PRELIMINARY REPORT ON THE VERTEBRATA DISCOVERED IN THE PORT KENNEDY BONE CAVE.

By Prof. E. D. Cope.

(*Read before the American Philosophical Society April* 7, 1871.)

My friend, Charles M. Wheatley, has already given an account of the discovery of a fissure in the Potsdam limestone of Chester Co., Pennsylvania, containing the remains of numerous animals and plants of the Postpliocene period (see Amer. Jour. Sci. Arts, 1871, April). Dr. Quick, of Phœnixville, having brought to his notice mastodon remains exposed in quarrying the limestone near Port Kennedy, he visited the spot, and determined the existence of the fissure and its contents. In the article in question he describes it as situated near the line of junction of the Triassic red sandstone. Its depth is nearly fifty feet, and the greatest width thirty; at the summit or surface of the limestone, its width is twenty feet. It is filled to a depth of forty feet with the debris of the neighboring Triassic strata, of a red color; below this point is a bed of tough "black clay eighteen inches in thickness, filled with leaves, stems, and seed vessels of post-tertiary plants. Scattered through all this mass of vegetable remains, and also in a red tough clay underneath for six to eight inches in depth, are found the fossils noticed in this paper."

Mr. Wheatley furnishes a list of the species we had identified up to the time of writing, viz.; twenty-seven vertebrata, ten coleoptera, and ten plants. These numbers have been considerably increased up to the present time, and I look to a much fuller and more complete exposition of the Postpliocene vertebrate fauna, in consequence of a more thorough examination of the remaining part of the fissure, by my friend, C. M. Wheatley.

As regards the position of the remains, the article above quoted, proceeds to state that "the remains of Mylodon, Ursus, and Tapirus have been mostly obtained from the tough red clay directly under the plant bed, but the remains of rodents, snakes, tortoises, plants, and insects, are entirely confined to the plant bed. Neither the bones nor the teeth are rolled or water worn, but all are sharp and well defined." The appearance of the specimens corroborates the above statements. I would add some exceptions. Thus two of the specimens referred to *Arvicola sigmodus* came from the red bed, and one from the black; one *Megalonyx wheatleyi*, came from the black bed, the others from the red. Milk teeth of Mastodon occur in the red bed also. General remarks are deferred to the close of the report.

Megalonyx, Jefferson.

The remains of species of this genus found in the fissure are more abundant and striking than those of any other. At least fourteen individuals are represented by the bones and teeth obtained. These belong probably to five species, as described below, four of them different from those hitherto known, three of them of a size equal to that of the *M. jeffersonii*, the others smaller. These species are only certainly distinguishable at present by the teeth, as the other bones are very similar to those of other species, so far as preserved.

The teeth consist of eighteen canine, and nineteen molar teeth, whose characters are discussed below. The bones are chiefly those of the feet, with portions of long bones, and numerous vertebræ. Cranial bones are in most instances destroyed, for though several complete crania were exhumed, the exposure to frosts and thaws with snow and rain, as they laid in the piles of material, disintegrated them. Of limb bones there are the extremity of a large tibia with cotylus for astragalus, several extremities of fibulæ, and some broken heads of femora.

Of the bones of the fore limb there are three unciforms, two magnums, and fifteen metacarpals with numerous phalanges. The bones of the hind limb include three astragali, seven cubiods, six scaphoids, and five incomplete metatarsals. The phalanges of both fore and hind feet, which much resemble each other, number thirty-two, of which nine are ungueal. Of vertebræ, no cervicals have been found, except an axis without neural arch. Caudals are most numerous; some of the vertebræ have coössified epiphyses, others not, indicating various ages. I have counted twelve individuals from the teeth, but it is quite possible that there are others represented by some of the bones.

The canine (molar) teeth present a remarkable variety of forms. As is known, the section of the crown is oval, on one side concave with a more or less prominent swelling interrupting it. The differences are seen in the development and position of the broad rib of which the swelling is a section, in the curvature of the shaft, and greater or less obliquity of the grinding surface.

There are three types of form among them as follows:

1st. The shaft curved, the triturating surface oblique, the internal longitudinal rib prominent, nearer one end of the crown than the other, dentine of inner side thickened anteriorly; two specimens.

2d. Shaft nearly straight, triturating surface transverse (in its long direction); rib of inner face median, prominent; dentine of inner side uniformly thin.

3d. As in the last, but the shaft more compressed, therefore the section narrower, the inner bulging rib being very low and insignificant.

The first of these represents a species distinct from those of the other series; one nearer the *M. jeffersonii*, and of large size.

In studying the present genus I have been under many obligations to Dr. Leidy's Memoir on the Extinct Sloth tribe of North America, published by the Smithonian Institute in 1855. In it the species *Megalonyx jeffersonii* is established for the first time on a solid foundation, and the characters, especially of the dentition, clearly pointed out.

Megalonyx loxodon, Cope, species nova.

The two teeth of the first type may, perhaps, be superior ones; their curvature accounts for the obliquity of the grinding face in the long direction. This curvature is seen in teeth of *M. jeffersonii* (See Leidy's Memoir on Extinct Sloth tribe, Pl. VI., figs. 4-6), which do not appear to be straight in the maxillary bone at least, at any time. These teeth differ from those of *M. jeffersonii* in having the posterior margin thinned out, while the anterior is thickened by the near aproximation of the interior rib. In the larger of the two the posterior margin is slightly incurved, the exterior convexity thus produced opposing that of the anterior face and inner rib, as one short side of a romboid does that opposite to it. The section of the smaller differs in the shortness of this intero-external face, and is thus rounded subtriangularly and antero-internally, as described by Leidy in the *M. jeffersonii*, and thus different from that seen in the *M. wheatleyi*. The external face has an open longitudinal concavity, The triturating surface in both teeth is a longitudinal groove; in the larger, the inner margin is highest anteriorly, the outer highest posteriorly.

These teeth I suppose to represent a species different from the *M. wheatleyi*, and perhaps from the *M. jeffersonii* also, as none of the sections given by Leidy (l. c. Pl. XVI), approach their form. The nearest is his fig. 3, where the section of the bulge is not quite central.

Megalonyx wheatleyi, Cope.

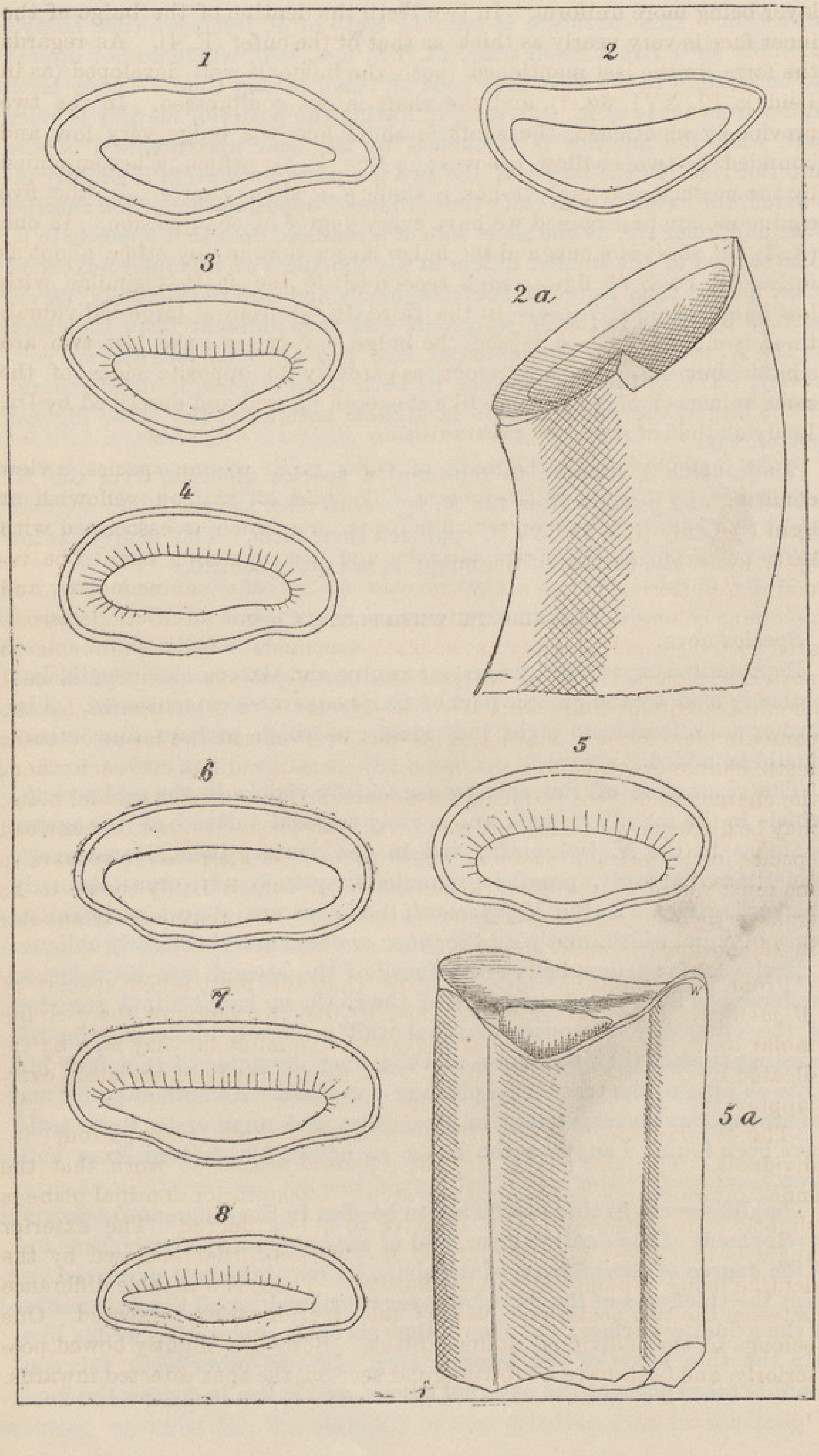
Species nova.

