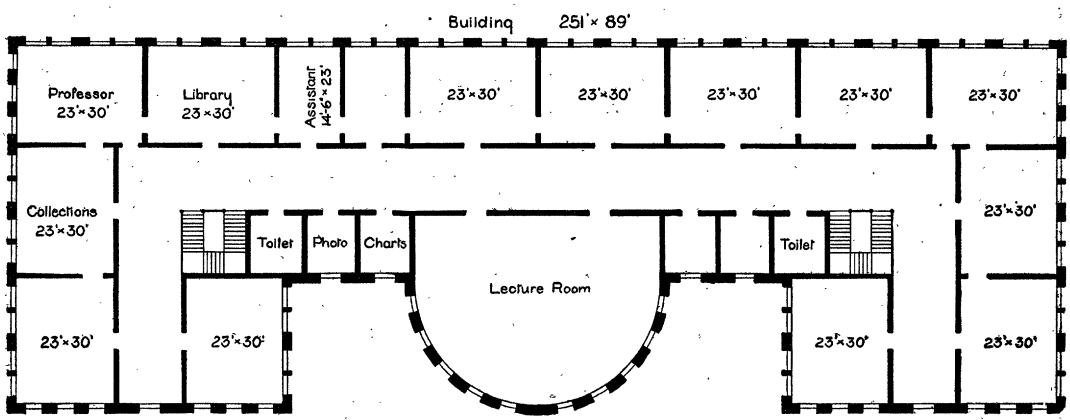
ratus may be placed which is rather for general and common than for personal use.

A candid examination of these six plans will, I hope, convince the reader that the proposed unit-room provides thoroughly convenient, but not excessive, accommodations for twenty-four students, and that the students may be distributed in many differing ways, according to special needs. It has not seemed worth while to pursue these plans further, with a view of showing how a smaller number of advanced workers could be disposed. The solution of such a problem is so simple as not to require illustration. If such a room is to be used for a collection, two cases could be arranged along the side wall, and if there are three windows, two sets of double cases could be placed against the space between the windows and run into the room as do the double rows of tables in the *zoology* plan.

In conclusion, attention is asked to the two studies for a floor plan. The first study is by Professor W. T. Porter, of the Harvard Medical School, to whose generous courtesy I am indebted for the opportunity to publish the plan for the first time. In this study the unit size adopted is 20 x 30 feet, but I have Dr. Porter's permission to state that he considers 23 x 30 feet preferable. In this study there is a central large lecture room connected with the main building, and there are two symmetrically placed wings, which, building space permitting, can be indefinitely extended, whenever enlargement shall become necessary. The second study, by myself, is merely a modification of the first: the size of the unit room is 23 x 30 feet, one room being drawn subdivided for assistant's use; the main building has been lengthened in order to provide small rooms near the lecture hall, and to increase the distance between the wings so as to secure better light; in order not to increase the floor space the wings are drawn shorter. Neither of these studies is to be regarded as more than a preliminary sketch, which needs competent revision and modification by a professional architect before it can become practically available. They suffice, however, for the purposes of this article and to illustrate the construction of a laboratory upon the unit system.



CHARLES S. MINOT.

HARVARD MEDICAL SCHOOL, BOSTON,
February 18, 1901.

THE NEW YORK STATE SCIENCE TEACHERS' ASSOCIATION.

THE fifth annual meeting of the Association was held at the University of Rochester, on Friday and Saturday, December 28 and 29, 1900, about two hundred members and others being in attendance. The

officers for the meeting were Charles Wright Dodge, University of Rochester, president; Albert P. Brigham, Colgate University, vice-president; O. C. Kenyon, Syracuse High School, secretary-treasurer.

