QUOTATIONS

THE PEKING SKULL

THE arrival of the official report on the Peking skull and the opportunity we now have of studying the undeveloped cast of it, which recently arrived in England, enable me to answer the many queries I have received as to the reasons for attaching to the discoveries in China the exceptional importance defined in my letter to *The Times* two months ago.

(1) *Sinanthropus* comes from a geographical area in which previously early man was unknown. While the remains are of approximately the same age as *Pithecanthropus* and *Eoanthropus,* the Man of Peking is generically distinct from both the Ape Man of Java and the Piltdown Man.

(2) The jaws and brain-case found at Chou Kou Tien reveal features some of which were hitherto unknown in any human skull except *Pithecanthropus,* while others were regarded as distinctive of the Piltdown skull. Hence the newly discovered specimens provide a link between these two types and reconcile what hitherto has been their puzzling lack of conformity with one another. Thus they give cohesion to our knowledge of the earliest human remains and add stability to our conception of the qualities likely to be found in the earliest common ancestor of all three, the as yet undiscovered Pliocene Man.

(3) The Peking skull was found, not in gravels where broken fragments were scattered and deposited by running water (as happened in the cases of the Java and the Piltdown skulls), but in the floor of a cave where the Man of Sin actually lived and died. Hence the association of the human remains with those of the early Pleistocene animals found alongside them is certain, and affords for the first time unquestionable evidence that the remains of Early Man do really belong to the Lower Pleistocene. Moreover, the conditions under which the bones were found suggest the probability that other parts of the same skeletons may be found during the further excavation of this site.

(4) The fact that the skull was found in an uncrushed state and in a form less incomplete than those of *Pithecanthropus* and *Eoanthropus* gives us a fuller and more convincing idea of the form of the brain-case in one of the earliest types of mankind, and corroborates the essential accuracy of the reconstruction of the Piltdown skull made by Sir Arthur Smith Woodward in 1912.

(5) The temporal region of the Peking skull presents features of quite exceptional interest and importance. It is much more primitive than that of the Piltdown skull, and reveals a striking resemblance to the condition that is normal in the adult anthropoid apes, and some analogy to that of the modern human infant. The features of this part of the skull (which unfortunately is unknown in the case of *Pithecanthropus*) afford new and emphatic testimony of the closeness of the kinship of man and the anthropoid apes.

(6) The fact that this skull was found in Eastern Asia does not settle the problem as to the original cradle of the human family. Long before the emergence of man, anthropoid apes (whose facilities for rapid migration were strictly limited by their lack of adaptability to new conditions) had wandered as far as Western Europe, South Africa and Eastern Asia. One can therefore assume that in Pliocene times primitive men, distinguished by the characteristically human qualities of greater adaptability and freedom of movement, had roamed throughout the same extensive territory as their less enterprising Simian ancestors had previously explored. Hence the three widely differentiated genera of Early Pleistocene Man found respectively in Java, England and China represent the scattered descendants of ancestors who had already been wandering east and west throughout the vast Euroasiatic continent for hundreds of thousands of years before any one of the three genera left the skulls in the places where they have recently been found. Hence the evidence they provide has little relevance to the determination of the birthplace of the Human Family.—G. ELLIOT SMITH *in the London Times.*

SCIENTIFIC BOOKS

Titanotheres of Ancient Wyoming, Dakota and Nebraska. By HENRY FAIRFIELD OSBORN. U. S. Geological Survey, Monograph 55, 1930. 2 vols., 4to, xxiv + 953 pp., 236 pls., 797 figs.

THE titanotheres are without doubt one of the most interesting of mammalian groups. Commencing in the early Eocene with hornless forms, some of which were no larger than a coyote, they increase rapidly in size and numbers, reach a climax in the huge horned types of the lower Oligocene and then, at the peak of their development, abruptly disappear. Their size and abundance and the fact that their center of evolution appears to have been our Western states have facilitated the collection of large quantities of material and rendered possible a more complete account of their evolutionary history than is the case with any other vertebrate group except the equids. Published facts on the group, however, have been widely scattered in the literature, and no comprehensive account has ever been given.