Represented especially by fourteen canine and sixteen molar teeth, but probably also by the greater part of the bones above mentioned. The former are referable to eight individuals, to which perhaps four others should be added.

The characters of the species are chiefly visible in the molar teeth, which in the maxillary bone are acutely trigonal instead of triangular ovate as in the *M. jeffersonii*; and in the dentary bone, transversely, sometimes narrowly, parallelogrammic, frequently narrower internally than externally. In the *M. jeffersonii* the latter are almost as broad as long, of equal width, and with the inner or outer margin slightly oblique.

In the *canine-molars* before mentioned of the second and third types, we have but little or no curvature of the shaft, no longitudinal grooving of the outer face, the outer dentinal wall uniformly higher on the triturating surface than the inner, and the long diameter of this face but little oblique to the transverse plane of the shaft. As both superior and inferior molars corresponding in size, color, and number to these teeth have been found, I suppose the latter to have been derived from both jaws.

The differences in these teeth are to be seen in the different degrees of development of the dentine layer, and of the bulge on the inner face, and of the degree of compression of the shaft. Five of the best preserved exhibit the thickness of the external layer continued round the extremities of the grinding surface, and then rather abruptly contracting wedge like, into the thin layer of the interior face. In two other teeth this contraction takes place at the external curves, and is less in degree, the inner


1
2
2 a
3
4
5
5 a
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layer being more uniform. In two teeth the dentine of the bulge of the inner face is very nearly as thick as that of the outer (F. 4). As regards the form, in the last mentioned tooth the bulge is well developed (as in Leidy's Pl. XVI. fig. 1), and the shaft is not compressed. In the two previously mentioned, the shaft is short and the bulge very low and bounded by two shallow grooves; in one (F. 6) (which is accompanied by the posterior molars), it has a shallow median groove. In the five canine molars first named we have every degree of compression. In one (F. 3) the shaft is stout, and the bulge larger than in any other, about as in Leidy's Pl. XVI. fig. 2; in a second (F. 5) the shaft is similar, with low bulge, like fig. 7. l. c. In the third (F. 7) from a large individual, there is more compression, and the bulge is very low; the last two are similar, but smaller; they belong apparently to opposite sides of the same animal (F.8). These are like the tooth figured and described by Dr. Leidy as that of *Megalonyx dissimilis.*

I am inclined to refer the teeth of these types to one species, a view confirmed by a study of the molars. They are all stained yellowish or light rust color except one, which is black, and which is associated with three posterior molars of similar color and corresponding size. The remaining posterior molars are of the color of the other canine molars, and no doubt belong to the same individuals in part, but none can be associated with the same certainty as the black specimens. On the light colored posterior molars I propose to establish the *Megalonyx wheatleyi*, since I should scarcely distinguish it from *M. jeffersonii*, or *M. dissimilis* by the canine-molars alone. There can be no question that the forms of these teeth, characteristic of the two supposed species, graduate into each other; the characters derived from the development of the interior enamel plate, may be distinctive, but in that case there is at least one other undescribed species in the series I have explained above. *M. dissimilis* it appears to me must repose on the posterior upper molar, which Leidy shows to be transversly oval and not triangular in section. That tooth is as triangular in *M. wheatleyi* as in *M. jeffersonii.*

From the preceding, it is probable that the most allied species of *Megalonyx*, cannot be exactly defined by the characters of their canine molar teeth, though, as in many species of Mammalia, they may be indicated by the extreme forms of those teeth, the range of variation overlapping.

The *superior-molars* (1a) belong to at least three (perhaps four) individuals. They are nearly straight trilateral prisms, so worn that the inner anterior angle is the most elevated. The anterior dentinal plane is slightly convex, the posterior concave to a less degree. The exterior angle is much less obtuse than in *M. jeffersonii*, that enclosed by the dentine being prolonged and very narrow. There is a notable difference between the two posterior molars of the superior series, preserved. One belongs to the individual stained black. Both are slightly bowed posteriorly, and both have a subtriangular section, the apex directed inwards.

In the light colored specimen the outer face is wide and nearly plane, the anterior very slightly convex, and the posterior concave, making an open longitudinal groove; the external angle is obtuse. In the black specimen the inner face is narrower, the anterior more distinctly convex, and the posterior convex also, rounding off to the more obtuse external angle. Both these teeth are worn obliquely as in *M. jeffersonii.*

The wearing of the median molars is transverse to the axis of the shaft anteriorly, oblique to it or descending inwards, posteriorly. The wearing in the long axis of the jaw bone, is obliquely forwards on the posterior dentinal wall, and divided on the anterior, one half sloping forwards and the other backwards, the slopes separated by a sharp ridge of the dentine.

A single tooth, which by its form is excluded from a place in the mandible, and by the character of the wearing of its crown, can be none other than the second molar, or first of the regular series. Its form is very different from that of the same tooth in *M. jeffersonii,* but is appropriate to the modification described below as characteristic of the inferior molars of *M. wheatleyi.* There is no anterior wear on the anterior dentinal plate, indicating the absence of any tooth anterior to it in the inferior jaw; this plate is much higher than the posterior, which has two worn surfaces, the anterior horizontal, the posterior oblique. The middle of the crown is concave, and the concavity is carried across the dentine of one end. The tooth is in section a transverse parallelogram with the outer short side oblique, instead of parallel to the inner. Anterior face slightly concave, posterior slightly convex.

The characters of the *inferior molars* are established by three posterior in place in the fragments of jaw held together by the matrix of red sand and clay. That they might be the superior series of another species is suggested by the subtriangular outline of two of them, and the jaw is so fragmentary that it is not sufficient to decide the case. The following points, however, are conclusive. If they were superior, the terminal teeth must be either the second or fifth molars, according to the relation to front or back in which they are viewed. That neither can occupy this place is proven by the following description:

The anterior is a rather narrow transverse parallelogram, with the sides and angles rounded. The posterior dentinal plate is worn transversely, the opposite one is oblique, descending to one side. The form is worn obliquely away from the centre of the crown, the latter is plane. The next tooth is a parallelogram narrowed towards one end, which is rounded obliquely to the other sides; it is narrower than the last, and the dentinal plates are worn in exactly the same way. The last tooth is much wider than the others, and has a subtriangular outline, the narrow end very wide and obtuse, and on the same side as the narrowed end of the one in front of it. The outline is worn in the same manner, except that the angle at one end of the base of the triangle is, perhaps, more elevated.

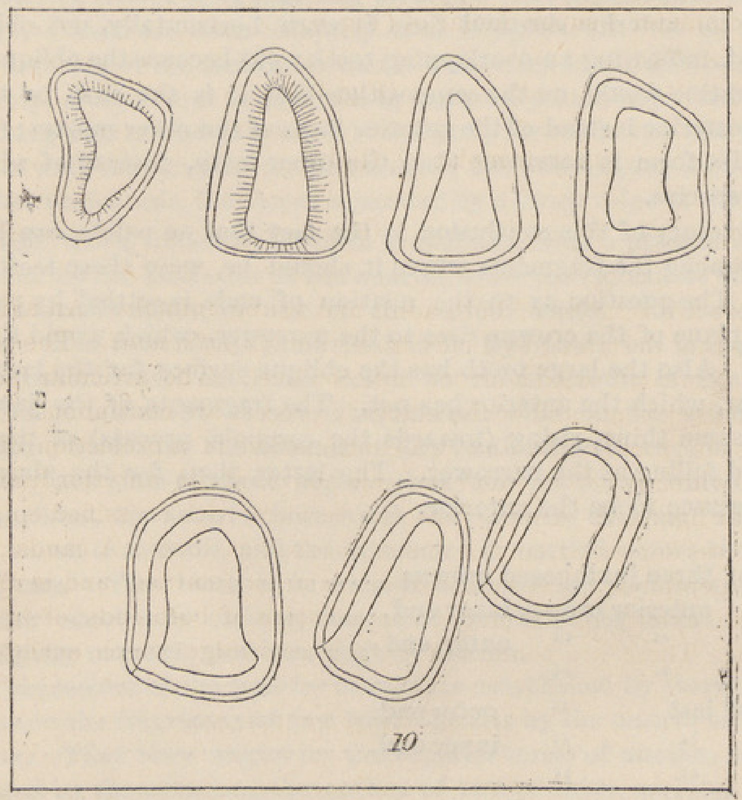
(1.) Neither of the extremital teeth have the oblique face of the posterior one of the known species of *Megalonyx*, nor the reduced size, so that it remains to ascertain whether either of them is the first superior molar. (2.) The larger is evidently not so, because it has an obliquely-worn distal face, indicating the existence of another tooth beyond it in the opposite jaw. (3.) The opposite one is not the anterior molar, because (a) its anterior dentinal face is worn horizontally, not obliquely backward, indicating an overlapping tooth ; (b) because the oblique wear of the dentine would, on the supposition that it is the first, be thrown on the posterior instead of the anterior faces of the other molars ; (c) and because its form is narrower than the other teeth, instead of wider as in other species.

