# E. L. YOUMANS: A CHAPTER IN THE DIFFUSION OF SCIENCE IN AMERICA

By Charles M. Haar

Edward Livingston Youmans (1821–1887), writer, lecturer, editor, popularizer of science and scientific education, was in harmony with the great intellectual movement of his age.[1] And the age was

[1] The most important source for the study of Edward Youmans is, of course, his own writings. These include: *The Scientific Basis of Prohibition; shall alcoholic liquors as common beverages be commercially outlawed?* (London, 1846); *A Class-Book of Chemistry in which the Principles of the Science are Familiarly Explained and Applied to the Arts, Agriculture, Physiology, Dietetics, Ventilation, and the Most Important Phenomena of Nature* (New York, 1851); *Alcohol and the Constitution of Man* (New York, 1854); *Chemical Atlas; or, The Chemistry of familiar objects* (New York, 1855); *Chemical Chart* (New York, 1855); *The Handbook of Household Science* (New York, 1857); "Masquerade of the Elements" in *Lectures of the American Institute of Instruction* (New York, 1860); *The Correlation and Conservation of Forces* (ed., New York, 1864); *The Culture Demanded by Modern Life; A Series of Addresses and Arguments on the Claims of Scientific Education* (ed., New York, 1867); *Exposition of the Development Hypothesis* (New York, 1871); "Herbert Spencer and the Doctrine of Evolution," in *Outline of the Evolution-Philosophy* by M. E. Cazelles (New York, 1875); *Herbert Spencer on the Americans and the Americans on Herbert Spencer* (New York, 1883). Especially important are the reviews and editorials he contributed to his own magazine, *The Popular Science Monthly* (New York, 1872–1887), hereafter cited as *PSM*.

John Fiske's *Edward Livingston Youmans, Interpreter of Science for the People* (New York, 1894), though uncritical and diffuse, is an interesting biography by a contemporary, and is a storehouse of material about Youmans. J. Fiske, "Edward Livingston Youmans: The Man and his Work," *PSM* (May, 1890), is a good brief account. His *A Century of Science and Other Essays* (Boston and New York, 1900), and *Darwinism and Other Essays* (Boston and New York, 1886), also contain pertinent information about Youmans. *The Letters of John Fiske,* edited by Ethel Fisk (New York, 1940), include only stray references to Youmans; J. S. Clark, *Life and Letters of John Fiske* (Boston, 1917), on the other hand, contains much interesting material. The obituaries by Eliza Youmans, "Sketch of E. L. Youmans," *PSM* (March, 1887); by Grant Allen, "Professor Youmans," *London Academy* (January 29, 1887); and in the *New York Tribune* (January 19, 1887), are all helpful. H. G. Good, "Edward Livingston Youmans, A National Teacher of Science," *Scientific Monthly* (March, 1924), and his "Edward Livingston Youmans" in the *Dictionary of American Biography* (New York, 1936), may also be consulted. Henry Holt, *Garrulities of an Octogenarian Editor* (Boston and New York, 1923), gives an interesting contemporary attitude towards Youmans. See also *Evolution in Science, Philosophy, and Art* (New York, 1891).

For the relations of Youmans with the House of Appleton, see *Brief Studies of General Book Publishing Firms of the United States* (Urbana, Ill., 1931); J. C.

a scientific one; an era when science was affecting all human interests as never before. Prof. Merle Curti has stated his belief that the gulf between the knowledge of the intellectual and of the masses has been less wide in America than elsewhere, this being perhaps "the unique characteristic of American intellectual history."[2] If this be true, it is due to the contributions of men of Youmans' stripe. Youmans shared a common nineteenth-century faith in public instruction and in the diffusion of knowledge among the people at large. Preaching a democratic concept of the use of science for the benefit of the masses, he became, in the words of his famed contemporary, a national "interpreter of science for the people."[3]

The great achievements of science in the period after the Civil War led men to scrutinize all things through its lens. It became the sovereign to whom all other forms of intellectual activity bent the knee. Scientific method—this was the age of Chauncey Wright, Charles Peirce, and William James—took the center of the stage.[4]

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Derby, *Fifty Years Among Authors, Books and Publishers* (New York, 1885); G. M. Overton, *Portrait of a Publisher* (New York, 1925); Marcus Benjamin, "A Century of Publishing," *Saturday Review of Literature* (April 11, 1925); and "Romance of the House of Appleton," "D. Appleton & Co., One Hundred Years Old," and "Appleton, of the House of Appleton," in *Publisher's Weekly* (August 17, 1917, February 21, 1925, and February 2, 1924, respectively). F. L. Mott, *A History of American Magazines, 1865–1885* (Cambridge, 1938), ch. v, has a valuable discussion of scientific magazines of the period. Circulation figures of *The Popular Science Monthly* can be found in *Rowell's American Newspaper Directory* (New York, 1869–1908), *Pettengill's Newspaper Directory* (New York, 1878), and *Ayer's Directory of Newspapers and Periodicals* (Philadelphia, 1880–1887).

Occasional letters and references to Youmans can be found in the biographies of contemporaries, but these are, on the whole, insignificant for our purpose. Cf. Lyman Abbott, *Henry Ward Beecher* (Boston, 1903); O. B. Frothingham, *George Ripley* (Boston, 1883); Don C. Seitz, *Horace Greeley, Founder of the New York Tribune* (New York, 1926); *Daniel G. Thompson* (New York, 1898); and Leonard Huxley, *Life and Letters of Thomas Henry Huxley* (New York and London, 1916). Special value attaches to Herbert Spencer, *An Autobiography* (New York, 1894), and to David Duncan, *The Life and Letters of Herbert Spencer* (London, 1908).

[2] *The Growth of American Thought* (New York and London, 1943), 593.

[3] John Fiske, *Edward Livingston Youmans, Interpreter of Science for the People, op. cit.*, 4. After commenting on the obscurity of Youmans, caused in part by the glaring repute of Fiske himself, Henry Holt concluded that "few men have done as much to diffuse science and philosophy in America" as did Youmans. *Op. cit.*, 47. Cf. also J. S. Clark, *op. cit.*, II, 276.

