has its natural explanation as the result of hybridization.

It seems clear that the phenomenon of parthenogenesis in plants and animals is likewise to be explained as a successful result of previous hybridization. Since the general sequel of hybridization is sterility, the only outlook for the offspring of a hybrid union is either the development of improved sexual fertility or the appearance of parthenogenesis.

The peculiarities of so-called mutating forms find their rational elucidation in the study of the phenomena, variational and cytological, of known hybrids. It accordingly follows that mutation, so far as it is a real cause of the origin of species, is merely the appearance of more or less constant offspring, following a previous hybrid union.

In our study of the origin of species we have now apparently, after many years of comparatively ineffectual effort, reached a point of view which will enable us to explain some at least of the fundamental causes of variation, fluctuating or fixed. One-sided attack has been shown to be futile. The great merit of Darwin's work is its many-sidedness. To-day, too, it seems clear that for permanently valid results in biology, structural and experimental work must go hand in hand. Moreover, observations in the field and observations in the laboratory must supplement one another for the most fruitful results.

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SCIENCE AS CULTURE

ONLY about ten per cent. of the undergraduates who, since the war, have taken general chemistry at ten leading colleges and universities[1] pursue further chemical courses. But one student in forty-five does postgraduate work in chemistry.

It would require an exhaustive study of registrar's records and post-collegiate careers to determine how many graduates make any direct or indirect use of chemistry in their life work; but this is not necessary to confirm the common observation that they would be only a small fraction of those who take an introductory course in the science.

What, then, should be the purpose of such a course? "To state the laws and define the conceptions of the science in terms of experimental facts"[2] is the object set forth, more or less aptly, in the prefaces of twoscore college texts. Hundreds of courses, described in the curriculum as "Chemistry I—general chemistry, lectures and laboratory work," are given each year, more or less successfully attaining this object. From the student's point of view, a firm foundation of chemical science with a year's training in scientific methods of work and scientific habits of thought is shooting wide of the mark. Judged by standards of interest and utility for the majority, it would be more profitable to teach ice-skating to the Hottentots.

Those who have given thought to this subject will not even debate these facts. It is conceded that pandemic chemistry, suggested by Bancroft,[3] serves the needs of the average student better by treating chemistry as a cultural subject. Such a course—the pioneer, I believe—was introduced tentatively at Marshall College under Professor Phelps two years ago, and at Harvard, Yale and Cornell, possibly elsewhere, too, similar experiments are being made. The subject is in the air—very much in the air—but the thought seems to be condensing that two distinct Chemistry I courses, professional and pandemic, must of necessity be developed best to serve the different needs of students who plan to follow medicine, engineering, or one of the natural sciences and those who will make no professional use of chemistry.

This thought I would examine in its nascent state. It will be easier to analyze before it crystallizes.

For this task I have no professional equipment. However, during the better part of ten years, I have served as liaison officer between the three groups who, after all, are most concerned with the practical results of chemical education; the industrial chemists, the chemical manufacturers and the industrial consumer of chemicals. From this coign of vantage it is my business to survey the chemical fields without becoming lost in the towering forests of chemical theory or being bemired in the swamps of chemical commercialism. This point of view is certainly interesting and perhaps helpful.

The time when a knowledge of the Greek and Roman classics was the hallmark of an educated man has past. To-day, even their cultural value is fast diminishing. To know Eros is nowadays not so important as to know what Freud believes about love. The fire Prometheus stole is less use to us than the energy generated by photosynthesis. Phoebus's chariot has become an internal combustion engine; radio replaces Mercury; the metamorphosis of cellulose into rayon, lacquers, celluloid, artificial leather, explosives and what not transcends the myths told

[1] Harvard, Yale, Princeton, Williams, Virginia, Ohio State, Michigan, Illinois, Northwestern and California. The records are not satisfactorily complete for this purpose; but the data are sufficient to assure representative results. Technical schools and universities where engineering courses are notably stressed were purposely omitted.

[2] Alexander Smith, "Inorganic Chemistry."

