bodies B and C and that forces equal to F, applied to B and C, cause accelerations a', a''. We recognize the truth of the following statements about the values of a' and a'':

Both a' and a'' are greater than a.

If one of the accelerations a', a'' is less than $2a$ the other is greater than $2a$.

If a' and a'' are equal, each is equal to $2a$.

The accelerations satisfy the equation $1/a' + 1/a'' = 1/a$. (This of course includes the three preceding statements.)

These statements are consequences of II.; but the reason we recognize this is because we recognize that A contains more matter than either B or C, and that the sum of the quantities of matter of B and C is equal to that of A. That is, in interpreting II. we regard *mass* as a measure of *quantity of matter.*

As another illustration, let A and B be any two distinct bodies such that when equal forces are applied to them the acceleration of A is less than that of B. Proposition II. tells us that the mass of A is greater than that of B; but is there any reason for saying that A *contains more matter* than B? There is this reason: We know that, by removing from A some quantity of matter, there will remain a body A' such that, if equal forces be applied to A' and B, their accelerations will be equal; or by adding to B some quantity of matter there will be produced a body B' such that, if equal forces be applied to A and B', their accelerations will be equal. Moreover, we know that the matter which must be taken from A to produce A', and that which must be added to B to produce B', have equal masses m as tested by II.; and that if the accelerations of A and B due to equal forces F are a' and a'', a body of mass m acted upon by a force F would have an acceleration a such that $1/a = 1/a' - 1/a''$. These facts are all recognized as consequences of II. because we regard *mass* as therein used to be a measure of *quantity of matter;* they would not follow if our notion of mass were derived wholly from proposition II. itself.

The significance of mass in the second law of motion is sometimes stated in the following form:

III. *The forces required to give equal accelerations to different bodies are proportional to their masses.*

It is easy to cite illustrative cases showing that in applying this proposition also we interpret mass as a measure of the matter of which bodies are composed. Thus the statement that "body A has three times the mass of body B" means more than that "body A requires three times as much force as body B to give it a specified acceleration"; it means that the material contained in body A might be made into three bodies, each of which would require the same force as body B to give it a specified acceleration.

It is of course true that an important part of the import of propositions II. and III. consists in giving precision to the definition of mass. But the illustrations which have been given show that the preliminary definition of mass as quantity of matter is not without important meaning, and serves a useful purpose in explaining the significance of mass in the laws of motion.

L. M. HOSKINS

STANFORD UNIVERSITY,
August 5, 1915

IS SIVAPITHECUS PILGRIM AN ANCESTOR OF MAN?

IN the "Records of the Geological Survey of India" for February, 1915, Dr. Guy E. Pilgrim has described the fossil anthropoids of India, including several new forms of great interest from the Lower, Middle and Upper Siwaliks. Through the kindness of Dr. Pilgrim the American Museum of Natural History has received casts of his types and principal specimens of Siwalik anthropoids, consisting of fragments of jaws and isolated molars. These casts, together with Dr. Pilgrim's excellent illustrations, have enabled the writer to make a critical comparison of the extinct Indian anthropoids with the existing anthropoids and with recent and extinct races of man.

Pilgrim describes several new species of *Dryopithecus,* a genus characteristic of the Upper Miocene of Europe. Its known range is thus extended to the Upper Miocene of

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.