

FLIES AND FLEAS AS FACTORS IN THE DISSEMINATION OF DISEASE.

THE EFFECTS OF PETROLEUM AS AN INSECTICIDE.

By J. S. PURDY, M.D., C.M. (ABERD.), D.P.H. (CAMB.).

[By courtesy of the Editor of "Kui Tiaki".]

OF late more attention is being given to the rôle of insects as carriers of disease.

Malaria, Yellow Fever and Filaria are carried by special varieties of the mosquito.

The bed bug has been shown to carry the spirillum of Relapsing Fever; a tick, Red Water Fever; the tsetse fly, Sleeping Sickness; the flea, Plague; and more recently, the owl-midge,—a special variety of the sand fly—the special form of Three Days Mediterranean Fever.

Much evidence has accumulated against the common house and other flies as carriers of Typhoid, Infantile Diarrhoea, Bacillary Dysentery, Cholera, Tubercle, Diphtheria, Erysipelas, Contagious Ophthalmia, Cerebro-spinal Meningitis, Anthrax, and possibly other diseases such as Small-pox.

With regard to the first of these diseases, Cols. Firth and Horrocks of the R.A.M. College, London, have shown that enteric stools may contain from three to five typhoid bacilli in 0.006 milligramme, almost an infinitesimal amount of dejecta. When the number and volume of evacuations from a single patient are considered, one can realise the enormous possibilities of infection unless the dejecta are at once removed, burnt, boiled, sterilised, or deeply buried. It is a fact also that long after convalescence the typhoid bacillus is voided in the urine, according to some observers in at least 25 per cent. of cases.

It is now definitely proved also that the typhoid organism may retain its vitality in the human alimentary canal for an indefinite period extending, as in the case recorded by Prof. Dean of Aberdeen, up to twenty-nine years after apparent recovery from the disease. Outbreaks of enteric fever have now been shown not to be exclusively water-borne.

Anyone who had any doubts on this subject may lay them aside in the light of the evidence from the epidemic in Auckland last year, where parts of the city and suburbs remained immune when the disease was rife in other parts receiving the same water-supply which bacteriological tests also showed to be unpolluted. With regard to pollution of the air, there is practically no evidence of enteric fever in this respect resembling bacillary dysentery, diarrhoea and cholera—unlike most other infectious diseases,—being carried direct from one patient to another by means of air.

In the case of typhoid it has been necessary to look for an intermediate stage of existence on the part of the bacillus, such as we are familiar with in the case of Malaria, where the duodenum of the mosquito is a necessary temporary habitat during one stage of the development of the living virus. Ordinary house-flies convey enteric-infected material not only on their legs, wings, bodies, but also on their heads, more especially the mandibles. This is easily shown in any laboratory by getting a fly to walk over a plate of media on which there are cultures of any pathogenic or other organisms and then transferring it to a sterile plate. Each fly has six legs on each of which are two pads each conveying 1,200 hairs. Each of these 1,200 hairs secretes a sticky fluid. It is this fluid which allows a fly to walk upside down on the ceiling. The mechanism is that the points are raised when the pads adhere to anything, and lowered when it is desired to take another step. Thus, by the pressure of their points against the ground and the lifting of the "heel" the pads are released. When flies stick to a wall as in autumn, it is owing to them becoming too weak to use this mechanism, and the glue becomes hardened and set.

Flies breed in almost any decaying animal or vegetable matter, horse dung being especially a favourite breeding place. The eggs are long and white, and are hatched in six to eight hours into white pointed maggots. These grow with enormous rapidity, cast their skins twice, and under suitable conditions reach full growth in four to five days, when the outer skin becomes hard, swells up, turns dark brown in colour. Within this is the true pupa, from the anterior end of the brown covering of which five days later the adult fly issues. Thus, a single generation comes to maturity in ten days and it is said that as many as twelve generations are developed in one summer in some countries. Dr. Jackson, of New York, has estimated that each fly during the season lays 1,000 eggs. Thus, it is easy to account for the enormous number of flies wherever there exists organic filth or food, on both of which they feed.

In 1907 I made some interesting observations on the breeding of flies at Motuihi, the Quarantine Island in Auckland Harbour, which I also repeated in the laboratory. The most interesting point noticed was the disappearance of the maggots for a time to take up a pupa or intermediate stage in the superficial layers of the earth.

Major F. Smith, D.S.O., has shown in the R.A.M.O. Journal that the larvæ, if the soil is impermeable to them, will travel as much as at least ten feet to find suitable ground. Major Smith concludes that in India, where the whole country is littered with faeces, the flies bred out of excrement deposited on the ground by man and animals are greatly in excess of the number from any other source, whether in or out of cantonments.

