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(Part Second.)

Post-Pliocene Vertebrates of Indiana.

By E. D. COPE and JACOB L. WORTMAN.

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JOHN COLLETT, State Geologist.

POST-PLIOCENE VERTEBRATES OF INDIANA.

The State Geologist has great pleasure in presenting the following carefully prepared paper on the ancient animals of the State. Each genus and many of the species are introduced by popular descriptions and deductions, followed by scientific explanations so necessary for the expert and the student, thus gathering the whole subject in short, concise information for the special and general reader.

Prof. E. D. Cope, so well known as an indefatigable student, and in the foremost ranks of comparative anatomists, has been assisted by Jac. L. Wortman.

This paper and accompanying figures answer questions which have been asked thousands of times, not only by the boys and girls, but as well by the men and women of the State.

JOHN COLLETT,
State Geologist.

LETTER OF TRANSMITTAL.

To John Collett, State Geologist of Indiana:

SIR—We have the honor to transmit herewith our report upon the collection of vertebrate remains recently placed in our hands by yourself for determination and study. It consists for the most part of remains derived from deposits of Post-Pliocene age in various parts of the State, and includes a number of species which are extinct.

It is highly probable that the present list displays but a small proportion of the species that inhabited the State during the Post-Pliocene or Quaternary period, and it may be expected that the future will reveal many additions to the list. It has been our endeavor to present in the following list a popular account of each species, detailing at the same time, in cases of extinct ones, whatever legitimate inferences can be drawn in regard to their size, probable habits, range and relations to living allies.

Very respectfully,

E. D. COPE,
J. L. WORTMAN.

PHILADELPHIA, May, 1883.

AN ACCOUNT

OF THE

MAMMALIAN FAUNA OF THE POST-PLIOCENE DEPOSITS

IN THE

STATE OF INDIANA.

BY PROFESSOR EDWARD D. COPE AND JACOB L. WORTMAN.

Since the species contained in the following list refer almost exclusively to the Post-Pliocene or Quaternary period it seems proper in this connection, and in keeping with the objects to be attained, to give a brief summary of the chief geological facts that have been ascertained in reference to it; together with a short consideration of the faunal relations it holds to the period immediately preceding it (Pliocene), and the one which succeeds it in time (Recent).

According to geological authority it is characterized as "a period of great and widely extended oscillations of the earth's crust in high latitude regions, attended with great change of climate," and divisible into three epochs as follows: Glacial, Champlain, and Terrace epochs, respectively. During the Glacial epoch the land surface in the northern hemisphere is supposed, for sufficient reasons, to have undergone great elevation; and there appears to be abundant evidence to show that the climate changed from a semi-tropical one, which obtained in the north temperate region during the Pliocene period, to that of the most intensely frigid character in the early Quaternary. This is especially indicated by the marks left by enormous glaciers in the form of drifts, moraines, rock markings, etc., which are found as far south as northern Pennsylvania in the eastern United States. They likewise touched southern Ohio and Indiana,*

* To Ohio river.

and stretched thence westward to the Rocky mountains and the Pacific coast. This period of elevation was followed by one of general depression, in which much of the land surface was covered by great inland fresh water seas. Thus it has been shown that Lake Champlain was connected with the Atlantic ocean by way of the St. Lawrence river; and it seems highly probable that the great lakes of the northern United States were connected with the Gulf of Mexico, submerging the whole Mississippi valley. This epoch constitutes the Champlain. From this submerged condition the land was gradually elevated to its present level, when the continent assumed the physical characters which it now bears. From the time when re-elevation began until the continent was restored to its present level is usually reckoned as the Terrace epoch. From this point geologists begin the Recent period.

Viewed from the standpoint of paleontological evidence the Post-Pliocene period is distinguished, in North America at least, by the presence of a number of animals which do not now exist within its borders, and a large proportion of which are entirely extinct. It is questionable, indeed, whether evidence of this character furnishes any support to the three subdivisions of the geologists already mentioned. Prominent among the distinguishing features of the Post-Pliocene fauna may be mentioned first of the *Carnivora*, or flesh-eating order, the great American lion, *Felis atrox*, described by Dr. Joseph Leidy, from near Natchez, Mississippi. This species, which is known from the lower jaw only, now preserved in the museum of the Academy of Natural Sciences, Philadelphia, was as large as the great cave lion of Europe, *F. spelæa*, and may, according to Dawkins, upon further investigation, prove identical with it. Its size was fully equal to that of the largest existing lion. Besides this one there were two other feline animals of formidable proportions, *Smilodon fatalis*, Leidy, from Texas, and *Smilodon gracilis*, Cope, from the Port Kennedy bone cave, Pennsylvania. They are sabre-toothed tigers, and are characterized by very long and powerful canine teeth. The first of these was equal in size to the Bengal tiger, with canines projecting from the jaw six or seven inches. The second was smaller. There was also a large species of wolf, *Canis indianensis* (?), Leidy, from the banks of the Ohio river, near Evansville, Indiana, as large as the grey wolf. Of the weasel kind there existed a large species, *Putorius macrodon*, described by Cope, from Maryland, about the size of the otter. Of the bear family we have a large extinct species, *Arctotherium simum*, described by Cope, from the bone caves of California, which equaled, if not exceeded, in size the largest grizzly of that region.

Of the even-toed ungulate division (*Artiodactyla*), it is proper to mention a species of extinct buffalo, *Bison latifrons*, Leidy, a gigantic animal at least one-third larger than the largest buffalo of the plains; two extinct species, *Ovibos cavifrons* and *O. bombifrons*, related to the musk-ox of the

north, from the Big Bone Lick, Kentucky, and elsewhere; a species of elk, *Cervicus americanus*, Harlan, from the same locality, as large as the great Irish elk, *Megaceros hibernicus*, Owen; two species, *Platygonus compressus* and *P. vetus*, Leidy, from various localities, related to the peccaries; and an extinct species of peccary, *Dicotyles nasutus*, Leidy, from Indiana.

Of the odd-toed group (*Perissodactyla*), there were two species of tapir, *Tapirus americanus* and *T. haysii*, Leidy, from the Southern and Middle States; at least two species of horse, *Equus fraternus* and *E. major*, Leidy and Dekay, from various parts of the Eastern United States.

The Proboscidian order was represented by the mighty mastodon, of which there appears to be but a single Post-Pliocene species, *Mastodon americanus*, together with one well marked species of elephant, the hairy *Elephas primigenius*, somewhat smaller in size.

The *Rodentia*, or gnawing order, show several striking peculiarties in this period, in *Castoroides ohioensis*, Foster, a gigantic beaver-like animal, as large as the American black bear; and a peculiar extinct form, *Amblyrhiza inundata*, Cope, from the southern States and West Indies, which appears to belong to the porcupine division of the order (*Hystricomorpha*). This peculiar and interesting animal, as has been ascertained by Cope, was as large as a small sized deer. Besides these, there was a species of Capybara, *Hydrochærus æsopi*, Leidy, from the Southern States.

The sloth tribe appears to have been abundantly represented by at least three genera and a number of species. The former are *Mylodon*, *Megatherium* and *Megalonyx*.

The foregoing comparison displays the most salient characteristics of the Post-Pliocene fauna as contrasted with that of the Recent, but it must be remembered that the remains of a large number of existing forms are found associated with the extinct ones, and some even date their existence from the Pliocene period. When we attempt to compare its fauna with that of the Pliocene on the other hand, we are at the very threshold beset with many serious difficulties. From the confused condition and imperfect knowledge we at present possess of the exact limits of the Pliocene in this country, it is difficult, if not impossible, to say whether the older cave deposits, containing so large a percentage of South American Pampean forms, refer to the Pliocene or Post-Pliocene period. It has been urged by Prof. Cope that the so-called Pliocene deposits of Kansas and Nebraska, commonly known as the Loup Fork beds, contain too large a percentage of Miocene types to be referred to the Pliocene period. If this be true, and the Pampean deposits of South America be regarded as Pliocene, there seems to be no other alternative than to regard the older cave deposits in this country, or such deposits characterized by the presence of *Mylodon*, *Megalonyx* and *Megatherium*, as truly Pliocene in age. However this may be, without attempting to solve this mooted

question at present, and for the sake of convenience, we will provisionally regard the former already mentioned as belonging to the Post-Pliocene.

The deposits in which mammalian remains of this period are most frequently found are those of (1) caves; (2) marshes and peat-bogs; (3) drifts; (4) sands and clays of fresh water lakes; (5) beaches and terraces; (6) ice cliffs and frozen soils. We are not informed of the character of the deposits from which the following remains have been obtained, which would be a matter of some interest.

CARNIVORA.

Professor Owen remarks: "As the order *Carnivora* includes the most noxious and dangerous quadrupeds, and those which oppose themselves most to the profitable domestication of the useful herbivorous species, it has suffered the greatest diminution through the hostility of man, wherever arts and civilization, and especially those of agriculture, have made progress." This accounts for the extensive disappearance of the great majority of our existing carnivorous mammals from the regions east of the Mississippi River. In the densely wooded and mountainous districts, however, there still linger a few of the more formidable species, which have become species of the past, as far as the cultivated regions are concerned. The five families of terrestrial *Carnivora*, viz.: *Felidæ*, *Canidæ*, *Mustelidæ*, *Ursidæ* and *Procyonidæ*, now living within the limits of the United States, are at present principally confined to forest regions, which formerly extended over the entire East. Of this order we are at present concerned with but a single family.

CANIDÆ. (Dog Family.)

This group embraces the genera *Canis* and *Vulpes*, including at least seven species now living within the limits of the North American continent. During the Miocene and Pliocene periods we meet with a number of extinct genera to which Prof. Cope refers twenty-five species.* None of these appear to have attained a size greater than that of the grey wolf of our own time, but many present curious modifications, which constitute approaches to other families, much nearer than we now see in living species of this group.

CANIS LATRANS, Say. (Coyote).

The specimens upon which this determination is made, consist of the proximal portions of both humeri, the distal extremity of the left humerus, the shaft of a radius, and the distal portions of a left femur and left tibia.

*"On the extinct Dogs of North America," American Naturalist, March, 1883.

They were found in association with the remains of the mammoth in Boone county, and are contained in the collection submitted to our inspection. These remains may, as far as size or any differential characters they possess are concerned, be referred to a domestic dog (*Canis familaris*) as well as to the above species; there is so little difference between certain breeds of dogs and the coyote that it is often a matter of great difficulty, if not an impossibility, to distingnish between them, even when we are in possession of the entire animal.

Certain it is that the limb bones furnish no distinguishing characters. There is, however, a character which seems to have been overlooked, to be found in the teeth.* If the adult unworn teeth of the two species be carefully compared, it will be seen that the cusps upon the posterior molars of the coyote are sharper and more pronounced than those of the dog; the blades of the sectorial, or flesh teeth, are thinner, more elevated, and the teeth themselves have less transverse extent than the corresponding ones in the dog.