[3] Walter D. Bancroft, *Jl. Chem. Educat.*, 3, 396 (1926).

by Ovid. Chemistry, physics and biology are to-day not only "a systematized and co-ordinated body of facts," they are also the tools and the toys of the man on the street. They are at once the subject of erudite monographs by specialists and of common gossip around the tea table. Their laws govern the operation of our factories; their principles are applied in the kitchen; their technical terms have become newspaper jargon. In the marketplace or by his own fireside a man is deaf, dumb and blind without at least a working knowledge of the sciences. They are, as Br'er Rabbit said, "de mos' kulturines' t'ing in de world."

The case for chemistry as culture is easily proved; but what of the student who intends to use chemistry in a scientific or engineering career? Should he have, as it were, a professional foundation in chemistry substantial along the lines of the present courses in Chemistry I? Or would he profit more by an historical and philosophical introduction to the science which would make clear its relationships to all human knowledge and emphasize the important rôle chemistry plays in art, agriculture and especially in modern industry.

In the first place, not one college student in a hundred has any clear, predetermined plan for his life's work. He has no notion whether he will become a chemist or a chiropodist. Too often chance makes this most important decision for him. So often, in fact, that it prompts us to question the present methods of teaching the sciences. When chemistry is presented to the student as a coordinated body of scientific knowledge, as in the course in general chemistry, it can not but appear so complete, so closely knit that he forms no conception of its gradual development in the service of mankind. Because he knows nothing of the long series of lucky accidents, of bold hypotheses, of painstaking studies, that have gradually built up this hard-won knowledge of ours, he fails utterly to comprehend the fundamental sequence of practical application, theory and established scientific fact. Accordingly, he does not put chemistry in its proper relationships with the other sciences, and he can not appreciate its importatnce in the development of our modern industrial civilization. In his general chemistry course he fits together, as in a jigsaw puzzle, a jumble of laws and formulas; but he can not place them in the broader picture of human experience and everyday existence. The result is that he lashes his memory while, too often, his interest lags. The pathetic enthusiasm roused, among both undergraduates and postgraduate students, when I have lectured to them on the commercial organization and economic functions of the chemical industry show how stimulating is a tangible contact with these workaday realities.

In the second place, there are all the obvious dangers of early specialization. Certain swift-moving, far-reaching changes within the growing chemical industry, which will surely be reflected in chemical science, make these dangers, at this time, particularly grave.

During the last three decades of the nineteenth century the spirit of pure science surged strong through every branch of chemistry. This was no altruistic ideal: it was an inspiration as vivid and forceful as medieval religion. Facts, new facts, more facts were greedily sought. Inductive reasoning was so lauded and philosophical theorizing so damned that many good chemists actually believed that any chemical problem might be solved merely by observing with sufficient accuracy a sufficient number of chemical reactions. Chemistry was not the only science which suffered from overdoses of unadulterated Baconism, and there were even certain compensating advantages. A splendid treasure house of recorded analysis and synthesis was built, although much of all this good work was scientific only in its amazing technical precision. This laboratory dexterity—truly more an art than a science—was a curious, but very useful fruit of that era of inductive science.

That treasure house of chemical facts has been drawn upon heavily by the great chemical industry which, thanks to that technical skill, has been developed during the past forty years. Chemical processes have multiplied throughout all industries, and the consumption of chemicals vastly increased. Like a rolling snowball, every new commercial application of chemistry has brought with it other processes and new products. The coal-tar dyes, as a familiar example, have helped to revolutionize the bleaching of textiles and the tanning of leathers. All this chemico-industrial activity created an economic demand for chemically trained men, a demand our universities and technical schools have been striving to fill with that exotic hybrid, the chemical engineer. The whole spirit of chemical education has been so changed that pure science has become a pale and impractical ideal; courses must be practical; and research, subsidized by industry, is scientific only in the journalistic sense of that much overworked adjective.

