Mackenzie's previous gift of his local material and undistributed duplicates. Mr. Raymond V. V. Miller, brother of the late Waldron DeWitt Miller, associate curator of birds at the American Museum of Natural History, has contributed the latter's private herbarium, consisting largely of plants collected in New Jersey. The collection contains between 2,500 and 3,000 specimens and forms an important accession to the local herbarium consisting of plants growing within 100 miles of the City of New York.

SCIENCE SERVICE reports that the Seventy-Second Congress now in session is expected to take favorable action on a bill establishing a national park in the Florida Everglades. The last congress considered such a bill, the Park Service of the Interior Department made a favorable report on the project and the bill passed the Senate, but failed in the House because it got caught in a legislative jam. This park would be part of a "comprehensive eastern park system" as viewed by the National Park Service. Great Smoky Mountains Park and the Mammoth Cave Park project, as well as the Shenandoah region of Virginia are among the others. The National Park Service is continually asked to investigate park projects, and has now on its docket for such investigation fifty-five national park and forty-four monument projects. Accomplishments of the past year listed by the National Park Service include the development of museums in parks and monuments, particularly the unique plan to emboss an actual fossilized skeleton of a dinosaur in his own home territory in the Dinosaur National Monument. The park and monument system increased its total area from 10,339,506 acres to 12,113,621 acres.

MR. STEPHEN C. SIMMS, director of the Field Museum of Natural History, reports that more than one and one-half million persons visited the museum during 1931. This marks a new record for a year's attendance, and makes the fifth consecutive year in which the one million figure has been exceeded. The previous record was made in 1930 when the attendance was 1,332,799, over which the 1931 total represents an increase of 182,664 or approximately 13½ per cent. In addition to the number of persons actually coming to the museum, as recorded in the attendance figures, more than 700,000 children have been reached through the extra-mural activities of the museum conducted through the N. W. Harris Public School Extension and the James Nelson and Anna Louise Raymond Foundation for Public School and Children's Lectures. This brings the total number directly reached by the museum's activities to well over two million. Beyond these, a still wider but numerically incalculable public is reached by the publications issued by the museum and circulated internationally, and by press reports, motion picture newsreels and radio lectures concerning the institution and its activities. Mr. Simms writes: "It is most gratifying to observe the constant and rapid increase in attendance at the museum, because it reflects the growth of public interest not only in the institution but in the sciences which the museum's exhibits serve to illustrate. It indicates that the museum is successfully fulfilling its mission as an educational factor in the life of our city."

A SCIENTIFIC reunion was held recently at the British Museum (Natural History), South Kensington, by the director and scientific staff, who displayed a number of exhibits selected from recent acquisitions. The London *Times* reports that a large sketch map of Central America and the adjacent island groups, prepared by Mr. P. R. Lowe, created much attention, since it was decorated with the bodies of different species of the West Indian Flower-pecker (*Coereba*) according to their distribution. Copies of photographs of the Eastern Gorilla, presented by the proprietors of the *Times*, and the photograph by Lady Broughton of a Tanganyika lion were among the exhibits of the Zoological Department. Another zoological exhibit was an unusual trout, from the River Coa in Portugal, which habitually grows upon its head a filamentous mass of sedge. The department of botany showed specimens from the Argentine-Chilean border lent by the King, while the department of minerals displayed photographs and specimens from the meteoric craters at Henbury, Central Australia, which were made known this year as the second largest meteoric craters in the world. A meteoric stone found by Mr. Bertram Thomas was also on view.

DISCUSSION

A THEORY OF DISINFECTION

DUCLAUX, in his "Traité de Microbiologie,"[1] (1898) devotes a volume or more to a consideration of enzymes. The bacterial cell, according to his views, carries on its activities entirely through its enzymes, the cell itself being relatively inert. In the final analysis, the properties of the cells are those of its enzymes, and by defining the latter we have a complete description of the former.

While such a point of view could hardly be accepted in its entirety to-day, it still provides a very satisfactory basis on which to explain the various phenomena connected with the disinfection process.

[1] E. Duclaux, *Traité de Microbiologie*, Masson et Cie, Paris, 1898.

