ON DIPTERA AS SPREADERS OF DISEASE (Classics Revisited)

SOBRE DIPTEROS COMO PROPAGADORES DE DOENÇAS (clássicos revisitados)

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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, en 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 Slates 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 be 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 Filariae, 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 mediaeval 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 calcitram*, the blowflies, gadflies, 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 larvae 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 larvae. 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 henhouses, forming thus, in short, a mixture of evil odor, and well adapted for the breeding-place of not a few Diptera.

The uses to which this "dust" is put when ultimately fetched away are surprising: without being freed from its organic refuse it is used to fill up hollows in building-ground, and even for the repair of roads. A few weeks ago I passed along a road which was being treated according to the iniquity of Macadam. Over the broken stones had been shot, to consolidate them, a complex of ashes, cabbage-leaves, egg and periwinkle shells, straw, potato-parings, a dead kitten (over which a few carrion-flies were hovering), and other promiscuous nuisances. The road in question, be it remarked, is highly "respectable," if not actually fashionable. The houses facing upon it are severely rated, and are inhabited chiefly by "carriage people." What, then, may not be expected in lower districts?

Much attention has lately been drawn to the fish trade of London. It has *not*, however, come out in evidence that the fish retailers, if they find a quantity of their perishable wares entering into decomposition, send out late in the evening a messenger, who, watching his opportunity, throws his burden down in some plot of building land, or over a fence. When I say that I have seen in one place, close alongside a public thoroughfare, a heap of about fifty herrings, in most active putrefaction and buzzing with flies, and some days afterward, in another place, some twenty soles, it will be understood that such nuisances can only be occasioned by dealers. To get rid of, or at least greatly diminish, carrion-flies, house-flies, and the whole class of winged travelers in disease, it will be, before all things, essential to abolish such loathsome malpractices. The dustbins must cease being made the receptacle for putrescent and putrescible matter, the destruction of which by fire should be insisted upon.

The banishment of slaughter-houses to some truly rural situation, where the blood and offal could be at once utilized, would be another step toward depriving flies of their pabulum in the larva state. An equally important movement would be the substitution of steam or electricity for horsepower in propelling tram-cars and other passenger carriages, with a view to minimize the number of horses kept within greater London. Every large stable is a focus of flies--*Journal of Science*.

On the relations of minute organisms to certain specific diseases

At the recent Medical Congress in London, Professor Klebs undertook to answer the question: "Are there specific organized causes of disease?"

A short historical review of the various opinions of mankind as to the origin of disease led, the speaker thought, to the presumption that these causes were specific and organized.

If we now, he said, consider the present state of this question, the three following points of view present themselves as those from which the subject may be regarded:

I.--We have to inquire whether the lower organisms, which are found in the diseased body, may arise there spontaneously; or whether even they may be regarded as regular constituents of the body.

II.--The morphological relations of these organisms have to be investigated, and their specific nature in the different morbid processes has to be determined.

III.--We have to inquire into their biological relations, their development inside and outside the body, and the conditions under which they are able to penetrate into the body, and there to set up disease.

First.--With regard to the first question, that of the possibility of spontaneous generation, the speaker gave a decided negative.

Second and third.--There is in microscopic organisms a difference of form corresponding, as a rule, to difference of function. The facts regarding these various lower forms are briefly reviewed.

"Three groups of hyphomycetae, algae, and schizomycetae, have been demonstrated to occur in the animal and human organism in infective diseases. Their significance increases with the increase of their capacity for development in the animal body. This depends partly upon their natural or ordinary conditions of life, but partly also, and that in a very high degree, upon their power of adaptation, which, as Darwin has shown, is a property of all living things, and causes the production of new species with new active functions.

"1. The hyphomycetae, on account of their needing an abundant supply of oxygen, give rise to but few morbid processes, and these run their course on the surface of the body, and are hence relatively of less importance. It will be sufficient here to refer to the forms, achorion, trichophyton, oïdium, aspergillus, and the diseases produced by them, favus, ringworm, and thrush, to show this peculiarity. Nevertheless, we see that these organisms also (as was proved by the older observations of Hannover and Zenker) may, under certain circumstances, penetrate into the interior of the organs. Grawitz, moreover, has recently shown that their faculty of penetrating into the interior of the

organism, and there undergoing further development, depends on their becoming accustomed to nitrogenous food.

