SOME EXPERIENCES IN THE CONTROL OF FLY-BREEDING.

By Major E. B. Allnutt, M.C.

Royal Army Medical Corps.
D.A.D.H. and F., Bermuda Command.

The term "Prevention of Fly-Breeding" leaves nothing to be desired as a headline to a command order; those, however, who attempt to carry it out soon realize that to maintain even effective control of the breeding of house-flies requires constant supervision and unceasing labour.

Under modern sanitary conditions the house-fly cannot obtain access to one favourite form of breeding place, i.e., human excreta. Consequently, the female Musca domestica will for choice deposit her progeny in batches of 150 at a time upon that attractive and readily accessible site, horse manure.

In the effective treatment of horse manure, then, lies the solution of the problem of the prevention of fly-breeding.

To burn all horse litter in suitable incinerators is the easiest and most certain way of ensuring the desired result.

Unfortunately the local problem cannot be solved in this manner, manure being regarded as a most valuable asset in Bermuda, and every scrap of it is carefully preserved for use on the land. Therefore the method adopted for the treatment of manure must in no way detract from its subsequent value as a land fertilizer.

To deal with such existing circumstances, experimental work in manure treatment has been carried out during the whole of the past year.

The investigations led to the evolution of a simple and practical method for dealing with stable litter, which not only appears to be really workable and foolproof, but also actually to prevent the breeding-out of any house-flies in the manure so treated.

The principle of this method is the destruction of the house-fly in the larval stage by means of the treatment of horse manure by close packing combined with frequent "turning over" of the surface layers, and subsequent storage, entirely carried out in a suitable impervious receptacle so constructed as to form a larval trap.

The compression of moist manure by close-packing results in the centre of the heap becoming so hot, owing to fermentation, that the heat generated is quite sufficient to kill the fly larvae which are hatched out from the eggs previously deposited by flies in the fresh manure.

It is found, however, that quite a considerable number of larvae escape the heat in the centre by moving to the outer and cooler exposed layers of the heap.

Many of the larvae which thus survive will, when mature, endeavour to
reach the cool dry earth, in which to pupate. Their migrations are prevented by the open channel in which they are entrapped and destroyed in the cresol solution. Furthermore, their escape over the walls is prevented by the projecting and over-hanging ledge which causes them to fall back on to the heap. The impervious platform base prevents larvae from reaching the soil beneath the packed heap.

A certain number of these surviving larvae will, however, remain in the cool outer layer of the heap and complete their development into adult flies. To remedy this, the outer exposed surfaces must be raked off and turned into the hot centre of the heap every other day during close-packing.

When a packed manure dump reaches a convenient size, it is stored for an adequate period, to ensure sufficient fermentation throughout, both to kill all surviving larvae and also to render the manure so unattractive to flies that it may be safely used on the land without the possibility of further fly-breeding in it.

Based on these facts a standard type of two-stalled manure receptacle for local use has been constructed from existing manure pits. This has proved to be the most suitable type of structure for the purpose here, and with minor modifications should be adaptable to any local conditions. It consists of a platform slightly above ground level, walled in on three sides, with an open gutter in front. This manure receptacle cannot logically be styled a "manure pit," though, as the term is generally used to denote any form of fixed structure in which manure is deposited, it is employed in this article for the sake of brevity.

Each manure stall must be of adequate capacity to close-pack the daily accumulation of manure during the period in which the other stall contains the completed pack which is undergoing storage.

Although by these means fly-breeding can be prevented, the desired result will not be attained, unless each detail of the process is intelligently carried out by those concerned in the actual disposal of stable litter.

**Method of Treating Stable Litter in a Two-Stalled Manure Pit.**

*Close-packing and Turning.*—Into one of the two stalls of the manure pit, for example, the right hand one, the manure and stable litter is stacked daily.

Prior to stacking the manure, any excess of dry straw is raked off from the stable litter and burned.

Each day's manure is stacked on the previous day's supply and well beaten down with a spade, care being taken to pack tightly into the wall both at the back and sides of the heap.

