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The Role of Parasitic Protophytes. Are they the Primary, or the Secondary Cause of Zymotic Diseases? By W. N. Lockington.

(*Read before the American Philosophical Society, April 6, 1883.*)

Parasitic unicellular organisms or microbes, usually considered to belong to the vegetable kingdom, are found, in some form or other, in the interior of the higher animals, both when in their normal state of health, and when suffering from disease.

Certain rod-like forms have received the generic name of *Bacillus;* spherical globules that of *Micrococcus*, while other shapes have been entitled *Vibrio, Bacterium*, and *Cladothrix*. The idea of those who gave these titles was evidently that each of these forms is actually distinct under existing circumstances.

Nomenclature has even proceeded farther than this, since such binomials as *Bacillus anthracis* exist.

During the last few years the microscope has been largely employed in the investigation of diseased tissues, especially in cases of those diseases called "zymotic;" and the result of this examination has been to show that certain specific forms of disease are invariably accompanied by what appear to be specific types of microbes—or at any rate by types that are constant in their relation to the disorder they accompany.

In this way Pasteur has made us acquainted with the parasite which accompanies anthrax, charbon, or malignant pustule, and with some others, Laveran has described and figured that of malaria, and Koch has shown that consumption has also its parasitic companion.

So generally have special forms been found associated with special diseases, and so invariably have these special forms been found to increase in number of individuals as the disease with which they are associated has increased in severity, that a large proportion of scientific and medical men have arrived at the conclusions that every *inflammatory* disease (if not every disease) has its *specific* parasite; and that the parasite is the cause of the disease.

This explanation certainly lies upon the face of the facts, but a little consideration will show that neither the *specific* nature of the parasite, nor its direct causation of the disease, are proved by any series of observations yet on record.

Observations upon the *higher* animals have conclusively proved that they are subject to considerable changes caused by their environment.

Within the limits of a single so-called species occur so many variations that the definition of a species has become difficult. Besides those variations due to sex and to age; individual, racial, and varietal differences occur, to such an extent as to render the systematic arrangement of living forms a most bewildering task, and one respecting which no two biologists agree.

These variations right and left of the average of a species are admitted on all hands to be produced by natural forces, organic and inorganic, by gravity, heat, cold, moisture or drouth, plenty or lack of food, confinement or freedom, cultivation (which is an environment of man's making) or heredity, which is the effect of the continued environment of ancestors.

No man can look dispassionately at his own physical and mental condition without acknowledging that, leaving heredity aside, he is what he is on account of what he has experienced.

The changes of cell-structure which take place in the arm of a man who abandons the yard-measure for the blacksmith's hammer would, could they be examined with the microscope in the same way that we can watch the changes of an amœba, be seen to be a thousand-fold greater and more complicated than those of that rhizopod.

As instances of what a change of environment can do in creatures built up of many thousand cells, each cell as complex as is the entirety of the parasitic organisms we are inquiring into, the following will suffice: The

same species of trout attains a larger size in large rivers than in small streams; anadromous salmon of a large species have, when by accident confined within a small fresh-water lake, in a few years so altered, becoming sexually mature when quite small, that a naturalist who did not know the cause might take them for a new species; fishes confined within a space so narrow that normal growth was impossible, yet supplied with food, have grown to fit the space; the clear silvery tints and graceful forms of salmon when in the sea are so unlike the muddy colors and misshapen outlines presented by the same individuals after ascent of a river that observers have founded on them many false species; and the larva of the conger eel becomes at times converted into a transparent, colorless pelagic fish that has received the name of *Leptocephalus Morrisii*.

Is it not reasonable to suppose that the outline of a plastic atom of protoplasm, bounded only by a delicate pellicle, is more readily amenable to the influences surrounding it than that of the million-celled creatures which are known to change so greatly?

The vegetable kingdom offers examples of variation as striking as those of the animal.

It is as hard to find two leaves of the same plant exactly alike as it is to find two Dromios. The stem-leaves and root-leaves of the same herbaceous plant differ more from each other than from the corresponding leaves of a kindred species. In some trees, as the ivy and the mulberry, the play of form is so great, that one unacquainted with the facts would certainly believe that forms gathered from the same stem belonged to different species. Each leaf, as truly as each human being, has its own particular environment, its share of light, heat, nutrition, etc., and these work changes in its form.

The change effected by the environment upon a plant goes further than form, size, or color, and extends to the nature of its secretions, so that plants which, when grown under certain conditions, are good food for man and beast, become toxic under other conditions. This is true of many of our garden vegetables; and, to come nearer to our microscopic organisms, it is true of certain many-celled fungi, such as the common agaric of the meadows.

In the latter case the fungus is on all hands allowed to be the same, yet while one specimen it innocuous, another is toxic.

Would it be very remarkable if it should be proved that an innocent one-celled microbe, surrounded with diseased and poisonous pabulum, should, if able to resist the influences around it without perishing, become poisonous itself?

Against the usual form of the germ theory, with its specific germs inducing specific diseases, it is allowable to put forth the following:

The microbes that swarm within the body of the victim of a zymotic disease, are either the lineal descendants of those which inhabited the same body when in health, or are the lineal descendants of those which once dwelt in some other

body when in health; and, if poisonous in their nature, have been so rendered by the poisonous nature of the secretions around them.

