fectly reversible, which certain experiments seemed to prove, and resemble somewhat the union of an alcohol and an acid which combine to reach a condition of equilibrium. They assume for the toxin-antitoxin reaction the perfect applicability of the Guldberg-Waage mass action formulas, and for a number of relations have calculated the value of the constant k. It is interesting to note that a number of the leading physical chemists have taken part in the discussion. About a year ago Michaelis reviewed the subject in a long article in the *Biochemisches Centralblatt* and this has recently appeared in expanded book form under the title, 'Die Bindungsgesetze von Toxin und Antitoxin.' Michaelis does not accept the Arrhenius work as satisfactory or convincing, and points out several conditions necessary for the applicability of the mass action laws which do not obtain in the cases in question; for example, the mixtures are not homogeneous and the degree of reversibility is extremely limited, if it really exists.

On the other hand, the doctrine of the toxoids and toxons appears to explain the apparent discrepancies and in certain mixtures secured in the experiments of Keyes and Sachs, known to be free from these bodies, the toxin and antitoxin combination followed in proportions represented by an almost perfect straight line.

It remains to add that this whole discussion can not fail to have an important influence on the attitude of medical men to the rapidly developing physiological chemistry. The Arrhenius theory seemed to simplify the question somewhat and make it one of analogy with other well-known phenomena. The facts more recently adduced by the Ehrlich workers do not seem to permit this theoretically preferable solution. The toxoid and toxon hypotheses are necessarily chemical, however, and for the present may better serve in the advance of investigation.

J. H. LONG.
NORTHWESTERN UNIVERSITY MEDICAL SCHOOL, CHICAGO, ILL.

SCIENTIFIC BOOKS.

The Evolution of Man. By ERNST HAECKEL. Translated from the fifth German edition by JOSEPH MCCABE. 2 vols., 8vo. New York, G. P. Putnam's Sons. 1905.

In the two stately and richly illustrated volumes before us we have a translation of the fifth edition of Haeckel's 'Anthropogenie,' and coming as they do from the pen of one who may now be regarded as a Nestor of zoology and the most vigorous exponent of the historical method of investigation, they present not a little interest. They profess to give in their course of some nine hundred pages an account of the embryological and comparative anatomical evidence bearing on the origin of man, a subject of perennial interest not only to the laity, but also to professional zoologists, since it involves the problem of the origin of the vertebrates.

The work opens with a chapter upon the biogenetic law, or, as it is termed, 'the fundamental law of organic evolution,' and then follow five especially interesting chapters devoted to a history of the development of embryology and phylogeny. To these succeed an extended account of the principal embryological stages of the vertebrates and a discussion of their significance, in which the germ cells, segmentation, gastrulation, the germ layers, metamerism, the fetal membranes and the development of the general form of the body, are all considered from the standpoint of their bearings on the ancestral history. This completed, the author passes on to a consideration of the recent representatives of the ancestral stages and concludes with several chapters devoted to the phylogeny of the various organs of the human body.

It would require much space to consider adequately the entire contents of the volumes, and the purpose of this review will, perhaps, be best served by indicating briefly the line of descent which Haeckel advocates. It is essentially the same as that presented in earlier

editions, of which the third has appeared in an English translation, but differs in the greater detail and precision with which the various stages are defined.

It starts with the Monera, non-nucleated masses of protoplasm which 'stand exactly at the limit between the organic and the inorganic worlds' and have originated by spontaneous generation. Of these, two varieties existed, differing in their physiological activities; the one group, the phytomonera, being plasmodomous, building up protoplasm from unorganized material, and the other, the zoomonera, being plasmophagous, finding their nutrition in already organized material. The phytomonera were the more primitive of the two, the zoomonera arising from them by metasitism or metatrophy, the reversal of the mode of nutrition, a process which may have occurred several times independently and among cytodes as well as moners. Hence not only have zoomonera been derived from phytomonera, but nucleated unicellular plasmophags have arisen from similar plasmodomes, and so Haeckel takes as his second stage of the ancestry the Algaria, represented to-day by such unicellular algæ as the Palmellaceæ. From these he derives the third stage, that of the Lobosa, represented by Amœba and having corresponding to it the ovum stage of ontogeny.

The line of descent is then traced through the moræa, blastæa and gastræa, familiar to all readers of Haeckel's writings, and then passes to the Platodaria and Platodinia, two groups of turbellarian worms represented to-day by the so-called Acœla and the Rhabdocœla. The ninth stage is that of the Provermalia, represented by such recent forms as the Rotatoria and Gastrotricha, and presenting an advance upon preceding stages in the possession of a body cavity and an anal aperture; and to these succeed the Frontonia, a group which many will regard as decidedly heterogeneous, since both the Nemerteans and the Enteropneusta are regarded as being its modern representatives. Then follows the Prochordonia stage, characterized by the possession of a definite notochord and branchial slits and by the absence of a well-defined metamerism; its nearest representatives among recent forms are the copelate ascidians and the appendicularia larvæ.