[4] See Philip P. Wiener, "Chauncey Wright's Defense of Darwin and the Neutrality of Science," *Journal of the History of Ideas*, VI (Jan., 1945), 19 ff. Also,

This "highly sterilized, germ-proof system of knowledge, kept in a cool, dry place"[5] infiltrated every subject of human and social interest. What is loosely termed the "intellectual climate" underwent a revolution in America that was destined, to quote perhaps the keenest critic of this period,[6] "to disintegrate the old theological cosmos, push far back the boundaries of space and time, reorient the mind towards all ultimate problems, and bring into question all the traditional faiths—political and social as well as theological and philosophical."

This current of his age is clearly reflected in Edward Youmans' ideas and activities. Conversely, his glowing enthusiasm for science is understandable only by setting it against a period wherein science progressed by leaps and bounds. Youmans fought for the dissemination of scientific ideas, constantly directed people's consciousness towards them, battled tooth-and-nail with the older cultural traditions of theologians and conservatives, and shared the mystic belief that science would lead to eventual perfection. A channel through which science was diffused to the common man was Edward Livingston Youmans, rationalizer of a new order.

Youmans was born June 3, 1821, at Coeymans, New York. The special influences on his youth, which may have instituted his scientific bent, were three: blindness, agrarianism, and religion.

Youmans' youth was difficult and pathetic, for he suffered recurrent attacks of blindness. The slightest strain, or nervous tension, plunged him into total darkness. He could not go about unled. By the time he was thirty, Youmans had developed the characteristic *facies* of the blind.[7] His condition, due to ophthalmia, had been aggravated by the treatment of a quack-doctor.[8] This, together

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Sidney Ratner, "Evolution and the Rise of the Scientific Spirit in America," *Philosophy of Science,* III (Jan., 1936), 104–122.

[5] Thorstein Veblen, *The Higher Learning in America* (New York, 1918), 7.

[6] V. L. Parrington, *The Beginnings of Critical Realism in America, 1860–1920* (New York, 1930), 190.

[7] It is interesting to note that his eyes cleared up somewhat in later life—after he had begun to achieve success. His sister testified that he looked younger at thirty-five than he had at twenty-five.

[8] Even Youmans' mother, the last to give up hope, finally tried to reconcile him to his fate: "Nothing can be worse than these endless alternations of hope and despair. If, in all the fifteen years you have been struggling with disease, the only gain has been brief intervals of partial seeing—intervals that continually become rarer and shorter, while the subsequent lapse into blindness grows harder and harder

with his later need for daily supervision by a trained physician, must have instilled a deep appreciation of science, and may have determined Youmans' choice of science as his life-work. Almost wholly self-educated, he became one of the best-informed scientific men of his day only after a bitter struggle. Like the blind historian, Prescott, he devised a frame to hold the paper and guide his hand;[9] his sister, Eliza, served as his eyes, performing experiments and reading books to him.

Youmans' experience with farm work aroused a strong interest in science. He observed the methods of his father, and of the neighboring farmers, and concluded that they were "unbusiness-like" (and unsuccessful) in their technique of agriculture only because of a lack of training in science. Sharing the agrarian values, he felt that the cultivation of the soil was the best of all possible vocations;[10] in order so to remain, agriculture had to base itself upon sound scientific principles. This belief inspired many of his writings, and also developed into an attempt to have his brother, Earle, establish a modern experimental farm, where all that was new in agricultural chemistry could be applied.

The third major influence was that of religion. Naming him after a minister, his mother had hoped that he would also become one. In his youth he was "laboured with," and, once, when eleven or twelve, we learn that he even went forward to the "anxious seat" at a Baptist meeting. However, concern with "saving people" manifested itself in Youmans as an urge to popularize science. He often assured his mother that the diffusion of science was the most important work in the world, and that, in his own fashion, he was accomplishing moral good. (His devout mother, of course, was never completely convinced.) In Youmans, John Fiske once wrote, the new era found its John the Baptist; in utilizing this phrase, Fiske unwittingly revealed the attitude of their entire group.[11]

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to bear—how much happier you would be to give it up and adapt yourself to the circumstances." Fiske, *op. cit.*, 60.

[9] This accounts for the rather peculiar nature of Youmans' handwriting. It is a thin, diagonal scrawl. One committee mistook the date of Youmans' proposed lecture in their city because of inability to decipher the writing.

[10] "Among the various occupations which require a knowledge of this science to be successfully carried on, that most noble, useful, and universal of all human pursuits, agriculture, stands prominent." Introduction to *A Class-Book of Chemistry, op. cit.*, 15.

[11] The irascible Samuel Butler, with some justification, spoke of "Pope Darwin" and "Saint Huxley."

With true religious fervor—for the key to the movement is to be found in its similarity to a religious crusade—Youmans dedicated himself to educating the mass of the people.

"Our instrumentalities for communicating to the educated public a knowledge of the scientific world have, until lately, been nearly as defective as our means of scientific publication, and notwithstanding certain recent improvements, are still far behind those of other nations," complained the famed Yale astronomer, Simon Newcomb. "Previous to the establishment of the 'Popular Science Monthly,' " he added, "we had not in this country a single journal designed to diffuse the knowledge of either general or exact science."

The founding and editing by Youmans of the *Popular Science Monthly,* the most influential scientific magazine of the age, was motivated by the consuming drive of his life—the popularization of scientific knowledge. He occupied a peculiarly favorable position for this purpose. One day, his sister led him into the store of D. Appleton & Co., and William Appleton urged him to use any book he desired. This led to a mutually profitable relationship, for soon the House of Appleton published his books, and he became their literary adviser on all scientific publications. From the very beginning of this association Youmans nursed the idea of publishing a magazine which would deal with scientific subjects. And in April, 1869, he succeeded in putting out the first number of *Appleton's Journal of Popular Literature, Science, and Art.* He stated the need for popularization:

> Why is it that our educational journals drag out their existence at such a poor dying rate, that the presumptions are constantly against their continuance, while many of them can only maintain the breath of life by voluntary subsidies or state aid? It is not because the subject is uninteresting, for there is today, to the very borders of civilization, a deeper concern in educational questions than the world has ever before witnessed. . . . The reason is that educational journals are professional, and therefore appeal to a narrow constituency.[12]

Youmans conceived the new magazine as a reporter of contemporary scientific ideas. Not much science was included, however, for the publishers—as is their quaint habit—were haunted by a fear of boring the general reader. The first issue was just off the press when Youmans had occasion to write, "The paper is having

[12] *Appleton's Journal,* Apr., 1869, 122.

a curious experience. The bare announcement that it would give attention to science and valuable thought raised an almost universal condemnation of it in advance as a certain failure. And although we have had no science in it, and made it as vacant of ideas as possible, it is voted heavy.''[13] The *Journal* thus fell between two stools, and Youmans resigned its editorship after a year. From 1871–1874, he edited the ''Scientific Miscellany'' of the *Galaxy*.

