plenished with oxygen and returned to the chamber. This type of respiration apparatus has always been recognized as being the most perfect in theory, but serious practical difficulties have been found in its use, and the more easily manipulated if less perfect Pettenkofer apparatus has been the type most commonly employed. It was a bold attempt, therefore, to reconstruct a complicated apparatus, in a scale sufficient for experiments on man, and the authors are to be congratulated upon their success in devising the first practicable large apparatus of this type.

It is, of course, entirely outside the scope of a review to enter upon even an outline description of the apparatus. A study of the monograph can not fail to impress the reader with two things—the ingenuity displayed in the devising of the various parts of the apparatus and the unusual amount of care which has been devoted to the search for sources of error and the determination of their probable magnitude. In the latter respect the volume affords an instructive example of true scientific accuracy, consisting not in inerrancy, but in a critical estimate of the degree of approximation to the truth. Noteworthy, too, is the very interesting method of computing the results of the respiration experiments by which they are made to a large degree to check each other. Check tests of the accuracy of the apparatus as a calorimeter have been made, in which known amounts of heat were generated in it electrically, and also so-called alcohol check tests, in which known quantities of ethyl alcohol were burned in the apparatus and the evolution of carbon dioxide, water and heat and the consumption of oxygen were compared with the theoretical amounts. The observed results differed from the theory by less than one per cent., thus justifying the claim of the authors that the results approach in accuracy those of the most approved methods of chemical analysis.

The monograph closes with a description of one of the numerous experiments on men which have been made with the apparatus, the experimental periods covering from one to thirteen days, and which have demonstrated its entire practicability. American science is to be congratulated upon the addition to its resources of this exceedingly valuable instrument of research, and the Carnegie Institution has performed a great service in rendering its construction possible.

H. P. Armsby.

Studies in General Physiology. By Jacques Loeb. The Decennial Publications, Second Series, Volume XV. Chicago, The University of Chicago Press. 1905.

These studies present a collection of widely scattered papers of Loeb on subjects of general physiology. The two volumes contain 37 papers, monographs, essays and shorter papers, only 13 of which were previously published in English. The publications cover a period of fourteen years, from 1889 to 1902. Some of these papers were published in pamphlet form and were quite inaccessible. These papers present by no means all the studies which this productive investigator has published during that period; nor are there included in this collection such studies which were published in conjunction with some of his associates and pupils—a fact which the reviewer can only regret. With the exception of two or three short papers, every study in this collection presents a more or less extensive original investigation on some biological subject, invariably bringing to light new facts and new points of view. Although these studies deal with a great variety of diverse subjects, there is one apparent background to them all: it is the aim to discover the physical and chemical causes of living phenomena.

The papers are arranged chronologically: the first of them dates from 1889 and the last was published in 1902. The great variety of subjects treated in these numerous papers might, perhaps, be classified in the following four groups: 'Tropism,' 'Physiological Morphology,' 'The Physiological Effects of Ions' and 'Artificial Parthenogenesis,' intermingled with a few miscellaneous subjects not exactly belonging to any one of these groups. The chronology of these papers helps us to get an insight into the gradual development of the

diverse problems in which our author has done pioneer work. The following incident might give us perhaps the key to his starting point. From 1886 to 1888 Loeb was assistant in (animal) physiology in Würzburg. At that time the chair of botany at that university was occupied by Julius von Sachs, one of the foremost plant physiologists, who made a special study of tropism in plants and whose celebrated lectures on plant physiology appeared in 1887 in a second edition. This great investigator apparently exerted a lasting influence upon the direction of Loeb's searching mind. Thus we find that the first larger piece of work of our author consists in a pamphlet entitled: 'The Heliotropism of Animals and its Identity with the Heliotropism of Plants.' That pamphlet forms the first paper of this collection. Through a number of ingenious but simple experiments it is shown for the first time how the dependence of animal movements on light is in every point the same as the dependence of plant movements on the same source of stimulation. In the next paper it is shown that the same holds good also for the movements of sessile animals. In other papers which followed, the influence of gravity upon the movements of animals (geotropism) and the influence of contact irritability (stereotropism) were studied and were also found to be identical with the same influences in plants. The similarity of these phenomena in animals and plants demonstrated to Loeb their independence of a nervous mechanism, and in a paper on 'Instinct and Will' he comes to the conclusion that what has been taken for the effect of 'will' or 'instinct' is really the effect of light, gravity, friction, chemical forces, etc. In a study upon 'Heteromorphosis' he shows that by the above-mentioned physical influences, as in plants, the regeneration in some animals would lead to the production of an organ different in form and function from the original one. In this study the factor of turgescence, of hydrostatic pressure is mentioned for the first time. In a further study on 'Organization and Growth' upon marine animals it was found that besides the above mentioned physical factors, the concentration of the sea water was an important factor, there was no growth nor regeneration in concentrations above 5.4 per cent. nor below 1.3 per cent. Furthermore, the presence of oxygen as well as of potassium and magnesium was indispensable. From now on we meet with studies in which the importance of oxygen and especially of osmosis as physiological factors were considered in the first place. We meet them in the 'Experiments on Cleavage,' in the studies 'On a Simple Method of Producing from one Egg two or more Embryos which are Grown Together,' in the studies on the 'Sensibility of Fish Embryos to Lack of Oxygen and Loss of Water,' etc. Meanwhile the studies of Van't Hoff, of Arrhenius and of Ostwald upon osmotic pressure and dissociation of electrolytes created a new epoch in the sciences of physics and chemistry, and we find Loeb henceforth profoundly engaged in unraveling the mysteries of life with the aid of the newly established science of physical chemistry. The fruit of these new efforts we find laid down here in numerous papers on 'Artificial Parthenogenesis,' on the physiological effects of ions, on ion-proteids, on the effect of ions on contractility, on the toxic and antitoxic effects of ions, etc. It is, of course, impossible to give here any intelligible account of the multitude of important new facts laid down in these papers. We have here before us the fruit of a most indefatigable and ingenious investigator who has done pioneer work in many fields in biology. These studies will be a source of instruction and stimulation to many an earnest student in general physiology, and we ought to be thankful to the author as well as to the editors of the Decennial Publications of the University of Chicago for presenting to us the collection of these very valuable studies.

S. J. MELTZER.

ROCKEFELLER INSTITUTE.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for April contains but three papers: the first 'The Freshwater Copepoda of Massachusetts,' by A. S. Pearse, adds seventeen species, two new, to