The base of the heap must not be allowed to extend to within a foot of the open channel in front of the stall.

The manure must be kept moist; daily watering of the heap before beating down is therefore necessary in dry weather.
During close-packing the outer layers of manure on the exposed upper and frontal surfaces of the heap are raked off every other day and deposited in the hot, fermenting, deeper portion of the heap, the centre of which is opened up for the purpose.

Close-packing and turning over the surface is continued in this manner each day until the manure in the stall reaches to a height of within six inches of the top of the walls, when the other, in this case the left hand, stall is taken into use in a similar manner.

Each stall will contain, at least, ten daily additions of manure, provided that this is packed close after removal of the surplus straw litter.

A sliding wooden shutter is fitted to the open front of each manure stall. Its function is merely to protect the open gutter from falling manure, and it is not intended to assist tight packing in any way, for which it is not suited, either structurally, or from its position, and, it may be added, to obtain a really close-pack against it is not possible. The front surface of the manure is consequently to be regarded as an exposed one, and treated accordingly.

The shutter is to be removed each day before packing, and replaced afterwards, care being taken to make use of the stop on the retaining groove which is intended to prevent the shutter from closing completely down. This provision allows migrating larvae to pass beneath the shutter to be trapped in the open channel beyond.

Storage.—The manure in the right-hand stall, now packed to its full capacity, is stored during the period of ten days or more, during which the left-hand stall is in daily use for close-packing.

Before the manure is left for storage, the exposed surfaces, i.e., the top and the front, are again turned over in the manner described above, hot fermenting manure from the centre of the heap being brought out and spread over the surface to replace the outer layer thus turned in. The heap is then beaten down firmly with the spade.

To further render the completed heap unattractive to flies during storage, it is recommended that a thin layer of earth mixed with cresol or crude oil be spread over the exposed upper and frontal surfaces of the packed manure, which is then left intact for ten days or more.

As an alternative in lieu of oiled earth, when this for any reason is not available, the excess straw from the stable litter, or some such dry refuse, is spread over the exposed surfaces of the packed manure and burnt, the resulting ash acting as a fly-deterrent during storage.

At the end of this period of storage the manure is removed from the right-hand stall, in order to make room for daily packing of manure therein; the left-hand stall by this time being fully packed.

Each stall is thus used alternately for packing and for storing manure.

After clearing out the manure from it, a stall will be sluiced down with a weak cresol solution before being again taken into use for close-packing.
Some Experiences in the Control of Fly-breeding

The open channel or gutter in front of the pit is kept free from manure, all debris and dead larvae being cleared from it daily. It is kept filled with water to which cresol has been added, thus ensuring the destruction of fly larvae which have fallen into it, and, at the same time, preventing mosquito breeding taking place therein.

The projecting ledge on the top of the walls is another device to prevent the escape of migrating larvae, but to make it effective, care must be taken that the packed manure does not come into contact with it.

Having personally tested this method of manure treatment during the past year I have no hesitation in stating that if it is thoroughly and conscientiously carried out, no fly-breeding will result.

The standard type of manure pit shown in the figure is of sufficient capacity to deal with the manure from one horse, each stall being able to contain at least ten days' supply.

In this connexion it may be stated that the period of storage required to render the manure safe for land use varies with local conditions of climate, and can only be determined by experimental work in both the hot and cold seasons of the year.

In this colony it was found that, provided the manure treatment had been thoroughly carried out, further storage in the manner described for a period of ten days would suffice under any local weather conditions.

The two-stalled manure pit in its present form was evolved from old manure pits existing in most of the barracks and quarters of this command.

These rectangular structures, built some years ago of local limestone, cement faced, consist of a platform at ground level of an area averaging six by five feet, protected along the back and sides by walls some four to five feet in height, the front being open.

In their original form these manure pits were well adapted to close-packing treatment, as the supporting walls were found to be particularly suitable for obtaining a really tight pack against them; furthermore, the advantage of having only two exposed surfaces, i.e., the upper and front, of packed manure to "turn over" and also to cover for storage, is only fully appreciated when the labour involved in dealing with the five surfaces of a pack in the open has been experienced.

