a large leaf surface, large stem, large root system, and an extensive vascular system. Branching is restricted to a few lateral, pistillate branches in which vegetative development is suppressed. The lateral ear-producing branch (or branches) is so placed on the plant that there are many leaves above and below it. The ear is large in diameter and has seeds that are many times larger than those of other cereals. All the afore-mentioned characteristics, many of which are not present in other grasses, contribute to making the maize plant a superior seed producer.

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A New University

William Seifriz

Botanical Laboratory, University of Pennsylvania, Philadelphia

THE current issue of the *Annual Review of Physiology* has just come into my hands. In the prefatory chapter, Otto Loewi deplores the trend that science and its literature have taken. As I read, and so wholeheartedly approved, I wondered whether this trend, which seems inescapable in our modern life, need necessarily affect all living and thinking. Loewi's plea for a greater emotional appeal in science is, in reality, a groping for something of basic moral value. He says:

> A scientific worker nowadays rarely finds it possible to publish papers which have a personal touch; [he is not permitted] to discuss the origin and development of his problem, to draw conclusions of hypothetical character . . . such revelations are not found in the ordinary papers which fill the scientific journals.

Loewi then quotes a remark made by one of his students:

> For me the most exciting papers are those which describe exactly what the individual scientist experienced from the beginning to the end of his experiments, the mistakes he made and how he learned through them what the answers were.

One of my own former students, now a research worker in his own right, came to me the other day and, as he handed me a manuscript, said: "What shall I do? This is a good article, the best I've written. The editor accepted it provided that I omit all discussion and my conclusion. That leaves only the data!" "That is all the editor and his critics want," I said. "Send it to Europe." He did and it was accepted in full. These two students have struck at the very roots of our university and of our social life as well.

I had a chapter on adsorption. The critic objected to irrelevant facts: "Cut the history and the ancient guessing, and tell the student what adsorption *is*, then stop." Do we know what adsorption is? That master of adsorption chemistry, Herbert Freundlich, thought otherwise. He taught that the adsorption bond can be anything from primary valence to the loose attraction between gases and metals. The critic also objected to my insistence that adsorption is often nonstoichiometric. "A discarded view," he said. For me, the nonstoichiometric proportion between adsorbent and adsorbate is the very essence of adsorption and of colloid science in general. I turned to the writings of America's foremost authority on adsorption and found such statements as

> In general, surface adsorption must be considered as nonstoichiometric . . . nitrogen is held exclusively by physical adsorption on iron below 100°C and by chemical adsorption above this temperature.

There was another chapter on the rheology of biological fluids. The European editor wanted 150 printed pages. The author answered: "According to American standards that is too much." The editor replied, "You Americans write terse articles; we over here like to know how a subject developed. You write for the expert, the experimenter; we for the student and scholar." This last remark brought to my mind the English comment that Americans are "uneducated experts." The author did what the European editor asked and what Loewi would approve—he gave the background of the subject. The first American comment after publication was, "There's no excuse for so long a chapter."

Now what was the real trouble with these critics? It was not objection to the facts presented, as they implied, but rather impatience with the very quality in scientific writing that gives the student a background.

To test Loewi's philosophy—and it is a philosophy—I sought out two books, one a readable 600-page volume and the other a terse 275-page one, both covering the same subject, and asked for an opinion from my students. Their composite answer was: "The first book we enjoyed, the second gave us nothing; we just could not get started." Wondering what the two publishers had to say, I sent inquiries to them. The publisher of the first book replied that it had gone into four printings and was now sold out. The publisher of the second book reported that it had not paid expenses; copies were still to be had from the first and only printing. Apparently, students want what Loewi asks for: "lines of thought by which the discoveries have come about"; in short, the development of a problem.

I wrote on water of crystallization. "Why tell the students what Bragg thought 20 years ago, instead of telling them what we now know to be true," a critic wrote. But what is it that we now know to be true? Is it the nature of water of crystallization? Let us see. The adsorption of water vapor on certain inorganic gels, such as the silica gel,

> . . . is combined so intimately with the surface of the gel that it may have a binding in the range of 50–75 kilocalories per mole of water. On the other hand, a considerable amount of adsorption of water vapor on silica gels can be shown to be of a physical variety that is very easily removed by evacuation at room temperature.

This quotation from an authority is good science and good teaching.

A physicist was much upset because the plus and minus signs had been incorrectly placed beside the short fat line and the long thin line that are symbols for the poles of a Daniell cell. In 1887 Ostwald used the minus sign for the zinc electrode; in 1889 Nernst said that zinc is positive; in 1893 Ostwald switched to the positive sign; in 1900 Nernst did the same; in 1908 everyone was using the minus sign as a matter of course, at least in England and Germany; in the United States the practice does not yet appear to be uniform. Just what is it we now *know* to be true?

What these critics wholly miss is that the student, in hearing the historical background, is better prepared to accept new ideas, which are sometimes resurrected old ideas. If the student of 30 years ago has been told that light was once thought to be corpuscular but is now believed to consist of waves transmitted through the "ether"—that "imaginary substance postulated to convey a physicist's misconceptions from one place to another"—then that student is better prepared to accept, when he is 30 years older, the "new" corpuscular theory of light and with it discard the ether.

Apparently, human nature is such that, in becoming a scientist, one makes oneself either a collator and computer of data or a visionary dreamer in the false belief that the two characters are wholly incompatible.

It is the dreamer in science who has given us what we know of natural laws. From him comes the initial spark that sets a matter-of-fact experimentalist on the road to discovery. Von Laue thought that the symmetrical distribution of atoms in a crystal presents a lattice sufficiently fine to scatter the exceedingly small waves of x-rays. The idea appeared to be scientifically sound, at least to von Laue, but to certain of his colleagues, all classicists, it was untenable. The kinetic energy, or heat movement, of the atoms would, they said, disturb the diffraction phenomena and obscure the picture. But von Laue had confidence in his hypothesis and the courage to see it through. In his laboratory, there were two assistants, both able experimenters, and they proved the truth of von Laue's speculation.

Clerk Maxwell, whose contributions greatly enriched the inheritance left by Newton and consolidated the work of Faraday, was as sound a mathematical physicist as the world has produced, yet he was a dreamer. His first recollection, he tells us, was that of lying on the grass before his father's house and looking up at the sun and wondering.

Another dreamer was Kekule. One summer evening he was returning by the last omnibus through the deserted streets of London. "I fell into a reverie," he says, "and lo, the atoms were gamboling before my eyes." Thus the structural formula of the benzene ring was born.

Strachey wrote of Francis Bacon, "It is probably always disastrous not to be a poet. His imagination with all its magnificence was insufficient; it could not see into the heart of things." And so it is with all true scholars. Helmholtz, physician, biologist, and physicist, said that his best mathematical ideas came to him spontaneously, while walking in his garden early in the morning.

It is no matter of chance that the greatest scientists of all time, Copernicus, Newton, Kepler, Linnaeus, Faraday, Darwin, and Maxwell, were men of noble character, modest, straightforward, and full of human

sympathy. The great French mathematician, Henri Poincaré, stated that the chief end of life is contemplation, not action. George Sarton tells us that we need purer knowledge, not more knowledge, and knowledge that is less harsh. In a somewhat different way, William Wheeler said the same thing:

> We should all be happier if we were less completely obsessed by problems and somewhat more accessible to the esthetic and emotional appeal of our materials.

We condemn European philosophy, and Europeans condemn our technology. The English call us "a nation of gadget makers." We developed the atom bomb, but the basic concepts of atomic fission came from Europe, from within a relatively small circle that reached from Berlin to London and from Paris to Uppsala. Here Rutherford, van't Hoff, Arrhenius, Niels Bohr, Max Planck, Nernst, and von Laue lived and worked. I have spent many months, off and on, in this circle, and no scientific experiences of my life are equal to those lived there. The seminars with Fritz Haber, Freundlich, Warburg, and Polanyi were inspiring episodes, devoid of narrow specialization and the pedanticism of teachers.

Research technicians are often very able men, and their contributions are the technical foundation of science. One need only mention Michelson, as necessary an adjunct to the advance of science as was Einstein who used his data. So let me give full credit to the young and enthusiastic research workers, full of high-energy phosphate bonds. What I deplore is their attitude of mind. Science has become tough, and the students learn to accept it that way.

Recently, three of my former students called upon me and recounted their experiences under new professors. One of these new intellectual guardians was a "swell guy; he called the dean a bag of peanuts." My heart sank as I realized what a failure I had been, for I could not remember ever having called our dean a bag of peanuts. Another boasted that his professor "swore like a trooper"; and the third told how his new chief was the first on his feet at every meeting to ask a question no matter what the subject. This might all seem trifling, but is it so very different from the type of hero worship prevalent among our high-school students who, today, are a serious community problem? Are we, the teachers, not worshiping false gods and presenting false values to our students? Enthusiasm is high, but where are the broad-mindedness, imagination, humility, and deep devotion for which Loewi pleads?

Our scientific congresses are a hodgepodge of trivia. The conversation is that of men on the defensive. An incident that made a deep impression on me recently was the sudden change in voice of a fellow-scientist when I spoke to him. He was, as were most others at this large gathering, very busy speaking loudly and vigorously as if to maintain prestige through sheer force of voice. As I approached, he addressed me in the same manner, but when I asked a question in a subdued tone, his voice suddenly dropped to that of a normal man. The next 15 minutes was an intellectual treat, for he is a brilliant man. His previously forced and artificial manner was in keeping with the times. Science has become tough.

Loewi pleads for an education that will acquaint students with principles that transcend the boundaries of a special field. He expresses a hope that is impossible to fulfill in a modern university, where conformity dictates behavior and definitions define the teaching. The average man is cautious and dull. Little things are important to him—definitions, correct pronunciation, the proper verb for *data,* the species of a genus written large when it should be small, or should it? His life is guided by them. "In science we define our terms!" All right, my good fellow, define *time.*

I am not unsympathetic toward a pedantic view, because, in a sense, I too am a purist who still prefers the King's English to Brooklynese, although I fear the latter will win out in the end. But when pedanticism takes the place of scholarly learning, I rebel. I do not mind our medical schools and colleges of engineering being trade schools, for this is what they are intended to be. When a surgeon ties up my hernia or an engineer builds a bridge that I am to cross, I want no philosophy to enter into the work. But have you noticed how beautiful a well-built bridge can be? Goethe knew this—which reminds me of an article recently rejected because Goethe was quoted. The author commended Goethe's concepts of the meaning of form. I wondered whether the critic condemned the article because of antebellum resentment, or because he could not comprehend Goethe—many persons cannot—or because he felt that philosophy had no place in science. Goethe, as a philosopher, was often wrong in fact but never in principle. His insight is well shown in the first part of the following sentence, and his good sense is revealed in the last phrase: "Your poetic sense should always accompany you but never lead you." There arises in scientific work, says Loewi, "a feeling which can only be described as religious." Einstein called it "cosmic religious experience."

While this manuscript was being written, an article by Richard Goldschmidt appeared, entitled "Different philosophies of genetics" [*Science* **119**, 703 (1954)]. Herein is expressed a view that is essentially the same philosophy of science that I advocate. Goldschmidt writes,

> . . . the statistical attitude calls for explanations in terms of additional genes for whatever has to be explained, while the physiological attitude looks for interpretations in terms of genic action upon development.

In short, Goldschmidt wishes to replace the static and limited statistical method of classic genetics with a dynamic and natural philosophy.

Technicians, teachers, and trade schools are all necessary; science and education cannot advance without them. But can we not have a university as well, a real university such as Padua had? It will have to be a *new* university if we are to accomplish anything in it, a guild of scholars such as Padua was.

The position of the university in ancient times was a strong one. It absorbed from the church the rights

of higher learning. The status of professor attained a dignity that surpassed, in many instances, the dignity of a bishop or a nobleman. The call to a chair at Padua or Pisa was deemed the greatest honor. This spirit of unfettered liberalism was maintained throughout the Middle Ages, and the university developed into a democratic guild whose independence was recognized by all and blessed by the church. The titular head of the university was the rector, but his duties were purely perfunctory. The university of old had many of the attributes of the church. It was an asylum for the persecuted, a political and intellectual sanctuary. There was respect for learning, a respect that is almost unknown today.

