FLY CONTROL BY MEANS OF THE FLY-LARVAL-TRAP MANURE ENCLOSURE.

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A SIMPLE AND INEXPENSIVE DEVICE FOR STORING MANURE AND FERMENTING WASTE MATTERS IN SUCH A MANNER AS TO TRAP ALL FLY LARVAE MIGRATING THEREFROM.

The fly-larval-trap described here has been given very extensive trial under varying circumstances, not only at military centres, but by civil authorities and others, and has proved of value in all cases where manure or other fermenting animal or vegetable waste matters are accumulated in such a way as to give rise to fly-breeding; it is cheap to construct and requires little attention.

An improvised form of the fly-larval trap, employing the same principle, was first introduced during the war at the Potchefstroom mobilization camp for dealing with the manure of about 1,000 horses. This improvised device was described in the *Lancet* of March 13, 1918.

In the control of the breeding of flies proper storage of manure is a fundamental factor, and it is believed that the simple arrangement which the writer has devised for this purpose, and which is described herein, will be widely adopted as it becomes more generally known.

To those unacquainted with the usual life cycle of the common fly a few remarks in this connexion will possibly help to a better understanding of the working of the larval trap.

Flies find a favourite breeding place in the manure of horses, cattle and other animals, also in fermenting filth generally, provided it is fairly moist and furnishes the necessary heat for the hatching of the eggs and food for the larva. They develop through successive stages so dissimilar as to suggest wholly different forms of life. The female lays 120 to 150 eggs at a time, and may lay several times during the season, so that each female may produce 600 to 900 eggs. The eggs are usually deposited in batches on the surface of the breeding place, and hatch out in from eight hours to three days to a small larva, cream-coloured, and about three-eighths of an inch in length.

The larva feed on the decomposing material in which they have been hatched, and in warm weather become fully grown in about five days. They then migrate from the hatching ground (usually at night) and burrow into the subjacent ground to a depth of a few inches, where the body shrinks to an elongated barrel shape; the outer skin hardens slowly and later takes on a deep brown colour, forming the pupa or chrysalis.
The pupal stage lasts three to four days under favourable conditions and the fly emerges, then working its way through the soil to the surface. At first the wings are crumpled and folded, and until these expand the flies are often seen running over the breeding ground looking somewhat like spiders. About an hour after emergence the wings are fully expanded, and a little later the fly is capable of flight.

The total life round may be as short as seven days under favourable conditions, though during cold weather this may be extended almost indefinitely; sexual maturity is reached at the end of a further ten days when the female lays her eggs, and so the cycle goes on.

To contend with the fly it is necessary to abolish all possible breeding places, and in this connection it is important to remember that in ninety per cent of cases stable manure is chosen by the female fly when depositing her eggs. As a result of many observations made by the writer it has been found that an average of 5,000 fly larvae mature and migrate from the amount of manure which would fill an ordinary 200 lb. grain bag, or 130,000 from a single Scotch cart-load of manure. These figures represent average catches obtained during summer months in a place where adult flies were not particularly numerous.

The larvae are not very easily suppressed, and although buried beneath two feet of soil will complete their life cycle and later appear on the surface as flies. It is also interesting to note that the larvae may be kept submerged in water for twenty-four hours and yet become very active when taken from the water and placed in the sun.

The larvae are unable to climb a perpendicular dry surface, though if such surface be wet or damp, or if only the body of the larvae be moist, they have considerable ability to climb; they can even climb out of an ordinary glass tumbler with the aid of moisture. As a result of many experiments carried out by the writer it has been found that fly larvae cannot climb around an overhanging sharp edge, even with the aid of moisture; this fact has been taken advantage of in designing the larval-trap, the metal overhang of which forms an essential part of the device.

Influence of Temperature and Moisture.

During all stages of its life-round the fly is greatly influenced by temperature and moisture; this is particularly the case during the larval or maggot stage, when it moves from one part of a manure heap to another in great colonies seeking the optimum temperature and moisture for feeding, and later, in which to pass to the next stage of its development, i.e., the pupal or chrysalis stage. Colonies of pupae numbering thousands may often be found among the outer layers of a loosely packed manure heap.