To render these pits adequate for their purpose, the wall surfaces on the inner side, which were full of holes and cracks which would harbour larvae, were refaced with cement and concrete, and all corners and angles rounded off with the same material.

The next step was the erection of a medium partition wall from front to back of the same height as the side walls, thus forming two walls, one for packing the daily manure, whilst the other contains packed manure undergoing storage.

This precaution is a most necessary one, as attempts to pack and store manure at the same time in one continuous heap prove most unsatisfactory, and render fly-breeding preventive measures quite unworkable.
In spite of careful supervision in carrying out these details, the success of which was shown by the absence of pupae or mature larvae in the manure stall, conclusive evidence that fly-breeding was still taking place was obtained on examining the soil surrounding the manure pit, when numbers of mature larvae and pupae were unearthed.

The size of the platform has no apparent effect in deterring larvae in their migration, as they were found to traverse a platform extending six feet and more from the base of the manure dump to reach the soil beyond.

To decide upon a method of trapping likely to prove successful a close observation was kept upon the habits of fly larvae. Owing to the nocturnal activities of the larvae, much of this investigation had to be carried out at night with the aid of flashlamps, and by these means their ways of escape were detected, and measures taken accordingly.

On the fifth evening after commencing close-packing, larvae were seen to migrate from the heap, and escape from the stall by the open front. They then burrowed into the soil beyond.

The presence of an open half invert drain extending across the open front of certain manure pits was found to cause the destruction of some of the larvae thus migrating, owing to their being drowned in the rain water which was retained when the drain became blocked.

This observation led to the use of this “water jump” as a larval trap, and its efficacy was further ensured by the adoption of Baber’s [1] principle in its construction.

Investigations made here led to a gutter of this pattern being constructed, the overhanging lip forming an unsurmountable barrier to larvae, whose escape from an ordinary half-invert channel was found to be a possible occurrence, especially if it was allowed to become dry or partially filled with debris.

The Baber type of gutter with its sheer drop from the overhanging edge, however, proved a veritable descensus averti to the migrating larvae.

These gutters were at first made entirely of concrete and cement, but owing to the overhanging edges becoming broken away, even when protected by boards for the passage of a wheelbarrow, non-slipping metal treads four inches in width were let into the surface of the cement on each side to form a more durable lip.

This channel or gutter extends along the whole of the open front of the manure pit to just beyond the side walls, and is closed at one end, the other leading to a sump and soakaway, but guarded by a two-inch retaining lip to maintain the water level in the gutter.

The gutter measures three inches across from lip to lip, and from the lip to the invert it is three and a half inches in depth.

Cresol solution is retained in the gutter for its larvicidal action on both mosquitoes and house-flies.

By this means migrating fly larvae which attempt to reach the soil in front of the manure stall to pupate are caught and killed in the gutter trap.
Some Experiences in the Control of Fly-breeding

The efficacy of the gutter as a larval trap was patent to anyone at a glance, hundreds of dead larvae being present in the cresol solution on and after the fifth day of commencing a pack.

Larval activities were found, however, not to be limited to migrations from the open front of the manure stall.

In stalls packed with manure to the full height of the walls, fly larvae were actually observed to traverse the upper surface of the wall, down the outer side of which they dropped to reach and burrow into the soil beyond.

To remedy this, the principle of Baber's [1] trapping device was again utilized in the construction of a lip with an overhanging shape edge, projecting two inches inwards, along the top of the walls of each manure stall.

This edge was made to extend in continuity along the top of back, partition, and side walls, being carried down the front edge of the two last-named, to terminate at platform level.

This device proved entirely adequate for its purpose, as, in attempting to negotiate the obstacle, migrating larvae were observed to fall back on to the packed manure in the stall below.

To render this safeguard effective, manure must not be allowed to reach or adhere to it; hence the injunction that packed manure must not extend to a height of within six inches of the top of the walls of the stall.

The efficacy of these devices is proved by the results obtained in the routine working of them.

