ease with which it may be obtained, sawdust is very absorbent. The pads are somewhat bulky, but this feature, with careful management, is seldom inconvenient. The discharge is so evenly distributed throughout the mass of sawdust, that the bandages and bedclothes are not soiled nearly so quickly as they are with other forms of dressing. The resin of the wood seems to act as a deodorizer, and probably also as an antiseptic.

Sawdust is well adapted for civil or stationary military hospitals. Its extensive use at the present time would save hundreds of pounds. Other materials more portable, but more expensive, might be reserved mainly for field use.

REFERENCES.

¹ *Lancet*, vol. i, 1877, p. 902. ² *BRITISH MEDICAL JOURNAL*, September 19th, 1914. ³ *Colonial and Camp Sanitation*, 1903, p. 29.

INSECTS AND WAR:

V.—FLIES. (I) THE HOUSE-FLY
(*Musca domestica*).

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*Musca est meus pater nil potest clam illum haberi
Nec sacrum nec tam profanum quidquam est, quin
Ibi ilico adsit.*

PLAUTUS, *Mercator*.

"The common house-fly," says Ruskin, "is the most perfectly free and republican of creatures. There is no courtesy in him; he does not care whether it is a king or clown whom he teases, and in every step of his swift mechanical march and in every pause of his resolute observation there is one and the same perfect expression of perfect egotism, perfect independence and self-confidence and conviction of the world having been made for flies. Your fly free in the air, free in the chamber, a black incarnation of caprice, wandering, investigating, fleeting, flitting, feasting at his will with rich variety of feast, from the heaped sweets in the grocer's window to those of the butcher's back yard and from the galled place on your horse's neck to the brown spot on the road from which, as the hoof disturbs him, he rises with angry republican buzz; what freedom is like his?"

The house-fly is all that Ruskin describes it to be, but it is more. It is the most cosmopolitan of insects. Wherever man is there is the fly. It is found "From Greenland's icy mountains"
To "India's coral strand."

But it is naturally more frequent in warm climates than in cold, as the rate of its development depends very largely upon temperature,

Unlike the lice and the bed-bug, the fly, like the flea, passes through a complete metamorphosis. It will breed in almost any rotten matter, whether vegetable or animal, and it breeds most successfully, as Gordon Hewitt has pointed out, when certain processes of fermentation are taking place. Probably the fermentation has a favourable effect upon the food of their larvae. Undoubtedly the place most readily selected by the female for laying her eggs is stable manure. A few years ago there was a remarkable reduction in the number of house-flies in London, and Lord Montague of Beaulieu attributed this reduction to the refreshing and antiseptic petrol vapour with which the streets were then bathed. I do not know what experiments Lord Montague had made on the subject of the insecticidal value of petrol vapour, but the ordinary man in the street attributed—and I think more correctly—the diminution of the plague of flies to the absence of the nidus in which the female fly prefers to lay her eggs. Stable-yards had been turned into garages. Flies will, indeed, breed in almost any kind of dejecta, including the human, and in rotten straw, rotten wool, cotton garments, decaying vegetables and fruits, bad meat, rotten grain, and even in spittoons; but they prefer horse-manure.

In our country flies usually begin to breed in June and July, continuing well on into October if the weather be but warm. Their greatest activity is, however, in the hotter month of August and the beginning of September. In warm stables, restaurants, and kitchens, flies are able to develop

the whole winter through. A single fly will deposit at one time 100 to 150 eggs, and in the course of her summer life may produce five, or even six, batches of this size. The eggs are pearly white, elongated structures, with two converging lines, along which the egg-case will ultimately split to give exit to the larva. The eggs are laid by means of a long ovipositor a little way beneath the surface of the dung heap in a position where they will not be dried up. In favourable conditions the eggs hatch in from eight to twenty-four hours.

The first larva is legless, tapering towards the head, which bears a pair of breathing holes, or spiracles; the body is much stouter towards the hinder end. On the whole it is a white, unpleasant-looking maggot, called by freshwater fishermen a "gentle." By contracting and expanding its body it pushes its way through its moist surroundings. The skin is usually moulted some twenty-four hours later, but all these

Fig. 1.—Photograph of enlarged model of the house-fly (*Musca domestica*) in the American Museum of Natural History, New York. (From Gordon Hewitt.)

time limits depend much upon the temperature and favourable conditions. With normally high temperatures—say with 30° to 35° C.—the larva will become fully

grown in five or six days. The third and final larval stage, after the second moult or ecdysis, lasts three days, and when fully grown the maggot is now about half an inch in length. Externally twelve segments are

Fig. 2.—Mass of eggs of *M. domestica*. (From Gordon Hewitt.)

visible, but the internal anatomy shows that thirteen are really present though one is masked.