With reference to the distinctness of these species, and their capacity for interbreeding, we can not do better than quote the interesting conclusions reached by Dr. Elliott Coues, published in the American Naturalist, 1873, p. 385, in which he says: "Next we continually find dogs of both sexes on the frontier deserting their haunts at particular (sexual) periods, and if the occurrence of a feral wolf-dog (female coyote and a male dog) has not been recorded, there are numerous cases of the production of the same from male coyotes and female dogs in domestication. I have, finally, information which I consider perfectly satisfactory in still stronger evidence of the readiness with which the two animals interbreed. * * *

"Indians not unfrequently bring it about themselves. On suitable occasions they picket ont their female dogs over night to procure the cross, with constant success.

"These crosses are not known to be otherwise than fertile, and the result is, in every Indian community there are mongrel dogs shading into coyotes in every degree—all having the clear wolf strain, and some being scarcely distinguishable from the prairie wolf."†

If failure to interbreed be any test of specific distinctness, then it would appear that the coyote is but a wild dog at best, and we can readily recognize the fallacy of Dr. J. E. Gray's arrangement in establishing a sepa-

* Cope, Proceedings Academy, Philadelphia. 1873, p. 184.

† During extended travel in western United States my experience has been the same as that recorded by Dr. Coues. It is by no means uncommon to find mongrel dogs among many of the western Indian tribes, notably among Umatillas, Bannocks, Shoshones, Arrapahoes, Crows and Sioux, which, to one familiar with the color, physiognomy and habits of the coyote, have every appearance of blood relationship, if not, in many cases, this animal itself in a state of semi-domestication. The free interbreeding of these animals, with a perfectly fertile product, has been so often repeated to me by thoroughly reliable authorities, and whose opportunities for observation were ample, that I feel perfectly willing to accept Dr. Coues' statement. J. L. W.

rate genus (*Chrysocyon*) for its reception. It would not prove a matter of surprise if future writers on the subject would discard the species altogether, and reduce it to the rank of a variety, where it seems to belong. What is here said of the interbreeding qualities of the prairie wolf with the domestic dog is probably also true of the gray wolf, but the evidence is not so conclusive. If the remains in question refer to the coyote, it would indicate a more extensive range formerly than the one it now occupies.

CANIS LUPUS, Linn. (Grey Wolf.)

Although not indicated in the collection, yet there is now preserved in the museum of the Academy of Natural Sciences, Philadelphia, an almost complete maxillary bone of the left side of the upper jaw of a large wolf, containing all the molar and premolar teeth, except one. This specimen, together with the remains of *Megalonyx*, *Bison*, horse, tapir, and deer, were obtained by Mr. Francis A. Lester, from the banks of the Ohio river, near the mouth of Pigeon creek, a short distance below Evansville, Ind., and were described by Dr. Leidy, in Proceedings Academy Natural Sciences, Philadelphia, for 1854, under the name of *Canis primævus*. This name being pre-occupied, it was afterwards called *Canis dirus* by the same author, who finally in Journal Academy, Philadelphia, 1867, settled upon the name *Canis indianensis* to designate the remains.

This species was proposed upon size alone, and Dr. Leidy remarks: "Certain naturalists may regard the fossil as an indication of a variety only of *Canis lupus*, and of the correctness of this view I will not attempt to decide." Since the Doctor seems to have been somewhat in doubt as regards the distinctness of the fossil from the ordinary grey wolf, it is proper, with the increased facilities we now have for extensive comparisons, that we attempt to demonstrate the true position and rank of the fossil in question. For this purpose we have selected a series of five crania of American grey wolves from the museum of the Academy of Sciences, Philadelphia, representing the extremes of modification, and noted carefully the differences, or the amount of individual variation, which we are compelled to admit within the limits of the species. In the following table, No. 1 is a cranium from New Mexico; No. 2, from Ohio; No. 3, from Missouri; No. 4, from Kansas; and No. 5, is the so-called *Canis gigas* of Townsend, from Oregon, which has never been admitted by authors to be more than a variety of *Canis lupus*. The following are the more important measurements, as compared with the fossil jaw:

FOSSIL MEASUREMENTS.

Measurements in Twentieths of an Inch.	No. 1, from New Mexico.	No. 2, from Ohio.	No. 3, from Missouri.	No. 4, from Kansas.	No. 5, from Oregon.	Fossil.
Greatest length of cranium . . .	175	180	190	208	219	. . . . .
Width between zygomata	93	91	107	106	120	. . . . .
From back of last molar to base of canine	63	70	66	72	79	92
From back of last molar to front of sectorial	34	40	35	36	39	44
From back of third premolar to base of canine	30	32	29	36	39	46
Dimensions of last molar tooth (breadth x length)	10 x 7½	13 x 8½	10 x 6	9½ x 7	11 x 8½	12 x 8
Dimensions of penultimate molar	15 x 12	20 x 15	17 x 13	17 x 13	18 x 13	19 x 15
Length of sectorial	16	21	19	20	22	26?

It will be seen by reference to the above figures, that the entire length of the cranium varies from 175 to 219, a difference of 44, while the width between the zygomata ranges from 91, in No. 2, to 120, in No. 5, a difference of 29-twentieths inches. The greatest difference in the total length of the molar and premolar teeth of the recent specimens is 16, while the difference between the corresponding parts of the largest of the recent crania, and the fossil is only 13. The greatest difference observable from the back of the last molar to the front of the sectorial among the recent specimens is 6, while the difference between the largest of the recent in this measurement (No. 2) and the fossil, is but 4. From the back of the third premolar to base of the canine tooth, it will be seen varies 9, among the recent crania, while between the greatest length of the recent and that of the fossil is only 7. In the dimensions of the last two molars, the specimens from Ohio (No. 2) exceeds those of the fossil in size, although much smaller in every other measurement. The length of the sectorial was impossible to obtain, owing to its damaged condition, but judging from the roots, it could not have been over 26, which would fail to show a greater difference than obtains between Nos. 1 and 5.

From a careful consideration of these facts it is evident that the fossil does not display a *single instance* in which it presents greater differences from the larger specimens of *Canis lupus* than do these from the smaller ones, which are admitted upon every hand to belong to the same species. For these reasons it seems to us that it is impossible to admit this fosssil to the rank of a distinct and well defined species, but it appears, in our judgment, to be but a variety which has a living representative in the mountains of Oregon, to-day. When we take into consideration the extreme variability of our American wolves, as regards size, slight peculiarities of dentition, color, etc., we gain some useful hints with reference to other specific names that have been proposed, and are taught to regard

with much circumspection and doubt, species that rest upon such characters. In this category we would place J. A. Allen's *Canis mississippiensis* from Illinois which has been proposed* upon a few limb bones, and whose only peculiarity consists in their slightly exaggerated size. As far as we are able to judge, they refer to the large variety of *Canis lupus* already considered.

UNGULATA.

The large assemblage of placental *Mammalia* included under this term may be conveniently defined as those in which the terminal phalanges are depressed in form, constituting bases of support, and not prehensile or digging organs. They are generally enclosed in a corneous epidermic covering, either partial or entire, denominated "hoofs," in contradistinction to the curved and compressed forms (claws). In the earliest Eocene period, however, according to the researches of Prof. Cope, the clawed and hoofed mammals approached one another to such a remarkable extent that with no other evidence than the ungual phalanges to depend upon, it would, in a few instances, be a difficult question to decide whether the animal was really "clawed" or "hoofed." Accepting a common origin for the two divisions, which the rapidly accumulating evidence of paleontology necessarily compels us to do, we can then understand how they have gradually diverged from the ancestral stem, and it is when the later expressions or results of this divergence are considered, our definition is most strikingly applicable.

In the history of the *Mammalia*, as evolution has proceeded, different groups have been specialized in different directions, while some retain the primitive characters of their ancestors, having undergone little or no modification. The *Primates*, beginning in the lemurs, and terminating in man, have become by far the most highly specialized in brain structure, but are primitive in other respects; the *Carnivora* have surpassed all in the development of organs specially adapted for seizing, lacerating and destroying their prey; the *Cheiroptera*, or bats, have developed members for flight; the *Rodentia* exhibit a peculiar character of the jaw articulation, together with incisor teeth specially fitted for gnawing habits; while the *Ungulata* have attained the most perfect foot structures and the greatest complexity of teeth, which naturally adapts them to modes of life and diet in which they have no competitors. It is in accordance with these various modifications that the definitions of the major groups designated "orders" are constructed.

If we had but the existing forms to consider, classification would be easy enough, but since the process of evolution has been a gradual one, each acquisition to our knowledge of the extinct fauna of the earth, sup-

* Amer. Journal Science 1876, p. 49.

plies us with forms which point towards the obliteration of established definitions, and bridge over chasms, separated in living animals by wide intervals. For this reason any system of arrangement must be looked upon as expressing the present state of our knowledge of the evolutionary processes.

In the *Ungulata* some have retained primitive characters; hence it is clear that any well directed effort looking to the internal arrangement of this group must take into consideration the structure of either the feet or teeth, or both, to sufficiently express the ordinal characters. In this respect, the teeth are of little service, since their specialization was a later production, and in all probability largely dependent upon success in the specialization of the feet. Fully impressed with the importance to be attached to the modification of the limbs, Prof. Cope has proposed to divide them into four orders,* as follows:

ORDER I. Scaphoides supported by trapezoides, and not by magnum, which supports luuar. Cuboid articulating proximally with calcaneum only. *Taxeopoda.*

ORDER II. Scaphoides supported by trapezoides, and not by magnum, which supports lunar. Cuboid extended inwards and articulating with distal face of navicular. *Proboscidea.*

ORDER III. Scaphoides supported by trapezoides, and not by magnum, which with unciform, supports lunar. Cuboid extended inwards, and articulating with astragalus. *Amblypoda.*

ORDER IV. Scaphoides supported by magnum, which, with the unciform, supports the lunar. Cuboid extended inwards so as to articulate with the astragalus. *Diplarthra.*

The first of these orders, *Taxeopoda* has but a single living representative, the African genus *Hyrax*, or as it is more familiarly known, the "cony." By far the greater proportion of the order is extinct, and belongs, so far as our present knowledge extends, to the Eocene period. The second order, *Proboscidea*, is represented by but two living genera, *Elephas* and *Loxodon*, or the Indian and African elephants respectively. The third, *Amblypoda*, is entirely extinct, and pertains to the early Eocene; while the fourth order, *Diplarthra*—corresponding to the order *Ungulata* of some authors,—is the most abundantly represented among living ungulates. It includes two distinct sub-orders, *Perissodactyla* (odd-toed), of which the horse, tapir and rhinoceros are the only living examples, and *Artiodactyla* (even-toed), of which the sheep, deer, goat, ox, camel, etc., are familiar types. Beginning in reverse order we will take up for consideration first the

*Proceedings American Philos. Society, Philadelphia, 1882, p. 444.

