ARNOLD HENRY GUYOT.

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THE SINS OF LEGISLATORS.

By HERBERT SPENCER.

II.

THE reply to all this will doubtless be that nothing better than guidance by "collective wisdom" can be had—that the select men of the nation, led by a reselected few, bring their best powers, enlightened by all the knowledge of the time, to bear on the matters before them. "What more would you have?" will be the question asked by most.

My answer is that this best knowledge of the time with which legislators are said to come prepared for their duties is a knowledge of which the greater part is obviously irrelevant, and that they are blameworthy for not seeing what is the relevant knowledge. No amount of the linguistic acquirements by which many of them are distinguished will help their judgments in the least; nor will they be appreciably helped by the literatures these acquirements open to them. Neither the history of Thucydides, nor the biographies of Plutarch, nor the dialogues of Plato, will in any considerable degree prepare them for judging how this or that measure will operate on social life. Not even Aristotle's "Politics" will give them much help in judging how acts of Parliament are likely to work. They may ponder on the doings of all the great men by whom, according to the Carlylean theory, society is framed, and they may spend years over those accounts of international conflicts, and treacheries, and intrigues, and treaties, which fill historical works, without being much nearer understanding the how and the why of social structures and actions, and the ways in which laws affect them. Nor does such information as is picked up in the

resonator having but one aperture, which may be formed of a glass ball cut away at one side and cemented to a glass plate having a small hole in the center. When the air ejected from the mouth of the resonator is examined by the method of mixing smoke with it, and then viewing it through slits cut in an open disk, the currents are seen to consist of a series of vortex rings. A variation of this anemometer may be made by taking a card pierced with a hundred holes and placing it between the resonant box and the "mill," when the latter will rotate in the wind which passes through the conical holes.

The machines of Mayer, Mach, and others, are closely akin to those of Professor Dvorák in design and action. Mr. Edison also has contrived a phonometer, or instrument for measuring the mechanical force of sound-waves produced by the human voice, in which the vibrations produced in the phonograph-diaphragm by a sound made in the mouthpiece propels a finely-cut ratchet-wheel with considerable velocity. With this device Mr. Edison has "literally accomplished the feat of talking a hole through a deal board."

ARNOLD HENRY GUYOT.

By Professor W. B. SCOTT.

THE political disturbances of 1848, injurious as they were to Switzerland, were directly a great gain to America, for they gave to this country both Agassiz and Guyot, for a long time co-laborers for the advancement of American science and the diffusion of sound learning among the people. "We are led to wonder how much scientific progress would have been delayed in this country if it had not been for the inspiring and co-operating influence of these noble immigrants." *

Arnold Henry Guyot was born near Neufchâtel, Switzerland, September 8, 1807. His early education was obtained at his native town, and it is interesting to note that during his school-life there he was president of the gymnastic club, and one of the best of the school athletes. His slight, wiry frame thus received a training in strength and endurance which afterward stood him in good stead when he undertook the immense labors of glacier-study in Switzerland and of mountain-surveying in America. On leaving Neufchâtel he went to complete his studies in Germany, attending successively the gymnasia of Stuttgart and Carlsruhe. At Carlsruhe he was an inmate of the family of the Brauns, and there met his countryman Agassiz, who, with Imhoff and Carl Schimper, was making a vacation visit to his friend Alexan-

* "Science," No. 55, p. 220.

der Braun. This period was one of the critical points in Guyot's career. There was formed that close and tender friendship with Agassiz which lasted until the latter's death, and found its final expression in the beautiful memoir of Agassiz which Guyot prepared for the National Academy of Sciences in 1877. But of still greater importance was the impulse toward the study of science which he received from the enthusiastic group of young naturalists with whom he was thus brought into daily and hourly contact. He says of this period: "My remembrances of these few months of alternate work and play, attended by so much real progress, are among the most delightful of my early days. . . . It would be idle to attempt to determine the measure of mutual benefit derived by these young students of Nature from their meeting under such favorable circumstances. It certainly was very great, and we need no other proof of the strong impulse they all received from it than the new ardor with which each pursued and subsequently performed his life-work."