After brief remarks by the retiring president, LeRoy C. Cooley, of Vassar College, an address of welcome by President Rush Rhees, of the University of Rochester, and the introduction of the president-elect, the opening address on 'The Method of Science and the Public Schools' was delivered in the general session by Professor S. A. Forbes, of the University of Illinois. The speaker held that while the methods of study pursued by the chemist, the physicist and the biologist in their various fields of investigation are by no means identical, there are certain underlying features common to all, and these may be abstracted and generalized and called the method of science. This does not mean mechanical manipulations of tools or of apparatus of any sort, but is essentially psychological in its nature. The study of this method is the study of the scientific mind while engaged in the pursuit of science. The application of the method was illustrated by descriptions of the mode of procedure followed in several recent pieces of investigation. The paper criticized much of the present science teaching in the schools as being unsuited to train the mind of the pupil in the mental operations of independent observation, classification, generalization, deduction and experiment which are the essential features of the scientific method.

The section meetings began on Friday afternoon. In the section of physics and chemistry Professor Henry S. Carhart, of the University of Michigan, gave an address on 'The Place of Physics in a Liberal Education.' As one of the oldest and most fundamental of the sciences, physics should have a prominent place in a general plan of liberal education; its intrinsic interests make it attractive to those who study it; its laws are capable of exact quantitative statement, and it thus furnishes, with the reasoning involved, an excellent instrument of education; its applications to practical and every-day life are so numerous and so important that every intelligent citizen should have a good general knowledge of the subject; it ought, then, to be a part of every high-school course.

Following the paper, Professor Edward L. Nichols, of Cornell University, described a number of devices useful for demonstration purposes in physics. These were (1) an apparatus for showing, in a semi-quantitative way, the expansion of air at constant pressure; (2) floats adjusted to show the phenomenon of maximum density of water; and (3) the torsion balance electrometer.

Before the section in biology, Professor Frederic S. Lee, of Columbia University, spoke on 'The Teaching of Physiology in Secondary Schools.' Dr. Lee advocated a broader view of the subject than most teachers in secondary schools possess. Physiology is the science of the life processes in all organisms, not merely those of the human body. As the basis of all are the vital functions of protoplasm, and of these the pupil ought to have a clear conception. Plain distinctions should be made between gross and minute anatomy on the one hand and physiology on the other, and only so much of structure should be taught as will serve to elucidate function; the idea of physiology proper must be kept paramount. Instruction by practical experiments performed by the pupil or, failing this, demonstrations by the teacher was urged. The number of good laboratory manuals suitable for use in seconday schools now makes such a method entirely feasible. Physiology should follow physics and chemistry in the curriculum. Teach-

ers were urged to inform themselves as to the true status of the alcohol question since most of the statements in the text-books are misleading.

In the same section Professor W. J. Beal, of Michigan Agricultural College, read a paper on 'How shall a Young Person Study Botany?' The paper opened with a very interesting account of the reader's experience as a pupil of Agassiz and of Gray—"The work with Agassiz helped me more than that of any other teacher with whom I ever came in contact, and yet no teacher ever told me so little." The paper advocated the study of plants rather than the study of books about plants; the examination of many related species instead of so many isolated 'types.' The use of the compound microscope ought not to be learned until the latter part of the course. The formation of an herbarium was discouraged. The paper contained a list of most suggestive and interesting topics for individual work for beginners.

Professor W. M. Davis, of Harvard University, addressed the earth science section on 'Practical Experiments in Physical Geography.' Laboratory work for demonstration purposes is most important in this subject, and schools should have proper facilities for it, including sufficient room for practical work, flat roof for sky observations, basement room for experiments with earth and water, as well as an abundant supply of models and charts. The schedule of daily work should be so arranged as to provide for these practical exercises, just as in physics and chemistry. The exercises should include the study of the earth as a globe, the atmosphere, the oceans and the land. The study of the land must be of a kind which will lead pupils to understand what they see in a landscape. Geography ought to serve some other purpose than the education of post-office clerks and express messengers. The study should extend through successive school years, and the speaker suggested that a committee of members of the Association plan a course in the subject to extend through as many years as seem suitable. Stress was laid upon the proper training of the teacher. The preparation of local guides for field work was strongly urged.

The 'Significance and Limitations of Nature' was discussed in the section in nature study by Professor Stanley Coulter, of Purdue University.