DIPLARTHRA.

This order includes animals ranging in size from the small chevrotains of Africa and India, but little larger than a prairie hare, to the hippopotamus and rhinoceros. The higher forms of this group represent the extreme points of departure, reached by any of the hoof-bearing series. They show the most highly specialized or perfected organization (1) in the structure of the limbs, (2) in complexity of the alimentary system, and (3) in the specialization of the molar teeth. As in almost every other group of animals, primitive types are still in existence; but these usually have a limited distribution, and are found in regions which, for sufficient reasons, it is conceivable present conditions most nearly like those of the geological age in which they reached their greatest development, and may be said properly to belong. Reasoning from analogy, however, the principal causes which appear to have been most potent in the extinction of the majority of the earlier types of this order, may be set down as (1) climatic vicissitudes with their dependent causes, and (2) incursions from carnivorous enemies. Human agencies have likewise contributed largely to the disappearance of many ungulate species from certain regions, especially in later times.

If now we reflect upon the probable causes that have led to the modification of the organs in which they show the greatest perfection of structure, it is not improbable that we may be able to discover some relation between the causes which have been influential in the extinction of the inferior types, and those sufficient to produce the modification in question. In the first place, it may be stated as a rule of pretty general application that the existing representatives of early forms of this order, viz.: *Tapirus*, *Rhinoceros*, *Suidæ* (including the pigs and peccaries) and *Hippopotamus*, are (1) polydactyle (many-toed); (2) they are lovers of swamps, marshes, or dense forests; (3) they have a comparatively simple alimentary system; and (4) their teeth present little or no modification of the simple four-lobed pattern which is the prevailing type of the middle and upper Eocene period.* Although there is no positive evidence of the fact, yet there is every reason to believe, and we are at liberty to conclude from an analogical stand-point, that these animals, during the Eocene and Miocene periods, had habits very similar, if not identical, with their near relatives of the present epoch, and were also swamp-lovers, etc. Any widespread physiographical changes destroying the conditions under which they had been reared, would necessarily entail one of three alternatives, viz.: migration, modification, or extinction. That extensive changes did

*The type of dentition of the rhinoceros presents a considerable advance over the others, and is more indicative of Miocene time.

take place during the Eocene and Miocene periods, causing a general drying up and disappearance of the marshes and swamps in certain regions, is now well known to geologists.

Migration was one of the alternatives of which certain species availed themselves, and finding conditions adapted to their organization, have persisted to the present day. In attempting to modify themselves to meet the requirements of the new conditions, many of those that remained perished, and their fossil remains are the only souvenirs left to attest to their former existence. Of those that have succeeded, we are not at a loss to understand more intimately the probable causes of modification. Life upon the open plain would render them more conspicuous objects, and hence, subject them more to the attacks of their carnivorous enemies. Deprived of their former means of escape, necessity compelled them to develop some defense against the ever threatening cause of their extermination. Timidity and natural instincts to escape by running, resulted in the selection and cultivation of this means. The doctrine of Cope in this matter has been thus stated by Wortman, "that in plantigrade animals (those that walk on the soles of their feet), the ends of the digits or toes describe a semi-circle, and that in the act of running the heel and wrist are raised from the ground, leaving the middle digits to sustain the weight of the body." "An infinite repetition of this posture in animals incapable of withstanding the attacks of their fierce carnivorous cotemporaries, and whose only escape was in flight, has resulted in the selection of either one or two of the middle digits, while the outer ones have either fallen into a rudimentary condition or entirely disappeared."* This has most probably taken place in accordance with the law of "use and effort," by which the organ sustaining that certain amount of pressure, strain, etc., in which the physiological waste does not exceed the amount of nutrition, grows in size and in the direction indicated by the force in question. While we do not see in any living representative of this order a plantigrade animal, yet paleontological evidence is very conclusive that their ancestors were both pentadactyle (five toed) and plantigrade, and that specialization of the limbs has consisted of the gradual reduction in the number of digits and the interlocking of the carpal and tarsal bones.

With reference to the specialization of the teeth and digestive system Wortman has likewise suggested,† "that among existing animals in which the teeth possess short crowns, with low blunt tubercles on their triturating face (the bunodont type of dentition), we observe comparatively simple digestive organs. In others, the higher ungulates, where the crowns of the teeth are greatly lengthened in a vertical direction, uniformly broadened, and the face presents a complex folding of the enamel plates (the

*Kansas City Review, 1882. Cope on the Effect of Impacts and Strains on the Feet of Mammalia, American Naturalist, 1881, p. 542.

† Kansas City Review of Science and Industry, 1882.

selenodont type), we notice more complicated digestive organs. The relations of these conditions to the character of the food upon which the respective types subsist is obvious. The bunodonts require condensed and nutritious diet for their support and are omnivorous, while the selenodonts are fitted to subsist upon food containing a smaller proportion of the nutritive elements, and of which greater quantity is required. The food of the former usually consists of nuts, berries, roots, etc., while the latter feed upon grasses and branches of trees." When forced into the open field it is evident that food of the former kind only was afforded, whence the environments of the animal immediately demanded modifications suitable to the new conditions. By the laws of use and effort, and the influence of ordinary mechanical forces, all the striking peculiarities of these animals may be accounted for.

It has been proposed by Owen to divide the order into two very natural subdivisions or sub-orders which have been defined as follows:

Astragalus truncate distally; number of toes on the hind feet odd; the median one the largest on both anterior and posterior feet; a third trochanter on femur. *Perissodactyla.*

Astragalus with distal ginglymus; number of toes even in both feet; the two median ones the largest; no third trochanter on femur. *Artiodactyla.*

Of these two groups the *Artiodactyla* is, in the present epoch, by far the more important, both in the number of species and diversity of structure. The *Perissodactyla* are now represented by but three living genera, *Equus*, *Tapirus* and *Rhinoceros*, while in the *Artiodactyla* the genera are much more numerous. In the Eocene period, however, the *Perissodactyla* exceeded them in every respect.

ARTIODACTYLA.

The early history of this group is so little known that it is impossible at present to say anything of its primitive origin. It has been traced to a very limited representation far back in the middle Eocene, but even in this early time the form of the astragalus, one of the most characteristic features in the osteology of the group, is still markedly artiodactyle. It is highly probable that they came off early from the *Taxeopoda*, but the evidence necessary to demonstrate such a supposition is as yet entirely wanting. The classification recently adopted by Prof. Flower in his article "Mammalia," in the Encyclopedia Brittanica, represents very well the state of our information on this subject. It is as follows:

Section A, Bunodonta.

Molars brachyodont (short crowned) and tuberculous; palatine bones articulated with terminal portion of maxillaries; never less than four complete toes;* no horn-cores developed on frontals; stomach imperfectly divided.

Section B, Selenodonta.

Molars hypsodont (long crowned) or brachyodont, with four crescentiform folds, whose convex surface is internal above and external below; palatines separated by a wide sinus from terminal portion of maxillaries; toes often reduced to two; with or without horn-cores; stomach divided.

These definitions, somewhat modified from those usually given, express the more striking characters observable in the *Artiodactyla* from the lowest to the highest types. Specialization or perfection of structure has taken place (1) in the development of long crowned crescented molars; (2) in the separation of the terminal portion of the maxillary bones from the palatines; (3) in the loss of incisor teeth from the premaxillary bones; (4) development of horns; (5) in the loss of the outer digits and union of the third and second metapodials into a "cannon" bone; (6) change of the odontoid process of the axis into a hollow half-cylinder; (7) co-ossification of ulna and radius with great diminution in size of the distal extremity of the former; (8) disappearance of the middle portion of the fibula, and (9) complete division of the stomach into four compartments.

Since the different steps through which these perfections have been accomplished were gradual ones, it is more than probable that, with increase of knowledge of the fossil forms, this classification will break down completely. The group *Bunodonta* includes, among living animals, the peccaries, hogs and hipopotamus, together with numerous extinct genera. Many of these latter, however, are so imperfectly known that it is impossible at this moment to indicate their exact position in the system. A classification of the living *Suidæ*, including the extinct American peccaries, appears to be most naturally accomplished as follows:

Superior canines directed downward. Terminal portion of superior maxillaries separated by a slight sinus from palatines. Glenoid cavity strongly concave from before backward, and with a well defined preglenoid crest. *Dicotylinæ* (Peccaries).

Superior canines directed upward. Terminal portion of maxillaries united with palatines. Teeth without cement. Angular process of mandible slightly or not at all deflected. Glenoid cavity slightly convex from before backward, and without preglenoid crest. *Suinae* (True swine.)

Dentition extremely aberrant. Incisors in young individuals two above

*Entelodon, a Miocene genus, according to Kowalevfsky, had only two toes.

on each side and three below. Molars reduced in old individuals to last true molar, which is greatly elongated and composed of three longitudinal rows of columnar tubercles, having the valleys occupied with a thick deposit of cementum. Superior canines directed upward. Distal portion of maxillaries articulating with palatines. Angular process of mandible not deflected. Glenoid cavity convex from before backward, and without preglenoid crest. *Phacochœrinæ* (Wart hogs.)

This last group includes as yet but a single genus, *Phacochœrus*, with two species confined to the tropical regions of Africa. They present a peculiar modification of the teeth analogous to that of the elephants. The second sub-family, *Suinæ*, is represented in the present epoch by three living genera *Sus*, *Potamochœrus* and *Babirussa* containing eight species which range over Europe, Asia, Northeast Africa and the East India Islands. The *Dicotylinæ*, on the other hand, are confined exclusively to North and South America.* The sub-family includes two living and at least twelve extinct species, grouped into five genera.

DICOTYLINÆ.

Synopsis of genera.

Three premolars in the upper jaw, with single external and internal lobes. A wide diastema between the anterior one and its successor. With one species from Miocene of Oregon. *Chœnohyus*, Cope.

Upper premolars four, with single external and internal lobes. Lower premolars four. A diastema before and behind the first. With three species Miocene of Oregon. *Thinohyus*, Marsh.

Premolars four above and below without diastemata. Last (4th) upper premolar with two external and one internal tubercle. Miocene of Europe and America. *Hyotherium*, Meyer.

Premolars three above and three below, with single external and internal lobes. Wide diastemata between premolars and canines. With two species Post-Pliocene of America. *Platygonus*, Le Conte.

Premolars three above and three below. Fourth upper and third and fourth lower premolars like first true molar, with four lobes. Wide diastemata between canines and premolars. *Dicotyles*, Cuvier.

**Hyotherium*, which is arranged here, is also found fossil in Europe.

DICOTYLES, Cuvier.

The species of this genus, so far as known, are susceptible of definition in the following manner:

Upper incisors cutting, with posterior cingula on crowns; the median pair the larger. A slight depression in front of and beneath the orbit. No maxillary ledge above first and second premolars.

