Preliminary report on a Late Pleistocene death-trap fauna from Monroe County, Indiana

Steven Alan Volz, Department of Geology, Indiana University, Bloomington, Indiana 47401

Abstract

Fragmented remains of numerous Late Pleistocene mammals have been collected from a gryke in the Salem Limestone of Monroe County, Indiana. This gryke, which was exposed during construction on State Highway 37, has yielded remains of *Platygonus vetus, Smilodon fatalis, Canis dirus, Canis lupus, Canis* cf. *latrans, Ursus americanus* and *Neotoma* sp.

Of the remains collected the most abundant are from *Platygonus vetus* and from carnivores, particularly *Canis dirus*. This evidence suggests that the accumulation resulted from entrapment of susceptible animals in a natural cavity from which escape was not possible, although some remains may have been imported by activities of the wood rat. The high degree of fragmentation of the preserved material is interpreted as the result of slow burial and periodic disturbance by rodents and newly entrapped animals.

Acknowledgments

This writer wishes to thank William Turnbull of the Chicago Museum of Natural History for his generosity in allowing access to the vertebrate collections and willingness in answering questions. Also, thanks are given to Phillip Gingerich of the University of Michigan Museum of Paleontology for allowing similar access to the vertebrate paleontology collections of that institution and for his help with several questions. Further, the writer acknowledges the Department of Geology at Indiana University for financial support of the museum trips and for defraying costs of the radiocarbon dating that was done by Geochron Laboratories. Finally, this writer acknowledges and thanks Donald Hattin of the Department of Geology at Indiana University for his review and editing of this manuscript.

Introduction

In April of 1974 the writer participated in a sedimentation and stratigraphy field trip led by William Pullen and the late Ned Smith of Purdue University. The party discovered a few scattered teeth and skeletal remains of some Late Pleistocene animals in a road cut situated south of Bloomington, Indiana. The remains were preserved in clayey deposits of a large gryke which occurs within a hill underlain by Salem Limestone. The fissure had been transected by the then recently completed State Highway 37. The site lies about nine tenths of a mile south of Zikes Road on the east side of the highway (see Plate 1).

This paper is the result of two subsequent collecting expeditions in the winters of 1974-1975 and 1975-1976 during which a portion of this deposit was removed for study.

Description of Deposit

The fossiliferous deposit lies within one of numerous grykes which occur along this stretch of highway. Before construction of the road, the grykes were completely filled by detritus consisting primarily of clay. These fissures are now being eroded. They may extend several meters laterally into the hillside and range in width from a few centimeters to a few meters.

The cavity from which the studied material came is about 1.5 meters wide and extends back 1.7 meters into the hillside from the edge of the road cut. Original dimensions of the fossiliferous gryke cannot be estimated; part of its length was destroyed by road building and the full depth can be determined only by further excavation. The top of the fossiliferous clayey deposit lies about 3.0 meters beneath the adjacent upland surface. Approximately 0.7 meters of fossiliferous clay has been removed from the gryke.

The sides of the gryke are nearly vertical and consist of well-weathered surfaces which have solution pits and secondary cave-type calcareous deposits. These sides extend to the upland surface with little overhang or beveling.

The fossiliferous deposit is more or less chaotic with only the clay fill having any semblance of stratigraphic order. Clay nearest to the upland surface is comprised of red to purple *terra rosa*. The *terra rosa* is underlain by brown clay, which is replaced laterally by *terra rosa* directly adjacent to the limestone walls. Beyond this no stratification is apparent.

The clay contains considerable numbers of much-fragmented mammal bones and teeth. No other macroscopic organic remains have been identified. The skeletal remains are jumbled haphazardly and usually are so fragmented as to be unidentifiable. Most often, the bone fractures have sharp edges although a few specimens appear to show wear by abrasion. Several specimens have been crushed. The best-preserved material consists of teeth most of which have been separated from the respective jaws. No complete bones more than 4 or 5 centimeters in length have been recovered. The extent of disarray of the deposit can be summarized best by the description of one block of collected material. This block, which was about the size of a man's fist, contained the posterior left portion of a dire-wolf palate, the hoof of a peccary and a large, unidentified, fragmented incisor. The block also contained countless splintered and unidentifiable bone fragments.

The most dense occurrence of these skeletal remains is in the brown clay although bones occur also in the lower part of the *terra rosa* mantle and in the *terra rosa* that lies against the limestone walls. Skeletal material occurs in abundance to the deepest level excavated and considerable amounts probably remain.

In addition to the mammal remains, the clay deposit contains a large number of scattered angular limestone fragments. These range in size from pebbles to boulders. These blocks were derived almost exclusively from the St. Louis Limestone which lies above the Salem

Limestone. The St. Louis no longer crops out in the immediate vicinity of the gryke; however, in the road cuts directly across the highway, a thin layer of St. Louis is recognizable at the top of the section.

In addition to the primary detrital fill, a considerable amount of secondary calcite occurs in the deposit. Usually the calcite nucleated around limestone or fossil fragments. Consequently, large masses of limestone fragments, fossil fragments and clay have been cemented together into irregular masses of material.