The most thorough search in the soil in the vicinity of the manure pit on all sides failed to reveal a solitary larva or pupa; although hundreds had been found in such situations prior to the installation of the larval trapping devices.
The movable wooden shutter to each stall slides vertically in metal grooves in the side and partition walls about two inches behind the projecting lip. These grooves are blocked by metal stops, some two inches above the platform, which prevents the shutter being completely closed down, and thus allows space beneath for migrating larvae to reach the gutter trap beyond.

The plan shows the various points described and the construction of the manure pits.

**Practical Points in Working the Method.**

The method was adopted in its entirety after prolonged trials in all varieties of weather conditions, during which other methods of manure treatment proved to be less satisfactory.

Thorough close-packing in itself undoubtedly causes the destruction by heat of large numbers of the fly larvae present in the manure, but careful investigation reveals the fact that an almost equal number of larvae escape to pupate and give rise to adult flies. In dry weather especially fermentation is inhibited to some extent in the exposed layers of manure, and larvae reaching such cool surroundings are enabled to pupate and develop unchecked.

“Turning over” these surface layers regularly is found to deal most effectually with these survivors, who are killed at once by the heat in the centre of the pack.

Any excessive dryness of the stable litter may be remedied to some extent by removing from the manure before packing any superfluous dry straw, which may then be burnt, and also by drenching the manure heap with water each day before packing down.

Manure well packed and turned on a base of soil, even if the latter has been oiled and rammed down, may appear to be giving rise to no fly-breeding from the absence of larvae and pupae in the heap, but the fallacy of this will be quickly exposed if the ground beneath is examined, when pupae and mature larvae will invariably be detected.

The importance of an impervious base such as bare rock or a concrete platform for packing manure on is thus realized.

The close-packing of manure was first carried out in the original manure pits, and the observations made during the actual working on these lines led to the evolution of the standard type of manure pit now used throughout this command.

When supervising manure treatment in these pits a brief inspection is sufficient to detect faulty methods; the detection of pupae, or even of mature larvae in the outer layers of the packed manure, is definite evidence of neglect, namely, failure to “turn over” the surface manure every other day, whilst the presence of any surviving larvae, at a depth of six inches or more, indicates that an insufficiently tight pack has been obtained.

It has been interesting to compare observations made in various manure
Some Experiences in the Control of Fly-breeding

pits in use here. Although they were all of the same standard type, the results varied considerably as judged by the number of dead larvae present in the gutter trap, on and after fifth day of commencing a close-packed heap.

The number of larvae which survive to reach the gutter is in inverse ratio to the thoroughness of tight packing and turning over of the manure from which they migrate.

In a manure pit that is structurally intact, the absence of pupae or mature larvae anywhere in the stall of packed manure, together with few traces of destroyed larvae in the cresol solution in the gutter, indicates thoroughness of method. It is, however, to deal with lapses, due to carelessness or neglect, that such safeguards are essential.

Manure treated and stored in this manner will then be safe for use on the land without any fly-breeding resulting, and furthermore, many agricultural experts state that its value as a fertilizer of soil is even greater than that of loosely stacked stable litter [2].

Experimental Work in Connexion with Fly-Breeding in Manure.

A large number of experiments were carried out in order to obtain the necessary data for standardizing a routine method for the treatment of manure in the command.

Fly-Breeding.—Observations were made both with fresh manure in tins or other close receptacles with a lid made of wire gauze, and also in portions of actual manure pits covered in with similar material.

It was found that under most favourable conditions of climate, the fly does not emerge from the pupa until the twelfth day after deposit of the egg in the manure.

This occurs during August and September, when the heat and relative humidity are both at their maximum. (Temperature 90° F., relative humidity 90 to 100).

Larvicidal Effects of Close-packing.—A series of experiments was conducted, in order to determine the temperatures reached at various depths and situations in close-packing, and the effects produced thereby upon fly larvae.

It was noted that the larvicidal effects of certain temperatures and the length of exposure required vary with the stage of development of the larva, freshly hatched specimens prove to be less thermophylic than larvae which have accomplished their second moult. Similarly, mature larvae ready to migrate are slightly more tolerant to heat, whilst pupae will survive even higher temperatures still.

