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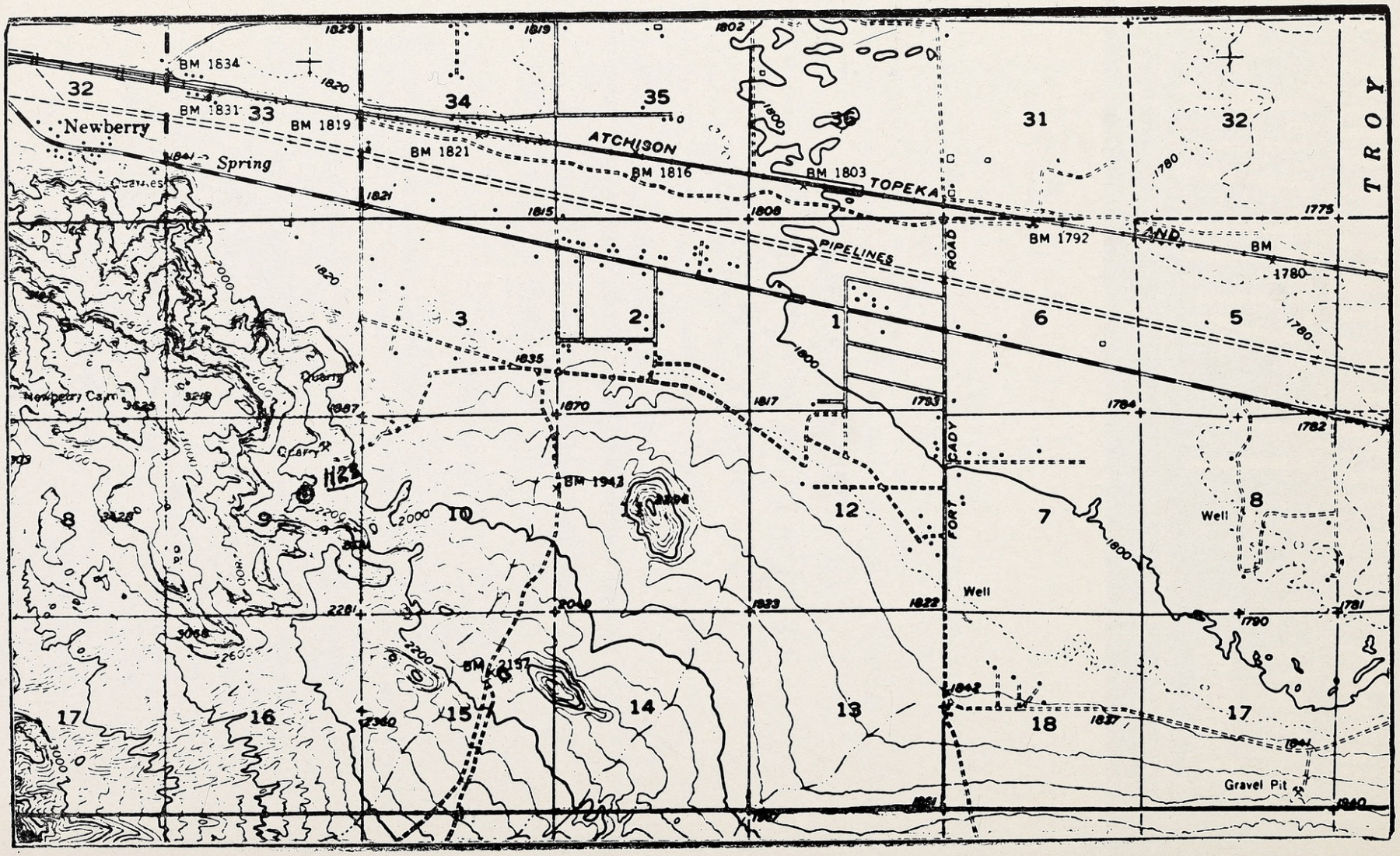
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QUATERNARY ANIMALS FROM SCHUILING CAVE IN THE MOJAVE DESERT, CALIFORNIA

By THEODORE DOWNS[1], HILDEGARDE HOWARD[2], THOMAS CLEMENTS[3], AND GERALD A. SMITH[4]

INTRODUCTION

This is a report on a cooperative investigation of a recently discovered cave in Southern California by archeologists, paleontologists and geologists from three institutions: the San Bernardino County Historical Society, the Los Angeles County Museum, and the University of Southern California. The discovery of this cave brings to light the first complete account of a southern California Pleistocene cave fauna. A preliminary paper, stressing archeological finds, has been published by G. A. Smith (1955). Howard (1955a, p. 20) has briefly discussed the birds, and Brattstrom (1958) has written on the reptiles from the cave.

The data from this study aid considerably in the interpretations of age relationships of the Mojave Desert geologic events, provide more information on the paleogeographic distribution and morphology of the late Pleistocene mammals of the coastal area, and give a brief view of the environment of the not too distant past of the Mojave Desert region.