Thus, there arose a tradition of protection, of liberty in action, and of freedom in thought. Neither royal charter nor papal bull hampered academic expression; on the contrary, they guaranteed it. The university became the intellectual center of the community.

From this delightful situation, the universities gradually drifted, until during the 16th and 17th centuries, their democratic constitutions were superseded by small oligarchies of officials. Rectors, deans, and proctors banded together and acquired control. Thus, an intellectual feudal system was established that persisted, for example, in France until the whole was swept away by the French Revolution. For another century the universities of Europe again enjoyed their ancient freedom.

One is impressed by the similarity of this situation to that in the American university today. James Ewing, of cancer fame, once wrote that whereas a demotion or dismissal is readily pushed through an American college, such drastic action could not possibly occur in a European university without a thorough investigation and the approval of the faculty. Demotions and dismissals in American universities are rarely justified. They merely give someone the courage to live.

Ewing entertained one false hope. He said, "Put a self-effacing man in power." One cannot help but smile at this remark, so contrary is it to experience. The only answer for the true university is not to put any one man in power. This is essentially the situation at the Sorbonne. The faculty is in charge, and not one among them has the power to wield a whip hand over his colleagues.

The new university should not be large; it need not be, for our universities today are crowded with students who neither desire nor need a higher education. The girls are there to spend their maturing years in some advantageous way until marriage. A group of them in a small college went to the dean and demanded a revision in their curriculum. "Nothing but mathematical equations, scientific experiments, languages, and the appreciation of art, but not a word on how to live." I am inclined to think that the girls were right.

The majority of the boys are in college in order to acquire the fundamentals of a profession. For the average man, the junior college is sufficient. The French *lycée* and the German *Gymnasium* are the European counterparts, and they give excellent schooling. The professional man must go higher through his particular specialized school. There is nothing arrogant or snobbish in these statements concerning the majority, for every person will have the right to attend the new university. We ask only that he want it and be equal to it. Education, like art, can be appreciated only by those who understand it.

Many persons will not take this plan for a new university seriously. They will not regard the situation as deserving of so much concern. If the fate of civilization the seriousness of lawlessness and of juvenile delinquency, and the need of an intelligent understanding of one's fellow-men are of no importance, then well and good. Let every man live for himself alone in any way that he wishes. There are persons who think this way.

There is another aspect of the problem that disturbs me. The books that have sold well recently bear such titles as *Peace of Mind, Life Is Worth Living,* and *Faith and Prayer*. Each and every one is an appeal "to return to God," just as if we had lost Him or He us. To all this, I heartily agree. Many men and women have told me that were it not for their Sunday-School training as children they would never have acquired a real knowledge of right and wrong. But there are weaknesses in this trend back to religion of which the university man should take cognizance. The appeal is purely emotional, the reasoning often biologically unsound, and the approach too sentimental. Wholly lacking is the "righteous wrath" of which the Bible speaks. Man is half animal—I was about to say, and let us handle him accordingly, when I glanced at the well-run society of animals outdoors and wondered whether the animal half of man is not the better half.

Religion is a power for good, but it is not enough. Youth craves action, and science has given it to him in death-dealing forms. In a recent article, Kirtley Mather [*Science* **119**, 299 (1954)] writes of a scientist's obligation to the layman. The obligation goes further; it is not an obligation of the scientist alone but of the university as a whole. People expect goodness from the church, justice from the state, and enlightenment from the university. Enlightenment is more than knowledge. It is knowledge softened by understanding, and in this respect science has failed.

The stupid expression, "the scientific way of life," is meaningless. Science does, to be sure, seek the truth regardless of the consequences, and to this extent it is good, but of what did it boast during the war? Printed in red letters across its journals was, "Science Is Power." If this is all it is, then the less we have of it the better. The pursuit of science is a wonderful experience, but we have degraded it by the use to which we have put it. At best it is not a way of life.