Confirmatory of this conclusion is the fact that no palate can be discovered among the fragments where it should be, were these teeth maxillaries. The question as to the relation of ends is settled by the fact that the plane of the crowns rises to the narrower, which would thus be anterior. Also the large tooth has the oblique surface for the last superior molar, which the anterior has not. The fragments of the jaw indicate the same thing, rising (towards the coronoid process) at the large tooth and falling at the narrower. The latter, then, for the above reasons, I assume to be the anterior.

	M.
Length of three juxtaposed crowns	0.053
" anterior crown, inner end	.013
" " " outer end	.013
Width " "	.02
Length of last " outer end	.014
" " " inner end	.0016
Width " "	.02
Length of shaft first tooth	.054

There are five isolated molars of the same type as the above. Three of these are evidently anterior or second inferior molars, two of the left side and one of the right. Their section is suboval, and all the details, size, &c., are as above described. Two others are like the second (or third) inferior molars. One of these is peculiar in being a little concave on the anterior face, the inner extremity very oblique, the other is more oval.

The question as to the *specific relations* of these inferior molars may be stated as follows. Their large size precludes the probability of their belonging to either *M. tortulus* or *M. sphenodon*. They appear to belong to one species, without doubt. The superior molars also belong to one species, and as no other species is represented in any thing like the same abundance, it is reasonable to suppose that these, with the most abundant of canine molars, belong to the same form of Megalonyx. The canine molars differ from those of *M. loxodon*, and the posterior upper molars from those of *M. dissimilis*. The disproportion between the sizes of the second and last inferior molars, with the narrow oval and triangular forms of the same, separates the animal from the *M. jeffersonii.* The only known molar of *M. validus*, Leidy, is like nothing found in the present species, and *M. rodens* and *M. meridionalis* each have their peculiar features. I therefore call the present animal *M. wheatleyi.*



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Another molar, perhaps the third inferior of the three, is larger, and appears to belong to another individual; it is a little wider inwardly, and resembles Leidy's fig. 13 of Pl. XVI., except in its narrower angle and perfect symmetry. It may belong to *M. wheatleyi*, but the outer angle is regularly rounded; it may be *M. sphenodon.* It differs from those of *M. jeffersonii* as the *M. wheatleyi*, in the greater extension in a transverse direction, and in the concavity of one of the long sides. The enclosed area of osteodentine is in section a frustrum of a narrow triangle, instead of rounded parallelogrammic as in *M. jeffersonii.*

Measurements of teeth.

	M.
Long diameter, (Fig. 5) light cold. canine molar	0.0316
Short " " "	.018
Long " of (Fig. 3) " "	.0325
Short " " " "	.019
Long " of (Fig. 6) black "	.035
Short " " " "	.017

Long diameter of (Fig. 6) black super. molar			.021
Short " " " "			.015
Long " (Fig. 9) light, "			.0215
Short " " " "			.0158
Total length " "			.062
Long diameter 4 super. molar of (Fig. 6)			.017
Short " " "			.011
Long " " (Fig. 9)			.018
Short " " "			.0129
Long " inferior molar (light)			.0223
Short " " "			.015
Length " 2d " (loose)			.0214
Width " "			.015

There are *vertebræ* of both adult and young animals. An axis is much like to that described by Leidy in *Megalonyx jeffersonii*. The centrum is much depressed, with a strong inferior keel. The articular faces of the lateral abutments and of the odontoid process are continuous. This process is short and conic, and is a continuation of a projection of the centrum, which is notched on each side above, at its anterior limit, for the annular ligament. A more posterior cervical, with coössified epiphyses, is much less depressed, and is about as broad as long. A caudal, with coossified epiphyses, has subround articular extremities, and is remarkable for the extent of the chevron articulation of both ends of the inferior aspect. These are connected by a lateral ridge which encloses a deep fossa.

Measurements of Vertebræ.

	M.
Length axis	0.089
Greatest width	.096
" neural canal	.035
Width centrum behind	.044
Depth "	?? .028
Length poster. cervical	.054
Width " articular face	.0565
Depth " "	.05
Lengh caudal	.052
Width " articular face	.057
Depth " "	.05
" " young, larger animal, with separate epiphyses	.083
" articular face, dorsal of young	.05
Width " "	.062
Length centrum of "	.0455

The *carpals* do not present marked difference when compared with those figured by Leidy under *M. jeffersonii*. Among the *tarsals*, one astragalus is exactly like that of the latter species; another is deeper and shorter, viewed from the inner side, with vertical truncation below in front, and much deeper superior ligamentous pit. Of the scaphoids, two probably of the same animal, are deeper posteriorly, and with the convex part of the superior articular face rounded ; four others are flatter, two with the articular face above rounded, and two subconical. The cuboids differ in the degrees of depression of form. Two are more depressed, three larger less so, and one still less.

The *metacarpals* are all present, and belong to several animals. There are four of the first, which appear to have belonged to two species. Three exhibit the articular extremity as very oblique to the superior plane of the bone, and including a groove between it and the surface of attachment to the 2d metacarpal. The inferior surface exhibits a swollen knob, and a pit behind it. The fourth is nearly plane above and below, with the articular ginglymus at right angles to both, and articulation to second metatarsal also at right angles to them. No groove between these surfaces, but a regular concavity. Outer extremity not projecting as in the first. The other metatarsals have the form and proportions already described by Leidy.

	M.
Length of Metatarsus I	.045
Width " posteriorly	.036
Length " II,	.059
Depth " "	.052
Length " III,	.0945
Depth " "	.057
Length " IV,	.104
Depth " "	.05

The phalanges are like those figured and described as belonging to the *M. jeffersonii*. Many of them are the proximal ones of greatly shortened proportions, characteristic of the sloths. The penultimate are of various sizes, an average one measures as follows:

	M.
Length	0.071
Depth behind	.045
Width "	.037

But the following measurements of a proximal phalange indicate an immensely large example.

	M.
Length	0.031
Depth behind	.062
Width "	.053

The *ungueal phalanges* are compressed and curved, with obtuse rounded superior margin. Only one exhibits a tendency to the acute superior margin characteristic of those typical of *M. jeffersonii*, though claws of both kinds have been ascribed to the latter. The inferior plane is gently convex. The insertion for flexor tendon is expanded laterally over the origin of the nutritious foramen on each side, into a shelf: general form longitudinal oval. The superior direction of the median radius of the cotylus for the last phalange, shows that the claws were always flexed to some degree.

Fragments of many long bones, including many condyles, accompanied the above, but in the lack of certainty as to their proper reference, are not described.

This species is dedicated to Charles M. Wheatley, of Phœnixville, to whom Natural Science in the United States is under many obligations. The expense and much labor requisite for the proper recovery and elucidation of the remains contained in the cave are entirely due to his liberality and exertions. Similar devotion to Science has preserved to us the finest series of fossils of the triassic period of the Northern States in existence, and the finest collection of fresh water shells in America.

Megalonyx dissimilis, Leidy.

Proc. Acad. Nat. Sci., Phila., 1852, 117. Sloth tribe N. A., 45, Pl. xiv., figs. 4—8, xvi., 8 and 15.

Probably represented by three canine molars, which belong to at least two individuals. They have been described under head of the preceding species (see 1 a c). The canine molars are the only ones which can be compared with Leidy's figures and descriptions, with which they agree closely.

Measurements of teeth.

	M.
Long diam. canine molar, larger individual of 1 a c	0.036
Short " " " "	.0158
Long " " smaller "	.032
Short " " " "	.014
Length shaft " " "	.079

This species is evidently about the size of the *M. wheatleyi* and *M. jeffersonii*.

Megalonyx sphenodon, Cope.

This species is the smallest of the genus yet known from North America. It is indicated certainly by the canine-molars of opposite sides of one individual only.

These teeth are flat and a little curved. A principal peculiarity consists in the regular increase in their diameter, from the apex to the base, in both the longitudinal and the transverse directions. The long diameter of the triturating surface is four-fifths that of the base where broken off. The dentinal layer is thick externally; it contracts after turning, and the layer of the inner aspect is uniformally thin, but less so than in *M. dissimilis*. The inner bulge is well marked, and is a little nearer the anterior margin than the posterior; the latter is the thicker. The triturating surface is slightly oblique in the long direction, as in the two species preceding this, and concave transversely ; the inner dentinal plate being worn much lower than the outer. Exterior face of tooth regularly and gently convex.