The cave is located approximately two miles southeast of Newberry in San Bernardino County, California, in the SW¼, NE¼, Sec. 9, T8N, R3E, San Bernardino Base and Meridian. This area is shown on the Newberry quadrangle map of the U.S. Geological Survey, 1955 ed. The locality has been given Los Angeles County Museum, Vertebrate Paleontology locality No. 1123 (see fig. 1). The cave measures approximately 18 feet in width, 13 feet in horizontal depth and 7 feet in height, and is situated about 10 feet above the floor of the present dry canyon that cuts through the volcanics and old alluvial fill. The site is approximately 2160 feet above sea level.

In December of 1953, Dr. Walter Schuiling, Curator for the San Bernardino County Museum Association, discovered the small cave and found that it contained a great variety of prehistoric life forms. After the initial discovery, Schuiling was assisted by Ritner Sayles and G. A. Smith in the recovery of human remains from the top layers (24-30 inches) of the cave deposits.

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Fig. 1. Location of Schuiling Cave, L.A.C.M. V.P. No. 1123; shown on part of the Newberry, California quadrangle, San Bernardino Co., U. S. Geol. Survey, topographic map, 1955 ed. Scale 1:62,500.

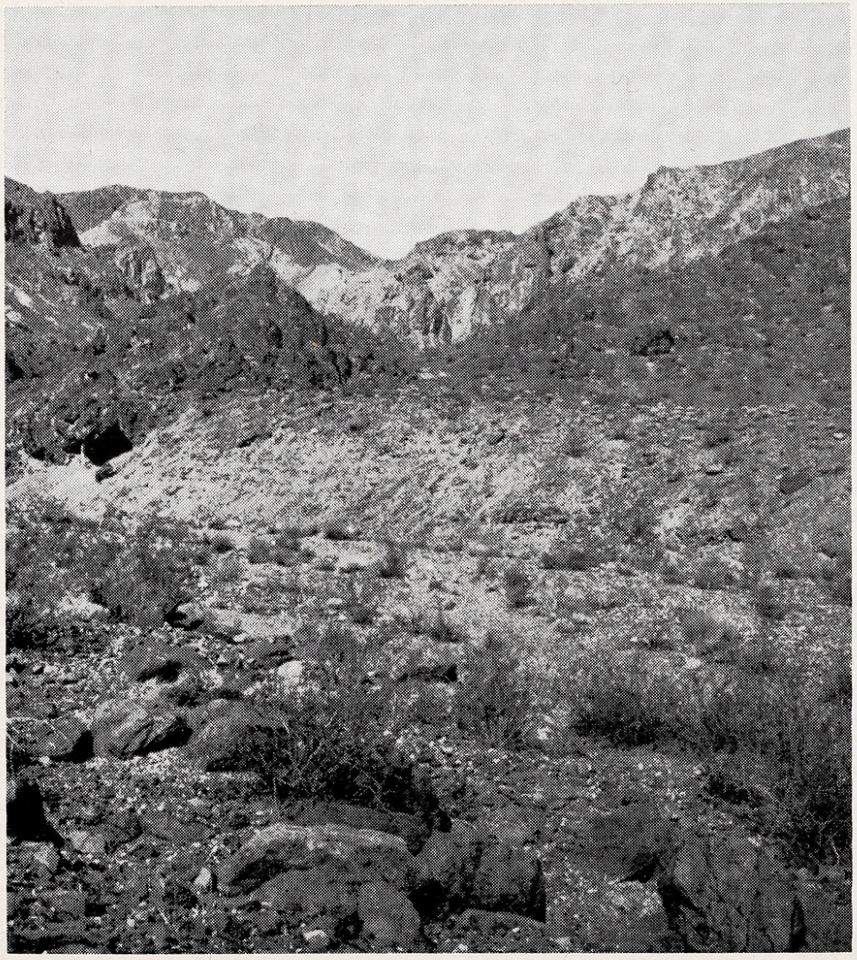


Fig. 2. View toward the west looking up stream in the dry canyon that has cut through the tilted rhyolite flow (left center) with Schuiling Cave (dark area) and old alluvial fan remnant.

Fig. 3. View toward the northeast, with six foot man standing at cave entrance. Old alluvial fan remnant extends across center of picture, fading out into dry basin in background.

Extinct animals were first located below the human remains in December of 1953, and soon thereafter Dr. Smith invited the Los Angeles County Museum paleontologists to continue excavation and study of the material. Many individuals contributed their time and energy in digging out the fossil material; only a few of these can be mentioned: Mr. Burr Belden, Mr. Carl Cambridge, Mr. Thomas Heric and Mr. Leonard C. Bessom. We are indebted to Mr. Geoffrey D. Woodard and Mr. R. H. Tedford for helpful suggestions and Mr. Arnold G. Kluge for aid in plotting the cave horizon data. Mr. George F. Brauer made the photographs of the map and specimens; Mr. Richard W. Saar prepared the final charts of the cave fauna distribution.

