It appears to the writer that as the number of persons who will work at a research laboratory is relatively small, richness of fauna and healthfulness of location are probably of more importance than accessibility.

Ideal conditions for a laboratory can not be found in the tropical Atlantic.

The mainland Florida coast is infested with mosquitoes in summer, and its pelagic life is relatively poor. The climatic conditions and healthfulness of the Antilles are not of the best, while their marine fauna is probably inferior to that of the Bahamas or Tortugas. They possess, however, a restricted but interesting land fauna and flora.

The Bahamas lie upon the windward side of the Gulf Stream, and on this account their pelagic life is probably poorer than that of the Tortugas.

The Tortugas are relatively inaccessible, but here we find very pure ocean water, a relatively cool climate, a long period of remarkably calm weather during the late spring and summer, healthfulness due to isolation, and few mosquitoes. The last-named advantage will be appreciated by all who have attempted to live upon the Florida coast or the West Indies in summer.

Were a research laboratory to be established under the auspices of the Carnegie Institution, it might seem advantageous to found it in cooperation with such of our leading universities and colleges as are granting the doctorate for original research. As a tentative proposition, each college might contribute at least $150 annually for each student which it might send to the laboratory, thereby gaining the privilege of nominating students, who, subject to the approval of the Carnegie Institution, should be given free use of all facilities of the laboratory for the purpose of carrying out some definite research work. The traveling expenses of this student should be paid by the laboratory and his research should be published in a suitable manner with illustrations. The proper maintenance of such a laboratory would require an assured annual income of at least $10,000. It would be better to abandon the project than to attempt to carry it out with inadequate equipment and income.

In conclusion, it should be stated that the sole aim of the present writer is to focus the interest of the country upon this project; he desires no official connection with the laboratory, but speaks merely as one of at least forty-three zoologists who are interested in the project. There would appear to be no better medium for a thorough consideration of the subject than the columns of SCIENCE, and it is hoped that sufficient interest will be awakened to evoke an active discussion of the project from all points of view.

The establishment of the Carnegie Institution has, in increasing the possibility for the development of research, placed a corresponding responsibility upon each and every man of science. No laboratory should be founded unless our biologists ardently desire its establishment, and stand ready to avail themselves of its advantages to the fullest extent.

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SCIENTIFIC BOOKS.

I. *Experiments on the Effect of Freezing and other low Temperatures upon the Viability of the Bacillus of Typhoid Fever,* with considerations regarding ice as a vehicle of infectious disease.

II. *Statistical Studies on the Seasonal Prevalence of Typhoid Fever in Various Countries and its Relation to Seasonal Tempera-*

ture. By WILLIAM T. SEDGWICK and CHARLES-EDWARD A. WINSLOW. *Memoirs of the American Academy of Arts and Sciences,* August, 1902, Vol. XII., No. V.

In these two papers by Professor Sedgwick and Mr. Winslow—one dealing with their personal experiments on the viability of typhoid bacilli in ice, and the other a statistical study of the determining factors of the seasonal prevalence of typhoid in various countries—we have presented to us an array of interesting data, and especially is this true of the second paper, in which the authors in a painstaking manner have brought together, correlated and made deductions from the statistics of typhoid fever prevalence in many and diverse localities.

Constantly recurring outbreaks of typhoid fever, even where rational precautions seem to have been taken to insure the safety of the public, and the never-failing seasonal rise and fall due to conditions often not fully understood, lend a peculiar interest to all trustworthy investigations bearing on these problems. Bacteriology has already aided in the solution of many obscure problems of disease and its dissemination. The etiology of various diseases has been established beyond all reasonable doubt and much information has been gained in regard to the life histories of many pathogenic bacteria. Yet, in the majority of instances, few, or at best unsatisfactory data have been brought to light in regard to the conditions of the life of these organisms in nature, their habitat outside of the bodies of infected animals and man, and the extent of their distribution. Little is known positively of the conditions of their increase, survival or destruction in nature in the various soils, water, ice, etc., and the effects of variations in temperature, especially those due to seasonal changes on their life and growth. The solution of these problems is of prime importance, and its accomplishment must eventually lead to the establishment of more rational, sure and, it may be assumed, often less irksome precautions for the protection of the individual or community. The outcome of such investigations tends in general toward two principal ends: either to indicate danger where none was supposed to lurk, or to dissipate the fear of a danger which does not exist.

