are found here it is at least as likely that they may be a factor in the causation of this seven-day type of fever, as they appear to be now generally regarded as being the active agents in its propagation in other parts of the country.

THE BIONOMICS OF THE MALTESE PHLEBOTOMI.

By CAPTAIN P. J. MARETT, R.A.M.C.,

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It is places which are dark, damp, and usually inaccessible, and with a requisite temperature and a suitable food supply, that the phlebotomus flies select for their breeding grounds.

That darkness is the natural condition is to be deduced from an examination of the larvae, which are devoid of eyes, their place being taken in the adult larvae by two patches of pigment. A certain amount of moisture is necessary, for two reasons—the one, that, if placed in dry surroundings, the larva will shrivel up, and the other that the food of the larva being excretal matter, cannot be eaten when in a dry condition. Excess of moisture is equally harmful, as has been experienced in breeding experiments, where excessive spraying of a breeding dish resulted in the loss of all the larvae.

Quiet is essential, as the larval stage is somewhat lengthy, and if exposed to inclement weather during this period a fatal result is a foregone conclusion. The proper food supply of the larva has been found to be the excreta of the various insects and animals found in walls. Special attention has been paid to the excrement of woodlice, lizards and bats, and undoubtedly, in experimental breeding, the first—that of woodlice—gives the best results. The requisite temperature for active breeding is above 70° F.; below 60° F. larvae appear to roll themselves up in detritus, whilst the higher the temperature is above 70° F. and up to 86° F. the more rapid is the life cycle.

All the above physical conditions are to be found in the interior of rubber walls, in crevices of caves, artificial embankments, and, in Malta especially, in the interior of the old bastions, many of which contain long disused chambers. In searching these places, of which only the interiors of the first three have been examined, the number of specimens of larvae and pupae found has not been in proportion to the quantities of flies prevalent, but this has been found to be due to the fact that the larvae bury themselves, and that of the pupae, in nature, only those adhering to stones have been found. In experimental breeding only about 5 per cent. of pupae so attach themselves, the remaining 95 per cent. lie free on or under the detritus.

Newstead, in his article on the *Papatasii* flies (Phlebotomus) of the Maltese Islands, describes three varieties: *P. papatasii* Scop., *P. perniciosus* Newstead, and *P. minutus* Rond; of these *P. papatasii* is the largest, *P. minutus* the smallest, whilst *P. perniciosus*, as regards the size of its body, resembles *P. papatasii*, but its legs are not nearly so long. *P. papatasii* breeds out in caves and in embankments, whilst *P. perniciosus* and *P. minutus* breed chiefly in the rubble walls and in bastions, the result being that the two latter species are seen more often in dwellings, unless caves and embankments are in close proximity.

Flies appear about the middle of May, in small numbers; they gradually increase, and by the end of June they are numerous; during July, when the breeding grounds are somewhat dry, their numbers decrease, and only on the onset of the damp sirocco, about the middle of August or beginning of September, do their numbers rise once more, when they appear in far greater numbers than earlier in the year, and persist till the onset of the rains and wind, about the middle of November. They can still be found in their breeding haunts in small numbers during December.

The latest date on which a fly was seen was January 14th; this was in a breeding ground where the temperature kept up to 70° F. till January; on the temperature falling to 60° F. no flies were seen. There is thus an interval of about four months during which the adult fly is not to be found; that is to say, the fly does not hibernate, but the winter is passed in the larval stage.

The causes for the fluctuations noted in nature have been worked out experimentally; it is found that dryness of surroundings prolongs the length of the various stages, and on the other hand, that with suitable moisture and heat the various stages are passed through rapidly; in the former the complete cycle takes up to four to five months; in the latter, the shortest time has been found to be thirty-four days.

A summary of the length of life of the different stages, for wild flies and for tame flies, is best given in tabulated form.

Summary of the Length of Life of the Different Stages, for Wild Flies and Tame Flies.

Stage.	Duration of Stage:	
	Wild Flies.	Tame Flies.
1. Pregnancy stage ...	Unknown	7 to 10 days.
2. Egg stage ...	(a) 6 to 9 days (b) In dry weather up to 20 days	(a) Average, 8.4 days. (b) Shortest in incubator at 30° C., 5 days. (c) Longest in October at room temp., 10.1 days.
3. First larval stage ...	14 days	(a) Shortest, 6 days. (b) Longest, 14 days.
4. Total larval stage ...	Up to 5 months	(a) Longest, 140 days. (b) Average longest, 92 days. (c) Average shortest, 24 days.
5. Pupal stage ...	11 to 16 days	6 to 16 days.
6. Length of life of fly	8.4 days	Females: (a) Shortest, 7 days. (b) Longest, 25 days. (c) Average, 12.5 days. Males: Average, 4 days.