L.A.C.M. refers to Los Angeles County Museum, vertebrate paleontology specimen numbers; SB refers to San Bernardino County Museum Association specimen numbers.

EXCAVATION PROCEDURE

Three basic reference points were established for measuring the position of the material in the cave. Point A (see fig. 7) was the lowest prominent rock projecting from the roof of the cave, at a distance of 4 feet from the rear of the cave and about 9 feet from the entrance. Two more reference points were established near the ceiling at the northwest rear corner (West point) and northeast rear corner (East point). These points (see fig. 8) were marked by inserting permanent iron spikes in the cave wall. Horizontal measurements were taken from the West and East points, and depth measurements were taken from point A for each specimen discussed in this report and other lesser materials not itemized.

Before the cave was disturbed, the top layer of pack rat guano and debris accumulation was about six inches below the ceiling of the cave. Excavation operations were discontinued when the apparent floor of the cave was reached at about seven feet below the ceiling.

A more detailed account of excavations performed by the San Bernardino County Historical Society and the Los Angeles County Museum personnel is given in Smith (1955).

GEOLOGY

Schuiling Cave is a shallow opening in the side of a small canyon cut in rhyolite of probable Miocene age (fig. 2). It is but one of many such caves in the area, and probably originated as a large gas pocket in the lava. Apparently the cave was exposed when the canyon was cut in the rhyolite during the normal process of erosion.

When first discovered, Schuiling Cave was almost completely filled with unconsolidated angular fragments, mostly of rhyolite, in a matrix of finer particles of the same material, and fine aeolean dust. Some perlite fragments (volcanic glass) also were present, presumably derived from outcrops observed up the hill from the cave. While some of the larger chunks of rhyolite in the cave may have fallen from the roof, much of the material is alluvial fill, washed by streams into the cave after it

was first opened by erosion. This is evidenced not only by the nature of the material, but also by the fact that the fill is similar to remnants of alluvial deposits that remain along the borders of the canyon wall just down stream from the cave (fig. 3).

The last-mentioned remnants of alluvial fill, now deeply dissected, occur on both sides of the canyon, and indicate that after having been cut originally, the canyon was later filled, at least to an elevation approximating that of the top of the cave and possibly some 10 feet higher. Still later, this fill was dissected and largely removed as the canyon was again eroded or exhumed. The canyon, therefore, has had a somewhat complex history.

It is the opinion of the writers that the canyon was first cut by stream erosion and the cave exposed in early Pleistocene time, when the Newberry Mountains were first uplifted. It is further postulated that a later rise of local base level caused the stream to aggrade its channel, and filling started. This aggradation must have been brought about by the presence of a lake, possibly ancestral Troy Lake, in the basin to the north and east into which the stream probably drained (see fig. 1). A more humid climate of the Ice Age was probably responsible for the presence of this lake, as well as for similar lakes in other basins throughout the desert (as for example, in Death Valley and Manix).

When the canyon fill reached the elevation of the floor of the cave, the cave also began to fill as the ancient stream, meandering on its aggrading floor, occasionally swept in material. It was probably during the early part of this period of deposition that the bones of various Pleistocene mammals, reptiles, and birds (which included water birds) were buried. These were either washed in by the stream, or brought in by other animals, or were the bones of animals using the cave for shelter. The bones were buried as more detrital material was carried in by the stream. Possibly in the later part of the same depositional period the artifacts were brought in and buried as the cave continued to fill.

With the change in climate at the end of the Pleistocene, and the advent of greater aridity, the lake disappeared, and base level was again lowered. The rejuvenated stream, although enfeebled by the diminished rainfall, nevertheless began the dissection of the deposits that had accumulated in the canyon while the lake was present. But whereas an aggrading stream sweeps from side to side, and could fill a cave, a degrading stream cuts vertically downward, and so the canyon was rejuvenated without apparent disturbance of the deposits in the cave.

It is possible that during the time of the stream rejuvenation, the artifacts and a few of the skeletal remains were buried in the cave dust that is so common in the upper strata. This would imply a difference in time of deposition of some of the bones. The definite restriction of the human remains to the upper levels of the cave (see fig. 7) substantiates

the idea that at least the cultural materials may have been buried at a later date than the remains found at lower depths.

It certainly is well within the realm of probability that there are other similar caves and comparable remains, not only in the same basin, but in other of the desert basins where a like combination of cavernous rocks and Pleistocene lake may be found.

FOSSIL VERTEBRATES

At least 28 species of vertebrates are represented by the 90 or more identifiable mineralized specimens recovered from the lower levels of the cave. As may be seen from the following list, mammal remains are most abundant but there are more avian species represented.

