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THE HISTORY OF CHEMISTRY IN AMERICA WITH REFERENCE TO YALE[1]

I AM indeed grateful for the opportunity of speaking to you on the "History of chemistry in America with reference to Yale." This is an epoch occasion, and while we rejoice in the possession of this magnificent, palatial edifice, designed for the service of chemistry, it is well in this moment of exultation to take a backward look and note the

> rock from whence we were hewed and the hole of the pit from whence we were digged.

So that, with your permission, I shall briefly touch upon facts

> pick'd from the worm holes of long vanish'd days and from the dust of old oblivion rak'd.

Chemists—American chemists—in tracing the history of their science, are apt to turn to other countries. For chemistry was born in the dawn of civilization and to older lands one looks for its gradual evolution. As the oldest of the experimental sciences, it is coexistent with man's own rise and development. One need not search far to find evidences of its presence. Yet, Americans have frankly admitted their ignorance of the earliest days of chemistry in this western world. In fact, it has only been within the last quarter of a century that any effort has been put forth to ascertain when chemistry had its beginnings among us and what contributions it has made to the upbuilding of society.

It is to Jamestown, Virginia, founded in 1607, that the student of the history of chemistry must go, for there in the year 1608, before the ring of the axe was heard in the forests of America, bold spirits erected a glass house "in the woods" producing a product which was sent home in crude form, but still proof of the possibilities of an industry which might con-

[1] Address at the dedication exercises of the Sterling Chemistry Laboratory at Yale University, April 4, 1923.

tribute to the maintenance of the settlement and to the coffers of the mother land. Glass beads made in that glass house exist to-day, showing that this product of chemical activity had for its purpose a means of effecting trade with the aborigines, who were attracted by the pearly, colored objects. And in 1619 two or three furnaces for the reduction of iron ores were in operation not far away.

Chemistry was rapidly serving man in this then distant land at a day less than a century and a quarter after its discovery by the immortal Columbus. What more might have been accomplished in addition to the extraction of coloring matter from new plants, in addition to the isolation of substances possessing medicinal virtue, can only be conjectured, for further attempts were frustrated by the frightful, appalling massacres perpetrated by the Indians in 1622. The glass house and furnaces were completely demolished. Dead was chemistry in its applications at Jamestown.

To the Old Bay State the student must next go. For there it was that John Winthrop, the younger, a graduate of Dublin, an early member of the Royal Society, inaugurated chemical work by the development of ore industries which he carried far along in the state of Connecticut, of which he became the first governor. He held frequent correspondence with scientific friends in London. At their suggestion, and following, too, his own thought, he experimented widely, bringing to light many highly interesting facts afterwards placed upon the pages of the *Proceedings* of the Royal Society. As an associate of the leading alchemists of England, as a believer and promoter of the art of transmutation of the baser into the nobler metals, he breathed into the atmosphere about him the spirit of the projector or alchemist; and traces of that spirit continued far into the eighteenth century, subtly enchaining a son of Yale, born in New Haven, a minister of the Gospel, a lawyer, and again a preacher of the Word, and finally seventh president of Yale—*Ezra Stiles*.

It is he who must be regarded as Yale's first promoter of chemistry. In existing records it is noted, among other things, that Stiles repeated Priestley's experiments on fixed air; that he impregnated water with it, thereby making artificial "spa water"; and that in his leisure moments, generally at night, he tried certain reagents and wrote:

> If spirits of sea salt or the muriatic acid be drawn over the semi-metal called mangenese, it becomes a solvent of gold.

This fact had been mentioned by a Mr. Jones, who delivered a chemical lecture in New Haven. And from this same Mr. Jones, Stiles had received a quantity of vitriolic æther which apparently engaged his study for quite a little while. He observed that

> the æther imbibed a solution of gold and the next day when commixt with the *aqua regia* was again separated and held the gold distinctly separated.

