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A FOSSIL DEPOSIT IN A CAVE IN ST. LOUIS

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INTRODUCTION

This paper describes a discovery of fossil bones in a cave in the city of St. Louis, Missouri. The presence of a rich deposit of fossil mammals in the midst of a great city is, in itself, of interest. The nature of the deposit is also unusual and has considerable geological interest, even though inferences as to its origin are necessarily somewhat speculative. The fauna as now known includes no striking novelties, but one member, a woodchuck, represents a hitherto unknown subspecific group to which a name, *Marmota monax hessi*, is given in this paper. A large extinct armadillo, although not a new species, is the most unusual member of the fauna and sets a new record for the northward extension of armadillos. The great majority of the fossils represent the common Pleistocene peccary *Platygonus compressus*. The large series of remains of this animal obtained from the cave in St. Louis permits study of variation in this species and notes on its status and the status of some related forms.

This fossil deposit was discovered by Mr. Lee Hess, the owner of the cave. In the course of clearing out clay-filled passages, he noticed bones in this filling and sent them to the American Museum for identification. Finding that we were interested in further investigation, Mr. Hess invited us to visit St. Louis and work in the cave. George O. Whitaker, of our fossil vertebrate laboratory, and I spent the latter part of March, 1946, on this interesting task. Mr. Hess provided us with living quarters in the old De Menil mansion, above the cave, and also provided workmen to assist us and helped us in innumerable other ways. I cannot too strongly express our gratitude towards Mr. Hess and appreciation of this contribution to vertebrate paleontology.

In New York preliminary sorting of the peccary bones was done mostly by William A. Eames. All the measurements of *Platygonus* and most of the statistical calculations were made by Nathan Altshuler. Mr. Altshuler also drew the text figures for this paper, except figure 1 which is by Marie Bohrn, and assisted in other ways. Mr. Whitaker's assistance, in the laboratory as well as in the field, is also gratefully acknowledged.

LOCATION AND GENERAL DESCRIPTION

The fossil deposit occurs in Cherokee Cave (formerly the Lemp Brewery Cave) in the southeastern part of St. Louis, about six blocks from the river front and in a limestone ridge that rises above the river level. The present entrance to the cave is an artificial shaft on the north side of Cherokee Street between 13th and 18th Streets. (It is here one block from 13th to 18th.) From this point the accessible part of the cave extends eastward and northward under the former De Menil property (now owned by Mr. Hess), east of 18th Street and north of Cherokee Street. The bones were collected from the part of the cave beneath this property.

The cave was almost completely filled with clay when first discovered, but parts of it were excavated during the nineteenth century to provide constant temperature storage for beer, and the cave was connected underground with the Lemp Brewery buildings, on the south side of Cherokee Street, now occupied by the International Shoe Company. After the cave ceased to be used as a beer lager, it was used for a time for recreation, and a small underground theater was installed in one of the former storage rooms. I have elsewhere (Simpson, 1946) published a popular account in which some other details of the cave's history and of our work there are given.

The accessible part of the cave consists of two long, connected channels, one running nearly east-west and the other, with a small offset, nearly north-south, probably representing underground water channels oriented by a joint system in the limestone. The dimensions and general layout are given in the accompanying map (fig. 1), which was not surveyed but is drafted from my field sketches, a sufficient approximation for present purposes. The northward extension of the north-south channel, beyond the offset, had been walled off by the brewery, and the clay in it had not been removed. Mr. Hess broke through this wall and drove an exploratory tunnel through the clay filling. It was here that the bones were found, most of them being from the sides of the recently excavated passage between its beginning (near point A of fig. 1) and the wider cross connection with a water channel shown on figure 1. (Since this map was sketched Mr. Hess' clearing of the cave has been carried much farther.) Incidentally, the bone-bearing clay undoubtedly extended also into the rooms excavated for the brewery and hundreds or probably thousands of bones must have been hauled out by its early workmen. If they noticed the

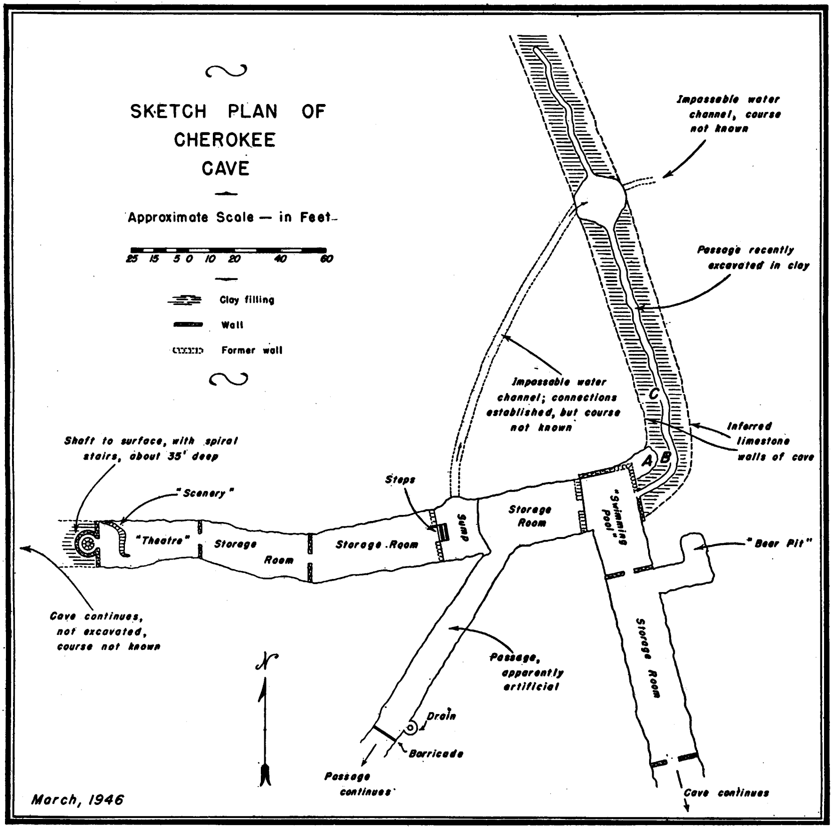

FIG. 1. Sketch plan of Cherokee Cave, St. Louis, showing extent of excavation of newly opened passage in March, 1946. A, B, and C are the locations of sections shown in figures 2–4.

bones at all, no record has survived and no bones were saved as far as known.

The floor of the excavated parts of the cave is still on the clay filling, and the limestone floor, which is probably far below the ground-water level, has not been seen or located. In places a foot or two of air space was present above the clay before excavation, but much of the cave was filled to the ceiling.

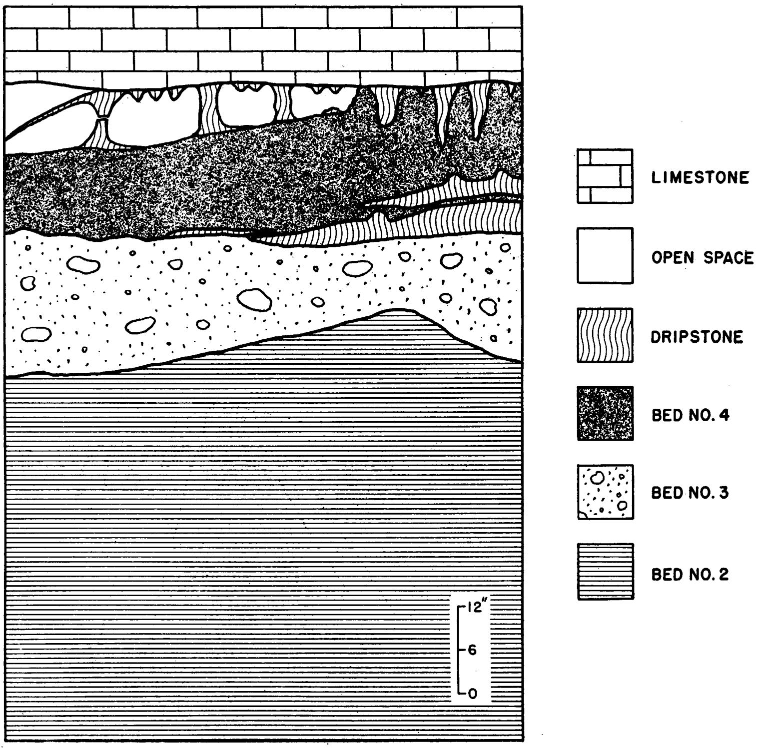

FIG. 2. Diagrammatic section of cave filling at point A of figure 1. The bottom of the diagram is the floor of the excavation, and the clay filling continues below this point. See the text for explanation of designations of the beds.

STRATIGRAPHY

In the part of the cave filling examined by us, four distinct strata can be distinguished, separated by clear-cut disconformities, in addition to dripstone deposits of various ages. The accompanying diagrammatic sections (figs. 2–4) show the relationships of these four strata, the dripstone, and the limestone cave ceiling at points A, B, and C of the map (fig. 1). Conditions farther north along the newly opened passage were variable but similar to those at point C and add nothing of importance for interpretation of the deposits.

For convenience in description the four strata may be distinguished by numbers, starting with the oldest and lowest as No. 1.

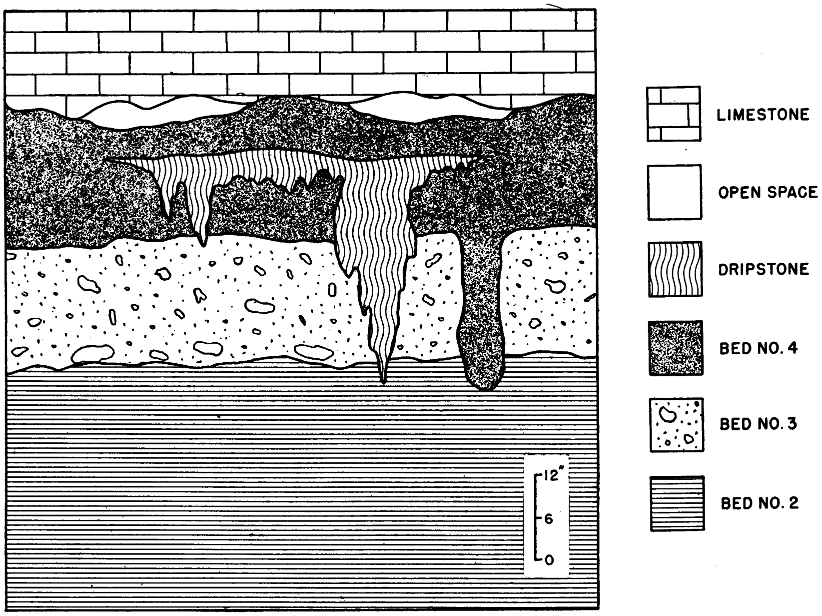

FIG. 3. Diagrammatic section of cave filling at point B of figure 1. The bottom of the diagram is the floor of the excavation, and the clay filling continues below this point. See the text for explanation of designations of beds.

The bottom of bed No. 1 was nowhere seen. The bed is a massive, slightly gritty, yellowish gray clay, without lamination or other visible structure. No bones were found in it. Its top is uneven. At points A and B it has sunk below the approximately horizontal floor of the passage, but northward of B it rises as much as 3 feet above that floor. The surface is also irregular in detail. When the cave was being filled, this surface apparently formed the floor of the cave for some time while deposition ceased. It is commonly covered with a layer of dripstone, 0–5 inches in thickness, from which rise occasional stalagmites, which were buried by later deposits.

Number 2 is a very fine-grained, unctuous, yellow clay which is thinly laminated or varved. It contains some irregular limey concretions and an occasional thin dripstone layer, but no bones or coarse rock fragments were seen in it. It does, however, contain an occasional small lens of fine gravel. It tends to fill in hollows on the surface of No. 1 and reaches a thickness of at least 5 feet at point A (bottom not seen), where the top of No. 1 is below the present floor. Northward, where the top of No. 1 is higher, No. 2 thins out and disappears altogether in places. The top of No. 2 is irregular and was eroded before or during the deposition of No. 3, but no dripstone was seen on this contact, and there is no evidence that it preserves the surface of what was the cave floor for any considerable period.

