been written and published, but its effect on the insect life has received too little attention. Mr. Froggatt deals with this and points out that the loss of trees means the loss of birds, loss of nesting-places. The insect and animal life varies and alters according to any change or variation in conditions; when this is slight the variation in the fauna may be indistinguishable, but where the alteration, due to the loss of the forests, is as great as it is in Australia, the modification of the fauna of the country must be great. It must be remembered that birds are not the only enemies of the fly; spiders, dragonflies, etc., also kill off great numbers.

The ordinary **Red** or **Sugar Ant** is a great enemy of the maggots and pupæ, and is of some assistance in the control of the pest.

To summarise, Mr. Woodburn advises :—

1. Destroy all carcasses.
2. Destroy all wool containing maggots.
3. Crutch all ewes.
4. Shear early—as early as possible.
5. Apply the best remedy available.
6. Protect and encourage insectivorous birds. (Plant trees and encourage reafforestation.)

He also advocates :—

A. If the district is a bad one for flies, run wethers ; it pays as well as ewes, in spite of any superstition to the contrary.

B. Breed cross-breds rather than merinos.

C. If breeding merinos, cull the wrinkly ones.

D. The wool round the crutch might be destroyed by potassium sulphide and lime.[1]

[1] This method needs some care in application, and seems scarcely advisable. Potassium sulphide is quite cheap, and is improved, as a depilatory, by the addition of lime. Lime and sulphur mixture is also an excellent depilatory, for which purpose it should not be diluted. If great care is not taken, however, the skin will be cauterised and made to crack and become raw.

THIRD PRIZE ESSAY

(ABSTRACTED)

By A. E. McLEOD and J. B. HOLME,

Canonbar Station, Miowera.

THESE contributors give some details as to damage, on the estimate that the number of breeding ewes in New South Wales in 1909-10 was 17,000,000:—

Loss in Sheep, direct or indirect, on account of the pest, supposing 10,000,000 are handled—1% at 10/- each	£50,000
Loss of Wool, from actual damage or from travelling —½ lb. per sheep, @ 8d. per lb.	166,000
Expense of Treatment—5/- per 100 sheep	25,000
Loss of Lambs, caused by disturbance, handling, etc. —5% on 7,000,000 lambs=350,000, @ 4/- per lamb ...	70,000
Loss of Ewe Weaners	8,700
Loss of Wool from 3,500,000 ewe weaners, at ½ lb. per head, @ 8d. per lb.	58,000
Total loss to the State per annum	£377,700

(*This figure does not include loss in other States.*)

Considering the propagation of the flies due to dead rabbits, the writers point out that in 1889 and 1894 the rabbits "lay dead in millions in the Lachlan and S.W. Riverina districts, yet the fly trouble did not exist at that time. Again, the fly appeared in 1899 and 1903, when practically no rabbits existed anywhere."

The writers state also that in North Queensland, "where no poison cart has ever been used, and where rabbits are non-existent," the blow-fly abounds. On the other hand, on the Meryula station, in

the Cobar district, "where the poison cart has been in constant use for twenty-five years, the fly trouble is practically unknown."

In cases of long-standing neglect, the maggots enter the natural orifices and continue their work within the body of the animal. A sheep thus attacked will die within a fortnight.

In one year on Canonbar, an extensive pastoral property situated in the Central West of the State, fully 60 per cent. of the March shorn sheep were attacked, in spite of all usual precautions. A later shearing has therefore been adopted upon that station, with improved results.

The fly varies its attacks, usually selecting the ewes and newly shorn lambs. It may attack the weaners and leave the ewes untouched; at other times it attacks the ewes and not the weaners. The writers state that "it is a remarkable feature that ewes in lamb are not so liable to be struck as those that are dry."

The chief preventive measure is "crutching" and dressing.

As to an efficient dressing, the writers are doubtful as to whether such exists, but they consider bluestone to be the best—2 lbs. to 4 gallons of water, with some soft soap. It must be carried in wooden vessels and applied with a mop.

"Dipping is in many ways a valuable adjunct to the process already described."

The searing of lambs' tails is objected to, as the smell of the burnt flesh is an additional attraction to the fly.

This essay contains an account of treatments with fifty-two different mixtures. It is felt, however, that no useful object would be attained by printing them in full, and it is impossible to abstract them. Such as might be of use are mentioned later.

PART III

REMEDIAL MEASURES

THE pastoralist will be interested, more particularly, in ascertaining what information has been obtained from the essays concerning measures :—

1. For preventing the attack.
2. For treating the struck sheep.
3. For killing the maggot.
4. For exterminating the fly.

In scarcely any essay are these four points separated. In most they are inextricably involved, and some writers go into the matter in such detail as to bewilder the reader.

It is difficult to convey the information contained in the whole of the essays, since the number of remedies is so great. The number of mixtures which have been proposed or used, as remedies or preventives, is very great; many differing but slightly in composition, the proportions of the ingredients varying so little in different mixtures, yet having so wide a range of variation, that it would serve no useful purpose to give them all.

