Subsequent to 1860, I have fourteen series, ranging in length from ten to twenty-four years, with an aggregate of two hundred years. The results, presented below, show that the rainfall in the two halves of these series was identical.

STATIONS.	YEARS.	AGGREGATE RAINFALL.		DIFFERENCES.
		1st half.	2d half.	
Amherst	14	318	310	—8
New Haven	14	347	348	+1
Boston	24	597	572	—25
Fort Trumbull	10	241	229	—12
Middletown	14	324	338	+14
Lawrence	12	279	265	—14
Lunenburgh	14	313	343	+30
New Bedford	14	300	348	+48
Providence	16	377	393	+16
Albany	16	328	305	—23
Flatbush	12	234	237	+3
New York	16	373	382	+9
West Point	10	246	209	—37
Gardiner	14	305	303	—2

With these results in view, it seems idle to discuss further the influence of forests upon rainfall from the economic point of view, as it is evidently too slight to be of the least practical importance. Man has not yet invented a method of controlling rainfall.

HENRY GANNETT

THE GERM THEORY AS A SUBJECT OF EDUCATION.

THE time is past when it is necessary to discuss the probability of the 'germ theory' as explaining infectious diseases. This is no longer a theory, but as fully demonstrated as most of the other universally accepted conclusions of science. No one to-day who is competent to form a judgment from a knowledge of the facts, will doubt that many infectious diseases are caused by the growth of microscopic organisms in the body. Of course, no general proof of the parasitic nature of all infectious diseases has been adduced, nor is such general proof possible; but when the causal connection between certain specific bacteria and definite infectious diseases has in many cases been proved by a demonstration so conclusive as to be beyond question, and when such causal connection has been rendered extremely probable in many other cases, indeed in almost every infectious disease, it is only ignorance of the facts that can explain any doubt as to the very general applicability of the theory. It is true that many, perhaps a majority, of practising physicians do not have much sympathy with the conception of the parasitic nature of infection, sometimes indeed treating the whole subject with ridicule. Some are incapable of forming correct judgments, but most of them have not found the time or inclination to study the subject enough to know what facts have been established. At the time when most of the physicians who are now practising were pursuing their studies, the germ theory of disease was scarcely entertained as a theory, and nowhere accepted. Only three or four years ago some of our better medical schools taught their students that the theory was a wild hypothesis, and destined to be exploded like any other visionary speculation. It is not surprising, therefore, that they should still refuse to accept a theory which so revolutionizes the conceptions of disease. But our leading physicians, including professors in better medical schools, are now convinced of the truth of the theory and the great importance of the subject, and medical papers throughout the country are giving more and more space to the subject of bacteriology. The inevitable result of this will be that the next generation of doctors will accept the germ theory as the basis of practice.

This discovery of the parasitic nature of infectious diseases is of more than scientific interest: it is of vast practical value. It has not yet, perhaps, contributed very materially to the methods of treating disease directly, although we may confidently expect great results in the future along this line. There is nothing to prevent direct experiments with germicides upon living bacteria in the laboratory, and we may hope in this way to get a more scientific method of curing infectious diseases, after the theory of their parasitic nature becomes more truly the property of doctors as well as of scientists. Thus far, however, the value of the theory has been rather as the foundation of the science of preventive medicine. Here its importance cannot be overrated, and is only beginning to become realized.

We need do no more than mention the advances made in surgery in the last twenty years, which are due almost solely to the knowledge of septic bacteria. It needs no words to enforce the value of discoveries in this line. Every one appreciates this matter; and the value of antiseptic dressing, which alone makes the difficult operations possible, is almost everywhere recognized, and its use taught in all medical schools.