Dicotyles torquatus, Collared Peccary (living.)

Incisors cutting and without posterior cingula; median pair the larger. No preorbital depression. Infraorbital foramen situated above first upper true molar. A strong maxillary ledge above first and second premolars. Canines more robust. Species larger. Length of diastema above equal to length of superior premolars.

Dicotyles labiatus, White-lipped Peccary (living.)

Upper incisors and diastemata unknown. Superior molars and premolars curved outwardly, and not straight, as in the other species. About one-half the bulk of *Dicotyles torquatus*.

Dicotyles hesperius, Marsh (extinct.)

Upper incisors and diastemata unknown. Equaling in size *Dicotyles labiatus*. Enamel of the crowns of the molars without wrinkles and minor tubercles as in the living species. *Dicotyles pristinus*, Leidy, (extinct.)

Upper incisors sub-equal and conic. Length of the diastema of the upper jaw greatly exceeding that of premolars. Second superior premolars without anterior or posterior cingula. No maxillary ledge. Species slightly larger than the last. *Dicotyles nasutus*, Leidy (extinct).

Upper incisors, unknown. Lower incisors, three. Diastema in lower jaw, equaling in length the lower premolar and first true molar combined. Last upper molar, one-third longer than penultimate one. Enamel without wrinkles and devoid of external and internal cingula. First, inferior premolar, with rudimental anterior cingulum. Size, about one-fourth larger than *D. labiatus*. Canines relatively small.

Dicotyles condoni, Marsh (extinct).

Of the species above enumerated and defined, two are living and the rest are extinct. The first, *Dicotyles torquatus* or the "collared peccary," is commonly known as the "wild hog" in southwestern United States, and ranges from southern Arkansas to Paraguay in South America. The animal is as large as a small-sized hog, which it otherwise resembles very much in external appearance. The "white lipped peccary" is somewhat larger, and is confined to the dense forests of South America.

The third species, *hesperius*, was described by Prof. Marsh, in American

Journal of Science and Arts for July, 1871, from specimens submitted to his examination by Prof. Thomas Condon, of the University of Oregon, found by him in the Loup Fork bed of the John Day Valley, Oregon.

The fourth species, *D. pristinus*, was described by Dr. Leidy, from a few teeth found in the Loup Fork beds of Oregon, in the same locality as the last. For a knowledge of this species we are likewise indebted to Prof. Condon, its discoverer. Upon the acquisition of more perfect material this species may yet prove identical with either *D. labiatus* or *D. nasutus*. The characters upon which the species was proposed do not appear to be very striking, and may pertain to individual variation only.

The fifth species, *D. nasutus*, is likewise extinct. It was first described by Dr. Leidy in the Proceedings of the Academy, Philadelphia for 1868, p. 230, from material placed in his hands by the late Dr. David Dale Owen, a gentlemen whose name will long be remembered in connection with geologic science, for his scholarly attainments and his energy in bringing to light many rare and interesting specimens of fossil remains. "The specimen consists of the fore-part of the upper jaw, containing on one side the canine and anterior two premolar teeth. It also retains the socket of the other canine and those of the incisors, one of which is likewise preserved." It was obtained at a depth of between thirty and forty feet in digging a well in Gibson county, Indiana, and is figured by Dr. Leidy in his "Extinct Mammalian Fauna of Dakota and Nebraska." The principal characters, as far as we are able to learn from the fragmentary specimens, have already been given.

The last species is *Dicotyles condoni*. This species was originally described by Prof. Marsh in American Journal Science for 1871, under the name *Platygonus condoni*, with a question. A number of teeth from the same locality which agree with Prof. Marsh's description have lately come under our inspection. The premolars display the characters of the genus *Dicotyles* instead of those of *Platygonus*. The species which was described by Prof. Cope, from the Loup Fork beds of Nebraska, under the name *Dicotyles serus*, probably pertains to this species. This determination was based upon the lower jaw alone, while the original *D. condoni* was described from the upper molars. Among the specimens of this latter species from Oregon, which are now preserved in Prof. Cope's collection of vertebrate remains, there is a last lower molar associated with the molar teeth of the upper jaw. The size and details o structure of this last inferior tooth agrees perfectly with the corresponding tooth of the type of *D. serus*. For this reason and until we know the upper teeth of *D. serus*, it is proper to regard them as identical.

Another species has been described by Dr. Leidy, under the name *Dicotyles lenis*, from a few isolated teeth found in the Southern States. After having inspected carefully the type specimens upon which this species was proposed, and taking into consideration the amount of individual

variability seen in the dentition and osteology of the species, which it is said to most resemble, *Dicotyles torquatus*, we must conclude that it is too imperfectly known to rank as a species. The characters upon which the species rests obtain equally well as individual variations of the collared peccary, *D. torquatus*. The next genus is

Platygonus, Le Conte.

Two species are certainly known.

Last upper molar with cingula continuous, or nearly so, around the base of the crown. Inner cingula of upper molars strong and well defined. *Platygonus compressus.*

Last upper molar without internal or posterior cingula. Inner cingula of upper true molars rudimentary or wanting. Species almost one-third larger than first. *Platygonus vetus.*

Platygonus compressus, Le Conte.

Plate 1.

This animal is indicated in the Indiana collection by the anterior or symphysial portion of the mandible, with a considerable part of the left ramus attached, supporting all the premolar and molar teeth, except the last. According to the label which it bears, it was derived from Laketon, Wabash county, Indiana. Numerous remains of the same species occur in the vicinity of Galena, Ill., from which place Dr. Le Conte obtained the specimens upon which the original description of the genus and species was founded. Dr. Leidy has recently exhibited before the Philadelphia Academy two almost complete skeletons of the same species obtained in the State of New York. A beautiful and complete skull, deposited by the American Philosophical Society, is now preserved in the museum of the Academy of Philadelphia. It was found in a cave in the State of Kentucky as early as 1805, but was not known to represent a distinct genus until some years later, when brought to the notice of Dr. Leidy. The remains above enumerated, together with numerous fragments of teeth and bones of various parts of the skeleton, preserved in different collections, constitute the material that has so far been recovered, and upon which our knowledge of this extinct quadruped depends.

In size they indicate an animal as large as a common sized hog, but of more slender proportions. The animal was probably a fair runner, and had habits similar to the living peccaries, if analogy furnishes us any basis for judgment. Its range must have been from the Canada border on the north to the Gulf of Mexico south, and in all probability extended from the Missouri river on the west to the Atlantic. *Platygonus vetus* was much larger, but is known from a few fragments only that were obtained in a bone cave in Pennsylvania. Two other species have been described

by Prof. Marsh in Amer. Journal Science for 1871. The first of these, *Platygonus ziegleri* was obtained from the Bridger Eocene of Wyoming. It is much more probable that the few teeth which Prof. Marsh has referred to this genus pertains to some other. If, indeed, they do pertain to the genus *Platygonus*, they indicate a most remarkable history for it. We choose to regard the evidence as too imperfect for such a determination. The other species, *P. striatus*, described at the same time, was established upon a few teeth from the Loup Fork of Nebraska. The characters upon which this species was proposed, are of the most trifling and variable kind, and are otherwise too fragmentary to be entitled to recognition.

Having concluded a mention of the species included in the *Bunodonta*, we come next to a consideration of the higher group, or selenodont division of the sub-order. Until more is known of the structure of the Miocene representatives of this division it is difficult, if not impossible, to express in a system of classification their exact relations. For this reason we will not attempt at present to indicate their arrangement. However there appear to be two branches, if not three or four, that have been sufficiently differentiated from the primitive stock to rank as primary divisions of the *Selenodonta*.

The first of these is the *Ruminantia*, including such animals as the ox, sheep, goat, deer, giraffe, etc., which are distinguished by the coossification of the third and fourth metapodials into a "cannon bone," usually by the presence of horn-cores on the frontals, by being entirely digitigrade and finally by the complete loss of the incisors from the premaxillary bones.

The second *Tylopoda*, including the camels and llamas, are devoid of horns; they have the arches perforated by the vertebral canal in the cervical vertebræ instead of the transverse processes as in the *Ruminantia*. They walk upon the plantar and palmar surfaces of the phalanges; and finally they have at least one incisor upon each side in the premaxillaries.

The relations of the chevrotain group to the extinct *Anoplotheriidæ* of Europe and the *Oreodontidæ* of America have been decided in favor of the latter, from which they possibly descended, but it is probable that two more primary subdivisions will be recognized. However this may be, we are at present concerned with the first division only.

RUMINANTIA.

Prof. Flower remarks: "The *Pecora*, or true Ruminants, form at the present time an extremely homogeneous group, one of the best defined and most closely united of all the *Mammalia*. But, though the original or common type has never been departed from in essentials, variation has been very active among them within certain limits, and the great difficulty which all zoologists have felt in subdividing them into natural minor groups arises from the fact that the changes in different organs

(feet, skull, frontal appendages, teeth, cutaneous glands, etc.) have proceeded with such apparent irregularity and absence of correlation that the different modifications of these parts are most variously combined in different members of the group. It appears, however, extremely probable that they soon branched into two main types, represented in the present day by the *Cervidæ* and the *Bovidæ*—otherwise, the antlered and the horned ruminants. Intermediate smaller branches produced the existing musk-deer, giraffe, etc."

In the antlered division, the horns consist of outgrowths of osseous material from the frontal bones of the skull, covered in the growing state by a highly vascular and sensitive integument, which, upon completion of the antler, dies and peels off. After a time absorption occurs, when the horns are shed, to be renewed by the same process.

In the giraffe, the horns are united to the skull over the coronal suture, or junction of the frontal with the parietal bones, as epiphyses, and are permanently covered with a hairy integument. The horn-cores are finally anchylosed with the cranial bones, and are never shed.

In the group with true horns, the bony cores are outgrowths from the frontal bones with which they are always firmly united, and are covered by an integument modified into a dense corneous sheath. Their classification with appropriate definitions would, therefore, be indicated as follows:

Frontal appendages when present in the form of antlers. Molars brachyodont, with little cement. Two orifices usually to lachrymal duct. Lachrymal bone not articulating with nasal. An anteorbital pit and vacuity. (Flower.) *Cervidæ*, (Deer.)

Frontal appendages consisting of a pair of short, erect bony processes ossified from distinct centres, and afterward united to frontals by anchylosis. Horns covered with hairy integument. Molars brachyodont, and without cement. *Camelopardalidæ*, (Giraffe.)

Frontal appendages when present in the form of permanent horns. Molars hypsodont. Usually one orifice to lachrymal. Lachrymal bone articulating with nasal. No vacuity or anteorbital pit. Molars with cementum. *Bovidæ*, (Sheep, Ox, Goat, Antelope, etc.)