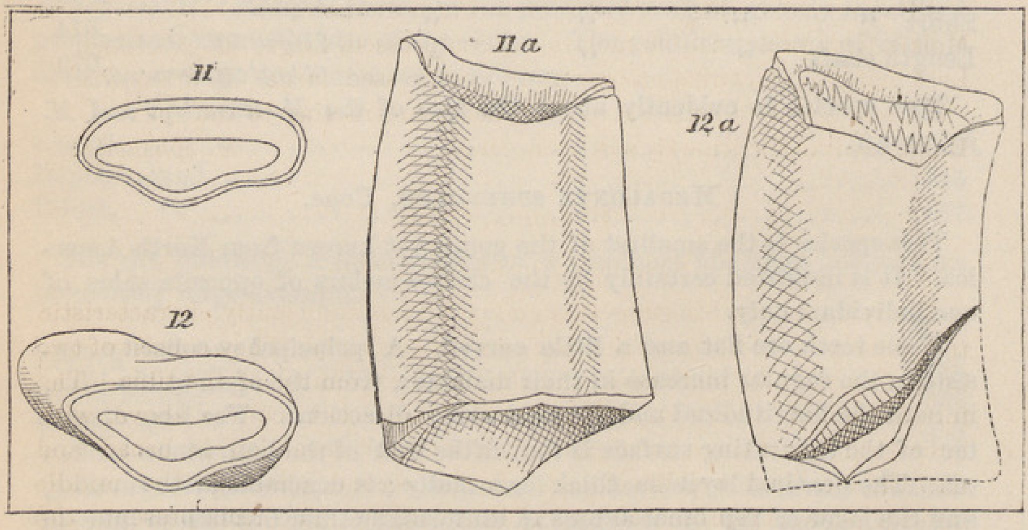
	M.
Length of fragment of tooth	0.044
Long diameter at grinding face	.025
" " " base fragment	.0275
Short " " " "	.0148
" " " grinding face	.0125

The question has naturally arisen, whether this tooth has not belonged to a young animal of *M. wheatleyi* or *M. jeffersonii.* Its small size and subconic form would suggest this view. Teeth of the monophyodont type, generally possess the character of those of the successional type, in being protruded of the full size, and not increasing in diameter with age. Exceptions, however, occur in some *Rodentia*, as the beaver. It has however, never been seen among the numerous teeth of sloths, which have been studied by authors, while a genus allied to *Mylodon*, *Sphenodon* of Lund, presents this character at maturity. Further, the most expanded portion of these teeth presents considerably smaller dimensions than the smallest of the *M. jeffersonii*, figured by Leidy ; the diameter of the triturating surface is only .66 of that of the same, (Leidy, l. c. xvi, fig. .6).

In the moderate development of the inner bulge, these teeth are like some of those of *M. wheatleyi.*

MEGALONYX TORTULUS, Cope, sp. nov.

Established on two corresponding canine-molars of opposite sides of a sloth, found in association with the preceding. These teeth are more dis-



tinctly curved than in the three species preceding, but are more as in *M. jeffersonii* and *M. loxodon.* Its shaft possesses a peculiarity of the latter, which is not seen in *M. wheatleyi*, *M. dissimilis* and *M. sphenodon*, i. e., it is twisted, so that the vertical plate of the triturating surface is quite oblique to that of the basal portions of the shaft.

The triturating surface is, in its long diameter, transverse to the margins of the tooth adjacent; the short diameter is very oblique. The bulge is well marked, and in the specimens a little anterior to the middle. The inner layer of dentine is thickest anteriorly, where it is but a little narrower than the thick external layer, but it is nowhere very thin. The outer face is concave, a feature not seen in the three species above mentioned, and not exhibited by any of the sections of the teeth of *M. jeffersonii* given by Leidy, l. c.

	M.
Length of fragment of tooth	0.043
Long diameter grinding surface	.0232
Short " " "	.0145

These dimensions show that the *Megalonyx tortulus* is not larger than *M. sphenodon*, perhaps not so large, as the diameters of the apices of their teeth are identical, while that of the base is equal to the apex in the former, greater in the latter. The concavity of the outer face, and disposition of the dentine, are entirely different from that seen in *M.* and *sphenodon* other species, and more as in *M. jeffersonii* and *M. loxodon.*

For the better discrimination of these species, the following synoptic table of dental characters is added.

A Canine-molars, much curved, of equal diameter.
Large, bulge median; grinding surface oblique. *M. jeffersonii.*
Large, bulge anterior; grinding surface a groove. *M. loxodon.*
Small, concave externally. *M. tortulus.*
B Canine-molars little curved, of uniform diameter.
Molars triangular, canine-molars less compressed, large. *M. wheatleyi.*
Last molar oval, canine-molars more compressed, large. *M. dissimilis.*
C Canine-molars little curved, diameter contracting to the apex.
Bulge median, dentine thin within, small. *M. sphenodon.*

Mylodon, Owen.

Mylodon ? harlani, Owen.

The remains representing this genus are not sufficiently characteristic to enable me to determine the species with certainty. They consist of two imperfect ungueal phalanges, and the distal extremity of the tibia. The former indicate a very large animal; they are stout, convex above, with lateral ridge and three basal plates. The flexor insertion is broad and flat, the foramina well developed. In the second phalange the middle inferior plane is represented by an obtuse angle. The tibia presents the excavation for the astragalus, as in *M. robustus* Ow,* but is narrower or with less anteroposterior diameter than in that species.

*See Owen on Mylodon. Pl. xx fig. 4.

Measurements.

	M.
Long diameter end of tibia	0.135
Short " " " (transversely)	.08
Vertical diameter ungueal phalange at nutritious foramina	.053
Transverse " " " " "	.037

These claws are similar to those of the *M. harlani* which have been discovered.

SCIURUS, Linn.

SCIURUS CALYCINUS, Cope.

Species nova.

Established on two imperfect rami of the under jaw, with the incisor and first, second and third inferior molars *in situ*. The size approximates it to the *S. hudsonius*, and exceeds that of the *S. panolius*. The forms of the ramus so far as visible, is not unlike that seen in the same squirrel. The characters which distinguish it from *S. hudsonius*, are chiefly to be seen in the molar teeth, especially the anterior. The crowns of all are deeply cupped, and the triturating surfaces form anterior and posterior narrow bounding bands, which widen outwardly. The margin of the tooth is elevated and entire, except externally, where the two usual low cusps are separated by a deep notch. In the *S. hudsonius* the interior and exterior margins are both emarginate, each notch supporting a median cusp, thus forming three on each side. The anterior molar exhibits this character still more strongly. Its crown is a cup as wide as long, with high uninterrupted margin, except on the outer side, where it is deeply notched, It has but two roots. In *S. hudsonius* this tooth has three roots, is longer than wide, and has three marginal cusps on the inner and outer sides of the crown.

Length of three crowns m. 0048 ; length exserted portion of inferior incisor m. 007 ; transverse diameter do. at point of issue m. 0023.

From the extent of the worn surfaces of the molars, the animal described is adult. The second ramus is of the same size; the dental series is complete, and the teeth are worn so as to present a dentinal area surrounded by a thin margin of enamel. The outlines of the teeth are like those of the first specimen.

As compared with *S. panolius*, the species is larger, and differs in the form of the m. 1, as much as in the case of *S. hudsonius*.

JACULUS, Wagler.

JACULUS ? HUDSONIUS, Zimm.

One ramus mandibuli with incisor and second molar preserved. The latter nearly resembles the figure in F. Cuvier's Dents des Mammifers, and the ramus is about the size of that of the existing jumping mouse. Nevertheless, in lack of specimens of the cranium of the latter, I am unable to determine its specific relations, now first found in the Postpliocene.

HESPEROMYS, Waterhouse.

A ramus with first and second molars and incisor, agreeing in details of structure, with the group with which our recent *H. leucopus* is type, and of the size of that species, not certainly referable to the latter, without further comparison.

ARVICOLA, Lacep.

Remains of species of the genus are numerous in all the cave formations of the United States which I have examined. Those obtained by my friend, C. M. Wheatley, are referable to three sections of the genus, one of them the group Pitymys, as defined by Prof. Baird,† the others new; one intermediate between Arvicola and Pitymys, and third an exaggeration of the peculiarities of the last. They are defined as follows, the character of the sub-genus Arvicola being added for comparison.

Arvicola, Lac. Anterior lower molar triangles $1\,\frac{3}{2}\frac{}{3}$, 1 three lobed; middle lower, $1\,\frac{2}{2}$; middle upper, $1\,\frac{2}{2}$.

A. riparia, Ord.*

Isodelta, Cope. Anter. inf. molar, $1\,\frac{2}{2}$; 1 three lobed; 2d inf. mol. $1\,\frac{2}{2}$.

A. speothen, Cope.

Pitymys, McMurtrie. Ant. inf. mol. $1\,\frac{2}{1}\,1$, lobed; 2d inf. mol. $1\,\frac{1}{1}\,1$.

A. pinetorum, Lec. *A. sigmodus*, Cope. *A. didelta*, Cope. *A. tetradelta*, Cope.

Anaptogonia, Cope. Ant. inf. mol. $1\,\frac{4}{3}$, 1 several lobed, the triangles all connected medially, the posterior nearly enclosed.

A. hiatidens, Cope.

The third group is represented by the greatest number of individuals and species.

ARVICOLA SPEOTHEN, Cope.

Sp. nov.

This species is represented by the entire dentition of the left ramus mandibuli, with a few fragments of the adjacent bone. As already pointed out, its characters entitle it to rank as a distinct section of the genus. Thus the triangles of the inner side of the anterior inferior molar are one less than in any species of the section *Arvicola*. The anterior loop presents two well marked angular basal areas, while its terminal portion is regularly rounded. The accompanying outline will give a good

†I have depended on Prof. Baird's well known work in studying this genus.

*ARVICOLA RIPARIA, Ord.

Baird, U. S. Pac. R. R. Surv , viii, 522.

