concur as to the "pressure due to mounting scientific knowledge," but I look with suspicion upon proposals for streamlining education. Dadourian suggests elimination of everything which is not indispensable. He also suggests teaching of physical and biological sciences from kindergarten through high school. The latter should find favor with science teachers, but would it not be one of the dispensables of others?

The second group of suggestions which troubles me includes "greater use of the historical and philosophical approach." I have wanted to follow this but have been unable to see how to include it in courses already too short for fundamentals. "Greater use of the laboratory method" is also suggested, but I gather from slight exposures to the streamliners that this is a waste of time.

Many years ago a colleague expressed the opinion that there was too much duplication in education. My old-fashioned mind, impressed with the difficulties the modern generation has in simple sums and grammatical constructions, responded: "Yes. To-day we shall teach $2 \times 2 = 4$; to-morrow we must not repeat that, but teach something else."

I have long felt that learning should be regarded as a photographic process. A good impression is secured by using a fine stop and long exposure. The modern photographer reduces time by use of faster plates, and there are those who hold that modern methods of teaching accomplish a similar end. It is probably fortunate that we can not change the brain cells so easily. Nature slowly heals over the scars of volcanic eruption and those of devastating war. Two times two are still four; there still are 24 hours in each day; plants still synthesize the life-giving carbohydrates.

Some years ago I evolved a definition of education, *viz.*, "something to keep the child busy while he is growing up." I have been told that this is all wrong, that modern methods recognize definite goals and procedures. Perhaps this period is not "education." Perhaps education only begins with graduation from college. Perhaps it is largely extra-curricular. Many of our students profess to have discovered that it is so. In any case, we need to recognize that it differs greatly in individuals and in subjects. Differences in opinion are usually differences in interpretations. My definition could scarcely be training for a profession, and those who do not approve of it can easily hold that all education should be training for profession.

After more years of trying to participate in education, I still feel that my definition has some merit. I recall some pithy advice of another colleague of the old school: "It doesn't matter what courses you take. Pick out the best teachers and take the hardest courses they offer." My own son wrote to a leading law school to ask what undergraduate courses they would suggest. They recommended no specific courses but only that he take substantial ones and follow them through.

After some years of trying to use short cuts in laboratory biology, I find myself tending to revert to the old style requirement of making drawings, because they give longer exposures and opportunity to raise questions which cause students to begin to think and to consider what they are seeing. Others will no doubt succeed better with new methods. Good teachers are deplorably rare and too often are drawn into more lucrative fields.

The pressure due to mounting knowledge is very real. It is serious. Perhaps we wonder if we begin to see reasons why ancient civilizations decayed after reaching a high peak. I am a pessimist. It is difficult to be otherwise, faced with colossal waste of war, strife and bickerings, when there is crying need for reasonable cooperation. There are heartening signs of serious attempts to meet the present situation, and it should be possible to at least postpone general calamity.

Reasonable solution of present affairs will not relieve the pressure due to mounting knowledge. I have no panacea to offer, unless it be willingness to know less, to do less, to live more slowly and sanely. The streamliners and post-war adjustmenters would have us believe that they are solving problems, but when the smoke and dust have cleared away, even if our civilization tumbles, two and two will still make four, the sun will still shine and the earth will be green.

O. A. STEVENS

NORTH DAKOTA AGRICULTURAL COLLEGE

SCIENTIFIC BOOKS

THE VELOCITY OF LIGHT

The Velocity of Light. By N. ERNEST DORSEY. 110 pp. Transactions of the American Philosophical Society, New Series. Vol. xxxiv, Part 1. 1944. $2.25.

THIS is something that has needed doing for a long time, and Dr. Dorsey has set a standard of rigorous and objective criticism that should serve as a model and guide for future workers in this field.