It is only during these larval stages that the insect grows, and it is never more bulky than in the third larval stage. Now it leaves the moist situation, in which it has flourished, and, crawling through the manure, seeks some dry or sheltered corner. For a time it rests, and then after an hour or two's quiescence it retracts, its anterior end assumes a barrel-shaped outline, its creamy white colour slowly changing to a mahogany brown. The larval skin forms the pupa case, and within this pupa case the body of the larva undergoes a wonderful change, far greater than even human beings undergo at the time of puberty. Many of its organs are disintegrated and re-formed, and in the course of three or four days the white, legless, repellent maggot, who "loves darkness rather than light," is changed into a lively, flying insect, seeking the sun and the companionship of man. As the

Fig. 3.—Eggs of *M. domestica*, $\times 40$, dorsal and dorso-lateral views. *a*, Anterior end. (From Gordon Hewitt.)

Frenchman said of the pork which goes into one end of the machine in the Chicago meat factory as live pig and comes out at the other in the form of sausages, "il est diablement changé en route."

In a short time after leaving the pupa case the fly has

Fig. 4.—Mature larva of *M. domestica*. *a.sp.*, Anterior spiracular process; *an.l.*, anal lobe; *sp.*, spiniferous pad. I-XIII, Body segments. (From Gordon Hewitt.)

stretched her wings, the chitin of her body has hardened, and she flies away "on her several occasions."

Flies become sexually mature in a week or ten days, and are capable of depositing their eggs four days after mating, so that if the conditions be indeed favourable the whole development from the egg to the perfect fly may be accomplished in nine, or ten days, and the second genera-

tions are able to lay their eggs ten days later. The appalling fecundity of such an insect explains the fact that in the hotter parts of the world nearly everything seems to be half covered with them.

The proboscis of a fly can only suck in liquid food, and when we see it feeding on solid substances, such as sugar, it has really dissolved the sugar by depositing some saliva on it, and is sucking up the sugary solution so produced. It not infrequently regurgitates its food in a spherical drop, which it generally reabsorbs.

As we have seen, flies are very susceptible to temperature, and with the approach of cold weather they either die or retire to hiding places in warm dwellings, and here in a state of suspended animation they pass the winter months. Many of them undoubtedly die in the autumn, as bees die, of old age; they are literally

worn out. But a great number fall victims to a parasitic fungus called *Empusa*. Flies killed by this fungus are frequently to be seen in autumn, hanging dead on windows, etc., surrounded by a little whitish powdery ring of spores discharged by the fungus. Like many other insects, they are extremely difficult to keep alive in captivity, and few have succeeded in rearing them for more than a month or two. It seems probable that those flies which survive the winter are fertilized females of the younger broods. During the winter they live upon their fat bodies and their abdomen shrinks, but in the spring it very soon regains its former proportions after a meal or two.

Gordon Hewitt, Copeman, Howlett and Merriam, and others have made experiments as to how far a fly can travel. Marked flies have been taken within forty-eight hours at distances ranging from 300 yards to a mile. Apparently the direction of the wind plays a considerable part in the distance they travel.

The house-fly has recently become of very great importance to humanity, and especially to humanity at war, as a carrier of disease, especially of bacterial disease. Moses was as great a Principal Medical Officer as he was as a Director of Supplies, and this is shown in Deuteronomy, chapter xxiii, where he deals with the need of strict

Fig. 5.—Pupal case or puparium of *M. domestica* from which the imago has emerged, thus lifting off the anterior end or "cap" of the pupa; ventro-lateral aspect. *a.sp.*, Remains of the anterior spiracular process of larva; *l.tr.*, remains of the larval lateral tracheal trunk; *n.sp.*, temporary spiracular process of nymph; *p.sp.*, remains of the posterior spiracles of larva.

