AN INVESTIGATION OF THE VIBRATIONS OF PLATES VIBRATED AT THE CENTRE.

By Professor Thomas R. Baker.

Since the publication of the paper under the above heading we have received from Professor Baker two drawings illustrating the same, which we now produce.

The first, Fig. 1, shows Professor Baker's method of producing the sand pictures, useful for class illustration:

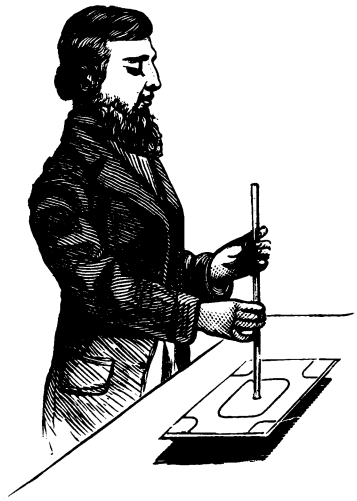

Fig. 1.

Most of the plates used were window panes of various shapes and sizes, they were vibrated by rubbing an attached glass rod. The tubes, which were about $\frac{3}{16}$ of an inch in diameter and 20 inches long, were attached at right angles to the face of the plate with sealing wax. The support for the plate was a rubber cap, the common lead pencil eraser, fitted on the end of a post projecting from a disk of lead. A short rubber-capped lead pencil fixed upright in a wooden block answers the purpose just as well.

The plate was balanced on the support, the tube standing upright, and held loosely between the thumb and forefinger of the left hand. Then catching the tube between the moistened thumb and forefinger of the right hand and rubbing downward the vibrations of the plate were produced.

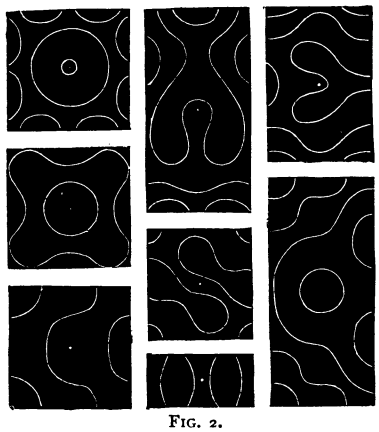

Fig. 2.

Fig. 2 represents copies of various sand pictures thus produced. He states:

"The figures were copied by placing the plate over paper which had been wet with a solution of potassium bichromate and dried in the dark. The plate and paper were exposed to diffused light, or to the vertical rays of the sun. The paper not hid by the sand soon darkened, and when this change had taken place the plate wasre moved and a lead pencil run along the bands of lighter colored paper representing the sand lines. This paper was then placed on white paper, and the figures copied by pressure. About 150 sand-figures were copied and traced."

For a summary of the facts derived from these experiments we refer our readers to Science, Vol. I., No. 13, September 25th, 1880, page 157.

FIELD WORK BY AMATEURS.*

By Helen Harelin Walworth.

It is announced, I believe, that one of the aims of the American Association for the Advancement of Science is to make Natural Science popnlar, to encourage its pursuit among all classes of people. It is because I have such an understanding of its aims that I presume to speak a word in behalf of the class who love science, yet can give to it but a limited portion of their time and thoughts.

Such a class of persons are important factors in the development of every department of knowledge and art. The professor, the artist, the specialist may have higher aims; they certainly do more thorough work, yet they would scarcely be understood, appreciated and encouraged if there did not exist the intermediate class who admire, applaud and exhibit the work they cannot themselves perform.

I therefore deprecate the scorn with which the professional too often contemplates the dabbler in his specialty, as he will perhaps designate the amateur. "A little knowledge is a dangerous thing" only when it is pretentious. A mere elementary knowledge of any natural science is a proposition from which reason starts; it is a foundation on which thought builds, and a height from which imagination takes its flight. It is an education in all other knowledge, because it demands attention, observation and accuracy with well-defined expression.