Recently we have placed pieces of meat exposed to flies in specially constructed cages of wood and gauze. The maggots made for the floor of the

cage. At first when we placed earth in the cages, we found the fly went through the stages of development described above. As a result of further experiments without earth we have bred flies direct from the meat, the maggots and pupa simply honey-combing the flesh. Thus we have demonstrated that it is not essential for the breeding of flies that the pupa should develop in earth.

An interesting experiment in our laboratory was the placing of flies on gelatine media,—not only did we obtain organisms, chiefly the *B. Putrefaciens*,—but also thirteen maggots from one fly. These maggots bored their way into the gelatine and were suffocated.

Maggots kept in corked test tubes apparently died in four hours but on admitting air revived. A lighted taper placed in a test tube in which maggots had been kept was extinguished, thus showing that although Carbonic Anhydride was formed, it did not kill the maggots as quickly as higher forms of animal life.

The United States Department of Agriculture has published recently a report by Prof. Howard, their entomologist, in which it is stated that, assuming that only one-half of a fly's output of eggs hatch out and live to raise families of their own, in thirty days the number of flies is 216,000, and in forty days over twelve millions. Allowing 1,000 flies to the ounce, we find that the total produce of one fly at the end of forty days would weigh 810lbs. or more than five times the weight of a 160-lb. man. Thus, no further argument is needed to show the importance of endeavouring to exterminate as far as possible the housefly at the beginning of the season.

Prof. Santori, from cultures derived from flies frequenting a Roman market-place, isolated a bacillus which morphologically and by culture tests was identical with the organism shown by Dr. Volpino to be most frequent in epidemic diarrhoea.

Although in the laboratory it is easy to show that pathogenic organisms pass through the alimentary canal of a fly, yet it is not claimed that other than as mechanical carriers of germs do they transmit disease.

Whilst working in the Quarantine Laboratory at Port Said in 1908, I obtained *B. Coli* from the excrement of flies. Owing to the danger of infection, flies being very difficult to keep under control in transferring them from one medium to another, I have not experimented with typhoid stools or cultures.

Dr. Fricker has shown that flies fed on typhoid cultures give off the bacilli twenty-three days after infection. Typhoid bacilli were found in the intestine nine days after feeding on typhoid materials.

Whilst serving with Plumer's column in South Africa, I recorded the observation in the *Lancet* that whilst other columns suffered largely from typhoid, we remained comparatively immune until after we had rested a fortnight in a standing camp at Wakkerstrom. The reason we escaped during

our first nine months' service, was probably due to the fact that we seldom camped two days running in the same place, and seldom re-occupied a previous camping ground. With the outbreak of typhoid we had coincident therewith a plague of flies. The latrines speedily became their breeding and happy hunting ground in the intervals between their visits to the supply stores and the different messes. Had the bugle been the signal to go to mess, one could almost have believed that the flies knew the call. Although convinced of the part flies played in carrying disease from having seen them feeding on typhoid stools in South Africa; in Egypt, on the pus of contagious ophthalmia, and in the Sinai Peninsula on the excreta of pilgrims, dead and dying of bacillary dysentery, perhaps one of the most striking cases of fly infection within my ken was that at the outbreak of the typhoid epidemic in Auckland last year.

Ever on the outlook for instances of the conveyance of infection by flies, advocating *ad nauseam* the regular removal of all organic refuse, more especially stable manure and excreta—favourite breeding grounds—as well as the use of kerosene as an insecticide, I hardly expected to come across so remarkable an example of this method of typhoid conveyance. On the removal of one of the earliest cases to the hospital, the relatives left the infected house. A wooden box—the usual receptacle in that suburb at that time—contained the discharges of the patient. “Because it was not full” on the occasion of his fortnightly visit, the contractor's man did not remove the contents. The flies immediately proceeded to do so. Some days later our Inspector (Mr. Grieve) found the box “swarming with maggots.” Small wonder that even in a small borough, with a population of a little over 2,000, we had 23 cases in two months. Around the first house affected the other cases occurred in such a way as to show a cluster of flags round this centre on a “spot map.” In a letter last May, Professor Kenwood, speaking of this, wrote: “The fly-borne outbreak at Newmarket is one in which the evidence is very direct and convincing.”

The dry-earth or pail-closet system in towns is therefore absolutely reprehensible from a sanitary point of view, especially so is this in New Zealand, where there is great difficulty in getting labour to remove the pans, and a total lack of co-ordination between town and rural authorities as regards the latter permitting the use of land in their areas.

(To be continued.)

“Is Mr. Fusse much afraid of microbes?”

“Well, I should say: he washes the antiseptic gauze gloves he wears in an antiseptic fluid before he even handles the sterilized glass that contains the boiled and filtered mineral water he intends to drink,”