Three years after the first attempt, Youmans' driving energy[14] turned again to this idea, this time to find success with the *Popular Science Monthly*. In May 1872, as Herbert Spencer's agent in America, he had contracted with the *Galaxy* to serialize Spencer's *The Study of Sociology*. Difficulties developed when the *Galaxy* could not cooperate in simultaneous publication with the *English Journal*.[15] Youmans then and there decided to start a magazine of his own, and to publish these articles in it. ''I am utterly glad that things have taken the course they have. I have long wanted a medium of speech that I can control, and now I shall have it.''[16]

Whereas the work of creating science had been organized for years, the work of diffusing science was but imperfectly organized. This clearly was the next step. Hence Youmans intended to bridge the gap between scientists of original thought and the general reading public. ''The growing importance of scientific knowledge to all classes of the community,'' said the first issue, ''calls for more efficient means of diffusing it. The Popular Science Monthly has been started to promote this object, and supplies a want met by no other periodical in the United States. . . . It has been started to help on the work of sound public education by supplying instructive articles on the leading subjects of scientific inquiry. It will contain papers, original and selected, on a wide range of subjects, from the ablest scientific men of different countries, explaining their views to non-scientific people.''[17]

In the middle period of the venture, Youmans again expressed the same idea in his ''Editorial Table.'' The *Monthly* was founded

[13] Letter to Herbert Spencer, Apr. 27, 1869, Fiske, *op. cit.*, 260.

[14] This was a dominant trait. Spencer often wrote his friend, expressing fear that he was overtaxing his system.

[15] Probably Spencer's failure to cooperate within the time-limit caused this mix-up, and not the *Galaxy's* fear of printing Spencer's articles. F. L. Mott, *op. cit.*, 495, is in doubt as to which version is the correct one.

[16] To Spencer, Apr. 3, 1872, Fiske, *op. cit.*, 302.

[17] "Purpose and Plan of Our Enterprise," *PSM*, I (May, 1872), 113.

to interest the non-scientific public and to create a taste for scientific literature, and an appreciation of scientific knowledge in the reading community. The general ignorance of science is simply deplorable! . . . The theory of this periodical is, that those who write for it shall turn their backs upon the scientific world, and address themselves to a class so uninstructed in scientific matters that everything requires to be explained.[18]

The same philosophy prevailed until the end:

The Popular Science Monthly will continue, as heretofore, to supply its readers with the results of the latest investigation and the most valuable thought in the various departments of scientific inquiry.

Leaving the dry and technical details of science, which are of chief concern to specialists, to the journals devoted to them, the Monthly deals with those more general and practical subjects which are of the greatest interest and importance to the public at large. Received with favor at the outset, it has gone on increasing in circulation and in influence, until its power is felt and acknowledged in the highest departments of intellectual activity, and its leadership is recognized in the great work of liberalizing and educating the popular mind.[19]

This monthly of 128 octavo pages (later increased to 144 and to 158) proved a surprisingly healthy baby. "When started, we said it would go on if well supported. The enterprise will be continued and gives promise of permanence. It was entered upon as an experiment and generally thought to be a hopeless one."[20] However, public support was greater than even the perennially optimistic Youmans had hoped for.[21] At first, only 5,000 copies of the first two numbers were printed; 2,000 more of each number had to be rapidly reprinted, and they were both soon out of print. This success, which astonished the publishers, was not due to the American public's love of novelty alone. After a year and a half Youmans could write: "There can be no doubt that the Monthly is doing an important work in this country. We continue to print 12,000 although the monthly demand fluctuates around 11,000 and seems to be stationary for the last few months."[22] The circulation—so far as can be determined from the fragmentary figures—continued

[18] *Ibid.,* VI (Dec., 1874), 244.

[19] As advertised in *The Cooperative Index to Periodicals* (1886).

[20] "Our First Year's Work," *PSM,* II (Apr., 1873), 745.

[21] See his happy letter to Spencer, Apr. 23, 1872, in Fiske, *op. cit.,* 152; also one of June 2, 1872, *ibid.,* 153. "The stroke is unusually applauded and the incoming support is more than we expected."

[22] *Ibid.,* 313.

to increase until by 1886 it reached 18,000, a remarkable number in those days for a technical and expensive monthly.[23]

The magazine contained, in addition to original articles, selections from other periodicals and books, and copies of learned addresses before equally learned societies. An "Editor's Table," literary reviews, and a miscellany of short scientific subjects filled out the remainder. A frontispiece portrait of a famous scientist appeared in each issue, accompanied by a short biography.[24] Herbert Spencer[25] was by far the most frequent contributor, rarely

[23] The figures of circulation are sparse. N. W. Ayer's *Directory of Newspapers and Periodicals,* Philadelphia, begins only in 1880. The circulation is placed at 13,000 for 1881–3, in 1884 at 15,000, and in 1886–7 at 18,000. The earlier G. P. Rowell, *American Newspaper Directory,* New York, first mentions the Monthly in 1879, merely stating that it is F 1, i.e., exceeds 10,000 (the date of founding is mistakenly cited as 1850).

[24] Later collected together in book form by William Youmans under the title of *Pioneers of Science in America* (New York, 1896).