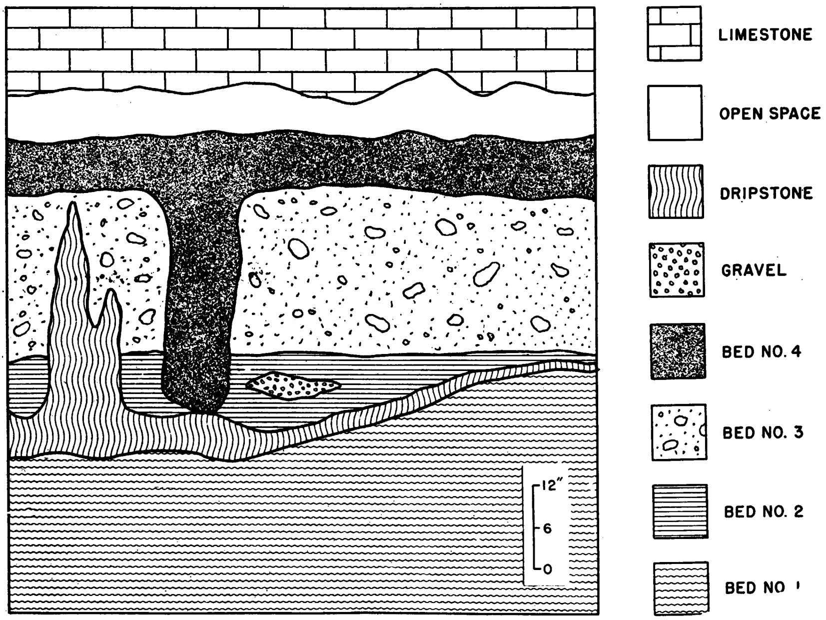

FIG. 4. Diagrammatic section of cave filling at point C of figure 1. The bottom of the diagram is the floor of the excavation, and the clay filling continues below this point. See the text for explanation of designations of beds.

Number 3 is the main fossil-bearing stratum. All the *Platygonus* bones were in this bed. It pinches out locally near the walls, but it is present along the center of the channel, at least, throughout the length of the excavation accessible at the time of our work.

In places it reaches a thickness of several feet, but the average thickness is about 20 inches through most of the region examined by us. The bed as a whole is composed of sticky, plastic, bright yellow clay without lamination or apparent internal stratification. It contains many fragments of leached limestone, broken pieces of stalactites, stalagmites, and flat dripstone, and concretions apparently secondarily deposited and derived from bed No. 2. Some of the limestone and dripstone fragments are as much as a foot in diameter, although most are smaller. They are angular, without any apparent water wear, and they occur without evident orientation throughout the clay mass.

Bones are scattered throughout this bed, although probably somewhat more common towards the bottom of it. There seems to be some tendency for long bones to lie nearly horizontally, but this is not general, and some are even vertical in the bed. The skeletons are completely disarticulated. No two bones were found in association, and there was no clear tendency for bones of an individual to occur in the same area. In a few cases broken pieces of the same bone were near each other, and the separate rami of an individual porcupine were found within a few feet of each other. Small, compact bones, such as phalanges, carpals, or tarsals, are usually unbroken, but a large percentage of the longer and more fragile bones were broken when found. The epiphyses of young bones have almost always been separated and dissociated. Very young skulls are all disarticulated, but young adult to old skulls have in some cases held together, generally with some breakage.

The top of bed No. 3 is fairly constant in level, but irregular and undulating in detail. It formed the cave floor for some time and is covered with dripstone in places, but this is local and thin. There was some erosion of this surface in places before the deposition of No. 4, and there are occasional thin lenses of laminated clay between No. 3 and No. 4.

Bed No. 4 is composed of loose, granular clay or earth, which looks as if it had been extensively worked since deposition and which contains much pore space and is not compacted. It everywhere overlies No. 3 but is highly variable in thickness, from a mere film up to about 20 inches. It sometimes fills the top of the cave right to the ceiling, but often leaves a small air space at the top. It also fills a number of burrow-like pipes or cavities that extend down into the lower beds (see figs. 3 and 4). There are no *Platygonus* bones in bed No. 4, but it contains some bones of more recent aspect, those of pocket gophers being most numerous. There are also some local concentrations of broken snail shells.

ORIGIN OF THE DEPOSITS

The cave was originally formed by solution localized along fissures, and its form suggests that it provided open, underground, run-off channels while its upper part, at least, was well above ground-water level. Rise in that level or the damming of an outlet or both then caused clay and dirt, washed into the cave, to accumulate there as the No. 1 bed (and any others that may lie below this). Appreciable drainage into the cave then ceased for a time—probably a long time in years, since dripstone up to 5 inches or more in thickness accumulated then. Standing water later formed small pools or lakes in the depressions of the floor and in these there was slow deposition of varved clays, bed No. 2. This evidently represents a wetter time than the post-No. 1 dripstone, but without appreciable drainage through this part of the cave.

The characters of bed No. 3 and of its included rock fragments and bones strongly suggest that it was deposited by running water, torrentially and probably in one short episode. Somewhere a single, large flood of water broke into the cave and washed rapidly through it, spreading along its length a mass of clay along with broken bits of dripstone and of projections from the limestone country rock torn off in the flood. The bones of many peccaries, certainly dozens of them and perhaps hundreds, along with those of a few other animals, came in with the flood and were spread out in the sedimentary mass. It seems highly probable that these remains had not previously been in this part, at least, of the cave and that they were tumbled along in the depositing torrent.

Thus far the interpretation, without being certain, does seem reasonably to follow from the stratigraphic evidence. The still more interesting problem of how the bones were accumulated in the first place and how they came to be washed into the cave (or into this part of it) cannot be surely solved and discussion becomes speculative. It is possible, at least, that the bones were originally in a fissure, where the animals were trapped. Such accumulation of remains of Pleistocene animals, including *Platygonus*, are known at various places in limestone regions. The clay and bone contents of the fissure may then have been suddenly washed or flushed into the cave. The mechanics of this event are still more speculative, but one possibility is that the fissure clay sealed an earlier natural passage from the fissure into the cave, that standing water accumulated above the seal, and that the pressure of this water plus solution in the limestone suddenly broke the seal and let the water drain torrentially into the cave, carrying the fissure filling with it. Even if this speculation is correct, the chances of locating the original fissure and checking the hypothesis are extremely slight, because almost the whole surrounding region has been built up or paved.

After deposition of bed No. 3, whether or not it occurred as postulated, there was another quiescent period in the cave. The floor, now on top of bed No. 3 and in most places within about 2 feet of the ceiling, was only moderately irregular and held only scattered puddles rather than pools as did the floor at the top of bed No. 1. Some dripstone accumulated, but it was thin and localized and apparently dripping was not widespread in the cave. Finally another thin layer of dirt was washed in and covered this floor, filling the cave nearly, in places quite, to the ceiling. The extraordinary thing about the present condition of this layer is that it all seems to have been reworked and aërated and that what can hardly be interpreted as anything but burrows were driven down from it into the underlying deposits.

The probable agent of this activity is represented by remains in bed No. 4: *Geomys bursarius*, the pocket gopher that still lives around St. Louis. It is highly improbable that pocket gophers colonized the cave, even though the evidence of extensive work by them there seems inescapable and even though a practicable nearby entrance, now lost, may have existed. There cannot have been suitable food for the gophers in the cave, and it certainly is not likely that they would voluntarily have worked so extensively at any great distance from a food supply. A possibility is that gophers were repeatedly trapped in the cave and that each worked energetically, instinctively seeking food in the cave earth, before it starved to death.

FAUNAL LISTS, CORRELATION

The following forms, further data on which are given in the succeeding section of this paper, occur in the compact, older, bone-bearing bed, No. 3 of the preceding discussion:

Dasypus bellus, extinct armadillo
Marmota monax hessi, extinct (subspecies of) woodchuck
Castor canadensis, American beaver

Erethizon dorsatum, Canada porcupine
Canis sp., large wolf (possibly an extinct form)
Ursus americanus, black bear
Procyon lotor, raccoon
Platygonus compressus, extinct peccary
(A few scraps of undetermined chelonians also occur.)

Of the seven species positively identified, two are extinct and are characteristic of the Pleistocene, although they may also be postglacial in some occurrences. Five species have lived in this general region into historic times. All of these are known from the Pleistocene as well as the Recent. One is represented by an extinct subspecies (or temporal race), and some of the others might also prove to be slightly different from the living subspecies of the region if more reliable comparisons could be made.

In itself the fauna is not conclusive as to age, but it suggests late Pleistocene or early Recent. The presence of *Dasypus*, its most northern known occurrence, may indicate a climate somewhat warmer than at present, but the difference need not have been great and the other forms present are not particularly suggestive of a very warm climate. There is at least some probability that the fauna was interglacial (in that case perhaps the last interglacial epoch) or postglacial (in that case clearly very early postglacial). In faunal type it is what is usually denominated a late Pleistocene fauna, although it is now known that such faunas also occurred in times post-Pleistocene by some other standards.

The presence of a well-marked disconformity and of dripstone above the bed containing these remains is consistent with antiquity, from the point of view of the Recent, but does not necessarily place the bed in frankly Pleistocene time. The episodes of deposition in the cave might conceivably lend themselves to more precise physiographic dating by tying in with regional study of Pleistocene and Recent climate and events, but I am unable to suggest such correlation at present. The paleontological value of precise stratigraphic dating would be limited by the fact that this is not the original site of accumulation of the bones and that the latter may be appreciably older than the bed in which they occur.

The more superficial, loose earth deposit (bed No. 4) above the (nominally) Pleistocene fossil deposit (No. 3) contains the following forms, which are not discussed in the later pages of this paper:

Blarina brevicauda, short-tailed shrew; one mandibular ramus in our collection (A.M.N.H. No. 45745)

Procyon lotor, raccoon; one mandibular ramus (A.M.N.H. No. 45737)

Tamias striatus, chipmunk; two mandibular rami and a premaxillary (A.M.N.H. No. 45744)

Geomys bursarius, pocket gopher; parts of two skulls, five mandibular rami, odd teeth, partial skeletons, etc. (A.M.N.H. No. 45743)

There are also numerous fragmentary skeletal elements which seem, for the most part, to belong to the forms listed above on the basis of jaws. There are also some chelonian bones, and fragmentary snail shells, not identified, are locally abundant. The mammals listed above are all Recent species of this region and show no evident differences from forms presumably common at this site before it was overgrown by the city. We also found at this level one mandibular ramus (A.M.N.H. No. 45739) indistinguishable from *Marmota monax hessi*, but its preservation is somewhat different and it was probably derived from the underlying clay. With this exception the fauna is consistent with fully Recent age. The development of dripstone above the layer suggests some historical, but not necessarily geological, antiquity. It is, in any event, definitely younger than the *Playtgonus*-bearing bed and evidently belongs geologically to the Recent epoch.

DESCRIPTIONS OF FOSSILS FROM BED NUMBER 3

ORDER **EDENTATA** CUVIER, 1798

FAMILY **DASYPODIDAE** BONAPARTE, 1838

DASYPUS LINNAEUS, 1758

Dasypus bellus (Simpson, 1929)

Tatu bellus SIMPSON, 1929, p. 579.

This species is represented by six movable band scutes, complete or nearly so, two fragments of similar scutes, a complete caudal scute, and a well-preserved astragalus, all grouped under A.M.N.H. No. 45746. These remains represent a very large *Dasypus*, and are not essentially different from the type and original hypodigm of "*Tatu*" *bellus*[1] from the Pleistocene of Florida. The scutes seem to run slightly larger than the average for the Florida material. The astragalus, on the other hand, is slightly smaller and more lightly built than the one astragalus

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[1] The change from *Tatu* to *Dasypus* is nomenclatural only. When I wrote in 1929 it was believed that the correct name for the peba or nine-banded armadillos was *Tatu*, but the type of *Dasypus* is now fixed as belonging in that group and *Dasypus* is a prior name.

known from Florida. (The legend of Simpson, 1929, fig. 8, is incorrect; the Florida astragalus is there shown $^2/_3$, not $^4/_3$, natural size.)

As far as I know, this is the most northern known record for an armadillo, recent or fossil.

ORDER **RODENTIA** BOWDICH, 1821

FAMILY **SCIURIDAE** GRAY, 1821

MARMOTA BLUMENBACH, 1779

Marmota monax (Linnaeus, 1758)

Marmota monax hessi,[1] new subspecies

TYPE: A.M.N.H. No. 45738, nearly complete skull, without teeth except base of right incisor.

HYPODIGM: Type and A.M.N.H. No. 45740, two mandibular rami without cheek teeth.

HORIZON AND LOCALITY: Pleistocene, doubtfully sub-Recent, Cherokee Cave, St. Louis, Missouri.