Fig. 6.—"Nymph" of *M. domestica* dissected out of pupal case about thirty hours after pupation. *an.*, Swellings of nymphal sheath marking bases of antennae; *cx.*, coxa of leg; *lb.*, labial portion of proboscis sheath; *lbr.*, labral portion of same; *n.sp.*, spiracular process of nymph; *w.*, wing in nymphal alar sheath. (From Gordon Hewitt.)

hygiene in the camp. In the middle of last century already attention was being drawn to the fact that the house-fly and the blow-fly transmitted various diseases. But it was during the American-Spanish war and the South African war which followed shortly afterwards that the part played by these pests in conveying enteric became definitely established. Flies coming straight from the latrines with their legs and their wings and their proboscides soiled with typhoid bacilli would enter the camp and

Fig. 7.—*M. domestica* in the act of regurgitating food. $\times 4$.
(From Gordon Hewitt.)

the tents of the soldiers and settle on their food supplies, crawling over their jam, floating in their milk. Thirty per cent. of the deaths in the Boer war were due to typhoid fever. The bacillus, as is well known, is capable of existing for a long time and of persisting alive in the alimentary canal of the insect; and Graham Smith has shown that the bacilli may remain active for six days after feeding, and that the feet of flies which have the bacillus on them are capable of infecting surfaces upon which they walk for at least two days after first coming in contact with the germs.

Faichne reared maggots in dejecta infected with typhoid bacilli, and he was able to show that the flies into which these maggots turned contained virulent typhoid germs in their intestines. There is absolutely no doubt that typhoid is largely conveyed by the agency of these insects, and as flies are perfectly controllable if the people will but have it so, it is one of the disgraces of our civilization that this disease should be so prevalent.

The protective inoculation against enteric is now almost perfect, and its value is shown by two quotations from a valuable leaflet issued by the Research Defence Society:

Sir William Leishman, in a letter published

during the present war, August 22nd, 1914, says: "The benefits of inoculation are so well recognized in the regular forces that we find little difficulty, in foreign stations, in securing volunteers for inoculation; for instance, about 93 per cent. of the British garrison of India have been protected by inoculation, and typhoid fever, which used to cost us from 300 to 600 deaths annually, was last year responsible for less than 20 deaths. Inoculation was made compulsory in the American army in 1911, and has practically abolished the disease; in 1913 there were only 3 cases and no deaths in the entire army of over 90,000 men."

In Avignon, in the south of France, during the summer of 1912, typhoid fever broke out in the barracks. Of 2,053 men, 1,366 were protected and 687 were not. The non-pro-

ected had 155 cases of typhoid, of whom 21 died; the protected had not one case. In the winter of 1913 the French Senate resolved that the protective treatment should be made compulsory throughout the French army; and, in special circumstances, among the reservists.

Infantile diarrhoea, which so afflicts the crowded poorer quarters of our cities in the summer, is another disease

Fig. 8. A, Foot of a fly, showing hairs bearing bacteria; B, a single hair more highly magnified; C and C', bacteria.

intimately connected with the *Musca domestica*. But that is hardly a disease likely to trouble the soldiers. The tubercle bacillus is another germ conveyed by flies. They are particularly fond of feeding on saliva, and Lord, Hayward, and Graham-Smith have obtained virulent bacilli from the intestines and dejecta of flies which had been fed on tubes containing tuberculous sputum. These experiments have been amply confirmed by other workers. Any one who has ever been in Egypt will remember the terrible

sight of the flies attacking little children suffering from ophthalmia, and it is believed that the wide prevalence of this most pitiful trouble is attributable to the abundance of flies—the flies of Egypt.

Another disease—anthrax, or wool-sorter's disease—may be conveyed by the same carriers from infected cattle, and there is a good deal of epidemiological and bacteriological evidence available to show that flies play an important part in the spread of cholera, which is now becoming alarmingly prevalent in the Eastern seat of the war, and possibly in disseminating the organisms which cause yaws and tropical sore.

It will be noticed that the fly is not a necessary second host for any of these germs. They are conveyed, as if by an

inoculating needle, by contact with the proboscis or the legs or other organ of the fly. Other bacilli, however, pass through the alimentary canal apparently unchanged and unharmed, and are deposited either with the regurgitated food from the fly's stomach, or with the dejecta of the insect. There is no subcutaneous inoculation such as takes place in the case of the mosquito when it conveys malaria, or in the case of the tsetse fly conveying sleeping sickness, where the disease-causing organism is injected into the human body. The action of the fly is mechanical, but none the less efficient. The poisoning of the soldiers' food supply is its chief rôle.

(To be continued.)

Fig. 9.—Chart illustrating the relation of the numerical abundance of house-flies to summer diarrhoea in the city of Manchester in 1914. Prepared from statistics and chart given by Niven.