Recovery and Preparation of the Fossil Material

The fossiliferous clay was removed in bulk with a shovel, although especially well-preserved specimens were removed carefully by hand whenever possible. Good specimens were recovered from the secondary calcite masses and from clay that was free of calcite cement. Generally, better specimens were recovered from the calcite masses.

Owing to the frailty of the material, preparation of the vertebrate material was difficult and time consuming. Generally, a needle probe was used to pick away the calcite and clay. Some specimens disintegrated during this process, although many were saved by progressive application of coats of alvar during picking, and by immediate gluing of specimens broken during the cleaning process. Some specimens were sufficiently durable to be worked free without special treatment. These were later coated with shellac.

Despite a considerable amount of primary fragmentation, parts of the same specimen usually were located in close proximity, and many teeth or jaw fragments were reassembled from parts that unquestionably had been separated before final burial.

In addition to the picking and cleaning, some of the sediment was sifted. Several rodent incisors were recovered in this way.

Recovered Fauna

The following list includes species that are represented by fossils from the clay-filled gryke.

Platygonus vetus
Smilodon fatalis
Canis dirus
Canis lupus
Canis cf. *latrans*
Ursus americanus
Neotoma sp.

The assignment of specific names to these specimens and other points germane to them are discussed below.

Platygonus vetus

The most abundant material collected from the site consists of juvenile and mature teeth of the extinct genus *Platygonus*, a Late Pleistocene peccary (see Plate 1). Of particular note is the fact that many of these specimens are unusually large, larger than any *Platy-*

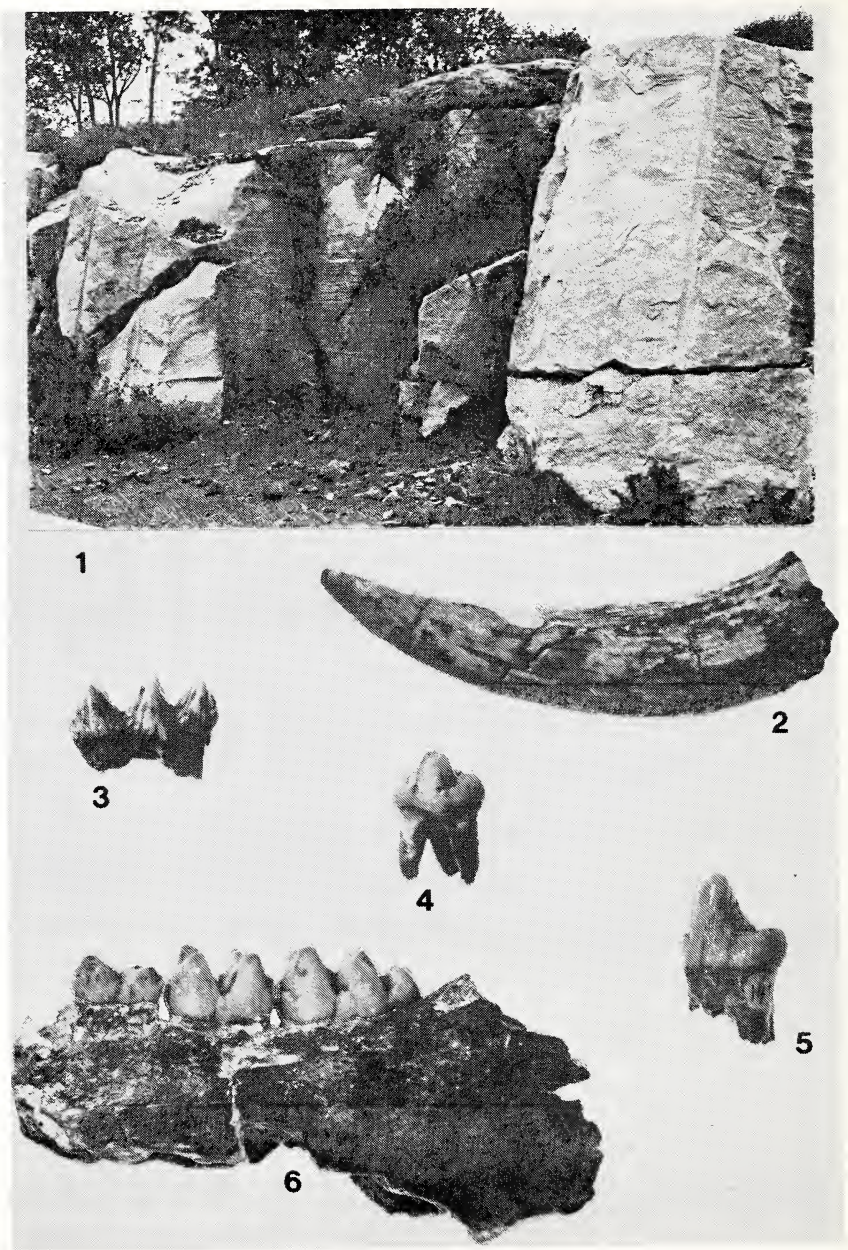

FIGURE 1. *Fossiliferous gryke locality.*
FIGURE 2. Platygonus vetus *Leidy* C_1 *IU 14627-24* × *2/3*
FIGURE 3. Platygonus vetus *Leidy Deciduous* P_3 *IU 14627-40* × *1*
FIGURE 4. Platygonus vetus *Leidy* P^2 *IU 14627-11* × *1*
FIGURE 5. Platygonus vetus *Leidy* P_3 *IU 14627-8* × *1*
FIGURE 6. Platygonus vetus *Leidy Mandible with* M_3, M_2, *and* M_1 *IU 14627-1* × *2/3*

gonus material reported previously. In addition to numerous teeth, proximal, medial and distal phalanxes have been identified. (Indiana University 14627-45, 14627-46, 14627-47, 14627-48).