The above data are gathered from breeding experiments. Of tame flies from the middle of August, 1913, to the end of March, 1914, four generations were bred out.

The eggs are white, but rapidly darken; they are marked with distinct patterns (36 μ by 12 μ). The larvae on hatching are minute and with a dull white body, the head and the two tail hairs being a shiny black; at two days old the size of the larva is 0.4125 mm. and the length of the tail hairs 0.5 mm.; total length, 0.9125 mm. They rapidly increase in size and take on the brownish colour of their surroundings; on moulting, which they do once, they once more become white, and shortly after the head and tail hairs assume the black colour, but now the larva has two pairs of tail hairs. The larva is motile and eats voraciously; when about to pupate (its size is then about 4 mm. and tail hairs 1 mm.; total length, 5 mm.) it becomes motionless, empties its intestinal canal, and its head curves over till it touches its abdominal surface.

The colour of the pupa, which is obtectate, is on emergence a dull white, having its terminal segments covered by the remains of its larval skin. In a couple of days the eyes show their black pigment, and about two days prior to emergence the wings, body and legs take on their pigmentation, brownish to jet black. The size of the pupae varies with species and with sex; in *P. papatasii* the males are 4 mm. long and are thin in comparison to the female flies; the females are 3 mm. The extra length of the males is due to the claspers, which are held fully extended. Pupae are more resistant to the action of water than larvae.

When a larva is about to pupate, it comes up to the surface; if the surface of the detritus, however, is dry it will remain in the depths, so that under these conditions, when the fly hatches, it has to work its way up to the surface. The fly emerges from its pupal case through a sagittal slit at its anterior extremity.

Flies are sexually mature within a few hours of emerging, thus it is impossible to state the duration of pregnancy in the wild fly.

Tame flies usually feed before pairing, the females alone suck blood; when pregnancy is short (for example, seven days), the eggs are more likely to be fertile, and when this is the case, the eggs are all laid within twenty-four hours, and the fly is found dead by the last of her eggs—this is the usual course with wild flies.

With the tame fly, where eggs are laid and the fly dies

after ovipositing, the eggs are usually fertile; where flies do not lay their eggs all at the same time, they do not succumb till some days later and the chances of their eggs maturing is much lessened.

Examples.

In the third generation of laboratory-bred flies, one fly hatched on January 18th, 1914, and died on the 25th of the same month, having completed oviposition, a length of life of seven days; from her eggs 40 larvae hatched on February 1st and 2nd—that is, all eggs were fertile. Another fly of the same generation, hatched on January 19th, 1914, laid eggs from the 28th of the same month for some days; the first lot of eggs produced 2 larvae on February 3rd, and the fly died on February 5th. Here out of all the eggs only 2 were fertile.

The longest life of a fly in these experiments was 25 days, and all her eggs were unfertile.

The average length of life of female tame flies is 12.5 days, of males 4 days.

The average longevity of both sexes of wild flies in captivity has been worked out at 4.2 days, and is inferred to be one half the viability. In this experiment, which was continued for a month, the true viability works out at 8.4 days.

On warm sirocco nights the flies appear just before sunset; leaving their haunts, they are attracted to inhabited dwellings, where they cause annoyance by their persistent biting. Flies bite both warm and cold blooded animals. At sunrise they disappear, either to their breeding haunts, which they can be seen to enter, or they retire to dark corners of rooms, where they are to be found seeking shelter behind hangings; on windy nights they do not leave their haunts. The flies dislike sunlight, but are attracted by artificial light, and are to be found in considerable numbers on and around paraffin lamps.

The only way in which the distance of their flight has been worked out has been from a knowledge of the habitats of the different species—that is, knowing that *P. papatasi* bred out in a certain cave, it was found that this fly was present in dwellings within fifty yards of the cave, but only rarely beyond this limit. They do not fly high, and the top rooms of houses which are not shut in by high walls are comparatively free from flies.

In the course of breeding experiments it has been found that abnormalities occur, the most noticeable being varying degrees of malformation of the male claspers, up to complete transposition of superior and inferior claspers. At present the males are identified by their claspers and by the number and arrangement of hairs thereon; these minute details being inconspicuous characters are stated to be uninfluenced by adaptation; however, the fact of these abnormalities occurring is rather against such a classification. Among the females there is a gradual loss of fertility, due probably to in-breeding; the eggs of such flies assume abnormal shapes, but the pattern of the reticulations does not appear to be altered.

