vessel of best thin Lowmoor plate (1 millimeter thick), about 16 centimeters in height, and having an internal volume of about 540 cubic centimeters, was weighed, first empty, and subsequently when filled with distilled water at a known temperature. The necessary data were thus afforded for accurately determining its capacity at the temperature of the air. Molten silver was then poured into it, the temperature at the time of pouring being ascertained by the calorimetric method. The precautions, as regards filling, pointed out by Mr. Mallet, were adopted; and as soon as the metal was quite cold, the cone with its contents was again weighed. Experiments were also made on the density of fluid bismuth; and two distinctive determinations gave the following results:

$$\left.\begin{matrix}10{\cdot}005\\10{\cdot}072\end{matrix}\right\}\text{ mean, }10{\cdot}039.$$

The invention of the oncosimeter, which was described by one of the authors in the "Journal of the Iron and Steel Institute" (No. II., 1879, p. 418), appeared to afford an opportunity for resuming the investigation on a new basis, more especially as the delicacy of the instrument had already been proved by experiments on a considerable scale for determining the density of fluid cast iron. The following is the principle on which this instrument acts:

If a spherical ball of any metal be plunged below the surface of a molten bath of the same or another metal, the cold ball will displace its own volume of molten metal. If the densities of the cold and molten metal be the same, there will be equilibrium, and no floating or sinking effect will be exhibited. If the density of the cold be greater than that of the molten metal, there will be a sinking effect, and if less a floating effect when first immersed. As the temperature of the submerged ball rises, the volume of the displaced liquid will increase or decrease according as the ball expands or contracts. In order to register these changes the ball is hung on a spiral spring, and the slightest change in buoyancy causes an elongation or contraction of this spring which can be read off on a scale of ounces, and is recorded by a pencil on a revolving drum. A diagram is thus traced out, the ordinates of which represent increments of volume, or, in other words, of weight of fluid displaced—the zero line, or line corresponding to a ball in a liquid of equal density, being previously traced out by revolving the drum without attaching the ball of metal itself to the spring, but with all other auxiliary attachments. By means of a simple adjustment the ball is kept constantly depressed to the same extent below the surface of the liquid; and the ordinate of this pencil line, measuring from the line of equilibrium, thus gives an exact measure of the floating or sinking effect at every stage of temperature, from the cold solid to the state when the ball begins to melt.

If the weight and specific gravity of the ball be taken when cold, there are obtained, with the ordinate on the diagram at the moment of immersion, sufficient data for determining the density of the fluid metal; for

$$\frac{W}{W_1}=\frac{D}{D_1},$$

the volumes being equal. And remembering that

$$W\text{ (weight of liquid)}= W_1\text{ (weight of ball)}+x$$

(where x is always measured as $+ve$ or $-ve$ floating effect), there is obtained the equation:

$$D=\frac{D_1\times(W_1+x)}{W_1}.$$

The results obtained with metallic silver are perhaps the most interesting, mainly from the fact that the metal melts at a higher temperature, which was determined with great care by the illustrious physicist and metallurgist, the late Henri St. Claire Deville, whose latest experiments led him to fix the melting point at 940° Cent. The authors of the paper showed that the density of the fluid metal was 9·51 as compared with 10·57, the density of the solid metal. Taking their results generally, it is found that the change of volume of the following metals in passing from the solid to the liquid state may be thus stated:

Metal.	Specific Gravity, Solid.	Specific Gravity, Liquid.	Percentage of Change.
Bismuth..	9·82	10·055	Decrease of volume 2·3
Copper..	8·8	8·217	Increase " 7·1
Lead	11·4	10·37	" " 9·93
Tin	7·5	7·025	" " 6·76
Zinc.....	7·2	6·48	" " 11·10
Silver ...	10·57	9·51	" " 11·20
Iron	6·95	6·88	" " 1·02

HYDROPHOBIA PREVENTED BY VACCINATION.