In other lines than surgery the value of the germ theory is even greater, though at first sight not quite so apparent, since the matter is yet in its infancy. The great advantage which we are to acquire through this theory is not in curing infectious diseases, but in preventing them. Professor Koch, in a recent address to a class of medical students, voiced this fact: "Gentlemen," he said, "you have been hitherto taught only how to cure disease, in the future you will be taught how to prevent disease." We can see in this direction great practical results arising along at least two different lines. The first is by preparing the body to resist the disease, the method of inoculation. The most widespread instance of this method of treatment is of course vaccination for small-pox. Vaccination was discovered, it is true, empirically, and entirely independent of the germ theory; but it finally received its *rationale* through the brilliant work and generalizations of Pasteur. Working in accordance with the same idea of preventing a severe form of a disease by giving the individual previously a mild form, Pasteur has successfully treated splenic-fever and hydrophobia. Others, following in his lead, claim success in a similar treatment of yellow-fever and cholera, although these claims certainly need further verification. But only a beginning has been made in this direction, and it does not seem improbable that we may see a time when many of our most severe epidemics may be as thoroughly subdued by inoculation as small-pox has been by vaccination.

But of much more importance than inoculation is the more natural method of avoiding the diseases. We are now learning to keep the bacteria away from our bodies, either by directly destroying them or by keeping away from the contaminating material. When we know the exact nature of an infectious disease, — what are the habits of the organism which produces it; where they are most likely to be found lurking during epidemics, whether in water, food, clothing, drains, in the air, in the excreta or scales from the skin of the patient; in what conditions they will grow, and what will kill them; how they make their way into the healthy body, whether by food, drink, by breathing, or by contact of infected material with the skin, — in short, when we understand the natural history of an infectious disease, it is usually easy to avoid it. If the disease is taken in drinking-water, it may be avoided or rendered harmless; if in food, the food may be cooked; if from excreta or clothing, they may be easily disinfected by some of the effective germicides; if by contact with the skin, care in handling the infected material, and disinfecting the skin afterward, will usually suffice. As yet we have discovered no way of avoiding contagion which comes to us in the air, but we are just beginning to find out the extremely important fact that the air does not become contaminated with bacteria unless they are allowed to dry. Recent investigations have shown a smaller number of bacteria in the air of a well-kept sewer than in that of a poorly ventilated schoolroom. It is a valuable discovery that this means of infection by breathing — a means which we cannot guard against — is uncommon. The air is not the ordinary mode of transferrence of germs, and would be scarcely at all, if proper precautions were taken to prevent infectious material from drying. Here we immediately get suggestions as to the management of the hospital and the sick-room, and as to general sanitary measures, which will enable us to stamp out many of our most dreaded diseases. How suggestive to remember the experience of Professor Koch and his associates! While at Alexandria, although surrounded by the cholera epidemic, they had no difficulty in avoiding the disease by the adherence to certain precautions which a knowledge of the germ nature of cholera had taught them; but upon return to Germany, and being thus many hundreds of miles from the disease, one of them acquired the disease by a careless handling of the cholera germs which they had brought with them. What better proof could there be of the value of knowledge of the facts? By study of bacteria we are beginning to understand why one disease is contagious and another not contagious, or why a third disease may be sometimes contagious and at other times not at all so. We are learning what are the sure and what the worthless methods of disinfection. Thus the mysteries connected with infectious diseases are disappearing.

It is not of very much value to know the simple fact that a particular disease is parasitic in its nature, unless this is made the basis of further intelligent observation. Nor does it help us any, as Dr. Hunt recently pointed out in this journal, to be able to distinguish the specific germ producing any disease if we end our observations with this discovery. It is of great value, however, to know the habits of the microbe and the conditions in which it can live, and these facts can only be discovered by the study of the microbe itself. This is the share which the biological laboratory must have in the matter. It is of course necessary to study the disease itself, and the conditions under which it propagates itself, with vigor; to study the origin of epidemics, their spread and decline; but this can only be done intelligently when we understand the nature of the organism producing it. When we know the habits of a microbe, — whether it lives in acid or alkali solutions, whether in filth or cleanliness, whether best in heat or cold, etc., — then we can successfully ask questions concerning the conditions in which the disease develops; then we can discover the history of the organism from the time it leaves the body of the sick person until it gets into a second individual and again produces its disease; then we can learn what conditions favor and what hinder the disease; then we can discover how to prevent this transferrence, how to kill the microbe in its passage; and then we shall have gone far toward ridding the race of our vigorous epidemic diseases. Sanitary measures need no longer be blind methods applied tentatively, but may proceed directly at the root of the disease from a knowledge of its cause. Sanitary science must indeed be founded upon the knowledge of the nature and habits of microbes.