All this while Stiles was reading Macquer's "Chemistry," from which he made a selection of experiments, performing them with more or less success, always at night. He was truly an enthusiastic student of chemistry. Men who had had experience in the science visited him and together they held discourses on chemistry and made inquiry concerning the hermetic philosophy. Stiles was in ecstasies when Dr. Eneas Munson, of New Haven, showed him a piece of malleable, whitish metal "which he himself made within a month past. It was fixed mercury, the first I ever saw," said Stiles.

One gathers from the notes of Ezra Stiles that in addition to his many duties as president and professor in Yale, his fondness for chemistry led him to speak of it and of the remarkable discoveries, unfolded through its agency, to his classes. He corresponded with Franklin, whom he idolized, and to him he gave account of his practical work in the science. Self-trained, it is but natural that he should have presented his subject in a crude form. There is also no question but that the matter of projection or transmutation was in his mind. He endeavored to free himself from it, with but partial success, for he was the intimate of Dr. Munson, Judge Danforth and the Reverend Mr. West, of whom he said:

> They believed in the reality of the Philosopher's Stone, although neither of them ever obtained it.

And in his diary occur these words:

> Terra Fol, æethere sublatâ hodie.

Absolute proof that he was really dabbling in alchemy! And yet, perhaps because in the thought of most people alchemy, the black art,

belonged with witchcraft, Ezra Stiles did not care to be allied with those who practiced the latter. He was perturbed, and a little suspicious of himself, exclaimed:

I am not versed in the books of the adepts. I have seen but a few of these authors and read less. Perhaps all the little I have read collectively would not equal a common octavo volume. I am infinitely less acquainted with them than any other of the sciences in the whole encyclopedia. I have never observed the extracted sulphur of gold *in terra*. I have no practical knowledge of the matter; the few ideas I have about it are only imaginary, conjectural and speculative. Coram Deo Veritas.

Dear old Dr. Ezra Stiles! We rejoice that you turned from witchcraft, which looks backward, but are profoundly thankful that you were, despite your lovely disclaimers, allied with alchemy, which looks forward; for truly it was experimental science in the making, a science that does not yet acknowledge its finite bounds, "but aspires, star-eyed, to illimitable possibilities." Yes, you were Yale's first experimenter in the science which has called us together this morning, and may your benign, fatherly spirit at this moment rest approvingly upon all who are here rejoicing with Yale in this new abode of chemistry.

Time rolled on. The soul of Ezra Stiles went out on the lonesome trail, and another son of Yale, who like Stiles became a lawyer, but animated by the latent purpose of the dear old alchemist in his predilection for chemistry heeded the call of *alma mater,* in 1802, to the chair of chemistry. Before assuming its duties, however, he journeyed to Philadelphia, then the center of art, literature and science, that he might sit at the feet of James Woodhouse, the Napoleon of experimental endeavors in America. Let us for a few moments follow this eager, earnest student—Benjamin Silliman, the elder.

What a delightful company awaited him in his lodging house in the city of Brotherly Love: Horace Binney, Charles and Elihu Chauncey and Robert Hare—young men of great prominence—educated men—men of elevated position in society, their manners in harmony with their training. Silliman wrote:

As Robert Hare was a brewer of porter and was one of our number, his porter was in high request, and, indeed, it was of an excellent quality. He was a genial, kind-hearted person, a year younger than myself, and a proficient in chemistry upon the scale of that period. Hare invited me to join him in the study of his oxy-hydrogen blowpipe.

While perceiving that this instrument was ingenious, Silliman saw that it was unsafe as regards the storage of gases, and its correction in this particular was entirely due to him.

It was a genuine pleasure for Silliman to stand by his friend Hare in 1802 when the latter repeated his blowpipe experiments before Dr. Joseph Priestley, James Woodhouse, Thomas Cooper, Adam Seybert and others. One wishes that he might have a picture of that group!

The possibilities of the oxy-hydrogen flame were constantly in the thought of Silliman, and the very first pneumatic trough, including Hare's blowpipe, was constructed by Silliman for the laboratory of Yale College in 1803. In later years he wrote:

The fusion and combustion and complete dissipation of platinum, gold, silver, nickel, cobalt and most of the metals, and the fusion of the principal earths and of their more refractory compounds have been made familiar and easy class experiments of every course of chemistry in Yale College for years.