Organisms placed in the midst of matter that has undergone a chemical change, and accustomed to feed upon the products of disease, are likely to introduce that disease if themselves introduced into a previously healthy body.

Their substance is permeated with the diseased secretions, their surface is covered with them. They have fed upon abnormal products, therefore they excrete abnormal products, and, if placed within a healthy animal, are apt to start within it the same unhealthy metabolism to which they are acclimated.

Even if the parasitic germs have not themselves yet become toxic, it is a physical impossibility to introduce them unaccompanied by the virus that surrounds and permeates them.

Yet the primary cause of the disease is an abnormal change in the processes of life, affecting first the animal, and afterwards the parasite.

All analogy is, as has been shown, in favor of this view, and no observations yet made have weakened, still less disproved, analogies in harmony with evolutional facts.

Many well-known medical men, notably Dr. Lionel Beale, and Dr. Benjamin Richardson, refuse to believe in the potency of mysterious specific germs peopling air, water and soil, and ready at any moment to enter upon a work of wholesale destruction, and recently Dr. Formad, of this city, has announced his adherence to the older and more rational view, at least in the case of consumption.

We need no microscope, and no doctor, to assure us that germs are not the primary cause of most of the ills that flesh is heir to. He would be a bold man who would dare attribute the evils following excessive indulgence of any kind to the presence of parasites; the catarrh that follows facing a rough north-easter, or "cooling off" in a draught can scarcely be due to germs; nor can the pneumonia that succeeds a thorough wetting and chilling; the rheumatism of the muscular man who has habitually exposed himself to cold and damp; or the headache that punishes intellectual excess, be set down as caused by microbes.

Yet these disorders are accompanied with more or less of that inequality of the bodily processes, that undue activity in one spot, and stagnation in another, which constitutes inflammation; and there is little doubt that, were a microscopic examination made, it would be found that microbes were present, probably in larger numbers than usual in a state of health.

Between these ordinary ailments and epidemic diseases there is no provable distinction in kind. The products of disease, whether particles of the diseased organism, or parasites become diseased by a residence in that organism, are dangerous to the health of others, and the danger increases in proportion to the virulence of the disease.

Diseases are processes of dissolution, and dissolution must occur, sooner or later, as the complement of individual evolution.

The role of microscopic parasites is probably similar to that of the more tangible *tæniæ* and other worms that live as commensals within the body, devouring the nutriment intended for it; or, at the very worst, they are feeders upon the secretions of their host. In either case, they are fed at his expense. To one in thorough health they do little harm, but become a burden to those of weaker powers, and may become, in those attacked with a grave disorder, so diseased themselves that they may act as carriers of the disease to previously healthy bodies.

The power possessed by these parasites, taken from the victim of an infectious disease, of producing descendants which, for several generations, are capable of reproducing that disease, is often pointed to as a proof both of the specific nature of the parasite, and of its potency as the primary cause of the disease.

Yet these facts, when looked at properly, tend to prove the reverse.

The presumably toxic microbes, removed from their accustomed pabulum, reproduce themselves, it is true, in healthy infusions, which by their presence are rendered toxic, but at each removal to a fresh environment some of the toxic power is lost, until at last the virus has become so attenuated that it can safely be used as a medium of inoculation (as has been practised largely by Pasteur upon domestic animals) reproducing the original disease in a mild form, and thus (in some way not easy to explain) ensuring the subjects treated with it against the fatal form of the disease.

What is this gradual enfeeblement of the toxic powers of the parasite but its gradual return toward its normal condition—toward the neutral properties and probably toward the external appearance presented by its ancestors when they dwelt within a healthy animal?

Let the cultivation proceed for a sufficient number of generations, and the reversion will be complete.

Observers, principally chemists, who have studied the microbes of disease, have figured their forms, and in some cases have registered the transformations of a generation; but much more than this is necessary to prove their specific distinctness, or their direct connection with the disease.

If, after an examination of hundreds of individual animals, some in health, others in every stage between health and the crisis of the disease, and others in the various stages of recovery, no transition form is in any one instance noted—no microbe intermediate in character between that of health and that found in the disease; the evidence, though still negative, will be in favor of the ordinary germ theory, but if in only one animal among hundreds intermediate forms are found, that one instance will be positive evidence in favor of the views here advocated; since the diseased form, when once produced, can reproduce its characters for several generations.

Microscopic examinations of the cultured organisms up to the hundredth generation would throw some light on the subject.

Identity between a micrococcus-form and *bacillus*-form has been already noted.

M. Miguel, who has recently studied in a most thorough manner the germs found in the air, gives figures of the development of an organism which, at one stage of its life, has all the characters of a very long *bacillus*, and afterwards by segmentation into spherules of equal size, forms chaplets of *micrococci*, liable to separate into small groups.

The editor of the *Revue Scientifique*, that stronghold of the microbe contagion theory, admits, in a late issue, that the forms found in disease are probably varieties of habitat, and not species, yet still considers them as the cause of the diseases they accompany.

After admitting the great variability of these simple organisms, in accordance with their habitat, is it not arguing in a circle to maintain that varieties caused by certain conditions are themselves the primary cause of those conditions?

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