Advance along these various lines of preventive medicine has been rapid in the last few years, and is becoming more and more so, and chiefly through the study of facts discovered in connection with the growth and distribution of microbes. Although many questions still remain unanswered, the knowledge of the parasitic nature of infectious diseases is enabling doctors and scientists together to ask intelligent questions concerning such diseases, and to search for their answers in the right direction. Until this knowledge had appeared, such questions and researches could only be made at random. In short, the knowledge collected concerning the parasitic nature of disease and the habits of the specific microbes is giving us hundreds of ways of fighting the diseases outside of the body, even though it has yet not been very fruitful in directing our physicians how to treat the disease when it has once vigorously attacked the body.

The importance of a general understanding of the facts connected with the discoveries in this direction cannot be overrated. Who is there, old or young, who would not be benefited by a knowledge of the source and cause of infectious diseases? Who is there who is not better prepared for life by a knowledge of what is meant by cleanliness, and why it is so desirable, particularly in time of epidemics, to keep our surroundings perfectly clean? Ought not every one understand as far as possible where the infectious organisms are likely to be, and how they may be avoided? Indeed, is not this subject one of the many which we are beginning to recognize as desirable in our public-school teaching? Physiology is taught now in our schools by law, but what branch of physiology can be of more value to the public than a few principles connected with infectious diseases, and the means of keeping contagion away from our doors? If physiology is to be taught in the schools, would it not be well to include in it some such principles of vital importance, instead of compelling the student to learn the names of the bones in the body? At present the public gets informed in such matters only through the uncertain medium of the press, which contains as much false science as true; and as a result it is almost impossible rigidly to enforce sanitary measures. It is needless to say that the public schools have not yet taken up the subject. Our colleges, too, ought to see that every student knows something of this matter. A few of them already realize the fact, and have made a beginning in this line. Our training-schools for nurses ought certainly to put much force upon this subject and the practical precautions connected with it. But, after all, we must look primarily to our medical schools for teaching in this direction. Doctors will always be regarded as authorities in matters connected with health, in spite of nurses or the sayings of scientists; and it is through them that the public must receive its education. The medical schools must therefore lead in this matter. It is true that medical schools aim to teach chiefly how to cure disease, and as yet the germ theory has not materially aided in this direction. It is of course difficult to find time, in the already crowded course, to introduce any new subject not directly related to the cure of disease. But bacteriology is a subject too important to be neglected: it readily forms a part of pathology, and most schools do find time for a treatment of this subject. Our medical schools are now pushing on in this direction. Two or three years ago the theory was dismissed with a word, even in our best schools; and that word was frequently one of ridicule. Now many of the leading medical schools pay considerable attention to the subject. Several of them have among their faculty special bacteriological students who give instruction in this line. A few have well-equipped bacteriological laboratories, and others are looking in the same direction. To what extent the subject is treated in the medical schools of the country in general, or in the training-schools for nurses, cannot be stated at present. Inquiries are being set on foot in this regard, the results of which will appear in some future numbers of this journal.

H. W. CONN.

AMERICAN SOCIETY OF NATURALISTS.