Twenty-nine bird bones were recovered, of which 25 were identifiable. These represent 15 species. Strictly speaking there are no extinct forms represented, although certain bones (fig. 4) of California Condor (no. 2584) and Horned Owl (no. 2588) are of the large size characteristic of *Gymnogyps* and *Bubo* as found in the Pleistocene deposits of Rancho La Brea. Fisher (1944, p. 290) has assigned the Rancho La Brea condor to the extinct species *Gymnogyps amplus* Miller on the basis of its large size and certain minor distinguishing characters of the skull. However, with few exceptions, measurements of various limb elements reveal overlapping in range of size between the Recent and Pleistocene forms (Fisher, 1947), and there is little doubt that *G. amplus* is the direct ancestor of the present-day *G. californianus*. Similar overlap occurs in the size range of skeletal elements of the Horned Owl of Rancho La Brea and the present-day *Bubo virginianus* (Howard, 1947, p. 12), although, again, the fossil form averages considerably larger. In this instance detailed studies of the skull have not been made and the La Brea Pleistocene Horned Owl retains the name of the Recent species. The two bones of the California Condor (rostrum and partial humerus) and the measurable specimens of Horned Owl taken in Schuiling Cave are larger than those of any skeleton of the modern forms available for measurement and fall within the size range of Pleistocene forms.

Three species of reptiles and ten species of mammals are represented in the cave. At least five of the mammals are known to be extinct (see list). The reptile representatives appear to have no special attributes that distinguish them from Recent forms, according to Brattstrom (1958, p. 11).

Taxidea cf. *taxus* is represented by a nearly complete skull, jaws, limb elements and vertebrae (L.A.C.M. No. 1992) of apparently one individual (fig. 4). The material is notable in the absence of the P_2 in both mandibles, and the rami are slightly heavier than the average for *T. taxus* as known in the area today. Hall (1940) noted that only 2% of 110 specimens of *T. t. neglecta* showed an absence of a premolar or presence of an extra tooth; therefore, it seems remarkable to obtain a record of a fossil form of *Taxidea* so characterized. However, the fossil could simply be a

SCHUILING CAVE FAUNAL LIST
(Approximately 150 specimens collected)

		Number Individuals[5]	Number Specimens[6]
Reptiles			
Gopherus agassizi	Desert tortoise	1	Many frags., 1 partial carapace
Sauromalus obesus	Chuckwalla	1	4
Crotalus[7]	Rattlesnake	1	2
Birds			
Anas cf. *platyrhynchos*	Mallard duck	1	1
Anas cf. *carolinensis*	Green-winged teal	1	1
Mareca americana (?)	Baldpate duck (?)	1	1
Nyroca cf. *americana*	Redhead duck	2 ?	2 ?
Oxyura jamaicensis	Ruddy duck	1	1
Mergus merganser	American merganser	1	1
****Gymnogyps amplus*	Ancestral California condor	1	2
Aquila chrysaetos	Golden eagle	1	1
Buteo jamaicensis	Red-tailed hawk	2	2
Fulica americana	Coot	3	4
Recurvirostra americana	Avocet	1	1
Zenaidura macroura	Mourning dove	1	1
****Bubo virginianus*	Horned owl	4	5
Colaptes cafer	Flicker	1	1
Corvus corax	Raven	1	1
Mammals			
Perognathus	Pocket mouse	2	2
Neotoma	Wood rat	2	3
Taxidea cf. *taxus*	Badger	1	15
Canis cf. *lupus*	Wolf	1	1
Urocyon	Gray fox	2	2
**Equus* sp. small	Small horse	2	23
**Equus* sp. large	Large horse	1	1
*cf. *Tanupolama*	Llama-like camel	1	4
*Camelid sp. large	Large camel	1	3
**Breameryx* sp.	Diminutive antelope	1	2

**Pleistocene form ?
*Extinct form

[5]Figures represent minimum possible number of individuals
[6]Identifiable specimens
[7]Two vertebrae of the rattlesnake *Crotalus* recorded by Brattstrom in the museum catalogue, but the record is unpublished

variant, similar to those rarely found in Recent skulls; until more specimens are found it is deemed inadvisable to attach taxonomic significance to this material.

Two skull fragments (L.A.C.M. No. 1983) of *Urocyon*, the Gray fox, were found but were not identifiable beyond the generic designation.

The proximal half of a third metacarpal (L.A.C.M. No. 3698) assignable to *Canis* was recovered at the 39 inch level. Gross inspection eliminates the possibility of assignment to the coyote on the basis of the large size of the fossil. However, there is resemblance to the living wolf; a specimen of *Canis lupus nubilus* (Univ. of Calif. at Los Angeles, department of Zoology No. 16708) shows greater size but similar proportions. A random series of specimens of the dire wolf, *Canis* (*Aenocyon*) *dirus* from Rancho La Brea was compared (table 1), and the measurements definitely indicate a stouter or thicker shaft in the metacarpal of the La Brea species. The nature of the material allows only the designation *Canis* cf. *lupus* for L.A.C.M. No. 3698.