Dr. Henry A. Kelly, of the Ethical Culture Schools in New York City, spoke on 'Synthetic Nature Study.' The object of nature work is to interest the child in natural objects and phenomena rather than to give him definite courses in elementary science, to develop a sympathetic appreciation of living creatures and to encourage habits of observation and comparison. Too great emphasis is placed upon analysis in much of our school work, especially in the object lessons. More attention ought to be given to synthetic, creative work. This end may be accomplished by selecting for study topics which are naturally related. Productive results are often obtained by combining nature study with the work in literature.

After the section meetings a general session was held to listen to a discussion of the question, 'What does the College Instructor wish the Scientific Student to know and to be able to do when he enters College?' The speakers were Professors Nichols and Carhart for physics, Coulter for biology, Beal for botany, Lee for physiology and Davis for physical geography. The trend of opinion was to the effect that unless the student could have proper instruction in methods from a competent and well-trained teacher during his high-school course, he had better enter college without any previous study of science.

The evening session on Friday was held

in the new gymnasium at the University. The members of the Association, faculties of the University, the Theological Seminary and the Mechanics' Institute, members of the Academy of Science and of the Engineering Society, together with a number of guests assembled to listen to addresses by Professor J. B. Johnson, of the University of Wisconsin, and Dr. Robert H. Thurston, Director of Sibley College, Cornell University. The former spoke on 'The Scientific Basis of Modern Industry.' By modern industry is meant the entire productive activities of the machine-using nations. Since the introduction of the steam engine the world has made more progress than in all its former history. The steam engine does as much work in a year as all the men in the land could do in a century. Without knowing the real essence of things—gravity, heat, light, electricity—we can know in some degree the laws of their action, and this knowledge is scientific. The effect of this knowledge has been to revolutionize industrial methods. Scientific education is to-day the foundation of all material prosperity, hence industrial education on a scientific basis should receive the most liberal encouragement. Germany has been the first nation to recognize the importance of this work, and now the technical schools of that country are of the same educational rank as the great universities. The applied scientist must be a specialist, and must be given facilities for investigation if discoveries are to be made which shall extend our knowledge of the forces of nature and adapt their actions to human needs.

Dr. Thurston's address was entitled 'The Citizen, his Schools, his Industries, his Life.' Dr. Thurston emphasized the increasing need of every citizen to be educated and to be aided by the State to secure and maintain the best possible position among his fellow men, for individual effort alone avails much less now than when competition was less severe. The material progress of a nation may be measured by its consumption of iron and steel. A better gauge of advancement is the progress of higher education as supplementary to that of the common schools, particularly the development of the modern forms of technical school and the scientific departments of our colleges and universities. A comparison of statistics shows that during the century just closed there was a parallel advance in the development of technical education, the growth of that product of industrial activity which represents permanent wealth, the increase of national wealth, both aggregate and per capita, and the wealth which is secured by the people as wages. The larger educational insitutions of this country now graduate yearly about a thousand students trained in the applied sciences. "The compulsion which has brought about this immense development of higher education has consisted of three main elements: (1) that ability attained, through increased and more widely and uniformly distributed wealth, on the part of the people, to secure higher education, which always marks such progress as we have traced in our material evolution; (2) that constantly growing demand for more generally learned men in the professions, including now the constructive professions; (3) that constantly growing and increasingly intense demand, in all industrial vocations, for a scientific basis for all industries and for highly trained, learned men in all great enterprises and in every system of industrial production. But all these elements of the aggregate compulsion rise out of and accompany the evolution of the modern industrial system, which, in turn, is based upon that progress in civilization through the work of the inventor, the mechanic and the man of science, which is giving us such marvelous accumulations of material wealth, with all its higher accompaniments

in the realms of the sciences, the literatures and the arts, fine, useful and æsthetic." For the past thirty years the demand for mechanical engineers has been increasing at a remarkable rate and is likely to continue. The sciences will more and more become the foundation for all industrial occupations, hence, scientific education should be begun in the preparatory schools, and instruction should be given by teachers who have received adequate training. "One great mind lost to the world through lack of the higher education which it is capable of utilizing is a more grievous loss than sunken fleets. * * * One great exploiter of scientific knowledge counts for an army, for he makes effective an army, saves a country from ruin, raises a nation to previously unimagined heights, confers the comforts of the highest civilization upon the people, or gives his fellow men leadership toward hitherto unexplored realms of wisdom, knowledge and opportunity. The grandest financial expenditures by the state are those which develop new moral, intellectual and physical forces for the benefit of the nation."

