India. One of these Indian species of *Dryopithecus* (*D. punjabicus*) is apparently related to the gorilla; another (*D. giganteus*), perhaps to the chimpanzee; an allied genus, *Palæosimia,* bears a significant resemblance to the orang; a fourth type, *Palæopithecus sivalensis* Lydekker, is a synthetic form with resemblances to the gorilla, chimpanzee and gibbon. In the reviewer's opinion all these are more primitive than any of their modern relatives and indicate that in the Upper Miocene northern India was not far from the center of evolution of the anthropoids and man.

The important genus and species *Sivapithecus indicus,* from the Lower and Middle Siwaliks, rests upon fragments of the lower jaw and dentition. From these Dr. Pilgrim has attempted a restoration of the lower jaw that shows a subhuman divergence of the opposite rami and a very short, man-like symphysis. Pilgrim regards this genus as in or near the ancestral line of *Homo sapiens.*

The reviewer regrets to report that after a careful study of the evidence he believes Dr. Pilgrim has erred in attributing the above-mentioned human characteristics to *Sivapithecus,* the jaw of which, in the reviewer's opinion, should be restored rather after the pattern of the female orang jaw. The evidence for this conclusion will be given elsewhere. The reviewer would also dissent from Dr. Pilgrim's allocation of *Sivapithecus* to the Hominidæ, preferring to place it by definition in the Simiidæ, since it had ape-like canines and front premolars, and, as the reviewer interprets the evidence, also an ape-like symphysis.

William K. Gregory

CASTLE AND WRIGHT ON CROSSING OVER IN RATS

In a recent number of Science (August 6) Castle and Wright describe a case of linkage in rats. One point of general interest indicated by their results is not pointed out by these authors; namely, that crossing over occurs in both sexes. This conclusion depends on the appearance, in F_2 of their cross (red-eyed yellow by pink-eyed yellow), of doubly recessive rats. They state that two such rats appeared, this being inferred from the fact that two of the F_2 pink-eyed yellows, when mated to red-eyed yellows of stock, "produced only red-eyed (yellow) offspring." This result must mean either that these two rats were not sufficiently tested, and were not really double recessives; or else, if they were double recessives, that there had been crossing over in both sexes of F_1 rats. As to the first possibility, the crucial point is the number of red-eyed offspring produced in the test mating. Unless this number was large enough to completely rule out the possibility of the F_2 pink-eyed rats having been only heterozygous for the red-eye factor, the second alternative is not necessarily true. If the second possibility be true it follows that the relation of crossing over to sex determination is different here from that in *Drosophila* (Morgan) and the silkworm moth (Tanaka), where no crossing over occurs in the sex which is heterozygous for the sex factors[1] (male in *Drosophila,* female in the silkworm moth). Since the evidence from sex-linkage and cytology shows that in several mammals (man, cat, etc.) the male is heterozygous for the sex factor, we should expect, if the relation to crossing over is a general one, that no crossing over would take place in the male mammal.

A. H. Sturtevant

August, 1915

SCIENTIFIC BOOKS

A Monograph of the Existing Crinoids. Volume 1. *The Comatulids:* Part 1. By Austin Hobart Clark, Assistant Curator, Division of Marine Invertebrates, United States National Museum. Bulletin 82. Washington, Government Printing Office. 1915. 4to. Pp. vi + 486; with 513 text-figures, and 17 plates.

The last general treatise upon the Recent Crinoids is contained in the monumental volumes of P. Herbert Carpenter upon the "Stalked Crinoids and the Comatulæ," published in 1884 and 1888 by the British government as part of the results of the voyage of H. M. S. *Challenger.* Although based chiefly

[1] See Sturtevant, A. H., *Amer. Nat.,* XLIX., 1915.

upon the *Challenger* collections, these volumes constituted a thorough monograph of the group as it was known at those dates. During the ensuing quarter of a century extraordinary activity in marine exploration has prevailed in all the oceans, resulting in an enormous increase of material for study—both in the way of specimens, and of accurate records of occurrence and distribution, by which the influence of depth, temperature and ocean currents upon the growth and modification of crinoid faunas can be studied in a manner not hitherto possible. New species and genera have thus been brought to light to an extent wholly unexpected. With this great multiplication of new forms, it has become increasingly evident to those interested in the subject that the criteria employed for discrimination of the Fossil Crinoids are only applicable in a limited degree to the Recent, and that some new method of treating the latter is required in order to adequately deal with the new facts. The practical working out of such a method is perhaps the most important general result of Mr. Clark's researches; this will be fully developed in his monograph, of which the present volume is the introductory part, to be followed by others treating systematically the genera and species of the Comatulids and Stalked Crinoids.