DIAGNOSIS: A *Marmota monax* with skull and jaws near the upper limit for that species in all dimensions and above the recorded size of recent specimens in postpalatal length, zygomatic breadth, and length P_4^4–M_3^3. As large as a robust *M. caligata*, but not a member of that specific group. Strong, high, long, single sagittal crest present in the type. Tooth rows divergent anteriorly. Zygomata unusually broad and heavy.

From its size this might be taken for a hoary marmot rather than a woodchuck, an identification that would have considerable interest in view of the locality. There is, however, no doubt that it belongs in the *M. monax* and not the *M. caligata* group. The *M. flaviventris* group does not come into serious consideration. The interorbital region is broad and the postorbital processes are at right angles to the long axis of the skull, not inclined posteriorly. The nasals are wider than the premaxillaries posteriorly. The basioccipital is marked by low ridges converging towards the foramen magnum. The palate is abruptly truncated posteriorly. The interpterygoid fossa is wide. The palatal foramina are narrow anteriorly. These are diagnostic characters of *M. monax* as given by Howell (1915) and confirmed on a large American Museum series of that species. A character not given by Howell and variable and intergrading in the species groups but still suggestive is

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[1] For Mr. Lee Hess, in recognition of his discovery of this faunule and his assistance in its collection.

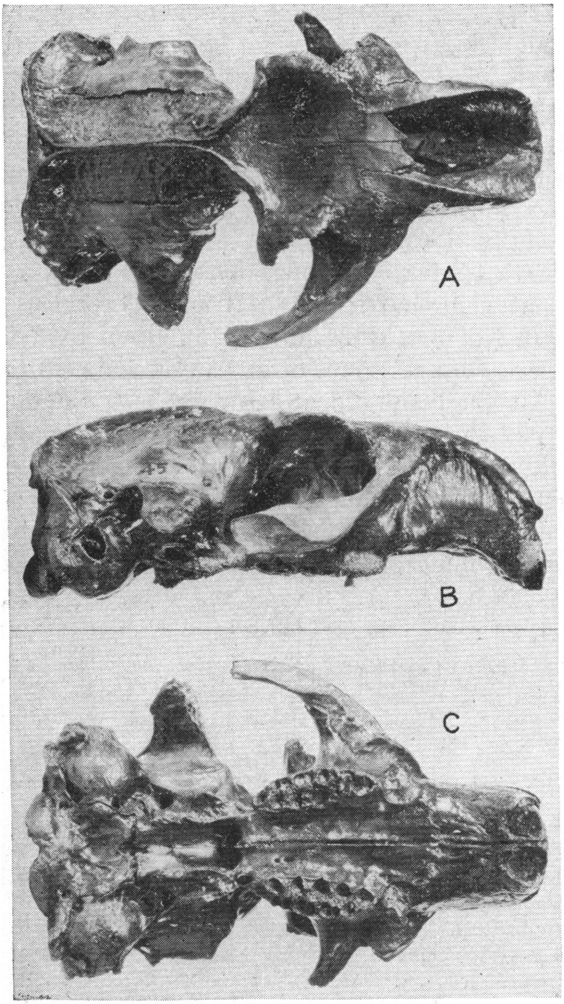

FIG. 5. *Marmota monax hessi*, new subspecies. Type, A.M.N.H. No. 45738, skull. A. Dorsal view. B. Right lateral view. C. Palatal view. Two-thirds natural size.

that in *M. monax* the nasals usually project posteriorly into the frontals and have straight, parallel, anteroposterior sutures against the latter. This character also is shared by the fossil.

The only determinable characters of the fossil not in accord with Howell's definition of *M. monax* are the strong development of the sagittal crest and the (moderate) divergence of the tooth rows anteriorly. *M. monax* does frequently develop a sagittal crest, although I have not seen a specimen with this quite as strong as in the fossil. This is, in any case, to a large extent a function of age and size of skull. An old *M. monax* as large as *M. caligata* might be expected to have as strong a crest as the latter, and such is the condition of the fossil. Tooth rows as divergent as in our fossil do sometimes occur in *M. monax* as an individual or perhaps local population character.

The fossil thus clearly belongs near *M. monax* and probably should be placed in that species. It is, nevertheless, outside the observed range of recent *M. monax* as given by Howell (1915) from large series of specimens or as seen in series in the American Museum. Although the recent samples are too heterogeneous in origin and the fossil sample is too small for statistical comparison, there is little doubt that a valid difference exists on a subspecific level at least. The existence of a robust Pleistocene subspecies or temporal race of a Recent species is a common phenomenon. Table 1 gives some comparisons with Howell's figures for *M. monax monax*, which is the largest Recent subspecies and the one that now occurs in this region. Our largest specimen of this subspecies is within the ranges given by Howell.

TABLE 1

SKULL MEASUREMENTS IN MILLIMETERS OF *Marmota monax hessi* AND *M. m. monax*

	Type, *M. monax hessi*	*M. monax monax* after Howell (N = 10)
Condylobasal length	102.1	90.4–102.5
Palatal length	60.2	53.4–59.5
Postpalatal length	39.7	32.6–37.8
Zygomatic breadth	*ca.* 72	59.5–67.3
Breadth across mastoids	*ca.* 49	42.9–50.2
Least interorbital breadth	29.3	23.5–29
Breadth of rostrum	23.4	19.5–23.7
Maxillary tooth row (alveoli)	23.5	20.5–21.9

As far as I know, the only Pleistocene American possible member of the *M. monax* group to which a distinctive name has previously been applied is "*Stereodectes tortus*" Cope, 1869. This was based on an upper incisor, which is not well identifiable and may represent a Recent form. The name is, in any case, essentially a *nomen vanum*, and comparison with *M. monax hessi* would be neither necessary nor profitable.

There is, unfortunately, some question as to the exact level in the cave of the type skull of this subspecies. It was found by workmen after we left St. Louis, and its color is dark brown, unlike the cream or yellow with black stains usual for bones in bed No. 3. There is, however, one *Platygonus* jaw closely similar in color and preservation, and the bones from the top layer, No. 4, are not brown. We also found certainly in bed No. 3 right and left mandibular rami (A.M.N.H. No. 45740) of an unusually robust *Marmota*, with tooth series longer than in Recent *M. monax* and of the right size to occlude with the skull of *M. monax hessi*, to which subspecies these mandibles of known horizon may be referred. A closely similar, equally robust ramus (A.M.N.H. No. 45739) was also found in bed No. 4, above the clay with *Platygonus*. Its preservation is more like that of the bones in the older clay than like the other bones found at this upper level, which look distinctly more recent. It is thus probable that this robust *Marmota* jaw was actually derived from the top of the *Platygonus*-bearing clay and reworked into the younger deposit.

FAMILY **CASTORIDAE** GRAY, 1821

CASTOR LINNAEUS, 1758

Castor canadensis Kuhl, 1820

A beaver, within the range of the common living species, is represented by a left lower jaw with the incisor and M_{1-3} (A.M.N.H. No. 45741), and by a few other fragments.

FAMILY **ERETHIZONTIDAE** THOMAS, 1897

ERETHIZON CUVIER, 1822

Erethizon dorsatum (Linnaeus, 1758)

Right and left mandibular rami, with left P_4–M_3 and right M_{2-3} (A.M.N.H. No. 45742), were found separately but apparently belonged to a single individual. They are somewhat above average size for the Recent Canada porcupine but are within its range in all respects.

ORDER **CARNIVORA** BOWDICH, 1821

FAMILY **CANIDAE** GRAY, 1821

CANIS LINNAEUS, 1758

A very large wolf is represented by numerous foot bones, especially eight complete metapodials, and other fragments, but no teeth. At least two individuals are represented. Adequate series of foot bones of recent wolves have not been available for comparison, but two specimens of the large, so-called *Canis occiden-*

TABLE 2

MEASUREMENTS IN MILLIMETERS OF METAPODIALS IN PLEISTOCENE WOLF FROM ST. LOUIS AND A LARGE RECENT TIMBER WOLF

	Pleistocene A.M.N.H. No. 45732		Recent A.M.N.H. No. 98230
MC[a] II			
L[b]	98.5		93
W[c]	12.1		10.0
W/L	.12		.11
MC IV			
L	101.4		104
W	10.8		9.9
W/L	.11		.11
MC V			
L	99.5	94.6	101
W	14.5	13.6	10.9
W/L	.15	.14	.11
MT[d] II			
L	111.9	103.9	101
W	13.0	12.3	10.0
W/L	.11	.12	.10
MT IV			
L	126.6		115
W	12.5		10.0
W/L	.10		.09
MT V			
L	101.6		106
W	12.9		9.3
W/L	.13		.09

[a] MC, metacarpal.

[b] L, maximum length, which is approximate only for the recent species, the bones of which are articulated.

[c] W, maximum diameter at the middle of the shaft.

[d] MT, metatarsal.

talis[1] have most of the metapodials and phalanges shorter and more slender than this fossil form. Published data on foot bones of the Pleistocene wolves are also inadequate for sufficient comparison or exact identification of these fossils, but the foot bones of our two skeletons of *Canis dirus* from Rancho La Brea, as well as those described in the literature on that form, are decidedly smaller than the St. Louis fossils.

I have been unable to find any record of a wolf with feet quite as heavy as these fossils, but very little attention has been paid to foot bones in this group and it remains possible that some form known from teeth or from small variants did have feet that reach this size. As shown in table 2, an exceptionally robust recent specimen does have the fourth and fifth metacarpals and the fifth metatarsal slightly longer than in the fossils and the fourth metacarpal is about as stout, although the other three compared metapodials are shorter than in the fossil and all but one of the six compared are more slender. Possible differences of proportions suggested by the inconsistencies cannot be emphasized strongly because the fossil bones are not individually associated. The comparison shows that the fossils could belong to remarkably robust representatives of the Recent group. There is, nevertheless, a distinct possibility that they represent a large extinct form.

FAMILY **URSIDAE** GRAY, 1826

URSUS LINNAEUS, 1758

Ursus americanus Pallas, 1780

The collection includes part of a right mandibular ramus with M_3 and alveoli for the other cheek teeth and the canine (A.M.N.H. No. 45729), a loose M_3 of a different individual (A.M.N.H. No. 45730), and a loose lower canine (A.M.N.H. No. 45731), all of which are referred tentatively to *Ursus americanus*. The lower jaw has only a flattened or slightly concave area in place of the distinct anterior masseteric fossa of *Tremarctos* or the extinct arctotheres, and it is more slender than in any adult *Ursus horribilis* in our collection. It can be closely matched among recent specimens of *U. americanus*. M_3 and (as seen by their alveoli) the other cheek teeth are, however, considerably larger than is usual

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[1] In a modern, genetically valid taxonomic system this group would probably become a subspecies, perhaps of *Canis mexicanus*, as has been suggested by Anthony, or perhaps of a pan-Holarctic species *Canis lupus*.

in *U. americanus.* M_3 of this lower jaw measures 16.7 mm. in length and 12.3 mm. in width. The loose M_3 is larger still: 19.6 by 14.6 mm.

At first sight it seems improbable that these two teeth could belong to the same species or that either one could belong to the living species of black bears. There are, however, Recent black bears in our collection that have M_3 as large as the larger of the fossil teeth, although most of them have M_3 smaller than the smaller fossil. These very large Recent black bears also have exceptionally heavy jaws, heavier than the fossil jaw, and the latter cannot be precisely matched in our Recent series. *U. americanus* is extraordinarily variable in depth of jaw and size (also shape) of M_3, and the several characters of the fossils are, separately, within the demonstrated range for the Recent animals. Their being near the apparent limits of that range for size of M_3 and the unusual combination of robust teeth and slender jaw might indicate a distinction around the subspecific level, but there is no firm basis for this at present.

By reasonable and modern criteria for species as genetically intergrading populations, there are only three living species of bears in North America: *Ursus americanus*, the black bears and their various phases of other colors; *Ursus horribilis*, the grizzly bears and the big northern brown bears; and *Ursus maritimus*, the polar bear. The first two of these species apparently show considerable differentiation at or below the subspecific level, but the true nature of this differentiation and the ranges of subspecies really definable in terms of populations rather than of individual variations are not at present established. It is not likely that the many "species" recognized by Merriam correspond with recognizable subspecies or make any real contribution to an understanding of these groups. Pending a more realistic restudy of these problems, there is no good way of evaluating apparent peculiarities of fossil black bears, and the present specimens can only be recorded as belonging somewhere in a general *U. americanus* Pleistocene-Recent complex.

