nominally committed to a preference for the latter, in spite of its bizarre features, he may perhaps be excused for failing to follow it throughout the text, for, if he did, much of the presentation would be unintelligible to the average reader without considerable effort.

Part II treats of infection as a concept, methods of disease transmission, the characteristics of infection, predisposing factors, types of infection, modes of disease production, the defenses of the host (humoral and cellular), resistance and immunity, and artificial immunization. The importance of disease carriers, both to the dentist and to his patients, is adequately emphasized. But the dental aspects of the problem in this portion of the book are really incidental; infection and immunity are presented from a broad scientific standpoint and the references to the dental applications do not obtrude but rather serve to round out the discussion of a subject in which this phase is usually neglected.

The special infections of the oral cavity are covered in Part III, with careful and fairly complete reviews of the bacteriology of the streptococcus-pneumococcus group, the oral spirochaetes, dental caries, periapical infections, pyorrhea alveolaris, Vincent's Angina, tuberculosis, syphilis, focal infections and the rare gonorrheal stomatitis. The final chapter is devoted to clinical dental bacteriology in an attempt to organize a satisfactory technic for this poorly developed field.

There are few adverse criticisms, and none serious. An obvious misprint, as on page 188 (lines 9–10), and the apparent misplacing of a few paragraphs, as at the bottom of page 194 and on page 195, can be corrected easily in a new edition.

The general makeup is pleasing. There are ninety-one engravings and five colored plates. It is the best general contribution to the subject of dental infections that has appeared since 1890, when W. D. Miller published "The Micro-organisms of the Human Mouth."

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SPECIAL ARTICLES

A PRELIMINARY NOTE ON THE ETIOLOGY OF VERRUGA PERUVIANA

IN certain narrow valleys among the Andes Mountains, particularly between Lima and Oroya in Peru, a peculiar disease exists which has long been regarded with special interest not only by local physicians but by all workers in the field of tropical medicine. The lesions on the skin, as the name "verruga" suggests, have the form of nodules or warts. As a rule the disease is of chronic type, and there are evidences of systemic as well as local infection, *e.g.*, fever, which is usually mild and of intermittent or remittent character, and anemia of moderate degree. The eruption on the skin is often preceded by a period of acute high fever, during which anemia is very severe, and peculiar bacilliform microorganisms are demonstrable in the red blood cells. This condition, which is called Oroya fever, may also occur simultaneously with the eruption on the skin, or it may follow the local manifestations. For many years Oroya fever was regarded as the severe form of the disease and verruga a milder manifestation of the same infection, but this theory has been open to question since 1913, when a commission from the Harvard School of Tropical Medicine studied both conditions and pointed out that their frequent association in the same individuals and their similar curious geographical distribution did not necessarily indicate that they were caused by the same parasite. The Harvard commission concluded that two distinct diseases were involved, because (1) either condition might occur independently of the other, (2) the peculiar intracorpuscular parasites, discovered by Barton in 1906 and named *Bartonella bacilliformis* by the commission, were not found by them in cases of simple verruga, and (3) monkeys and rabbits were readily infected with verruga by direct injection of suspensions of nodular tissue from verruga patients, but inoculations of a monkey and rabbits with blood of Oroya fever patients yielded no results, notwithstanding the presence of the parasite in the blood injected.

In order to determine whether or not Oroya fever and verruga are actually different phases of the same disease, it was necessary to isolate the microbic incitant in each instance and make comparative studies of the morphology, cultural properties, pathogenicity, and immunological relations of the microorganisms. It was recently found,[1] as reported in this JOURNAL, that the parasite of Oroya fever, *Bartonella bacilliformis*, could be isolated in pure culture, and that various manifestations of the disease could be induced in young *rhesus* monkeys by inoculation of the culture. It also developed in the course of the experiments that inoculation of the cultures of *Bartonella bacilliformis* into the cutaneous tissues of the monkeys induced at the site of injection a typical "verruga" indistinguishable from that observed in human beings or in monkeys directly inoculated with verruga tissues. *Bartonella bacilliformis* was demonstrated both in the skin lesions and in the erythrocytes of the experimental animals.

[1] Noguchi, H., and Battistini, T. S., SCIENCE, 1926, lxiii, 212; *J. Exper. Med.*, 1926, xliii, 851.