The larvae prefer a temperature of about 90° F. and quickly succumb to a temperature of 115° F. or above, particularly if the manure or other fermenting material is in a wet state, when a temperature of 108° F. is fatal.
MAGGOT FALLING BACK INTO THE TRENCH.

TRENCH AND FENCE COMPLETE.
When fresh manure, with or without the addition of bedding, is placed in a heap, it rapidly heats consequent on the fermentation of organic matter, the heating is much more rapid when the manure is damp and is compressed or stacked firmly. The writer has observed a firmly-stacked heap of fresh manure to heat up to 140°F, and the larvae come tumbling out within thirty minutes of stacking, on the following day the heap registered 160°F, on the fourteenth day it registered 130°F, and thereafter the temperature gradually declined.

The temperature varies according to the degree of density of the manure heap, the amount of moisture it contains, the freshness of the manure, also on the percentage of bedding present; it is naturally lower in the outer layers, where it is just above that of the surrounding atmosphere. At an inch or two below the surface it increases and at a depth of six to twelve inches, depending upon compactness, frequently reaches 130° to 150°F in the case of fresh manure.

A continuous record was recently made in Pretoria of the varying temperature of manure heaps, and it was found that a manure heap measuring 4 feet by 4 feet by 4 feet reached and maintained a temperature of 120° to 130°F for seven weeks, when it gradually cooled, but registered 80°F at the end of fourteen weeks, this heap was regularly wetted with four gallons of water daily. A similar heap maintained under identical conditions, but in a perfectly dry state, consistently registered 20 lower throughout the whole period. These observations were made during the cool months when light night-frosts were experienced.

**The Larval-Trap.**

Having briefly detailed the usual life-cycle of the fly, the manner of constructing the larval-trap will now be dealt with.

Detailed illustrations are given of the device which should render the construction a comparatively simple matter. The whole structure should be substantially built so as to enable it to withstand very hard and rough usage, and exposure to weather. The platform is best built in good concrete, but may if preferred be of brick grouted in cement.

The construction of the trench or channel requires some care, building it of brick is probably the simplest way and this method is shown in the diagram; it may of course be built of concrete, though this will entail the making of suitable moulds.

**The Overhang.**

The metal overhang is the essential part of the device, as it prevents the escape of the larvae from the trench and sump and should under no circumstances be omitted. It may be conveniently made from ordinary sheet galvanized iron, cut into strips 6 inches wide and bent down 1½ inches as shown in the drawing, it is then laid in position between the courses of bricks and projects out over the trench. The top course of bricks is brought out to protect the metal from damage.
All joints in the metal overhang must slightly overlap, as should any openings be left between the ends of the metal strips, the larvae will certainly find them and escape.

The edge of the inner side of the trench should be bevelled as shown, so that the larvae falling thereon may not be able to crawl back into the manure but will roll down the inclined surface direct into the trench.

The Sump.

A sump of suitable size is necessary for the collection of liquids flowing from the manure. The sump must be provided with the metal overhang in precisely the same way as previously described for the channel; this is specially important, as the larvae invariably find their way along the channels to the sump and the majority will usually be found there.

The liquids are best thrown back on to the manure heap, where they assist fermentation.

In very dry climates much better results will be obtained if the manure heap is regularly wetted, and where large installations are concerned it is desirable to arrange for the special provision of water for the purpose; it is also a useful measure to fix a small hand-pump for returning the liquids contained in the sump back again to the manure heap. As already
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mentioned, moisture assists fermentation and the generation of heat, also as damp heat is much more repugnant to the larvæ than dry, they migrate from a moist manure heap more rapidly and completely than from a dry heap.

The bottom of the sump should be concave, this facilitates the removal of liquids and larvæ.