"2. Only one of the algae, viz., leptothrix, has as yet acquired any importance as a producer of disease. It gives rise to the formation of concretions, and that not only in the mouth, but also, as I have shown, in the salivary ducts and urinary bladder.

"Another alga, the sarcina of Goodsir, may indeed pass through the organism, without, however, producing in its passage either direct or indirect disturbances. It seems more worthy of note that many schizomycetae, and especially the group of bacilli, are evidently nearly allied to the algae in their morphological and vegetative relations--so as to be assigned to this class by several authors, and especially by Cienkowski.

"The schizomycetae furnish, without doubt, by far the most numerous group of infective diseases. We distinguish within this group two widely different series of forms, which we will speak of as bacilli and cocco-bacteria respectively. The former, which was first exhaustively described by Ferdinand Cohn, and the pathological importance of which, especially in relation to the splenic disease of cattle, was first shown by Koch, consist of threads, in the interior of which permanent or resting-spores are developed. These spores becoming free, are able, under suitable conditions of life, again to develop into threads. The whole development of these organisms, and especially the formation of spores, is completed on the surface of the fluids, and under the influence of an abundant supply of oxygen.

"The number of affections in which these organisms have been found, and which may be to a certain extent produced artificially by the introduction of these organisms into healthy animal bodies, has been largely increased since the discovery of Koch, that the bacteria of splenic fever (anthrax) belong to this group. Under this head must be placed the bacillus malarise (Klebs and Tommassi-Crudeli), the bacillus typhi abdominalis (Klebs, Ebert), the bacillus typhi exanthematici (Klebs, observations not yet published), the bacillus of hog-cholera (Klein), and, finally the bacillus leprosus (Neisser). It would exceed the time appointed were I to attempt to describe these forms more minutely. This may, perhaps, be better reserved for discussion and demonstration.

"Alongside of these general infective diseases produced by bacilli, local affections also occur, which indicate the presence of these organisms at the point where disease begins. As an example of these processes, which probably occur in various organs, I would mention gastritis bacillaris, of which I shall show you preparations. In this, we can trace the entrance of the bacilli into the peptic glands, as well as their further distribution in the walls of the stomach, and in the vascular system.

"The second group of the pathogenetic schizomycetae I propose to call, with Billroth, cocco-bacteria, because they consist of collections of micrococci, which are capable of transforming themselves into short rods. The former usually form groups united by zoögloea; by prolongation of the cocci rods are formed, which sprout out, break up by division into chains, and further lead again to the formation of resting masses of cocci. I distinguish, further, in this group, two genera--the microsporina and the monadina; in the former of which the micrococci are collected into spherical lumps, in the latter into layers. The one class is developed in artificial cultivation fluid, the other on the surface. The former requires a medium poor in oxygen, the latter a medium rich in oxygen, for their development.

"Among the affections produced by microsporina, I reckon especially the septic processes, and also true diphtheria. On the other hand, to the processes produced by

monadina belong especially a large series of diseases, which according to their clinical and anatomical features, may be characterized as inflammatory processes, acute exanthemata, and infective tumors, or leucocytoses. Of inflammatory processes, those belong here which do not generally lead to suppuration, such as rheumatic affections, including the heart, kidney, and liver affections, which accompany this process, sequelae which, as is well known, lead more especially to formation of connective tissue, and not to suppuration. Here, also, belong croupous pneumonia, the allied disease erysipelas, certain puerperal processes, and finally, parotitis epidemica, or mumps.

"Among the acute exanthemata, the following may, up to the present time, be placed in this group; variola-vaccina, scarlatina, and measles.

"The group of infective tumors is represented by tuberculosis, syphilis, and glanders. Throughout the whole group of cocco-bacteria the demonstration of organisms in the diseased parts encounters difficulties which vary considerably in the different kinds."

The speaker concluded by describing the methods (now well known) by which the powers of the different organisms are tested.

He also referred to Pasteur's, Chauveau's, and Toussaint's recent experiments.

His conclusion was that the specific communicable diseases are produced by specific organisms.