tive rod) as the causative factor. Nocard's findings (1892), he believed, represented a fixation of species, whereas the local epidemic (less virulent in form, with a mortality of only 5 per cent.) was apparently derived from a "generalized" bacterial protoplasm, often amorphous, residing in the intestines of the healthy parrot of this species in a harmless saprophytic guise. This more primitive form conceivably retained a plasticity which under the stimulus of abnormal conditions enabled it to undergo metamorphosis, assuming a number of different forms, rod-like or coccal, and displaying an affinity for a wide range of living tissues. The chilling of healthy birds and the resultant changes in intestinal exudates were surmised to serve, in natural surroundings, the same rôle as the bouillon extract which, in the laboratory, sufficed to provoke mutation and the development of pathogenic traits in the intestinal flora obtained from healthy birds.

It was found possible to induce the disease with material which had passed a filter, but in less virulent form, with slower course. In McClintock's opinion, the larger, centrifugible units were more effective. As in previous epidemics, there was an incubation period of from five to ten days, and there was lack of evidence of the transfer of infection from one human being to another. Three forms, influenzal, pneumonic and typhoidal, all accompanied by severe headache, were distinguishable in human patients, though the typical tests for pneumonia and typhoid were negative and agglutination variable. Post-mortems, however, revealed the hemorrhagic conditions characterizing the disease picture throughout the tissues, although most frequent in the lungs or intestines of the affected bird or animal. In spite of the mounting evidence of contact between sick birds and patients, the state authorities, so far as I recall, refused to identify the disease as psittacosis.

McClintock's preliminary findings were reported before the Luzerne County Medical Society on May 17, 1917. The detailed account of his researches, including his hypothesis relating the Wilkes-Barre epidemic to a more primitive, less differentiated form than that represented by Nocard's bacillus, lay in manuscript until 1926, owing to conditions peculiar to the war period. McClintock saw a possible connection between the etiology of psittacosis and that of trench fever, and rushed his monograph to conclusion outside the long hours absorbed by his private practice and his duties as pathologist at the city hospital, working over his results from 8 to 12 at night, writing from 5 to 8 A. M. In September, 1918, while hunting a publisher and making final arrangements for army service, he contracted the influenza then epidemic in a severe and all but fatal form, never regaining his health. Publication under the existing war conditions proved impracticable, and so far as I know he never touched his manuscript again. It was printed posthumously in 1926 as "Pleomorphism in Bacterial Protoplasm: A Study in Psittacosis," in a form which the author had hoped would render it useful as an introduction to pathogenic bacteriology —a field in which, his researches convinced him, a less dogmatic approach than the conventional one was desirable.

McClintock's view that psittacosis is not a simple disease entity, that the causative factors in different epidemics may be different and may, in certain instances at least, be derivable from a minute, unfixated protoplasmic form, harmless under normal conditions of the host, certainly merits wider dissemination among laboratory workers.

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ARTIFICIAL BACILLI

IN September, 1928,[1] I communicated to this journal a preliminary report on the discovery of living micro-organisms in certain Precambrian rocks. These investigations have been continued and have involved painstaking and laborious checking of the technique employed. While the indications are still as given in the earlier paper, a final statement with respect to them must await the completion of a little further work. A final report should be ready next summer. Meanwhile, conclusive evidence has been obtained to prove the existence of living micro-organisms in anthracite coal derived from mines in Wales and in Pennsylvania. The interpretation of these results does not accord with those of Schroeder, Galle, Potter and Lieske, who also worked with anthracite coal. I hope soon to furnish a report also on these investigations.