Of the first family, *Cervidæ*, there is represented in the collection a species which was described by Prof. Cope, in Bulletin U. S. Geol. Surv. Territories, Vol. IV, 1878, under the name

CARIACUS DOLICHOPSIS, Cope.

Plate 2.

The following description was given: "John Collett, of the Geological Survey of Indiana, discovered in a late lacustrine deposit in Harrison county, Indiana, a number of Post-Pliocene fossils. One of these

is the ulno-radius, etc., of a *Bos*, and the other is the left mandibular ramus of a deer, probably of the genus *Cariacus*. The jaw differs in its proportions from those of *C. virginianus* (the common Virginia deer), *C. macrotis* (the "mule deer" of the Rocky Mountains), and *C. columbianus* (the "black-tailed" deer of the Cascade Mountains), with a considerable number of which I have compared it. It belonged to an animal of the average size of *C. virginianus*, but differs in having the diastema an inch or so longer, while the tooth line is shorter. Placing the first molars in line, the last molar of the fossil form attains only the penultimate column of that of the *C. virginianus;* in some cases just a little further. On the other haud, the angle of the mandible extends beyond that of *C. virginianus*, and the slope of the anterior base of the coronoid process is more gradual. At the same time this portion is less oblique in a transverse direction, owing to the prominence of the external face of the ramus. The ramus differs also in the great prominence and anterior position of the posterior edge of the masseteric fossa, which leaves behind it a wide oblique face, little developed in the existing species."

Additional observations and comparisons serve to confirm the validity of the species above described. The jaw differs widely from that of the Reindeer (*Rangifer tarandus*), in the shorter length of the dental series, and especially in the larger size and greater width of the true molars. The diastema is shorter than in the Reindeer. It differs most remarkably from all other species with which we have been able to compare it, in the character of the angle of the mandible. Beside the peculiar space behind the edge of the masseteric fossa already mentioned, the angle is considerably thickened and beveled from without inward. The posterior border of the ascending ramus, instead of descending with a gentle curve outward to its junction with the angle, as in all the species above mentioned, descends almost perpendicularly to meet the angular process, with which it forms a distinct ledge.

MEASUREMENTS.

	M.
Horizontal length of ramus from alveolar border	0.250
Length to first molar	0.100
Length of symphysis	0.047
Length of dental series	0.085
Length of premolars	0.034
Length of base of ascending ramus	0.058
Elevation of condyle	0.075
Length of base of coronoid process	0.021
Width of coronoid	0.021
Width of last molar	0.011
Length of last molar	0.021

Length of third premolar	0.011
Depth of ramus just behind symphysis	0.016
Depth of ramus at first molar	0.026
Depth of ramus at last molar	0.028

The collection likewise contains the greater portion of the right superior maxillary bone of a cervine animal bearing all the teeth with the exception of the last molar. It is highly probable that it pertains to the same species, but of this we can not be certain. The teeth resemble very closely those of the Virginia deer (*C. Virginianus*), and agree perfectly in size with an average size individual of this species.

The third family, *Bovidæ*, is represented by the distal part of an humerus only, which is referable to the living species of American bison (*Bison americanus*). It is, however, more than probable that the musk ox, *Ovibos*, of which two extinct species are known, *O. cavifrons* and *O. bombifrons*, inhabited the State during this period. Their remains are not uncommon in the drifts, peat-bogs, etc., in the States of the great interior basin. They ranged as far south as Arkansas, and probably to the Gulf.

Still another species of this family gives to the fauna an unfamiliar aspect, the largest and most powerful artiodactyle known to occur within the borders of Indiana. Its remains have also been obtained in the adjoining States, Ohio and Kentucky.* This is the *Bison latifrons* of Leidy. The species is known from a tolerably perfect skull from Texas preserved in the British Museum, as well as various crania and fragmentary remains of jaws, teeth, limb-bones, vertebræ, etc., most of which are contained in the collection of the Academy of Natural Science, Philadelphia. The chief peculiarities of the animal are its large size and immense expanse of horns. It was as large at least as the Indian buffalo (*Bubalus arni*) or arnee, which attains a size one-third greater than our American bison. The position of its horns, however, indicate its affinity and reference to the genus *Bison*.† The horn-cores measure twenty-one inches in circumference at the base, and the horns were upwards of four feet in length in the largest individuals. The horns differ from those of the arnee in being circular, instead of triangular in section, as in that animal. The length of horn attained by the arnee, however, is stated to be, in some instances, as much as six feet for each horn. From this species we pass to the second suborder of the *Diplarthra*.

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* Remains of *B. latifrons* are found in Vanderburg county. COLLETT.

† It is proper to observe in this connection that *Bison* differs from *Bos* in having the horn-cores placed somewhat in advance of the occipital crest.

PERISSODACTYLA.

As has already been mentioned, this group has in the present epoch but a limited representation, and is confined to three families, with few genera and few species. Two of these families, the *Rhinocerontidæ* and the *Tapiridæ*, are remnants of groups that attained their greatest development, both as regards numbers and diversity of structure, far back in the shadowy past. By inhabiting confined areas and favored localities, which present conditions most adapted to the state of development of their various organs, they have in a measure been granted immunity from an excessive severity of the struggle for existence, and although inferior, continue to represent their primeval brethren. It is thus from the evidence which paleontology furnishes that the philosophic and systematic naturalist is able to place within easy grasp of the understanding the systematic position, both in time and rank, of many living creatures that have been stumbling blocks to a less comprehensive knowledge of the many extinct groups of organized beings. But a single family of this sub-order, the *Equidæ*, or horses, really pertains, by virtue of their superior organization, to the present epoch, and the history of the various steps by which they have accomplished this degree of perfection is intensely interesting, and will be discussed further on. The group which first claims our attention is the

TAPIRIDÆ.

The earliest known appearance of this family is in the beginning of the Miocene period. Many Tapiroid animals, however, are found in strata of Eocene age, from which it is highly probable that the true tapirs were derived. The living species are grouped into two genera *Tapirus* and *Elasmognathus*. Besides these there have been two fossil genera described, one of which is clearly referable to this family. The one about which doubt exists is *Tapirulus* of Gervais, established upon a few molar teeth from beds of Oligocene (Lowest Miocene) age. The genus established by Prof. Marsh* under the name *Tapiravus* is only known from his description, which is characteristically brief. Leaving out the questionable genus *Tapirulus*, the remaining ones will be defined as follows:

Third and fourth upper premolar, only like first true molar.
Desmatotherium.

First upper premolar only different from first true molar; no heel on last inferior molar; nasal septum cartilaginous. *Tapirus.*

Teeth as in *Tapirus*; nasal septum osseous. *Elasmognathus.*

* American Journal of Science and Arts, Vol. xiv., 1877, p. 252.

TAPIRUS, Cuvier.

The living species of this genus are limited, with one exception, to the western hemisphere. The Malayan tapir, *T. malayanus*, forms this exception. It inhabits Farther India and the East India Islands. There are at least two well-marked species found in South America, together with two others from the Panama Isthmus, removed by Gill into a distinct genus, *Elasmognathus*, which he has created for their reception. The most common of the American species is the *T. terrestris*, or *americanus*, as it is often called, which is widely distributed in South America, east of the Andes mountains. A second species, *T. villosus*, is found high up on the mountain slopes of British Columbia and Ecuador. It is commonly known as the hairy tapir and is distinguished from *T. terrestris* by being covered by a heavier coat of hair, and other peculiarities.

Tapirus terrestris was quite abundant in North America during the Post-Pliocene period; its remains occur frequently as far north as Pennsylvania, and it is probably to this species that the fragments obtained by Mr. Francis A. Lincke, near Evansville, Indiana, in association with those of the wolf already mentioned, pertain. Another species has been described by Dr. Leidy under the specific name of *haysii*. This species, it may be remarked, rests upon size alone (a very unsafe guide), it being somewhat more robust than the *terrestris*. It is difficult at present, with the fragmentary material at our disposal, to say really whether it pertains to a group of individuals characterized by a more robust size than *T. terrestris*, or whether it is merely an individual variation of this species.

EQUIDÆ (Horses).

There has probably been no animal brought into a state of domestication by man, which has proved a more constant companion to him, or has rendered a greater amount of assistance in the growth and spread of civilization than the horse. Possessed of a kind, gentle and even-tempered disposition, which few animals of like proportions display, together with strength and powers of endurance, he is peculiarly adapted to the important station he occupies. So indispensable, indeed, has this animal become that without his continued assistance many of the most important industries of which civilization boasts must have ceased or been greatly retarded.

The existing horses are best classified in a single genus, *Equus*, containing at least six species, as commonly accepted by authors. Their distribution is now most extensive, two of them having been introduced by man into every region where civilization exists. The domestication of the common species, *E. caballus*, together with the most rigid practices of artificial selection in its cultivation, has resulted in the production of a

number of permanent varieties (breeds), some of which are quite as distinct from the original stock and from each other as are the various species in a wild or feral state.

Many of these breeds may now, with a considerable show of logic, be properly regarded as incipient or more or less distinct species. The fact that many, if not all of the so-called "thoroughbreds," when properly united transmit to their offspring the peculiarities of their race, such as speed, size, color, form, powers of endurance, etc., or in other words, the fact that there is a marked and constant tendency to breed true to their kind is well known to those who are accustomed to study the subject. Examples of this kind can be found upon every hand. The Shetland ponies breed true to their small size, and shaggy manes and tails. The Norman Percherons of France are also well known to breed true to their large size, heavy bone, general robust form, as well as peculiarity of color, when the male and female of pure blood are united. Certain breeds of Andalusian horses from Spain are characterized by large heads, beautiful leopard-like spots, and very scant manes and tails, which characters they will transmit with unerring certainty.

The different breeds of racers and trotters are well known to be possessed of qualities of speed and endurance equaled by no other. The offspring of pure strains of these racers are always known to horsemen by their lithe and beautiful forms, and are certain to display the characteristics of the breed by their activity, speed and endurance. It is from their numbers that all the famous horses distinguished for their running and trotting qualities have been derived.

The argument that has been used against the doctrine of evolution, as accounting for the origin of species, urges the inconstancy and general instability of these artificial products when abandoned to the natural environments and conditions to which wild species are subjected. It is highly probable, and no doubt true, that they will, in many instances, revert to the primitive stock from which they have been derived; but this fact, admitting it to be invariably true, is of no significance, and proves nothing. It must be borne in mind that permanent variations, or departures from the original type, whenever the result of artificial selection and special artificial conditions, constantly require these conditions to be maintained. In other words, their peculiarities mean simply adaptations to certain environments, and are the result of accumulation of an infinite number of slight variations in a given direction, rigidly selected with the view of making them conform to a certain desired standard of excellence. This has required special favorable conditions for its accomplishment. It has never been urged by evolutionists that wild species have been the result of artificial selection. The only fact of importance connected with it, is, that animals in a state of domestication, may be made to vary to such an extent, the varieties having a tendency to remain permanent as long as

surrounded with certain conditions, as to resemble very closely the products of nature in every essential and important character.

