together upon some eminence, when the males gathered about watch sharply the movements of their enemy; when closely pressed they take refuge in flight.

There has been much dispute as to whether the male antelope habitually sheds his horns. The weight of evidence is strongly in favor of it; but I should hesitate before positively affirming it myself. At all events the new horns must attain their strength and size *very* soon after the disappearance of the former ones. A female is occasionally shot having a remarkable development of rudimentary horns; in one instance, a doe with kids had horns that measured four inches, with the prongs proportionately developed. Their horns are, however, soft and pliable, with the rudimentary horn-core but little if any developed.

In conclusion, I would call the attention of naturalists to the importance of securing legal protection for this, one of the most interesting of all American mammals, that it may not share the fate that is fast overtaking the buffalo. The antelope can never exist in even a moderately inhabited country. The vast unproductive region of Western Kansas and Eastern Colorado will be its home so long as this region remains comparatively unsettled, provided suitable legislation can be effected in its favor.

ON THE LAWS OF DIGITAL REDUCTION.

BY JOHN A. RYDER.

AT a recent meeting of the Philadelphia Academy I called attention to several facts bearing upon an explanation of digital reduction. It was suggested that the fact of the number of toes being least wherever mechanical strains were greatest and impacts most frequent and most severe might be regarded as an effect of such increased intensity of strains. To make this conclusion appear valid it was only necessary to refer to the foot-structure of the different orders of the class of mammals.

It may be observed that among the primates the only creature having any one toe greatly augmented in size and strength is man; here it is the great one, or the first of anatomists. Its whole structure, especially the articulation with the carpus, calls to mind the condition of things found to exist in the groups which have undergone the most modification in the structure of the feet, namely, the ungulates or hoofed animals, kangaroos, and jumping mice. The calibre of its distal elements is greatly in-

creased, while the ento-cuneiform and navicular are greatly flattened or modified in the same way as the magnum and unciform of the manus and the middle and ecto-cuneiforms of the pes are in many ungulates, or as is the cuboid in the kangaroos.

In ungulates the third and fourth toes become functional, the second and fifth either disappearing or else assuming the office of lateral supports. In the jumping mice (*Dipodidæ*) the second, third, and fourth of the hind feet are the functional ones; in one species three toes are all that remain; in another with four the fifth, a rudimentary one, does not reach the earth; and in another species with five the first and fifth toes are rudimentary. In these three animals, then, of one family and only generically separable by the difference in the number of toes, we have a case in living animals resembling the "demonstrative evidence" of Professor Huxley drawn from fossil horses' toes, which so far as the necessity for time is concerned shows that creatures of almost identically the same habits and structure may be cotemporaneous, yet differing widely in the number and length of the hind toes. It indicates, it seems to us, that toe modification goes on at greatly varying rates. In the kangaroos the fourth and fifth toes of the hind foot are most strongly developed, while the second and third are atrophied and used only to cleanse the fur. It may be noted here, also, that the toes of the fore foot of the kangaroo remain entirely unmodified, and much the same as is the case in the jumping mice, for the reason that the strains are more equally distributed.

The *Chrysochloris* amongst moles offers an instance where the digital reduction has taken place in the anterior extremity, where also the mechanical strains are most frequent and severe. The same fact is observed in *Cyclothurus*, a little South American arboreal ant-eater, where but two functional toes remain upon the fore foot. In the great ant-bear (*Myrmecophaga*), the third digit of the manus is the strongest, the others evidently undergoing reduction, while the former is being constantly augmented by the strains to which it is subjected in obtaining insect prey.

The sloths of both recent and extinct groups furnish an instance where the number of toes has been reduced from the typical number five to as few as two in one pair of extremities in the living *Cholœpus*. The digits also in recent species are of about equal length, which cannot be said of the extinct terrestrial species, where in some cases (*Mylodon* and *Megalonyx*) considera-

ble inequality existed. The equality in existing species is no doubt due to the equality of tractile strains upon each one of the digits, owing to the peculiar method of climbing and hanging to the limbs of trees by the great hook-like claws.

The frequent reduction in the number of toes in the foot before it commences in the hand is seen in the carnivorous groups *Felidæ* (cats) and *Canidæ* (dogs), in odd-toed ungulates, in the swift-foot terrestrial *Rodentia*, and universally amongst such animals as perform locomotion entirely by leaping with the hind feet, as the kangaroos and jumping mice. Upon this point it may be observed that these creatures all more or less decidedly leap, or else pitch the body through space in running, mainly by means of the hind limbs. The effect of this unequal distribution of strains has shown itself in the hypertrophy of certain digits and their consequent specialization at the expense of the atrophy of the others. The direction in which growth force is manifested is here determined, as it is determined in all kinds of work or exercise, by the increased development of parts most exercised, and shows that the claims of a certain surgeon, who is said to have been able to tell the occupations of tradesmen by inspecting the development of the muscles upon the body are not without foundation. Two cases of this kind have fallen under my own observation, one in the person of a carpenter and another in that of a blacksmith.