This species has not yet been found in the Port Kennedy cave, and I introduce it for the purpose of recording its occurrence in the cave breccia, Wythe Co., Virginia, whose contents I examined and described in Proc. Am. Phil. Soc., 1869, 171. It is represented by a left ramus mandibuli, entire except in the angle and condyle, and with complete dentition. The size and proportions are identical with those of the existing species, as are also the triangles and form of terminal trefoil lobe of the anterior inferior molars. There is no difference to be observed between the third inferior molar when compared with that of *A. riparia* from Pennsylvania, but the anterior alternate triangles of the second, are not isolated, the reentrant inflection of the external enamel plate not reaching the internal, as in the recent animal.

idea of its form. That this is not one of the species of *Pitymys*, in which the basal lobe of the anterior trefoil has been cut off by unusual inflexion of the enamel angle, is demonstrated by the structure of the second molar, which is precisely that of typical *Arvicola*, all the triangles from the posterior being isolated and alternating, producing the formula, 1 $\frac{2}{2}$ 0. The third molar has the usual formula, 1-1-1, the posterior two lobes being crescentic, the anterior trapezoid.

Measurements.

		M.
Length grinding surface inferior molars, (No. 1)	....	0.0068
" " " 1st " " "	....	.003
" fang and crown " " " "	....	.005

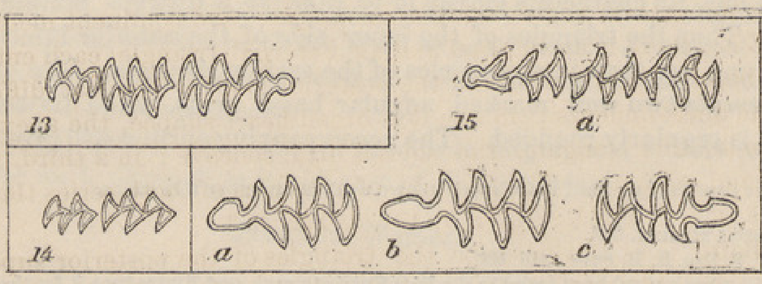
The structure of the molar triangles, i. e., their acuteness and thinness of enamel, induces me to describe here, without any certainty of reference, the superior molar teeth of one individual found near the same time. The formulae of the superior molars are (1) 1 $\frac{1}{2}$, (2) 1 $\frac{1}{2}$, (3) ? this, so far as known, identical with that of *A. didelta*. In another specimen represented by incisor and sup. m. 1., the former has an oblique antero-external face, with narrow truncate outer face ; enamel not striate, emarginate at the cutting edge. In *A. didelta*, (fossil, below), the antero-external face is more oblique, and without defined external plane ; the end is not emarginate (in one specimen). This tooth appears to be relatively smaller and weaker in the ?*A. speothen*.

		M.
Length fang and crown, 1st superior molar (No. 3)	....	.004
Width enamelled face incisor " "	....	.001

ARVICOLA TETRADELTA, Cope.

Sp. nov.

Represented by a portion of the cranium, which embraces the 2d and 3d superior molars, and parts of the m. 1, and incisor. The formula of the



two molars perfectly preserved is 1 $\frac{1}{2}$, 1 $\frac{2}{2}$. The terminal triangles are as well developed inside as outside ; the others are rather small and obtusely angulated. Those of the m. 3, are entirely separated, and the last is not followed by a loop, but is completely enclosed behind by the vertical enamel plate, which bounds the corresponding triangle in the m. 2. This is a character which distinguishes this species from any other of the genus Arvicola which has been described from North America, of which the corresponding tooth is known. The last triangle is slightly angulate in posterior outline.

	M.
Length grinding face of m. sup. 2 and 3........................	0.0037

It is only necessary to compare this species with the *A. speothen* and *A. involuta*, in which, unfortunately, the corresponding tooth is unknown. Its small and obtuse triangles distinguish it from the former. As reduction of the terminal loop of the m. inf. 1 is characteristic of the latter, the present tooth might be suspected to belong to it, but there is a real increase in the number of triangles over that of the most nearly allied species. *A. didelta*, and of the section *Pitymys*, to which it belongs, pointing most to the sections *Isodelta* or *Arvicola*. Size, .25 less than A. speothen.

ARVICOLA DIDELTA, Cope.

Species nova.

Represented by the mandibular rami of five, and superior dentition of probably three individuals. One imperfect cranium contains the dentition of both jaws, thus fixing the relations of fragmentary specimens, especially in the more important relation of the anterior, inferior and posterior superior molars. The characters of these show that it is allied to the *A. pinetorum*. The accompanying cuts illustrate the form of the first inferior molar tooth. The ridges are four internal and three external. The second molar exhibits the formula 1 $\frac{1}{1}$ 1, the anterior area with an approach to division into two triangles, alternating. This peculiarity is not seen in Prof. Baird's figure of *A. pinetorum*, l. c. liv. 1719, nor does the latter represent the loops of the last molar, as exhibited by our specimens. In the figure they are oval, in our specimens angulate crescentic. As the figure does not agree with the description, I do not rely on it for these details.

A more important difference is seen in the structure of the superior third molar, which Baird describes and figures as having but three isolated areas, the lateral angles being sub-opposite and confluent medially. In *A. didelta*, there is an internal and an external triangle, each entirely isolated, besides the anterior and the posterior loops. The last differs a little in its developments ; in one it is broad heart-shaped, the apex posterior ; in another elongate, the sides a little concave ; in a third, more elongate and concave. The formula of triangles of both series then is: Sup. 1, 1$\frac{2}{2}$. 2, 1$\frac{1}{2}$. 3, 1$\frac{1}{1}$1. Infer. 1, 1$\frac{2}{1}$1. 2, 1$\frac{1}{1}$1. 3, ?

Prof. Baird does not describe the triangles of the posterior superior molars in the *Arvicola austera* as isolated, though it might be inferred from his language. His figure, however, resembles that of the *A. pinetorum*. (See Baird, U. S. Pac. R. R. Surveys, viii, 539.)

ARVICOLA INVOLUTA, Cope.

Species nova.

Established on a nearly complete ramus mandibuli, with dentition perfectly preserved, It is nearly allied to the *A. pinetorum*, differing prin cipally in the form of the anterior lower molar; (see accompanying cut). The anterior lobe of this tooth is much shortened and crescentic, the inner horn of the crescent being the apex of a ridge of the tooth. Thus there are five internal and three external ridges to the tooth. Triangles of inferior series (1) $1\frac{2}{1}1$ three lobed; (2) $1\frac{1}{1}1$; (3) 1, 1, 1. The anterior loop of the second molar is contracted, outlining two triangles. the lobes of the third are angular sub-crescentic, the anterior trapezoid. This molar differs distinctly in structure from that of the next species, q. v. The *A. involuta* is nearer the *A. pinetorum*, and is of the same size.

Arvicola sigmodus, Cope.

Species nova.

This species belongs to the same group (as characterized by dentition), as the last two, and is of about the same size, viz: about that of our common *A. riparia*. It is represented by three imperfect mandibular rami, two with dentition complete, the other with the posterior molar only wanting. Its characters are near those of *A. austera*, Lec., as pointed out by Prof. Baird. It differs from the *A. didelta* and *A. involuta* of the present paper, in the five lobed anterior loops of the first inferior molar. The loop has, therefore, besides the two basal unenclosed triangles, a smaller projecting angle on each side, and the terminal slightly angulated lobe. In the most typical specimen, the median angles of this lobe are as prominent (fig. a) as the basal, or the triangles, though the loop of the lobe is not angulated at the end.

There are, thus, five internal and four external ridges of the tooth. The triangles are as usual $1\frac{2}{1}1$, 5 lobed, (2) $1\frac{1}{1}1$, (3), 1, 1, 1. The anterior loop of the second is contracted as in the two preceding species. The third is quite different from that described under the head of *A. involuta*, and that figured by Baird for *A. pinetorum*. Thus, its three loops are chiefly extended inwardly, their outer angles projecting very little beyond the point of junction; they form a w or sigma-shaped grinding surface, whence the name of the species. Prof. Baird's figure of *A. austera* represents the first inferior molar of this species exactly, but is very different in form of the last, which is like that of the *A. involuta*. Should however, the character as here described in this tooth of *A. sigmodus*, be found to occur in the *A. austera*, the former name will become a synonyme of the latter.

Measurements.

	M.
Length grinding surface infer. molars, (No. 1.)	0.0065
" " " 1st " " "	.003
" fang and crown " " "	.004
Width inferior incisor	.0015

The dental series of the more typical specimen, whose m. 1 is outlined in fig. a, is smaller and relatively a little narrower than the others.

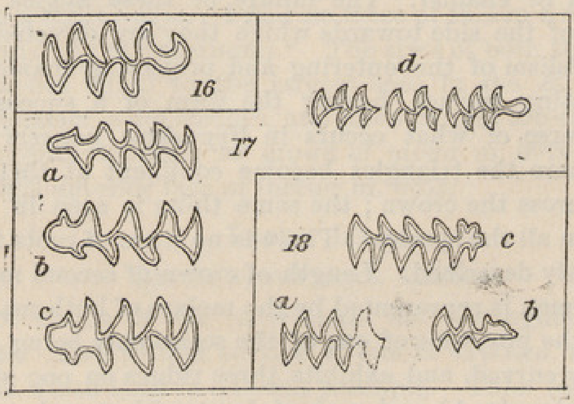
The supposed superior maxillary dentition is represented by both series, that of the left side lacking the first molar, with the palatine surface and one upper incisor. The lobe formula is $1\frac{2}{2}$, $1\frac{1}{2}$, 1, $\frac{1}{1}$ 1 three lobed. The lobe of the posterior molar is quite elongate, and divaricates into two angles anteriorly, the external of which is almost isolated, almost giving the formula for the tooth $1\frac{1}{2}$ 1. The teeth of both sides are exactly alike. The near approach to isolation of this external angle is due to the deep inflection of the posterior inner groove, and very near approach to a corresponding incurvature of the lobe. This specimen is referred to the *A. sigmodus* by the analogy to the relation between superior and inferior molars seen in *A. didelta*. In the latter the terminal loop of the inferior m. 1 is more simple and the loop of superior m. 3, agrees with it in its simplicity, having nearly the same form. The increased complexity of the anterior loop of the inferior m. 1 in *A. sigmodus* is shared by the m. 3 sup. here described, though not in exactly the same manner. I refer it, therefore, to this species with a reservation.