If now we ask ourselves what a species is, and we answer the question (as a large majority of naturalists at the present day do), that it is the product or simple aggregation of a large number of minute individual differences as size, color, anatomical peculiarities, etc., so intensified as to become permanent, we are not at a loss to understand the true significance of the breed characters of our domestic animals. We must conclude that they are the same thing produced only under appropriate circumstances.

Respecting the existence of the horse upon the American continent at the time of its first discovery by European explorers, there is a widely accepted opinion among naturalists generally, that it was entirely extinct, and that the vast herds of wild horses subsequently seen roaming over the South American pampas, were derived from the horses which the Spaniards brought over with them when the country was colonized.

Upon this question, however, Mr. E. R. Berthoud has, in Kansas City Review, thrown considerable doubt. Having had occasion to examine the records of discovery and maps of Cabot, the Spanish explorer, he says: "It is an incontestable fact that Cabot went in 1527 to the east coast of South America on an exploring voyage; that he discovered the rivers La Plata and Parana, and explored them some distance inland, returning to Spain in 1530.

"Upon examining that map, I find that the Rio La Plata was explored up to the 25th parallel of north latitude, and Spanish names were given to its branches and all prominent points; and in addition he has marked on the map pictures of natives, prominent animals, and some trees, and that at the head of the La Plata, with the puma and parrot, and perhaps the condor, he has given the horse as apparently a quadruped that existed then on those vast plains of the *Gran Chaco*, where to-day they roam in countless herds. It may be claimed that this is not proof of their native origin; but we claim that it is a fair presumption, for neither Spaniards in Peru or other parts of America, nor even Portuguese, had been long enough in South America for the few Spanish horses introduced to have roamed wild from Peru to the head of the Paraguay and Parana rivers, and increased in numbers sufficiently to have attracted the attention of the Spanish explorers. The period was too short, and the distance too great from the Spanish possessions in Peru, across the vast forests of the Andes, for such a rapid increase. We can reconcile this discrepancy only by believing that the paternity of the vast herds of the Argentine Republic and Paraguay was a native breed of American horses, mixing afterward with the Spanish breed introduced by the conquerors. Not twenty years had passed between the discovery of Peru and the discovery of the Rio La Plata."

Presumptive evidence of a very striking nature can be drawn from

paleontology to support the conclusions reached by Mr. Berthoud. For example, the remains of an animal which is indistinguishable from the existing domestic horse, occur in beds of Post-Pliocene age over a large part of the United States, and come so near to the Recent period that it is often difficult, if not impossible, to say definitely whether they are the remains of horses introduced into this country by the Europeans, or whether they pertain to an indigenous stock. In some instances, however, it is perfectly clear that they pertain to a native breed. Supposing therefore (as there are good reasons for doing) that the physical conditions of the continent were nearly the same toward the close of the Post-Pliocene period as they now are, and seeing that the present conditions are so admirably adapted to the support and multiplication of what is to all appearances the same species, we are at a loss to understand what would cause its extinction. As in the case of the llama, driven south by glacial cold, they probably entered South America, and it is in this region we would most reasonably expect to find them. It is by no means an established fact, however, that the horse was not cotemporary with man upon the North American continent.*

The horse is one of the few animals the genealogy and geological history of which is now completely known. All the successive links necessary to demonstrate its ancestry are found in this country in strata ranging from the early Eocene to the present. For a full discussion of this question, however, we must refer the reader to publications by the senior author in the Paleontology of the Wheeler Survey, vol. IV, 1877, and by the junior author in "Kansas City Review" for 1882 (repuhlished in "Revue Scientifique," Paris, 1883), "On the Origin and Development of Existing Horses."

PROBOSCIDEA. (Elephants and Mastodons.)

The definition of this order has already been given. It includes within its limits animals most gigantic in size of all the terrestrial *Mammalia;* and if we are able to interpret correctly the affinities and relationship of mammals generally from osteological evidence, they have had a long and eventful career, dating their existence from a very remote period of the earth's history. The peculiar modification of certain of their organs, as well as their general unique appearance, has been instrumental in misleading systematic writers on this subject, to a proper conception of their correct position in the scale of animal organization.

The recent interesting discoveries of Cope have placed within reach of our understanding a more definite knowledge of the primitive condition of the ungulates in general; and with this knowledge in view, we are en-

*See Cope, Proceedings Academy Natural Sciences, Philadelphia, 1882, p. 291.

abled to understand in what particulars these animals retain primitive characters, and in what they are specialized. Thus, in the structure and manner of replacement of the teeth, together with the possession of a proboscis and certain modifications of the skull and incisor teeth, they are highly specialized, while on the other hand in the structure of the limbs, and as Prof. Flower remarks, "in the presence of the two anterior venæ cavæ," as well as other features, they retain a primitive condition. The generalized character of the limbs is seen, in the anterior ones, in the complete separation of the ulna and radius, the serial arrangement of the carpal bones,* and the possession of five fully developed toes; in the posterior members, in the absence of a *ligamentum teres* of the femur, the freedom of the tibia and fibula, the partial non-interlocking of the tarsal bones, and likewise in the possession of five toes.

The structure and method of replacement of the teeth in the later representatives of the *Proboscidea* is quite curious, and indicates a wide departure from the primitive condition, but fortunately we are now able to supply the intermediate links which have preceded the highly specialized ones in time, and gain some useful hints, if not positive knowledge, of the steps by which this specialization has been reached.

As already indicated, one of the most interesting peculiarities connected with their dentition is found in the method of replacement of the grinding teeth. By the way of general information, it may be stated that in a large majority of the *Mammalia* there are two sets of teeth, denominated the *deciduous*, or *milk* dentition, and the *permanent* dentition. The deciduous teeth are always fewer in number than the permanent ones, and are displaced by vertical growth of the permanent set. Now of the grinding teeth, or those situated behind the canines, those that displace or vertically succeed milk molars, are termed *premolars*,† while those that do not have any deciduous predecessors are termed *true molars*. In most, if not all, the diphydont *Mammalia* (those that have two sets of teeth), the difference in the period of eruption of the permanent teeth is very constant, making the disparity in the amount of wear sustained by the individual teeth a conspicuous feature, and serving as a useful guide in the determination of the molar and premolar series in both recent and extinct mammals. It is proper to remark here that the dentition in the *Batrachia* and *Reptilia* consists of not one or two sets, as in the *Mammalia*, but the teeth are replaced by vertical successors to an indefinite extent. As fast as a tooth is worn out a new one takes its place from beneath. If we look

*By serial arrangement is meant the super-position of those of the proximal row (viz.: Scaphoides, semilunar, cuneiform), directly upon those of the distal row (viz.: Trapezium, rapezoid, magnum, unciform). Thus the unciform supports the cuneiform only, the magnum, the lunar, and the trapezoid the scaphoid. In the *Diplarthra* the bones of the two rows interlock or alternate.

†Sometimes there is a failure, in ordinary diphydont mammals, for the first premolar to be succeeded, in which case it is a persistent milk molar.

upon the *Reptilia* as the ancestors of the Mammalia (for which there appear to be good reasons), it is clear that the diphydont dentition is the more primitive of the two, as far as replacement is concerned. In the living representative of this order, *Elephas* and *Loxodon*, or the Indian and African elephants, the teeth do not succeed one another in a vertical direction, but come in from behind forward. The individual teeth are so large that no more than one or parts of two are in use at the same time in each jaw. The molar teeth are seven in number upon each side in either jaw (the normal number), but it not unfrequently happens that the two anterior ones are shed early in life. There is never any vertical displacement of any teeth. For this reason it appears that the four anterior grinders are persistent milk molars, while the three posterior ones represent the true molars of the ordinary mammal.

As we pass backward a step in geologic history, we meet with the remains of an animal of elephantine proportions which, as we are able to judge from analogy, presented the external appearance and peculiarities of the existing species; this is the genus *Mastodon*, which furnishes us with an important intermediate link. It was pointed out by Owen as early as 1846, that the first and second grinders, both in the upper and lower series, were succeeded by teeth developed in the jaw above and below as ordinarily observed. Another step backward in time brings us to the *Dinotherium*, the earliest true proboscidean known. In this animal the deciduous or milk teeth were all replaced in the normal method. From these facts we are able to learn that the complete suppression of the four premolars of the adult dentition was accomplished by a series of gradual steps, and that it began at the posterior end.

The structure of the molar teeth next demands consideration. If the adult worn tooth of an Indian elephant, *Elephas indicus*, be examined, the grinding surface will be seen to consist of a number of greatly flattened elliptical areas of dentine, bordered by vertical laminæ or plates of enamel, which have a more or less crimped appearance. These will be found to be comparatively of great depth, connected at the base, and having the intervening spaces as well as the outside covered by a thick deposit of cementum. The number of these elliptical areas or ridges (for such indeed they may be properly regarded, with their tops worn down by attrition) vary in the different teeth as we pass from before backward. The average number for the six successional teeth beginning with the second, is given by Prof. Flower as 4, 8, 12, 12, 16, 24.

In the African elephant, *Loxodon africanus*, the ridges are fewer in number and so thickened in their middle portion as to give to the dentinal areas a lozenge-shaped appearance when worn. The enamel plates are likewise much thicker and less crimped than in the Indian species. The "ridge formula" is given by the same author as 3, 6, 7, 7, 8, 10.

In the genus *Mastodon*, the ridges are always still fewer in number,

never exceeding five; and there is no thick deposit of cementum in the valleys and upon the exterior as in the teeth of the other two genera. The mamillary projections into which the ridges are often divided has given the name to the genus, *mastodon* meaning "nipple tooth." The absence of the cementum causing the wide gaping valleys between the ridges gives to the teeth a very different aspect, and one would scarcely suspect that they had much relationship with the elephants, did he not know of the many intermediate and connecting links between them. Owing to the smaller size of the individual teeth, there were sometimes three in use in each jaw at one time.

The molar dentition of *Dinotherium* presents nothing peculiar in its structure. As already observed, the premolars succeed milk molars in the manner of the ordinary mammalian dentition. The true molars are still more simplified, resembling very strongly those of the tapirs and lophiodons, with only two cross crests or ridges, except in the first true molar, where there are three. In all the genera except the last, two incisors are enormously developed, forming the so-called "tusks" in the males; they are of small size, or entirely wanting in the females. In the males of the mastodons, small tusks are not unfrequently found in the lower jaw as well. In *Dinotherium* on the other hand the tusks are apparently absent from the premaxillaries, but are compensated for by the appearance of two strong decurved tusks in the lower jaw.

Of the order *Proboscidea*, remains of two species occur in Indiana, the first of which is referable to

ELEPHAS PRIMIGENIUS, Blum. (Mammoth).

Plate 6, *Figs.* 2, 3, 4, 5.