How can the popular interest in science be stimulated and increased? A majority of educated people shrink with aversion from the memory of tasks performed at school. The bare mention of a natural science recalls pages of unpronounceable words and incomprehensible classifications. Yet, if a practical geologist or botanist will take any three of these individuals into the field with him and beguile them into breaking rocks or gathering flowers scientifically, two out of every three will be delighted with the occupation, and will strive to recall the classical names which inspired them with disgust while they were merely theoretical. It is then only while science is an abstraction that it repels; render it practical and it invariably attracts.

In every city and village of our country we find numerous clubs and societies devoted to special objects of literature and art, and a few to science. These last are rare, they would be numerous and active if slight encouragement were given to them by those who have the ability to guide and direct. Such clubs and associations should begin with a short and well directed course of reading, accompanied, if possible, by a few interesting lectures as a preparation for field work which should not be delayed through timidity or a feeling of ignorance. A few visits to the field by a geological club will serve to arouse enthusiasm, and inspire a desire for research, which months of reading would not accomplish. It cannot be urged that many live in localities where there is nothing to study, for I believe it may be safely stated that uninvestigated scientific facts lie over and under every square mile of the United States. Yet I have heard the members of a geological club, who studied exclusively in the class-room, make such a plea. When visiting their city I said to one of them, "What rocks have you in this vicinity?" The person addressed looked at me with unqualified surprise and answered, "We have none." I exclaimed, "you have a river and hills, and many railroad cuttings, the foundation of things must be visible somewhere." But this individual insisted that there was absolutely nothing to examine within walking or driving distance of that city. There is, of course, a difference in varying localities. In Davenport, Iowa, where there is now a well-established Academy of Science, located in its own fine building, and displaying a great museum, a few years ago there were but half a dozen persons who met in a hired

*Read before the A. A. A. S., Boston, 1880.

room to talk informally about science. They soon, however, began collecting and investigating in the suburbs of their city; it is, as you know, the region of ancient mounds. Their discoveries have been remarkable and valuable.

In Saratoga Springs, where I reside, we have, in a limited way, an interesting geological region, and we have an active Field Club. It labors under disadvantages, having had no regular instruction, and no course of lectures, but it has been assisted by two gentlemen who have had some experience in geological research. As this club is now established upon an apparently permanent basis, some account of its efforts may not be amiss. There are between thirty-five and forty members, the larger number studying geology; a few botany, and others, who are studying art, accompany these to sketch from nature. This community of interest among those who are pursuing different studies has the advantages of economy in the hiring of vehicles and in the purchase of instruments like the microscope, which can be used in common.

The Saratoga Field Club makes excursions into the country every Saturday, when the weather is favorable for field work; they also have in-door meetings once a week, to compare and examine specimens; papers are then read on subjects relating to special objects of study and discussion, and conversation concerning them is encouraged. Meetings are also held during winter preparatory to the summer work.

We have in Saratoga the rocks of the Laurentian, the lower Silurian of the drift, the Champlain and Hudson river periods. But in the Laurentian granite alone there is an endless variety for those who are interested in minerals. Then, too, one experiences a certain awe in handling the oldest rocks that formed a boundary of the world's first continent. The gloom of that almost lifeless age seems still to creep along the dark, stout foliage that strives to cover the baldness of these venerable rocks. Worn and ground by the action of ages they display few picturesque forms, but strength and endurance seem moulded into shape among their rounded hills, while nestling among their unattractive gray shadows are found the garnet, the chrysoberyl, the tourmaline and other beautiful gems. The Potsdam sandstone lying above the granite, shows great variety and beauty of color, and Ruskin says very justly, "that nature tempts us, like foolish children as we are, to read her books by the pretty colors in them." The ripple marks and glacial scratches of this rock are also countless and interesting. The calciferous sand-rock coming next in succession, and upon which the western half of our village rests, is in many places brilliant with crystals and finely-marked with Fucoids; it bears also whole acres of the marvelous concentric Stromotopara, which is peculiar to this vicinity. The Trenton limestone, next above this is, as usual, rich in fossils, and an afternoon amid its quarries will render the members of the Field Club oblivious of heat or cold or fatigue in their search for Erinoids, Brachiopods and Trilobites. Such interest is scarcely diminished in their laborious wanderings in other directions among the Hudson river slates and shales for the rarely found Graptolites. The morains and pebble-laden hills of the drift period are sought out and discussed. The sands of the Champlain, and the terraces of the Hudson river periods are subjects for thought and surmise as we ride over the country toward some definite object of investigation. The great geological fault which has given birth to our justly renowned mineral springs, coming forth as they do from tue hidden fossil oceans of the buried centuries, stimulates us to ponder and to inquire. Yet for years most of the members of this club have walked blindly through these treasures, seeing, but not observing; knowing, but not seeing. A new world has been opened to them, and this world of nature and of science would be a revelation to hundreds of others if they were induced to engage in out-of-door studies.