M. PASTEUR and other French savants have lately been devoting special attention to hydrophobia. The great authority on germs has, in fact, definitely announced that he does not intend to rest until he has made known the exact nature and life-history of this terrible disease, and discovered a means of preventing or curing it. The most curious result yet attained in this direction, however, has been announced by Professor V. Galtier, of the Lyons Veterinary School. This inquirer has found, in the first place, that if the virus of rabies be injected into the veins of a sheep, the animal does not subsequently exhibit any symptoms of hydrophobia. This in itself would be a sufficiently curious result to justify attention, though its importance, except as confirmatory testimony, becomes less striking when it is remembered that M. Pasteur has lately shown that the special *nidus* of the disease appears to be the nervous tissue, and particularly the ganglionic centers. But there is this further curious consequence: sheep who have thus been treated through the blood, and who are afterwards inoculated in the ordinary way through the cellular tissue, as if by a bite, are proof against the disease. It is as though the injection into the veins acted as a vaccine. Twenty sheep were experimented upon; ten only were treated to the venous injection, and then all were inoculated through the cellular tissue. The ten which had been first "vaccinated" continue alive and well; they have not even shown any adverse symptoms. The other ten have all died of rabies. It remains to say why M. Galtier experimented upon sheep, and not upon dogs and cats, which usually communicate the disease. The incubation of the disease is much more rapid and less capricious in the sheep than in the dog or in man, and hence M. Galtier was able to get his results more certainly within a short period. Having succeeded so far, he is now justified in undertaking the more protracted series of observations which experiments upon the canine species will involve; and this he proposes to do. Experiments of this nature are not without a serious risk, and admiration is almost equally due to the courage and the intelligence of the experimentalist. But what will the anti-vaccinator say?—*Pall Mall Gazette.*

ON DIPTERA AS SPREADERS OF DISEASE.

By J. W. SLATER.

THE two-winged flies, in their behavior to man, stand in a marked contrast to all the other orders of insects. The Lepidoptera, the Coleoptera, the Neuroptera, the Hymenoptera no doubt occasion, in some of their forms at least, much damage to our crops. But none of them are parasitic in or upon our bodies; none of them persistently intrude into our dwellings, hover around us in our walks, and harass us with noise and constant attempts to bite, or at least to crawl upon us. Even the ants, except in a few tropical districts, rarely act upon the offensive. The Hemiptera contain one semi-parasitic species which has attained a "world-wide circulation," and one degraded, purely parasitic group. But the Diptera, among which the fleas are now generally included as a degenerated type, comprise more forms personally annoying to man than all the remaining insect orders put together. These hostile species are, further, incalculably numerous, and occur in every part of the globe. Mosquitoes swarm not merely in the swampy forests of the Orinoco or the Irrawaddy, but in the Tundras of Siberia, on the storm-beaten rocks of the Loffodens, and are even encountered by voyagers in quest of the North Pole. The common house fly was probably at one time peculiar to the Eastern Continent, but it followed the footsteps of the Pilgrim Fathers, and is now as great a nuisance in the United States and the Dominion as in any part of Europe. It is curious, but distressing, to note the tendency of evils to become international. We have communicated to America the house-fly and the Hessian fly, the "cabbage-white," the small-pox, and the cholera. She, in return, has given us the *Phylloxera*, a few visitations of yellow fever, the *Blatta gigantea*, and, climate allowing, may perhaps throw in the Colorado beetle as a make-weight. In this department, at least, free trade reigns undisputed. It is a singular thing that no beautiful, useful, or even harmless species of bird or insect seems capable of acclimatizing itself as do those characterized by ugliness and noisomeness.

But, returning from this digression, we find in the Diptera the habit of obtrusion and intrusion, of coming in actual contact with our food and our persons, combined with another propensity—that of feeding upon carrion, excrement, blood, pus, and morbid matter of all kinds. This is a combination far more serious than is generally imagined. If the fly—which may at any moment settle upon our lips, our eyes, or upon an abraded part of our skin—were cleanly in its habits, we need feel little annoyance at its visits. Or if it were the most eager carrion devourer, but did not, after having dined, think it necessary to seek our company, we might hold it, as is done too hastily by some naturalists, a valuable scavenger. I fear, however, that I have already made too great a concession. So long as very many persons are suffering from disease—so long as many diseases are capable of being transmitted from the sick to the healthy—so long must any creature which is in the habit of flying about, and touching first one person and then another, be a possible medium of infection and death.

