

with technical students, who are only too apt to regard mathematics as a game instead of an essential part of their business. The book is, for the rest, well proportioned and quite suitable for its purpose.

(6) The subject known as "Elementary Algebra" has been so metamorphosed in the past ten or twenty years that its name ought to be changed. Graphs, differentiation, integration, and nomography are not algebra as understood by Salmon, Chrystal, or Weber. A little trigonometry and as much geometry as is required should be added and the whole called elementary mathematics. The breaking down of the watertight compartments into which school mathematics used to be divided is a development in the right direction.

The scheme of this book is interesting. The book-work is only given in outline in the text or hinted at in the introduction. It remains for the teacher to fill in this framework according to his own lights. And then the text-book gives him examples that are both numerous and apposite. The scheme has much to recommend it, and will be welcomed by teachers who are accustomed to do their work thoroughly. The authors need not apologise for introducing a chapter on nomography, although this chapter will be found difficult without a much fuller treatment.

(7) It is a melancholy fact that examinations dominate and thereby spoil much of the education that they are intended to test and encourage. A considerable part of the education in this country has no higher purpose than the passing of a public examination at some future date. Mr. Durell, who is capable of much better things, says quite frankly that he has compiled a cram book, and we can recommend it for that purpose. The range is roughly that of the Cambridge schedule.

(8) The syllabuses for the Army entrance examinations and those conducted by the Oxford and Cambridge Joint Board have been assimilated, in the hope that Army classes at public schools may thereby be discontinued. This is a little unfortunate for Mr. Fawdry, whose "Co-ordinate Geometry" is written for Army candidates. But the book should prove quite suitable for the general classes into which the Army classes may be merged. Mr. Fawdry has the humanity to insert one or two historical notes (pp. 29 and 75). They are slight, but it is wonderful how much interest they add to the reading. We should like to see more of them.

(9) One of the difficulties of the teacher of modern elementary geometry is the devising of life-like examples. He will solve this difficulty if he gets Mr. Scott's text-book on practical geometry. The text-book is meant for young draughtsmen, and is full of such things as

draughtsmen have to draw. The only general criticism we would make is that, while Mr. Scott gives clear instructions, he never justifies them, and we cannot believe that rule of thumb is a good rule even for draughtsmen. Chap. 8, about which the author is a little apologetic, is rather out of place. It contains some methods of constructing a "true length," when plan and elevation are given. The chapter is good in itself, but it stands at a different level from the rest of the book. The subject should be either left out or treated more fully. Standing alone, it will not be understood by the majority of readers.

H. B. H.

Studies in Symbiosis.¹

Tier und Pflanze in intrazellulärer Symbiose. By Prof. P. Buchner. Pp. xi + 462 + Tafel 2. (Berlin: Gebrüder Borntraeger, 1921.) 114 mk.

THE third section of Dr. Buchner's book deals with the highly controversial thesis that symbiotic bacteria are the cause of luminosity in many insects and marine animals. In this discussion, the author's critical faculty is at fault. He does not set out clearly the opposing lines of evidence nor does he do full justice to the work of Dubois, the protagonist of the "enzyme-theory" of animal luminosity.

Briefly, the issue is between the enzyme and the bacterial modes of light production. According to Dubois and Newton Harvey (whose work was reviewed in NATURE, October 6, p. 174), luminous animals contain two substances, one of which, when oxidised in the presence of the other, gives rise to light of an extremely "efficient" kind. The firefly's light is the standard—the most efficient light known, so far as the amount of light in relation to the expenditure of energy is concerned. One of these substances is a heat-stable, dialysable, oxidisable light producer, the other is not heat-stable, is non-dialysable, and is apparently a proteid. These substances are obtained by "dissolving" whole animals or their phosphorescent mucus in water or alcohol and precipitating with ammonium sulphate. No attempts appear to have been made to test the solutions for the presence of bacteria. An aqueous emulsion boiled in 20 per cent. hydrochloric acid for three hours retains the power of producing light when added to a cold-water emulsion. In the former the heat-stable "luciferin" has been separated from the unstable catalyst "luciferase," while both are present in the cold-water extract. The presence of the activator is necessary for light

¹ Continued from p. 539.

production which in that case accompanies the rapid oxidation of luciferin; otherwise the process occurs without the evolution of light. The cold-water extract glows for a time until its luciferin is completely oxidised, and it may be made reluminescent by adding some of the hot-water extract.