It may be well to note in this place that man, the only *primate* whose feet serve exclusively for purposes of locomotion, belongs to the foregoing class. The outer toes in man are weaker, shorter, and less developed than in any of the higher apes, and what may eventually be the fate of these outer toes, if, as many do, he keeps on wearing shoes that a savage would not wear for a single hour, combined with the structure now admirably conditioning a gradual reduction, only our descendants will be able to determine a thousand years hence.

The lines of bones through which strains have been directed are in some way determined by the uses which the feet serve in the life of the animal and its ancestral series. This is supported by the fact that where the strains to be overcome are equally distributed amongst all the digits there is rarely any specialization of toes. In aquatic, marine, and arboreal animals the distribution of strains is comparatively equal, and I now call to mind but a very few exceptions to this rule, which is but slightly affected by even these. One case is the *Cyclothurus*, where, however, the hind foot and tail are modified into grasping organs,

leaving the great pair of claws in front for the purpose of tearing up the bark and getting into crevices in searching for insects. The *Dendrolagus* or tree kangaroo is another instance, but here the descent from the terrestrial kangaroos is too obvious to require discussion. In studying the fossil kangaroos Professor Owen noticed that the fur-claws were not as rudimentary as in the living species, showing that at one time there was a more uniform distribution of strains than now.

Among fossorial animals it is usual to find the claws and toes well developed upon the fore limbs; this is so in the moles, armadillos, recent and fossil, and in the *Geomyidæ*, or gophers, where the distribution of strains is very unequal in respect to the fore and hind pairs of limbs. So, too, in the group in which man has been included, where the strains are greatest upon the hind pair, as in animals that run rapidly or are capable of making great leaps, like dogs, cats, rabbits, tapirs, cavies, or guinea pigs.

It seems to us the most convincing proof of the doctrine of descent to find man an instance of the same kind of specialization determined by the manner of the distribution of strains as is so often found among the lower groups, such as the horses, sloths, jumping mice, and even-toed ungulates. We would not put him in respect to foot-structure among the true plantigrades, for unlike them the elements of the digits are not uniformly of the same strength and calibre. He might be somewhat clumsily called an inequidigitate plantigrade.

Now as to the osteological side of the question: in man the bones through which the line of greatest mechanical strain passes are the first digit, ento-cuneiform, navicular, calcaneum, and astragalus. In the horse this line passes through the third digit, external cuneiform, navicular, astragalus, and calcaneum in the hind foot; through the third digit, magnum, scaphoid, and lunar in the fore foot. In the kangaroo through the fifth, but mainly through the fourth digit, the cuboid, calcaneum, and astragalus in the hind foot. It will be noticed also that in the highest member of the highest group it is the first digit that is specialized; in the intermediate groups that the intermediate digits are specialized; that next to the very lowest group it is the fourth digit; and, further, that there are corresponding chains of specialized bones which receive and distribute the strains.[1]

[1] It may be as well to note that birds belong in the category of types which have undergone digital reduction. The ostrich for obvious reasons is the extreme. Among reptiles, turtles and dinosaurs may be included, both of which stand near the birds in the system.

The following summary and conclusions are offered: —

I. That the mechanical force used in locomotion during the struggle for existence has determined the digits which are now performing the pedal function in such groups as have undergone digital reduction.

II. That where the distribution of mechanical strains has been alike upon all the digits of the manus or pes, or both, they have remained in a state of approximate uniformity of development.

III. It is held that these views are Lamarkian and not Darwinian, that is, that they more especially take cognizance of mechanical forces as mutating factors in evolution, in accordance with the doctrine of the correlation of forces.

ON THE DISTRIBUTION OF FRESH-WATER FISHES.

BY DAVID S. JORDAN.

THE writer has been engaged during the two past summers (1876–1877) in collecting fishes in the upper waters of the different river basins in the Southern States, with a view to ascertaining the fish fauna of each and to throw as much light as possible on the laws which govern the distribution of the species. In 1868 and 1869, Professor Cope made very thorough explorations of the upper waters of the Cumberland, Tennessee, Kanawha, James, Roanoke, Neuse, Great Pedee, and Santee. In order to supplement Professor Cope's work, the writer, with his ichthyological assistants, Prof. A. W. Brayton and Mr. C. H. Gilbert, began with the Santee, and proceeded westward across the different river basins, including the Santee, Savannah, Oconee, Ocmulgee, Chattahoochee, Alabama, Tennessee, Cumberland, and Ohio. These rivers, as well as those examined by Professor Cope, have their rise in the Alleghany Mountains, from which they flow in different directions and under the most widely varied physical conditions, thus affording the most favorable opportunity for the study of the effect of these conditions on the distribution of fishes.

Some forty-three species new to science were obtained by us in these Southern rivers, among them several singular and interesting forms, but of these I do not purpose to speak at present. I shall confine myself to the statement of a number of propositions — apparently truths — in regard to the distribution of