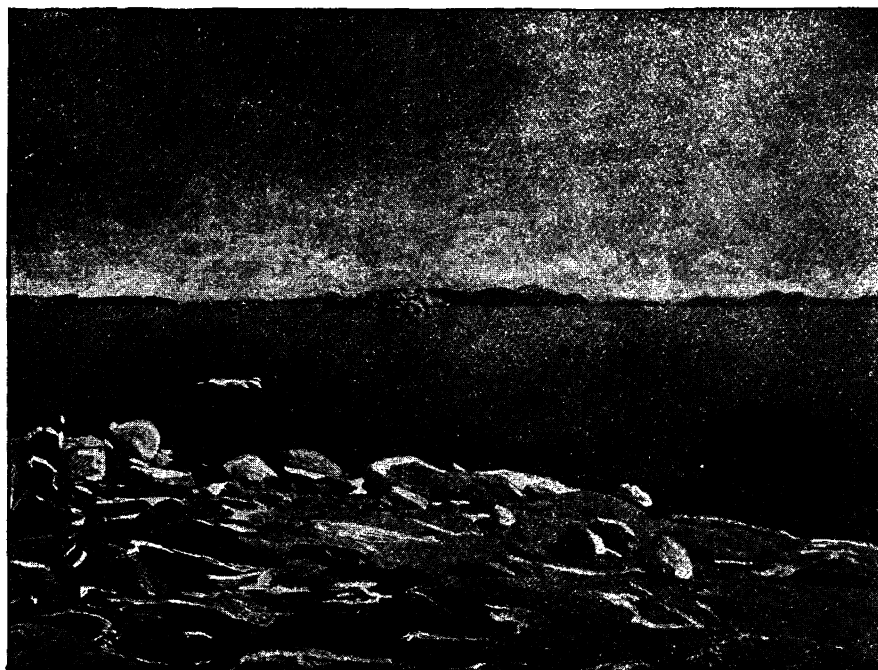


huge rocks and boulders. They varied somewhat in size, though averaging about a foot in diameter, outside measure. They were uniform in color, made of fine feathers and down plucked from the breast, the whole effect being dull gray. The eggs were from three to six in number, of a dull grayish-green or drab color, which varied slightly in the different nests. The average of fifty-one eggs from thirteen nests is 3.05×2.00 . The female, if startled, deposits excrement, and partially covers the nest with down by a quick back motion of her feet. In many nests examined this was not the case, and in all probability the female was away feeding at the time of our arrival. Nearly all of our party reported the same in the nests of startled birds. Whether done to conceal the eggs or whether done through fright is entirely a matter of conjecture.

At the time of our visit to Duck Islands, incubation was begun in nearly all cases; in many far advanced; and though several barrels of eggs were collected, there were but very few which would be of any use to Peary. The birds, though to us they seemed very abundant, were thought by Captain Pike to be rather scanty in number. Probably some Arctic whaler had been there before us. This supposition may have been correct, as the sets

relatively much greater than in the larger cities, partly because these schools receive considerable accessions from the surrounding country, and partly because the smaller towns are not well supplied with private and technical schools to divide the attendance. So it comes about that a large part of the membership of the public secondary schools of our land is found in the villages and minor cities. In many of these towns education is a leading interest, the teachers are a favored and highly respected class, and the schools are managed with vigor and intelligence.

Now it is in the schools of these smaller cities and villages that the graduates of the numerous normal schools of our land find employment, either as superintendents, principals, or instructors. The district or rural schools rarely feel that they can retain the services of a trained teacher, so that the constant effort of normal faculties to induce their graduates to "go into the country and build up the rural schools" are only moderately successful. In the large cities the corps of teachers is usually recruited from the local high school or training school with little aid from without, and thus it becomes the distinctive work of the normal schools to give tone to education in communities too small to support a training school.



DUCK ISLANDS.

of eggs we collected contained but from three to six, while most authorities give from six to ten as the normal number.