FAMILY **PROCYONIDAE** BONAPARTE, 1850

PROCYON STORR, 1780

Procyon lotor (Linnaeus, 1758)

Partial upper and lower jaws (one of each; A.M.N.H. Nos. 45736 and 45735) from bed No. 3 are within the range of variation of this modern species. There is also a nearly complete skull (A.M.N.H. No. 45733), of unknown level but probably from bed No. 3, which likewise represents a robust raccoon, within the range of *Procyon lotor* and confidently referred to that species. It is above the average size of the Recent specimens used for comparison, but Recent raccoons do reach its size and it is in any event common for Pleistocene populations to average slightly larger than Recent populations of the same species. The basal length of this skull is 105 $^1/_2$ mm.

This species also occurs in the superficial bed (No. 4) above the *Platygonus*-bearing clay (No. 3) as noted above, and we also have a lower jaw of unknown level (A.M.N.H. No. 45734) found by workmen before our visit to the cave.

ORDER **ARTIODACTYLA** OWEN, 1848

FAMILY **TAYASSUIDAE** PALMER, 1897

PLATYGONUS LECONTE, 1848

Platigonus LECONTE, 1848a, p. 103; PETERSON, 1914, p. 114. [Original spelling evidently a misprint, although adopted by Peterson.]

Platygonus LECONTE, 1848b, p. 258; and almost all later authors, see standard bibliographies.

Hyops LECONTE, 1848a, p. 104; = *Platygonus*, Leidy, 1857, p. 100.

Euchoerus LEIDY, 1853, p. 340; = *Platygonus*, Leidy, 1857, p. 100.

Coyametla DUGÈS, 1887, p. 16. [First published as an acknowledged synonym of *Platygonus.*]

The bulk of the present collection belongs to this genus and to its commonest species, *P. compressus*. The genus and species are so well known and have already been discussed so voluminously in print that extended descriptions would be superfluous. The opportunity is taken, however, to present some new data on variation and to summarize some other points of interest on which new light is thrown by this collection.

Platygonus is a characteristic member of the various Blancan faunas. (See Colbert, 1938; Cope, 1893; Gazin, 1938; Gidley, 1903; Hibbard, 1937, 1941; J. R. Schultz, 1937.) Reports of the genus from pre-Blancan horizons are dubious or probably incorrect. The Blancan species seem to be distinct from those of later ages, but they are still inadequately understood. The genus also occurs in South America from the Chapadmalalan to the sub-Recent (Rusconi, 1930). This is one of the items of evidence that place the Chapadmalalan as Blancan, at earliest, in age.[1] The various South American species are mostly based on inadequate materials and of doubtful status, although *P. carlesi* Rusconi, 1930, is based on a good skull.

In post-Blancan, frankly Pleistocene beds in North America *Platygonus* is a rather common fossil and evidently ranged over the whole of what is now the United States and also in Mexico. Although it may be quite absent or rare in some otherwise rich Pleistocene faunules, when it does occur in a faunule, it is likely to be abundant or even to constitute the bulk of the material, as it does in the faunule here described. This suggests the probability that the animals, like their living relatives, favored widespread or recurrent but more or less local ecological conditions and were gregarious. Aside from burial of a few strays, preservation ensued when a whole group of them was overtaken by catastrophe (for example, the group found by Williston in Kansas; see Williston, 1894b) or when a fissure or other trap happened to occur in their favored local range and took repeated toll of the herds (for example, Gidley and Gazin, 1938, and probably the occurrence here discussed).

The great majority of North American Pleistocene *Platygonus* seem to belong to a single, highly variable species, *P. compressus*, some notes on which are given below. There are, however, three other proposed species, all of which seem to be distinct from *P. compressus* but which remain of quite doubtful status and possible synonymy among themselves: *P. vetus* Leidy, 1882, *P. alemanii* Dugès, 1887, and *P. cumberlandensis* Gidley, 1920 (with its synonym *P. intermedius* Gidley, 1920; see Gidley and Gazin, 1938). *P. vetus* was based on upper and lower jaw fragments from Pennsylvania. A few still less perfect specimens have been referred, but the specific characters of the skull and dentition as a whole have never been established. *P. alemanii* was based on a partial palate and lower jaw from Guanajuato, Mexico. Leidy (1889) was inclined to consider this synonymous with *P. vetus*.

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[1] Thus Rusconi, who considered the Chapadmalalan as middle Pliocene but who implied that its peccaries are probably post-Blancan, was forced to list the supposedly ancestral Blancan *P. bicalcaratus* as if it were from the Mio-Pliocene transition (Rusconi, 1930, fig. 30, p. 208). In more recent studies it is universally agreed that the Blancan belongs a whole epoch later, on the Plio-Pleistocene transition. Dispute as to whether to call it latest Pliocene or earliest Pleistocene is purely formal and does not concern its relative position in the sequence, which now cannot even by formal and verbal arguments be considered as early as middle Pliocene.

Most other students have tentatively kept the two separate, but without particular investigation of the possible synonymy. Recently Skinner (1942) has referred to *P. alemanii* four good skulls and some other material from Arizona, but he was unable to make the comparisons that would have tested their pertinence to *P. alemanii* and their distinction from *P. compressus. P. cumberlandensis* seems to be distinct from *P. compressus* and from Skinner's referred *P. alemanii*, but possible synonymy with either or both of *P. vetus* and typical *P. alemanii* does not seem wholly excluded by the published comparisons.

There is little question as to the generic synonymy given above, which omits one or two possible synonyms described from South America. *Hyops* and *Euchoerus* date from early discoveries when the genus was poorly known, and their separation was early corrected by Leidy (1857 and subsequently). In 1857 Leidy was inclined to equate both these names and also *Platygonus* with "*Dicotyles*" (= *Tayassu*). He subsequently recognized that *Platygonus* is quite distinct from the living genus (e.g., Leidy, 1869), and this has been abundantly confirmed and accepted by all later authors. Dugès (1887) stated that he had placed the Mexican form in a new genus *Coyametla* until Cope pointed out its pertinence to *Platygonus*. As far as I can find, Dugès had not previously published *Coyametla*, and it appeared only as a stillborn synonym, so acknowledged by its author.

Leidy also considered the genus *Protochoerus* LeConte, 1848, as a synonym of *Platygonus*, and on his authority it has usually been so listed by subsequent students. I have not restudied the very fragmentary type specimens, but from what published data there are, it does not seem certain that the type species, *Protochoerus prismaticus* LeConte, 1848, belongs to *Platygonus*. It may be preferable to ignore possible synonymy with this or some other group of peccaries and to maintain that *Protochoerus* is a *nomen vanum*, that is, a hollow name attached to an unrecognizable genus.

Platygonus compressus LeConte, 1848

Platigonus compressus LECONTE, 1848a, p. 103. ["*Platigonus*" probably a misprint.]

Platygonus compressus, LECONTE, 1848b, p. 258; LEIDY, 1853, p. 234, 1857, p. 100, 1869, p. 383.

Dicotyles compressus, LEIDY, 1857, p. 100.

Hyops depressifrons LECONTE, 1848a, p. 104; = *Platygonus compressus*, Leidy, 1857, p. 100.

Dicotyles depressifrons, LeConte, 1852a, p. 3; Leidy, 1853, p. 330; = *Platygonus compressus*, Leidy, 1857, p. 100.

Dicotyles costatus LeConte, 1852b, p. 5; Leidy, 1853, p. 331; = *Platygonus compressus*, Leidy, 1857, p. 100.

Euchoerus macrops Leidy, 1853, p. 340; = *Platygonus compressus*, Leidy, 1857, p. 100.

Protochoerus macrops, Leidy, 1857, p. 100; = *Platygonus compressus*, Leidy, 1857, p. 100.

Platygonus leptorhinus Williston, 1894a, p. 164, 1894b, p. 27; = *Platygonus compressus*, Wagner, 1903, p. 780.

Platigonus leptorhinus, Peterson, 1914, p. 114.

Platygonus setiger Hay, 1920, p. 84.

Platygonus francisi Hay, 1927, p. 299.

HISTORY AND SYNONYMY

This was one of the earlier American fossil mammals to be found and (approximately) identified, although it was nearly 50 years before the original discovery made its way into print. An excellent skull was obtained in 1804 or early in 1805 by Dr. Samuel Brown of Lexington from a cave in Kentucky. Brown forwarded it in November, 1805, to the American Philosophical Society. At the meeting of January 17, 1806, Dr. Caspar Wistar, who may properly be designated as the first American vertebrate paleontologist, correctly reported to the Society that the skull belonged to a peccary. (See Simpson, 1942.) It was not, however, until 1853 that a description of the skull was published by Leidy. In the meantime LeConte had named *Platygonus compressus* and its synonym *Hyops depressifrons* from much more fragmentary materials found in a fissure near Galena, Illinois, as well as another probable synonym, *Dicotyles costatus*, from still more fragmentary material (an isolated lower canine) from Benton County, Missouri.

In his memoir of 1853, Leidy recognized all of LeConte's species as distinct and placed the Kentucky skull in a new genus and species, *Euchoerus macrops*. He later made a study of variation in peccaries and, reaching an understanding of specific scope better than that of too many of his successors, concluded that his and LeConte's supposed genera and species were all variants of a single species (Leidy, 1857). "*Euchoerus macrops*" was thus reduced to synonymy with *Platygonus compressus*. Ever since 1857 the Kentucky skull has been used as a standard of comparison for the latter species in place of the much less perfect or diagnostic types and has, indeed, become a sort of informal neotype. Leidy

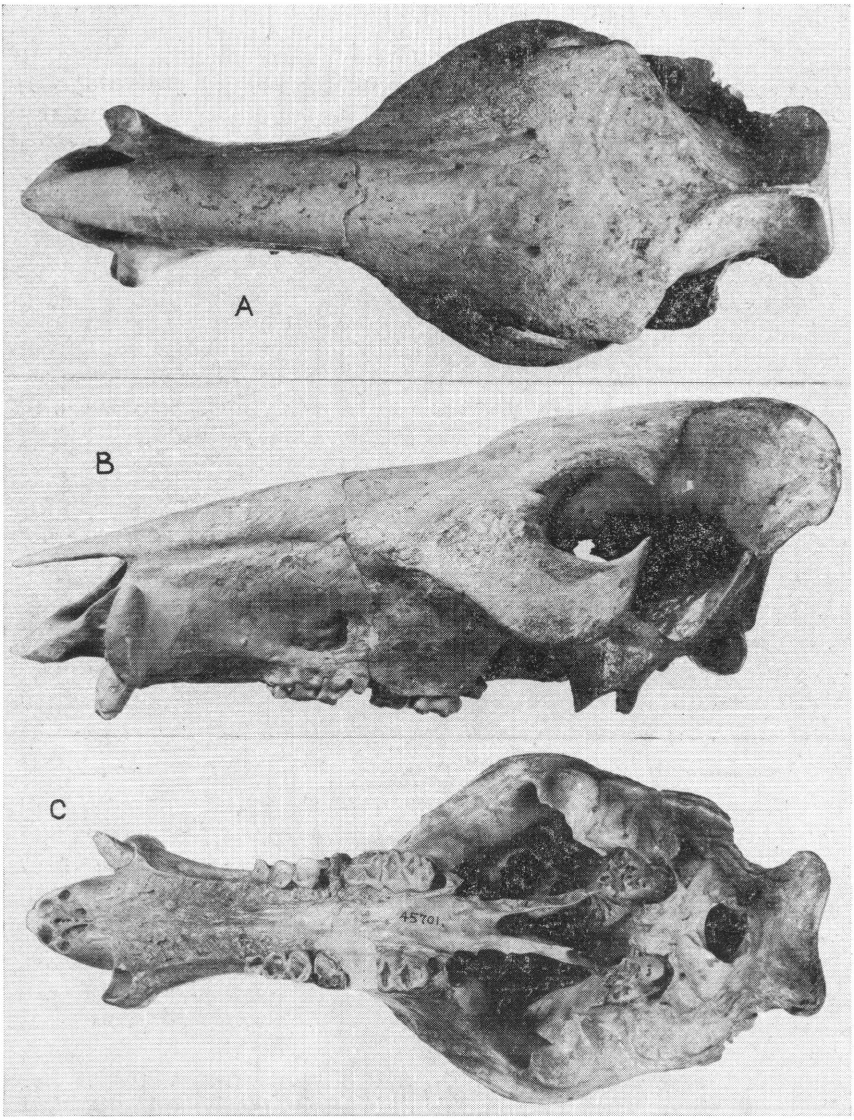

FIG. 6. *Platygonus compressus.* A.M.N.H. No. 45701, old skull from Cherokee Cave, St. Louis. The tip of the nasals is restored. (This specimen has been returned for display in the museum at the cave.) A. Dorsal view. B Left lateral view. C. Palatal view. One-third natural size.

finally (1889) also described and figured another skull (associated with an undescribed skeleton) which was one of a series found near Rochester, New York, and sold by Henry A. Ward.