Haeckel thus omits metamerism as a fundamental and primitive condition whose existence in several groups of animals implies a community of descent; for him it is merely a mode of growth and as such has been independently acquired in different phyla. He regards the metamerism of the annelids and arthropods as something quite different both structurally and phylogenetically from the metamerism of the vertebrates, and consequently excludes the annelids from the line of descent.

The next stage ushers in the vertebrate phylum and is that of the Prospondylia, which finds its modern representative in the larval *Amphioxus,* and then succeeds a stage corresponding to the adult *Amphioxus,* then the Archicrania, represented by the Ammocœtes larva, and then a stage corresponding to the adult cyclostome. The line then passes through the Proselachii, Proganoidea and Palædipneusta, thence through the stegocephalous Amphibia to the Proreptilia represented most nearly by the modern Hatteria, and so to the Monotremes, which represent the Promammalian stage. Then follows the Prodidelphian stage and then that of the Prochoriata or Mallotheria, represented by an extinct group of placental mammals which included the stem-forms of the rodents, ungulates, carnivores and primates and, perhaps, finds its nearest recent representatives among the Insectivora. From the older Mallotheria the Prosimiæ are descended and of these Haeckel recognizes two ancestral stages, the Lemuravida and the Lemurogona, both belonging to Eocene times. From these the Simiæ with a true discoidal placenta are descended, but a discrepancy occurs between the general text, which is identical with the earlier edition in passing directly to the catarrhine forms, and the table given on p. 551, in which the line of descent is taken through primitive platyrrhines and thence through the Cynopitheca. However, the

twenty-eighth stage is that of the Anthropoides, most closely approached by Hylobates among recent forms, and then succeeds the Pithecanthropi or Alali, which included forms similar to, but not identical with, the gorilla and chimpanzee and finally, as the thirtieth stage, comes man.

Without attempting either a general or particular criticism of such a scheme, it may be said of the work that while clearly and interestingly written, it will hardly carry conviction to the mind of the reader. The gaps in the plan are too evident and too lightly passed over; conflicting theories, if mentioned, are treated too summarily; similarities between forms are frequently exaggerated; and, in short, the entire tone of the work is too dogmatic to be convincing. Sentences such as the following are by no means rare: 'In their first stage of development * * * the embryos of all the vertebrates, from the fish to man, are only incidentally or not at all different from each other,' 'Comparative evolution leads us clearly and indubitably to the first source of love—the affinity of two different erotic cells, the sperm cell and ovum (*erotic chemotropism*).'

On the other hand, one looks in vain for many facts which would have added strength to the general argument, and especially is this so in the chapters dealing with the phylogeny of the organs. Much that is highly pertinent has been omitted from the chapters on the muscular and nervous systems, and it is disappointing to find merely a mention of the recent important researches of Schwalbe and Klaatsch on the Neanderthal and Pithecanthropus remains.

But, notwithstanding these imperfections, the book is exceedingly interesting and contains a wealth of information on the questions under discussion. One can not help feeling, however, that it would have gained in value and authority if it had been limited to a discussion of the more general question of the descent of man, without attempting to define some thirty ancestral stages. It is especially in connection with the details that the dogmatism offends.

Finally, it may be remarked that it is unfortunate that more care has not been taken with the translation and proof-reading, in the latter especially with regard to proper names. Thus one finds Dreisch for Driesch, Moll for Mall, Ralph for Rolph, Dalton for D'Alton and Wiederscheim. Numerous terms are employed in the translation which are unfamiliar to English-speaking zoologists, and so much so as to indicate a lack of familiarity with the science on the part of the translator. It is possible to recognize the earthworm in the designation 'rainworm,' but to speak of a Turbellarian as a 'coiled-worm' can not be said to have the authorization of usage; 'tinting and dissection' mean staining and sectioning in ordinary parlance; and it is rather amusing to find one of His's reconstructions described as 'invented' by him. The rabbit is throughout transformed into a hare; *Echidna* is labeled a 'sea-urchin,' and a plate showing variations in the form of the pinna of the ear has for its legend 'ear muscles' (cf. Ohrmuscheln). On the whole, however, the translation is readable and set forth in idiomatic English.

J. P. McM.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Comparative Neurology and Psychology for July contains two leading articles: (1) 'The Sense of Hearing in Frogs,' by Robert M. Yerkes. Although in nature frogs seem very insensitive to sounds, yet both field observations and laboratory experiments show that their hearing is good over a wide range of sounds. The sense of hearing apparently serves rather as a warning sense which modifies reactions to other simultaneous or succeeding stimuli, than as a control for definite auditory motor reactions. Sounds which never cause a motor reaction are found to reinforce an accompanying visual or tactile reaction and under other conditions to inhibit reaction. (2) 'The Reactions of Ranatra to Light,' by S. J. Holmes. A detailed laboratory study of the phototactic reactions of the common water scorpion, with a discussion of the general theories suggested by them.