Besides the eider ducks, there was but little else of interest on the islands. Two or three snowflakes, *Plectophanes nivalis* (Linn) Mayer, a northern phalarope, *Lobipes hyperboreas* (Linn), Cuv., and a single king-eider, *Somateria spectabilis* (Linn) Boie, made the entire list of birds. Several spiders and an ant, which was not caught, made up the rest of animal life observed; although there were several pools which looked as if they might be worthy of investigation.

The "Kite" had been steaming constantly from place to place, to avoid the bergs floating in the vicinity; and at 12 M., much against our wishes, we were recalled to pursue our journey northward.

Reading, Pa., Sept. 19.

PREPARATION OF TEACHERS OF SCIENCE AS CARRIED FORWARD IN THE MICHIGAN STATE NORMAL SCHOOL.

BY E. A. STRONG.

THE list of towns and villages in our country having a population below 20,000, or even below 10,000, is a large one. In these towns the number of pupils who attend a public high school is

This is a great work, and it need hardly be said that it yet wants much of even reasonably complete accomplishment. Still, during the past few years there has been great improvement in the training of teachers, and the normal schools of the land are coming to deserve more and more the interest and sympathy of the friends of sound learning. A concrete example may best exhibit what the normal schools are doing or attempting, and the department of the physical sciences in the Michigan State Normal School will be used for this purpose.

Of the thousand students in this school rather more than one-half take the full or four-years' courses, and about one-third of this number specialize their work in the direction either of the biological or the physical sciences. Of those who elect the physical sciences about 63 per cent have during the past five years come to the school certificated as graduates of "approved high schools," 19 out of a class of 21 being the largest ratio and 18 out of 63 the smallest. Of those who went out from the school between the years 1885 and 1890, 86 are teaching or have taught physics in some high school, and fifty-four are teaching or have taught chemistry. These numbers seem small; but it must not be forgotten that many of these people take up teaching as a life-work, and that the number of normal schools with a presumably similar or better record is very considerable.

The teaching force in this department is supplied by three instructors, with some regular and efficient assistance from advanced pupils, many of whom are teachers of experience. The department occupies three floors in the south-east angle of the building. Upon the lower floor is a shop, 33 feet by 28 feet, with a modest equipment of lathes, benches, and tools; a physical laboratory, 34 feet by 54 feet, supplied with water, gas, stone and oak tables and benches, a water-motor, a small dynamo and accessories, and a considerable collection of American, English, and German apparatus for measurement; a store-room, twelve feet square, containing cases for apparatus, one side of the room being used as a balance-room; two dark rooms, each 6 feet by 15 feet, with optical benches and the usual equipment for photometry and lens work, one side of one of the rooms being fitted up for primary batteries. Upon the middle floor is a recitation-room and laboratory for elementary physics, 34 feet square, furnished with recitation seats and tables for students' work, cases for students' apparatus and demonstration tables; an apparatus-room, 12 feet by 30 feet, with cases for demonstration, apparatus and tables for teachers' use; and a recitation-room and laboratory for higher physics, 20 feet by 24 feet, with the necessary furnishings and equipment. The third floor is devoted to chemistry, and contains a lecture-room, 20 feet by 24 feet, a laboratory 34 feet square, with tables for 40 students, and a work and store-room 12 feet by 30 feet, all with the usual fittings, apparatus, and appliances.

The course of study of this department contains the following titles: 1, Physics I.; 2, Physics II.; 3, Physical Laboratory Practice; 4, Training in the Physical Sciences; 5, General Chemistry; 6, Advanced Chemistry; 7, Physical Technics, including Advanced Laboratory Practice; 8, General Astronomy; 9, Advanced Physics; 10, Instrumental Astronomy; 11, Sanitary Science; 12, Meteorology.