Much of the work to be embodied in the subsequent volumes has already been done, and the results published in preliminary form in a series of papers appearing in various American and foreign journals during the past eight years, which give evidence of the extraordinary energy with which the author has prosecuted his studies. These publications, beginning with the description of the new genus *Ptilocrinus* in June, 1907, now amount to a total of 114 papers, of which 23 were issued in journals of England, Denmark, France, Holland, Germany, Monaco, India, New South Wales and western Australia. Some of these are really treatises in permanent form—notably that upon the "Crinoids of the Indian Ocean," a fine quarto volume of 325 pages and 59 figures, published in 1912 by the trustees of the Indian Museum at Calcutta; this was based upon the collections made during a number of years by the Royal Indian Marine Survey steamer *Investigator,* and placed by the authorities of the museum in Mr. Clark's hands for description. Another quarto work of 209 pages and 10 plates is "Die Crinoiden der Antarktis," published in Germany upon the collections made by the steamer *Gauss,* of the Deutsche Sudpolar-Expedition, which were sent to the author for investigation. A paper upon a collection of crinoids from the Zoological Museum of Copenhagen was published in the "Vidensk Medd. fra den Naturhist. i Kjöbenhaven," 1909; one of 100 pages on the "Recent Crinoids of Australia," in the Memoirs of the Australian Museum at Sydney, in 1911; and another in the same year on the "Crinoidea" of the Hamburg Southwest Australian Expedition was published as Band III., Lieferung 13, of the scientific results of that expedition.

Of the remaining 91 papers published in America, the greater part have appeared in the Proceedings of the U. S. National Museum. Out of the total number of papers, 69 have been upon collections examined. Some idea of the wide range of the researches upon which this monograph is founded may be had from an enumeration of the collections, and of material from expeditions which have been studied. In addition to the already large collections of the United States Bureau of Fisheries, and of the National Museum, accumulated by the dredgings of various Coast Survey and Fisheries vessels, including the recent cruises of the *Albatross* in the Pacific Ocean, the following foreign museum and special collections have been placed at Mr. Clark's disposal and sent by their owners to Washington for his use: Zoological Museum, Copenhagen; Hamburg Museum, containing the types of Hartlaub's species; Museum für Naturkunde, Berlin, containing the type material of Johannes Müller's classical works upon the recent crinoids; Indian Museum, Calcutta; Australian Museum, Sydney; Western Australian Museum and Art Gallery, Perth; Sv. Gad collection from Singapore; Svensson collection from East Asia, Copenhagen. Also the

material collected by the following special expeditions, which has been sent to Mr. Clark from time to time for description: *Ingolf* (Danish), Greenland and Northwest Atlantic; Danish expeditions to Siam and to the Danish West Indies; *Investigator* and *Golden Crown* (Indian), Indian Ocean; *Helga* (Irish), West Ireland; *Siboga* (Dutch), East Indies; *Gauss* (German) Antarctic; *Gazelle* (German), East Indies and Australia; *Golden Hind* (Japanese); *Endeavor* (Australia). It may be remarked in passing that in consideration of the work done upon the collections of these various expeditions, a liberal portion of the specimens has in all cases been left in Mr. Clark's hands, which have been placed by him in the National Museum; and that as a result of these accessions this museum now possesses a far more extensive and varied collection of the Recent Crinoids than any other institution in the world.

The author's method of treatment, and the classification proposed by him, have gained general acceptance by the leading authorities upon the recent crinoids, and his new genera have been adopted in practise by Dr. Hubert Lyman Clark, of the Museum of Comparative Zoology, Cambridge; and in Europe by Dr. Theodor Mortensen, of Copenhagen; Professor Ludwig Doederlein, of Strassburg; Dr. August Reichensperger, of Bonn; Professors Rene Koehler and C. Vasey, of Lyons. Dr. Mortensen and Professor Doederlein turned over the extensive Danish and German collections under their control to Mr. Clark for description; and the magnificent collections made by the Marine Survey steamers of the Indian government were placed in his hands for study and publication upon the suggestion of Dr. F. A. Bather, the distinguished crinoid authority of the British Museum.