In the meantime the chemical industry has gone forward by leaps and bounds. Vigorously stimulated by the war, spurred on by the keen competition resulting from over-production; ably assisted by the world's best chemical brains, it not only dominates, it is even beginning to lead, chemical science. Certainly, our industrial application of both catalytic action and bacterial fermentation is fast outstripping our knowledge of the chemistry involved. While in the past, great chemical discoveries have been personal achievements, to-day they are the carefully plotted results of directed, organized staff research. Formerly, gifted chemists of rare vision and patience, aided by a faithful student or two, have hunted down chemical secrets. Now, corps of chemists, in elaborate laboratories, fitted with every modern appliance and reinforced by libraries stored with the accumulated chemical experience of the past, are besieging chemical problems. These research armies are made up of specialists, each working on some particular phase or part of a general problem which he often but dimly apprehends. Need one press further the dangers of too early specialization on the part of professional students of chemistry?

These dangers are obvious even to our industrialists who lead a movement to foster work in pure science. The fountainheads of our scientific knowledge must be cleansed and revivified. This requires men armed for inductive reasoning with all the chemical facts we have accumulated and all the chemical technique we have acquired. But, above all else, they must be men of courage and imagination who will throw into the chaos of the unknown the grappling irons of deductive theory.

Not only for training such scientists, but also for attracting men of the requisite bold devotion to the science, I submit that a foundation of chemical history and the philosophy of chemistry is best. Such a course, while admirably fitted to the needs of the average student, would be no sinecure. In presenting chemistry historically, from the caveman's discovery of fire, of tanning, of ore smelting to the isolation of Illium and the perfection of the Mont Cenis process of ammonia synthesis, showing how empirical application preceded scientific knowledge and tracing out chemical theory checked by experiment, such a course in pandemic chemistry would cover all the ground of the present Chemistry I. Thus, even for the professional student, little time would be lost. Plainly he would then begin professional study with an understanding of chemistry's true and proper place and an appreciation of the nature of chemical problems that would be invaluable in coordinating his work and rationalizing his generalizations.

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NEW YORK, N. Y.

SCIENTIFIC EVENTS

THE PUTNAM BAFFIN ISLAND EXPEDITION

SAILING under the auspices of the American Geographical Society, the Museum of the American Indian, Heye Foundation, the American Museum of Natural History and the Buffalo Society of Natural Sciences, George Palmer Putnam, publisher and explorer, will lead this summer another expedition to the Arctic Circle.

Last summer Mr. Putnam headed the American Museum Greenland Expedition to North Greenland regions and brought back extensive zoological collections for the museum. This year's expedition will be known as the Putnam Baffin Island Expedition. Mr. Putnam expects to sail from New York in June. This trip, like the one last summer, will be made on Captain Robert A. Bartlett's two-masted schooner *Morrissey*.

The probable route of the expedition, subject to seasonal ice conditions, will be westerly through Hudson Strait and thence north into the Fox Basin district, which is less known than any other similar area on the North American continent. Some of it, so far as mapping is concerned, has remained virtually untouched since the original visit of Luke Fox in 1631. Expeditions into the interior of Baffin Island will be attempted.

Professor L. M. Gould, of the department of geology of the University of Michigan, will be in charge of the geographical work. His assistants will be Robert E. Peary, George Baekeland, Wallace R. Hawkins and George Weymouth.

The expedition's anthropological activities will be carried on in behalf of the Museum of the American Indian, Heye Foundation, which will be represented by Donald A. Cadzow. The zoological collecting for the American Museum of Natural History will be done by Fred Limekiller, a member of last year's expedition. Oceanographic work will be conducted for the Buffalo Society of Natural Sciences. Specimens will be collected by plankton nets and dredging.

THE ANNUAL MEETING OF SCIENCE SERVICE

THE annual meeting of Science Service, Inc., the institution for the popularization of science, was held on April 28 and two new members of the board of trustees were elected. Dr. David White, home secretary of the National Academy of Sciences, was named by that body as one of its three representatives upon the board, and Marlen E. Pew, editor of the weekly publication, *Editor and Publisher*, was chosen a representative of the journalistic profession. Trustees who were reelected were: Dr. D. T. MacDougal, director of the Desert Laboratory, Tucson, Ariz., representing the American Association for the Advancement of Science; Dr. C. G. Abbot, acting secretary of the Smithsonian Institution, representing the National Research Council; Thomas L. Sidlo, of Cleveland, Ohio,