The most complete knowledge of the genus, and probably also of the species, has, however, been based on nine articulated skeletons found together near Goodland, Kansas, and described especially by Williston (1894b), with additional comments by Peterson (1914) and others. Williston showed that the skulls of these individuals have numerous (but minor) differences of detail from those referred by Leidy to *Platygonus compressus*. Williston confessed his inability to decide whether his specimens represented a different species, but he proposed to call them *Platygonus lepto-*

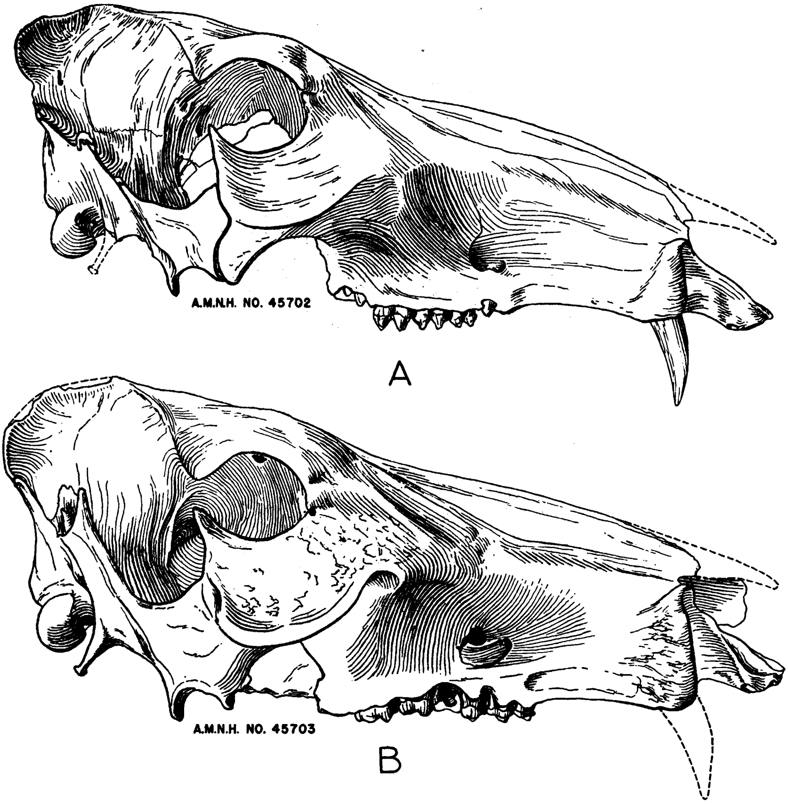

FIG. 7. *Platygonus compressus*. Contrast of age characters in skulls from Cherokee Cave, St. Louis. A. A.M.N.H. No. 45702, young skull. B. A.M. N.H. No. 45703, senile skull. Right lateral views. One-third natural size.

rhinus pending more extended comparison of all known material of the genus. Wagner (1903) considered *P. leptorhinus* a synonym of *P. compressus,* but Peterson (1914) kept them separate, depending still on minor deviation from Leidy's figures of the referred Kentucky skull. The present material, together with the availability of one of Williston's syntypes for direct comparison,

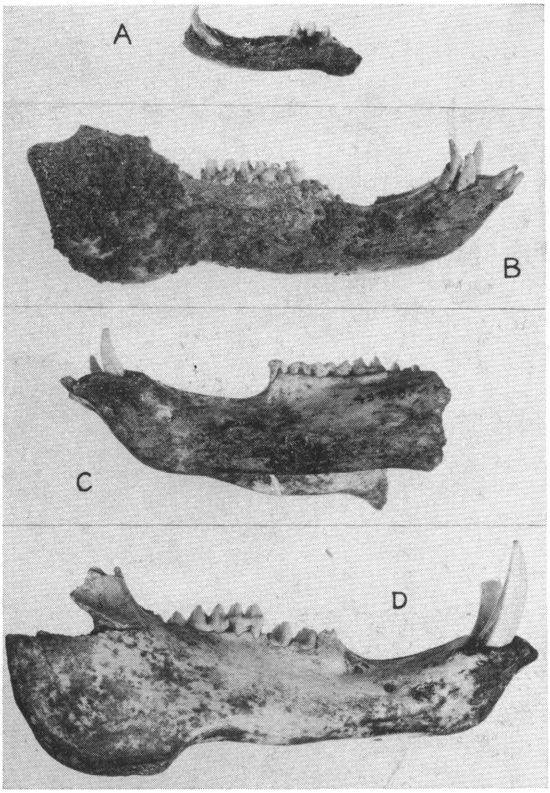

FIG. 8. *Platygonus compressus.* Contrast of age characters in lower jaws from Cherokee Cave, St. Louis. A. A.M.N.H. No. 45747. Left lower jaw, neonate, with dc and dm_4, both unworn, and alveoli for dm_{2-3}. B. A.M.N.H. No. 45722. Right lower jaw. Deciduous and permanent canines both functioning. Dm_{3-4} in place, M_1 erupted but unworn, M_{2-3} not erupted. C. A.M.N.H. No. 45720. Left lower jaw. Deciduous canine recently lost, permanent canine functioning but not fully protruded. Dm_{2-4} all well worn, M_1 beginning to wear, M_2 erupting. D. A.M.N.H. No. 45719. Right lower jaw. Permanent canine well protruded. Deciduous premolars lost, P_{3-4} erupting, M_1 beginning to wear, M_2 erupted but unworn. All lateral views, one-third natural size.

permits further consideration of this point, which is discussed below with the conclusion that *P. leptorhinus* is based on a local population of *P. compressus*.

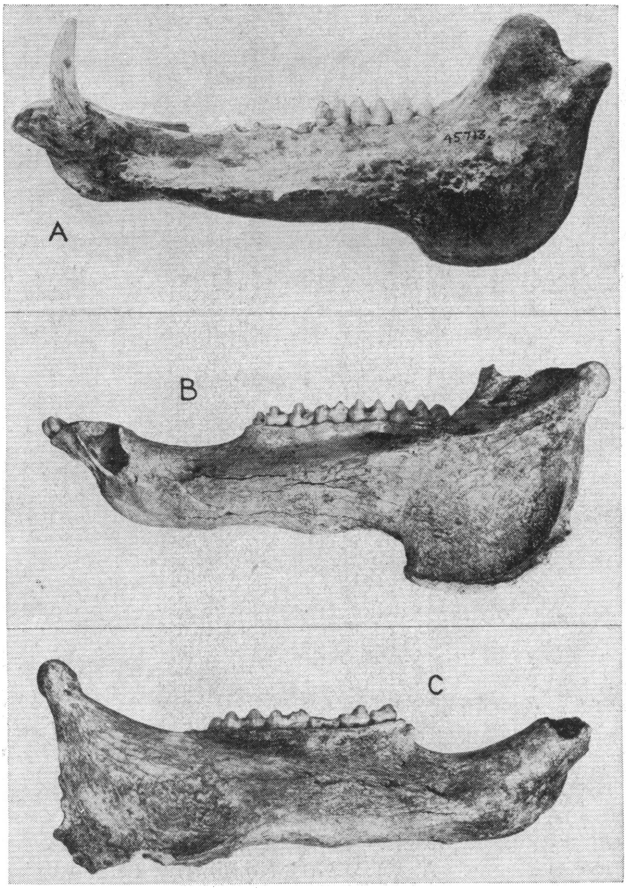

FIG. 9. *Platygonus compressus.* Continuation from figure 8 of age series of lower jaws. A. A.M.N.H. No. 45713. Left lower jaw. M_1 slightly worn, M_2 in place but unworn, M_3 erupting. (Nearly same age as A.M.N.H. No. 45719, fig. 8D.) B. A.M.N.H. No. 45724. Left lower jaw. All permanent teeth in place, M_3 slightly worn. Fully adult. C. A.M.N.H. No. 45727. Right lower jaw. M_1 worn to roots, M_{2-3} well worn. Senile. All lateral views, one-third natural size

Hay's proposals of two additional species were based on inadequate materials without sufficient comparison of previous specimens or proper consideration of variation in the established species. The type of *P. setiger* is the isolated root of a lower canine. It is slightly larger than any specimen in the St. Louis collection and is not precisely like any of them but could readily be a robust variant of the same species. Such material is not, in fact, specifically characteristic, and it seems justified to get rid of this ill-founded name by placing it in the synonymy of *P. compressus*. *P. francisi* has a somewhat better but still inadequate type, consisting of fragments of a lower jaw with M_{2-3}. The only possibly significant character in Hay's description, measurements, and figures seems to be the keel on the lower surface on the symphysis, which is less sharp in his specimen than is usual in specimens previously referred to *P. compressus*. This character is not known in the

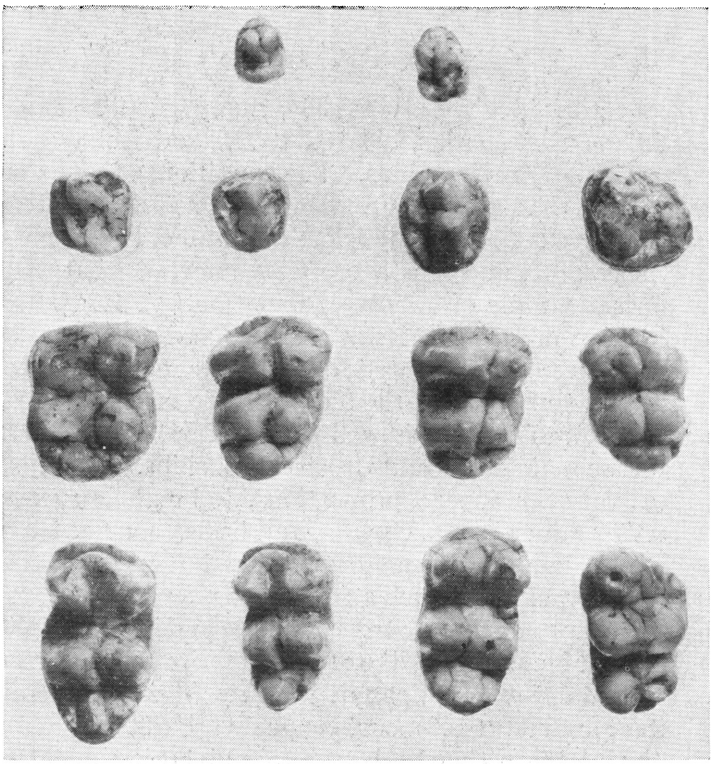

FIG. 10. *Platygonus compressus*. Morphological variation in isolated teeth from Cherokee Cave, St. Louis. Top row, P_2. Second row, two left figures, P^3. Second row, two right figures, P^4. Third row, M^3. Bottom row, M_3. All crown views, natural size.

actual type of *P. compressus*, and if it were really indicative of specific distinction, then *P. compressus* would become indeterminate. I see, however, no present reason to conclude that this variation does reflect a difference in species, and the simplest solution to the problem is to consider *P. francisi* as another synonym of *P. compressus*.

Notes on Variation

The collection includes five skulls, many partial palates and jaws, still more numerous isolated teeth, and isolated skeletal bones, particularly metapodials. The conditions of occurrence do not guarantee that all these remains are precisely contemporaneous, but there is no internal evidence that more than one sort of peccary is present, and it is a probable inference that the whole collection is a sample of a single population. A study has been made of variation in the series as a whole, and some data in convenient form are here presented for the parts most likely to be of use in comparative studies: the teeth and the metapodials.

The basic tooth pattern is well fixed and relatively invariable as regards the main cusps and their relationships. There is, however, great variation in size, proportions, and many structural details affecting minor crests, cingula, and heels. One or two of the teeth seem to represent malformations, but even within the apparently normal range such structures as, for instance, the heel of M_3 or M^3 show marked differences in size and in the number and arrangement of cuspules. Extended descriptions are not presented here, but the accompanying figures (fig. 10) give an idea of the extent and nature of morphological variation.

Statistical data on the cheek teeth are given in tables 3–5 and figures 11–13. The following abbreviations are used:

N = number of measurements included
OR = observed range
SR = span of standard range (see Simpson, 1941)
M = mean
σ = standard deviation
V = coefficient of variation
L = maximum length between planes tangential to the ends of the enameled crown and at right angles to the long axis of the tooth series
L_i = length (as above) measured on teeth in series in the jaw
L_o = length (as above) measured on isolated teeth
W = maximum width between vertical planes tangential to the sides of the enameled crown and parallel to the long axis of the tooth series,

with the tooth oriented (in the jaw or as if it were) with the tooth series horizontal

W_a = width (as above) across anterior lobe

W_m = width (as above) across median lobe (on dm_4 only)

W_p = width (as above) across posterior lobe (not counting the posterior cingulum or minor third lobe of M_3^3)

TABLE 3

STATISTICAL DATA ON PERMANENT UPPER CHEEK TEETH OF *Platygonus compressus* FROM ST. LOUIS

	N	OR	SR	M	σ	V
P^2						
L	7	9.1–10.7	3.34	9.81 ± .20	.52 ± .14	5.27 ± 1.4
W	7	9.3–10.1	1.76	9.76 ± .10	.27 ± .07	2.78 ± .74
P^3						
L	12	9.5–11.5	3.25	10.43 ± .14	.50 ± .10	4.82 ± .98
W	12	10.4–12.1	2.77	11.49 ± .12	.43 ± .09	3.72 ± .76
P^4						
L	21	9.3–12.7	5.31	10.78 ± .18	.82 ± .13	7.59 ± 1.2
W	21	12.3–14.8	4.30	13.25 ± .14	.66 ± .10	5.01 ± .77
M^1						
L_i	19	12.9–15.2	4.74	14.08 ± .16	.73 ± .12	5.19 ± .84
L_o	10	13.3–15.4	4.94	14.23 ± .24	.76 ± .17	5.35 ± 1.2
W_a	29	11.9–16.0	5.91	13.57 ± .17	.91 ± .12	6.72 ± .88
W_p	29	11.6–15.2	5.85	13.50 ± .17	.90 ± .12	6.69 ± .88
M^2						
L_i	17	14.8–18.2	6.27	16.71 ± .23	.97 ± .17	5.79 ± .99
L_o	17	15.1–19.3	6.40	17.49 ± .24	.99 ± .17	5.65 ± .97
W_a	34	13.8–17.4	5.96	15.59 ± .16	.92 ± .11	5.90 ± .72
W_p	34	13.6–16.5	5.70	15.01 ± .15	.88 ± .11	5.86 ± .71
M^3						
L_i	14	18.2–22.6	9.40	20.26 ± .39	1.45 ± .27	7.15 ± 1.4
L_o	12	19.0–23.6	8.23	21.00 ± .37	1.27 ± .26	6.07 ± 1.2
W_a	26	14.8–17.9	6.02	16.20 ± .18	.93 ± .12	5.73 ± .80
W_p	26	12.0–16.6	6.16	13.70 ± .19	.95 ± .13	6.94 ± .96

Standard errors are given for M, σ, and V. Measurements are all in millimeters.

Measurements of length were kept separate for teeth in series and those isolated when the available teeth were numerous enough in both groups to warrant separate calculation of statistics. In the course of his painstaking measuring, Mr. Altshuler felt that the impossibility of closing the calipers on both ends of a tooth in series must make such measurements inaccurate and probably consistently smaller than length measurements on isolated teeth.

This is a matter of general methodological interest, because paleontologists have commonly compared measurements of isolated teeth and those in series indiscriminately. The present work seemed to present a test case for judging the extent to which this factor may influence such comparisons. The prediction proved to be justified, for the means of lengths as measured on teeth in series are smaller than the means of homologous measurements on isolated teeth in all but one case (for LP_3, where the slight difference is probably due to chance). The consistency of this result makes it probably significant, but for each individual dimension

TABLE 4

STATISTICAL DATA ON PERMANENT LOWER CHEEK TEETH OF *Platygonus compressus* FROM ST. LOUIS

	N	OR	SR	M	σ	V
P_2						
L	7	8.0–10.3	5.02	8.87 ± .29	.78 ± .21	8.75 ± 2.3
W_a	7	4.9–7.0	3.90	6.06 ± .23	.60 ± .16	9.93 ± 2.7
W_p	7	5.2–8.6	6.18	6.70 ± .36	.95 ± .25	14.22 ± 3.8
P_3						
L_i	14	9.8–11.3	2.79	10.56 ± .12	.43 ± .08	4.08 ± .77
L_o	11	9.7–11.4	3.30	10.63 ± .15	.51 ± .11	4.80 ± 1.0
W_a	25	7.1–8.5	2.72	7.82 ± .08	.42 ± .06	5.37 ± .76
W_p	25	7.8–10.2	3.67	8.59 ± .11	.57 ± .08	6.60 ± .93
P_4						
L_i	15	10.4–12.1	3.38	11.40 ± .13	.52 ± .10	4.57 ± .84
L_o	10	11.0–13.8	4.91	12.11 ± .24	.76 ± .17	6.25 ± 1.4
W_a	25	8.7–10.8	3.53	9.36 ± .11	.54 ± .08	5.80 ± .82
W_p	25	8.9–12.2	4.99	9.90 ± .15	.77 ± .11	7.78 ± 1.1
M_1						
L_i	15	13.3–15.0	3.29	14.22 ± .13	.51 ± .09	3.57 ± .65
L_o	4	13.3–15.2	4.78	13.95 ± .37	.74 ± .26	5.28 ± 1.9
W_a	19	8.9–10.3	2.38	9.48 ± .08	.37 ± .06	3.88 ± .63
W_p	19	9.7–11.0	2.33	10.25 ± .08	.36 ± .06	3.52 ± .57
M_2						
L_i	29	13.9–18.2	6.11	16.61 ± .18	.94 ± .12	5.68 ± .75
L_o	13	15.0–19.5	8.16	16.97 ± .35	1.26 ± .25	7.42 ± 1.5
W_a	42	10.2–13.4	4.39	12.06 ± .10	.68 ± .07	5.62 ± .61
W_p	42	10.4–14.4	4.70	12.46 ± .11	.73 ± .08	5.82 ± .63
M_3						
L_i	18	21.5–25.3	5.98	23.36 ± .22	.92 ± .15	3.95 ± .66
L_o	24	21.2–26.5	7.39	23.71 ± .23	1.14 ± .16	4.81 ± .69
W_a	43	12.0–14.6	3.99	13.37 ± .09	.62 ± .07	4.61 ± .50
W_p	43	11.8–14.6	3.97	12.83 ± .09	.61 ± .07	4.78 ± .52

the differences are so slight that they would normally be obscured by random sampling variation. In no case is the difference in means for teeth in and out of series greater than .78 mm. Even in this extreme case, the probability of such a difference appearing purely by chance (estimated by Student's *t* test) in samples of this size from the same population is greater than .02. In all the other instances the probability is greater than .05, and the difference (for each individual tooth) has no statistical significance. In short, length measurements on teeth in series do run slightly lower than on isolated teeth, but the difference is so small that it is unlikely to vitiate any proper comparisons that could reasonably be made with such materials.

TABLE 5

STATISTICAL DATA ON DECIDUOUS CHEEK TEETH OF *Platygonus compressus* FROM ST. LOUIS

	N	OR	SR	M	σ	V
dm_2						
L	2	8.1–8.4	—	8.25	—	—
W	2	4.9–5.1	—	5.0	—	—
dm_3						
L	4	9.2–10.5	—	9.73	—	—
W	4	6.5–7.4	—	6.80	—	—
dm^2						
L	7	17.0–18.1	2.20	17.51 ± .13	.34 ± .09	1.94 ± .52
W_a	7	7.8–8.8	2.29	8.34 ± .13	.35 ± .10	4.24 ± 1.1
W_m	7	7.2–8.6	3.08	7.69 ± .18	.48 ± .12	6.19 ± 1.7
W_p	7	8.8–9.3	.96	8.97 ± .06	.148 ± .04	1.66 ± .44
dm^2						
L	5	8.6–9.5	—	9.14	—	—
W	5	6.8–8.3	—	7.38	—	—
dm^3						
L	7	10.2–12.9	5.64	12.19 ± .33	.87 ± .23	7.14 ± 1.9
W_a	7	7.4–8.5	2.36	7.81 ± .14	.36 ± .10	4.66 ± 1.3
W_p	7	10.1–11.4	2.44	10.79 ± .14	.38 ± .10	3.48 ± .93
dm^4						
L	13	11.9–14.4	4.26	12.95 ± .18	.66 ± .13	5.08 ± .10
W_a	13	10.7–12.8	3.63	11.92 ± .16	.56 ± .11	4.70 ± .92
W_p	13	10.9–13.0	4.11	12.02 ± .18	.64 ± .12	5.28 ± 1.0

There is no evidence that measurements on teeth in series are less accurate or consistent than those on loose teeth. Any note-

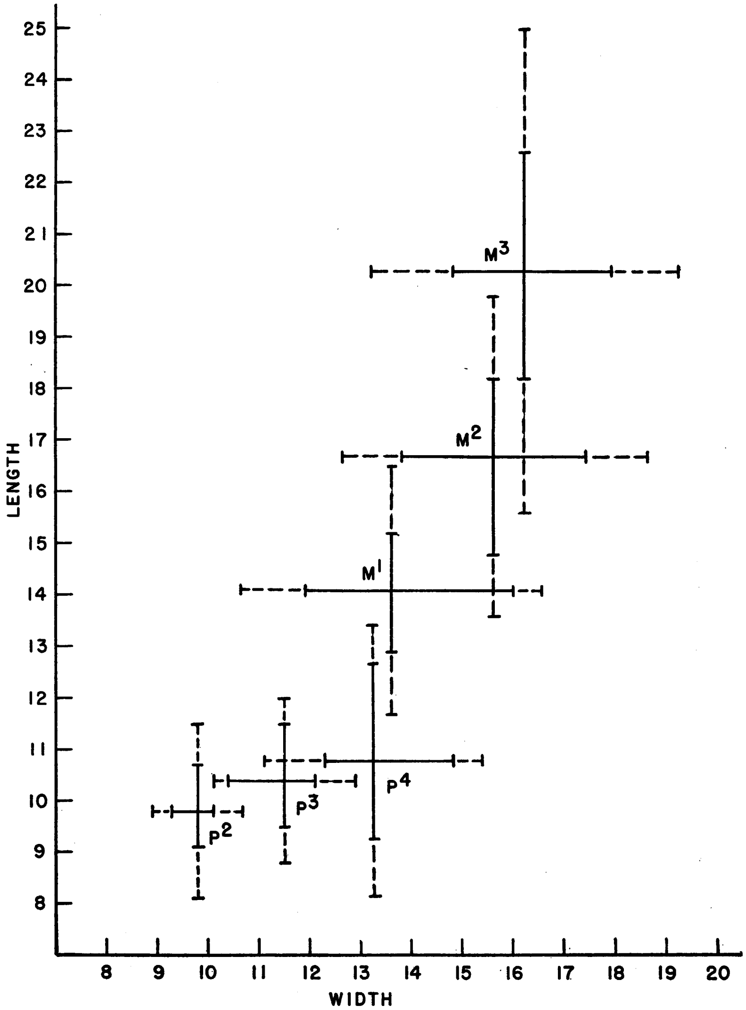

FIG. 11. *Platygonus compressus.* Diagram of lengths and widths of upper cheek teeth from Cherokee Cave, St. Louis. For each tooth, as labeled, the intersection of the two lines is at the mean length and width. The solid lines represent observed range of the corresponding dimension, length in the case of vertical lines and width in the case of horizontal lines, and the dashed lines continue these to the calculated limits of the standard ranges. For M^{1-3} the length data are for teeth in series.

worthy difference in this respect would probably affect the coefficient of variation. In fact variation, by this index, is on an average smaller in the measurements made on the teeth in series.