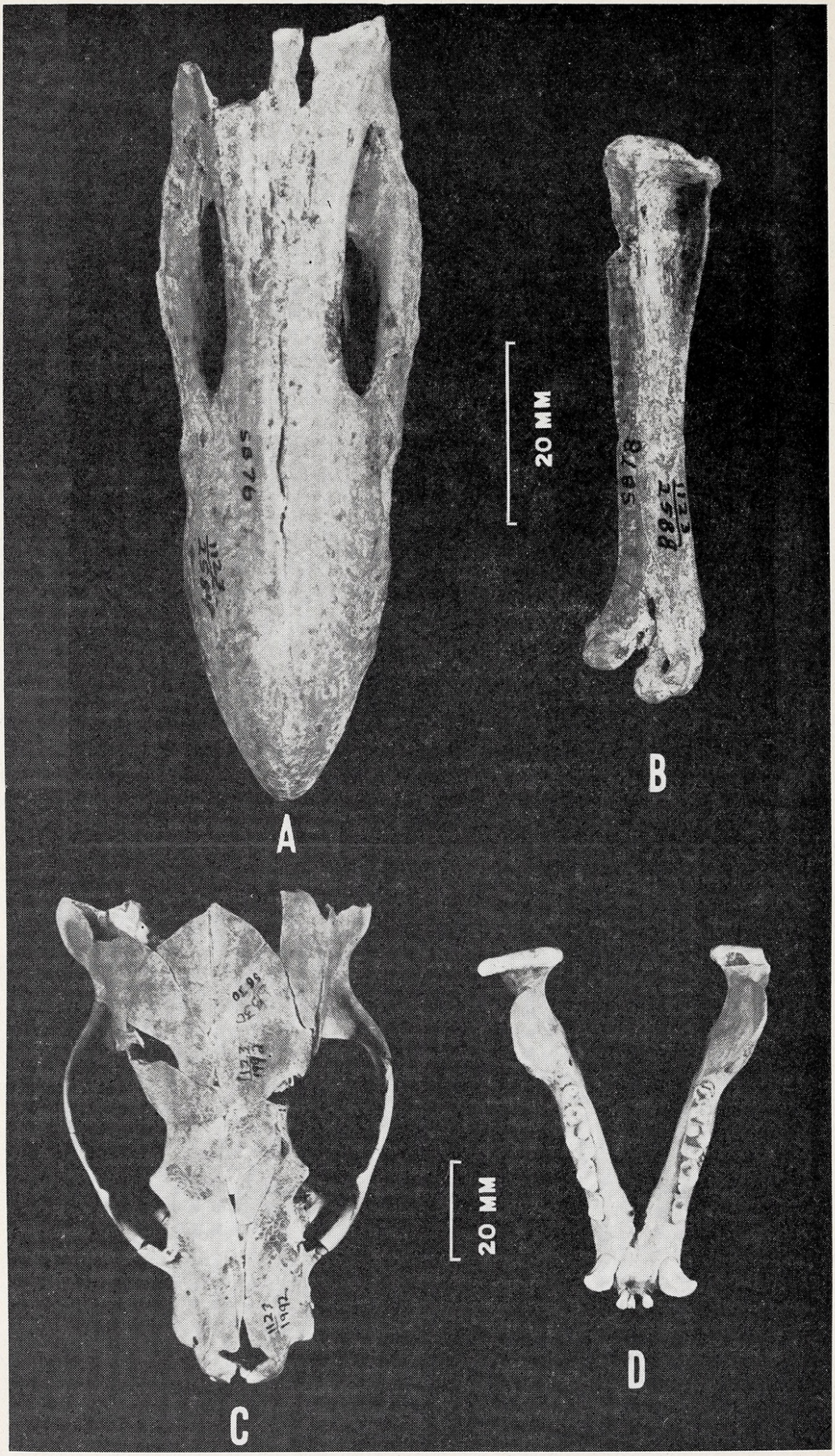
One of the most important genera recovered from the cave is the horse, *Equus*. This is apparently represented by a large and a small species, as evidenced particularly by the foot elements. There are more specimens representing this genus (23 identifiable elements) than any other mammal or bird recovered from the cave.

Among the foot elements are five small phalanges indicating that there are at least two individuals of the small horse represented. Table 2 shows that the proximal phalanges (L.A.C.M. No. 1991), cuneiform (L.A.C.M. No. 1979) and astragalus (L.A.C.M. No. 1572) are small compared to the Rancho La Brea horse and suggest possibly smaller size than the horse from San Josecito Cave, Mexico, which has been characterized in part by

TABLE 1

Comparative measurements of the third metacarpal in *Canis* species (in millimeters)

	Number Samples	Mean	Observed Range
Greater Proximal Width			
Schuiling Cave	1	10.8	10.8
Rancho La Brea			
Canis (A.) *dirus*	48	11.8	9.5 - 13.5
Recent			
Canis l. nubilus	1	11.5	11.5
Greatest Width at 25 mm From Proximal End			
Schuiling Cave	1	7.5	7.5
Rancho La Brea			
Canis (A.) *dirus*	48	9.3	8.0 - 11.0
Recent			
Canis l. nubilus	1	8.4	8.4


20 MM
A
B
20 MM
C
D

its small feet (see Stock, 1953, in which he uses the name *Equus conversidens leoni* subsp. nov. without a description or diagnosis). A horse magnum (L.A.C.M. No. 1990) from Schuiling Cave is as large as that of the La Brea horse (see table 2), and we tentatively consider this bone to be from a larger form than the species represented by the phalanges, cuneiform and astragalus. That the small horse bones do not represent young individuals is indicated by complete ossification of the fully formed extremities (no epiphysial separation) of the phalanges, and presence of a clear, well-formed groove for articulation of the metapodial.