If there were general agreement as to any material being useful, or even as to any that were useless, some definite conclusions might be arrived at; but there is a wide difference of opinion on every material or mixture that has been tried. For example, some writers say that carbolic acid is an excellent material for a dressing, others say that it attracts the fly and so aggravates the trouble; similarly with turpentine, tar, kerosene, and others—some consider these excellent, others state that they are useless.

The substance which finds most general favour, as a remedy, is a solution of *copper sulphate or bluestone*, though some writers condemn it. The proportions most generally used seem to be ½ lb. of bluestone to 1 gallon of water. Some advocate the use of soft soap in the water; but this can scarcely be advisable, as the copper would form an insoluble compound with the soap, which would not be likely to be of much use.

Turpentine is in fairly general favour, but many point out that its effect is too severe.

Several writers use *fish oils* in their mixtures. Others, however, point out that the smell of these oils attracts the fly; this is what one would expect, but it must be remembered that the "fish oils" differ very much in their smell and composition. Mr. Froggatt mentions, also, that such oils sometimes attract the flies (p. 45).

Tar seems to have given divergent results; but this may be accounted for by the variation in the constituent chemicals contained in the tar. One great objection to tar is that it would stain the wool; and wool treated with it would stain and damage other wool in the same bale, unless it were carefully sorted out at shearing.[1]

Experiments at Quambone Station, N.S. Wales, extending over many years, made with various materials at different periods, showed that *dipping* in a bath prepared from an Arsenic-Sulphur Sheep Dipping Powder, gives the best and longest protection of anything, especially if the dipping is carried out immediately before the fly season. The dip should be used at the strength recommended for dipping for "Tip and Wool" (that is to say, with Cooper's powder, 1 packet to 150 gallons of water), and the sheep must be kept in for the full time—one minute.

Some writers advocate rubbing a "poisonous dip" on to the maggots and the wound. This treatment, however, must be condemned as being dangerous, both to the sheep and to the men.

1 This point has been referred to by several wool authorities. In *The Wool Record*, 1910, Aug. 4, for instance, it is pointed out that the English Wool-Buyers' Association has repeatedly called attention to this point. It is said that Bradford lost £100,000, annually, owing to the use of tar for marking sheep.

A few writers have tried *spraying* the sheep, and some remarks, here, may be of value. The method of spraying has come into general use in South Africa, but for *spraying of cattle against ticks.* It must be observed that the treatment of cattle against the tick-pest is entirely different from the treatment of sheep. Cattle are clothed with short, thick, open hair; sheep are covered with comparatively long, fine, dense wool. In cattle, the hairy clothing is of no value at all and need not be considered; in sheep, the wool is of great value and must be considered as much as anything else. Cattle are easily wetted with a spray, as they run through a race; sheep, however, are very difficult to wet, partly on account of the length, and of the fineness and denseness of the wool, partly because the wool is provided with grease which prevents the wool from being wetted. It must be remembered that, in order to obtain fine wool, one must have a fine and delicate skin; consequently, fine-bred sheep are delicate and easily influenced by slight alterations in their condition, so that nature provided them with a natural grease to prevent them from being wetted, lest they should "catch cold." But, even in the case of cattle, spraying is not so efficacious a method as dipping, as has been found by the present writer from a large experience in South Africa; it is specially useful for short-interval treatment (three or five day interval), when the possibility of damage to the cattle from the dipping has to be taken into account. Nevertheless, it is by no means impossible that spraying may be found to be of value for sheep.

Of the materials suggested or tried by the essayists, those which appear to be most valuable are given below; others have been given in the abstract of the essay by Mr. Woodburn.

ABSTRACT OF REMEDIES, OBSERVATIONS, ETC., FROM THE PRINCIPAL ESSAYS.

PROCEDURE, SUBSTANCES, OR MIXTURES RECOMMENDED.

ESSAY No. 1. Raw Turpentine.

A mixture of:—

Rendered Fat ...	...	1 kerosene tin
Stockholm Tar	...	2 bottles
Turpentine ...	...	1 bottle
Carbolic ...	...	3 ozs.

Sheep Dip.

Some eight or nine other mixtures.

ESSAY No. 2. Fish Oil attracts flies.

Dip the sheep.

Kerosene and Sulphur.

ESSAY No. 6. Copper Sulphate, 3 lbs. to 10 gallons of water, is not effective.

Carbolic Fluid.

Same mixture as Essay No. 1, without the carbolic.

ESSAYS Nos. 7 and 8. Careful dipping.

ESSAY No. 9. Change of paddock.

Kerosene.

This writer uses:—

Kerosene ...	...	...	12 parts
Stockholm Tar	...	...	5 parts
Turpentine ...	...	...	7 parts

But he states that, though under certain weather conditions this has proved highly satisfactory, yet, in wet, muggy weather, the flies seemed to blow in a few days after the application.

ESSAY No. 11. Tar and Turpentine only kills live maggots.

ESSAY No. 12. Solution of Arsenic and Soda, as dressing.

ESSAY No. 16. Dipping with poisonous dip, or spraying of the hind-quarters of the sheep. Several writers seem to have tried spraying (see pp. 59, 61, 62, 64).

Essay No. 19. 10 to 15 lbs. of Sulphur, to 1 bag of coarse salt, as a lick.