After the addresses a reception was given by the Trustees of the University for the Association and guests.

The section meetings were resumed on Saturday morning. In the section in physics and chemistry John S. Shearer, of Cornell University, spoke on the 'Relation between High Schools and College Courses in Physics.' Struck by the fact that in the elementary college courses in physics those students who had received no previous training in the subject were capable of doing quite as good work as those who had taken a preparatory course, the speaker made a careful study of the average standing of the two groups of students and found that those in the second stood only about three per cent. higher than those in the first group. Among the apparent causes of this condition the following were mentioned: Formulæ are memorized without any clear understanding of their meaning; problems are solved by rule of three as a substitute for careful analysis; the student is carefully shielded from the real difficulties of the subject; the idea is too prevalent that physics pertains only to the class-room and the laboratory and has no connection with actual affairs; the habit of self-reliance in testing things by experiment and by deduction from known laws is not developed. In a word, poor teaching is at the bottom of it all.

'The Manual Training of Chemistry' was the title of a very practical paper written by Professor William E. Bennett, of the Rochester High School. The manual training of the trade school is purely utilitarian. It aims to develop manipulative skill to the point of being automatic or reflex, while in the larger and better sense such training should also stimulate mental activity and equip the student to cope with unexpected difficulties. This he can do only if he understands the reasons for each step in the progress of his work. Chemistry, with its delicate operations and manipulations was claimed to be one of the best disciplines to develop the faculties involved.

In a paper on 'The Relative Value of the Qualitative and the Quantitative in Laboratory Work,' Professor W. C. Peckham, of Adelphi College, Brooklyn, held that the greater part of laboratory work in physics should be quantitative in character and that the deductive method of presentation is preferable in high-school work.

Dr. Henry R. Linville presented in the section in biology a paper entitled 'The Framing of a Course in Biology for Untrained Minds: a Discussion of Principles.' The writer stated what he considered should be the main features of such a course and described the work planned for the boys from the 'East Side' in New

York City, outlining the course of study and method of work in zoology in the DeWitt Clinton High School.

'Zoology in Secondary Education' was discussed by Professor Jacob E. Reighard, of the University of Michigan. Professor Reighard held (1) that science teaching in secondary schools should have for its object the developing of scientific method (intellectual) rather than the imparting of information, and that it should be disciplinary rather than technical; (2) that biology does not resolve itself in the final analysis into physics and chemistry; that it is a distinct science with its own principles, and that its intellectual methods are therefore distinctive and different from those of physics and chemistry; (3) that the intellectual methods of the biological sciences are like those employed in the historical, social and other humanistic sciences; (4) that properly conducted biological work in secondary schools therefore affords the best possible training in those intellectual methods which are of the most value to the future citizen, for it trains for citizenship; (5) that the biological sciences are homogeneous, in the sense that there is no necessary sequence of parts, and, aside from practical considerations, their study may be taken up at almost any part and pursued in any order of parts. The paper also dealt with the question, What biology is it possible to teach in secondary schools, and what parts of the subject are of highest training value?

In the earth science section Professor F. M. McMurry, of Teachers College, Columbia University, spoke on 'Controlling Ideas in Geography Work in the Grade,' maintaining that the basal units of geography ought to be taught far more fully than has heretofore been the case, that the proper presentation of these units calls for numerous excursions and the type treatment of topics, that the latter provides for far more frequent and effective reviews than have been customary, and that there is an extensive causal sequence in geography, the beginning point being physiographic and climatic conditions.