These observations indicate the importance of "turning over" the surface of packed manure at least every other day, to ensure immediate destruction of the larvae in their immature and most vulnerable stage of
development. Furthermore, the "turned in" manure must be buried into the centre of the heap, where the heat causes instantaneous death to the larvae.

In actual practice it is found that temperatures at which larvae are not killed in less than a minute are not really larvicidal to any great extent, for the simple reason that as soon as it becomes uncomfortably hot in the centre of the heap larvae, other than those just recently hatched out, are sufficiently active to migrate and seek cooler surroundings without delay. As regards the larvicidal temperatures recorded, the results obtained for the most part corroborate the observations made by other investigators of this subject.

If anything the fly larvae appear in some cases to be slightly more tolerant to heat than previous records elsewhere would lead one to expect. It is probable that the stage of development reached by the larvae is the factor in the case.

The larvae used for the experiments were forty-eight-hours-old specimens, which would be the stage of existence reached by those "turned in" from the outer layers of the heap when this procedure is carried out, as it should be, every two days.

At 113° F. no ill effects were noted, but as the temperature of the manure neared 120° F., larvae were seen to migrate rapidly to cooler surroundings, and if prevented from doing so soon succumbed. At 130° F. death ensued within one minute, and at 140° F. it was instantaneous.

Mature larvae ready to pupate were found to require slightly longer exposure to such temperatures to ensure their destruction:

The Effects of Fermentation on Manure.—Apart from the larvicidal heat generated in fermenting manure, investigations were made as to the effects of storage in rendering manure safe for use on the land, without any subsequent fly-breeding resulting.

The period of storage necessary was found to depend upon: (1) the closeness with which manure is packed; (2) climatic conditions.

As regards (1) manure tightly packed reaches the degree of fermentation required throughout, in approximately half the time taken by loosely stacked manure; (2) climatic conditions include both the humidity and the temperature of the atmosphere.

Excess of humidity, as in wet weather, rapidly increases the fermentation process, consequently in dry weather close-packed manure should be watered daily.

The effects of the temperature of the air vary with its humidity, in that warmth combined with moisture assists the process of fermentation, whereas extreme cold retards it, as does also dry heat. To solve our local problem of storage, a series of dumps of manure, of varying degrees of close-packing and watering, after fly-deterrent coverings had been applied, were stored.
Some Experiences in the Control of Fly-breeding

for different periods, both in hot and cold weather. At the end of such periods, these heaps were opened up, and examined for the presence of larvae or pupae, and the fermented manure was then spread out in situations where flies were prevalent.

It was conclusively proved that, under local weather conditions least suited to the process, manure well watered and tight packed, including, of course, regular turning in, is rendered safe for use on the land after ten clear days' storage.

It was noted that the degree of alkalinity (tested by litmus on manurial solutions) seemed to have a bearing on the attraction of some manure samples for the house-fly.

**Larval Traps.**—Many observations were made upon the habits of migrating larvae, and their powers of climbing or negotiating obstacles, with a view to determining the efficacy of various larval trapping devices.

As regards climbing propensities, the surfaces of the walls of the manure stall being usually moist in this humid climate, mature larvae are able to ascend vertically for several inches.

They can also climb out of an open channel pipe, especially if assisted by the presence of debris of any kind in the invert of the channel. In actual practice, however, this was a rare occurrence, as the presence of cresol in the channel quickly destroyed any larva thus entrapped. Tests carried out with the projecting ledge on a wall, and also with gutters constructed on Baber's (1) principle, proved the efficacy of this device in dealing with such larval activities, larvae failing to overcome the obstacle provided by the overhanging edge in either instance, provided that the latter are kept free from manure or other debris.

At different times, trial was made of various types of larval traps, and the conclusion reached that, although many of these contrivances do assist to some extent in reducing fly-breeding, the method of trapping devised by Baber is by far the most satisfactory, both in its simplicity and the foolproof manner of its working; furthermore, it is unique in that it is a definite method of fly-control in itself.