The fly possesses one fairly common ectoparasite, a mite, which hatches out in the woodlouse excreta, and is to be found hanging on to the thorax of the fly; apparently it is not a true parasite, as it lives in dishes in which no flies have been present and it does not injure the larval stage. On the other hand there is a minute pseudo-scorpion which does injure the larval stage.

Work is being done on the bacteriology of the various stages. Mention will here be made of a fungus only. This fungus is pathogenic to the fly and is provisionally called *Empusa papatasi*. A fly so infected is recognized by the fact that ingested blood appears to remain in the thorax, causing it to appear nearly as red as the abdomen. On dissection of such a fly the salivary glands show motile forms, "swarm spores," whilst the mycelial form is seen in the intestines. When such an infected fly is dipped in absolute alcohol and flamed till the wings and legs are burnt off and is then emulsified in 10 per cent. citrate, a flocculent growth is obtained, consisting of mycelium and spores. Subcultures from the citrate on to Sabouraud's medium and on to glycerinated egg medium give rise to a white fungus; in this stage spore formation is by intercalary formation. When the growth in citrate is subcultured into N.N.N. highly motile forms are seen, corresponding to those seen in the salivary glands. Experimental inoculations with the motile forms into rabbits and guinea-pigs give rise to symptoms. The white fungus under certain conditions gives rise to yellow bodies (ascospores); here apparently spore formation is by aecogenous segmentation, which would allow of its being

included in the Entomophthoreae, to which family the *Empusae* belong.

In conclusion, it is thought advisable to make a note of the effects of inoculation, as this *Empusa* appears to have pathogenic properties, and involuntarily the thought arises that it is quite possible that the *Empusa muscae domesticae* may be the cause of infantile diarrhoea.

NOTES ON THE TRANSPORT OF CASES OF FRACTURED THIGH.

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THE provision of satisfactory methods of fixation for cases of fractured femur has proved most difficult in the present war.

It is not surprising that adequate results have not always been secured in these cases, for all the appliances in common use for fractures of the femur have been developed in order to deal with cases under stationary conditions and, in general, for simple fractures.

It is true that reasonable comfort of the patient is usually secured by the administration of morphine. On the other hand, in the later course of these cases a good many amputations have been necessary, and the mortality has proved surprisingly high. It seems probable that the complications of severe infection and haemorrhage—both reactionary and secondary—should be attributed in some degree to the unsatisfactory fixation of the injured limb during the necessary period of transport. Laceration of muscles and vessels is bound to occur under such conditions, and, unless efficient extension is exerted on the limb, any wound, unless very large, becomes plugged by ruptured muscle. This obstruction to free drainage in the early days of the injury obviously assists the development and spread of any infection present in the wound track.

It is noticeable that the patients themselves seldom complain of great discomfort during the journey. This is undoubtedly due to regular and proper use of morphine. Yet the position of the limbs in such cases by the time they reach the base generally leaves much to be desired. The foot is usually rotated inwards, and the thigh is commonly telescoped owing to the lack of proper extension.

I propose to show that the method in common use of fixing these cases in some form of long outside splint is not satisfactory, and that in the majority of instances a modified form of Thomas's knee splint gives much better results.

Requirements to be Fulfilled.

If one defines the ideal requirements of a method of fixation suitable for use in the transport of these cases from the field ambulances to the base and thence to England, one would set down the following requirements—the first four apply to the present conditions in relation to the rapid handling and transport of large numbers of wounded; the last two are more purely surgical:

1. The splint should not be cumbersome, and should be standardizable.
2. The standard pattern should be easily adapted to all varieties of individual cases.
3. The application of the splint should be simple, and effected with the least possible disturbance of the patient.
4. After application of the splint, movement of the patient and his transfer from stretcher to bed should not displace the splint.
5. The apparatus should secure steady extension in the long axis of the limb; the fulfilment of this requirement presupposes fixation in the natural position, and secures the comfort of the patient.
6. When the splint is in position, access to any part of the limb for the purpose of changing dressings should be possible. Nursing duties should be rendered simple.

At the present time, for the transport of cases from the front to the base, an interrupted or bracketted long outside splint with an adjustable foot-piece is generally used. If one compares the features of this apparatus with the