Professor Albert P. Brigham, of Colgate University, followed with an address on 'The Personal Equipment of Teachers of Geology and Geography.' The teacher should feel genuine interest in his work and ought to have had as much field experience as possible, including detailed and careful observation and description. Verification in the field of the results obtained by others should also be practised. The acquirement of full knowledge of some one phase of the subject is highly desirable. The economic bearings of the subject ought not to be neglected. Acquaintanceship with other workers in the same field is to be cultivated, and attendance at meetings of scientific societies should be both a duty and a pleasure. The teacher needs also to possess a well-selected library and to be familiar with its contents.

The last paper in the section was by Professor Amos W. Farnham, of the State Normal School, at Oswego, on 'The Purpose of Geography.' It is the purpose of geography to take into account all those physiographic elements, in a related way, which are of use to man, and those, also, which hinder his progress. The child regards the various earth forms of his environment as sources of enjoyment and of interest. Later, he learns the economic importance and the physiographic effect of climatic changes, rainfall, the flow of streams, the amount of sunshine, the effects of drought and so on. Geography cultivates the pupil's intellectual processes, stimulates his emotional nature, and leads him to realize man's dependence upon, as well as to understand his control over, the forces of nature.

In the nature study section, E. Howard Eaton, of the Bradstreet Preparatory School

for Boys, Rochester, spoke on 'Birds in Nature Study.' The rapidly increasing study of birds and bird-life is due, in part, to the general awakening of interest in nature; but there is also a wide-spread feeling that the number of our native birds is decreasing very rapidly, and that it is only by instructing the rising generation in the value of birds and the ways of protecting them that we can hope to preserve the varied, beautiful and highly beneficial species which are disappearing before the onward march of railroads, telegraph wires, plate-glass windows, electric lights, milliners, wood-choppers, ditch-diggers, English sparrows, murderous boys and untutored men. There is, moreover, a great inherent value in bird study. Children are interested in life, and birds are the most alive of all animals. Their highly specialized structure and life activities, their motion, song, language, arts, architecture, community interest, travel and personal traits are highly suggestive to the youthful mind. In this department of nature study there is also a chance of directing the dawning moral sentiments which can not be neglected. To tell children that life is sacred and that nothing that lives should be killed is weakly sensational, irrational and insulting to the ruler of the universe. Boys should be taught why, when and what to kill; not never to kill. The teacher of bird study must know not merely technical biology, but also the natural history of birds, and teach the general structure, relations, habits, food, song, flight, and special adaptations of the different families of birds and the common individuals of each family. Let the boys and girls become acquainted with our bird neighbors and their occupations, and when they know them as well as they do their own friends and recognize them as easily, then they will be good bird protectors.

Mrs. Anna Botsford Comstock, of Cornell University, discussed the subject of 'Nature Study and the Grade Teacher,' describing the work being done in the State in the way of introducing nature study into the schools and mentioning the difficulties encountered in getting the work properly started, owing to the lack of preparation on the part of the grade teachers.

At the closing general session Professor Frank Carney, of Keuka Institute, presented a paper on 'The Moral Value of Science Studies,' and John W. Spencer, of Cornell University, described 'The Work of the Junior Naturalists' Clubs.' These clubs are composed of boys and girls in various parts of the State and were started for the purpose of developing interest in nature. The membership now includes several thousand.

At the business meeting with which the session closed it was announced that forty new names had been added to the membership roll and that the financial condition of the Association was satisfactory. The following officers were elected: *President*, Professor Franklin W. Barrows, Central High School, Buffalo; *Vice-President*, Professor Frank M. McMurry, Columbia University; *Secretary-Treasurer*, Professor A. R. Warner, High School, Auburn.

After adjournment many members took the opportunity to visit Ward's Natural History Establishment, the works of the Bausch and Lomb Optical Company, the Eastman Kodak Company and other places of interest.

Exhibits of scientific apparatus, museum and laboratory supplies, charts, etc., were made by Bausch and Lomb, Ward, Marine Biological Laboratory, Denton Brothers and others.

The proceedings of the meeting will be published in full by the Regent's Office in Albany.

CHARLES WRIGHT DODGE,
Secretary.