**Removal of Manure from the Larval-trap.**

An important point with regard to the use of the larval-trap is to decide when it is safe, from the standpoint of safety from further fly-breeding, to remove the manure from the trap. This point does not arise in cases where the larval-trap is used at stables for the temporary storage of manure pending regular removal, such as occurs with town stables from which the manure is removed at fairly close intervals, but is of much importance where larval-traps are used on a large scale for the final storage of manure pending its use for agricultural purposes, as by Government Institutions and Municipalities.

Decision in regard to this point is largely dependent on temperature and climatic conditions, also on the exact composition of the manure heap. In South Africa, under normal summer conditions, the writer has found that the maximum migration of the larvæ is from the fifth to the twelfth day, after which it rapidly decreases, until by the twenty-first day it almost ceases. It should be noted that these periods are given as commonly occurring under our average summer conditions, the periods may be greatly extended under unfavourable conditions of temperature, moisture, etc. Generally speaking, therefore, it is safe to remove the manure from the platform after it is four weeks old, for fertilizer purposes, or for storage elsewhere, without appreciable danger from fly-breeding; but this must not be considered a definite rule, as even after this period the heap may again heat up if wetted by warm rains, under such circumstances it may again, to a small extent, become attractive to the egg-laying fly. It is found that such conditions are unusual and the number of larvæ which mature and migrate during the second period is but a fraction of the number during the first period of fermentation.

**Size and Number of Larval-Traps Required.**

The next point for consideration is the matter of the size and number of larval-traps which should be constructed under given circumstances.

In the case of ordinary stables, where but one larval-trap is installed and manure is stored temporarily pending regular removal, there is very little difficulty in deciding upon the dimensions; provision being necessary only for the maximum quantity of manure likely to accumulate between the intervals of removal.

Where large quantities of manure and fermenting waste matters are stored for the purpose of rotting down for agricultural purposes, the
question of the number and dimensions of the larval-traps becomes very important. Under such circumstances the provision of a series of four or five larval-traps is recommended, each capable of holding about a week or ten days' accumulation, the principle being, that whilst one of the enclosures is being filled the contents of the others will be rotting down and the larvae migrating therefrom; these full enclosures will then be ready for clearing in rotation as required. Where a series of larval-traps is arranged it is a useful measure to connect all channels to one large sump, and to fix a pump for returning the liquids to the manure to assist in the fermentation process and to increase the fertilizing properties of the manure.

**Hints on Management of Larval-Trap.**

Like all sanitary devices the larval-trap requires at least some slight attention if it is to give satisfaction, and such attention will be well repaid.

In filling the enclosure the manure should be firmly stocked, particular attention being given to tightly pack the material against the wire surrounding the enclosure.

Larvae should be removed from the trenches and sump two or three times a week and suitably disposed of; they may be fed to poultry, subject to care being taken to prevent them escaping; they may be destroyed with boiling water or a solution of any of the commonly used disinfectants.

The trench must be kept clean and free from any litter or other material falling from wagons or enclosures, as litter in the trench may easily afford means for larvae to escape.

Most of the larvae will usually be found in the sump into which they fall in the course of their journey along the trench. The writer prefers to maintain the trenches free from liquid, though some users keep a quantity of solution in the sump with the object of drowning the larvae; this latter method is unnecessary, though if a 1 in 100 solution of arsenite of soda is used for this purpose it acts at the same time as a poison-bait for flies in the adult stage.

**The Larval-Trap and Abattoir Waste.**

The temporary storage or disposal of the waste from abattoirs in such a way as to prevent the breeding of flies is commonly a matter of very considerable difficulty, and whilst it is not claimed that the larval-trap will entirely eliminate this difficulty, it is the case that more than one municipality have installed them for this purpose and are getting good results therefrom. In this connection I cannot do better than quote Mr. Walton Jameson, City Engineer of Kimberley, who writes:

"You will be interested to note that when I was in Mafeking some time ago I visited the local abattoir and found the building teeming with flies, both blue-bottle and the ordinary house-fly. I suggested to
the municipal authorities that they should put up a fly-trap, and sent them a copy of Captain Baber's design, similar to the one we are using here. I suggested they should throw the offal which was distributed in and around the abattoir into the fly-trap in the following way: Put in a layer of paunch grass and then a layer of waste offal and so on, sandwich fashion, until they had the fly-trap full. I pointed out that in our experience in treating horse dung there was no smell, the only odour would come from the paunch grass. They adopted my suggestion. I visited Mafeking again a week ago and found everybody delighted with the results. The abattoir is almost entirely free of flies, there is no smell, except from the paunch grass in the fly-traps, and the contents of the trap, which are now three months old, are largely decomposed. The contents are now being removed, and used without offence for gardening purposes."

From experience gained in the storage of such waste as that from abattoirs, consisting as it largely does of cow manure and the contents of cattle paunches, it would appear to be necessary to retain it on the larval-trap for some considerable period longer than in the case of ordinary horse manure if immunity from further fly-breeding is to be assured.

Village Sanitation.—The Larval-Trap and Human Fæces.

With small communities, employing a bucket system of removal of human excrement, the final disposal of fæces presents a difficult problem, the disposal trenches frequently proving a grave source of danger from fly-breeding during the warm months.

On the suggestion of Dr. L. G. Haydon, D.S.O., M.B., C.M., D.P.H., Assistant Health Officer for the Union of South Africa, the larval-trap has been employed in connexion with the disposal of human fæces as well as stable manure, the contents of latrine pails being sandwiched between layers of stable manure.

It is found that no nuisance of any kind arises and an excellent fertilizer is obtained. It is thought that the sustained heat of fermentation, i.e., 150° to 160°, is sufficient to destroy any pathogenic organisms which may be present.

The system has also been extended to the disposal of sewer screenings at municipal sewage works and has been very favourably reported on.

Dr. Haydon has very kindly given permission to quote from a communication which he has received from Mr. Walton Jameson, which proceeds as follows:—

"You will remember when you were here some time ago you suggested that for village work we might try a system of putting down a layer of horse-dung and then emptying the contents of 200 night-soil buckets over this and so on, sandwich fashion, until the trap was full. We adopted the suggestion six months ago. The results have been in every way satisfactory.
The system adopted was to put in eighteen inches of horse-dung and then empty the contents of night-soil buckets on the horse-dung and so on layer after layer until the trap had received about 1,000 buckets of night-soil. The moment the night-soil was covered with horse-dung no smell was noticeable except from the horse-dung, and the whole contents of the completely full receptacle were entirely inodorous.

"After the receptacle had remained full for three months, the contents were emptied and used as a fertilizer with highly satisfactory results. I think it may be finally stated now that such a system may be universally adopted in all small townships with the happy results obtained here. I don't know of a more satisfactory hygienic method which could be adopted, having regard to economics, than the system suggested by yourself and proved here to be in every way successful."

The remarks of Dr. Herbert Willis, Physician Superintendent of the Mental Hospital, Pretoria, are also of great interest; he writes *inter alia* :-

"Five Baber's enclosures have been put down as a means of dealing with the fly pest. Three of these were built to the plan we had forwarded to us. These were put into operation on about November 1, 1922. The fly pest at that time was very bad, especially at the Native Yards and Staff residences situated fairly close to the stables and piggeries. After the traps had been in use for about a month or so, enormous quantities of fly-larvae were shovelled up daily, and places that were at one time black with flies showed a very much decreased number."

Finally, I should like to quote from a paper, "Some Public Health
Dr. Haydon stated:—

"I should like to see this inexpensive system of dealing with manure and kitchen refuse inaugurated throughout South Africa—not only in small dorps, but the bigger towns, and on farms where I know that much of the manure is wasted and washed again by rain.

"I believe that if we had throughout the country reforms in our methods of dealing with human excreta and fermentable (fly-breeding) refuse on the simple and economical lines indicated, we could very appreciably lessen the incidence of intestinal communicable diseases, and that it would no longer be possible to reproach our health authorities with the speedy death of one child in every ten born."