In consequence, the appearance of Professor Osborn's monograph has been eagerly awaited. Begun by him in 1900, it was sent to press in 1919 and finally has appeared this spring.[1] The delay has been long; but it is forgotten when one sees the magnificent work which has eventually appeared. For completeness and breadth of treatment the monograph leaves nothing to be desired. As to its thorough nature, one need merely cite the magnitude of the work: nearly a thousand pages of quarto text, more than two hundred plates, nearly eight hundred text figures. Every angle of titanothere evolution has been comprehensively treated. But the monograph is more than its title implies, for the various aspects of the subject have led the author into interesting discussions of many topics of a broader nature. It can not, I think, be questioned that Professor Osborn's hopes will be fulfilled in that the monograph has set a new standard of broad, thorough and exhaustive research in vertebrate paleontology, and that it will exercise a permanent influence upon future studies of the geological history of the great West.

The work may be, for purposes of review, divided into three sections. Chapters I to IV deal with introductory matters; in Chapters V to VIII the facts concerning titanothere morphology are set forth, while in Chapters IX, X and XI the data are summarized and applied to the solution of adaptational and evolutionary problems. In addition, a short appendix brings the work up to date with an account of recent discoveries of titanotheres in Mongolia.

In Chapter I, "An Introduction to Mammalian Paleontology," Professor Osborn, using the perissodactyls as examples, outlines the problems to be met with and his method of attack. He gives an interesting discussion of systems of classifications. In the days of Linnaeus, when evolution was undreamed of and fossils were merely curiosities, taxonomy was a simple problem. A family or genus was a clear-cut group, readily definable through the presence or absence of definite characters. But to-day with an extra, paleontological, dimension thrown into the picture, definition is far more difficult, if we attempt to retain a "natural," vertical, classification. To take the case of the titanotheres themselves as an example, all the later, Oligocene types are large, heavy-limbed, horned types. If these forms were living to-day and we had no knowledge of their history, their common characteristics could be used in definition of the group. But we know, as a result of Professor Osborn's work, that the numerous Oligocene phyla have all been derived independently from small hornless Eocene forms. As our knowledge grows, definitions become increasingly difficult; there are few definite characters, for example, by which *all* titanotheres may be distinguished from the horses or rhinoceroses. It is only by tendencies towards the acquisition of certain new features and proportions that we may characterize a group.

Resulting from this situation, the main criteria upon which the author bases his interpretation of the titanothere family tree are (1) the incidence of new characters ("rectigradations") and (2) characteristics resulting from changes in proportions ("allometrons"). Rectigradations through growth become allometrons, and since new characters appear comparatively rarely in the group, emphasis naturally is placed on allometrons (as, for example, dolichocephalic and brachycephalic tendencies in the skull). The velocity with which changes of proportion take place is stressed, and apparently justifiably so, as an index to relationship.

With regard to modes of evolution, the author propounds the question as to whether there is "evidence of chance origins and chance rudiments of certain types of structure possessing sufficient survival value to establish themselves through the principle of the survival of the fittest, or whether there is some other orthogenetic principle at work causing the definite and adaptive origin of new characters."

A second chapter, treating of the geological environment of the titanotheres, covers far more ground than the title indicates, for it includes a comprehensive survey of early Tertiary stratigraphy and discussion of the division of this period of time on the basis of faunal zoning as well as an account of the physiographic, floral and faunal environment of the titanotheres. Chapter III gives a chronological account of titanothere discoveries, in which original descriptions and type figures are reprinted in full, while a short fourth chapter details earlier classifications of the group and the classification finally adopted for the monograph.

With Chapters V and VI we are plunged into the main body of the work, for these sections deal with the structure of the skull and dentition of Eocene and Oligocene titanotheres. An immense amount of material is described in the three hundred pages devoted to this topic; in many instances a dozen or more

[1] The task of putting a huge scientific work of this character through the press is time-consuming in itself. But in addition one is at liberty to suspect that the unfortunate ''economies'' to which the Geological Survey has been subjected during the past decade may have been a major reason for the delay. It is to the lasting credit of the survey that it has been able to publish such a work of pure science despite its straitened financial position.

skulls of a single species are figured and measurements given. Among the striking features of the titanothere skull is the extreme conservatism shown in the persistently low-crowned teeth and the small brain, in contrast with the wide range of variability in skull proportions and the almost simultaneous independent development of horns in the various phyla near the close of the group's history.