The first five subjects in this list are taken by nearly all intending teachers who graduate upon the four-years' courses, and are designed to give some knowledge of the content and the methods of the physical sciences and such skill in manipulation as are needed in general teaching. The three numbers following also form a natural group designed to meet the wants of special teachers of the physical sciences. The last three are post-graduate subjects. Physics I. is a course, complete in itself, consisting of a daily lesson for twenty weeks, with additional laboratory work, upon molecular and mass mechanics. Special prominence is given to the states and properties of matter and the transference of energy. Physics II., a course of the same extent upon sound, electricity, and light, is also made complete within itself as far as possible to meet the wants of those students who have had a brief course in physics elsewhere, but who wish to extend their knowledge of these subjects. For most pupils the two form a continuous course of one year, with supplementary practical work.

The only condition for entering upon this subject is the completion of algebra and plane geometry; but the high average age of the members of the class, — between nineteen and twenty, — coupled with the fact that a large number of those who enter upon this subject have already completed elementary physics in one of our excellent high schools and desire to review and extend their studies in this direction with reference to teaching, permits and invites a strong and extended course.

The experimental work is of two sorts, teacher's class experiments or demonstrations and students' individual work carried forward at their tables. Our experience would indicate that the former cannot be entirely omitted without loss. A piece of apparatus does not teach its own best use. The student who knows how to investigate thoroughly and to question himself wisely has already passed the elementary stage of scientific work. As to the character of this demonstration apparatus, a portion consists of the ordinary apparatus sold by dealers, but a still larger portion is derived from the home, the farm, and the workshop — commercial, working pieces. Important demonstrations are repeated by pupils before the class, so that they may get a feeling for artistic demonstration and neat manipulation before a class. This is regarded as very important, though it is far easier to gain this ability than the power to question wisely. The catechism is the infinite matter.

In addition to these daily class demonstrations, our course contemplates students' individual work, mainly in measurement, two afternoons a week after the "collective" system. That is, each member of the class has a piece of apparatus exactly like that of the others, and does the same work in the same time. So each student is supplied with a balance in case, turning easily with one milligram, with fine weights; a set of burettes and measuring glasses, English and metric units divided with accuracy, and, in general, examples of the simpler apparatus in dynamics, heat, electricity, and optics.

As to method, a very important part of the work is presented inductively. That is, physical changes are observed and described by members of the class; the conditions upon which these changes depend are then varied in many cases and in many ways, and in each case the pupils are asked to observe and describe. Wise questioning leads the class to distinguish that which is constant from that which is variable in these changes until the law which governs them comes spontaneously into view and is fully apprehended and formulated. With somewhat similar material and under somewhat similar circumstances the pupil repeats the work at his own table. Further illustrations, exercises, and problems follow. If a book is used — as is the case in a portion of the work — the subject is assigned as a lesson to be recited in good form — the least valuable part of the work, but still not without value. So, by the exhibition of material and wise questioning, the pupil passes from the observation and statement of fact to the apprehension and statement of law. It hardly needs to be added that this so-called inductive method is not identical with the method of discovery, since the student would not of his own instance know what experiments to try or what questions to ask; but from his point of view he is a real discoverer of fact and law, and the process has to him the interest and especially the suggestiveness of discovery.

The method of verification and illustration is also freely used, by which that which is dubiously or imperfectly known is brought into fuller knowledge. This method blends easily with the preceding. Resort is had to the method of authority for those numerous cases in which experiment and verification are impossible under the circumstances. This is especially necessary in the case of a teacher, who needs to have a complete view of his subject, and who must appeal to book or lecture for the ground of much of his knowledge. This knowledge of what other people have found to be true is so vivified by the more vital knowledge that the student has gained for himself by similar methods, that it is neither unreal nor unfruitful. Much attention is given here and elsewhere to the selection, care, and use of apparatus, to the graphical method of recording facts, and to the bibliography of physical science.