Incidental to the study of the bacterial flora of rocks, however, the attempt to work with strictly sterile media has led to a striking discovery which I present in this communication. When agar in the shredded or powdered form is mixed with tap water, sea water or other salt solutions in the cold, a microscopic examination shows only the irregular shapes and sizes of colloidal particles. When, however, it is heated in such solutions to a temperature of 45° C. or more, a microscopic examination of stained and unstained preparations thereof reveals a large number of perfectly shaped rods varying in length and thickness. These forms are practically always rod-shaped with rounded ends and most strikingly resemble bacilli. They even show diplo-bacillus forms

[1] SCIENCE, 68: 272–3, September 21, 1928.

as if the rods were in process of division. They take the methylene blue and gentian violet stains readily and frequently show polar, more deeply stained spherules and other structures in the interior. These rods are not bacteria since even sterilization of the agar for fourteen hours or more in the autoclave at pressures varying from eighteen to twenty-two pounds fails to destroy them, and since besides the original agar suspension does not contain them but a few minutes' heating produces them.

A discussion of this discovery with Professor J. W. McBain, of Stanford University, convinces me that I have discovered a colloidal phenomenon which is the result of the assumption of one form of structure among the compounds of the agar which takes expression in the type of aggregates just described. This form is evidently fairly insoluble and fairly stable. An account of the studies carried out respecting the properties of these artificial bacilli will be published later.

As regards the foregoing statements it may be said that we are dealing with facts which can be easily confirmed by any one. It is fascinating, however, and irresistible to speculate as to whether or not these artificial bacilli may, under the proper environmental conditions, take on the properties of living cells. While of course this seems like a wild notion, I am investigating this possibility.

To Mrs. Dorothy Doyle Thomas, who is assisting me with the laboratory investigations, I wish here to express my thanks.

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ACTION OF BACTERIA AND ENZYMES ON CARBOHYDRATES AND THEIR BEARING ON PLANT SYNTHESIS

THE question of the nature of plant synthesis is an important one not only for the plant physiologist but also for the scientist concerned with the structure and industrial application of products of plant metabolism. This is particularly true with regard to the utilization of derivatives such as sugars, starch, inulin, cellulose, etc.

One interesting mode of attack appears to lie in an investigation of the action of bacteria and their corresponding enzymes on carbohydrates and polysaccharides, a method which has been followed with some success by two of my coworkers, Messrs. H. L. A. Tarr and R. S. Tipson. It has long been known that *Bacillus mesentericus* converts cane sugar into "gum levan," and it is now found that the same change is apparently brought about by the enzyme isolated from the bacteria. "Gum levan" has been definitely identified by methylation, acetylation and hydrolysis experiments as a polymerized form of an anhydro fructose derived from "active" or "gamma" fructose. It is closely related to inulin, which is the fructose-anhydride-polysaccharide found in the dahlia and artichoke.

Complete methylation of "levanose" (gum levan), followed by hydrolysis, yields crystalline trimethyl γ fructose, which, so far as known, is the first crystalline active or gamma sugar to be isolated.

The action of *Bacillus mesentericus* and its enzyme is specific. They do not bring about any changes with carbohydrates and sugars in which the active form of fructose is absent. Raffinose apparently yields the same product as cane sugar. The action on gentianose and melezitose is to be investigated.

Bacillus xylinum (Aceto bacter xylinum) acts upon glucose, mannose, galactose, maltose, sucrose, fructose, "levanose," etc., with "pellicle" formation and change of the carbohydrate into a polysaccharide. It appears to convert glucose directly into cellulose. Of the sugars already examined the only one on which it exerts no action is lactose.

The action of both bacteria and enzymes on a variety of carbohydrates is being actively investigated and the preliminary results are to be published in the immediate future in the *Canadian Journal of Research*.

Of considerable interest is the fact that *Bacillus xylinum* is apparently able to carry the polymerization of "gum levan" to a further, more complex, stage.

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SPECIAL CORRESPONDENCE

THE MONTANA TICK PARASITE EXPEDITION TO AFRICA

IT is now possible to summarize the 1928 African tick parasite expedition of the Montana State Board of Entomology. The purpose of the venture was to get as much information as possible on parasites that destroy ticks and particularly to discover new parasites which might be brought to America to be used in the possible control of the Rocky Mountain spotted fever tick, *Dermacentor andersoni* Stiles. The procedure was to collect as many ticks as possible from all kinds of domestic and wild animals, hold them under observation alive and determine if parasites were present. Effort was made to extend the collecting over as wide areas as possible and, at the same time,