This species, which is essentially an elephant, and therefore referable to the genus *Elephas*, finds its nearest relative in the Indian species, *E. indicus*. It is indicated in the collection by several molar teeth, one of which is shown in Pl. 6. Another tooth of this species was presented to the museum of the Philad. Acad. Sciences, where it is now preserved, by Dr. Hallowell, which he obtained in Madison, Ind.

This is one of the few extinct animals the structure of which is thoroughly known. The finding from time to time of more or less complete carcasses in the frozen soils and ice cliffs of Siberia, is so familiar to every one as to need no repetition here. It is well known to have possessed a very dense covering of hair, whence the appellation "Hairy Mammoth." Besides the abundance of this hairy coat, the species differs from its Indian relative, in the character of the molar teeth, by their greater breadth as compared to their length, by the narrowness of the dentinal areas and consequent crowding of the enamel plates, and finally by the coarseness of the "crimping" which is so fine in the *E. indicus*. The tusks were very large and had a tendency to a spiral twist, a condition peculiar to the

species. There are two well marked varieties of this species, both of which appear to have been represented in America. Those in which the transverse plates of enamel are very thin, are known as the "thin plated variety," and those in which the plates are thicker are known as the "coarse plated variety," approaching in this respect the *Elephas antiquus* of Europe. These varieties are sometimes regarded as distinct species, but owing to the intermediate conditions discoverable between them, this determination is materially weakened if not altogether invalidated.

The size of the mammoth was about one-third greater than its living congener, *E. indicus*, whose average height does not exceed nine feet. By the possession of a dense covering of hair and under-wool it was fitted to inhabit higher latitudes; and indeed, that northern Siberia was the great theater where countless hordes of this mighty monster roamed at will, is attested by the numerous remains that have been left in the Post-Pliocene deposits of that region. So numerous and well preserved are these remains, that ivory furnished by the tusks of the mammoth has formed a regular export from the country since the beginning of the tenth century.

The thin plated variety appears to belong to the northern latitudes and is best known; while the coarse-plated variety (*Elephas columbi*, Falc.), in this country at least, comes from the southern portions of the United States. It is impossible to say whether or not it was likewise covered with a woolly coat as was the northern variety; but if it be true that its habitat was in tropical or sub-tropical regions, the inference that it was not, seems well grounded. All that we will ever be able to know of the habits of these creatures must be inferential. Thus we are perfectly safe in assuming that they were exclusively herbivorous, and were doubtless gregarious to a certain extent. In view of the great development of the tusks in connection with the shortness of the neck, neither of which would permit the mouth to reach the ground, they must have obtained their food by means of a proboscis, as in the existing species.

MASTODON AMERICANUS, Blum.

Plate 3, *Figs.* 1, 2; *Plate* 6, *Fig.* 1.

Of the characters of this genus already mentioned, the principal ones are the simplified form of the molar teeth as compared with the elephants, and the replacement of some of the milk molars by permanent premolars growing in a vertical direction. Many transitional forms, however, are known which establish a close connection with both the genera *Loxodon* and *Elephas*. It is doubtful whether more than one species has so far been found in the Post-Pliocene deposits of this country, notwithstanding the fact that several have been described. The imperfect remains upon which the paleontologist must frequently form judgment, together with the individual variability of the teeth, no doubt caused by their large

size, makes it a matter often of considerable difficulty to decide upon their validity. In this case, however, it seems best in our judgment to regard the Post-Pliocene forms as constituting but a single species. This one is represented in the collection by several molar teeth belonging to both jaws. They agree in every respect with the corresponding teeth of *Mastodon americanus*, to which, without question, they are referable.

In general the mastodons resemble the elephants very closely as far as their osteology is concerned, and, indeed, they may justly be regarded as a more ancient and primitive type of this modification of the ancestral mammal. In size the species are both smaller and larger than the mammoths, and like them display the characteristically short neck, large tusks, as well as the elephantine conformation of the skull, all of which indicate the possession of a proboscis. The tusks are always large and strong, and do not appear to have been so much curved as in the true elephants. Some of the species present the peculiarity of having longitudinal bands of enamel, which traverse the entire length of the tusk and blend into a true sheath at the point. Some of the species display tusks in the lower jaw, which are generally insignificant in size as compared with those of the upper jaw. In the species under consideration there were two tusks in the temporary dentition in the lower jaw, neither of which appear, to have been replaced by permanent ones in the female, but of which one was succeeded by a permanent tooth in the male.

In time the genus *Mastodon* ranges from the Upper Miocene into the Post-Pliocene deposits inclusive. Its distribution in space is very extensive, having been found from the 60° of north latitude, it is claimed, throughout the greater part of South America. The habits of these creatures will doubtless ever remain shrouded in mystery, and in this as well as all other extinct animals we must depend upon analogical evidence for our opinions respecting them. It was believed by no less an authority than the immortal Cuvier that the food of the *Mastodon* consisted of tender vegetables, roots, and aquatic plants, in view of the tuberculous character of the teeth; the analogy of this is seen in the hogs and hippopotamus. This regimen would require more swamp-haunting and aquatic habits than the elephants possess, which indeed has been conjectured to be the case. Prof. Owen, on the other hand, suggests "that the large eminences on the grinding teeth, the unusual thickness of the enamel, and the almost entire absence of the softer cement from the grinding surface of the crown, would rather indicate that they had been instruments for crushing harder and coarser substances than those for the mastication of which the more complex but weaker grinders of the elephants are adapted."

RODENTIA.

With this order we enter a very natural group of smooth-brained, clawed *Mammalia*, which are either aquatic, arboreal or terrestrial in habit. The most natural primary grouping of the Monodelph mammals is best indicated by division into at least four branches. Beginning with the highest we would have, 1st, the series including the orders *Carnivora* and *Primates*, or the flesh-eaters, monkeys, apes and man, characterized by comparatively large and well-developed brains; 2d, the orders *Cetacea* and *Sirenia*, or whales, dolphins and seacows, characterized by the absence of hind limbs; 3d, the Ungulate or hoofed series, including the orders *Taxeopoda*, *Amblypoda*, *Proboscidea* and *Diplarthra*, which have just been considered; and 4th, the series embracing the orders *Cheiroptera*, *Bunotheria*, *Rodentia* and *Edentata*, or the bats, lemurs, insectivores, gnawers, anteaters, sloths and armadillos, characterized by having small, nearly smooth cerebral hemispheres, which leave the olfactory lobes and cerebellum uncovered, with claws or compressed ungues.

This latter series no doubt had a common origin with the ungulate division far back in the Eocene or Jurassic periods, and from which stem doubtless the existing Marsupials also sprung. From some of the earlier representatives of this series we can with little difficulty derive, (1) the *Carnivora*, through the *Creodonta*, a sub-division of the *Bunotheria*; (2) the *Cheiroptera*, through the insectivorous division; (3) monkeys and man, from the Prosimian sub-order of the same; and (4) lastly the *Edentata* and modern *Insectivora* have persisted with comparatively little modification. The *Pinnipedia* may represent an early off-shoot from the modern *Carnivora*, but taking into account the structure of the molar teeth as well as other points of osteology, they appear to have come off in the early Eocene from the *Creodonta*, when some of them possessed the simplified molars now exhibited by the seals. Prof. Huxley has endeavored to point out some affinities with the *Ursidæ* of the *Carnivora*, but the evidence which he adduces is scarcely sufficient to demonstrate such relationship.

As to the origin of the *Cetacea* and *Sirenia*, we know so little that it is useless to speculate. Upon this subject our ignorance is indeed dense, and how soon the light of paleontology will enlighten us the future will reveal.

This rude outline probably expresses the more important divergences that have taken place in the evolution of the *Mammalia*, and is strongly supported by the paleontological evidence at our command.*

The characters by which the *Rodentia* are separated from the two allied orders may be briefly stated as follows:

*See Vols. III and IV of the Hayden Geological Survey, final report, where this system is fully presented.

Teeth when present without any enamel covering. *Edentata.*

Teeth with enamel; mandibular condyle transverse; a post-glenoid process. *Bunotheria.*

Teeth with enamel coverings; mandibular condyle longitudinal; no post-glenoid process. *Rodentia.*

In point of numbers, as well as wealth in genera and species, the *Rodentia* are the most important of all the *Mammalia.* Notwithstanding the fact that they furnish the principal food supply for the more predaceous species, they continue to be the most numerous, and enjoy a wider geographical range than any other order of mammals, the loss which they sustain from carnivorous enemies, being compensated for by the rapidity with which they increase. Over 900 species are now known.

The principal modifications to be met with in the osseous system are seen in the skull and dentition. The premaxillaries are always large and exclude the nasals from contact with the maxillaries; the frontals are moderate and do not possess post-orbital processes except in squirrels, marmots, and hares; the zygomata are always present; the malar never sends up a process to meet the post-orbitals, and the orbital and temporal fossæ are always freely continuous. In the Porcupine division of the order, the infra-orbital foramen is enormously enlarged, almost equaling in size the orbital cavity; a portion of the masseter muscle passes through this opening. The palate is always very narrow, as compared with the width of the zygomata; and there are always well developed auditory bullæ.

In the dentition there are never more than two incisors in either jaw (except in the hares, which have four above), which grow from persistent pulps, and are always large, well curved, and strong; they are covered with enamel upon the outside only, an arrangement by which the tooth upon attrition continually preserves a chisel point. Canines are never developed, and there is a wide interval between the incisors and premolars. The normal number of true molars, 3, is present in all except the Australian Water Rats, in which they are reduced to two in each jaw; the premolars vary from $\frac{3}{3}$ in the hares and rabbits, to $\frac{0}{0}$ in other forms. The structure of the teeth in this order is subject to much variation, the most complex type being displayed by certain members of the Porcupine division, as the Capybara for example.

The primary division of the order is effected by arranging those that have only two incisors in the upper jaw, with fibula not articulating with calcaneum, and without an intertrochlear crest of humerus in one series; and those in which the incisors are $\frac{4}{2}$, fibula articulating with calcaneum, and an intertrochlear crest of humerus in another series. The first series includes three distinct divisions, the first of which is the *Hystricomorpha*, or the porcupines, and their allies; the second is the *Sciuromorpha*, or the

squirrels, marmots, and beavers; and third, the *Myomorpha*, including the mice and their allies. The second series includes but a single division, the *Lagomorpha*, or the rabbits, hares, and pikas.

The largest living representatives of the order are found among the *Hystricomorpha*, as the Capybara and Viscacha, for example, although the *Sciuromorpha* have a representative of considerable size in the beaver. The remains of an extinct rodent are found in the Post-Pliocene deposits of this country, which, without doubt, refer to a member of the *Sciuromorpha*, and which exceed in size any known rodent, living or extinct; this is

CASTOROIDES OHIOENSIS, Foster.

Plate 4, *figs.* 1, 2, 3.