	M.
Length of dental series	0.007
Width between middle of m. m. 2	.005
" incisor tooth in front	.0015
Length from m. 2 to incisive foramen	.0049

Arvicola hiatidens, Cope.

Species nova.

Represented by several molar teeth. These are several times as large



as the teeth occupying the same position in any of the species already mentioned in this essay, and suggest the genus Fiber. The distinctive features of the latter are the compressed oar-like tail, with rooted molars, and it is evident that the relationship of this species is not to it. Perhaps it is neither an *Avicola* nor a *Fiber*, since it differs in the structure of the teeth from the known species of both. None of the triangles are isolated, but are connected by a narrow strip of dentine, which is narrow posteriorly but widens anteriorly until it opens out into the terminal loop. Thus the sectional name *Anaptogonia* may be found ultimately applicable to a separate genus. The separation of the enamel folds merely carries to the highest degree that which is seen in the anterior part of the tooth of *A. sigmodus*.

In the inferior m. 1, the triangles which do not open on one side to the anterior loop are $1\frac{4}{3}$, then one on each side, and the short wide terminal loop which is bilobed or emarginate in the middle of the end. The ridges, which are very prominent and acute, are, therefore, $\frac{6}{5}$; at the extremity there are two short ones, between which a third and more prominent one rises a little below the grinding surface. A little more attrition would give the distal loop a trilobate outline, and a little more, an acuminate one, from the loss of the lateral angles; finally the median ridge disappears also. In its present state one of the terminal lobes is almost external, making the ridges $\frac{6}{6}$.

Measurements.	*M.*
Length grinding surface	0.005
Width "	.0024
Length fang and crown	.0078

The accompanying cut of twice natural size explains the above remarks.

Two opposite molars held in natural relation by the matrix, resemble the above in structure and size so closely as to leave little doubt that they belong to the same species. Whether they should be referred to the superior or inferior series is uncertain, though analogy with the *Hypudæus gapperi* would suggest the latter. They represent the right and left second molars, and the triangular areas if isolated, would be $1\frac{3}{4}$, not one of them, however, is isolated, the dentine being continuous round the entering angles of enamel. The failure of these angles to reach the enamel margin of the side towards which they are directed, and an approach to parallelism of the entering and projecting enamel plates produces a triturating surface, having the form of a succession of Ws. This is the reverse of what occurs in *Hypudæus gapperi* according to Prof. Baird, where the triangles become confluent at their bases, thus extending all across the crown; the same thing is seen in the posterior inferior molar in all the species. There is no trace of roots to these teeth or that previously described. Length of crown of second molar, m. 0056.

A third specimen is represented by the molars of both maxillary bones, much broken, the posterior of one of the series only being entire. This tooth is slightly curved, and exhibits three ridges on one side, and four on the other; triangles $1\frac{2}{1}$ and a short loop with two basal angles, the inner more prominent than the other. None of these triangles are isolated, but are rather angular expansions of the continuous dentine. The two inner angles are much more prominent than the outer, but in old age they would probably be equal, judging from their appearance at the base of the tooth. Viewed from below, they appear to be closed, showing that the character of the group *Anaptogonia* in this respect is derived from a "retardation" of growth in a point which is early attained in true *Arvicola*.

	M.
Length of tooth	0.005
" crown	0.003
Width palate	0.004

ERETHIZON, Cuv.

The remains of a porcupine of the existing North American genus occur in the deposit. It is evidently different from the recent *E. dorsatum* and presents the following characters.

ERITHIZON CLOACINUM, Cope.

Species nova.

Represented by a last superior molar of the left side, and a portion of one of the inferior incisors. The former indicates the distinctness of the species by two peculiarities. One of these is the greater vertical depth of the external inflection of enamel. It is nearly as deep as the internal, while in *E. dorsatum* it is very much shallower, the internal extending down to the alveolar border. This appearance in the present species is not due to deficient attrition, for the molar in question is well worn, so as to leave the margins of the anterior island well posterior to the anterior enamel margins of the tooth. This anterior island is a transverse oval, slightly concave behind.

The general form of this tooth is T shaped, with an expanded triangular base. The second specific character is seen here ; for while the recent species posesses an enamel island or annulus which occupies this space entirely, the *E. cloacinum* exhibits two, the additional one being on the inner side and smaller than the usual one. It is suboval, and occupies the inner posterior angle of the triturating surface, which is expanded, and less than a right angle. I find no trace of this in five crania which I had the opportunity of examining.* The sizes of both this tooth and the incisor are about equal to the largest seen in the *E. dorsatum.* The enamel of the latter is not smooth, and has a minute interrupted striation.

Antero-posterior diameter of crown of molar m. 0076 ; transverse do. m. 0077 ; width anterior face of incisor m. 0055.

LEPUS, Linn.

LEPUS SYLVATICUS, Bachm.

Portions of crania of six individuals not distinguishable from this recent species. The palatal surface of one is exposed, and is longer in relation to its width than in a recent example. Thus in the former the length enters the width between the two anterior alveoli 1.2 times ; in the latter 1.6 times. In Prof. Baird's figure it enters 1.4 times. Some of the specimens are smaller, some larger than the average of our recent ones. One of them had an oval mass of carbonaceous matter in its mouth, probably the remains of its unswallowed vegetable food.

PRAOTHERIUM, Cope.

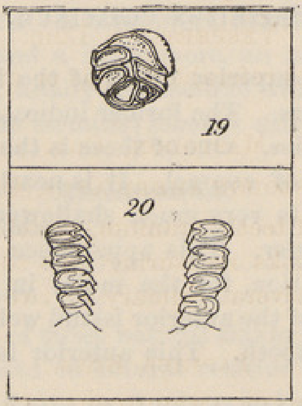
Molars similar to those of *Lepus*, rootless, with oval crowns transverse to the axis of the series, all simple ; masticatory surface not divided by median ridge, enamel boundary emarginate on the inner side. Number in maxillary bone ? four.

* I owe a skeleton of the *E. dorsatum* from Muncy, Penna., to the kindness of my friend, Jas. S. Lippincott.

PRAOTHERIUM PALATINUM, Cope.

Species nova.

This rodent is represented by the palatal region of the cranium of one individual, with four superior molar teeth of each side in position. The latter diverge symmetrically, probably in consequence of pressure, But a



small part of the palatine surface is preserved. The normal number of teeth is uncertain, but the anterior tooth is known from its relation to the fragments of maxillary bone and perhaps zygomatic arch. It resembles the three molars which follow it. Behind the fourth no trace of tooth or bone could be found on exploring the matrix, though the latter was unbroken, hence it is possible, though not certain, that there were none.

The genus differs from those of the *Geomyinae* of Baird, in the simplicity of the first molar. The wide palate and narrower zygoma, as well as the forms of the teeth, are those of the rabbits, but it differs from the two genera, *Lepus* and *Lagomys*, in the identity of structure of the first molar with the others, and the absence of an enamel band dividing the triturating surface of each of them. In some of the teeth a trace of the dividing lamina is visible, but does not appear to have been elevated into a crest of the grinding surfaces.

In specific characters, this rodent differs from our rabbits in its small size, and in having the molars deeply longitudinally grooved on the inner face, instead of the outer. In worn teeth this groove is continued into the grinding surface of the crown, without interruption from the enclosing enamel. The form of this surface is then an oval, notched on the inner side, and rounded or slightly truncated on the outer. The palatine face is but partially preserved, and is considerably wider in proportion to the diameter of the teeth than in *Lepus sylvaticus*.

	M.
Length crown of four consecutive molars	0.0061
Width " one molar	.0021
" palate between bases of molars	.0100

SCALOPS, Cuv.

The only remain certainly referable to this genus is a humerus. As the form of this element is very characteristic among the Talpidæ, the species may be determined from it with considerable precision. Its form is less stout than in *Talpa europæa* and *Scalops aquaticus*, but considerably more so than in *Condylura cristata*. In the uncertainty as to whether it can belong to *Scalops breweri*, I leave it without a name.

?VESPERTILIO, Linn.

Numerous slender bones referable to this or an allied genus, are found in the cave deposit.

MASTODON, Cuv.

MASTODON AMERICANUS, Cuv.

Numerous fragments of teeth, cranium, vertebræ, and extremities, of a large individual, with tusks measuring five to six inches in diameter. Some three-crested, and several primary or two-crested molars, indicate a second, smaller animal.

TAPIRUS, Briss.

TAPIRUS AMERICANUS, Auct.

Numerous teeth from all positions in both jaws indicate several individuals of different sizes. Some of them are of the size of the existing species of South America, and do not exhibit any differences of specific importance.

TAPIRUS HAYSII, Leidy.

Holmes' Postplioc. Foss. S. Ca., Pl. xvii. figs. 4, 5, 7, 8.