In 1829 young Guyot went to Berlin in order to complete the theological studies which he had begun at Neufchâtel; but the love of science was strong within him, and the new field which the lectures of Steffens, Hegel, and Ritter opened up to his view decided him to enter upon the study of Nature as his life-work. Having thus decided, he determined to lay his foundations broad and deep, and with this end in view he attended lectures on nearly all departments of natural science: chemistry, physics, meteorology, zoölogy, geology, and physical geography, alike received attention, and his subsequent career showed the great wisdom of this thorough preparation. In 1835 he received the degree of Doctor of Philosophy, and at once proceeded to Paris. Here he resided more than four years, quietly pursuing his preparatory studies and extending them in vacation by tours of observation through various European countries. He also took up the subject of history under Michelet, and, like everything else which he touched, made it valuable in the great pursuit of his life, the study of earth and man.

In the spring of 1838 Agassiz came to Paris, enthusiastic upon the subject of glaciers, and this induced Guyot to turn his attention in the same direction. In the summer of the same year he went to Switzerland and began his work on the glaciers of that country. The results of the summer's work were presented in a paper before the Geological Society of France during the session of 1838, at Porrentuy. This paper is mentioned in the "Proceedings" of the society ("Bulletin," vol. ix, p. 407), but, owing to a long illness of the author during the following winter, it could not be printed. The great laws of glacial phenomena first enunciated by Guyot in this paper were afterward announced as new discoveries by other observers, and were the occasion of bitter quarrels. Afterward, when a discussion arose between Forbes and Agassiz, the manuscript was, on motion of Agassiz, and by

a formal vote, deposited as a voucher with the Society of Natural Sciences at Neufchâtel, and was printed by that society in 1883. This paper contained the following contributions to the subject: 1. The sloping of the terminal beds of glaciers toward their interior, and their origin as closed-up crevasses. 2. The laminated structure or blue bands of glacier-ice. 3. The cause of the fan-shaped disposition of crevasses. 4. The more rapid motion of the glacier's center than of the sides. 5. The more rapid motion of the top than the bottom of the glacier. 6. The movement of glaciers which takes place by means of a molecular displacement, whence results the plasticity of the glacier. Later, he added the law of the formation of transverse crevasses in a plane perpendicular to the steepest slope of the glacier. With rare modesty Guyot never took part in the fierce discussions caused by the claim laid by others to his own discoveries, contenting himself with a simple statement of the facts published long afterward in his memoir on Agassiz.

In 1839 Guyot accepted a call to the Academy of Neufchâtel, where his friend Agassiz was then settled, and there he remained till his removal to America in 1848. His chair was that of History and Physical Geography, and he regarded the years of his work there as the period of his greatest intellectual activity. During this time he gave much attention to his glacial work, taking up the geological side of the question, the erratic blocks and ancient extension of the glaciers, and devoting to this work "absolutely single-handed, seven laborious summers, from 1840 to 1847." This gigantic undertaking was brought to a successful conclusion, though the results were but partially published, inasmuch as the "Système Glaciaire," by Agassiz, Guyot, and Desor, never went further than the first volume (Paris, 1847). Guyot's collection of five thousand erratic rocks, illustrating eleven erratic basins, now fills a room in the Princeton Museum, a monument of incredibly pains-taking labor.

The political disturbances of 1848 induced Guyot to follow his friend Agassiz to America, and he lived for some time at Cambridge, Massachusetts. He first attracted public attention by the remarkable series of lectures afterward published in the well-known book "Earth and Man." These lectures were the starting-point of a great reform in the historical and geographical teaching of this country. For six years he was engaged by the Board of Education of Massachusetts as a lecturer to the normal schools on geography and the methods of teaching it, and after he came to Princeton he followed up the work there commenced by preparing a series of geographical text-books and large maps. To use the words of a recent writer in "Science" with regard to these books: "It is not too much to say that they revolutionized the methods of teaching geography. Every series of geographies which has since appeared shows the influence of Guyot." He threw aside the old routine methods, and brought the pupil face to face with Na-

ture, showing the bearing of the earth's physical features upon every department of human interest.