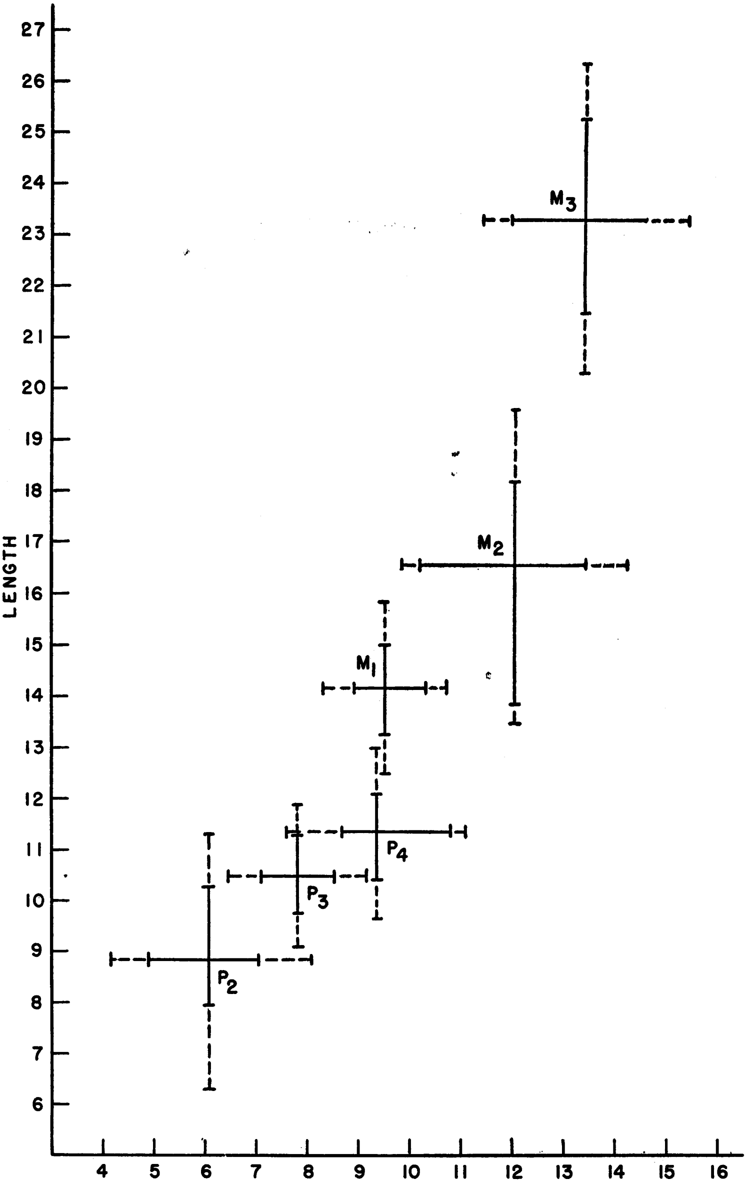

FIG. 12. *Platygonus compressus.* Diagram of lengths and widths of lower cheek teeth from Cherokee Cave, St. Louis. For P_3–M_3 the length data are for teeth in series. The construction of the diagram and its conventions are as in figure 11.

This is probably a chance result (the differences are not statistically significant, either individually or in their consistency among the eight variates), but in any case it opposes rather than favors the hypothesis that measurements in series are less reliable.

The variability in size of the various tooth dimensions is reasonably consistent throughout and seems to be about that usual for dimensions of functional teeth in most species of mammals. Almost all the coefficients of variation run in round numbers from 4 to 7. The only remarkably low V's are 2.8 for WP^2 and 1.7 for W_pdm_4 and these are for small samples (only 7 in each case) and probably are chance sample deviations below the population values. One tooth, P_2, has values of V considerably higher than those for any other tooth. The sample is so small that the sig-

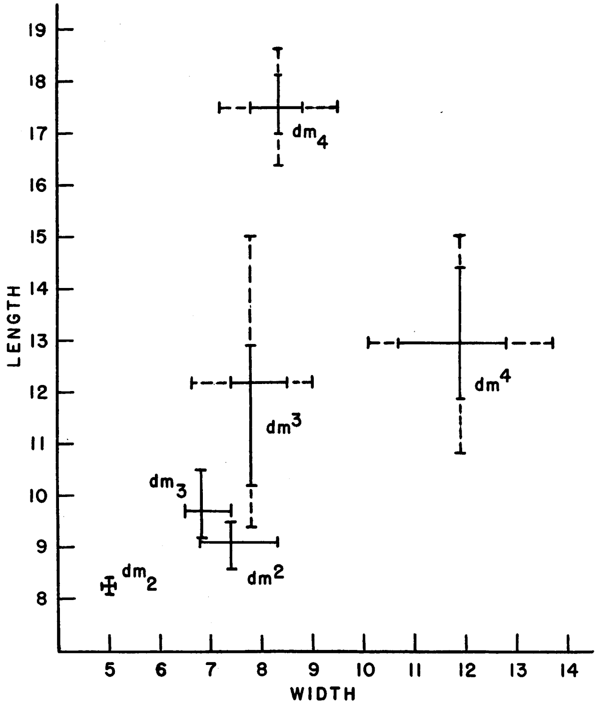

FIG. 13. *Platygonus compressus.* Diagram of lengths and widths of deciduous cheek teeth from Cherokee Cave, St. Louis. The construction of the diagram and its conventions are as in figures 11 and 12. Standard ranges are not given for the small samples of dm_{2-3} and dm^2.

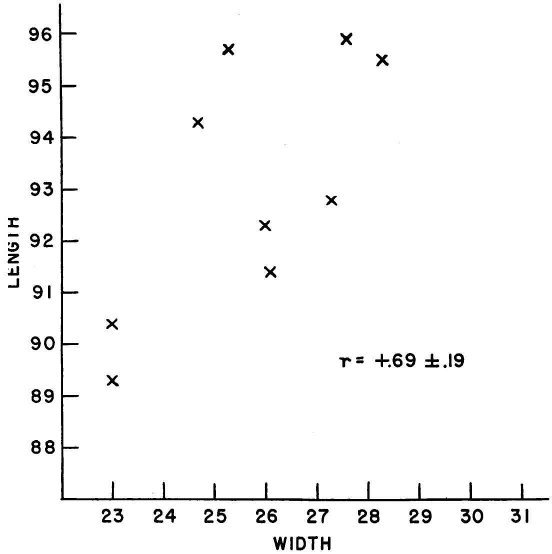

FIG. 14. *Platygonus compressus.* Scatter diagram of corresponding lengths and median shaft widths of metacarpals (both sides) from Cherokee Cave, St. Louis.

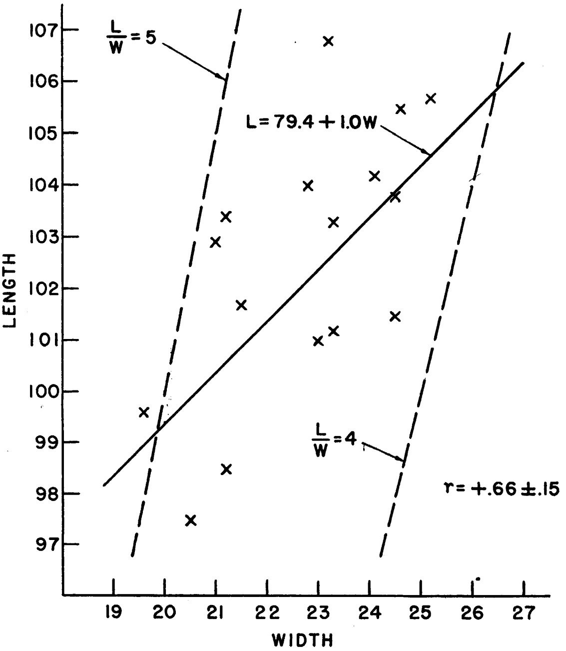

FIG. 15. *Platygonus compressus.* Scatter diagram of corresponding lengths and median shaft widths of right metatarsals from Cherokee Cave, St. Louis. The least-squares regression line is given (solid) as well as two ratio lines (broken)

nificance of these high values is somewhat dubious, but this may well be an unusually variable tooth in this population. It may be in process of evolutionary change (reduction?) or perhaps it shows some sexual dimorphism. It has been suggested (e.g., Gazin, 1938) that the premolars tend to be more slender in female than in male peccaries, but our series shows no clear evidence of association of cheek tooth size with sex.

The metapodials show no striking variations in structure, but they vary considerably in size and proportions. Statistical data are presented in table 6 and figures 14–16. Abbreviations are the same as for the cheek tooth statistics except that L is here maximum length between planes touching the proximal and distal ends of the bone and at right angles to its shaft, W is the minimum transverse width of the shaft, and the additional symbol r is used for the coefficient of correlation. The bones measured are all essentially adult, with the epiphyses at least partially fused and with the shafts of the two appressed metapodials also at least partially fused.

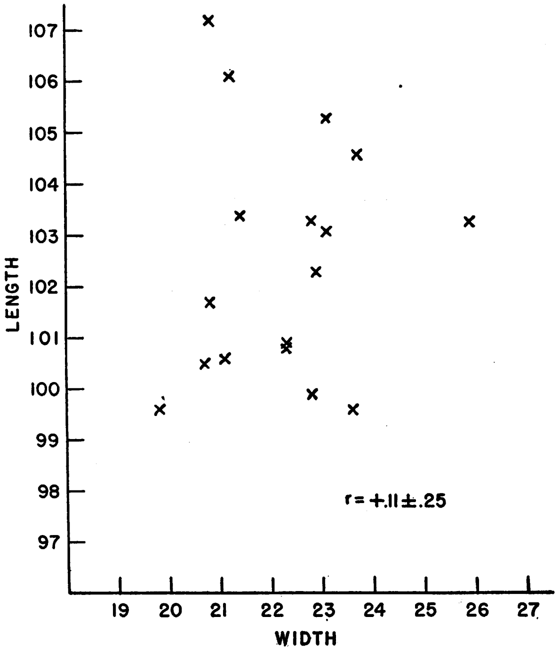

FIG. 16. *Platygonus compressus.* Scatter diagram of corresponding lengths and median shaft widths of left metatarsals from Cherokee Cave, St. Louis.

TABLE 6

STATISTICAL DATA ON METAPODIALS OF *Platygonus compressus* FROM ST. LOUIS

	N	OR	SR	M	σ	V
Metacarpals						
L	9	89.3–95.9	14.84	93.07 ± .76	2.29 ± .54	2.46 ± .58
W	9	23.0–28.3	11.60	25.70 ± .60	1.79 ± .42	6.98 ± 1.6
Right metatarsals						
L	17	97.5–106.8	15.88	102.49 ± .59	2.45 ± .42	2.39 ± 1.3
W	16	19.6–25.2	10.56	22.72 ± .41	1.63 ± .29	7.19 ± 1.4
Left metatarsals						
L	17	99.6–107.2	14.64	102.49 ± .55	2.26 ± .39	2.1 ± 2.30
W	17	19.8–25.9	7.39	22.25 ± .35	1.14 ± .25	6.49 ± 1.2
Total metatarsals						
L	34	97.5–107.2	15.29	102.49 ± .40	2.36 ± .29	2.38 ± .28
W	33	19.6–25.9	10.11	22.48 ± .27	1.56 ± .19	6.91 ± .85

The coefficients of variation for length are the same for metacarpals and metatarsals (within limits of probable sampling error) and are low. This relatively slight amount of variation probably reflects the functional importance of metapodial length and rather strong selection against variation in it. The width of shaft may be presumed to have less functional importance, or to have wider limits of structural tolerance, and the samples reliably show that this is a more variable dimension than length. The possibility that the bones continued to grow in width after they ceased to elongate may also be considered as a possible cause of greater variation in width, but this is not a probable or at any rate a sufficient explanation.

Statistics for the metatarsals, of which adequate samples were available, were calculated separately for right and left sides as well as for the total of both. No significant difference was expected or was found between M, σ, and V values for the two sides. There is, however, some probability that the whole sample includes some pairs of metatarsals from the two sides of the same animals, and these pairs would show individual correlation. The standard errors of the combined sample might then be spuriously low, and correlation of length and width might also be affected.

The correlation of length and width is not very close, and the relative slenderness of the metapodials is highly variable. For the metacarpals (an inadequate sample) the correlation coefficient r is +.69 ± .19, doubtfully significant statistically in so small a sample.

For the right metatarsals, r = +.66 ± .15, which is significantly positive but does not suggest strong correlation. For the left metatarsals, r is only +.11 ± .25, which is far from significant. This low sample result could be (and doubtless was) derived from a population in which the correlation was real and was as high as that for the right metatarsals, but it suggests that the correlation in the population was really lower than for our sample of the right metatarsals. It happens that among the left metatarsals there are two that are extraordinarily long and slender, a chance of sampling that reduces the correlation.