The ants (Formicidae) prevalent all over this colony are not unnaturally regarded as a plague, all food supplies having to be adequately protected against their depredations. But scarcely an experiment was carried out without ocular evidence of the value of the ant as a fly larvicide. Considerable interest was aroused amongst the troops by the common spectacle in the vicinity of manure heaps, of struggling fly larvae, each being carried off by three or four ants, to be subsequently deposited in the nests of the latter and destroyed there, as further investigations proved to be the case.

From the many observations made, it would appear that large numbers of venturesome larvae carried off from the surface of manure heaps are destroyed in this way, and on several occasions flies' eggs were taken from fresh manure in a similar manner.
INVESTIGATIONS OF VARIOUS METHODS OF TREATMENT OF MANURE.

The method of manure treatment described above was not adopted without due consideration being given to other and simpler methods, which were only eliminated after thorough tests had proved them to be unsuitable for local use.

The following epitome of our experiences of various methods explains briefly the reasons for their being discarded for general use.

(a) Incineration.—Not feasible, as all manure is required for land fertilization.

(b) Fly-Deterrent Measures:

(1) Spraying manure heaps with fly-deterrent solutions has often been favoured, apparently owing to the fact that immediately after spraying the manure no flies are seen upon it, consequently it is inferred that no fly-breeding is going on.

That this is a fallacy is easily proved by turning over the surface of the manure, when fly larvae can be found beneath, the solution sprayed on to the surface having entirely failed to prevent the successful hatching and subsequent development of larvae from the eggs of the house-fly previously deposited in the fresh manure. Furthermore, it was found that natural fermentation had been inhibited or delayed to some extent in manure drenched with such solutions as compared with control manure heaps which had not been so treated.

To provide a fly-deterrent covering for close-packed manure during the period of storage, substances such as crude oil or cresol have their uses, especially when mixed with earth in the proportion of about one part of oil to twenty-five parts of earth. The use of oiled sacking for this purpose proves unsatisfactory on the whole, as this material becomes very foul in time, and attracts all kinds of insect pests.

Solutions containing kerosene are sometimes tried, but are useful as a temporary measure only, as owing to dilution by rain or evaporation by heat, their effect is very evanescent, and flies have been observed depositing on the manure within a few hours of spraying.

(2) The so-called Panama method of burning a layer of straw or other dry and inflammable refuse on the surface of a manure heap is a useful measure and deters flies from depositing their eggs thereon, but is similarly fallacious as regards the apparent absence of fly-breeding, which may be found to be taking place in the manure beneath.

A certain number of larvae are undoubtedly destroyed in the surface layers of manure by this means, and it is also a useful alternative to oiled earth for covering packed manure during storage.
Some Experiences in the Control of Fly-breeding

(c) The Spreading of Manure.—This was carried out as a routine method during a period of eight months, including both the hot and cold seasons of the year. On the ground selected for the purpose, five areas were marked out, each of which was used in turn to receive the thinly spread day's stable litter, which was raked over and turned at least once daily.

On the sixth day, the area used for the first day was cleared and used again, and so on in daily sequence, the manure so removed after five days' exposure being used on the land.

In dry and sunny weather, manure so treated did not give rise to fly-breeding, provided that a rocky or similar site was used for the purpose.

The adoption of spreading as a permanent routine method was defeated by the local climate, the constant humidity of the air preventing sufficient desiccation of the manure, and furthermore the strong prevailing winds carried fragments of the horse litter all over the lines.

Observations made under average weather conditions revealed the presence of fly larvae in fragments of spread manure of less than 1 inch in thickness, and both larvae and pupae in the manure that had been stacked after five days' careful spreading.

Larvae and pupae were also unearthed from the soil in the vicinity of the spread manure, in instances where there had been neglect in regular spreading or turning.

Where a number of horses were concerned, there was often difficulty in securing a large enough area of suitable level ground for the spreading of five days' supply of stable litter.

The labour involved is a further disadvantage, and renders somewhat prolonged supervision necessary for the success of the method.

