authors in a thoroughly judicial way, although with a bias towards Pasteur's main contention perhaps unavoidable in the light of our present knowledge. "Those who attempt to explain the putrefaction of animal substances by animalcules," wrote Liebig, "argue much in the same way as a child who imagines he can explain the rapidity of flow of the river Rhine by attributing it to the violent agitations caused by the numerous water-wheels of Mainz, in the neighborhood of Bingen." Liebig, as is well known, was soon forced to retreat from the position that the alcoholic fermentation is due not to the activity of the living yeast plant, but to the decomposition of the nitrogenous components, and was obliged to yield to the overwhelming evidence adduced by Pasteur in support of the view that not the dead or the dying, but the live yeast-cell was responsible for the phenomenon. Liebig later acknowledged defeat so far as to admit the share of the live yeast plant in the process, but still clung tenaciously to his hypothesis of a transmission of molecular vibration, itself a modification of the view long before advanced by Willis and Stahl, while Pasteur advocated with equal tenacity the view that the yeast plant simply breathes at the expense of the oxygen of the sugar molecule. The recent discovery by E. Buchner of an alcohol-generating enzyme in the fluid pressed out of pulverized yeast-cells—a discovery, by the way, sadly in need of confirmation—can hardly be said to conclude the controversy, although bringing us to somewhat closer quarters with the real problem.

Pasteur's memorable researches upon anthrax are described at some length and in a very interesting fashion, although with an exaggeration of the hero's rôle as compared with that of Koch and others, which is perhaps more pardonable in a biographer than it would be in an historian of science. There are not lacking some other instances of unnecessary magnification of Pasteur's achievements—although one is tempted to ask oneself if they can ever really be made to bulk too large—and of French bacteriology in general. Is it quite correct, for instance, to mention Calmette's work upon the production of immunity towards abrin (p. 197) in such a way as to convey the impression that he was the pioneer in this work? Despite some blemishes of this sort, however, and despite, too, an excess of divided infinitives and a profusion of bellicose metaphors, this biography presents a just and interesting account of the life of a great man.

The closing chapters of the book contain a vivid and picturesque description of the master's methods of work, of his founding of the Institut Pasteur, of his work on rabies and of his last years. In simplicity of life and in the patience, persistence and fire that mark the genius, Pasteur stands as one of the shining figures in the science of the century. "He makes me uneasy," said one of his early friends; "he does not recognize the limits of science; he loves only quite insoluble problems." At the dedication, on November 14, 1888, of the great institution that bears his name, Pasteur himself gave a bit of his inmost life. "This that I ask of you is what you again, in your turn, will demand of the disciples who gather round you, and for the investigator it is the hardest ordeal which he can be asked to face, to believe that he has discovered a great scientific truth, to be possessed with a feverish desire to make it known and yet to impose silence on himself for days, for weeks, sometimes for years, whilst striving to destroy those very conclusions and only permitting himself to proclaim his discovery when all the adverse hypotheses have been exhausted." Yes, that is a difficult task.

"But when, after many trials, you have at length succeeded in dissipating every doubt, the human soul experiences one of the greatest joys of which it is capable."

EDWIN O. JORDAN.
UNIVERSITY OF CHICAGO.

A College Course of Laboratory Experiments in General Physics. By SAMUEL W. STRATTON and ROBERT A. MILLIKAN. Chicago, The University of Chicago Press. 1898. Pp. 100.

In a recent issue of SCIENCE a writer whose specialty is chemistry refers to the following remark in which he had indulged: "There is small doubt that, were it not for the expense of printing, every teacher of chemistry would use a text-book made by himself with either pen

or scissors." A foreign critic's comment upon this was: "Sad, indeed, if true!"

Most teachers of science who have laboratories to control, whether in chemistry, physics or biology, will probably be ready to express their accordance with the view of the chemical writer. No one can direct students in a physical laboratory without finding that his own needs are not met in any one of the considerable number of laboratory guide books with which the market now abounds. Nor would he be any more fortunate if the number of these became tenfold greater. No two laboratories are alike; no two teachers are alike. Every laboratory manual is a compound product of teacher, laboratory and special circumstances. It is never made deliberately for the purpose of instructing the world at large, but specially for one laboratory in particular. It is then published, in the hope that its contents may be useful in other laboratories.

The earliest laboratory manual for students in physics, that of Kohlrausch, was written so concisely that, while apparently as good for one laboratory as for another, it was found by its users to be always in need of supplementary matter. Each instructor usually prepares special cards with such directions as are found needful under given conditions of use. The instructor must in any case be within reach to respond to the student's needs; but there is great saving of time, breath and patience if everything is plainly written or printed that can be reasonably demanded by a student of ordinary ability. Laboratory work is far superior to class work in revealing the possession or absence of that power of quick discernment and practicality which is colloquially called 'gumption.' The student who is naturally blessed with this power needs but little more than the instruction cards, but there are always some who cannot be kept from blundering even if the instructor is continually present. These are the ones that sap his energies; and in self-defense he is often compelled to adapt his cards to them, giving specific directions adjusted to the particular apparatus to be employed, anticipating the mistakes they will make, and sacrificing educative aims to the need of saving apparatus from injury.