THE annual meeting of the American Society of Naturalists was held in the Peabody Museum, New Haven, on Dec. 27 and the two following days. The object of the society is to help instructors in the natural sciences by discussing the methods of research and of instruction. Leaving to the other scientific associations the function of presenting and discussing results, this society, composed of professors and specialists, devotes itself to the publication of new methods, improved apparatus, and aids to science-teaching, all of which are apt to be scattered through various periodicals, and thus fail to secure that general adoption which a practical demonstration of their usefulness would bring about. The work of the society falls into two sections, — biology and geology, — and a day of each meeting is devoted to each of these topics, while the third day is given over to a general discussion upon some attractive subject. The society, though in existence only for a very few years, has a large membership, including in its list many of the eminent leaders of science in this country and in Canada. The attendance at the recent meeting was quite large, and the proceedings both interesting and profitable.

The proceedings were opened by the address of the president, Dr. Harrison Allen of Philadelphia. His subject was 'The Inconstant in Biology,' and was devoted to the discussion of variations in animal structure not easily referable to any law, but to which careful study would attach considerable significance. In particular, he called attention to the prevalence of hairy parts and of color-spots in animals that had to a greater or less extent deviated from their normal type. If, for example, a variety broke from the prevailing color of its kind, the original color would be retained at certain very definite spots: these are found at the tip of the tail, another around the eyes, a third on the skin covering the dorsal column, and elsewhere. The peculiar constancy of these places of retention of the original color was especially emphasized, and the inference drawn that here was something too deep for natural or other selection to weed out, and the explanation of which would be a valuable contribution to the history of animal life. Dr. Allen illustrated his propositions with a series of mounted specimens, and brought out an interesting discussion upon color-markings in general.

Dr. Oliver exhibited a series of carefully prepared wools for the detection of color-blindness and of sub-normal color-perception. Professor Gage described an easy method of injecting the thoracic duct and of demonstrating it for students. Professor Osborn exhibited some sections of the brain and spinal cord prepared by a method that allows of more accurate work than has hitherto been possible. Dr. Minot exhibited a new microtome of his own invention, for which he justly claimed some important advantages. In this the knife is stationary, and by a simple motion of a wheel the thinnest sections can be automatically cut as accurately and as rapidly as desirable. The instrument will be supplied by the Educational Supply Company, Boston. Prof. H. N. Martin showed a very simple device by which either the closing or the opening shock could be separately used for stimulating nerve-muscle preparations in physiological work. A very interesting paper was that of Prof. S. F. Clarke, presenting a classroom demonstration of variation in nature and under domestication. By a series of stuffed fancy pigeons the very varied and fantastic forms of variation that the will of man could bring about was most beautifully impressed; and in striking contrast to this was a series of sparrows, the distinction between which required the closest observation, but which represented no less than eight genera and thirteen natural species. Prof. E. S. Morse, with his usual happy manner, *résumêd* the kinds of museum show-cases employed in Europe, and accented the points of value in each.

To the general student of science the discussion upon science-teaching in the schools, to which an entire day was devoted, would form a most interesting feature of the meeting. The discussion was introduced by Prof. Ramsay Wright of the University of Toronto, who briefly sketched the admirable system of science-teaching in the schools of Ontario. Here the whole educational system is in charge of a minister of education, who has at his service the advice of the university professors, and who, with their aid, has drawn up a schedule of instruction in science which is utopian compared with any thing that exists in the schools of this country. Here the fact that the government controls the granting of certificates and the appointment of teachers has solved the problem of securing able science-teachers for the schools.

Prof. Alexander Winchell of the University of Michigan followed with a forcible plea for the educational value of the study of geology. He claimed for this study the discipline of all those powers of the developing mind upon which a true culture was based. In the child, observation, training of the senses, was the first natural process; and this it was, too, that geology first demanded. With the growth of mental powers came the wider field for their employment, in the induction of the general geologic principles from the observed facts, in the grand deductions from these, and in the exercise of the imagination that geological periods make necessary. He would thus urge the teaching of geology in the elementary schools; and, because this study afforded such varied opportunity for the exercise of all the faculties proportionate to the natural order of their development, he thought it proper to speak of a geological culture.