Dipping in a Sulphur dip.

Sulphur keeps the flies away; Carbolic attracts them.

Essay No. 20. Tried Iodoform, amongst other things, but found not to be lasting.

Essay No. 22.

Stockholm Tar	1 gallon
Spirit Turpentine	½ pint
Castor Oil	1 pint

As a dressing, this was found to be the best.

Essay No. 24.

Fish Oil	2 parts
Sulphur	1 part
Tar	1 part
Turpentine	2 parts
Linseed Oil	1 part
Little's Sheep Dip	½ part

This was very satisfactory as a dressing. But many mixtures are given in various proportions.

Corrosive sublimate was used, in water, and also in alcohol, for killing the maggots.

Essay No. 26. Change of pasture and dipping after shearing.

Essay No. 30.

Whale Oil	1 gallon
Iodoform	1 oz.
Sulphur	1 lb.
Stockholm Tar	1 pint

One quart of Castor Oil to be added when the wool is cut off very short. This mixture was good and lasted longer than any other mixtures tried.

Essay No. 31. Spray with a poisonous sheep dip, after crutching.

Essay No. 36. Kerosene not advised.

Essay No. 38. Suggests a weed "Stinking Roger" (*Tagetes glandulifera*) in conjunction with a poisonous sheep dip.

Essay No. 42. Poisonous sheep dip satisfactory as a preventive.

Carbolic dips, although good for killing the maggots, seem to attract the flies after a few days.

Essay No. 43. Bluestone and Sulphur, dusted on, gives best result.

Essay No. 45. Extermination of rabbits by a special plan.

Essay No. 46. Dipping, two to three months after shearing.

Essay No. 47. Suggests *rubbing* a poisonous sheep dip into the shorn hind-quarters—the dip to be used dry. (This would seem to be a very dangerous process, both for the sheep and for the men.—W. F. C.)

Essay No. 49. Uses Taylor's Chemical Fly Powder on the crutched sheep.

Essay No. 50. Carbolised oil for wounds.

Crutch and spray with double-strength Dip, a month before lambing; most successful.

Essay No. 51. Suggests the use of Pitch 1 lb., and Beeswax 1 dm., melted together and spread whilst warm with soft leather. This is to be applied to the head (of rams) when they begin to get sore.

Essay No. 53. Dip in strong sulphur dip after shearing. Then, four days later, dip in salt water of a strength equal to the brine used for canning meat.

Prefers powder dips, because the powder is objectionable to the maggots. Has used dry ashes, even, with splendid results on struck sheep.

Essay No. 55. Has used almost everything which is mentioned in any essay. Says that none are efficacious after six weeks, and some not so long. But states that an oleaginous dressing with a strong disinfectant is best, while it lasts; it does not damage the wool like tar, bluestone, etc.

This essay is by an inspector of stock, and he lays special stress upon the fact that a large number of carcasses are left to form breeding-places. "I have seen carcasses of horses, hundreds of carcasses of cattle, and thousands of carcasses of sheep left to rot and putrefy." Many essayists deny that the bodies are left about. But this inspector should have a wider experience and knowledge. So that it may be taken that, generally speaking, carcasses are left lying about.

Strongly advises killing the flies by poisoned baits.

Essay No. 58. Used tobacco water and tar or turpentine. If this not available, then wood ashes rubbed in, to dry the sore.

Essay No. 61.

Raw Linseed Oil	8 ozs.
Sulphur	4 tablespoonfuls
Stockholm Tar	4 to 5 tablespoonfuls

"This is said to be sufficient to dress 800 to 900 sheep."

Also suggests that, where practicable, the sheep should be shorn early in the year—as in Queensland. The best time would be to shear in March and dip in April.

Essay No. 64. Suggests that it is the grease in the wool that attracts the flies, therefore avoid oily mixtures. There is always sufficient yolk in the wool to neutralise any ill-effects due to a dip having too drying an influence.

Essay No. 65. Suggests Friar's Balsam.

Also quotes Martin's remedy (an English writer of 1858) :—

White Lead	4 parts
Arsenic	1 part
Sulphur	6 parts
"Cinnabar of Antimony" ...	2 parts

Well mixed together and sprinkled on the maggots.

Found that Carbolic Acid attracted the flies.

Essay No. 70. Used corrosive sublimate and salt, with some soft soap.

Enclosed Bulletin 12, N.S.W., by J. A. Gilruth, who points out that when crutching, the maggots strive to creep into the unshorn wool; that these must be followed out; that these maggots, left in the wool, may give rise to the supposition that the sheep have been "struck again."

Dipping essential.

Essay No. 70. Strongly advocates leaving the tail longer, as a preventive.

Essay No. 73. This essay summarises the measures as follows:—

(*a*) Kerosene kills maggots, but has no lasting effect.

(*b*) Fish Oil good for killing maggots; but it lowers the value of the wool.

(*c*) Arsenic kills the parasites easily.

(*d*) Turpentine too severe.

(*e*) Carbolic excellent, but must not be too strong.

(*f*) Corrosive sublimate in alcohol, spirits of tar, and quillaia bark, seems to be the most efficacious.

Essay No. 75. Dipping in poisonous dip greatly diminishes the trouble.