It may well be urged that few, if any, epidemics or even individual cases of typhoid fever occur that could not have been prevented by the intelligent application of knowledge at our disposal, yet the fatal neglect of well-known precautions by those in power, and the criminal negligence or ignorance of those upon whom we are forced to depend for much of our water, ice, milk and food supply, leave us little confidence in the bacterial purity of these in their natural state. In this connection the experiments of the authors on the viability of typhoid bacilli in ice have a special interest even for the general reader, since the facts presented and the conclusions reached are, on the whole, of a reassuring nature. Space will not permit of a review of these experiments in detail. They follow very closely in scope and character those carried out and reported in 1887 by Dr. Prudden. Prudden's work, although done many years ago and under certain conditions which the present investigators have thought fit to eliminate, has been largely confirmed and slightly extended. The chief departure in technique consisted in the substitution of freshly isolated typhoid bacilli for typhoid bacilli that had been for some time cultivated on artificial media, and the gradual lowering of the temperature during the process of cooling and freezing, so as to avoid a too abrupt temperature change, since Bordoni-Uffreduzzi claimed that on account of the rapid changes of temperature in Prudden's experiment and his use of attenuated cultures his results could only have a relative worth, and the results accomplished under natural conditions could not be directly deduced from them.

As a result of the authors' experiments on freezing typhoid bacilli in water and keeping them at 0° C. or below, the conclusion is drawn that less than one per cent. of the typhoid germs present in water can survive fourteen days of freezing, and that during the first half hour of freezing a heavy reduction takes place amounting to perhaps fifty per cent.; after this 'the reduction proceeds pretty regularly as a function of time.'

In this experiment the results of the analysis of control tubes left at the ordinary temperature have not been recorded. This appears to the reviewer a serious defect, as the authors seem to have entirely overlooked the fact that the transfer of organisms from one fluid to another, especially if these fluids be not isotonic, generally results in the destruction of many of the organisms, and that this fact renders it impossible for them to determine the exact part played by the lowered temperature. This defect is somewhat remedied by a comparison with a following independent series of experiments on the effect of temperatures slightly above the freezing point. Their conclusion from this series is largely what our knowledge would lead us to expect, namely, that typhoid bacilli behave in water much as they do in ice: "A large proportion of them are killed by a few minutes' exposure to the unfavorable conditions (cold?); during the next few hours the reduction proceeds *pari passu* with the duration of the experiment; while a few germs persist for some time." The results differ from those obtained by actual freezing in two respects. Freezing for short periods produced varying and uncertain results; ice over twenty-four hours old showed a constant reduction of over ninety per cent. In water the period of uncertainty was much extended; some of the water tubes containing half of their germ contents after a week. Complete sterilization, however, ensued more often than in frozen tubes. "The reduction in water at 10° C. does not seem to be greater than at 20° C." Here, as was surmised above, the temperature probably plays a minor part, and the decrease is largely, no doubt, due to other unfavorable conditions. We do not consider, therefore, that the authors have established in a more definite manner than their predecessors the exact part played in the destruction of bacteria by freezing and low temperatures. Their experiments may indicate in a fair degree the sequences of events when typhoid or other bacilli are suddenly transferred to water from some more favorable environment, but do not establish the behavior of those organisms which may have become accustomed to such new surroundings.

Our attention has also been attracted by a statement of the authors, that bacteria settling to the bottom 'may soon perish for want of air.' This statement must be born of pure hypothesis, as cultures of typhoid bacilli will in fact live for years anaerobically.

The result of experiments on the viability of typhoid bacilli in sterilized earth at various temperatures was the following: Typhoid bacilli in dry earth behave just as in water and ice. They die out rapidly at first, and their numbers are progressively reduced as the treatment is prolonged. A fraction of one per cent. persists for some time. Cold alone does not materially effect the reduction of typhoid germs in dry earth. In moist earth the destruction of the bacteria is much less rapid; at times when food supply is plentiful they appear to hold their own.

In another set of experiments it was found that sedimentation did not produce marked or constant effects on colon and typhoid bacilli in water during as short a period as twenty-four hours. Ice, however, formed on the surface of a quiet body of water contained only about ten per cent. of the bacteria present in the water. This difference, they conclude in agreement with various observers, is due to the physical exclusion by the process of crystallization, and not to any germicidal action, as the temperature of the ice can only differ from that of the adjacent water in a very slight degree. There are two forces at work: low temperature killing off the germs in ice and water nearly equally, and the crystallizing process extruding germs from the ice into the water.

The general conclusions and applications of the results of the experiments as given by the authors may be summed up somewhat as follows: The main factor determining the reduction of germs in water is *time*—the time during which the various purifying forces are left to act. Epidemiology shows clearly that disease follows most often a direct, quick transfer of infectious material from patient to victim; and if storage of water for some months could be insured, many sanitarians would consider such storage a sufficient purification. In ice this condition is realized—