Since the primary function of a laboratory manual is thus to save time and labor for both instructor and student, it follows almost as a necessity that each laboratory must be provided with its own manual. If this be printed, convenience is temporarily promoted. But each year brings changes. Old cards must be modified or new ones written, or the laboratory manual must be subjected to frequent revision. Manuals prepared for other laboratories must, it is true, be at hand for ready reference. They are highly useful, but never sufficient, because not adapted to the particular apparatus which the student is called upon to master.

The small volume of a hundred pages by Messrs. Stratton and Millikan is an excellent index of the good work through which junior students are carried in the Ryerson laboratory, of the University of Chicago. It bears much internal evidence that its authors were writing specifically for their own students, and writing with a degree of intelligence that indicates how successful their work must be. The book opens with some general directions regarding the method of making observations, keeping records of these, and estimating the accuracy attainable under given conditions of work. The exercises are grouped under three heads, Mechanics, Molecular Physics and Physics of the Ether. Under the former are included various methods of measuring distance, direct and indirect determinations of the acceleration of gravity, an excellent discussion of the use of the balance, the determination of density for solids and fluids, elasticity of tension and torsion, composition and resolution of forces, the ballistic pendulum, work and efficiency. The instructions are for the most part given very clearly, and in each case followed by a form of record with blanks to be filled in by the student. The last feature may at first seem a little procrustean, but the value of such specific guides is best appreciated by those who have had most experience in the wearisome work of examining report books.

Under the head of Molecular Physics are considered the surface tension of liquids, the properties of gases, hygrometry, thermometry, coefficients of expansion, specific heat, energy of fusion and vaporization, and methods of determining the velocity of sound.

Under the head of Physics of the Ether are considered the constants of mirrors and lenses, the combinations of these to form telescopes and microscopes, the spectrometer and spectrum analysis, magnetic and electric fields of force, absolute measurements of electric current, quantity, potential difference and resistance, battery electromotive forces and resistances, the use of galvanometers, the absolute determination of capacity and comparison of capacities, electro-magnetic induction, efficiency curves for incandescent lamps, thermo-electric power, and radiation.

On the assumption that such a course should be progressive in difficulty, the last parts require decidedly greater proficiency on the part of the student. Many juniors will find it necessary to read with special care the theoretic discussion of capacity. In the exercise on radiation Boys' radiomicrometer is employed in place of thermopile and galvanometer.

The book closes with a few tables of constants, of natural functions and of logarithms.

Upon the whole, this volume is a welcome addition to the literature of the subject. Apart from some obvious typographical errors, it may be consulted with confidence in the accuracy of its statements. While many other laboratories are less generously equipped than the Ryerson physical laboratory, and therefore cannot substitute this book for local instruction cards, it contains so much of good suggestion and is so well methodized that many instructors will surely utilize it in the improvement of the instructions which they prepare for their own students.

W. LE CONTE STEVENS.

SCIENTIFIC JOURNALS.

THE *American Naturalist* for April, which has just been received, opens with an article on the Sarcostyles of the *Plumularidæ*, by Professor C. C. Nutting, followed by the third chapter of the work on the wings of insects, by Professor J. H. Comstock and Mr. J. G. Needham. The present chapter treats of the specialization of wings by reduction and is illustrated by twenty-three cuts. There are briefer articles as follows: 'A Case of Variation in the Number of Ambulacral Systems of *Arbacia punctulata*, by H. L. Osborn; 'Relationship of the Chriacidæ to the Primates,' by Charles Earle; 'Further Notes on Thermometer Crickets,' by C. A. Bessey and E. A. Bessey; 'Pollination of the Closed Gentian by Bumblebees,' by R. J. Webb.

Popular Astronomy for June opens with an article on 'Scales of Seeing,' by Mr. A. E. Douglass, of the Lowell Observatory, in which he discusses a standard scale which he hopes will be generally adopted and used for comparison. There are articles by Dr. Herman S. Davis on women astronomers and Orrin C. Harmon on the astronomy of Shakespeare, and short articles by Messrs. E. J. Wilczyuski, J. A. Parkhurst and the editors, Professor W. W. Payne and Mr. H. C. Wilson.

A NEW journal of interest to students of agricultural science, entitled *Revue des Hybrides Franco-Americains*, has been published since January of this year by M. P. Gouy, Vals près Aubenas.

SOCIETIES AND ACADEMIES.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 486th meeting of the Philosophical Society was held at 8 p. m., May 28th, at the Cosmos Club. Two biographical sketches were read before the regular exercises for the evening. The first was of Mr. C. H. Kümmel by Mr. Marcus Baker, the second of Mr. Orlando M. Poe by Mr. O. H. Tittmann. The first scientific paper was by Mr. Louis A. Fischer, who described and illustrated in a general way the methods for comparing 'line' with 'end' standards. He also described in detail a special method for comparing such standards depending upon small auxiliary abutting pieces, the principal features of which are that they are very light and that the lines ruled upon them are so close to abutting surfaces (about 0.8 mm.) that the distance between the lines when the pieces are in contact with one another may be measured with the micrometer screw of any ordinary microscope. He called attention to the fact that certain systematic errors amounting to one part in 300,000 were discovered in the lengths of bars determined by the Fizean, or reflection, method at the International Bureau of Weights and Measures. This method was used