As a dressing for lambs:—

Fluid Dip	1 gallon
Powder Dip	1½ packets
Water	100 gallons

This was used on 20,000 lambs and found to be "unsurpassable."

Essay No. 76. Dipping in poisonous dip.

Dressing composed of:—

Sulphur	2 parts
Sheep Dip	1 part
Turpentine	1 part
Castor Oil	1 part
Water	6 parts

Essay No. 79. Kerosene and Stockholm Tar not satisfactory. Spraying with powder dip effective.

CRUTCHING.

Upon the value of crutching, nearly all are agreed; and the greater number of essayists draw particular attention to the necessity that it should be performed properly, in order to be effective.

Messrs. McLeod and Holme give very concise details, as follows:—

"*The operation of crutching should commence from well below the hocks, and should be carried out so as to bare the legs to a point a couple of inches above the hocks. It should then be continued upwards upon and within vertical parallel lines distant at least four inches on either side of the vaginal orifice, and sweeping to a point an inch above the butt of the tail.*"

Photographs were sent, showing the correct and the incorrect method of crutching. Unfortunately, however, these are not suitable for reproduction; Mr. Johnson, from Quambone, who was recently in England, sheared some English sheep, following, as exactly as possible, the directions and illustrations given by Messrs. McLeod and Holme. Photographs of these sheep are reproduced below (Figs. 16 and 17).

Fig. 16. Crutching. Incorrect method.

Fig. 17. Crutching. Correct method.

Most writers lay emphasis on the fact that where the maggots have travelled along the back, or elsewhere, they must be followed and traced right out, the wool being ruthlessly shorn off where they have penetrated.

Machine shears are preferred to hand shears.

Most writers, but not all, agree that some dressing should be applied after crutching, even if only grease or oil.

(See, also, Mr. Froggatt's remarks, p. 45.)

EFFECTS OF KNOWN SUBSTANCES ON FLIES AND MAGGOTS.

This matter is of the greatest importance in connection with the control of the pest, and it should be the first to be dealt with. Yet it does not seem to have been considered in detail by any scientific worker. Of all work, that of Herms (1911, p. 538) seems

to be the only one which deals with this aspect of the problem, and then only in relation to the dissemination of disease by flies.

As has been mentioned elsewhere, flies are very "peculiar" in their tastes and senses, and this is a point which should be carefully impressed on the minds of those who are making experiments with a view to finding some good means of eradicating or of controlling the pest.

That flies have a peculiar sense of smell, is shown by the fact that they are unable to detect the smell of formalin, which, at the same time, is very poisonous to them. So also, it has been mentioned that they are very easily attracted to the segments of tape-worms.

In connection with this, also, the well-known use of paraffin in controlling malaria, may be mentioned. (See Nuttall, 1899, p. 115, for references and notes.) This substance is allowed to spread over sheets of water, so that when mosquitoes settle on it to lay their eggs, they are "wetted" by the oil; consequently, they are no longer able to rise from the surface, and therefore die.[1] In this case, the paraffin does not prevent the flies from settling on the water, and it seems obvious that they cannot smell it.

It is desirable to know what substances attract the flies, as well as those materials which they do not like or which kill them; and the same is true of the larvæ or maggots. If one can find materials which have a great attraction for the flies, it might be possible to devise traps which should attract and kill them. This has been suggested in several of the essays, the material proposed being arsenicated meat or meat-juices.

The elucidation of the effects of known substances on the flies and the maggots, should be the first step towards devising a means of

[1] To prevent any misunderstanding, it would be well to point out that paraffin is useful in controlling the mosquito, on account of another property. The larvæ of the mosquito live in water; but they rise to the surface, periodically, to breathe. To do this, they spread out a sort of circular "fan" of hairs from their posterior end; this enables them to remain suspended from the surface, "head downwards," and to breathe air through the centre of the "fan." The paraffin prevents them from suspending themselves from the surface of the water; so that they sink to the bottom, and are actually drowned.

checking the pest ; but it should be undertaken by those who have a good knowledge of chemistry and some knowledge of the biology of flies. Most especially, it ought to be undertaken only by those who have had some experience in making such experiments—a matter which is seldom considered sufficiently by the non-scientific man. To conduct reliable experiments of this nature is a matter of the greatest difficulty. Much work of a similar class has been carried out in the Watford Laboratory ; and it has frequently been found that at one time results are obtained which appear to be most conclusive, yet, when the experiments are repeated, the result is almost the reverse of that obtained at first. It is felt that it is most necessary to emphasise this point, and the desirability of confirming results by *repeated* tests.

Several of the essays contained results of experiments which had been carried out ; but, almost invariably, it was obvious that insufficient attention had been given to this point. Far more would be achieved, if only a few substances were tried, and these tried repeatedly—at different times of the year—on different grades of sheep—the sheep grazing on different pastures—and particularly, on a large number of sheep at each trial. Also, in keeping records of experiments, it is always advisable to make notes of every circumstance that may, in any way, affect results.[1]

MISCELLANEOUS NOTES ON REMEDIES.