Silliman and Hare were pupils of Woodhouse, who, when interrogated upon the brevity of his didactic lectures, replied

that no man could dwell in discussion on a single topic more than five minutes without talking nonsense.

They were acquainted with his laboratory and the remarkable experimental work conducted by him, but in their leisure hours did very independent thinking and experimenting in their own laboratory in the basement of their lodging house.

To them it was delightful and profitable to meet Dr. Priestley very frequently at the home of Wistar. As Silliman was taking a broad view of science and its teachings, his hours with Wistar, the anatomist; Barton, the botanist, and Seybert, the mineralogist, were precious. In his mind were revolving brilliant schemes for the elaboration of all these subjects side by side with his thoughts on chemical research.

His friendship with Hare was unique. From their correspondence, continuing through life,

it may be inferred that they were believers in and real promoters of genuine experimental science. They discussed its possibilities to and fro, and mutually submitted plans for the elucidation of the chemical and physical problems which interested them. While their active coexperimentation ceased upon Silliman's return to Yale in 1804, they wrote many letters regarding their common love—chemistry.

Silliman began his teaching career in a subterranean lecture room fitted up for his laboratory, which was fifteen or sixteen feet below the surface of the ground. It was inconvenient! It was so gloomy—but there he courageously worked for fifteen years. There he analyzed minerals and meteorites and invented and perfected apparatus for demonstration purposes in chemistry and physics. In 1805 he was off again. This time to Europe, meeting in London Frederic Accum and Humphry Davy; and in Edinburgh, John Murray and Thomas Charles Hope, the polished, stately and formal gentleman who succeeded the gifted Joseph Black. In Edinburgh, Silliman fairly reveled in the teachings of the Wernerian and Huttonian geological schools. He grasped the prevalent geological thought. But in 1806 returned to New Haven, his days of tutelage passed and his actual teaching career begun. Mineralogy, geology and pharmacy were added to chemistry. He proved a most inspiring teacher and founded in 1818 that splendid medium of circulating the scientific work of his colleagues and himself—the *American Journal of Science and Arts,* now in its one hundred and fifth year; and further he was prominent in the establishment of many Yale activities, flourishing at this moment—the art gallery, the astronomical observatory, the medical school and the Sheffield School of Science.

But to look once more upon Silliman as a research chemist. His *fidus Achates,* Robert Hare, had devised an unusual battery—a plunge battery of powers not before suspected. Hare transmitted all his experiences with this instrument to Silliman and even sent him a well-constructed *deflagrator,* as it was termed. Both experimenters marvelled at the occurrences on attaching carbon rods to the deflagrator and studying the arc which ensued. In March, 1823, just one hundred years ago, Silliman wrote Hare:

> I gave you . . . an account of the fusion and volatilization of carbon by the use of your galvanic deflagrator. I have now to add that the fusion of plumbago (black lead) was accomplished yesterday by the same instrument.

Again Silliman sought to ascertain the behavior of diamonds in the oxy-hydrogen flame, and said:

> They exhibited marks of *incipient fusion.*

And thus it continued. Should the thought enter the mind of any one that Silliman was not a producer in his favorite science, let him read the voluminous correspondence which passed between him and Robert Hare. He will then promptly assign him a high place among researchers. The story of his laboratory would make a good prelude to the history of university education in this country as distinguished from collegiate.

Silliman possessed the genuine instinct of discovery, the quick recognition of new and interesting facts, and enthusiasm in following them up to novel and important results. That his successes in other directions somewhat overshadowed them does not detract from their permanent value

> for it must not be forgotten that those who smooth the road to science and facilitate its acquisition to others are often more permanently useful than such as are supereminently learned themselves; the greatest personal or mental acquirements die with the possessor; but those who labor that others may be wise are a benefit to all posterity (Mavor).