3. Laboratory Practice. This consists of "separate," or individual, work for ten weeks in physical measurements, following and completing the preceding courses. As the members of the classes in laboratory practice have passed over the whole of elementary physics, they are prepared to take any experiment within the range of this subject. Each student works with a different piece of apparatus and continues its use until he has mastered it and secured the highest attainable results. Thus it is not necessary to duplicate pieces, and this saving in the cost of extensive duplication is applied to the purchase of apparatus of a higher grade and of greater variety than would otherwise be possible; and thus the course is made more extended and exacting than it could be under the "collective" system. Moreover, many pieces of apparatus in mechanics and heat have optical or electrical accessories which can be understood and put into action only by students who have completed a course in physics. But the real reason for preferring the "separate" system in any serious work in laboratory practice is the facility which it affords for individual and independent work according to observed capacity and advancement. No text-book is used, but exercises are set from a printed list containing references to Pickering, Stewart and Gee, Glazebrook and Shaw, Worthington, Whiting, and other authors, with whose works the laboratory is supplied.

4. Training in the Physical Sciences. This is a course in methods, and consists of two parts — theory, presented by quizzes, lec-

tures, and reading; and practice, in which the members of the class taking the scientific course teach the elements of this subject for a term of weeks in the school of practice. The philosophy of methods rather than a definite course of practice mainly engages attention, and yet that most difficult special problem in modern pedagogy, how to teach the elements of the sciences in a real way to pupils below the high school, is attacked with vigor, and a possible course is marked out and illustrated in detail. Much time is also given to practical work in the smaller high schools. The course of reading in this class is quite extended, and its members become somewhat familiar with the best European and American methods of teaching secondary physics.

5, 6. Chemistry and advanced chemistry. In these subjects the members of the scientific course complete Remsen's "General Chemistry," Jones's "Junior Course in Qualitative Analysis," and have ten weeks' quantitative work. The work is arranged with special reference to teachers. The students have much practice in demonstration before the class, in the preparation of apparatus and reagents, in gas analysis, in blowpiping, and the attempt is made to interest each one in some sort of practical work which he will be able to continue, and in some chemical periodical which he will desire to read as a teacher.

7. Physical Technics. The subject of this course is the laboratory method, which is here viewed from its practical side as it is from its theoretical side in the course in training. Robins's "Technical School and College Building" is made the authority in most matters of construction. The members of the class make detailed plans and specifications for fitting up an ordinary school-room as a laboratory for physics or chemistry or both, and with various degrees of elaboration; prepare lists of apparatus of varying cost from \$50 to \$1000; and report in full, with drawings and price-lists, upon some high-school or college laboratory which is visited for this purpose. All do much practical work in making and especially in repairing apparatus; construct some important piece; have much practice in testing balances, galvanometers, etc.; report monographically upon some assigned topic, as, for example, the best form and material for fine weights, the spiral-spring balance as an instrument of precision, comparison of photometers, conditions determining the size of drops, etc.; and have much careful and continued practice with at least two instruments of precision, which were in general used with less completeness in the regular laboratory course, as the spectroscope, the saccharimeter, the sextant, the astronomical transit, etc.

8. Astronomy. The essence of this work consists in the actual observation of the heavens with the unarm'd eye, an opera glass, and a small telescope during one school-year. Great familiarity with the constellations is secured, and a full set of drawings showing the observed motion among the stars, and the telescopic appearance, at frequent intervals, of the moon and the planets visible under favorable circumstances during the year. A good high-school text-book is incidentally gone through with.

9. Advanced Physics. The objective point here is a mathematical view of physical science and the ability to read the stronger scientific books and periodicals with ease and profit. Those who enter the class have had work in trigonometry, higher algebra, and the calculus, and are able to master an advanced text-book. Much practical work is also done with the purpose of leading the members of the class toward some course of study or investigation to relieve and vivify their subsequent teaching. The post-graduate work will not be described as it has not yet become important.