An account of methods of dealing with the house-fly problem is given by Herms (1911, p. 538). This is in relation to the disinfection of stables and, more especially, of dung heaps and refuse ; but the same points apply to the treatment of refuse and carcasses in Australia. It should be observed that every small refuse heap, every piece of waste meat, etc., near a house may form the breeding-place of a large number of flies—not house blow-flies only, but other blow-flies also. The following short abstract of Herms' paper may be suggestive.

[1] It is scarcely necessary to add that all possible assistance, in any work proposed, will readily be given by this laboratory ; whether in criticism, or in suggestions as to what might be tried, or as to how the work might be carried out.

Poisons are: "contact poisons," which operate by contact with, or absorption through the skin, as kerosene, cresol, chloride of lime; or "stomach poisons," which, in order to be efficacious, must be swallowed with the food of the fly, as the arsenic compounds (lead arsenate, Paris green).

These last, he states, are too dangerous to recommend for poisoning dung heaps, dead carcasses, etc. Newstead (1907) recommended *arsenic compounds*, however; 2 oz. of Paris green to 1 gallon of water (an arsenical dip should suffice equally well). Newstead recommended, also, a 1 per cent. solution of *atoxyl* in water, and found that it killed all the flies. Atoxyl is a peculiar compound of arsenic, but the price of it renders it prohibitive for this purpose.

Chloride of lime is too expensive to be used efficiently. *Kerosene* is considered excellent by Herms, in America; but here again the difference in cost between kerosene in California—near the oil-fields—and in Australia, would be considerable.

Herms gives a formula for preparing a *cresol emulsion*[1] in linseed potash soap. He dilutes this, so that there is 1 part of cresol in 40 or 50 of water. This, he states, is the best material to use. Any disinfectant could be used instead of this preparation (which takes five to six hours to boil and three to four days to make) and would be far cheaper. But such a preparation *should be diluted according to the content of cresol. For this purpose, makers' directions for use as a disinfectant should not be observed*, many of the best disinfectants containing only a comparatively small quantity of cresol. A "high coefficient" disinfectant, for instance, should be diluted very much less than an ordinary common disinfectant, for this purpose.

A suggestion which may be of interest, is that it is stated that 20 drops of carbolic acid dropped on a red-hot shovel will kill all the flies in a room. So that, when carcasses are burnt, it might be well

1 "Cresol" is the term applied to a mixture of substances very similar to carbolic acid. It is generally held that it is more poisonous to lower forms, than to human beings. Whether cresol would be more effective than carbolic acid, when used on maggots, or against flies, it is not possible to state.

to sprinkle some strong carbolic fluid on them—since it is seldom that the whole of a carcass is properly charred.

Herms points out that *tobacco* decoctions are absolutely useless, as the larvæ thrive in the most concentrated.

Howard (1912, p. 175) discusses remedial measures, but he gives very few suggestions likely to prove of much value in combating the sheep blow-fly pest.

Chloride of lime is out of the question, as it would probably be so very injurious to the wool; also the quantities required seem to be fairly considerable.

Iron and copper salts, applied to the whole fleece, are also objectionable, as they would give rise to a very objectionable stain, which would be difficult to move. But even worse than this, they would give rise to a very great liability to deterioration of the finished woollen product. For it has been shown that iron and other oxides, but particularly iron oxide—the yellow stain or "iron-mould" produced in a cloth by ink is such an oxide—cause very rapid deterioration, and final destruction, of woollen and linen fabrics.

Lime, in any form, is objectionable, for two reasons. In the scouring process, the wool is treated with soap. This soap would form an insoluble mass with the lime, which is most objectionable to the dyer, for it makes it almost impossible for him to obtain even colours in his yarn or cloth. Also, a very small quantity of lime on the fibre of wool gives very uneven colours with certain dyes, and for this reason many dyeing baths are made up with other chemicals to counteract any such tendency. Attention is drawn to this, by Beech, in his book on the "Dyeing of Woollen Fabrics."

Though *lime* (Calcium Oxide or Calcium Hydrate) is objectionable on wool, yet it is possible that precipitated chalk (Calcium Carbonate) is not so objectionable. Lime is an oxide and a base, and wool has the peculiar property of combining with, or "adsorbing," such compounds; then they are very difficult to remove, and in that form they combine with soaps and dyes. The carbonate, however, is not basic, and, as far as can be ascertained, is not "adsorbed" by the

wool ; it does not combine with soaps, nor does it appear to affect dyes, or, at any rate, not to the same extent as the lime.[1]

The point is not without interest to the pastoralist. If certain essential oils, or certain chemicals, such as terpenes, oil of mirbane, creosote, cresols, etc., are found to be efficacious in killing maggots, or in preventing blowing, then it will be necessary to find some very cheap diluent for them, since they could not be applied undiluted. Water alone seems to have a serious effect on the wool under certain conditions, though of this we are not sure ; oils are costly and do not seem to be particularly advisable. On the other hand, precipitated chalk is very cheap and easily obtained ; its application appears, from our trials in the laboratory (and we know the objections to these), to be quite easy and effective. By the use of air, it can be blown on to the sheep, and apparently penetrates very well ; if it were efficacious, it would have the further advantage that it could be applied to a mob of sheep without removing them from the paddock.