Is it not to the inspirational teaching of Silliman that American science is indebted for Dana, world-renowned geologist and mineralogist; Brush, whose exhaustive mineralogical chemical studies are authoritative everywhere; Johnson, pioneer leader in chemistry applied to agriculture; Willard Gibbs, first among physical chemists of modern times; T. Sterry Hunt, profound in chemical philosophy and theory, and hosts of others—giants in the world of natural and physical science?

Last evening I stood "under the friendly silence of the moon" before the bronze figure of Benjamin Silliman out on yonder campus; how I wished that I might speak out my thoughts to you! I did whisper to him:

> To you, revered master, we are indebted for this magnificent laboratory. Your spirit, mysteriously conveyed to your successors in order, caused science—particularly chemical science—to so permeate the curriculum of Old Yale that the

subterranean laboratory has been brought to the surface, enlarged, developed and endowed, that its rays may illuminate the world—far and wide.

We chemists here assembled say to Yale that we are not envious—no, we are happy, felicitating you with all our hearts and with you thanking God

that Silliman, the elder, was born.

While to President Angell, I'd add:

As one arranges in a simple vase
A little store of unpretending flowers,
So gathered I these records of past hours,
And trust them, honored sir, to thy grace.

EDGAR F. SMITH

PSYCHOLOGY AS A LIFE WORK

THE student facing the choice of his life work should consider two matters with especial care. These are his abilities and interests on the one hand and, on the other hand, the opportunities that are offered by a profession for personal development, public service, and the respect of those whose respect is most worth while to him. Ability and interest are personal. Their true estimation requires self-criticism and the advice of those who know one best. The opportunities that a profession offers may be learned from the candid statements of experts in the field.

The field of psychology.—Psychology is primarily the science of human experience, behavior and personality. It reaches down into childhood and animal life. It reaches out into the abnormal and the unusual, to depravity and genius. A sound psychology is needed in medicine and the social sciences, in religion and art, in education, law and politics, in industrial management, vocational guidance and social service. It is involved in our attempts to answer some of the greatest riddles of the universe, such as the relation of brain and mind, the origin of intelligence, and the basis of right conduct. It seeks to know the sources and organization of experience and motives, the integration of human personality, and the bonds that connect us with our fellows. Every phase of human feeling, thought and action from birth to death belongs to the field of psychology in as far as it is capable of scientific observation, description and analysis.

Prerequisites to a career in psychology.—The first prerequisite to a career in psychology is a systematic knowledge of its tradition. This is generally initiated by an elementary course which introduces the student to the entire field. It should be supplemented by courses in analytical psychology, genetic psychology, comparative psychology, physiological psychology and social psychology. In addition, the student should gain as extensive laboratory experience as is practicable. Command of the French and German languages is a necessary auxiliary since a large part of the scientific literature is published in these languages. The student who chooses psychology for a career should have a good foundation in philosophy, mathematics, biology, physiology, physics and chemistry. Courses in applied psychology should vary according to the interests of the student. They should be supplemented by thorough study of the several fields to which they relate.

Elementary work in psychology is provided for in every well-equipped college of liberal arts. For his advanced study the student who wishes to specialize in psychology should go to that university whose faculty most nearly meets the needs of his special interests.

Types of careers in psychology.—As in most of the sciences, there are three main types of careers in psychology. These are teaching, research and applied psychology. Of these three, teaching is the only standardized career at the present time. It is usually the base from which one may develop research or applied psychology. Teachers of psychology are employed in colleges and universities, normal schools and some other technical schools. There is room not only at the top but all along the educational line for intelligent, thoroughly trained and devoted teachers of psychology. All such can be certain of earning a living and rendering human service the value of which can not be measured in dollars.

A teacher of psychology should always be more or less of an investigator. This is probably true of all teachers. Unless one appreciates scientific problems as he meets them and tries to collect data for their solution he can scarcely appreciate the meaning of science, its evolution and the dangers that beset scientific generalization. Moreover, he will miss the joy that comes to the explorer who pushes the dark boundaries of the unknown a little further away. It would, however, be disastrous for a