But although the skull and teeth are the center of interest, the remainder of the skeleton is by no means neglected, but is discussed in Chapter VII. However, as Professor Osborn notes, the amount of valid material is limited not only through the fact that articulated skeletons and skulls are rarely found in association but also because of the methods of early collectors, who plucked the skulls and neglected the skeletons.

A chapter on titanothere musculature, contributed by Dr. W. K. Gregory, follows. Dr. Gregory has pointed out that it is impossible fully to understand the skeleton of an animal without a proper appreciation of the muscles with which it is so intimately related. The present chapter is an illustration of the results to be obtained by this mode of attack. Using one of the common Oligocene forms as a type, the musculature, especially of the limbs and head, has been restored on the basis of careful comparative studies. Once the musculature is understood, the dry details of the skeleton become invested with new meaning. Logically following this, Chapter IX discusses the mechanics of locomotion in ungulates, the principles of leverage and muscular action and the significance of variations in the ratios of limb segments.

As in the case of the preceding sections, Chapter X goes far beyond the bounds of the titanotheres themselves in the treatment of their origin and ancestry. Following a discussion of the origin of the perissodactyls, an attempt is made to characterize a primitive perissodactyl, and the variations found in many structures are traced in all branches of the order. The facts concerning titanothere morphology presented in earlier chapters are reviewed with especial reference to their bearing on the adaptive radiation of the group.

In conclusion Professor Osborn treats of the causes of the evolution and extinction of the titanotheres. As to extinction, various reasons which have been suggested as responsible for the extermination of mammalian types are discussed, for the most part without the conclusion being reached that they have played any important rôle in the seemingly sudden disappearance of these strange animals. It is suggested, however, that a major factor may have been the fact that the teeth were inadaptive, lacking the possibility of becoming high crowned and thus permitting the titanotheres to take up the grazing habit which was rendered necessary by changed conditions.

It is only the paleontologist who has direct evidence as to the mode of evolution, and in consequence Professor Osborn's conclusions as to evolutionary processes, based upon an intensive study of titanothere phylogeny, merit serious consideration. He abandons the Lamarckian view-point held by Cope; selection is admitted as important. But to the mutation theory as held by the great majority of modern geneticists he takes objection. He holds that variations are not discontinuous and fortuitous, as the genetic evidence seems to show, but are orderly, determinate and generally adaptive. The initial appearance of new characters (rectigradations) are "timed" in the case, for example, of the rudiments of horns in various upper Eocene titanothere phyla, while in the case of changes in proportions (allometrons) "progressive brachycephaly and progressive dolichocephaly in the titanotheres point to the presence of some similarly acting influence affecting generation after generation in a similar manner." Reasoning from this evidence, he has reached his tetrakinetic theory of evolution. Germinal evolution is neither purely internal nor purely external, but a combination of the two; evolution is due to the interaction of the germinal material, the developing organism and the physical and biological environment.

While it does not seem improbable that the changes in proportions might be explained on the basis of mutation and selection, there appears to be considerable strength to Professor Osborn's argument when applied to such cases as the incidence of horns in titanotheres. The independent appearance of horn rudiments in related forms might be attributed to parallel mutations, such as have long been known to occur in various species of Drosophila; but it is difficult to see how there can have been the slightest survival value in the faint beginnings of these structures. It is unfortunate that at the time this section was written so little of the literature of modern genetics was available for discussion. However, the evidence shown for Professor Osborn's view-point by the titanotheres is fully presented in the monograph and is available for the consideration of any geneticist who may desire to attempt a Mendelian explanation.