Let us take the following case, by no means imaginary, but a generalization from occurrences far too frequent: A healthy man, sitting in his house or walking in the fields, especially in countries where the insectivorous birds have been shot down, suddenly feels a sharp prick on his neck or his cheek. Putting his hand to the place he perhaps crushes, perhaps merely brushes away, a fly which has bitten him so as to draw blood. The man thinks little of so trifling a hurt, but the next morning he finds the puncture exceedingly painful. An inflamed pimple forms, which quickly gets worse, while constitutional symptoms of a feverish kind come on. In alarm he seeks medical advice. The doctor tells him that it is a malignant pustule, and takes at once the most active measures. In spite of all possible skill and care the patient too often succumbs to the bite of a *mouche charbonneuse*, or carbuncle-fly. But has any kind of fly the property of producing malignant pustule by some specific inherent power of its own? Surely not. The antecedent circumstances are these: A sheep or heifer is attacked with the disease known in France as *charbon*, in Germany as *milz-brand*, and in England as *splenic fever*. Its blood on examination would be found plentifully peopled with bacteria. If a lancet were plunged into the body of the animal, and were then used to slightly scratch or cut the skin of a man, he would be inoculated with "charbon." The bite of the fly is precisely similar in its action. Its rostrum has been smeared with the poisoned blood, an infinitesimal particle of which is sufficient to inclose several of the disease "germs," and these are then transferred to the blood of the next man or animal which the fly happens to bite. The disease is reproduced as simply and certainly as the spores of some species of fern give rise to their like if scattered upon soil suitable for their growth. But flies which do not bite may transfer infection. Every one must know that if blood be spilt upon the ground a crowd of flies will settle upon and eagerly absorb it. Animals suffering from splenic fever in the later stages of the disease sometimes emit bloody urine. Often they are shot or slaughtered by way of stamping out the plague, and their carcasses are buried deep in the ground. But some loss of blood is sure to happen, and this will mostly be left to soak into the ground. Here again the flies will come, and their feet and mouth will become charged with the contagion. Such a fly, settling upon another animal or a man, and selecting—as it will do by preference, if such exist—a wound, or a place where the skin is broken, will convey the disease.

Again, M. Pasteur has thoughtfully pointed out that if an animal has died of splenic fever, and has been carefully buried, the earth-worms may bring up portions of infectious matter to the surface, so that sheep grazing, or merely being folded over the spot in question, may take the plague and die. Hence he wisely counsels that the bodies of such animals should be buried in sandy or calcareous soils where earth-worms are not numerous. But it is perfectly legitimate to go a step farther. If such worm-borings retain the slightest savor of animal matter, flies will settle upon them and will convey the infectious dust to the most unexpected places, giving wings to the plague.

Now it is very true that no one has seen a fly feasting upon the blood of a heifer or sheep dying or just dead of splenic fever, has then watched it settle upon and bite some person, and has traced the following stages of the disease. But it is positively known that a person has been bitten by a fly, and has then exhibited all the symptoms of charbon, the place of the bite being the primary seat of the infection. We know also, beyond all doubt, the eagerness with which flies will suck up blood, and we likewise know the strange persistence of the disease "germs."

Again, the avidity of flies for purulent matter is not a thing of mere possibility. In Egypt, where ophthalmia is common, and where the "plague of flies" seems never to have been removed, it is reported as almost impossible to keep these insects away from the eyes of the sufferers. The infection which they thus take up they convey to the eyes of persons still healthy, and thus the scourge is continually multiplied.

A third case which seems established beyond question is the agency of mosquitoes in spreading elephantiasis. These so-called sanitary agents suck from the blood of one person the Filariæ, the direct cause of the disease, and transfer them to another. The manner in which this process is effected will appear simple enough if we reflect that the mosquito begins operations by injecting a few drops of fluid into its victim, so as to dilute the blood and make it easier to be sucked.

So much being established it becomes in the highest degree probable that every infectious disease may be, and actually is, at times propagated by the agency of flies. Attention turned to this much neglected quarter will very probably go far to explain obscure phenomena connected with the distribution of epidemics and their sudden outbreaks in unexpected quarters. I have seen it stated that in former outbreaks of pestilence flies were remarkably numerous, and although mediæval observations on Entomology are not to be taken without a grain of salt, the tradition is suggestive. Perhaps the Diptera have their seasons of unusual multiplication and emigration. A wave of the common flea appears to have passed over Maidstone in August, 1880.