At any rate, the suggestion of the use of this material is put forward, as being quite new and as offering a means of overcoming certain practical difficulties.

Howard (1912, p. 189) suggests *Laurel Oil* as a preventive, and points out that it is used by butchers in Geneva. Sampson states that oil of lavender or eau de Cologne keeps gnats off. Other essential oils have been used as a remedy for the pest ; but, apparently, with indifferent success.

Pyrethrum—the chief constituent of most insect powders—is also mentioned. Howard refers to the necessity of obtaining *pure* powders.

With regard to *Quassia*, though many workers have recommended this for a large number of pests, Lounsbury fed flies on sugar containing quassia, and he found that they did not object to it in the least. It has been our experience, too, that it is quite useless.

[1] The precipitated chalk could be removed from the shorn wool very easily, also, any common acid would suffice, even sulphuric acid, as the calcium sulphate would be washed out in subsequent treatment. Most dye-baths for wool, too, are kept acid, so that the precipitated chalk would be removed in that process.

Sticky papers, or strings, are easily made. Drying oils, best of all, linseed oil, become thick and sticky when boiled. Heat linseed oil for some time in a flat open dish, or iron tray, until it becomes dark and thick; then draw pieces of string through it and allow it to cool; or let it cool and spread it on paper. Or the thick oil can be purchased from printers, or printing-ink manufacturers, as "treble blown oil." This is light coloured, but thick and sticky.

Before concluding, it might be well to refer, very briefly, to the value which children might be in the work against flies. A very interesting account is given by Howard (1912, p. 224) which everyone ought to read, even if only in consideration of the spread of infectious diseases. It is pointed out that the natural "cruelty" or tendency to torture flies, possessed by almost all children, can be turned to very good account. In the fight against the mosquito, almost phenomenal results were obtained in San Antonio, solely by means of children. Is it not possible to adopt the method in Australia, or to make some use of the suggestion?

Beyond these, very few suggestions can be obtained from the large mass of literature which has been read. It is a subject which should be very much more carefully studied. Until that is taken in hand, in a careful and systematic manner, nothing more can be said. So that one must hope that the notes above may be of some assistance in the fight against this most serious pest; and we can only trust that this publication may be of some assistance to that end.

PART IV

WHEN IS THE PEST MOST SERIOUS?

THE seasons when the flies are most serious, vary in different districts. Nearly all the essayists have mentioned the periods when the pest is most troublesome in their areas; and from these figures the following table has been drawn out.

In this table, a short line has been drawn where the months are definitely mentioned, and a long line where the seasons only are mentioned. From an examination of the table, it may be seen what agreement or divergence of opinion there is between different essayists in the same district—Nos. 6, 22, and 61, for instance.

Essay	District.	Dec. Jan. Feb. Summer.	Mar. April May Autumn.	June July Aug. Winter.	Sept. Oct. Nov. Spring.	
1	New England (N.S.W.)				— — —	
2	Geelong (Vict.)		———		— —	(During Lambing)
4	Coonamble		———			
5	Wallangra		———	———	———	
6	Liverpool Plains		— — —	———		(During Lambing)
7	Molong (N.S.W.)		———		———	(During Lambing)
8	E. Plains (S. Aust.)					(During Lambing)
10	N.E. Vict.		———		———	
12	Yass					
13	Forbes (N.S.W.)		———		———	
14	General					(During Lambing
16	Brewarrina		———	———		
17	Moree	———			———	
18	Tasmania	———				
19	New England (N.S.W.)		— —		— —	
20	General		— — —			(If weather mild)
21	Corowa (N.S.W.)	—	— — —	—	— —	
22	Liverpool Plains	—	— — —	— — —		
24	West of N.S.W.	—	— — —	— — —	—	

Essay	District.	Dec. Jan. Feb. Summer.	Mar. April May Autumn.	June July Aug. Winter.	Sept. Oct. Nov. Spring.	
26	General			—		
27	Dubbo		— —	— — —	— — —	
28	Forbes				— — —	
29	New England	—		— —	— — —	
30	New England		— — —		— — —	
31	New England		— — —		— — —	(If damp & warm)
32	Adelaide		— — —		— —	
34	Victoria			— — —		
35	Mudgee (N.S.W.)			— —	—	
36	?					(When scouring in spring)
38	Brisbane		— — —	— — —	—	
39	Adelaide		—	— — —	— — —	(In the South)
39	,,		—	— — —	—	(In the North)
40	Darling Downs	—	— — —			
41	N.W. Sydney	— —	— — —	— — —		
42	Central (N.S.W.)		—			
43	Burrawong	— —	— — —	— — —	— —	
46	S.W. Queensland		— — —		— —	—
49	Tasmania		— — —		— — —	
50	W. Australia			—	—	
51	N.S.W.		— —	— — —	— —	
52	Victoria	—	— — —		— — —	
54	W. Victoria	— —	— — —			
55	Moree		— — —	— — —	— —	
56	Forbes		— —	— — —	—	
57	General				— — —	
59	Queensland		— —		— — —	
61	Liverpool Plains		— —	— — —	— —	
66	New England		— — —	— — —	— —	
67	General		— —	— — —		
70	New Zealand				—	
71	Buchan (Vict.)		— — —			
72	Victoria		— —	— — —	—	
73	Victoria		— — —		— — —	
75	N.S.W.	—	— — —	—		
76	?			—	— —	

From this table, a curve has been drawn (see Fig. 18). This shows that, speaking generally, there are two periods when the fly is most serious; chiefly from March to May, but also in September and October. There does not appear to be so much trouble from June to August; and practically none at all in December, January, and February. Evidently, also, the trouble becomes serious very suddenly, just at the end of February.