[25] What Huxley was to Darwin in England, Youmans was to Spencer in America. "For Professor Edward L. Youmans was of all Americans I have known or heard of, the one most able and most willing to help me." Herbert Spencer, *Autobiography* (New York, 1894), II, 61. In fact, without Youmans' constant moral encouragement when Spencer was depressed, and his financial help on several occasions, Spencer might not have completed his *Synthetic Philosophy.* Much of the credit for popularizing the doctrine of evolution in the United States rightfully belongs to Youmans. One needs but gaze through their lengthy correspondence. "Your unflagging enthusiasm for the propagation of advanced ideas is something quite remarkable, and the spectacle of it serves one as a kind of moral tonic." May 12, 1863. "The energy and self-sacrifice you continue to show in the advancement of my scheme quite astonishes me; and while in one respect it is very gratifying to me, yet in another it gives me a certain uncomfortable sense of obligation more weighty than I like to be under. If it were not that the sense of obligation is in some degree qualified by the consciousness that you are in great part prompted to what you do by your love of truth and your philanthropic desire to aid the spread of it, my feelings on the matter would be really oppressive." Nov. 21, 1863. See Fiske, *op. cit.,* 151, 159.

In 1866 Spencer was on the verge on ending publication because of lack of funds. Youmans, by collecting $7,000, staved this off. This is but one of several instances. In 1872, Youmans, with his usual modesty, wrote the *Tribune* "to correct certain misstatements" *in re* his aid to Spencer; he wrote that he had merely allowed Spencer to apply himself with greater singleness of purpose. Herbert Spencer, *op. cit.,* II, 156 and Appendix H. Youmans' close relation to the influential philosopher of nineteenth century evolution is attested to by David Duncan, *Life and Letters of Herbert Spencer* (London, 1908). This is an official biography by the private secretary; not an "interpretive" study, it reveals the attitude of a contemporary. In the index, Youmans' name outweighs all the rest. Next only to

missing an issue; this, together with Youmans' constant propaganda for the doctrine of evolution, led to attacks upon the *Monthly* as merely a mouthpiece for evolutionary ideas. C. S. Peirce's "Illustrations of the Logic of Science" (1877–8) first appeared in the Monthly, as did articles by Henry George on Kearnyism in California. John W. Draper and Andrew D. White contributed their work on the conflict of religion and science, and many noted European scientists wrote popularly for the American public.

The magazine won critical approval as well as wide acclaim. "The new journal will meet with a deserved popular success, for the field is an open one, and the Popular Science Monthly is equal to the occasion; it is beyond comparison the best attempt at journalism of the kind ever made in this country," wrote the *Home Journal,*[26] "We think it is not too much to say that this is the best first number of any magazine ever published in America," was the judgment of the *New York World;* "A journal," echoed the *New York Tribune,* "which promises to be of eminent value to the cause of popular education in this country."[27] Finally, a glimpse into its contemporary significance is afforded by Oliver Wendell Holmes' letter to Youmans: "I must take this opportunity to tell you how much I depend on the Popular Science Monthly. It comes to me like the air they send down to the people in a diving bell. I seem to get a fresh breath with every new number."[28]

Youmans devoted most of his last fifteen years to the *Monthly,* and the volumes he edited (1872–1887) are the repository for many

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Spencer himself, more space is devoted to Youmans than to any other contemporary, even the English friends. On Spencer's influence on America, more profound than elsewhere, see T. C. Cochran and William Miller, "A Philosophy for Industrial Progress," in *The Age of Enterprise. A Social History of Industrial America* (New York, 1942), 119 ff.; and Richard Hofstadter, "The Vogue of Spencer," in *Social Darwinism in American Thought 1860–1915* (Philadelphia, 1944), 18–37.

[26] "This is just the publication needed at the present day, when people are beginning to wake up to the importance of knowing something of the grand and beautiful processes of Nature, and of the thousand departments of scientific knowledge, the study of which strengthens and elevates the faculties, and opens up so many new sources of intellectual enjoyment," wrote the *Montreal Gazette.*

[27] Youmans also took this tack: "That it met a demand is shown by the fact that it has been better sustained than any other scientific magazine of its class that has been started in any country. It has fulfilled its promise, and it has been increasingly commended with each succeeding issue," "The Work and Influence of the Monthly," *PSM,* IV (Apr., 1874), 747.

[28] Fiske, *op. cit.,* 315.

of his most provocative statements. He summed up this work: "I am not among the fortunate mortals who do work that is to survive. Yet the Popular Science Monthly is bound up in all the American public libraries, and it will hold its place there by sheer force of its bulk—it will hold over at least into the next century; and I am contented that it contains evidence that I knew a good thing when I saw it."[29]

The versatile Youmans was also one of the most popular lecturers of the day. His lectures, like his writings, were featured by a comprehensive order of statement, a retailing of detail to generalization, ample graphic illustration, and a glowing enthusiasm that communicated itself to others. Even Eliza Youmans, in an extremely impersonal portrait, wrote that "he was an impressive public speaker,"[30] while John Fiske proclaimed:

> His gifts as a talker were of the highest order. The commonest and plainest story, as told by Edward Youmans, had all the breathless interest of the most thrilling romance. Absolutely unconscious of himself, simple, straightforward, and vehement, wrapped up in his subject, the very embodiment of faith and enthusiasm, of heartiness and good cheer, it was delightful to hear him. And when we join with all this his unfailing common sense, his broad and kindly view of men and things, and the delicious humor that kept flashing out in quaint, pithy phrases such as no other man would have thought of, and such as are the despair of anyone trying to remember and quote them, we can seem to imagine what a power he must have been with his lectures.[31]

The lyceum system of popular lectures was then in its heyday. Youmans annually traveled through the states, going as far west as Wisconsin, speaking on science and its relationship to philosophy, evolution, and to other sundry questions. More specifically, he dealt with the relation of organic life to the atmosphere; the geological history of the world; the chemistry of organized bodies, vegetable growth, food and digestion; the sources and nature of alcohol and its effects on the human system; evolution; solar rays, the relation of the sun to the life on our planet, and the chemistry of the sun and stars; and the relation of chemistry and astronomy to alchemy and astrology.

[29] *Ibid.*, 470.

[30] Eliza Youmans, "Sketch of Edward L. Youmans," *PSM*, XXX (Mar., 1887), 695.

[31] John Fiske, "Edward Livingston Youmans: The Man and His Work," *ibid.*, XXXVII (May, 1890), 11.