Thus the apparent truth of Duclaux's proposition is revealed by such points as the following:

(1) Both enzymes and bacteria are destroyed by the same agents, *e.g.*, heat, light and chemicals. The effect of heat in each case becomes apparent at about 50 degrees Centigrade. Enzymes vary considerably in their response to chemicals, and no substance is known which is bactericidal and yet without action on any enzymes. Such agents as toluene are very destructive for certain bacterial enzymes. Mercuric chloride destroys the activity of enzymes but, on addition of a sulphide, the activity may be restored. Likewise bacteria "killed" by mercury may be restored to life by a similar treatment.

(2) In a dry condition, both enzymes and bacteria are highly resistant to heat.

(3) Both are resistant to cold to an astonishing degree.

(4) The rate of destruction when each is acted upon by an adverse agent follows that of a monomolecular reaction.

It will be seen that the phenomenon of disinfection may be explained on a no more complicated assumption than that the disinfecting agents act upon the enzymes of the bacterial cell in exactly the same way as if they were dispersed in solution. The cell itself need play no part; it is dead or alive at the end of a given exposure depending on whether or not it still contains a sufficient number of intact molecules of necessary enzymes. If a given species of organism contained in its make-up several different kinds of enzymes, one of which was very susceptible to the disinfecting agent, it would be this one which would determine the cell resistance.

It will be at once obvious from what we have said, that at the end of any given exposure three types of cells might be found in a suspension, *viz.*, cells which have not lost any enzyme, cells which have lost some, and cells entirely bereft of intact enzyme molecules. The last, of course, could not grow and would therefore be dead. One would expect a difference in the first two groups. In actual experimental work two types of survivors are found and while it is impossible to know the state of their enzyme molecules, their behavior accords very well with what one would expect from the enzyme theory. The two types actually found are:

(1) Organisms which appear not to have been affected by the disinfecting agent. They grow as well and as quickly as the untreated organisms.

(2) Organisms which develop only after a "lag,"[2] or, if tested on different media, are found to have become more particular in their nutritive requirements because of their exposure. The length of the lag period depends on the intensity and the duration of the treatment.

The types of survivors are well illustrated by some experiments of ours on an acid-fast organism.[2] This organism grew well on all solid media irrespective of the composition or the pH. It produced a large amount of alkali, bringing the medium on which it grew to pH 7.8. Practically the maximum number of colonies developed within 24 hours. After heating for one minute at 60° C. and plating, a few colonies developed within 24 hours, but the majority required 48 hours for development. When heated for 5 minutes no colonies appeared in 24 hours, a few appeared in 48 hours and many more in 72 hours. Finally, on heating for 20 minutes, no growth appeared in 72 hours and one colony developed in 96 hours. These tests were carried out with a medium of pH 6.6. It was found that a greater number of survivors could be obtained if the heated suspension were plated out on media of a pH close to the final one assumed by an unheated culture. Although the number of survivors was increased by such a medium the lag period was not affected. It will be seen that, provided the time of heating was short enough, a few organisms appeared to escape intact. Others were progressively injured as indicated by the lag before development or by their inability to grow on an acid medium.

In terms of the theory, our experiments would be explained as follows: A number, perhaps all, of the various enzymes in the make-up of the acid-fast organism were thermolabile at the temperature used. The application of heat progressively destroyed the enzymes so that at the end of a period of between one and five minutes no cells remained which had all of their enzyme intact. Some at this time still had enough enzyme to supply food so that more molecules of their kind could be formed, thus restoring the cell to its original condition. From 24 to 48 hours were required for this restoration. Other cells, which were more damaged, required longer periods. One type of enzyme molecule which was destroyed supplied alkali. This apparently was a more labile type of enzyme so that after certain heating periods there were cells totally lacking in this particular enzyme, yet having a sufficiency of all other necessary types. Such organisms recovered in an alkaline medium where the services of the enzyme in question were not so necessary.