We now see the way to some practical conclusions not without importance. Recognizing a very considerable part of the order of Diptera, or two-winged flies, as agents in spreading disease, it surely follows that man should wage war against them in a much more systematic and consistent manner than at present. The destruction of the common house fly by "*papier Moure,*" by decoctions of quassia, by various traps, and by the so-called "catch 'em alive," is tried here and there, now and then, by some grocer, confectioner, or housewife angry at the spoliation and defilement caused by these little marauders. But there is no concerted continuous action—which after all would be neither difficult nor expensive—and consequently no marked success. Experiments with a view of finding out new modes of fly-killing are few and far between.

Every one must occasionally have seen, in autumn, flies as if cemented to the window-pane, and surrounded with a whitish halo. That in some seasons numbers of flies thus perish—that the phenomenon is due to a kind of fungus, the spores of which readily transfer the disease from one fly to another—we know. But here our knowledge is at fault. We have not learnt why this fly-epidemic is more rife in some seasons than others. We are ignorant concerning the methods of multiplying this fungus at will, and of launching it against our enemies. We cannot tell whether it is capable of destroying *Stomoxys calcitrans*, the blowflies, gad-flies, gnats, mosquitoes, etc. Experiment on these points is rendered difficult by the circumstance that the fungus is rarely procurable except in autumn, when some of the species we most need to destroy are not to be found. Another question is whether the fungus, if largely multiplied and widely spread, might not prove fatal to other than Dipterous insects, especially to the Hymenoptera, so many of which, in their character of plant-fertilizers, are highly useful, or rather essential to man.

Another fungus, the so-called "green muscardine" (*Isaria destructor*), has been found so deadly to insects that Prof. Metschnikoff, who is experimenting upon it, hopes to extirpate the *Phylloxera*, the Colorado beetle, etc., by its agency.

Coming to better known and still undervalued fly-destroyers, we have interfered most unwisely with the balance of nature. The substitution of wire and railings for live fences in so many fields has greatly lessened the cover both for insectivorous birds and for spiders. The war waged against the latter in our houses is plainly carried too far. Whatever may be the case at the Cape, in Australia, or even in Southern Europe, no British species is venomous enough to cause danger to human beings. Though cobwebs are not ornamental, save to the eye of the naturalist, there are parts of our houses where they might be judiciously tolerated: their scarcity in large towns, even where their prey abounds, is somewhat remarkable.

But perhaps the most effectual phase of man's war against the flies will be negative rather than positive, turning not so much on putting to death the mature individuals as in destroying the matter in which the larvæ are nourished. Or if, from other considerations, we cannot destroy all organic refuse, we may and should render it unfit for the multiplication of these vermin. We have, indeed, in most of our large towns and in their suburbs, abolished cesspools, which are admirable breeding-places for many kinds of Diptera, and which sometimes presented one wriggling mass of larvæ. We have drained many marshes, ditches, and unclean pools, rich in decomposing vegetable matter, and have thus notably checked the propagation of gnats and midges. I know an instance of a country mansion, situate in one of the best wooded parts of the home-counties, which twenty years ago was almost uninhabitable, owing to the swarms of gnats which penetrated into every room. But the present proprietor, being the reverse of pachydermatous, has substituted covered drains for stagnant ditches, filled up a number of slimy ponds as neither useful nor ornamental, and now in most seasons the gnats no longer occasion any annoyance.

But if we have to some extent done away with cesspools and ditches, and have reaped very distinct benefit by so doing, there is still a grievous amount of organic matter allowed to putrefy in the very heart of our cities. The dust-bins—a necessary accompaniment of the water-carriage system of disposing of sewage—are theoretically supposed to be receptacles mainly for organic refuse, such as coal-ashes, broken crockery, and at worst the sweepings from the floors. In sober fact they are largely mixed with the rinds, shells, etc., of fruits and vegetables, the bones and heads of fish, egg-shells, the sweepings out of dog-kennels and hen-houses, forming thus, in short, a mixture of evil odor, and well adapted for the breeding-place of not a few Diptera.