a forced storage of at least weeks and at best of many months. In natural ice, besides the action of cold, there is another purifying influence, the exclusion of ninety per cent. of the germs by the act of freezing. Under natural conditions the pathogenic germs present in the most highly polluted stream are comparatively few. Of these few, one tenth of one per cent. may be present in ice derived therefrom. Even these scattered individuals are weakened by their sojourn under unfavorable conditions, so that it is doubtful if they could produce many, if any, cases of typhoid fever. With artificial ice the case is different, for such ice is made from water frozen solid and, as a rule, quickly consumed. Such ice, therefore, if made from impure water may contain the germs of infectious disease, and, being used quickly after its manufacture, may be a menace to the public health. With natural ice also there must always remain an element of doubt. Polluted ice might be cut at once, and served within a week or two, and sufficient disease germs might persist to cause infection. Yet the authors think such an instance must be very exceptional; and the general result of human experience, the absence of epidemics of typhoid fever traced conclusively to ice; the fact that cities like New York, and Lowell and Lawrence, Massachusetts, have used ice of polluted streams and have yet maintained low death rates from typhoid fever, all tend to support the conclusion at which they have arrived, namely, that natural ice can rarely be a vehicle of the infectious agent of typhoid fever.

Such results and conclusions as these, coming from this high authority, confirming in essential details the work of other investigators, as well as extending our knowledge of this important subject, are somewhat reassuring in regard to the use of ice.

This is especially true from the standpoint of the general sanitarian, who, accepting these data, may look upon stored ice as a neglectable sanitary quantity, and to the statistician in his estimates of usual sources of disease; but in the opinion of the reviewer, the individual facing the element of doubt in the purity of ice, and especially as ice is so universally handled just prior to using, should not be led by the purity of the ice in general to abate any reasonable precautions for his own protection. It has been too much our habit, as many fatal epidemics bear witness, to take chances in matters sanitary, and to bend to expediency and personal or public convenience rather than to strive for the ideal.

Such papers are apt to convey the impression to the lay and even, it is to be feared, to the official mind, that sanitary precautions may be neglected in the use of ice. Let us urge, however, that it is small comfort to the individual suffering from typhoid fever contracted from polluted ice to be told that ninety-nine per cent. of his friends use ice with impunity.

In the studies of statistics on the seasonal prevalence of typhoid fever in various countries and its relation to seasonal temperature, the authors review fully the literature on the seasonal prevalence of typhoid fever, setting forth at some length the various data as to the time of maximal and minimal occurrence, and the hypotheses that have been advanced in explanation of those variations. Chief among these, historically at least, as is so well known, is the view, supported by Pettenkoffer and his school, that there is a relation between the variations in level of the ground water and variations in the prevalence of typhoid—typhoid cases being abundant when the ground water is lowest. The only plausible explanation of the connection, however, between ground water and typhoid fever on the basis of the germ theory is, in the opinion of the writers, that furnished by Liebermeister, who in 1860 suggested that the phenomena might simply be due to the concentration of soil impurities in the wells at the time of low water, and their transmission in unusually large doses to those who drank therefrom. Dr. Baker in this country advocates this idea with modification, and a recognition of the fact that a well in use drains a wider area when the ground water is low and is thus liable to pollution from more distant sources.

Whatever the explanation, it seems to be true that at Munich in the period studied by

Pettenkoffer and his followers, a real relation did exist between ground water level and typhoid. In no other case, so far as the authors are aware, has the possibility of the influence of temperature been excluded. This varies inversely with the ground water and directly as typhoid fever, and the seasonal curve in many places may be more plausibly explained by this than by variations in ground water.

Murchison was the first forcibly to call attention to the importance of the temperature factor. Plausible as the explanation appears, it has not gained wide acceptance, and, as stated by the authors, has been practically ignored in Germany. In summing up this subject, they say: "Although most observers have noted a characteristic seasonal distribution of typhoid fever, others, including some of those who have written most recently, have denied the existence of such variations. Of those who realized that the variations did exist, a few sought an explanation in the factor of temperature. Their views did not, however, gain acceptance, as the evidence furnished was insufficient; and the common view among medical men and sanitarians has been that the fall maximum of typhoid fever was an unexplained phenomenon."

Sedgwick and Winslow have attempted, by careful collection and comparison of statistics, to see whether the relation shown by Murchison, Liebermeister and Davidson for a few places could be demonstrated for a wider field. They have, therefore, brought together statistics of the monthly variation in temperature and the prevalence of typhoid fever for thirty communities. These include the states of New York and Massachusetts, the District of Columbia, Baltimore, Boston, Charleston, Chicago, Cincinnati, Denver, Mobile, Newark, New Orleans, New York, Oakland, Philadelphia, St. Paul and San Francisco in the United States; the city of Montreal in Canada; the cities of Berlin, Dresden, Leipsic, London, Munich, Paris and Vienna in Europe; the Empire of Japan, and the British Army in India in Asia; and the cities of Buenos Ayres and Santiago de Chile in South America. Four continents and both hemispheres are thus represented, and a wide range of climate.

Monthly values for temperature and typhoid prevalence have also been plotted on appended plates in order to show graphically the relation of the two curves.