The least square regression line for our right metatarsal sample, the only one that gives a reasonably good regression, is $L = 79.4 + 1.0\ W$. Mean length increases at about the same absolute rate as mean width, and therefore at a lower relative rate. For small individuals with length around 100 mm. the ratio of length to width tends to be about 5, but for larger individuals with length around 105 mm., the ratio tends to be about 4.2, but with great variation in both cases. Metatarsals near the mean length may have length : width ratios from 4 to 5. The unusually long, slender left metatarsals mentioned above illustrate how radical this variation may be. They measure 107.2 and 106.1 mm. in length, but the ratios of length to width are 5.2 and 5.0, respectively, ratios as large as those of the shortest metatarsals in the collection. It is evident that relative elongation or slenderness of metapodials has relatively little taxonomic or functional significance in this group. It would seem advisable also to reëxamine some other groups in which importance has been given to moderate differences in metapodial proportions.

COMPARISONS WITH CLASSIC MATERIAL OF *P. COMPRESSUS* AND WITH *P. LEPTORHINUS* (= *P. COMPRESSUS*)

Bearing in mind that Leidy's measurements (Leidy, 1853) were in no case more precise than to $^1/_4$ line, about .5 mm., and that a difference must be on that order to indicate any real difference in the actual measurement, Leidy's measurements of syntype and lectotype of *P. compressus* all fall within the observed range of the St. Louis series except LP^2. LP^2 of *P. compressus* syntype is outside the observed, but within the standard, range for the St. Louis sample, which has only seven measurements of this dimension. Leidy's measurements are, however, all below the means for the

St. Louis sample, and this is real in terms of the precision of Leidy's units except for WP^2. In other words, as far as these measurements are concerned, the types of *P. compressus* could represent small variants from a population not significantly different from that sampled by the St. Louis collection.

Although Williston's sample, type series for his *P. leptorhinus* (Williston, 1894b), is small, it does suffice to make a more secure statistical comparison with the St. Louis series. (Williston's measurements are given to whole millimeters only and are thus less precise than Leidy's; the means are of course more precise but not so much as might appear from their conventional presentation here to two decimal places.) The means for "*P. leptorhinus*" are all below those for the St. Louis sample except for LP^2, where the difference is only .2 mm. and both samples are small. In some cases the differences between the two lots are significant in a tech-

TABLE 7

COMPARISONS OF ST. LOUIS SPECIMENS OF *P. compressus* WITH THE SYNTYPE OF THAT SPECIES AND THE SYNTYPES OF *P. leptorhinus*

	Syntype, *P. compressus*[a]	Syntypes, *P. leptorhinus*[b]			St. Louis Series[c]		
		N	M	OR	N	M	OR
P^2							
L	8.5	3	10.0	9–11	7	9.81	9.1–10.7
W	9.5	3	9.67	9–10	7	9.76	1.3–10.1
P^3							
L	—	4	10.25	10–11	12	10.43	9.5–11.5
W	10.6	4	11.25	10–12	12	11.49	10.4–12.1
P^4							
L	10.1	4	9.25	9–10	21	10.78	9.3–12.7
W	12.2	4	12.00	11–13	21	13.25	12.3–14.8
M^1							
L	—	5	12.60	11–14	19	14.08	12.9–15.2
W	—	5	12.20	12–13	29	13.57	11.9–16.0
M^2							
L	—	4	16.00	15–17	17	16.71	14.8–18.2
W	—	4	14.25	14–15	34	15.59	13.8–17.4
M^3							
L	—	2	19.50	19–20	14	20.26	18.2–22.6
W	—	2	14.00	14	26	16.20	14.8–17.9

[a] Measurements from Leidy, 1853, with lines converted to millimeters.

[b] Measurements from Williston, 1894b.

[c] The lengths are those of teeth in series, where these were separately tabulated; see tables 3 and 4

nical statistical sense. For instance P by Student's *t* test is well under .01 for the dimensions of M^1 and M_1 except WM_1, for which it is slightly above .05. These tests, when the available frequencies are large enough to show significance, and the almost complete consistency of the relationship, even for small frequencies, indicate that the population represented by Williston's measurements had the mean size of the cheek teeth smaller than that represented by ours. Comparisons with the types of *P. compressus* and of *P. leptorhinus* are given in tables 7 and 8.

TABLE 8

Comparisons of St. Louis Specimens of *P. compressus* with the Lectotype of that Species and the Syntypes of *P. leptorhinus*

	Lectotype, *P. compressus*[a]	Syntypes, *P. leptorhinus*[b]			St. Louis Series[c]		
		N	M	OR	N	M	OR
P_2							
L	—	4	8.75	7–10	7	8.87	8.0–10.3
W	—	4	6.25	6–7	7	6.70	5.2–8.6
P_3							
L	—	4	10.00	10	14	10.56	9.8–11.3
W	—	4	7.75	7–8	25	8.59	7.8–10.2
P_4							
L	—	4	10.75	10–12	15	11.40	10.4–12.1
W	—	4	9.50	9–10	25	9.90	8.9–12.2
M_1							
L	—	6	12.33	10–15	15	14.22	13.3–15.0
W	—	6	9.83	9–11	19	10.25	9.7–11.0
M_2							
L	15.9	5	15.40	15–16	29	16.61	13.9–18.2
W	11.6	5	11.40	10–13	42	12.46	10.4–14.4
M_3							
L	21.2	5	21.20	20–23	18	23.36	21.5–25.3
W	12.2	5	11.60	11–12	43	13.37	12.0–14.6

[a] Measurements from Leidy, 1853, with lines converted to millimeters.

[b] Measurements from Williston, 1894b.

[c] The lengths are those of teeth in series, where these were separately tabulated; see tables 3 and 4.

There remains the possibility that the difference is in the measurements and not in the teeth, that is, that Williston's measuring technique tended to give smaller measurements on the same objects than does ours. This cannot be fully checked without remeasuring all of Williston's material, which has not been practi-

TABLE 9

COMPARISONS OF MEAN DIMENSIONS OF CHEEK TEETH OF *P. compressus* FROM ST. LOUIS WITH THOSE OF A SYNTYPE OF *P. leptorhinus*

	A.M.N.H. No. 10388[a]	St. Louis Mean
P_2		
L	10.0	8.87
W	6.65	6.70
P_3		
L	10.55	10.56
W	7.5	8.59
P_4		
L	10.7	11.40
W	8.8	9.90
M_1		
L_i	13.95	14.22
W_a	9.15	9.48
W_p	9.85	10.25
M_2		
L_i	15.85	16.61
W_a	10.75	12.06
W_p	11.5	12.46
M_3		
L_i	21.45	23.36
W_a	11.5	13.37
W_p	12.4	12.83
P^2		
L	9.05	9.81
W	8.95	9.76
P^3		
L	10.2	10.43
W	10.8	11.49
P^4		
L	9.35	10.78
W	12.3	13.25
M^1		
L_i	13.7	14.08
W_a	12.75	13.57
W_p	13.1	13.50
M^2		
L_i	15.2	16.71
W_a	14.6	15.59
W_p	14.4	15.01
M^3		
L_i	18.7	20.26
W_a	15.1	16.20
W_p	14.05	13.70

[a] Measurements taken on both sides and means entered.

cable for us because the specimens have been dispersed. One of them is, however, in our collection, and Mr. Altshuler has measured it by the identical technique used in measuring the St. Louis sample, with the result given in table 9. Of the 30 dimensions compared, the Kansas specimen is smaller than the St. Louis mean in all but two, LP_2 and W_pM^3. This is not absolutely conclusive, but the agreement with the trend of Williston's more numerous measurements leaves little reasonable doubt that the teeth in Williston's specimens really do average smaller than the means for ours.

In spite of this difference in mean size, the observed ranges of these dimensions overlap extensively in the Kansas and St. Louis groups, a fact all the more striking in view of the small size of some of the samples.

Of the 24 dimensions studied, the observed range of Williston's measurements is wholly within that of the larger St. Louis sample, rounded to the same units, in 15 cases. For eight dimensions Williston's observed range extends lower than that for the St. Louis peccaries but still overlaps the latter, a large variant from the Kansas sample being as large as, or larger than, a small variant from St. Louis. In only one case, WM^3, do Williston's figures fail to overlap ours, and in this case he gave only two measurements and reported them as equal, 14 mm., while our smallest specimen measures 15 mm., in round millimeters. Even here overlap undoubtedly existed in the samples. In fact, Mr. Altshuler's more precise measurement of WM^3 on one of Williston's specimens is 15.1, which is within the St. Louis observed range although still well below its mean.

In tooth dimensions, Williston's specimens differ less from the lectotype and syntype specimens of *P. compressus* than do the St. Louis specimens. Leidy's referred specimens of *P. compressus*, essentially informal neotypes, also have teeth that tend to be smaller than those from St. Louis and that are not evidently different from Williston's specimens.

In distinguishing *P. leptorhinus* from *P. compressus*, Williston (1894b) did not rely on tooth measurements, which reveal no significant difference, but on minor morphological differences from Leidy's figures of referred, not type, skulls and jaws supposedly of *P. compressus* and especially the young skull that Leidy first named *Euchoerus macrops*. On restudying one of Williston's specimens, of about the same age as the "*Euchoerus*" skull, Peterson (1914) denied significance or reality to some of the supposed differences tentatively signalized by Williston, but concluded that the Williston specimen, and hence *P. leptorhinus*, differed from "*Euchoerus macrops*," hence by inference from *P. compressus*, in having the symphysis of the lower jaw heavier, with a more extended protuberance on the chin, in having shorter postcanine diastemata, and in having the jaws generally more robust and the face wider.

These differences, too, are deprived of probable specific validity by comparison with our more extended series of specimens. There can be little doubt that the St. Louis peccaries represent a single specific population, but among them are variants that match Williston's material (especially A.M.N.H. No. 10338, directly compared) closely in weight and protuberance of the symphysis, in length of diastema, and in width of face, and others that match Leidy's figured specimens equally well in these particulars.

As regards depth of lower jaw, our St. Louis specimens with P_4 erupted and the ramus well preserved give the following data for depth of ramus on the outer side from the alveolar margin at the middle of P_4 to the lower rim in a vertical from the alveolar line:

N	OR	SR	M	σ	V
8	40–44	8.51	41.50 ± .58	1.32 ± .33	3.19 ± .80

A.M.N.H. No. 10338, a syntype of *P. leptorhinus*, measures 48 mm. in this dimension and is thus significantly deeper than the jaws from St. Louis. However, the whole series of syntypes of *P. leptorhinus* measured by Williston has an observed range of 35–49 and a mean of 43.33 mm. Although this mean is higher than that for St. Louis, the difference is not statistically significant (by the *t* test, which gives P greater than .3), and Williston's observed range not only overlaps but also completely includes ours.[1] In other words, Williston's series does not have significantly heavier jaws than ours; it is simply more variable than ours, so that some individual variants are significantly larger and some are significantly smaller than our series.

In all this there is nothing that would warrant or permit placing the types of *P. compressus*, Leidy's referred specimens, Williston's syntype series of *P. leptorhinus*, and our series from St. Louis in

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[1] Williston did not well specify the dimension he measured, but check on our Williston syntype and on Leidy's and Williston's figures shows it as sufficiently near ours to warrant comparison.

more than one species. All are placed in *P. compressus*, of which *P. leptorhinus* is a synonym.

It is nevertheless clear that as populations, that represented by Williston's Kansas specimens is somewhat different from that represented by the series from St. Louis. Their variations fully intergrade and many individuals could not well be distinguished taken separately, but the mean size of their teeth (and perhaps some other averages for details) are somewhat different. They represent slightly different segments of one specific population. The Kansas specimens, apparently killed and buried simultaneously and together, may well be a single family group. The St. Louis specimens are too numerous to represent one family only, but probably are all from one local race, perhaps a single herd. The two different series are not likely to be exactly contemporaneous.

The two series could be regarded either as different geographic races or subspecies or as successive samples of a population changing with the passage of time. Choice between the two alternatives is impossible from the available information, and both geographic and temporal factors may be involved. It would be legitimate to apply separate trinomials (but not binomials) to the two groups, but this would be rather pointless at present. There were probably many local and temporal groups equally or more distinctive within this wide- and long-ranging species. It would be of great interest to be able to plot this subspecific differentiation for a Pleistocene species, and *P. compressus* seems to be promising in this respect. Recognition of some small-scale distinction in these two groups is a step in that direction, but many more such samples need to be gathered and analyzed in a similar way before a clear picture will be available. Subspecific nomenclature applied now would be premature and might complicate the eventual solution.

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