The question may next be raised as to the resistance of two suspensions differing only in the average enzyme content of their cells. From the enzyme theory it would be evident that those cells having the greater numbers of enzyme molecules would be the more resistant. While such a case is difficult if

[2] M. L. Isaacs, "Factors with Influence Tests of Bacterial Survival, I and II," *Jour. Bacteriology*, Vol. XX, No. 3, Sept., 1930.

not impossible to find with certainty, in practice, we probably have an approach to it in cultures of a given organism at different ages. In an older culture competition for nutrition is keener and one might expect therefore the greatest enzyme content per cell. Experimental results indicate that old cells are in fact more resistant than young ones. In the case of spores the situation is different. The freshly formed spore contains its maximum supply of enzyme. Being in a resting condition it can generate no more, so that the effect of time would result only in a decrease of that already present. Experiments carried out by several workers indicate that old spores are less resistant than young ones.

There are other facts, besides those which we have considered, which may be explained in terms of the theory. Thus, the germicidal action of substances which lower surface tension may be pictured as due to a washing off of enzyme from the bacterial cell. Such also may be the effect of physiological saline solution. The problem of salt solutions is a complicated one, however. Differences in susceptibility depend on the kind of organism and the concentration and kind of surrounding ion.

It is a curious fact that Duclaux, although regarding enzymes as the basis of cell life, explained disinfection on a different theory. He assumed that in the case of heat, at least, a coagulation of the proteins of the bacterial cell was responsible for death. He based his theory on the observations of Marshal Ward on the *Bacillus rhamosus.* Ward had noted an apparent coagulation in the body of this organism when it was exposed to concentrated sunlight. A similar explanation of disinfection has been developed by Chick (1910) and more recently by Bancroft and Richter. Such a theory and the enzyme theory are by no means mutually exclusive, for most enzymes are either protein themselves or so closely associated with protein that they coagulate in the presence of those agents which react with proteins. The two theories differ chiefly in that one pictures the protoplasm of the organism as resistant, the other as labile.

The coagulation of the bacterial cell proteins affords in itself an adequate explanation of many of the facts observed in connection with disinfection. There are several phenomena, however, which are more easily accounted for by the theory of enzyme susceptibility. Some of these may be briefly mentioned. (1) Certain salt solutions such as physiological saline are immediately injurious or germicidal for some organisms under conditions which probably do not involve coagulation. (2) The results obtained with the acid-fast organism described above can hardly be explained on the basis of coagulation. (3) The greater resistance of young spores is difficult of interpretation in terms of coagulability. One would expect, if anything, a greater resistance in old spores.

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THE COTTON ROOT ROT FUNGUS INDIGENOUS IN ARIZONA DESERTS

INVESTIGATORS who have been studying the cotton root-rot disease in Texas and Arizona have considered for several years that the fungus (*Phymatotrichum omnivorum*) was indigenous in the areas where the disease is prevalent. The occurrence of the fungus on the roots of certain native plants in the vicinity of cultivated areas, and the immediate appearance of the disease on susceptible crops, when planted on virgin lands, has been reported by Peltier, King and Sampson, Taubenhaus, Dana and Wolff, and by King and Loomis. At the root-rot conference at College Station, Texas, in January, 1931, Wolff reported the finding of infected wild plants and sclerotia on a railroad right of way that had not been under cultivation for forty or fifty years.

The writers have been studying the disease at Sacaton, Arizona, and have made it a practice on field trips through the desert to look for indications of the fungus on the native plants. Large areas of desert land are being brought into cultivation under several new irrigation projects in Arizona and California, so that it would be desirable to detect the presence of the disease before the expensive procedures of clearing, leveling and planting are undertaken.

On August 11, 1931, two of the writers observed extensive patches of spore mats of the root-rot fungus along the roadside in a desert area twelve miles north of Florence, Arizona, on U. S. Highway No. 80. These occurred intermittently over a distance of two miles on the vertical bank of the drainage channel made by the road grader in elevating the road bed. All the mats were located on the east side of the road, which was more shaded than the west, and which was still moist on the surface from recent rains. A profuse desert vegetation existed in this area consisting largely of *Covillea tridentata, Prosopis velutina, Franseria deltoidea, Opuntia fulgida, Condalia lycioides canescens, Sphaeralcea ambigua, Chamaesyce albomarginata, Aplopappus heterophyllus,* and various quick-maturing annuals. The nearest cultivated fields were about twelve miles distant, and the area, which was a high level plain near the mountains, was far separated from any of the general drainage water channels of the region.

On returning to the root-rot area three days later,