The nature of the problem to be considered is clearly stated in the introduction, and the suggestions concerning a secular variation of the velocity of light are

briefly reviewed. Unlike previous writers on this subject (including the reviewer), Dr. Dorsey does not base his discussion on the published definitive values given by the various observers. Instead, he points out that "the published definitive values, with their accompanying limits of uncertainty, are not experimental data, but merely the author's inferences from such data. Inferences are always subject to question; they may be criticized, reexamined and review at any time. When uncritically accepted, they form an exceedingly weak foundation for a revolutionary suggestion; in fact, the suggestion then rests solely on authority." Furthermore, the suggestion of a secular variation "cannot be satisfactorily attacked by merely pointing out that only slight changes in the admitted uncertainties of the measurements will render the suggestion unnecessary, especially if those changes must exhibit some kind of regularity. The most that can be accomplished by such criticism is to show the weakness of the foundation on which the suggestion rests, to show that the suggestion is unproven; whereas the critic presumably wishes to show that there is no basis at all for the suggestion."

Hence, Dr. Dorsey has undertaken to examine carefully the details of the work behind the published definitive values in order to independently appraise the objective value of the work in each case. His detailed discussion of the different investigations is prefaced by eight pages of remarks concerning the theory of errors, the method of least squares, averaging and absolute physical measurements. The treatment is original and stimulating and could very well be required reading for all who are concerned with precision measurements. In two valuable appendixes, Dr. Dorsey discusses (1) the experimental methods for determining the velocity of light and (2) motion maintained by periodic impulses.

All direct measurements of the velocity of light (denoted by V, instead of the customary c) are considered, with the exception of the work by Young and Forbes. The pioneer determinations by Fizeau and by Foucault are discussed briefly, but are not used to test the constancy of the velocity of light, owing to their great uncertainty. Cornu's work is very thoroughly discussed (22 pages) and a revised definitive value is calculated. Errors are found in the reductions of Perrotin and Prim, and Dorsey recomputes their value with corrected equations. Newcomb's work is shown to be affected by systematic errors of unknown sign and magnitude. Michelson's various determinations receive the most exhaustive (27 pages) and critical treatment of all. His reports are strongly criticized:

> Not one of his reports contains sufficient detailed information to enable a reader to form an independent and objective evaluation of the result. Whatever value he may attach to it is purely subjective, resting solely on his confidence in Michelson. . . . When details are given, they have to do with the simplest of measurements, those open to the least question. Of the more recondite measurements, those involving real difficulty and where mistaken procedures would not be especially surprising, little or nothing is said. . . . In none of his reports on the velocity of light prior to 1935 does one find any indication of a thorough experimental study of his apparatus and procedures.

The recent work by Karolus and Mittelstaedt, Anderson and Hüttel is perhaps too briefly presented, and without detailed criticism. The important question of the correction for "group velocity" is not satisfactorily handled, and it is to be hoped that Dr. Dorsey and others will look into this further.

Dr. Dorsey concludes that all determinations made prior to 1928 are of historical interest only, and bases his best value (299,773 km./sec.) on the mean of the Kerr cell determinations and the Michelson, Pease and Pearson determination. The actual uncertainty of this result (called the "dubiety") is thought to be perhaps as much as, but probably less than ±10 km./sec. Finally, it is concluded that "the data give no indication of any secular change in the velocity of light."

FRANK K. EDMONDSON

KIRKWOOD OBSERVATORY,
INDIANA UNIVERSITY

THE LIFE HISTORY OF AN AMERICAN NATURALIST

The Life History of an American Naturalist. By FRANCIS B. SUMNER. vii + 298 pp. The Jaques Cattell Press, 1945. $3.00.

THE author, whose death closely followed the publication of this book, stated that his aim in writing his autobiography was a desire to bring to as wide a circle of readers as possible some of his long-cherished ideas relative to present-day beliefs and behavior. To this end he has analyzed his own personality and remembered experiences with the same impartiality that has characterized his scientific investigations, and these have been widely acclaimed by biologists. In fact, he has been inclined to overemphasize his supposed inadequacies with a frankness that he thought necessary for strict honesty. Most of the twenty-four chapters are written in narrative form and all of them with an unusual degree of literary excellence. They portray the development of the child into the mature man of science, with an analysis of the influences, hereditary and environmental, which may have guided this development along the course which was followed.

Of intense interest are the author's accounts of his early struggles in his chosen career, hampered as he