Can we not have, somewhere in our society, a center, or many centers, from which will emanate a culture that man will respect, an intelligent biological system of ethics? The more biological it is, the more intelli-

gent, the more kindly it will be. I know of no institution that can house such a way of thinking other than the university, but it will have to be a new university. Perhaps you will say, "Men will no more respect it than they now respect anything in heaven or on earth, for do not churchmen make the Deity partner to their chicanery and do not city politicians pray?" Just so do men of learning use their status in science and the university as proof of their superiority, a conceit that often leads to vicious acts. This is all true, and yet I say you are wrong. I have not taught students for 30 years without noting how quickly and well some of them judge their teachers and how great is their respect for the scholar. This is, of course, not true of all, but the students who are capable of such judgment will set the standard for the rest. I have seen older men, those who once held power in a college where they had absolute and tyrannical control, become, literally overnight, quite decent men when they entered an institution of higher learning.

And so I come to my conclusion. Loewi's appeal is not merely a "great concern about the future of medical physiology because of the increasing schisms," nor is it just a cry, deploring with Howard Mumford Jones "the increasing tendency to train scientists predominantly as superb research technicians rather than carriers of a flame," nor is it only an appeal for a scientific literature that is interesting to the student: it is a prayer for "belief in the meaningfulness of the universe." Many will say that this is nothing more than religious faith. I have no objection to this, and perhaps it is true. But it carries with it the tragic admission that science and academic learning have failed. This failure is not necessary.

News and Notes

Ichthyologists and Herpetologists

The American Society of Ichthyologists and Herpetologists, a new affiliate of the AAAS, can trace its beginning back to 27 Dec. 1913 when the first issue of a 4-page pamphlet entitled *Copeia No. I* was published. Its announced purpose was to advance the science of cold-blooded vertebrates. The founders were a group of men in the American Museum of Natural History in New York and the Academy of Natural Sciences in Philadelphia who felt the need of an additional outlet for short notes. The initial number had an article on turtles, one on lizards, two on fishes, and one on a frog. John T. Nichols was the first editor. In 1916, after *Copeia* had been appearing for about 3 yr during which more than 30 issues were published, the A.S.I.H. was organized in New York at the American Museum of Natural History. The second annual meeting was held at the Academy of Natural Sciences in Philadelphia, and the third at the Museum of Comparative Zoology at Harvard.

In 1924, *Copeia* started carrying the statement "Published by American Society of Ichthyologists and Herpetologists" and officially became a monthly, although it had been one, in fact, since its start. But it was still a pamphlet until 1930, when it took its present form and became a quarterly of approximately 300 pages per year. In addition to the journal, the society has recently published the sixth edition of the *Check List of North American Amphibians and Reptiles,* by Karl P. Schmidt. A check list of fishes is planned.

A special function of the society is the maintenance of a revolving fund that is available to members who need help in expenses involved in publication, collecting, or transportation. A grant is not a loan, but it is hoped that recipients, when they are in a more favorable financial position, will replenish the fund.

Since the organization of the society, meetings have been held yearly without interruption, except during World War II, and the 34th annual meeting will take place in September in conjunction with the convention of the American Institute of Biological Sciences at the University of Florida. Annual meetings last about 3 days and are devoted to papers on herpetology and ichthyology, usually presented in separate sections. Occasionally joint sessions are arranged if enough papers of general interest have been submitted. Small cash prizes are given for the best student work in each field.

The A.S.I.H. is a member of the A.I.B.S. and also makes an annual contribution to the support of the *Zoological Record.* Two functioning divisions have been organized, the Southeastern Division and the Western Division.

The society has approximately 1200 members. In addition, 300 journal subscriptions go to institutions and agencies. Membership is world-wide, with of course the greatest bulk in the United States. It is made up of a fairly representative cross section ranging from eminent specialists through students and amateurs. The society is open to all persons interested in advancing the knowledge of the cold-blooded vertebrates.

ARNOLD B. GROBMAN, *Secretary*
Florida State Museum, Gainesville

Science News

The National Institutes of Health, Bethesda, Md., has received as a gift from the Liggett and Myers Tobacco Co., a 3,000,000-v **Van de Graaff generator** constructed in 1950 for an experimental program of the company. The 30-ton apparatus is being installed in the radiation wing of the new 500-bed Clinical Center at NIH, where it will be used in research on the biological effects of high-energy radiation. It operates