Dentition of one species (probably "sp. small") is represented by an adult partial mandible bearing P_3 - M_3 and fragments of isolated teeth (L.A.C.M. No. 1532). The teeth show (fig. 5) the subgeneric, V-shape plesippine character of the groove between the metaconid and metastylid and a possible caballine subgeneric trait in the absence of the parastylids (Savage, 1951, and McGrew, 1944). However, according to McGrew the absence of the parastylid is particularly true of *milk* dentition in caballine horses. The teeth in the mandible measure as follows: anteroposterior diameter, P_3 27.7 mm., P_4 29.0 mm. and M_2 26.4 mm.

The taxonomic relationships of the genus *Equus* and interpretations of paleogeographic distribution of the "cave equids" and even of those from Rancho La Brea, McKittrick and other late Pleistocene faunas of fluviatile origin, remain as unsolved problems; they need further investigation, particularly with respect to gaining a true knowledge of probable variation in population samples. Questions of taxonomy and morphologic interpretations involve the allocation of the names *Equus*, *Asinus*, *Plesippus*, etc. to North American populations. Briefly, we shall consider some of these points.

Hibbard (1958, and personal communication) considers *Asinus* to be a plesippine-like horse characterized by great depth of the lower jaw and presence of the V-shaped groove between the metaconid and metastylid. Quinn (1957) has characterized the lower dentition of the genus *Asinus* particularly by the V-shaped "valley," presence of a plicaballinid, and a median valley shortened and not protruding beyond the flexids. Using either interpretation (Hibbard or Quinn) these features may apply with respect to the Schuiling Cave specimen. It seems probable that a small plesippine-like horse existed in the late Pleistocene North American faunas, and such a form might represent an introduction of *Asinus* (which is apparently plesippine-like) from the Old World or separate evolution of a convergent line in North America. The question as to what taxonomic relationship is correct with respect to these plesippine-like equids is not

Fig. 4. A. Dorsal view of the rostrum of the ancestral California Condor, *Gymnogyps amplus* (L.A.C.M. No. 2584). B. Nearly complete tarsometatarsus of the Horned Owl, *Bubo virginianus* (L.A.C.M. No. 2588). C. Dorsal view of the skull of the Badger, *Taxidea cf. taxus* (L.A.C.M. No. 1992). D. Occlusal view of the mandible of *Taxidea cf. taxus* (L.A.C.M. No. 1922). All from Schuiling Cave.

finally settled. It seems most reasonable, for the present at least, to follow the opinion that the genus *Equus* should embrace the North American Pleistocene forms of horses, and thus favorably compare and equivalently rate with the characters diagnostic of other genera in the family Equidae. Perhaps a subgeneric designation (*Asinus*) would be justified for the later Pleistocene horses that retain plesippine-like characters. The early Pleistocene, true plesippine forms might be allocated the subgeneric rank *Plesippus* under the genus *Equus*.

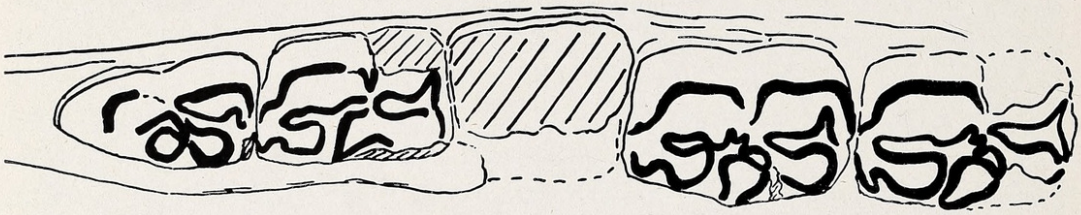


Fig. 5. Occlusal view of left mandible (L.A.C.M. No. 1532), *Equus* sp. small, from Schuiling Cave. Reduced approximately 1/5.