In the way of technical equipment for this work Mr. Clark has unusual advantages. In addition to a general zoological training he had the benefit of experience in collecting birds and insects in Europe, the West Indies and South America. After this he served as naturalist upon the steamer *Albatross* of the U. S. Fish Commission during a cruise of some 15,000 miles, prosecuting extensive and continual dredgings along the coasts of Alaska, the Aleutian Islands, Kamschatka, Japan and Korea, and returning *via* the Hawaiian Islands. On these voyages vast numbers of crinoids were taken, and the personal knowledge of their occurrence and distribution thus gained by the future author enlisted his interest in the intensive study of these organisms, to which he has since given his chief attention. By way of further necessary preparation Mr. Clark in 1910 visited the chief museums of Europe, and studied at first hand all the collections of historic interest containing types and other material used by previous authors from Lamarck and Müller to those of the present day, including the specimens from the *Challenger* and other British exploring steamers which had been studied by Sir Wyville Thomson and the two Carpenters. Detailed reports of the examination of several of these collections were published in the *Proceedings* of the National Museum, and the Smithsonian Miscellaneous Collections, and in journals of the museums visited.

The present volume, as already stated, is to a large extent introductory, and is chiefly devoted to the comatulids, or unstalked crinoids. After a very full historical introduction, a table of the terms employed in the description of a comatulid, and a discussion of the relative status of the crinoids as a zoological unit, there is an instructive explanation of the proper way to study a comatulid for purpose of identification. Then follows an elaborate treatise upon the structure and anatomy of the crinoids, in the course of which many new facts ascertained from dissections and other observations by the author are brought out. The illustrations, embracing a total of 602 figures, are prepared with great care for the purpose of definite information. With some experience in this line as to the fossil crinoids, the present writer is able to bear testimony to the immense labor involved in the preparation of these figures, especially those illustrating the minute anatomy of the crinoid skeleton, drawn by the author himself. No such lucid representation of these structures for the re-

cent crinoids generally has ever been given before.

There is not space to review the questions of zoological relationships discussed—some of which are speculative, and will doubtless meet with criticism—nor the many new discoveries touching the structure and characters of the crinoid organism, which testify to the industry of the author. Among the more general conclusions to which these researches have led, the following may be mentioned:

1. The Crinoids of the recent seas are far more numerous, both in individuals and in species, than is commonly supposed, and their relative importance does not fall short of that of the other echinoderm groups.

2. The Crinoids, after a paleontological record almost without a parallel for duration and for variety in development, are represented in the recent seas chiefly by two highly aberrant types, viz: (1) the Pentacrinites, which have departed widely from their prototypes by enormously increasing the length of the column through the indefinite reduplication of the first stem joint, or proximale; and (2) the Comatulids, which have departed just as widely by discarding the column and compressing what is virtually the entire column of the pentacrinites within the compass of a single highly cirriferous proximale. Thus while the two groups are parallel to each other, and are descended from the same ancestral stock, and represent the same phylogenetic stage, during their development they have diverged from their phylogenetic mean in exactly opposite directions; and both groups are therefore far removed from the direct line representing the progressive development of the class.

3. These two aberrant types dominate the recent seas to such a degree that in comparison with them all the other types become relatively insignificant. The comatulids, although in their relation to the fossil crinoids merely an inconspicuous family, far outnumber all of the other existing crinoids taken together, at the same time extending through a much wider geographical, bathymetrical and thermal range. They exist in a vast array of diverse forms, none of which depart in any great degree from the general structure of the group, so that their classification necessitates the creation of numerous subfamilies, and families, and higher groups, which are not systematically comparable to similar groups in the stalked crinoids.

4. Among the Recent Crinoids the calyx, usually reduced to insignificant proportions, is of comparatively little systematic value—the classification being placed chiefly upon the column (or homologous structures), and the proximal pinnules. This is, broadly speaking, the reverse of the conditions in the fossil forms, and this fact involves the recognition of characters for the differentiation of species and genera wholly different from those employed in dealing with the fossils. The application of these criteria to the study of the collections and material above mentioned has resulted in the proposal of nearly 100 new genera, and the description of several hundred species new to science, among the comatulids alone, the systematic treatment and illustration of which are to follow in a succeeding volume.

5. The author believes the echinoderms to be a highly abberrant offshoot from a primitive crustacean stock, and that they are far from being the anomalous creatures they are commonly considered.

The thanks of all students of the echinoderms are due to the authorities of the National Museum for their liberality in facilitating the publication of the results of these researches in so thorough and comprehensive a manner, and in thus giving to the scientific public a work which is destined to take rank with the great monographs following the *Challenger* Expedition—a series which in its entirety stands as one of the finest contributions to the knowledge of marine zoology ever produced.

FRANK SPRINGER

THE PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE eighth number of Volume 1 of the *Proceedings of the National Academy of Sciences* contained the following articles: