have been secured from various localities in this country and in South America.

The Development of the Ascocarp of Melanospora: Professor J. B. OVERTON, University of Wisconsin. (By title.)

Progressive Cleavage in Didymium: Professor R. A. HARPER, University of Wisconsin. (By title.)

On the Development of Immunity for Heart-rot Diseases in Trees: Dr. HERMANN VON SCHRENCK, Missouri Botanical Garden. (By title.)

The Influence of the Swaying of the Wind on the Formation of Mechanical Tissue in Plants: Professor F. C. NEWCOMBE, University of Michigan. (By title.)

A Study of Edaphic Conditions in Peat Bogs near Ann Arbor: Dr. G. P. BURNS, University of Michigan. (By title.)

DUNCAN S. JOHNSON,
Secretary

JOHNS HOPKINS UNIVERSITY

SCIENTIFIC BOOKS

Evolution of Mammalian Molar Teeth to and from the Triangular Type. By HENRY FAIRFIELD OSBORN, Sc.D., LL.D., D.Sc. Edited by W. K. GREGORY, M.A. Pp. 250. New York, The Macmillan Company. 1907.

This book, the most valuable contribution to mammalian odontology since that of Sir Richard Owen, consists of a series of collected and revised researches upon trituberculy with new sections on the forms and homologies of the molar teeth in the different orders of mammals. The theory of trituberculy was a conception of the late Professor Cope, but was elaborated by Professor Osborn, who has been by far the greatest exponent of the idea. Four principles have been developed in connection with the general theory: (1) That in the most primitive Tertiary mammalia there are "*three main tubercles on the crowns of both upper and lower molars, disposed in triangles*"; primitive trituberculy. (2) Origin of the tritubercular types from the single reptilian cone. "*The tritubercular type sprang from a single conical type by the addition of lateral denticles.*" (3) Cusp addition or differentiation; "a process analogous to budding or outgrowth in other tissues." An opposing theory to this is that of concrescence. (4) Reversed upper and lower triangles. "*In the lower molars the reptilian cone is external and the two denticles internal, while in the upper molars the reverse is the case,* namely, *the reptilian cone is internal and the denticles are external.*" It is on this principle that the Osbornian nomenclature, implying a serial homology between the cusps of the upper and lower molars, is based. As applied to the lower molars this principle is generally accepted; but as applied to the upper teeth, it has been most vigorously opposed in the light of three different classes of positive evidence—embryological, anatomical and paleontological. The embryological evidences seem to point to the antero-external cone (Osborn's paracone) as of the greatest antiquity and therefore the reptilian cone. This is also borne out by the analogy of the premolar cusp development (premolar-analogy), and by that of the lower molars. Evidence in favor of Osborn's theory is derived from paleontology, and is also shown by the mechanical development of the cusps, while on the other hand recent interpretation by Gidley of paleontological evidence is in harmony with that of embryology and with the premolar analogy theory.

In the summary of his introduction Professor Osborn says: "That the four great principles of molar evolution *do not stand or fall together.*" The first principle, that of primitive trituberculy, is now almost undeniable; the *reptilian cone origin* theory next in order of demonstration and acceptance; the *cusp addition* theory finding at present more advocates than the opposing idea of concrescence. Finally the greatest conflict of evidence occurs with reference to the homologies of the upper and lower cusps. There is no middle ground; either the Cope-Osborn theory is correct and the premolar-analogy plus the embryological theory wrong, or the reverse is true.

Following the introductory section is an admirable classification of the Mammalia and a diagram showing the chronological and stratigraphic succession of the formations in which fossil mammals have been found in the western states.

Chapter I. is a reprinted essay on the teeth of the Mesozoic mammals; Chapter II. sets forth the first outline (1888) of tritubercular evolution in mammals; Chapter III., trituberculy in relation to the human molar teeth and the Primates; Chapter IV., trituberculy in its application to the molar teeth of the ungulates or hoofed mammals and the completion of the nomenclature; Chapter V., the second outline (1897) of tritubercular evolution in Mammalia with discussions of criticisms; Chapter VI. is a brief review of the dental types observed in the successive geological periods; their chronological and geological succession; while Chapter VII. will prove of extreme value to the student of paleontology as it discusses and illustrates all of the ordinal types of molar teeth and often the entire dentition. Bibliographical references are found at the close of each section of this chapter and serve to show how far afield one must go to find the wealth of information which it contains. In the eighth chapter the evolution of the premolar teeth is discussed. Those of primitive mammals; and the adaptation of premolars in which "they either (*a*) enter upon an especial adaptive evolution of their own, as for example in the upper sectorials of the cats (Felidæ), or the elaborate fourth premolars of the Plagiolacidæ, or (*b*) by a serial analogous development they more or less closely mimic the structure and supplement the exact functions and uses of the molar teeth; this mimicry reaches its highest extreme among the Perissodactyl or odd-toed Ungulates, where the premolars gradually *metamorphose into the molar pattern* and even become superior to the molars in size and complication."

Osborn speaks further of this premolar metamorphosis as being "from the biological standpoint most interesting as illustration of convergence, because *form exactly similar to that of the molars* is finally attained from somewhat dissimilar beginnings." This of course depends upon whether one holds to the Cope-Osborn theory or that of premolar analogy. If the latter be true this premolar adaptation is merely a case of parallelism.

Chapter IX. is a very frank review of the objections and difficulties which have arisen with reference to the Cope-Osborn theory and of the rival theories that have been set forth. Professor Osborn finds that two classes of criticism have arisen: (I.) That the tritubercular type is not primitive. (II.) That the Cope-Osborn theory of the origin of the superior molars is incorrect. (I.) The opposing theories to that of trituberculy each presuppose a more complex tooth as the primitive one, arguing that the tritubercular, triconodont and protodont stages are secondary simplifications. The weight of evidence, however, seems to be largely in favor of trituberculy. (II.) The three powerful arguments arrayed against the Cope-Osborn idea of the origin of the upper molars, that of embryogeny, premolar analogy, and finally a different interpretation of the paleontological record, seem difficult to combat. Osborn believes the question to be still *sub judice,* in spite of the fact that he and Gregory have brought forth all of the evidence which ripe learning and exhaustive study have produced.

Writers agree that the Osborn nomenclature should in any case be retained because of its wide use in paleontological literature and its great convenience. One is somewhat dismayed, however, by the fact that the fourth upper premolar and first molar of the horse, for instance, teeth almost indistinguishable in structure, must needs be described by totally different nomenclatures.

The final chapter discusses the idea of rectigradations in the evolution of tooth cusps.

The whole book gives evidence of the most painstaking work, not only on the part of the author but of his able editor as well. Perhaps its most delightful feature is the judicial fairness and frankness with which the whole evidence is reviewed and discussed.

Richard S. Lull

Yale University