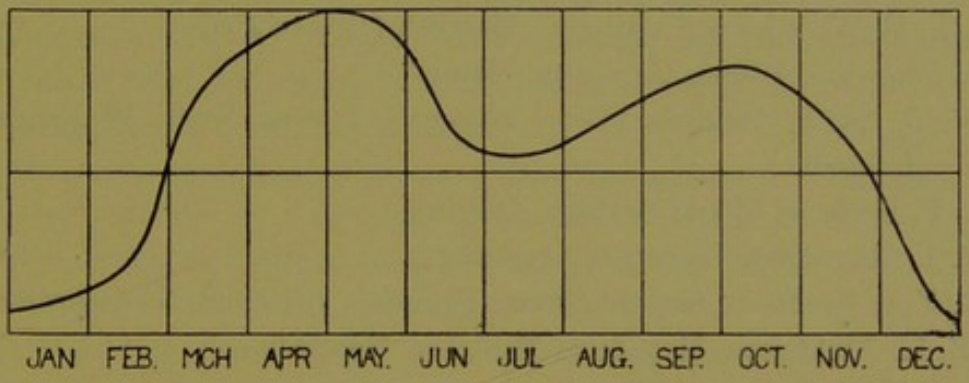

Fig. 18. Curve showing seasonal prevalence of Sheep Maggot-fly pest.

LIST OF ESSAYS

(Those marked with an asterisk (*) are considered to be "very good" by the examiners.)

J. J. Gillies, St. Leonards Creek, via Walcha.
H. W. Ham, Lara, Geelong, Victoria.
J. L. F. Woodburn, Cullingral, Merriwa (*Second Prize*).
S. Ferguson, Uluma, Armatree Siding.
W. F. St. L. Baldwin (Wool Classer), Spring View, Wallangra, Inverell.
L. F. Kemmis, Mooki Springs, Quirindi.
K. J. Abernathy, Loombah, Cumnock.
G. F. J. Needham, George Street, Parkside, Adelaide, S. Australia.
*E. H. Thompson, Napperby, Mullaley, Gunnedah.
P. C. Rowan, Terip Terip.
F. W. Chapman, Midkin, Moree.
Victor Bush, Berremangra, via Bowning, near Yass.
David Hannah, Jemalong, Forbes.
P. O'Connor, Fairview, Uralla.
Reginald Humble, Warrah, Willow Tree.
A. Baker, c/o T. Bossley, Willoh, Brewarrina.
F. Ion Bennett, Midkin, Moree.
Arthur M. Lea, Tasmania.
Hugh M. Croft, Booralong, Armidale.
*C. J. C. Cameron, 4 Bligh Street, Sydney.
F. W. Knight, Bolinda Glen, via Corowa.
H. C. Carter, Mooki Springs, Quirindi.
Francis Conder, Campbelltown, N.S.W.
A. Siddons, Glenariff, Bega.
M. Hargreaves, 136 Brougham Street, Darlinghurst.
J. H. Connor, 21 Rialto, Melbourne, Victoria.
J. J. Stevenson, Terramungamine Station, Brockelhurst, Dubbo.
J. F. Carmichael, Manna, Forbes.

J. H. Parsons, Lincoln, Armidale.

W. H. Webb, Hathrop, Bathurst.

John T. Fearby, Greylands, Uralla.

T. B. Mills, Millbrae, Native Valley, Nairne, S. Australia.

A. E. McLeod and J. B. Holme, Canonbar Station, Miowera, T.P.O. No. 3 West (*Third Prize*).

Robt. W. Morris, Murray Road, Heathcote, Victoria.

N. K. McDonald, Bodabeen Station, Mudgee.

"Moine" (E. Wilson), Farnham, Warnambool, Victoria.

T. D. Mutch, Chamber of Agriculture, 14 Castlereagh Street, Sydney.

C. P. de Winton, Eurella, S.W. Railway, Queensland.

A. Beviss, Dorset Park, Strathalbyn.

W. W. Anderson, Sheep Overseer, East Glengallan, via Warwick, Queensland.

Andrew Ferguson, Denmy, Gulargambone.

R. Stewart, Tyrie Station, Dandaloo.

S. R. Reynolds, Burrawang, Cumnock, via Molong.

T. W. Gibson, Ean Bank, Wingham.

Wm. Rodier, 131 Power Street, Hawthorne, Victoria.

Herbert F. Tapson, Manager, Yanna, Western Line, Queensland.

P. M. Brabazon, Kemuera, Cunderdin, W. Australia.

L. J. Martin, Sheep Classer, Penshurst.

H. B. Archer, Landfall, Launceston, Tasmania.

E. G. Allardyce, Muchea, W. Australia.

H. G. Smith, Mulwaree Gardens, N. Goulburn.

Ernest Ham, Hillston, Lara, Victoria.