Presently, two or three species of *Platygonus* are recognized from the Late Pleistocene of North America. In order to understand the assignment of this material to *Platygonus vetus*, a brief review of these Late Pleistocene species is pertinent (for a more comprehensive review see Slaughter (20)).

In 1848, Dr. John L. LeConte described *Platygonus compressus*, a moderate-sized, Late Pleistocene peccary from near Galena, Illinois (11). Later, several Late Pleistocene species were assigned to this genus by various authors. Most of these subsequent species were based on material which differed from *P. compressus* in minor characters of the skull and/or in the size of the skull or dentition. With the discovery of a cave in St. Louis that contained numerous remains from *Platygonus compressus* (G. G. Simpson (18)), it became apparent that a single population of *P. compressus* could be composed of a wide range of individuals that varied both in size and in relative proportions of dentition and skull. The Simpson paper extended the size range upward for the dentition and skull of *Platygonus compressus*, while at the same time showing that several earlier-named species of *Platygonus* should be considered synonyms of *P. compressus*.

The size range for *P. compressus* was extended still further by Slaughter (20), following study of a population from Laubach Cave, Texas. Slaughter showed that the size range in this population overlaps that of the St. Louis specimens and in some cases that of the Kansas specimens. Taken together, he showed the three populations formed a continuous series of size range. Based on his specimens Slaughter also reassigned one other *Platygonus* species (*P. alemanii*) to *P. compressus*.

Both Slaughter and Simpson recognized that a second main species of *Platygonus* existed in the Late Pleistocene, *Platygonus cumberlandensis*, which was first found in Cumberland Cave, Pennsylvania (Gidley (4)). *P. cumberlandensis* cannot be differentiated from *P. compressus* by tooth measurements (the first species falls within the upper size range now recognized for the latter). Rather, *P. cumberlandensis* is recognized by extreme development of the zygoma, which is about one and one-third times the size of the vertical diameter of the orbit in females and two or more times the diameter of the orbit in males. *P. compressus* shows not much more than normal development of the zygoma.

A third Late Pleistocene species, *Platygonus vetus*, is also tentatively recognized. This species was proposed by Leidy (12) for fragments of an upper and a lower jaw from Pennsylvania. Today, this species remains separate because of its somewhat larger size than the other two Late Pleistocene peccaries and also because a skull has not been found with which to examine the zygoma and other characteristics. A single specimen from Cumberland Cave (a portion of the palate from a young individual) has teeth of about the same size and pro-

portion as in *P. vetus*. Gidley (12) originally referred this specimen to *Platygonus vetus*. Later, Gidley and Gazin (5) considered that it might simply be a size variant of the other Cumberland Cave material but retained the original assignment, tentatively.

This brings up the possible synonomy of *P. cumberlandensis* and *P. vetus*. If *P. vetus* also showed an extreme development of the zygoma (i.e. if a skull with large dentition could be found with this zygoma), then *P. cumberlandensis* would be incorporated into *P. vetus*. If, however, this *P. vetus* skull showed no unusual development of the zygoma, then (assuming no other characters were found different enough to cause specific separation) *P. vetus* would become a synonym of *P. compressus*, and simply extend the size range of the latter species still further. Until a skull is found the relationship of *P. vetus* to the other two species will remain uncertain.

In the material I studied many *Platygonus* teeth are comparable in size to or even larger than the material reported for *P. vetus*. A few specimens, however, are in the upper size range of *P. compressus* (i.e. they are roughly the same size as *P. cumberlandensis*). Because no skull has been found, my assignment of the Monroe County material is made solely on the basis of tooth size. Consequently, this material is referred to the largest species known, *P. vetus*. This is not the first large Late Pleistocene peccary to be discovered in Indiana. Hay (8) reported an M^3 from Lawrence County which is comparable in size to material from my study site and which he referred to *P. vetus*.

Assignment of my specimens to *P. vetus* is done with the reservation that any one of five possible conditions could be true.

1. *P. cumberlandensis* is the same as *P. vetus*.

   If this is true, and it is supported by the fact that several of the specimens reported here are comparable in size to *P. cumberlandensis*, then *P. vetus* would be the appropriate name for these specimens.

2. *P. vetus* is the same as *P. compressus*.

   In this case, the upper limit of size range of *P. compressus* would be extended considerably and all *P. vetus* material would be referred to the species *P. compressus*.

3. *P. vetus* is a distinct species.

4. Two species are represented at the Monroe County site, *P. vetus* and either *P. compressus* or *P. cumberlandensis*.

5. Specific differentiation between the Late Pleistocene peccaries of the genus *Platygonus* should not be made on the basis of zygoma development.

   The trend defined by discovery of new populations of Late Pleistocene *Platygonus* has been toward simplification of the number of recognized species. This trend is owing primarily to the fact that individual populations demonstrate that these peccaries were highly variable not only in size but also in characters of dentition and skull. (Even Gidley (4) admitted that a

wide variation of zygomatic development occurred in his Cumberland Cave material.) Consequently, the ultimate end product of this trend would be to classify all present species herein discussed as subspecies of *Platygonus compressus.*

Smilodon fatalis

Remains of saber-toothed cats are rare in the Midwest, this being the first report of material from Indiana. Included in this material are a right and a left P^4 (Indiana University 14627-51 and 14627-50) plus a right and left P^3 (Indiana Unuiversity 14627-54 and 14627-55) (see Plate 2).

Several Late Pleistocene species of the genus *Smilodon* have been proposed based on characters of skull and dentition. Merriam and Stock (14) showed that several of these characters could vary widely within a single population, based upon a large sample from the La Brea site. Consequently, later authors have reassigned several species which had been classified originally on characters that the La Brea material suggests are of subspecific rank.

Slaughter (19) recognized three well-defined species of *Smilodon* in North America, based upon dental indices constructed from lower dentition plus some supporting skull data. These three species are *Smilodon fatalis* (=*S. troglodytes, S. conardi, S. nebraskensis, S. trinitiensis), S. floridanus (=S. californicus),* and *S. gracilis.* Recent discoveries in Florida (Webb (24)) have tended to confirm Slaughter's view. Unfortunately, the Indiana material does not contain any part of the lower dentition that could be compared with Slaughter's results. Consequently, this material was assigned to *Smilodon fatalis* by other criteria.

First, measurements of the Indiana *Smilodon* teeth are consistently smaller than any of the material reported from La Brea and assigned originally to *S. californicus* by Merriam and Stock (14). These authors stated that ". . . it is questionable whether there are any upper fourth premolars of sabre-tooth in the large collection from California asphalt deposits which approach closely the size or at least the anterior-posterior diameter of the type of *S. fatalis.*"

Second, both Indiana P^4's show evidence that they had well developed protocones. On both specimens in the place where the protocone would normally be developed there is a conspicuous hole through the enamel. Both holes show that enamel at the marginal edges is well worn as if by use by the animal during mastication. Because a dominant proportion of *Smilodon* P^4's from La Brea contain no protocone and because the overall size of their P^4's is uniformly larger than many *S. fatalis* specimens, *S. floridanus* (=*S. Californicus*) can be effectively eliminated from consideration.

Based on the material from my study site, *Smilodon gracilis* cannot be separated easily from *S. fatalis.* The Indana material falls approximately at the upper end of the size range for *S. gracilis.* The main criterion that can be used to separate *S. gracilis* from my material is the greater age of *S. gracilis.* Hibbard (9) considered the deposit which

yielded the original specimen of *S. gracilis* to be Yarmouthian in age. *S. gracilis* has not been reported from the Late Pleistocene which, as will be seen in a later section, is the age assignment of the Monroe County material based on the rest of the faunal association.

From the above I conclude that *S. gracilis* is not the best assignment for the species represented here. By elimination this leaves *S. fatalis* as the most likely species to which the Monroe County specimens should be assigned.

Canis dirus

The type specimen of *Canis dirus* Leidy was obtained originally from Pleistocene beds on the Ohio River near Evansville, Indiana. Within the Monroe County deposit, the second most abundant material obtained consists of teeth from this same great wolf (see Plate 2). The material matches so closely the La Brea dire wolf specimens in the Chicago Museum of Natural History that I have no doubt the Indiana material belongs to this species.

Canis lupus

Canis lupus Linné is represented in this deposit by a single, somewhat worn P^4 (Indiana University 14627-65) (see Plate 2). Its dimensions fall well within the range of modern subspecies of the grey wolf as presented by Goldman (7). It is not surprising to find *Canis lupus* preserved in fossil deposits because it was an indigenous species in Indiana at the time the first European settlers arrived.

Canis cf. latrans

A third species of *Canis* is represented in this material by approximately the anterior one third of a right M^1 (Indiana University 14627-66). Its size and shape compares favorably with *Canis latrans* Say. The coyote is presently an indigenous species in Indiana.

Ursus americanus

The collection contains several teeth referable to the modern species of black bear, *Ursus americanus* Pallas. (See Plate 2.) These teeth corresponded closely in proportion and morphological characteristics with those in the collection of recent black bear skulls in the University of Michigan Museum of Paleontology. However, the Indiana fossils are somewhat larger, about the size of grizzly bear (*Ursus horribilis*) specimens in the same collection. This is to be expected. Presently, *Ursus americanus* shows considerable size differentiation over its geographic range and in most fossil reports, according to Kurten (10), *U. americanus* is described as being larger than the living animals. Black bear, like *Canis lupus*, became extinct in Indiana with the arrival of white settlers.

Neotoma sp.

The rodent material from Monroe County includes several incisors and one right M^1 (Indiana University 14627-49). The right M^1 can be

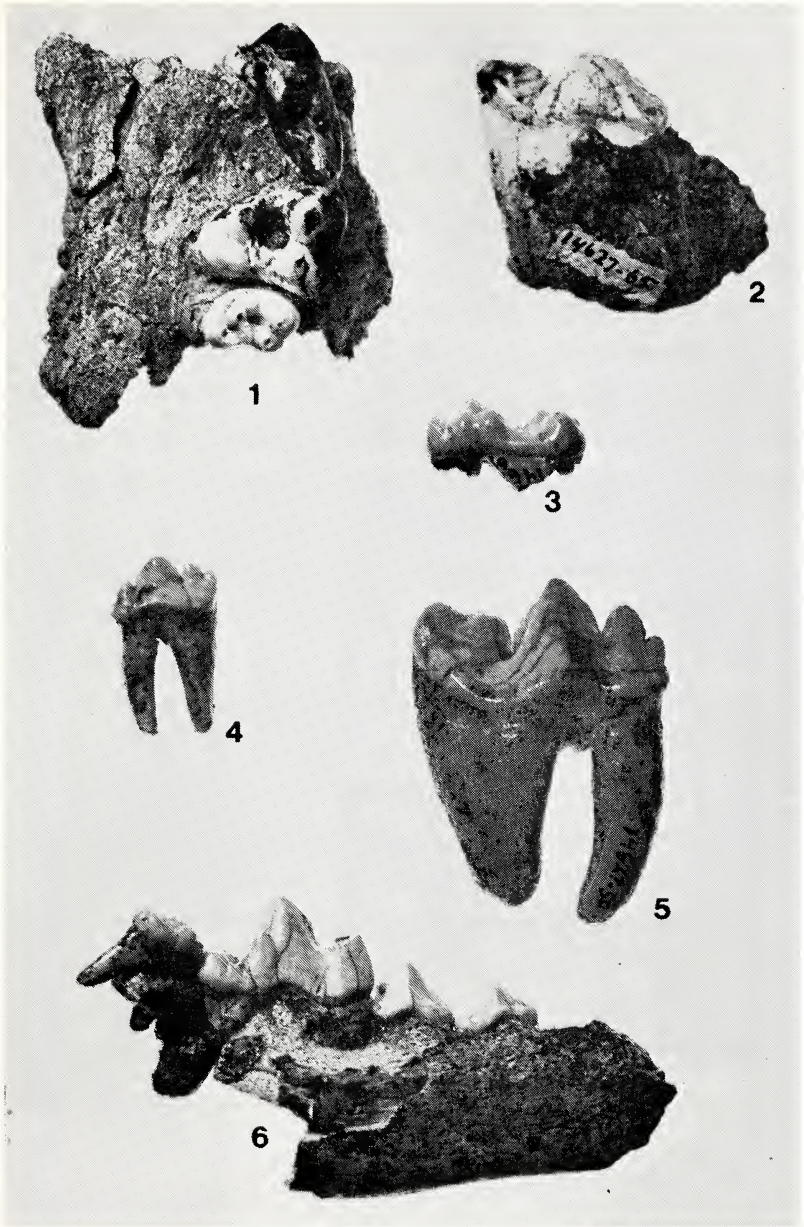

FIGURE 1. Canis dirus *Leidy Maxilla with* P^4, M^1, *and* M^2 *IU 14627-88* × *2/3*
FIGURE 2. Canis lupus *Linne* P_4 *IU 14627-65* × *1*
FIGURE 3. Ursus americanus *Pallas* M_1 *IU 14627-64* × *1*
FIGURE 4. Smilodon fatalis *(Leidy)* P_3 *IU 14627-54* × *1*
FIGURE 5. Smilodon fatalis *(Leidy)* P_4 *IU 14627-50* × *1*
FIGURE 6. Canis dirus *Leidy Mandible with* P_3, P_4, M_1 *and* M_2 *IU 14627-69* × *2/3*

assigned to the wood rat, *Neotoma* Say and Ord. *Neotoma floridana* is today indigenous to extreme southern Indiana.

Age and Environment

The fauna recovered from the Monroe County site indicates an early Late Pleistocene origin. Of the species recovered, *Ursus americanus*, *Canis lupus*, and *Canis latrans* are extant. Of the extinct animals of this fauna, *Canis dirus* is considered by Schultz (17) to be of Late Pleistocene age. Slaughter (20) gave the range of *Smilodon fatalis* as Middle Pleistocene to earliest Wisconsinan. The overlap in age ranges of elements in this fauna, plus the decidedly modern aspect of the fauna, leads me to conclude that the age must lie within the Sangamonian to Early Wisconsinan interval (i.e. early Late Pleistocene). This age assignment is supported in part by radiocarbon dating performed by Geochron Laboratories. Geochron reported no radiocarbon activity above the level of their counter background for carbon obtained from the apatite fraction of my material. This places the age of the deposit as earlier than 34,460 radiocarbon years before present. According to Flint (3), this dates the material as Middle Wisconsinan or older.