This travel brought him into contact with many devotees of science, and greatly enlarged his sphere of influence. He appeared in hundreds of towns and hamlets, bringing the new gospel of science.[32] He left new conceptions, new questions with thousands of audiences. America was ripe for the scientific doctrines. Typical, perhaps, was the schoolteacher who drove ten miles in a cold gale to attend the lecture; he later told Youmans that it had given him the first "view" he had ever held in science, and would prove to be the turning-point in his studies.[33] Wherever possible, he rounded up men for the "cause"; in this manner, he sought out John Fiske when the latter was a student at Harvard, and helped launch him on his career.

Youmans fully realized the value of lectures as a mode of public instruction—provided, always, they did not degenerate into a mere catering to the public amusement.[34] He publicized the lectures, and contributed in large measure to the success of Huxley, Bain, Tyndall, Spencer, Proctor, and others on their speaking tours in the United States.[35] He drew attention to coming lectures, described their wares as a hungry man pictures a steak with French fries, and was active in the commercial end of selling the tickets.[36]

In Youmans' efforts at popularization, he repeatedly came across one obstacle: the teaching of the sciences was uninspired. He blamed the prevailing classical system for this condition. Verbigeration so dominated the field of education that science, when taught at all, was taught by memorization and recitation rather than by the direct study of the objects themselves;[37] moreover,

[32] In frequent letters to his family, Youmans reveals many interesting aspects of American social life, 1851–1868. They also contain sidelights on the life of a lecturer: committees, Helen Hokinson clubwomen, the American hunger to be preached at, bad railroad connections, the practice of stealing shoes in railroad coaches, etc., etc.

[33] John Fiske, *Edward Livingston Youmans, Interpreter of Science for the People, op. cit.,* 88, quotes this letter to his sister.

[34] "Scientific Lectures," *PSM,* IV (Dec., 1873), 247.

[35] F. L. Mott writes that the success of many of these scientific lectures is attributable to Youmans' propaganda. *Op. cit.,* 496 ff.

[36] For example, see *PSM,* IX (Sept., 1876), 621, where he advises his readers that he has only a few seats left for the Huxley lectures.

[37] Cf. *PSM,* I (Aug., 1872), 497; also, "The Elevation of Phrases Above Things," *ibid.,* XXV (Oct., 1884), 844; and the review of E. C. Pickering's "Elements of Physical Manipulation," *ibid.,* IV (Nov., 1873), 117. For the modernity of these views, compare with the statement, in 1945, of the Interim Report of the

science texts[38] paid no attention to the mind of the child, ignoring the mechanism, growth, and conditions of his mental faculties.[39]

As a result, Youmans' textbooks emphasized the examination and investigation of phenomena by the students themselves. Believing that most texts put knowledge in wrong end foremost, forgetting that both the order of unfolding of the child's faculties and the order of facts in science itself necessitate beginning with the simple and familiar, only then gradually shading into the general and the abstract, Youmans wrote a new type of textbook.[40] He

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Council for Curriculum Reform: "Our criticism of existing science teaching is mainly that it is over-verbalized." *The Content of Education, Proposals for the Reform of the School Curriculum* (London, 1945), 193. The Harvard Committee also agrees that students "should be led to explore matters for themselves and to find answers to simple problems by direct experimentation." *General Education in a Free Society* (Cambridge, Mass., 1945), 157.

[38] Contrast the reviews of Maxwell T. Masters' "Botany for Beginners," *PSM*, I (Aug., 1872), 370, and of Eliza Youmans' "First Book of Botany," *ibid.*, I (May, 1872), 120, and of her "Second Book of Botany," *ibid.*, III (Sept., 1873), 648. In his review of Masters' book, Youmans wrote that in form, typographical execution, and illustration, nothing further could be required; in its scientific statements it was sound and trustworthy; but for the purpose indicated in its title it was worthless. The author knew much about plants but nothing of the mind of children. Being an exercise of pure memory upon arbitrary signs, his work stupefied instead of awakening the mind. Moreover, he foolishly thought children capable of grasping, right at the outset, the generalized results of science. Eliza Youmans' book, on the other hand, avoided lesson-learning. Its purpose was to train the pupil's observation powers by the study of the plants themselves, not by memorizing a certain amount of information about them.

[39] For this reason, Youmans attacked the "Science Primers" edited by Huxley, Roscoe, and Stewart, and written by the ablest English scientists. He felt that these texts paid no attention to the needs of the child. By beginning with the abstract and the general, they paralyzed his mental faculties. "Misuse of the 'Science Primers,'" *PSM*, XVII (June, 1880), 269.

[40] Youmans, following the lead of T. H. Huxley, stressed the beauty of Nature, and its appeal to the young mind. This cannot be otherwise, "for the infinite wisdom of the Creator is nowhere so perfectly displayed, as in the wonderful adaptation which exists between the young unperverted mind, and the natural world with which it is encompassed." Introduction to *A Class-Book of Chemistry* (New York, 1851), 17–18; see also *PSM*, VIII (Apr., 1876), 750. He even declared that Huxley was wrong in setting a limit on the age at which children should be allowed to experiment in the sciences. "Biology in Common Schools," *PSM*, X (Mar., 1877), 615. "Science being an understanding of natural things, and a child being born into the order of Nature, with a capacity for intelligence which is awakened and unfolded only by its intercourse with natural things, what can be more preposterous than to

sought to adjust his writings to the reader, to eliminate all dry and technical portions,[41] and by clear concise exposition to win the attention and interest of beginners in science. These texts served as invaluable aids in the teaching of the sciences, thus smoothing their way into the school curriculum.[42]

*A Class-Book of Chemistry*,[43] embodying these innovations, was his germinal book. As stated on the title-page, it was designed for the use of academies, schools and—indicating Youmans' orientation towards the general public—"for popular reading." He challenged the prevalent belief that chemistry could not be invested with popular interest or successfully taught as a branch of common education: "How a science which gives law to nearly all the processes of human industry, connects its operations with our daily experience, involves the conditions of life and death, and throws

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raise the question when a child shall begin to have its attention thoughtfully directed to objects around it?" The Harvard Committee is again in accord: "Education in science should begin early in the primary grades, surely not later than the seventh grade," *op. cit.*, 156.