The bacterial theory of animal light, though possibly consistent with the enzymic one, is based on entirely different data. In its modern form, as an explanation of the phosphorescence of fireflies, glow-worms, and such marine animals as *Pyrosoma* and certain cuttlefish, it is due to Italian zoologists, and especially to the work of Pierantoni. Dr. Buchner is a convert to this view and is a worker in this field. He gives a very interesting account of the evidence, which is of a biological, and not, as in the case of the enzyme school, of a chemical character. According to these observations, the luminous organs of cephalopods, be they never so complicated, are essentially cultures of bacteria in media suitable for their nutrition, and in situations favourable for obtaining oxygen.

In the common *Sepia*, for example, the organ (hitherto called the accessory nidamental gland and regarded as part of the egg-producing mechanism) consists of a modified part of the mantle within which different kinds of bacteria occur. Some are luminous, others are not. They also occur in the egg membrane before development, and Pierantoni describes the infection of the embryo by bacteria derived from those of the egg capsule. In a similar manner he explains the relationship between the luminosity of the egg of the glow-worm and that of the larva and adult beetle. The cells of the luminous organ of *Pyrosoma* contain structures that are also apparently symbiotic organisms. *Noctiluca*, however, has not yet been examined from this point of view.

The difficulty that many will feel in regard to this or the rival solution of an admittedly complex problem is the incompleteness of the explanation hitherto given of flash and occultation and of the apparent transmission of a mechanical stimulus from one part of a luminous animal (as in *Pyrosoma*) to another, lighting the "lamps" as it travels along. The solution seems to lie in the phases and disturbances not only of respiration, but of other controlling factors leading to continuous or alternating evolution of light.

Dr. Buchner has performed a signal service by collating much of what is known of intracellular symbiosis in animals, and his book is one that is most suggestive for further experiment and observation. It indicates the fruitfulness of border-line investigation, and should be widely known amongst biologists to whatever section of organic science they may belong.

F. W. GAMBLE.

Our Bookshelf.

Industrial and Power Alcohol. By Dr. R. C. Farmer. (Pitman's Technical Primer Series.) Pp. x+110. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 2s. 6d. net.

THE author has certainly contrived to include a very large amount of information regarding alcohol in this little book, which contains clear descriptions of the properties of the alcohols and the methods of production. There are interesting chapters on the technical applications and the use of alcohol for the development of power. By no means the least informative part of the book is the numerous references to government regulations and restrictions. Thus, after a statement of some of these restrictions, we read on page 31:—"Plant is stereotyped, and there is no encouragement to introduce improvements in method or in apparatus. Transport by tank is forbidden, and no distillery is permitted to be more than a quarter of a mile from a market town, whereas it would frequently be better to situate the distillery near to the raw materials." We can commend this book to any who are interested in the development of alcohol as a fuel.

Les Combustibles liquides et leurs Applications. Par le Syndicat d'Applications Industrielles des Combustibles liquides. Pp. iii+621. (Paris: Gauthier-Villars et Cie, 1921.)

ONE may liken this volume to the many similar pocket-book issues extant in this country as compendious guides to the various branches of applied science. It serves a double purpose as an epitome of petroleum technology and as a standard work of reference for immediate requirements in the field, refinery, and office, and although written essentially for the use of the French industries concerned with inflammable liquids, it deserves a much wider sphere of utility. This type of publication, though frequently condemned as inimical to the best interests of scientific work and commercial production, commands a degree of popularity for which it is not, perhaps, difficult to account.

H. B. MILNER.

The Development of Institutions under Irrigation; With Special Reference to Early Utah Conditions. By Prof. G. Thomas. (The Rural Science Series.) xi+293. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1920.) 16s. net.

PROF. THOMAS aims at tracing the evolution of water legislation in Utah from 1847, when the Mormon pioneers founded Salt Lake City, to the present time. He shows how the Mormons, if not the first people in America to practise irrigation, were certainly the first to establish it on an extensive scale, the whole of their civilisation practically resting on this type of agriculture. They showed the way to reclaim vast areas of arid land and on their pioneer attempts have been based the methods utilised in other parts of the United States. He also traces the influence of this type of agriculture on the plan and design of the cities of Utah. The book would have been improved by the addition of a map.