TABLE 2

Comparative measurements of the foot elements of *Equus* (in millimeters)

	Number Samples	Mean	Observed Range
Proximo-Distal Length of Proximal Phalanx			
Schuiling Cave	3	68.8	66.6 - 70.6
San Josecito Cave	28	74.14	66.6 - 82.1
Shelter Cave	6	77.4	72.2 - 82.3
Rancho La Brea	18	84.9	77.8 - 93.2
Distal Tranverse Diameter Of Astragalus			
Schuiling Cave	1	44.1	44.1
Shelter Cave	1	50.9	50.9
Rancho La Brea	11	64.7	58.8 - 70.7
Greatest Transverse Diameter Of Cuneiform			
Schuiling Cave	1	38.8	38.8
Rancho La Brea	16	58.2	53.5 - 68.0
Greatest Transverse Diameter of Magnum			
Schuiling Cave	1	50.0	50.0
Rancho La Brea	19	51.2	47.0 - 54.7

The Schuiling Cave mandible (L.A.C.M. No. 1532) and foot bones of the small species of *Equus* show great resemblance to the dentition and small proportions of the feet in horses found in San Josecito Cave in Mexico, Shelter Cave and Conkling Cavern in New Mexico, Gypsum Cave in Nevada, and the Manix Lake beds (in part) in California.

There are two types of camels represented in the collection, neither of which is positively identifiable as to genus. However, it is very probable that the llama-like *Tanupolama* was living in the area, as indicated by the character of three proximal phalanges (L.A.C.M. No. 1987 A and B, and S.B. 54) and one median phalanx (L.A.C.M. No. 3671). The small, slender form of these bones compares favorably with phalanges of *Tanupolama* from McKittrick (see table 3 and fig. 6). Evidence of a large camel is meager, but the epiphysis of half of the distal end of a young metapodial (L.A.C.M. No. 1986), measuring 36.0 mm. in transverse diameter, is too large for *Tanupolama*. It is slightly smaller than a series of seven young *Camelops hesternus* from Rancho La Brea, which measure in transverse diameter of one-half of the distal end of the metapodial, as follows: mean 37.3 mm., observed range 36.2 - 41.5 mm. A half portion of a Schuiling Cave camel molar (L.A.C.M. No. 3699), measuring 19.5 mm. in antero-posterior diameter at the base, probably belongs to the large form.

The identification of the small antelope, *Breameryx* sp., is based on two distal ends of metapodials (L.A.C.M. No. 1982) that are similar to Rancho La Brea specimens in general size and morphology (fig. 6). Measurements are as follows (in millimeters):

	Schuiling Cave	Rancho La Brea
Greatest transverse diameter	16.0 - 16.5; mean 16.3	15.4 - 16.7; mean 15.8
Greatest antero-posterior diameter	12.8 - 13.5; mean 13.2	10.8 - 12.3; mean 11.7

A slightly larger size in the Schuiling Cave material as compared to the La Brea form is indicated, but not enough specimens of the cave material are at hand to test the significance of this difference.

TABLE 3

Comparative measurements of the proximal phalanx of Camelidae (in millimeters)

	Number Samples	Mean	Range Observed
Greatest Length			
Schuiling Cave, cf. *Tanupolama*	2	90.4	89.7 - 92.1
McKittrick, Calif. *Tanupolama*	12	96.9	82.2 - 111.6
Least Transverse Diameter			
Schuiling Cave, cf. *Tanupolama*	3	15.3	14.7 - 16.2
McKittrick, Calif. *Tanupolama*	13	14.8	13.5 - 16.6

A few rodent bones, representing *Perognathus* and *Neotoma*, may have sifted downward from higher levels in the cave. However, the bones appear to be mineralized. If series of fossil specimens were available from the cave and compared with Recent species, possibly more definite determinations could be made. The present record is inadequate.