[41] But not with the idea of making them "easy." As a matter of fact, one of the reasons for his dislike of the "Science Primers" was their over-simplification of the subject. Mental power could be acquired only through active exercise. The true purpose of education is not to accumulate information, but to develop the power of the mind, so as to observe carefully, reason correctly, and to think independently; books and teachers may often hinder this process. Youmans' methods are set forth in a letter to his brother, then editing Huxley's "Physiology." He cautioned him against taking too much for granted in writing: "You must study the *art of putting a case* . . . throw yourself into the state of mind of one who knows nothing of the subject, and make the explanation simple and complete without his having to go to the dictionary or glossary." Fiske, *Edward Livingston Youmans, Interpreter of Science for the People, op. cit.*, 240.

[42] "The supremacy of self-activity, the symmetrical development of all the powers, the priority of character to information, the necessity of putting the real before the symbol, the concrete before the abstract, the necessity of following the order of nature and not the order of human connection—all these ideas at the outset so revolutionary, have filtered into the pedagogic consciousness and become the commonplace of pedagogue writing and of the gatherings where teachers meet for inspiration and admonition." John Dewey, *The Educational Situation* (Chicago, 1902), 9. As Lowell wrote:

> Thoughts that great hearts broke for, we
> Breath cheaply in the common air.

[43] *A Class-Book of Chemistry in which the Principles of the Science are Familiarly Explained and Applied* . . . (New York, 1851).

light upon the sublime plan by which the Creator manages the world, can be regarded as lacking the elements of universal interest, it is not easy to imagine.''

He conformed his style to the capacity of beginners, drawing his illustrations largely from the phenomena of daily experience—farming, cooking, washing, manufacturing. Established principles were explained, as was their application to the familiar affairs of common life. Oxygen, for example, was not simply an element to be weighed and analyzed, but became the very sustainer and destroyer of life. Instead of unconnected details, drifting in mid-air, every fact was presented in its relation to law, each step placed in its logical connection. In some 340 pages he gave the substance of the current inorganic chemistry, as well as a new treatment of organic plant and animal life. Outline in principle, the *Class-Book* reads like a modern review-book. On the bottom of each page—modern texts might adopt this idea—appear three or four questions which, if answered correctly, indicate mastery of the contents of that page. ''If his efforts shall have the effect, in any degree, of promoting a popular interest in Chemistry by presenting the subject in a more attractive aspect, the Author's highest object will have been attained.''

The *Class-Book* met with instantaneous approval. ''Either for schools or for general reading we know of no elementary work on Chemistry which in every respect pleases us so much as this,'' said one reviewer,[44] and the *Scientific American* wrote: ''Such a book in the present state of chemical science was demanded, but to present the subject in such a clear, comprehensive manner, in a work of the size before us, is more than we expected. . . . The number of men who can write on science, and write clearly, is small; but our author is among that number.'' Harvard University alone ordered two hundred copies, and Oliver Wendell Holmes wrote a highly appreciative letter to Youmans, congratulating him on ''so beautiful a book.''[45] Youmans twice revised the *Class-Book,* and by 1890, 150,000 copies had been sold.

The ophthalmia which so cursed his life with recurrent blindness supplied the next idea for the popularization of science. In

[44] *The New York Commercial Advertiser.* Said *The Farmer and Mechanic:* "It is designed as a popular introduction to the study of this beautiful science, and presents it in such a manner as to win the attention and engage the interest."

[45] Fiske, *op. cit.,* 146–7.

his talks with his sister Eliza about her laboratory experiments, he was hindered by the difficulty of treating phenomena at second-hand; or, when she read books to him, he was forced to form mental images of things and processes which he could not see with the eye. Suddenly it came to him that children were basically in the same predicament: they memorized unintelligible statements about queer-sounding things which they had never seen, and which they would not recognize if they were to see them. His *Chemical Chart*[46] "which is adapted to the Author's Class-Book," according to the publishers,

> accomplishes, for the first time, for chemistry, what maps and charts have long done for geography, geology, astronomy, etc., by presenting a new and valuable method of illustration. Its plan is to represent chemical composition to the eye by colored diagrams, so that the numerous facts of proportion, structure, and relation, which are the most difficult in the science, are presented to the mind through the medium of vision, and may thus be easily acquired and long retained. It is invaluable as an assistant to public lecturers, to teachers, and for reference in families.

Outlined according to the binary, or dualist, theory then prevailing in the chemical world,[47] it diagrammed the principal elements, binary compounds, salts, minerals, and the more important organic bodies. Different colors illustrated the atomic weights of the various elements, and the composition of the more familiar compounds.

The famous Asa Gray wrote, "It seems to me that it so simplifies the subject, that pupils in the classes in our common schools may acquire from a few lessons, with its aid, more knowledge of the laws and principles of this science, than from months of study without such means of illustration," and the superintendent of the New York common schools testified, "I know of no other chart like this; and as by its means Chemistry may now be taught with the same

[46] New York, 1851.

[47] Each element was represented by a colored square; single squares represented elements, and when joined together, as shown by converging lines, they indicated compounds. As a separate color was assigned to each element of a compound, its exact composition was available at a glance. The areas of the diagrams corresponded to the combining numbers, and thus relative quantities were represented to the eye. The hydrogen square was smallest, the carbon square 6 times larger, the oxygen square 8, and the chlorine 35 times larger. When the binary theory was no longer held by scientists, the Chart was not revised, for the new theories did not lend themselves to graphic illustration.

facility as geography or astronomy, I would earnestly commend it to the attention of school committees, teachers, and learners.''[48]

The success of the *Chemical Chart* suggested its amplification in book form, and in 1854 Youmans accordingly published *The Chemical Atlas.*[49] ''The application of the diagram is here much extended, occupying 13 plates in 16 colors, and accompanied by 100 quarto pages of beautifully printed explanatory letter-press.'' Elementary chemistry, chemistry of geology, homologous series of compounds, nitrogenized and non-nitrogenized principles of food, isomerism, and the theory of compound radicals were all illustrated. The processes of combination, respiration, penetration, and the chemistry of light (''solar dynamics'') were also graphically presented. These two works are original and ingenious examples of modern visual-teaching methods.