(d) Storage of Manure in Closed Receptacles.—Although this method is sound in theory, in practice it was found impossible to keep the receptacle fly-proof, even with the use of precautions such as a backstop to prevent the lid resting open. Our experience proved that under average working conditions this type of receptacle provided a perfect fly incubator, and cannot be advocated for general use.

(e) Baber's Method [1]. From the model (fig. 115) in Byam and Archibald's "Practice of Medicine in the Tropics," vol. I, a Baber enclosure was constructed nearly a year ago in the horse lines of an infantry regiment here [3].

Baber devised his platform for storing manure and freeing it from fly larvae, and directs that the manure be firmly stacked upon it daily, and packed tightly against the wire fence.

Migrating larvae fall into the surrounding gutters of characteristic shape with an overhanging edge, from which, if kept clear of manure, they are unable to escape.

It is recommended that these gutters be kept free from liquid, the larvae being cleared from them and suitably destroyed.
Our experience in the working of the method over a period of a year fully bears out its value in the control of fly-breeding, large numbers of larvae being trapped in the manner described. In fact this pattern proved to be by far the most effective device of its kind amongst the various methods of larval trapping investigated here. So much so, that the essentials were adopted to form the larval traps in our improvised manure pits, not only in the construction of the open channel, but also in a modified form as the overhanging lip which projects from the top of the walls of the manure stalls. In the course of many observations during the past year both these devices have fully proved to serve their purpose most adequately.

In the practical working of Baber's system it was found that fly-breeding, although well controlled, is apt to continue to some extent in the outside layers of the manure stack on its fly-exposed surfaces. It is not possible to obtain a really tight pack laterally against the wire fencing, in the vicinity of which, more especially at the base of the heap, large numbers of larvae and nests of pupae may be found.

The use of enclosures of the Baber type for our method of manure treatment was tested by actual experience. The conclusion reached was that for our use the manure stalls are more suitable from every point of view.

With the Baber enclosure, apart from the labour involved in dealing with the mass of manure on its five exposed surfaces, the fixed wire fencing is a disadvantage, not only because it is unsuitable for close packing but because its presence prevents free access to these surfaces for turning in, and also for covering up for storage. The conversion of the existing fencing to form hurdles of similar structure, but movable and attachable to the metal uprights at the corners, will remedy this, but on the other hand, the walls of the manure stalls of our pattern afford better surfaces for close-packing, and the stalled manure presents two surfaces only to deal with.

Furthermore, the walled manure pits in this climate have an added advantage, in that they prevent the stable litter from being scattered far and wide from the dump by the strong prevailing winds; this being apt to occur when open wire fencing is used for the enclosure.

Apart from such considerations the final decision was made, as is often the case, on financial grounds. The cost of converting the existing manure pits into the standard two-stalled type is only a third of that incurred in the construction of Baber enclosures of similar capacity, not taking into consideration the expense for upkeep of the gutters, the fencing, the metal of which soon deteriorates in this humid climate.

The period of storage of manure required to render it safe is a further factor in the question of expense. Manure stacked in Baber's enclosures requires three weeks' storage, and consequently adequate platforms to store all the manure which accumulates during that period is necessary. With the high degree of fermentation reached in the tight-pack obtainable in our
Some Experiences in the Control of Fly-breeding

manure stalls, ten days' subsequent storage has proved adequate for the purpose at any time of the year here. This is most important from an economic standpoint.

A minor disadvantage in the use of the Baber platform is, perhaps, the large extent of the guttering, which is four or even five times that used in the manure stall type, and the labour involved in keeping such gutters clear is considerable.

Local conditions, however, generally determine the choice of the method of manure treatment, and I am convinced from a year's personal experience of the system that Baber's installation should prove effective in civil life, when the routine carrying out of such thorough measures as are entailed in our method cannot be ensured.

In places where manure has usually been dumped in haphazard manner, devoid of any system, and in consequence fly-breeding continues uncontrolled, the mere deposition of all stable litter in enclosures of the Baber type will undoubtedly result in great reduction of fly-breeding.