The public mind has been awakened to an interest in science by means of the popular lectures delivered by men of acknowledged fame, and also through numerous popular publications. These have been a preparation for field work which can now be pursued with enthusiasm and profit. A search for geological facts in the fields affords an admirable means of self-discipline. In the beginning each one sees all that he seeks and believes that all he sees is of immense value, or he goes to the other extreme and pronounces everything worthless. He will be vexed with himself, crushed and mortified by turns, but each blunder will be an important lesson, and soon he will begin to discriminate, to learn and to search, until he finds himself, like the hunter in pursuit of game, eager, excited, and ever ready for a new chase.

When the guidance of a professor of Geology cannot be procured, much may still be done with the use of proper text-books, and the State Geological Surveys, especially if there are a few men or women in the association who have some experience in field work. In every community a few gentlemen will be found who possess such knowledge. It is a deplorable fact that few women possessing such knowledge can be found in any community, except, of course, in Boston. I say deplorable, because scientific training is, of all others, that which women need to correct the defects which, as a class, they display—defects which have become inherent through continuous superficial training. In this case like must cure like, for it will require several generations of women, gradually trained to scientific methods of thought and investigation, to eradicate the slipshod mental habits of the women of to-day. A few are struggling toward better and clearer ways, but the difficulties to be overcome prove the low standard of their starting point. Is it right that woman should be ignorant of the scientific facts embodied in the useful and beautiful things she handles? If these facts are of value to the world they are of value to women individually.

Invite women, then, to enter upon this field of labor, and science will gain thereby. Enlist the enthusiasm, the self-sacrifice and vitality of women in the cause o. science, and a new principle will stir the remotest member s of the body of scientific knowledge.

The effect of this labor upon the lives of women is beyond calculation. Where they are now weak, both physically and mentally, they will become vigorous and strong; where they are complaining and sentimental, they will grow cheerful and wise. Their restless longings will move into healthful channels, and they will learn to think, to observe, and to perform with accuracy and deliberation. They will discover that the ability to learn and to do is not a mere knack to be caught, but that it is the result of continuous and pains-taking labor.

Believing, as I do, that a practical knowledge of natural science will do more for the advancement and emancipation of woman than any laws that can be made, or any rights which can be granted to her, I appeal to the learned gentlemen of this association to invite and encourage women to labor in the various departments of scientific investigation.

The progress of woman depends on the exercise and discipline of her mental powers and the proper expenditure and economy of her physical powers. Both means are to be obtained mainly through a knowledge of the natural sciences, and they will take and retain their hold upon her more readily by means of out-of-door work.

There are also many men engaged in the professions and in business who would make time for open air excursions if they thought a study of natural objects feasible. In such studies of local geology the amateur may, by chance, make valuable discoveries, and he may in time become enlisted as an enthusiast and specialist. Goethe says that in science "treatment is nothing, all effect is in discovery; every new phenomenon that is observed is a discovery, and every discovery a property." If, then, it is allowable and desirable for amateurs to study science practically, it is important for them to receive suggestions and instruction from professors and specialists. In botany several American publications have been issued, which serve as admirable guides for such persons. In geology I know of but one popular book on field work. That is an English publication; we need one especially adapted to American geology. A series of articles published in one of the popular magazines, and bearing a name of authority, would give a wholesome impetus to this work, and would reach many persons who desire information concerning it. These vague desires and feeble reachings after such knowledge should be noticed and cherished, for in these there may exist some of the future discoveries and triumphs of science.