Ever since the time of the publication of the *Class-Book,* Youmans had planned to bring out a handbook for the household, since he believed that science could relieve the needless drudgery of the home. *The Handbook of Household Science*[50] limned Youmans' dominating purpose—the spreading of a knowledge of science among the people of the country, and popularizing the latest practical applications of science. It carefully studied the practical applications of science to the heating, lighting, purification, and ventilation of dwellings, and to the subject of foods in relation to health and economy. Youmans later amplified the *Handbook,* so satisfactory was the general demand for it, and bequeathed to his brother William the task of a comprehensive Household Cyclopedia.

Particularly significant was Youmans' achievement in introducing the works of foreign writers and scientists. By degrees Youmans had become an adviser to the publishing firm of D. C. Appleton & Co. Largely through his influence, that firm became the first to introduce many of the European scientists to the Ameri-

[48] "Mr. Youmans' 'Chemical Chart' is admirably adapted to assist the teacher in communicating, and the learner in receiving, correct notions of the law of chemical combination. I commend it to the patronage of schools and academies where chemistry is taught, and shall immediately introduce it into the institution with which I am connected." Prof. W. F. Hopkins of the U. S. Naval Academy.

[49] *Chemical Atlas; or, The Chemistry of familiar objects: exhibiting the general principles of the science in a series of beautifully colored diagrams, and accompanied by explanatory essays* (New York, 1854).

[50] New York, 1857. "Its object," as stated by the introduction, "is to offer a clear and popular scientific explanation of the facts, principles, and laws which all who dwell in houses are deeply concerned to know."

can public. The list is a veritable Who's Who of nineteenth-century science: Bagehot, Bain, Buckle, Carpenter, Darwin, Grove, Faraday, Helmholtz, Huxley, Lecky, Liebig, Mayer, Roscoe, Spencer, Sully, Tyndall. "Everyone knows that the Appletons are the publishers in this country of the great English scientists."[51]

*The Correlation and Conservation of Forces*[52] is an early example of this work. Edited "with an Introduction and Brief Biographical Notices of the Chief Promoters of the New Views by Edward L. Youmans," not only did it introduce brand-new concepts to America—concepts termed by Faraday "the highest law in physical science which our faculties permit us to perceive"—but also was the first American edition of these authors.[53]

After many years of introducing new scientific writers, Youmans conceived the idea of the International Scientific Series. He posed a Wildean paradox: was there an inverse relationship between learning and writing ability, so that the deeper a man's knowledge of a science, the poorer was his power of exposition? Answering in the negative, he insisted that a master of a science could write the best exposition of that science, provided that he kept the fact in mind that he was writing for the general reader.

Under the plan set forth by Youmans, leading scientific men were to contribute small volumes on their own specialty to the International Scientific Series. The Series would eventually embrace the entire field of science. The volumes were to be issued

[51] *The Dial* (June 1, 1894), 330–1. For the leadership of the House of Appleton in the publishing of scientific works, see the works listed above, footnote 1. This was a time when scientific works were an unknown factor in the publishers' markets, and most publishers feared to venture out on this new field. Van Wyck Brooks regards the rejection of Spencer's *Education* by Ticknor & Fields when offered them in 1860 by Youmans as "one of the first signs of the passing of Boston as the intellectual centre of the country. As a result of this first refusal, all these works of science, which dominated the mind of the coming epoch, were published by the Appletons of New York," *New England: Indian Summer* (New York, 1940), 110. (He is in error in classifying the *Education* as one of the International Scientific Series.)

[52] *The Correlation and Conservation of Forces; A Series of Expositions by Prof. Grove, Prof. Helmholtz, Dr. Mayer, Dr. Faraday, Prof. Liebig and Dr. Carpenter* (New York, 1864).

[53] In 1890, looking back at this work, Prof. Thaddeus B. Wakeman wrote: "The volume of essays by Grove and others, on The Correlation and Conservation of Forces, collected years ago by our friend Prof. E. L. Youmans (published by D. Appleton & Co.) swept the field and prepared the way for monism in this country." Article on Ernest Haeckel in *Evolution in Science.*

simultaneously in all countries covered by the agreement, the rights of each copy sold were reserved in every country, and so an international copyright was to be secured.[54]

Youmans was delegated full responsibility by the Appletons. He made quick trips to London, Paris, and Berlin; his days were crowded with interviews and enterprises. The task of compiling "the world's popular cyclopedia of ready science" was not an easy one. There were clashes of interest, jealous rivalries, unexpected delays, and many disappointments. Many scientists expressed skepticism of the proposal; some feared they were incapable of writing popularly; some had prior commitments to other publishers; some were just too busy; still others were disgusted with their experience in the original *Appleton's Journal,* which had failed as an educational medium; and many complained at the absence of any American element, for Youmans, as did others of his group, looked almost wholly to Europe for inspiration.

Practical politician and businessman, Youmans surmounted these obstacles. He drew up his strategy as for a military campaign.[55] Although he had constantly to smooth out difficulties and push its career, the Series finally proved itself a great success.

John Tyndall's *Forms of Water* (1872) was the first volume. "Prepared expressly for this series, it is in some measure a guarantee of the excellence of the volumes that will follow, and an indication that the publishers will spare no pains to include in the series

[54] Herbert Spencer wrote that the proposed arrangements seemed to "practically amount to international copyright." David Duncan, *op. cit.,* 256. Those were the days when international piracy was rampant in many fields. American publishers used the works of foreign authors without bothering with the payment of royalties. The Appletons were a notable exception to this practice, a trump-card Youmans relied on heavily in his dealings. Youmans frequently blasted against the abridging of international copyright; he saw it on the moral plane: there is "a need for an international copyright law to put a stop to the scandals robbing those foreign authors who are doing so much to maintain and elevate our intellectual life," "A Case in Moral Education," *PSM,* XXVIII (Mar., 1886), 699.

[55] Spencer, among others, was his chief aid. "Huxley backed me up grandly, and told them how much he had received from the Appletons for reprints." John Fiske, *op. cit.,* 278. Incidentally, Youmans' letters provide an interesting picture of many great Victorians. He kept in constant touch with them, and carefully described them in long letters home. Especially interesting is the portrayal of Spencer, whose close intimate he was. There is a description of Carlyle talking everyone about him deaf; and after his departure, Mrs. Carlyle proved that only her husband's presence had stemmed her own eloquence.

the freshest investigations of the best scientific minds,'' was the opinion of the *Boston Journal.* John Fiske, reviewing Bagehot's *Physics and Politics,*[56] said ''If the 'ISS' proceeds as it has begun, it will more than fulfil the promise given to the reading public in its prospectus.'' Herbert Spencer dedicated his contribution to the series, *The Study of Sociology,* to his ever-faithful disciple, Youmans. *The History of the Conflict Between Religion and Science* by John Draper proved the most popular, and ran into many editions. All in all, some 70 volumes, in uniform red bindings, which ''are to be seen in every library,'' were published in England, France, Italy, Germany, and Russia, as well as in the United States.