Four superior and six inferior molars do not differ in any respect from those of the preceding species. excepting in size. In this they exceed the latter, having about twice the superficial area. Leidy appears to have proposed this species on account of size only, and the specimens may indicate a valid species. Two superior molars, perhaps referable to the *T. americanus*, differ less in size, exceeding a little those of our recent specimens.

Dimensions of three superior molars of the largest (*T. haysii*), medium and smallest (*T. americanus*) size are given. The last two are worn, the first had not protruded through the gum.

	M.
Length, 1	0.029
Width, 1 (greatest)	.0332
Length, 2	.023
Width, 2 (greatest)	.029
Length, 3	.0218
Width, 3 (greatest)	.025

In addition to the teeth, there are numerous bones of the extremities, tarsus, &c., and vertebræ.

EQUUS, Linn.

Numerous phalanges of two species of slender proportions and smaller size than the recent domesticated horse. Neither the species nor genus are determinable as yet, from the remains.

Bos, Linn.

Extremity of a femur, several patellæ and fragments of metatarsals of a large species of ox or bison are preserved with the others. The species is not yet determined.

There are, perhaps, two other species of ungulate animals not as yet determined.

Ursus, L.

Ursus pristinus, Leidy.

Arctodus pristinus, Leidy. Proc. Acad. Nat. Sci., Philada., 1854, 90, Holmes' Postpliocene Fossils S. Carolina, 1860, 115, Pl. xxiii, f. 3–4.

This bear has been known hitherto by a molar of the lower jaw found by Prof. Holmes near Charleston, S. Ca., and the references above indicate descriptions and figures of this tooth alone. Mr. Wheatley's collection contains the first and second molars in a portion of the right ramus of the mandible, and the canine and first, second and third molars of the left ramus separated from it. There are also vertebræ of bears from the cervical and dorsal regions, which are appropriate as to size, and were found at near the same time as the teeth.

A character which at once distinguishes this bear from all those now living in the northern hemisphere (faunally speaking), and those known to have inhabited it during the postpliocene period, is seen in the first molar. Instead of the usual two series of tubercles, it has on its anterior half a single rather obtuse crest, above the outer side of the crown. The crest commences with the apex of an elevated conical tubercle, which marks a point three-fifths the length of the tooth from its posterior extremity. Two very small worn tubercles are seen behind it on each side, in the specimen, while the greater part of the surface of the crown is nearly plane, and covered by unbroken enamel. It is a little depressed, and compressed from the outer side at the posterior third. The enamel of the inner side of the crown is smooth, of the outer side obsoletely rugose. The second inferior molar is about as long as the first, but wider, and of different character. The triturating surface is parallelogrammic rounded at the ends, and narrowed at the anterior third, and contracted, as compared with the width of the base of the crown. The enamel, though worn, is nowhere worn through, and its surface is remarkable for the almost absence of tubercles. The grinding surface is concave transversely, and is bounded by elevated margins. The inner and outer display each three obtuse elevations, the latter the better defined, the anterior the most elevated and connected by a low cross ridge, which is depressed in the centre. The inner sides of the crown is swollen at the base, and more oblique than the outer; both are marked with obsolete ridges, which descend from the grinding face, those of the outer most distinct. The last inferior molar is two-thirds the length of the penultimate. The form is oval, broad anteriorly, narrow posteriorly. The crown is low and flat, without tubercles, the margin a little elevated, and interiorly and posteriorly mammillated; it has a single compressed root.

The inferior canine is represented by a crown. It is remarkably short. and stout at the base; the posterior outline very concave. The usual obtuse keel is seen on its anterior inner aspect, and worn surface postero-exteriorly. The apex of the crown is worn by use. The smaller premolars have not been recovered, but the last or sectorial has left its impression in front of the first molar in place in the matrix, and appears to have been of the proportions seen in the grizzly bear.

	M.
Length three inferior molars and fourth premolar together	0.096
do M. I crown	.029
Width do anteriorly	.013
Length M. II	.031
Width do anteriorly	.0202
Length M. III	.0233
Width anteriorly	.0188
" posteriorly	.0135
Length crown and root	.035

In size this species probably equalled the grizzly bear, as the teeth are as large as those of any of the numerous crania in the Museum of the Academy Natural Sciences, though Prof. Baird gives measurements of some in the Smithsonian collections, which are larger. Should the teeth be related to the skeleton as in our black bear *U. americanus*, a still larger size is indicated. The nearest relationship in the characters of dentition is to be seen in the *U. bonaerensis*, of Gervais* of Buenos Ayres. It has the peculiar form of the first molar seen in *U. pristinus*, but differs specifically in that of the second, which is interrupted in one of its outlines and rather more tubercular.

As compared with *Ursus amplidens*, Leidy, the following relations appear. The last molar has a smaller crown than in the type specimen of the latter. In *U. pristinus*, and the last is between .50 .75, the length of the second molar; in *U. amplidens*, exactly as in *U. horribilis*, five-sixths length of crown, or equal the extent of alveolæ. The third molar is less contracted behind in the type specimen of *U. amplidens*. The latter species appears to be in many ways nearly allied to the grizzly bear.

The discovery of this species by Mr. Wheatley, in Pennsylvania, is particularly interesting, as fixing an extended range for it, and proving that our cave bear is totally distinct from that of Europe, and rather of the type which was associated with the gigantic sloths in the southern regions of South America, at the same geologic epoch.

Felis, Linn.

Two proximal phalanges of a species of this or an allied genus, were found by Mr. Wheatley. They pertained to an animal of the size of the jaguar, (*Felis onca*). A fragment of a canine tooth indicates a cat as large as the tiger, but is too imperfect to allow of determination. Some vertebræ of a carnivorous animal, perhaps of a dog, were also found.

*Palaeontology of Castelnau's Anim. novo. on Rar Am. Sud., Pl. fig.

The result up to the present time may be summed up as follows:

	Species.	Individuals.
Edentata.		
Megalonyx	5	15
Mylodon	1	?2
Rodentia.		
Arvicola	6	15
Hesperomys	1	1
Jaculus	1	1
Sciurus	1	2
Erithizon	1	1
Lepus	1	7
Praotherium	1	1
Undetermined	2	2
Insectivora.		
Scalops	1	1
Chiroptera	?1	6
Ungulata.		
Mastodon	1	2
Tapirus	2	4
Equus	2	3
Bos	1	3
Undetermined	2	3
Carnivora.		
Ursus	1	?2
Canis	?1	1
Felis	2	2
Mammalia total	34	72

Of birds there are fragments of two species, one a turkey, with the spur preserved, probably the *M. altus*, Marsh; (*M. superbus*,† Cope. Trans. A. Phil. Soc., 1870, pp. 239, ii), the other a snipe. The reptiles include one or two species of tortoises, and three or four serpents. There are a few bones apparently of Batrachians. The whole number of species of Vertebrata is about forty, represented by perhaps ninety individuals.

Dr. Geo. H. Horn, to whom Mr. Wheatley submitted the insects, reports, at an early stage of the investigation, thirteen species of *Coloptera* and two or three of other orders, including *Orthoptera*. We await with much interest the further results of this research, as the determination of Postpliocene Coleoptera has not been practicable heretofore. The names already published by Dr. Horn,* are, Carabidæ—*Cychrus wheatleyi Cychrus minor*, *Cymindis aurora*, *Chlaenius punctatissimus*, *Pterostichus laevigatus*, *Pt. longipennis*, *Dicaelus alutaceus ;* Scarabaeidæ, *Aphodius scutellaris*, *Apho. micans*, *Phanaeus antiquus ; Copris punctulatus ;* Histeridæ ; *Saprinus ? ebeninus*.

† As it is now fifteen months since Prof. Marsh announced his species, and no description has yet appeared, it appears to me that *M. superbus*, the only name accompanying a description, will have to be adopted, if the two are really the same.

*Am. Jour. Sci. Arts, 1871, 385, in a notice by C. M. Wheatley.

General Observations.

Several authors have noticed the great difference in character between the postpliocene fauna of North America, and those which preceded it, in Tertiary time. It is well known, that while the Miocene Mammalia are more or less similar to those of Miocene Europe and Asia, and the Pliocene vertebrata have a corresponding resemblance to those of the same period of Europe and Asia, and the present one of Africa, the postpliocene resembles, in many particulars, that of South America or the Neotropical region.

In examining the list of postpliocene mammalia, known up to 1867,* I found, that of 30 species, eleven were represented by members of the same genus or family, in the Neotropical region. In an enumeration of the species from the caves in 1869,† which included 27 species of 23 genera, six genera were shown to be of neotropical type. In an unpublished list of vertebrata, which the writer exhumed in a bone breccia, from a cave in East Tennessee, there are twenty species included. Prominent among these, are *Megalonyx*, *Dicotyles*, *Tapirus*, *Cervus*, and *Sciurus*, the first three neotropical. The species from the Port Kennedy bone cave may be arranged as follows:

	Species.
Neotropical forms	11
Peculiar Nearctic (North America)	3
Genera common to north of both Hemispheres	11
Uncertain	9
Total	34

The theory of evolution requires that change of fauna in any very brief period of geologic time, should be accomplished by migration. Accordingly, authors have suspected that Asia and North America, and perhaps Europe, were connected by land during the miocene period. Thus Leidy, (Mammalia of Dakota and Nebraska, 1869, p. 360), suspects that North America was peopled from the west, from a continent now submerged beneath the Pacific Ocean. Prof. Huxley (Anniv. Address, Lond. Geolog. Society, 1870), makes a similar proposition, but adds that there is no evidence as to whether the connection was with Europe or Asia. In describing fossil *Cobitidæ*, a family of fresh water fishes, from Idaho, in 1871, (Proceed. Am. Philo. Soc., p. 55,) I have adduced evidence that the connection was with Asia. These *Cobitidæ*, as is well known, have no existing representatives in America, and are one of the Asiatic types, characteristic of our Pliocene period. As fresh water fishes, their migration is restricted to fresh water communication. Now, as the Rocky Mountain ranges were in large part elevated prior to Pliocene time, and the water courses had their present directions, it is obvious that the migration of fresh water fishes occupying waters on the west side of those ranges, must have been to or from the west, and not the east. That these

*Proc. Acad. Nat. Sci. Phila. 1867, 156. † Proceed. Am. Phil. Soc. 1869, 178.

fishes, then, passed through fresh water connections, existing on a continent now submerged beneath the Pacific Ocean, seems probable.