In military areas, where large quantities of manure in bulk have to be dealt with, as in the case of garrison manure dumps, it is an open question, and one which will be determined in each place by the various local conditions prevailing, whether the construction of Baber island platforms on a large scale, with or without movable fencing, will not prove to be more suitable than walled enclosures with a frontal channel, for carrying out the combined method advocated herein.

The Local Fly Problem.

The need for adequate measures for the control of the house-fly and its breeding places is a very real one here.

The prevalence of these pests in the colony is readily understood when the facilities for uncontrolled fly-breeding throughout the year are considered.

Motor vehicles are prohibited by law, the only means of transport being that provided by horses, some 3,000 of which are stabled in this small area of nineteen square miles.

The constant and plentiful supplies of horse manure, stored in heaps in the vicinity of livery and other stables, afford ideal sites for fly-breeding.

Economic conditions affecting civil and military communities alike necessitate the careful preservation of every scrap of manure to enrich the bare two foot covering of soil on limestone rock, every available acre of which must be cultivated.

The climatic conditions are most favourable to fly-breeding throughout the year, warmth and moisture being the most characteristic features; the air temperature varies between 60° F. and 90° F., with annual mean relative humidity of 84, and a rainfall of 50 inches, fairly evenly distributed amongst the months.
The constant presence of the enteric group of diseases in an endemic form amongst the civil population is a further incentive to a campaign against flies.

Observations show definitely the correlation of the seasonal variations in fly prevalence with the incidence of cases of enteric fever.

In this connexion it must be added that local water supplies obtained solely from rain water, collected mainly on roof catchments, and stored in suitable fresh water tanks, are not likely sources of infection, there being no surface fresh water on the island.

It may be added that protective inoculation, as carried out in the garrison here, is not generally adopted amongst the civilian population.

The abolition of many of the sources of fly-breeding throughout the colony would result from the substitution of motor for horse transport, which experiences elsewhere have shown to materially reduce the prevalence of house-flies.

In this connexion it may be mentioned that a marked diminution in the house-flies prevalent in London was noted to correlate with the general adoption of motor transport in the metropolis some years ago, due apparently to the conversion of stables into garages [4]. At the moment this radical change does not appear to be imminent here.

In such a constricted area as we have to deal with, and recognizing the fact that flies will normally travel distances up to one mile, to achieve any material results measures for fly control in civil and military areas must be co-ordinated.

The military authorities have adopted and put into practice the method advised herein, after a year's experience of it under local conditions, and it remains now for the civil Public Health Authorities to co-operate.

At the present time the local General Board of Health are considering the undertaking of similar measures of treatment of manure, with modifications to suit conditions in civil life.

**Conclusions.**

(1) The outstanding fact brought to light during these investigations is that no method of treatment of manure to prevent fly-breeding has the slightest chance of success without the intelligent assistance of those responsible for carrying out such measures in detail.

The education of these men must form the basis of the campaign against fly-breeding, to carry on which also requires the general interest of the garrison, obtained by suitable instruction in the form of lectures and practical demonstrations.

(2) The particular method to be adopted in any locality will be decided by local conditions, both economic and climatic, but it is most important to determine by thorough investigations whether the method selected will work successfully at all times of the year.
The value of experimental work in this connexion will be appreciated when it is realized that, as was the case here, a suitable manure pit was evolved from one already existing, at a much less cost than constructing new ones.

(3) Although many of the recognized methods of treating manure control fly-breeding to some extent, a combination of several such methods may actually prevent it.

(4) To ensure success, it is advisable to have a foolproof device to counteract the effects of slackness in carrying out the work involved, and not to be entirely dependent on the human element, which is liable to fail at times.

(5) The combined method which gave successful results in Bermuda should prove the solution of the fly problem wherever manure is accumulated for future use on the land.

The whole question of the prevention of fly-breeding has been tackled here from a practical standpoint, and although no new or startling facts have been elucidated, the conclusions reached may lead to a more general consideration of the inadequacy of the present methods of dealing with this problem in many places.

I am indebted to Qrmr.-Serjt. A. Cox, Royal Engineers, for the drawing of the two-stalled manure pit.

REFERENCES.