The results just described made it seem probable that *Bartonella bacilliformis* was the cause of both Oroya fever and verruga, and it was desirable that parallel cultural and experimental investigations be made with human verruga tissues. Such studies were rendered possible through the kind intermediation of Dr. E. Campodónico, of Lima. Subcutaneous nodules were excised under aseptic conditions from verruga patients in Lima, and portions were forwarded to New York for bacteriological and experimental study by one of us (N.), the clinical and pathological work being carried out by the other (H.) in Lima. What has been accomplished thus far may be summed up as follows:

(1) Two young monkeys (*Macacus rhesus*), inoculated with a saline suspension of nodular tissue from Case P. 5, manifested fever (104° F.) within 1 to 3 weeks after inoculation, and from the blood in each instance was isolated in pure culture a microorganism indistinguishable from the strain of *Bartonella bacilliformis* previously cultivated from the blood of an Oroya fever patient. (2) In one of the monkeys a hard nodule about the size of a walnut developed within seven weeks near the middle portion of the tail. The lesion consisted of highly vascular granulomatous tissue, rich in endothelial cells, and containing a considerable amount of fibrous connective tissue. Pure cultures of the same organism which had been isolated from the blood were obtained from the nodular tissue. (3) *Rhesus* monkeys inoculated with the cultures developed verruga lesions at the sites of intradermal injection and showed marked anemia. Characteristic bacilliform microorganisms were found in the red blood corpuscles, and pure cultures of what appears to be *Bartonella bacilliformis* were obtained from both skin lesions and blood. (4) Serological tests showed the verruga strain and the strain from Oroya fever to be closely related.

Clinical and pathological reports will be presented later, together with full details of the experimental work just outlined.

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ON THE EXTENSION OF THE DEBYE-HÜCKEL THEORY OF STRONG ELECTROLYTES TO CONCENTRATED SOLUTIONS

THE Debye-Hückel theory[1] explains the observed deviations of a solution of a strong electrolyte from the ideal solution by the electrostatic forces between the dissolved ions, which give rise to an additional term in the expression for the free energy of the solution. This free energy term depends, among other things, upon the dielectric constant of the solution. In the original theory, which applies only to dilute solutions (up to about 0.3M), the dielectric constant is assumed to be independent of the concentration of the solution. Hückel[2] has given an extension of the theory to concentrated solutions, assuming that the dielectric constant decreases linearly as the concentration increases. Through a faulty application of the so-called charging process,[3] Hückel's expression for the electrostatic free energy term is erroneous, and his further results, which are all derived from this expression, are therefore invalid.

The writers have shown that the correct expression for the electrostatic free energy is the same as in the original Debye-Hückel theory, the only difference being that the dielectric constant is no longer assumed to be independent of the concentration. The writers have furthermore developed methods for calculating, from experimental data (freezing point and vapor pressure lowering, electromotive force, solubility) not only the free energy term referred to, but also the ionic radius and the change in the dielectric constant with changing concentration.

It is found that the ionic radius varies rapidly with the temperature, the radii for LiCl, NaCl, KCl at 0° calculated from freezing points being roughly twice those at 20° determined from vapor pressures.

The dielectric constant also varies markedly with the temperature. Moreover, at any fixed temperature, but with increasing concentration, the dielectric constant begins by decreasing much more (from 50 to 100 times) rapidly than Hückel's expression indicates. It soon reaches a minimum and starts to increase more slowly, until in very concentrated solutions it is considerably larger than in pure water. This behavior of the dielectric constant is in entire qualitative agreement with the direct measurements of Walden and his collaborators[4] of the dielectric constant of non-aqueous solutions of electrolytes.

It is also found that certain salts, for instance, KNO_3, do not conform to the theory, the probable explanation being that in addition to its electric charge, the NO_3 ion also carries an electric dipole moment. Theoretical investigations in this direction are now in progress.

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[1] Debye and Hückel, *Physik. Z.*, *24*, 185 (1923).

[2] Hückel, *Physik. Z.*, *26*, 93 (1925).

[3] Debye, *Physik. Z.*, *25*, 97, (1924).

[4] Walden, Ulich and Werner, *Z. Phys. Chem.*, *116*, 261, (1925).