The destruction of the Pliocene fauna is generally admitted to have been brought about by the rigors of the glacial climate, and the extension southward of the ice sheet and snow falls. Near the same time, connection with Asia must have been severed by the descent of the North Pacific Continent. Some Pliocene types, not now existent in North America, may have been driven into the Neotropical region, and may be still represented in their descendants, the Lamas, the only existing *Camelidæ* of the new world, with the horses and perhaps others of the higher mammalia of that region. The existence of the extinct *Mastodon*, *Machaerodus*, etc., in the postpliocene of the same region, mentioned by Huxley, as a puzzling fact, (Address l. c.) may be accounted for in the same way.

Of course, on the northward retreat of the ice sheet, the mammalia fauna would have to be derived from the south, for communication direct with Asia no longer existed. If Behrings straits were not yet opened, the masses of glacial ice covering those regions would effectually prevent immigration by that supposed connection. The resulting Postpliocene fauna would naturally partake of the mixed character which our brief investigations into it have revealed. The neotropical forms would occupy regions left vacant, or peopled by a sparse remnant of boreal genera and species. This view I proposed some time ago,* and Dr. Leidy has added his valuable opinion to the same effect.†

Has any great disturbance of level intervened between the occupation of the post-pliocene fauna and the present period? Prof. Dana (Manual of Geology, 1862,) summarizes the results attained up to his writing (p. 553), by showing that the period succeeding the glacial drift was one of submergence, especially in arctic latitudes. He states the depression near Montreal to have been 450 or more feet, and 1000 feet in Arctic regions. Of the Middle States he says nothing, and of the south, that the evidence is not satisfactory. This descent of level he regards as that which caused the melting of the glacial ice, stratification of the drift, deposition of gravels, and elevation of temperature. All these changes would naturally precede the introduction of a postglacial fauna from a warmer region, so that for this and other reasons, the Champlain epoch may be regarded as that opening the post-pliocene, and its fauna to be represented by the Walrus, which extended its range to Virginia, the Reindeer to New Jersey, and the *Beluga* of the Champlain clays.

The origin of the caves which so abound in the limestones of the Allegheny and Mississippi valley regions, is a subject of much interest. Their galleries measure many thousands of miles, and their number is legion. The writer has examined twenty-five, in more or less detail, in Virginia and Tennessee, and can add his testimony to the belief that they have been formed by currents of running water. They generally extend in a direc-

*Proceed. Acad. Nat. Sci. 1867. 156. †Mammalia Dakota and Nebraska, 359, 1869.

tion parallel to the strike of the strata, and have their greatest diameter in the direction of the dip. Their depth is determined in some measure by the softness of the stratum, whose removal has given them existence, but in thinly stratified or soft material, the roofs or large masses of rock fall in, which interrupt the passage below. Caves, however, exist when the strata are horizontal. Their course is changed by joints or faults, into which the excavating waters have found their way.

That these caves were formed prior to the postpliocene fauna is evident from the fact that they contain its remains. That they were not in existence prior to the drift is probable, from the fact that they contain no remains of life of any earlier period so far as known, though in only two cases, in Virginia and Pennsylvania, have they been examined to the bottom. No agency is at hand to account for their excavation, comparable in potency and efficiency to the floods supposed to have marked the close of the glacial period, and which Prof. Dana ascribes to the Champlain epoch. An extraordinary number of rapidly flowing waters must have operated over a great part of the Southern States, some of them at an elevation of 1500 feet and over, (perhaps 2000) above the present level of the sea. A cave in the Gap Mountain, on the Kanawha river, which I explored for three miles, has at least that elevation.

That a territory experiencing such conditions was suitable for the occupation of such a fauna, as the deposits contained in these caves reveal, is not probable. The material in which the bones occur in the south is an impure limestone, being mixed with and colored by the red soil which covers the surface of the ground. It is rather soft, but hardens on exposure to the air.

The question then remains so far unanswered as to whether a submergence occurred subsequent to the development of the postpliocene mammalian fauna. That some important change took place is rendered probable by the fact, that nearly all the neotropical types of the animals have been banished from our territory, and the greater part of the species of all types have become extinct. Two facts have come under my observation which indicate a subsequent submergence. A series of caves or portions of a single cave once existing on the S. E. side of a range of low hills among the Allegheny mountains in Wythe Co., Virginia, was found to have been removed by denudation, fragments of the bottom deposit only remaining in fissures and concavities, separated by various intervals from each other. These fragments yielded the remains of twenty species of postpliocene mammalia.* This denudation can be ascribed to local causes, following a subsidence of uncertain extent. In a cave examined in Tennessee the ossiferous deposit was in part attached to the *roof* of the chamber. Identical fossils were taken from the floor. This might, however, be accounted for on local grounds. The islands of the eastern part of the West Indies appear to have been separated by submergence of larger areas, at the close of the period during which they were inhabited by postpliocene mammalia and shells. The caves of

* See Proceed. Amer. Phil. Soc. 1869. 171

Anguilla include remains of twelve vertebrates,* of which seven are mammalia of extinct species, and several of them are of large size. These are associated with the recent species of molluscs *Turbo pica* and a *Tudora* near *pupæformis*.† As these large animals no doubt required a more extended territory for their support than that represented by the small island Anguilla, there is every probability that the separation of these islands took place at a late period of time and probably subsequent to the spread of the postpliocene fauna over North America.

EXPLANATION OF THE CUTS.

Figs. 1–12. Sections of teeth of *Megalonyx* of the natural size.

Fig. 1–2. Sections of canine-molars of *M. loxodon*, Cope ; 2a, profile of 2 from within.

Figs. 3–6. Sections of canine-molars of *Megalonyx wheatleyi*, Cope ; 5a side view of 5 from the inner side.

Figs. 7–8. Sections of canine-molars of ? *Megalonyx dissimilis*, Leidy, or of *M. wheatleyi*, Cope.

Fig. 9. Sections of crowns of the superior molars of the right side of *Megalonyx wheatleyi ;* from separated teeth, the anterior probably of this species.

Fig. 10. Sections of crowns of the inferior molars of the right side of *M. wheatleyi*, from specimens in place in jaw.

Fig. 11. Crown of tooth of *Megalonyx sphenodon*, Cope ; 11a, same from the inside.

Fig. 12. View of canine-molar of *Megalonyx tortulus* seen from the crown ; 12a, inner view of same tooth.

Fig. 13. Grinding surfaces of left inferior molars of *Arvicola speothen*, Cope, enlarged.

Fig 14. Grinding surfaces of second and third superior molars of *Arvicola tetradelta*, Cope.

Fig. 15. Same of *Arvicola didelta*, Cope, enlarged ; a, b, c, of the first inferior molar ; d, of the superior molars.

Fig. 16. First inferior molar grinding surface of *Arvicola involuta*, Cope, enlarged.

Fig. 17. Same of *Arvicola sigmodus*, Cope, enlarged ; a, b, c, of first inferior molar ; d, of superior molars.

Fig. 18. Same of *Arvicola hiatidens*, Cope, enlarged ; a superior molar 1 or 2, incomplete ; b, 3d superior molar ; c, 1st inferior. The entering folds should not be in contact in figs. *a* and *b*, in cuts.

Fig. 19. Grinding surface of last superior molar of *Erithizon cloacinum*, Cope, natural size.

Fig. 20. Superior molar teeth (incomplete) of *Praotherium palatinum*, Cope, natural size.

* Loc. cit. 1869. 183; 1870, 608. A fourth species of gigantic Chinchillid has been found by Dr. Rijgersma, which may be called *Loxomylus quadrans*, Cope. It is represented by portions of jaws and teeth of three individuals. It is one of the largest species, equalling the *L. latidens*, and has several marked characters. Thus the roots of the molars are very short, and the triturating surface oblique to the shaft. The roots of the second and fourth are longer than those of the first and third. The last molar has four dental columns instead of three as in the other *Loxomyli*, and is triangular or quadrant-shaped in section; the third is quadrangular in section, and has three columns. The second is the smallest, being only .6 the length of the subtriangular, first. Length of dental series m. 063 or 2.5 inches. Palate narrow and deeply concave. There is but little or no lateral constriction in the outlines of the teeth; the shanks are entirely straight. In its additional dentinal column, this species approaches the genus *Amblyrhiza*.

The large Chinchillas of Anguilla are as follows, *Loxomylus longidens*, *L. latidens*, *L. quadrans* and *Amblyrhiza inundata*.

† See Bland, Proceed. Amer. Phil. Soc., 1871, 58.