An examination of the plotted curves shows a remarkable parallelism between monthly variations in temperature and typhoid prevalence. Of the thirty communities considered, eighteen show the parallelism to be almost perfect. Three other typhoid curves, those for India, for Charleston and for New Orleans, rise with the temperature in spring, and fall with it in autumn, but show a temporary decrease in the disease during the time of greatest heat. In these twenty-one cases the connection between the two factors seems too close not to indicate a vital relation. In northern cities the course of typhoid is acute; in cities with more and more equable temperatures the curve is progressively flattened.

In the northern localities the maximum occurs in September and October; in southern cities with a milder winter it comes in August or July. In the two cities of the southern hemisphere (Buenos Ayres and Santiago) the curves of both typhoid fever and temperature are exactly reversed. In the case of the tropical and subtropical regions—India, Charleston, New Orleans—it appears that the rise with the temperature, after beginning in the usual fashion, is checked by some other factor, perhaps strong sunlight or extreme dryness.

In the case of the nine cities which show more or less irregular curves, the authors call attention to a factor much neglected by previous students of seasonal variations; *i. e.*, the necessity of discriminating between sharp epidemic outbreaks and the slow succession of isolated cases which characterize that condition usually known as 'endemic.' They lay stress upon a distinction, vital to epidemiologists, which must be drawn between infection which reaches a number of persons at once through a single medium, as water or milk, and the slower, more complex process by which a disease passes from person to person; the path of the contagious material being different in each individual instance. The term 'prosodemic' has been used to describe this form of infection. Such prosodemic disease, they rightly consider, should be mainly considered in the analysis of data bearing upon seasonal prevalence. An epidemic must always be looked upon as a perturbing element. Curves based upon a small number of cases will always be liable to show irregularities due to single epidemics, and this is the explanation in four of the nine cities of their irregular seasonal curves. In the case of the other cities, the curves of which are based on ample statistics—Chicago, Cincinnati, Newark, Paris and Philadelphia—the curves show secondary maxima—one in December or January, the other between March and May. These five cities draw their supply from surface sources liable to gross pollution. Heavy autumn rains and spring floods carry into these surface water supplies a larger amount of pollution than reaches them at any other time.

The authors generalize: Winter and spring epidemics are characteristic of those cities whose water supply is most subject to pollution; they are absent from communities which use filtered water or water obtained from adequately protected watersheds. They conclude that wherever a sufficient number of cases have been considered a direct relation between typhoid fever and temperature appears to be general and invariable.

The probable mechanism of the seasonal changes, according to their conception, may be given in their own words: "The bacteriology and the etiology of typhoid fever both indicate that its causal agents can not be abundant in the environment during the colder season of the year. The germs of the disease are carried over the winter in the bodies of a few patients and perhaps in vaults or other deposits of organic matter, where they are protected from the severity of the season. The number of persons who receive infection from the discharge of these winter cases will depend, other things being equal, upon the length of time for which the bacteria cast in these discharges into the environment remain alive and virulent. The length of the period during which the microbes live depends largely upon the general temperature; as the season grows milder, more and more of each crop of germs sent at random into the outer world will survive long enough to gain entry to a human being and bear fruit. The process will be cumulative. Each case will cause more secondary cases, and each of the latter will have a still more extensive opportunity for widespread damage. In our opinion the most reasonable explanation of the seasonal variations of typhoid fever is a direct effect of temperature upon the persistence in nature of germs which proceed from previous victims of disease."

This paper on the seasonal prevalence of typhoid fever merits a careful study in the original, and, in the main, one familiar with this subject must be impressed with the justness of the conclusions based upon the data there brought together.

PHILIP HANSON HISS.

SCIENTIFIC JOURNALS AND ARTICLES.

THE April number of the *Transactions* of the American Mathematical Society contains the following papers: 'The approximate determination of the form of Maclaurin's spheroid,' by G. H. Darwin; 'On twisted cubic curves that have a directrix,' by H. S. White; 'Ueber Curvenintegrale im m-dimensionalen Raum,' by L. Heffter; 'The generalized Beltrami problem concerning geodesic representation,' by E. Kasner; 'On the holomorph of a cyclic group,' by G. A. Miller; 'Quadric surfaces in hyperbolic space,' by J. L. Coolidge; 'Ueber die Reducibilität der reellen Gruppen linearer homogener Substitutionen,' by A. Loewy; 'On the possibility of differentiating term by term the development for an arbitrary function of one real variable in terms of Bessel functions,' by W. B. Ford; 'On a certain congruence associated with a given ruled surface,' by E. J. Wilczynski; 'On the class number of the cyclotomic number field $k(e^{2\pi i/p^n})$,' by J. Westlund.

THE May number of the *Bulletin* of the American Mathematical Society contains: Report of the February meeting of the