A work of the magnitude of this monograph could not be the sole product of one man. Professor Osborn notes that Dr. Gregory has collaborated throughout in its preparation, and in the preface tribute is paid to the many colleagues and assistants who have aided in the work. The monograph is thus essentially a product of the department of vertebrate paleontology of the American Museum of Natural History; but viewed again in this light, it is again a personal triumph for

Professor Osborn. Founded less than four decades ago, the department has risen in that space of time to an unchallenged position of leadership in the field, while throughout the country there are few paleontologists who have not at some time or other been connected with this institution, few museums which have not been greatly influenced by the example set by the American Museum. The present monograph is a lasting monument to Professor Osborn's work in paleontology; but a still more enduring testimony to his labors for paleontology will be the American Museum's work and the inspiration it will continue to give to workers in the field of vertebrate history.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SIMPLE METHOD FOR THE GERMINATION OF OOSPORES OF SCLEROSPORA GRAMINICOLA

THE germination of oospores of *Sclerospora graminicola* has been a subject of interest since the time of Schroeter.[1] However, no one except Magnus[1] has succeeded in germinating oospores, prior to the writer's recent investigation.[2,3] In further studies in the department of plant pathology, University of Nebraska, a simple method for the successful germination of oospores has been devised. Briefly, the method consists of placing a layer of moistened cotton in the two parts of a Petri dish. Then a small piece of moist filter-paper on which small amounts of oospore powder are placed is put upon the surface of the moist cotton in such a way that the filter-paper will partly, but not entirely, touch the cotton. Both the cotton and filter-paper must be drained of excess moisture before the oospores are added to the dish. It is essential that the space between the two layers of cotton in the dish be about one half the height of the dish. Small blocks of 2 per cent. agar-agar, on which the oospores are scattered over the surface just as the agar is hardening, can be substituted for the filter-paper. One difficulty encountered when moist filter-paper is used is that the oospores on the periphery of the mass germinate earlier and better than those in the mass.

The time required for germination is markedly different at different temperatures. For instance, the time required for germinating at 35° C. is 22 to 40 hours; at 30° C., 24 to 45 hours; at 25° C., 30 to 48 hours; at 20° C., 42 to 60 hours; at 15° C., three to four and one half days, and at 10° C., nine to ten days. The percentage of germination, of course, varies with the temperature and also to a great extent with the source and age of the oospores. Therefore, it is advisable that oospores from different sources and ages be tested. Germination has been obtained within a range of 10° to 35° C. The optimum temperature appears to be near 20° C., although in previous experiments a higher optimum temperature over a short period of time was reported.[3]

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[1] J. Schroeter, *Hedwigia*, 18: 83–87, 1879.

[2] M. Hiura, *Agriculture and Horticulture* (Japan), 4: 11–20, 1929.

[3] M. Hiura, *Jour. Plant Protect.* (Japan), 16, 5 pp., 1929.

A PRACTICAL FLAGELLA AND CAPSULE STAIN FOR BACTERIA

THE following method of flagella and capsule staining is offered as a contribution both to the teacher of bacteriology and to the technician in the laboratory. It is rapid, simple and dependable. It has been especially designed for staining *Bacillus proteus vulgaris* and *Bacillus subtilis,* common soil species, and the various members of the colon-typhoid group. The procedure is as follows.

(1) Make a thin smear of 15 to 24 hour agar growth of bacteria in a loopful of water on a clean slide. Air-dry. Do not heat. (2) Cover with mordant (5 per cent. tannic acid, 3 parts; 10 per cent. ferric chloride, 1 part) for two minutes. (3) Put seven drops of mordant in a small receptacle and add 1 drop of Ziehl-Neelsen carbol fuchsin stain. Mix. Add 1 drop of concentrated hydrochloric acid. Mix. Add 1 drop of concentrated formaldehyde. Mix. (4) Pour off mordant from slide and cover smear with the mixture prepared in (3). Apply seven minutes. (5) Wash smear in running water. (6) Cover with Ziehl-Neelsen carbol fuchsin stain (Basic fuchsin, 10 grams; ethyl alcohol, 95 per cent., 100 cc; phenol, 5 per cent. aqueous, 1000 cc) and *gently* steam for one half minute. (7) Remove stain with running water. (8) Blot and examine.

The following precautions are in order.

(*a*) Take only a minute portion of the agar growth. Do not use semidry agar. For best results add the agar growth to a drop of water on a slide, stir, and let stand for five minutes, permitting individual bacteria to become detached from the agar mass; then spread loopful on another slide and work with this second slide. (*b*) The mordant will keep indefinitely and so can be prepared in quantity. The mixture