A. J. Logan, Mitimiti, Hokianga, New Zealand.

*Frank Pearson, 5 St. James's Buildings, 127 William Street, Melbourne, Victoria.

*H. A. Flood, Inspector of Stock, Moree.

*W. Gibson Dowling, Forbes.

E. Martin, Droubalgie, Forbes.

*Thomas Tabart, Chief Inspector of Stock, Hobart, Tasmania.

C. C. Chapman, Barimornie, Charleville, Queensland.

T. M. Harcourt, Quambone Station, Quambone.

Thos. A. Probert, Mowbray, Invermay, Launceston, Tasmania.

S. D. Clarke, Manager, Cressy, Stamford, Queensland.
John Selth, Sherborne, 131 South Terrace, Adelaide, S. Australia.
E. D. E. Van Weenan, Sydney.
Geo. J. Mackay, Kentucky, New England, N.S.W.
L. A. Wilkie, Station Manager, Cucumgilliga, Cowra.
H. A. Heazlewood, Westbury, Tasmania.
Flora H. Talbot, Gerang, Victoria.
Coleman Phillips, Carterton, Wellington, N.Z.
H. Prankerd, Grazier, Gillingall Station, near Buchan, East Gippsland, Victoria.
W. A. Hensley, Diapur, Victoria.
*K. K. Oliver, Manor Street, N. Brighton, Victoria.
Walter W. Froggatt, Government Entomologist, Sydney (*First Prize*).
*B. F. Johnson, Quambone Station, Quambone.
*P. G. Cox, Wheatlea, Eglinton, Bathurst.
P. M. Kain, Glenroy, S.E. South Australia.
David Chalmers, Devon, Deniliquin.
*J. G. Mathieson, Hummocks Station, Snowtown, S. Australia.
A. McLean, Marryatville, Adelaide.

SPECIMENS RECEIVED

Unfortunately some of these specimens came to hand broken, or empty bottles only were received. They have been identified and named by Mr. J. W. Shoebotham, N.D.A., of this Laboratory, using Mr. W. W. Froggatt's specimens as types.

Essay.	*Species.*
No. 5.	*Calliphora rufifacies* (fly).
, 15.	*Calliphora oceaniæ* (fly and maggot).
	Calliphora rufifacies (fly and maggot).
,, 18.	*Calliphora villosa* (fly, pupæ. Maggots and eggs).
,, 19.	*Calliphora oceaniæ* (fly).
,, 20.	Exhibit B 1 (maggot from green blow-fly).
	Exhibit D (a beetle).
	Exhibit F (fly-blown wool containing maggots).
,, 24.	*Calliphora rufifacies* (the metallic blue fly).
,, 25.	*Calliphora villosa* (fly).
	Calliphora oceaniæ (fly).
	Calliphora rufifaces (fly).
	And various pupæ.
,, 26.	Dirty wool in spirit.
,, 31.	Dirty wool.
,, 34.	*Calliphora villosa* (fly).
,, 40.	*Calliphora rufifacies* (fly).
,, 65.	*Calliphora oceaniæ* (fly).
	Calliphora rufifacies (fly).
,, 66.	*Calliphora villosa* (fly).
,, 74.	Specimens of flies sent and named by Mr. Froggatt:—
	The Metallic Blue ... *Calliphora rufifacies.*
	The Green Bottle ... *Lucilia sericata.*
	The Blow-fly ... ... *Calliphora oceaniæ.*
	The Common Blow-fly ... *Calliphora villosa.*
	Blow-fly ... ... *Pharonia personata.*
	Sheep Maggot-fly ... *Calliphora dux.*
	The Small Blue ... ... *Calliphora rufipes.*
	The Shining Black Fly ... *Ophyra nigra.*
	Sheep Maggot-fly ... *Lucilia tasmaniensis.*
,, 75.	*Calliphora oceaniæ* (fly and maggot).
	Calliphora rufifacies (fly and maggot).
,, 41, 43, 59, 61.	Empty.

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A DETAILED bibliography in relation to the spread of infectious diseases is given by Hewitt, 1910; Nuttall, and Jepson, 1909; and Howard, 1912.

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(*Recommends Tobacco; solution of Aloes; or Asafœtida.*)

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(*Turpentine, also Carbolic recommended; Sulphur useful. Cites papers marked with asterisk.*)

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(*C. dux—use 10 parts Kerosene, 1 part Chloroform; then Sulphur and Tar, with Oil.*)

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(*Recommends Train Oil, plus one-sixth part Turpentine; or dead Lime powdered on; also Sulphur. Flies breed on Sheep and Lambs.*)

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(*To prevent an attack of gnats :—*

Oil of Pennyroyal	...	...	*1 part.*
Olive Oil	...	...	*2 parts.*
Oil of Tar	...	...	*2 parts.*)

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(Oil of Lavender drives off; or Eau de Cologne. Note of three lines.)

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(General note. Spirits of Tar is of some use, but darkens the wool and cannot use for broken skin.)

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