Another pre-eminent service which Guyot rendered to America was the work he did in meteorology, a science which had received very little attention when he arrived in this country. From 1851 to 1859 he worked at the preparation of the "Meteorological and Physical Tables," published by the Smithsonian Institution, and also superintended the construction of accurate meteorological instruments. In connection with Professor Henry he must be regarded as the founder of the system of weather observations and reports which has resulted in the Government Signal Service.

In 1854 Guyot was elected to the chair of Geology and Physical Geography at Princeton, a post which he filled for the thirty remaining years of his life. Until compelled to cease by the increasing infirmities of age, he devoted all his vacations and spare time to his favorite investigations, making elaborate and careful examinations of the mountains from New England to South Carolina. This work involved an immense amount of hardship and fatigue, and he was fond of describing with quaint picturesqueness and humor his experiences in roughing it in the mountains of Pennsylvania and the Carolinas. In 1861 he published in the "American Journal of Science and Arts" the results of his work up to that time, "a memoir which remains to this day the best existing description." Again, in 1880, he brought out another memoir on the same subject, devoted chiefly to the Catskills, some of the rough work for which was done after he was seventy years old. Many shorter papers on meteorological, physical, and geographical subjects were written at intervals, but no complete list of them has ever been prepared. His work during this period is a noble example of what may be done without appropriations or endowments, for in those days Princeton was very poor, and he had to do as best he could without assistance.

As a friend and teacher Guyot will ever be held in loving remembrance till the last of his hundreds of students shall have followed him to the grave. His lectures were wonderfully fascinating, leading his hearers step by step to heights whence they could survey the whole field. His broad culture, gained by the combination of the humanitarian and scientific studies, had given him an extraordinary power of generalization, stimulating his students by showing them the relations of any subject which he handled to the whole realm of knowledge. He was able to depict these sciences in their true perspective without distortion or exaggeration, a power which is unhappily very uncommon. Those who had the rare privilege of pursuing advanced courses of study under his supervision will long remember the great stimulus to earnest work which they received from him, and the clear, philosophical views of Nature which he expounded.

For many years Guyot labored under great disadvantages from the

lack of proper appliances, but he never allowed these drawbacks to lower the character of his work. When Princeton's day of prosperity came, he showed that he knew how to apply money wisely, as before he had been able to do grand work without it. The system of scientific expeditions to the West, which has so greatly stimulated the study of natural science at Princeton, and added so greatly to the treasures of her museums, was organized under his direction; and the wonderful growth of all the departments of natural science in the college must be in very large measure attributed to the wisdom and foresight of Guyot.

The visible monument of Guyot's work in Princeton will always be the Museum of Geology and Archæology. He expended with consummate skill the sums placed at his disposal by generous friends, and organized an enthusiastic corps of workers, so that a superb series of collections has been gathered. Thus in every department of activity his influence has been of the utmost service to Princeton in particular, and to American science in general.

But even this brief and imperfect sketch can not close without some testimony to his noble and exalted character, modest, unselfish, and devoted. "He never seemed to be thinking of himself, but always of his subject and his hearers. He cared very little for fame, very much for the study of Nature and the education of man." * An earnest and consistent Christian throughout his life, he was ever charitable and tender, never indulging in acrimonious criticism or denunciation of those who differed even most widely from him. Always liberal, he sympathized with and appreciated honest opinion on whatever side it was uttered. He was remarkable for "the beauty in his daily life as well as for his nobly finished work." There is little cause for grief in the quiet close of such a splendid, useful, and complete career as this; nevertheless, we must mourn our irreparable loss, sorrowing most of all that we shall see his face no more.

* "Science," *loc. cit.*