It may be asked whether this preparation is sufficient to make a well-furnished teacher of science. For myself I would frankly answer, no. The highest attainable preparation is not sufficient, it is only hopeful—in the way to become sufficient. Our candidate for success as a teacher has been all along taught that the first condition of success is intimate and exact knowledge of his subject. He already has some knowledge and has been put in the way of getting more, and surely this is a hopeful condition. If it were further queried whether this man would not have done more wisely to attend a technical school or college for four years as a preparation for teaching science rather than give a large part of his time to English, history, mathematics, and German, to the

study of children, to practice-teaching, and to the history and philosophy of education, I would reply that it depends upon who the man is. A native talent for teaching or exceptional knowledge and love of young people may render the intending teacher independent of formal professional instruction; but it is my own observation continued for many years as principal of a large high school and superintendent of a system of schools, that the normal graduate will be the more painstaking and studious man, and that he will, in the long run and with important exceptions, do finer, sounder, and more rapid teaching than the technical student. At any rate he has fairly emerged upon the field of advanced secondary instruction and deserves recognition and interested and sympathetic criticism.

Ypsilanti, Mich., Sept. 17.

NOTES AND NEWS.

A PARISIAN Inventors' Academy is distributing letters to inventors in this country, informing them that "after examination of your last invention the Academy has conferred upon you the title of Honorary Member (*Membre d'honneur*) with award of the first-class Diploma and the Great Gold Medal (gilded)," on receipt of ten dollars to defray the cost of the gilded medal, etc. We advise our readers, if so addressed, to consider the value and probable standing of that institution very carefully before sending on their ten dollars. A note to our consul in Paris might assist them in securing such testimony as they may require on this point.

—Recently a communication from the Lick Observatory recorded a phenomenon which was thought to be as unique as it was beautiful. Fog filled a valley, and upon its level surface the mountain peaks were mirrored as if from a placid lake. Strangely, in the *Yorkshire Herald* of Sept. 7, "An Early Riser" records a precisely similar phenomenon at 6 A.M. on Sept. 5; It was seen from Leyburn, which overlooks Wensleydale. This lovely Yorkshire valley was half filled with fog, which looked like a mighty flood or lake. Upon it the opposite slopes, lit up by the bright sunshine, were reflected with "extraordinary distinctness."

—G. P. Putnam's Sons have in active preparation an edition of the "Works of Thomas Paine," which will be edited by Moncure D. Conway, author of "The Life of Thomas Paine" which they have just issued. The set will be in two or three volumes, the first division being devoted to the political and sociological writings, and the second to the religious and literary papers, of which the most important is "The Age of Reason." The volumes will be uniform with Mr. Conway's biography, and will include essays of importance not in any previous collection.

—In "A Chapter in Meteorological Discovery," in the October *Popular Science Monthly*, Mr. John Coleman Adams presents Benjamin Franklin as the father of American meteorology, and shows the part which Redfield, Espy, Dr. Hare, Professor Loomis, Blodgett, Mitchell, Coffin, and Dr. Joseph Henry have severally had in building up the science. A philosophical discussion, of much value and interest to thoughtful people, of the best methods of really learning foreign languages is given by Dr. Howell T. Pershing, in an article on "Language and Brain Disease." A curious and liberally illustrated article on the "Evolution of Dancing," by Lee J. Vance, shows how the custom has been largely derived from the religious, mystic, or festive exercises of the human races in the earlier stages of their civilization, and illustrates the various forms which dances assume among different peoples. Pertinently to the present vogue of the "Keeley Cure," Dr. T. D. Crothers discusses the merits of the various specifics for the cure of inebriety that have claimed attention at different times. An important article will appear on the disadvantages which the conditions of modern city-life throw in the way of the best physiological development of children, by Dr. Henry Ling Taylor. The subject is fully reviewed in a philosophical manner, and the attempt is made to measure the influence for good or ill which each of the factors in which city conditions differ from those of the country exerts upon the child's bodily and mental faculties.