The next contribution to the discussion was by Professor MacCloskie of Princeton College. He urged in a very emphatic manner the rights of science as opposed to the word-knowledge and the language-culture, that absorbs so much of school time and energy. While the position urged was not a new one, it very forcibly expressed the independent right of science to a very early and important place upon the curriculum of every school. The discussion was concluded by Professor Rice of Wesleyan College, who presented a masterly exposition of the theoretical and practical advantages of science-teaching in the schools. The boy or girl that has not been spoiled by artificial means is invariably interested in the phenomena of nature surrounding him or her on all sides. It is with reference to these that their questions are asked, and it is in the observation of these that they find a satisfaction of their natural curiosity. The current methods of teaching in large measure crush this natural interest, and substitute for it an unnecessarily stupefying word-drill. The result of this is that young men come to the higher schools with a total lack of appreciation for the world of natural fact, and, what is worse, a dulling of all the faculties by which such an appreciation can be attained. It is not the facts of science, but the appetite of the mind for this kind of knowledge, that is to be ever kept awake, and without which that new sense for the teachings of nature cannot be fostered.

All these papers brought out an animated and profitable general discussion from various members. The sense of the meeting was unanimously in favor of the views expressed above; and the advantages of introducing science into the elementary schools was urged not only for its practical value, but for its satisfying the requirements of the natural growth of mind and its general disciplinary value. That children properly trained to an interest in the affairs of science do really bring to their more mature years an appreciation for true science, and the ability to carry it on to a high grade of cultivation, has been proved more than once. On the practical side the question of the order of the sciences in school-work was discussed, and the general opinion was in favor of systematic botany as the topic with which to begin, then physiology, and then physical geography. A complete course in physiology, however, must be based upon some knowledge of physics and chemistry. A committee was appointed to consider the preparation of a schedule of science instruction for the schools, and was authorized to report in full at the next meeting of the society.

The geological part of the proceedings was opened with a paper by Prof. James D. Dana, who recounted some of his recent observations on the Hawaiian volcanoes with especial reference to the connection between seismic phenomena and lava eruptions. The rarity of explosive action, so common in most volcanoes, is well known to be the most distinguishing feature of the Sandwich Island craters. The mountains are nearly pure lava-cones, and the eruptions are fissure eruptions. In only two of the numerous recorded outbreaks, viz., in those of 1868 and 1887, have earthquakes of any violence been noticed. These shocks increased regularly in intensity, and were abruptly terminated with the appearance of the lava. Professor Dana concludes that they were produced by the forcible rending of the solid crust, caused primarily by the vapor tension from water heated from the outside of the lava-conduit; and secondly by the hydrostatic pressure of the lava itself within the conduit. In most cases the formation of the fissure through which the lava is extruded is accomplished so quietly that the first intimation of an approaching eruption is the red glow of the molten mass. In conclusion an interesting comparison was drawn between the quiet type of lava-flow prevalent at the Sandwich Islands and the violently explosive outbursts like those recently exhibited in Java and New Zealand.

A paper by Mr. C. D. Walcott of the United States Geological Survey described an ingenious method of measuring the thickness of inclined strata.

Professor Dwight described an admirable machine, devised by him, for cutting large sections in any plane through fossils. For this purpose a Kerr diamond saw is mounted horizontally, and held rigidly in a plane by two disks carrying small wheels which are in contact with both surfaces of the saw. The specimen to be cut is mounted and adjusted so as to bring any plane against the saw with an even pressure. A solution of soda was recommended as a lubricator.

Prof. W. O. Crosby sent a paper upon the method of teaching mineralogy and lithology at the Massachusetts Institute of Technology. The last paper was presented by Dr. G. H. Williams, on the educational value of micropetrography, and illustrated by the exhibition of a new microscope of American manufacture, designed especially for students in this subject.

A resolution was passed to request Congress to remove the duty on scientific books and apparatus, and to join with other associations petitioning for this change in the laws. Professor Marsh was elected an honorary member of the society, to fill the vacancy left by the death of Professor Baird. Dr. Allen was re-elected president, and Professor Clarke secretary. The next meeting will be held in Baltimore.