Nor were his activities confined to getting the books published; he also saw to their reception. In his attempts to bring the scientific volumes before the public, Youmans was helped by his wide acquaintance throughout the country among teachers and others interested in the diffusion of science. Wherever he knew a reviewer, he sought his aid in connection with the local press. In New York, his journalistic relations—especially with the *New York Tribune*—insured the widest circulation for the reviews he himself wrote.[57]

Science had created the new intellectual epoch. The flowering of the scientific attitude was as important as the particular concepts of science or its utilizations. This attitude soon found itself in opposition to the prevailing thought-pattern of America.[58] It can-

[56] An interesting if dubious example of the application of natural science to social problems, it attempted to prove that since the quantity of energy is limited, social reform is impossible.

[57] Youmans wrote to Spencer, Apr. 12, 1864: "I have sent you a notice of the Progress I prepared for the Tribune. It is not what it ought to be. I am thoroughly sensible of my incompetency to do you justice, but it is better than I could get done by anyone else. . . . I, however, take some little credit to myself for managing its publication. The Tribune is the most influential journal in this country. I long ago saw its importance in regard to our enterprise, and acted accordingly. The literary editor, Mr. Ripley, is a fine scholar, but a Unitarian clergyman to begin with, and classical to the core, and infected with German metaphysics—an unpromising subject certainly, and, most of all, pointedly and publicly committed against the new views of Herbert Spencer. The notice of the Education, I must confess, was fairly battled into the Tribune through friend Greeley's influence, Mr. Ripley vehemently protesting against this new evangel of education. . . . Considering that the Tribune circulates mainly among that class which it is important to reach, and is moreover of great influence with other newspapers, this gain is a telling one." Fiske, *op. cit.,* 176–7.

[58] For the American phase, see Herbert W. Schneider, "The Influence of Darwin and Spencer on American Philosophical Theology," *Journal of the History of Ideas,*

not be otherwise, observed a veteran of this conflict, "for every great advancement in natural knowledge has involved the absolute rejection of authority, the cherishing of the keenest skepticism, and the annihilation of the spirit of blind faith."[59]

But the milieu did produce a spirit of blind faith. People looked at what they had done, and, behold, it was good. "It is no longer possible to deny," exulted Youmans, "that science as the latest is also the highest and most perfect product of the mind of man."[60] Science was the open sesame for unlocking all doors of mystery. It became the religion of the brave new world, the laboratory its church. Even the very terminology was carried over. "Reason, Observation, and Experience—the Holy Trinity of Science," proclaimed the self-branded atheist, Col. Ingersoll.[61] "In so far as our age is an age of ideas," wrote Youmans, "the first great fact about it undoubtedly is, the ascendancy of science as a power that is moulding the mind of the period."[62]

Times have since changed, and those of the atomic age now speak of "the quaint Victorian faith in science." Machines had not yet turned into Frankenstein monsters,[63] and the warning of an Emerson that "things are in the saddle and ride mankind" could be cavalierly dismissed. Only the rosy tints could be perceived by the people standing at the dawn of a new age. Science—especially the doctrine of evolution—became popular, of absorbing interest. "But one interpretation can be given to this success, and that is the growing interest in matters of science, and the increasing appreciation of ability in its expounders. . . . The people have a wonderful appetite for science just now," concluded Youmans.[64]

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VI (Jan., 1945), 3–18, and Bert J. Lowenberg, *Darwinism Comes to America, 1859–1900,* address at A.H.A. meeting in New York (Dec., 1940), mimeographed.

[59] Thomas Huxley, who, in self-defense, coined the phrase "agnostic."

[60] *PSM* (Nov., 1885), 122.

[61] Cited by Ralph Gabriel, *The Course of American Democratic Thought. An Intellectual History since 1815* (New York, 1940), 181.

[62] *PSM,* VII (May, 1875), 110.

[63] Contrast the notions of the machine in Bellamy's *Looking Backward* and Butler's *Erewhon.*

[64] *PSM,* II (Feb., 1873), 499. "Things are going here furiously. I have never known anything like it. Ten thousand Descent of Man have been printed, and I guess they are nearly all gone. Five or six thousand of Lay Sermons have been printed. . . . The progress of liberal thought is remarkable. Everybody is asking for explanations. The clergy are in a flutter." Letter to Spencer, Apr. 21, 1872, Fiske, *op. cit.,* 266.

Hermann Kantorowicz once noted that "men possess thoughts but ideas possess men."[65] Convinced of science's "emancipation of the human spirit from the thralldom of ignorance," Youmans more than fulfilled Henry Ward Beecher's dictum: "Stir them up —subsoil the people with Spencer, Huxley, and Tyndall."[66] Youmans—with the singleness of purpose which bespeaks a complete confidence in the truth of one's cause—pressed on for the diffusion of science and scientific education. "By tongue and pen," summed up his renowned contemporary, "on the platform and through the press, he [Youmans] worked with devoted energy in this noble cause, until he had done more than any other American of his time to diffuse a knowledge of science and an appreciation of scientific methods among the American people. He did more than anyone else to prepare the way in America for the great scientific awakening which first became visible after the publication of The Origin of Species."[67]

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[65] As quoted by Max Lerner, *Ideas are Weapons. The History and Uses of Ideas* (New York, 1939), 3.

[66] Nov., 1864, Fiske, *op. cit.,* 201. And the last named wrote: "Go on and prosper, my dear Youmans, in the work you have undertaken. I hardly know any man in Europe or America who enjoys your opportunity of doing good, and the best of it is that it is an opportunity created by yourself." Letter from John Tyndall, Oct. 8, 1872, *ibid.,* 318.

[67] *Ibid.,* 4.