The enivronment represented by this assemblage is of considerable interest because the site lies close to the southern boundary of Late Pleistocene glacial activity in Indiana. Determination of the environment in which the gryke deposit was laid down should give clues to whether we are dealing with deposits of a glacial or interglacial stage.

The environment is interpreted herein as a grassy upland with scattered stands of trees. *Canis dirus* is believed by various workers, Schultz (17), to have been an inhabitant of open plains country. Similarly, many *Smilodon* remains (e.g. at La Brea) are interpreted as having inhabited open grassland environments. Ray, Denny, and Rubin (16); Slaughter (20); Lundelius (13); and Brown (1) believe that *Platygonus* occupied a similar environment to that of *Canis dirus* and *Smilodon*. Ray, Denny and Rubin (16) support this by referring to *Platygonus* ". . . faunal associations, wide distribution in the United States including the Plains and Far West, occurrence in loess, relative abundance, and apparently gregarious habits (frequent occurrence of multiple individuals)." In contrast, they point out that during the Late Pleistocene the solitary peccary *Mylohyus* probably occupied the woodland niche. In addition, the modern examples of *Canis latrans* and *Canis lupus* also inhabit open plains territory (Burt and Grossenheider, 1964), although not to the exclusion of other environments. Also, *Neotoma* may be found in grassy environments although Burt and Grossenheider (2) state that *Neotoma* is relatively tolerant of a wide range of climates and vegetation types and that this genus is fond of bluff ledges and crevices.

One member of this fauna, however, was probably not a typical inhabitant of plains. *Ursus americanus* is reported by Burt and Grossenheider (2) as presently inhabiting forests, swamps and mountains.

The preponderance of animals interpreted as inhabitants of open plains country, and the abundance of *Platygonus*, which almost certainly was restricted to such an environment, leads one to conclude the prob-

able existence of such an environment surrounding the Monroe County site. Broken tree cover probably explains the existence of *Ursus americanus*. Guilday (6) gave a similar interpretation for a Late Wisconsin fauna from central Kentucky. This fauna contained, among other elements, *Platygonus compressus*, *Canis dirus* and *Ursus horribilis*. He interpreted the total association as boreal semi-prairie or parkland.

The temperature of the environment was probably warmer than at present. The best temperature indicator in the fauna is *Platygonus*. Most researchers have held that *Platygonus* is a warm-climate indicator. This is supported by present distributions of peccaries and faunal associations of fossil finds. However, Ray, Denny and Rubin (16) reported *Platygonus compressus* in drift of Wisconsinan age which they believed indicated that the animal had died within a few miles of the margin of a wasting Late Wisconsinan glacier. They believed that the presence of *P. compressus* indicated expansion of an open-country habitat at the expense of woodland rather than the presence of a warm climate. The suggestion that *P. compressus* ranged from a non-glacial warm climate to a periglacial cold climate is supported by a possible northward clinal size decrease (a negative Bergmann's response) in Wisconsinan age *P. compressus*. If this clinal size decrease is real, and if *P. vetus* was governed by similar environmental parameters as *P. compressus*, then the Indiana site may record a very warm environment, indeed, owing to the large size of the *Platygonus* specimens from the Monroe County site. No other good climatic indicators are present in the fauna.

The sum of the faunal evidence indicates that the Monroe County site records existence of an open grassy plains environment in southern Indiana. This environment would correspond to a dry period which could be either glacial or interglacial. Evidence for the latter has been stated above. Unfortunately, the evidence for a warmer climate is not conclusive. Until further evidence comes to light, delimitation of the Monroe County site as either Sangamonian or Early Wisconsinan must remain indeterminate. Palynological study of this deposit might help to answer this question and also verify my conclusion that the site was in a predominantly open grassland.

Origin of Fossil Deposit

The concentration of vertebrate remains within this deposit most probably represents accumulation in a natural death trap, although activities of wood rats probably added material to the assemblage.

The proclivity of wood rats for the acquisition of bones and teeth is well documented. For example, Olsen (15) described a fossil site which most probably represents the personal collections of many generations of wood rats. In most ways, however, the Monroe County site does not compare at all favorably with the Olsen site. For example, fossils at the former site are strongly biased towards carnivores and peccaries. Presumably, wood rats were not selective in their acquisitions. Consequently, one would not expect to see any bias in the record of a fossil site that was the result of wood rat activity and this interpretation is ruled out. Nonetheless, at this site one might expect to see a few skeletal

remains of animals which were probably not susceptible to entrapment within a death trap of this kind and which can best be interpreted as resulting from wood rat importation.

Many animals, however, probably were susceptible to such entrapment. It is well known that *Platygonus* had an affinity for holes or fissures exposed to the surface. Other workers have postulated that similar concentrations of groups of *Platygonus* individuals found in circumstances similar to that of the gryke represent entrapment within a natural prison (e.g. Simpson (18), Gidley and Gazin (5)).

For several reasons a death-trap interpretation is very attractive for the Monroe County deposit. Such an interpretation helps to explain the unusual concentration of carnivores. It is not difficult to imagine a saber-tooth cat or one or two wolves from a pack being enticed into such a trap by the distressed squeals of a doomed peccary. Such an entrapped animal would seem to represent an easy meal. And even if the trap was ineffective for such an animal as a great, leaping saber-tooth, the cat might have found itself in grave straits when confronted by a seemingly unhealthy, but in reality very healthy and very large, peccary. Such a peccary could unquestionably inflict a wound that could doom the great predator to the same grave as its victim.

In order to be viable, the death-trap interpretation for the Monroe County site needs only a mechanism of allurement. Animals could have been enticed to enter the trap in several ways. First, some species might have been lured into the trap in the quest of shelter or water (assuming pools formed occasionally within the gryke). Secondly, some of the carnivores might also have been carrion feeders and have been trapped during their quest for earlier victims of this death pit. Young and Goldman (22) stated that wolves are well known as carrion feeders, which is true of most of the larger North American carnivores.

The question of carrion feeding also brings up one possible explanation for the common occurrence of *Platygonus* in such traps. If *P. vetus* and other *Platygonus* species were at least part-time carrion feeders, they may have been drawn to such death traps in the quest of food. The possibility of carrion feeding provides a ready explanation for the concentration through time of a large group of individuals at one locality by perpetuation of the mechanism of entrapment. Such a mechanism would yield a biased sample which would be weighted toward susceptible carrion feeders and carnivores, with the occasional or rare entrapment of other species that were seeking water or shelter.

The death-trap interpretation also helps to explain the intense disarray of bones in the deposit. Sedimentation here was sufficiently slow to permit complete decay of carcasses. Bones probably lay within the gryke and became brittle during extended periods of exposure. Periodic entry of more carrion feeders, including rodents, could have contributed to disarticulation of the skeletons and breakage of individual bones.

Whether carrion feeders could be totally responsible for the disarray of the deposit is indeterminate. Periodic flooding by heavy rains might have agitated the remains to some extent. However, there is no

evidence that a stream ever flowed into or through the fissure. Sediments or stratigraphic features indicative of streams or the fauna associated with them (e.g. turtle or mollusc remains) are not present. In addition, few specimens show evidence of transport. Those that appear abraded may be the result of rodent gnawing.

Other explanations for bone concentration at the Monroe County site are not as attractive as the death-trap hypothesis. The only other plausible interpretation involves use of the gryke as a natural shelter for carnivores. The problem with this interpretation is the numerical bias among the fossils recovered. The unusual concentration of carnivores could be explained by this concept but the lack of remains of any suitable prey, other than *Platygonus vetus*, cannot. If large carnivores were using this site as living and eating quarters, a greater variety of large prey animals would be expected. Because my report is based only on partial excavation of the total deposit, the possibility that remains of other large prey animals are present cannot be excluded. Nonetheless, a considerable amount of material has been recovered and searched during the preparation of this report. Based on the results of this work, interpretation of the site as a carnivore shelter is rejected tentatively.

Another possible interpretation for the remains at the Monroe County site is that this gryke did not act as a prison for all animals which entered it, but only for some. According to this hypothesis, some animals might have frequented the cavity as a place of shelter. Such an hypothesis is difficult to evaluate because the exact nature of the gryke entrance or size is indeterminate owing to partial destruction during highway construction.

It seems clear, however, that the fissure was of somewhat different size or shape in the past. This conclusion is based on the preponderance of St. Louis Limestone detritus within this Salem Limestone gryke. It should be recalled that at present the St. Louis Limestone is not preserved directly adjacent to the gryke although St. Louis beds do overlie the Salem Limestone in the cuts on the far side of the new highway. The St. Louis detritus indicates that a mass of St. Louis Limestone must at one time have bordered directly the edge of the cavity. Significant lateral transport of St. Louis clasts is precluded because none of the fragments show much evidence of such transport. Furthermore, large boulders of the St. Louis that have been recovered from the gryke deposit could not have been transported far. The lack of Salem Limestone fragments in the deposit suggests that this unit was protected from any surficial weathering that would have produced large Salem clasts.

It is possible that the presence here of St. Louis clasts resulted from collapse into the gryke of deposits formed earlier in a topographically higher cavern within the St. Louis. This appealing hypothesis helps to explain the intensely jumbled character of the bone-bearing deposit. It seems clear, however, that such a considerable amount of required overlying rocks units could not have been removed so completely by erosion in the time that has elapsed since deposition of the bone-bearing material. For this reason, I reject the hypothesis of redeposition by collapse of a St. Louis Limestone cave system.

I conclude, therefore that we are dealing here with the preserved portion of the original site of bone accumulation. Further, at this site the Salem Limestone lay under a protective mantle of St. Louis Limestone. This view would require a somewhat different climate than is present at the site today. A mantling layer of St. Louis Limestone along the border of the fissure could protect the Salem from mechanical weathering but not from chemical weathering unless a somewhat drier climate prevailed than is present at the site today.

Summary and Conclusions

On the basis of the present study I envision for the bone-bearing deposit the following scenario. Sometime within the early Late Pleistocene a parkland environment prevailed in southern Indiana. Across this open grassy country, typical carnivores of the period hunted among other animals, notably large peccaries. Peccary herds periodically fell victim to a natural death trap in the form of a cavity that afforded no escape. In doing so, they enticed carnivores and carrion feeders to a similar doom. Living within the cavity, woodrats periodically carried in additional material from surrounding areas. Eventually the cavity was filled with clayey deposits and preserved as seen today.

Other clay-filled fissures are exposed along this stretch of Indiana Highway 37 and hold promise for similar fossil discoveries. Even if these other fissures did not serve as death traps during exposure to the surface, they may have accumulated remains of animals which used the fissures for shelter or which were washed or carried in after death. Whether these other fissures were open to the surface concommitantly or at different times is indeterminate. None of the adjacent fissures have been excavated but all have been given cursory examination, with no positive results to date.

Literature Cited

1. BROWN, B. 1908. The Conard Fissure, A Pleistocene bone deposit in Northern Arkansas: With descriptions of two genera and twenty new species of mammals. Mem. Amer. Mus. Nat. His. Vol. 9, No. 4, p. 155-208.
2. BURT, W. H., and R. P. GROSSENHEIDER. 1964. A Field Guide to the Mammals. Houghton Mifflin Company. Boston, Mass. xxiii + 284 pp.
3. FLINT, R. F. 1971. Glacial and Quaternary Geology. John Wiley and Sons, Inc. New York, N.Y. 892 pp.
4. GIDLEY, J. W. 1920. Pleistocene peccaries from the Cumberland cave deposit. Proc. U.S. Natl. Mus. Vol. 57, p. 83-146.
5. ————, and C. L. GAZIN, 1938. The Pleistocene vertebrate fauna from Cumberland Cave, Maryland. Bull. U.S. Natl. Mus. No. 171, p. 1-93.
6. GUILDAY, J. E., H. W. HAMILTON, and A. W. MCCRADY. 1971. The Welsh Cave peccaries *(Platygonus)* and associated fauna, Kentucky Pleistocene. Carnegie Mus., Ann. Vol. 43, No. 9, p. 249-320.
7. GOLDMAN, E. A. 1937. The wolves of North America. Jour. Mamm. Vol. 18, p. 37-45.
8. HAY, O. P. 1912. Th Pleistocene period and its Vertebrata. Indiana Dept. Geol. and Nat. Res., Ann. Rept. 36, p. 541-784.
9. HIBBARD, C. W. 1958. Summary of North American mammalian local faunas. Papers Mich. Acad. Sci., 1957 meeting. Vol. 43, p. 3-32.

10. KURTEN, B. 1966. Pleistocene bears of North America. Acta Zool. Fennica. Vol. 115, 120 pp.

11. LECONTE, J. L. 1848. On *Platygonus compressus;* a new fossil pachyderm. Mem. Amer. Acad. Arts, Sci. Vol. 3, p. 257-274.

12. LEIDY, J. 1882. On an extinct peccary. Proc. Acad. Nat. Sci. Philadelphia. Vol. 34, p. 301.

13. LUNDELIUS, E. L. 1960. *Mylohyus nasutus*, long-nosed peccary of the Texas Pleistocene. Bull. Texas Memorial Mus. No. 1, 40 pp.

14. MERRIAM, J. C., and C. STOCK. 1932. The Felidae of Rancho La Brea. Carnegie Inst. Pub. No. 422, xvi + 231 pp.

15. OLSEN, E. C. 1940. A late Pleistocene fauna from Herculaneum, Missouri. Jour. Geol. Vol. 48, p. 32-57.

16. RAY, C. E., C. S. DENNY, and M. RUBIN. 1970. A peccary, *Platygonus compressus* LeConte, from drift of Wisconsinan age in northern Pennsylvania. Amer. J. Sci. Vol. 268, No. 1, p. 78-94.

17. SCHULTZ, G. E. 1969. Geology and paleontology of a late Pleistocene basin in southwest Kansas. Geol. Soc. Amer., Spec. Pap. No. 105, vii + 85 pp.

18. SIMPSON, G. G. 1949. A fossil deposit in a cave in St. Louis. Amer. Mus. Novit. No. 1408, 46 pp.

19. SLAUGHTER, B. H. 1963. Some observations concerning the genus *Smilodon*, with special reference reference to *Smilodon fatalis*. Texas Jour. Sci. Vol. 15, p. 68-81.

20. ————. 1966. *Platygonus compressus* and associated fauna from the Laubach Cave of Texas. Amer. Mid. Nat. Vol. 75, p. 475-494.

21. WEBB, S. D. 1974. The status of *Smilodon* in the Florida Pleistocene. In: Pleistocene Mammals of Florida. S. D. Webb, Ed. University of Florida Press. Gainesvelle, Florida. p. 149-153.

22. YOUNG, S. P., and E. A. GOLDMAN. 1964. The Wolves of North America, Part 1. Dover Publications, Inc. New York, N. Y. xvi + 385 pp.