This animal is indicated in the collection by an incisor tooth belonging apparently to the upper jaw. Its damaged condition, owing to the poor state of preservation, does not permit a satisfactory determination of this point. This species was first made known to science by Mr. J. W. Foster, one of the assistants in the Geological Survey of the State of Ohio; from an imperfect half of the lower jaw, an incisor tooth of the upper, together with a radius found in association with the remains of a *Mastodon*, in the State of Ohio, an account of which was published in Amer. Jour. Sci., vol. XXXI, p. 80. Subsequently an almost entire cranium was obtained from the State of New York, which was described and figured by the late Prof. Jefferies Wyman, in Boston Journal Natural History, vol. V, 1845–1847, pp. 385–401. Other fragments have been found from time to time in various parts of the United States, which indicate a wide range for the species.*

As the name implies, the bones resemble those of the beaver, *Castor canadensis*, to which family it has been referred. After a careful study of the remains, however, Mr. J. A. Allen has demonstrated the impossibility of referring it here on account of certain cranial and dental peculiarities. He has shown that it resembles the chinchillas and the beavers, but differs from both in important characters, on account of which he has proposed to establish a new family for its reception. He further adds: "The *Castoroides ohioensis* was about the size of a full grown black bear (*Ursus americanus*), hence somewhat exceeding in size the Capybara, the largest of existing rodents. A cast of a skull has a length of over twelve inches. The species being known from only a few cranial and dental remains, it is impossible to say much respecting its general form or probable habits. It may have been aquatic, like the beaver; but of this there is no evidence. The form of the occipital condyles and the surfaces for the attachment of the cranial muscles show that it differed greatly in habits from the beaver." The skull is represented in Plate 4.

*Bones and teeth have been found in Carroll, Kosciusko and Vanderburg counties, Ind.

EDENTATA.

This order has a moderate representation in the present epoch, there being upwards of forty species known, whose headquarters are in South America. The name, a most inappropriate one, signifies the absence of teeth, which is by no means true. It was, however, applied by Linnæus to signify the absence of teeth from the premaxillary bones, which is likewise not invariably the case; on this account the term *Bruta*, a scarcely less objectionable one, is not infrequently employed.

In the adult condition, the teeth are devoid of enamel; but Tomes has shown (Philos. Trans., 1876), that in one species at least (the nine-banded armadillo) there are enamel organs in the tooth germs, and he believes that all the species possess similar organs. This would seem to indicate that they represent, so far at least as their teeth are concerned, a degeneration from a more normal condition. So little is known of their geologic history earlier than the Post-Pliocene period that it is at present a question impossible to decide.

The order is most naturally divided into two sub-orders, the *Phytophaga*, or vegetable feeders, and the *Entomophaga*, or insect eaters. Although the principal food of the latter group is insects, yet some of them will not refuse worms or carrion, as an article of diet. The distinctive characters of the *Phytophaga* are seen in the coalescence of the acromion with the coracoid process of the scapula; the absence of medullary cavities in the long bones; the union of the scaphoid and trapezial bones of the carpus; the anchylosis of the ischia with the anterior caudal vertebræ; and finally, in a vertical process from the lateral part of the zygomata of the skull.

In the *Entomophaga*, on the other hand, the acromion and coracoid are never united; the long bones have medullary cavities; the scaphoid and trapezium remain distinct; the ischia are normal, and there is never any descending process from the lateral part of the zygomata, although in a few instances the anterior part of the arch sends down a prolongation. This group includes the "Ardvark" or Cape Ant-eater, the Pangolins or Scaly Ant-eater, the Ant-eaters proper, the Armadillos and the extinct Glyptodont forms from South America.

The *Phytophaga* embraces the sloths and a number of extinct sloth-like forms, mostly of gigantic size. The sloths proper are grouped in a separate family (*Bradypodidæ*), which includes two genera, the two and the three-toed sloths (*Cholœpus* and *Bradypus*), remarkable animals, confined to the dense forests of South America, where they lead a purely arboreal life, suspended by their long hook-like claws to the branches of the trees. The extinct forms of this division, of which seven genera at least are known, are included in the family *Megatheriidæ*. They vary in size from

that of an adult grizzly bear to proportions scarcely less than that of an elephant. The three genera best known are *Megatherium*, *Mylodon* and *Megalonyx*. This latter genus is indicated in the collection by the greater part of the skeleton of an adult individual, including the skull, which were obtained by Dr. David Dale Owen* on the banks of the Ohio River, some five or six miles below Henderson, on the Kentucky side. These remains formed a part of the collection of the bones of extinct animals which Dr. Owen submitted to Prof. Leidy's inspection in 1853, and their description was incorporated in his admirable "Memoir on the Extinct Sloth Tribe of North America," published in the Smithsonian Contributions to Knowledge in the same year. The anatomical description of these remains, given by Dr. Leidy, has been so thoroughly done that nothing remains to be said concerning this part of the subject. A figure of the skull is given in Plate 5.

MEGALONYX JEFFERSONI, Harl.

Plate 5, figs. 1 and 2.

This species, which is familiar to naturalists as *Megalonyx jeffersoni*, was first brought to the attention of the scientific world by the illustrious Thomas Jefferson, in a communication read before the American Philosophical Society of Philadelphia, as early as 1797, entitled "A Memoir on the Discovery of Certain Bones of a Quadruped of the Clawed Kind in the Western Parts of Virginia." The fragmentary remains upon which this memoir was based, consist of several claws, a femur, ulna and radius, together with several other bones belonging to the feet. The shape and form of the claws led Mr. Jefferson to regard them as having belonged to a gigantic carnivorous animal. Dr. Wistar and, later, Cuvier, upon the acquisition of more perfect material, subsequently demonstrated the affinity of the extinct animal with the existing sloths. Since that time, numerous remains of this genus have been found in cave deposits throughout the eastern and southern parts of the United States, and more recently in the sand-beds of Oregon, supposed to be of Pliocene age. Several species are known.

Owing to the great bulk of these animals, it is impossible to suppose that they were arboreal in habit; but, judging from the construction of their feet, adapted, as they were, for terrestrial locomotion, and provided with strong and powerful claws, it has been suggested that they were accustomed to stand upon their hind legs with the assistance of a large tail, and draw the branches within reach of the mouth. It is usually in this position that they are represented.

Since the descendants of this group are so exclusively arboreal, it has been further suggested that, by some probable decrease in size, the boughs no longer yielding to the accommodation of the animal, the sloth eventually yielded and went aloft among the branches.

* In cabinet of State University, Bloomington, Indiana. COLLETT.

The size of *Megalonyx jeffersoni* was about equal to that of a full grown ox.

In conclusion, we trust that we may be pardoned if we indulge the imagination in its retrospective reaches, and endeavor to picture to the mind a landscape containing a grouping of the more prominent animals, as they doubtless appeared, on the banks of the beautiful Ohio, in the misty twilight of long ago. Huge Mammoths and Mastodons would have been seen loitering near the water's edge, or lazily browsing on the neighboring trees; herds of Horses, giant Bisons, and Elk grazed upon the adjoining hills, while numerous smaller species of ruminants would be seen in their appropriate places; the Tapir, Peccary, and Peccary-like Platygonus, would have been found in the dense growths of the swamps and marshes; the mighty Sloths and Castoroides would also contribute to the scene; while, lurking in the back-ground, the stealthy Liou and wary Wolf waited to pounce upon their unfortunate victims. Whether this scene was ever beheld with human eyes, is a matter which yet lingers in the shadows of uncertainty, but it is probable that man was there in all the nakedness of his primitive barbarity.

APPENDIX.

GENUS EQUUS.

The following attempt at a discrimination of the species of Equus* known to me, or so fully described as to be well known, must necessarily be regarded as provisional, until the skeletons are more fully recovered. American extinct species only are introduced:

I. Long diameter of anterior internal lobe of superior molars not greater than one-third the long diameter of the crown.

Borders of lobes crenate; internal anterior lobe notched on the inner side so as to be bilobate; crowns a little curved; large . . . . *E. crenidens*, Cope.

II. Long diameter of anterior internal lobe more than one-third and not more than one-half the anteroposterior diameter of the crown.

α Crowns more or less curved.

Crowns wider than, or as wide as long; enamel edges little folded . . . *E. curvidens*, Owen.

$\alpha\alpha$ Crowns straight, or nearly so.

β Diastemata longer.

*See Owen's Philosophical Transactions, 1869, for figures of the dentition of these species.

Crowns nearly square; enamel not very complex; no facial fossa; maxillary bone produced much beyond M. iii . . . . *E. caballus*, L.

$\beta\beta$ Diastemata shorter.

γ No facial fossa.

Crowns nearly square; enamel not very complex; maxillary bone little produced behind last molar; smaller. . . . . *E. fraternus*; *E. hemionus*; *E. burchelli*; *E. quagga*; *E. zebra*; *E. asinus*, L.

Crowns longer than wide on face; enamel little complicated; face and maxillary unknown; large . . . . . *E. occidentalis*, Leidy.

Crowns square; enamel more folded than in other species; face and maxillary unknown; large . . . . . *E. major*, Dekay.

γ A facial fossa.

Crowns nearly square; enamel less complex; maxillary short posteriorly; smaller . . . . . *E. andium*, Wagner.

III. Long diameter of anterior inner lobe more than half that of crown of molar teeth.

Crowns square; enamel little complex (in Mexican specimens); diastemata and maxillary behind shorter; no facial fossa; large. . . *E. excelsus*, Leidy.

Crowns square; enamel little complex; smallest species . . . . . *E. barcenæi*, Cope.

In using the above table it must be noted that gradations in the diameter of the anterior internal column (or lobe) exist, not only between individuals of the same species, but between different teeth in the same jaw. This diameter is always greatest in the last superior molar, and the characters of this tooth are such that they can not be used in connection with the above table.*

As already remarked (p. 6), two species of horses have left their remains in the Post-Pliocene and Pliocene beds of Indiana—the *E. fraternus*, Leidy, and *E. major*, Dekay. The former is generally rather smaller than the latter, and is not yet distinguishable by its teeth from the *Equus asinus* and its immediate allies. From the absence of specimens of crania, its affinity to the *E. caballus* is not yet traceable. It is probable, however, that it is like the *E. tau*, Owen, of the valley of Mexico, of which crania are known, and it may be even identical with that species. (In this case the name *E. tau* becomes a synonym.) In that case the species belongs to the *E. asinus* division. It will then follow that the evidence for the existence of the *Equus caballus* in North America prior to the advent of Europeans will be much weakened, since it is on teeth of the *E. fraternus* that such a possibility has been predicated. Many of the teeth referred to the *E. fraternus*, are, as observed by Leidy, not distinguishable specifically from those of the *E. caballus*. *E. D. Cope.*

*See Proceedings American Philosophical Society, 1884, p. 10, for a discussion of the American extinct horses.