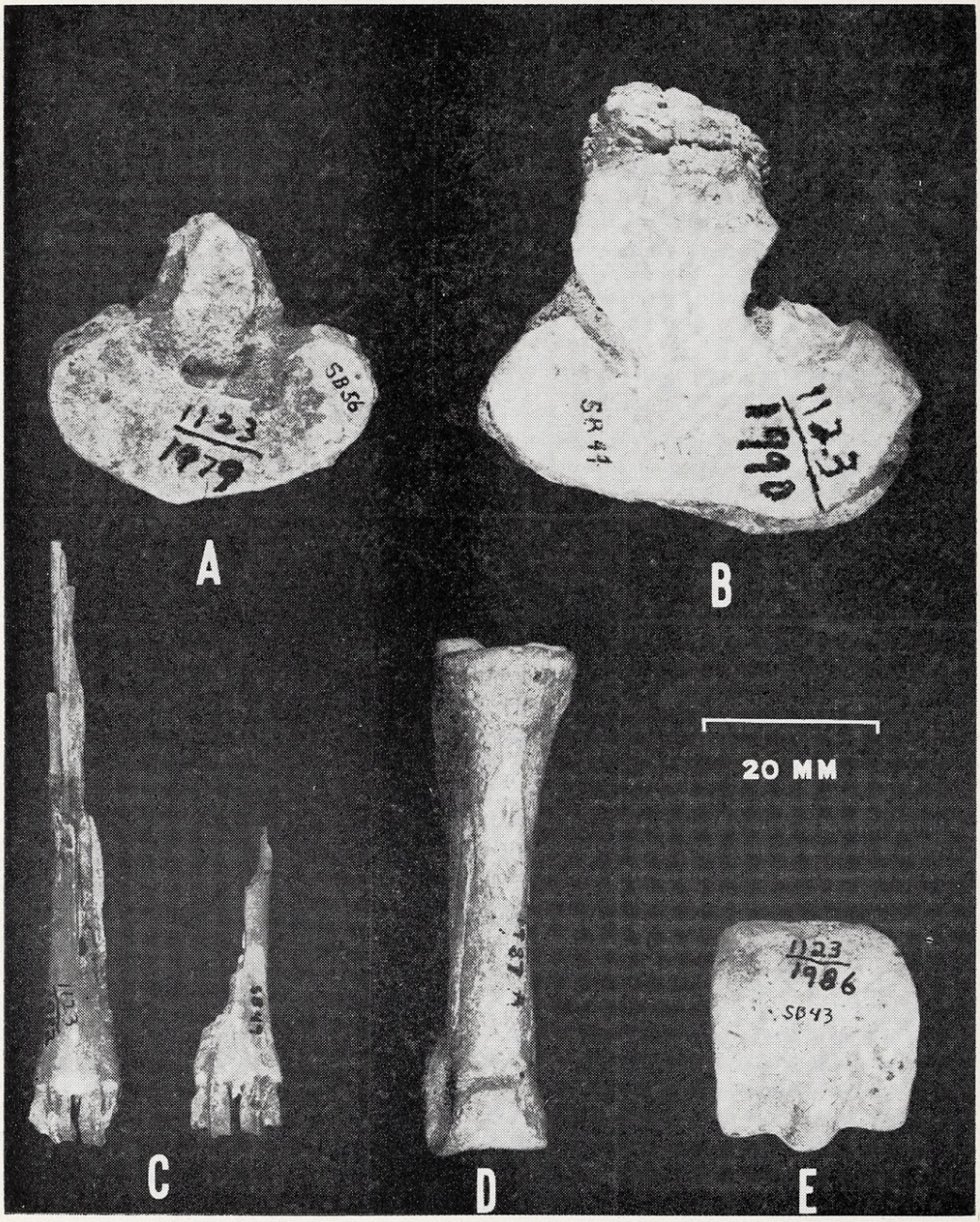


Fig. 6. A. Proximal view of cuneiform of the horse, *Equus* sp. small, (L.A.C.M. No. 1979). B. Distal view of the magnum of *Equus* sp. large, (L.A.C.M. No. 1990). C. Distal ends of metapodials of diminutive antelope, *Breameryx* sp. (L.A.C.M. No. 1892). D. Anterior view of proximal phalanx of llama-like Camel, *cf. Tanupolama* (L.A.C.M. No. 1987A) E. Anterior view of the half of a distal metapodial of Camelid sp. large (L.A.C.M. No. 1986). All from Schuiling Cave, and to same scale.

Remains of apparent mountain sheep were found although generally at a higher level than the other mammals; possibly they represent recent additions to the cave. Horn cores were not recovered and thus more detailed identification is not feasible.

STRATIGRAPHIC OCCURRENCE

The bird bones were unassociated and widely scattered throughout the cave (see fig. 7 and 8). None was found above the 2 foot level; most of them occurred between 3' and 4' 7", with three owl bones at 5' 8" – 5' 10", and a dove bone at 7' 10". Only four species are clearly represented by more than one specimen: the condor, owl, coot and hawk. The two bones of the genus *Nyroca* may represent two species. It is possible that the two bones of condor are from the same individual; they were found at the same depth about 2½ feet apart. At least four individual Horned Owls appear to be represented. The coot bones all occurred on the east side of the cave, but at varying depths; at least three individuals are represented. Data as to location in the cave are available on only one of the two Red-tailed Hawk bones; however, the specimens show a difference in preservation that suggests nonassociation.

The disassociation of the bird bones indicates that their accumulation in the cave was entirely fortuitous, possibly being washed in with the sediments in which they were found or brought in by other animals. With the exception of the Horned Owl and condor, none of the species would normally seek shelter in a cave. There is nothing to indicate that the owls whose bones were found actually died in the cave; in fact the absence of more complete skeletal material is evidence to the contrary.

All of the mammalian remains are fragmentary, seemingly scattered at random in the deposit. The most complete specimen is the badger skull with jaws. Possibly this particular animal crawled into the cave and died; this is probably true also of tortoises represented by one nearly complete carapace and many scattered shell remains. The tortoise is abundant throughout the deposits horizontally and vertically and is known today to frequent cave shelters in order to conserve body water and escape the heat of the day.

There is concentration of most of the fossil material toward the central part of the cave (between the 3 and 5 foot levels). This concentration may be due, in part, to the nature of the ancient stream current passing in and out of the cave, perhaps forming an eddy accumulation.

In brief, it is believed that the animals could have been deposited in one or more of the following ways: (1) washed in during stream deposition or flooding as the old alluvial fill was accumulating; (2) carried in by natural predators (especially such victims as the antelope, woodpecker and water-birds); (3) died in the cave (especially the tortoise and badger); (4) brought in by humans (any of the edible vertebrates).

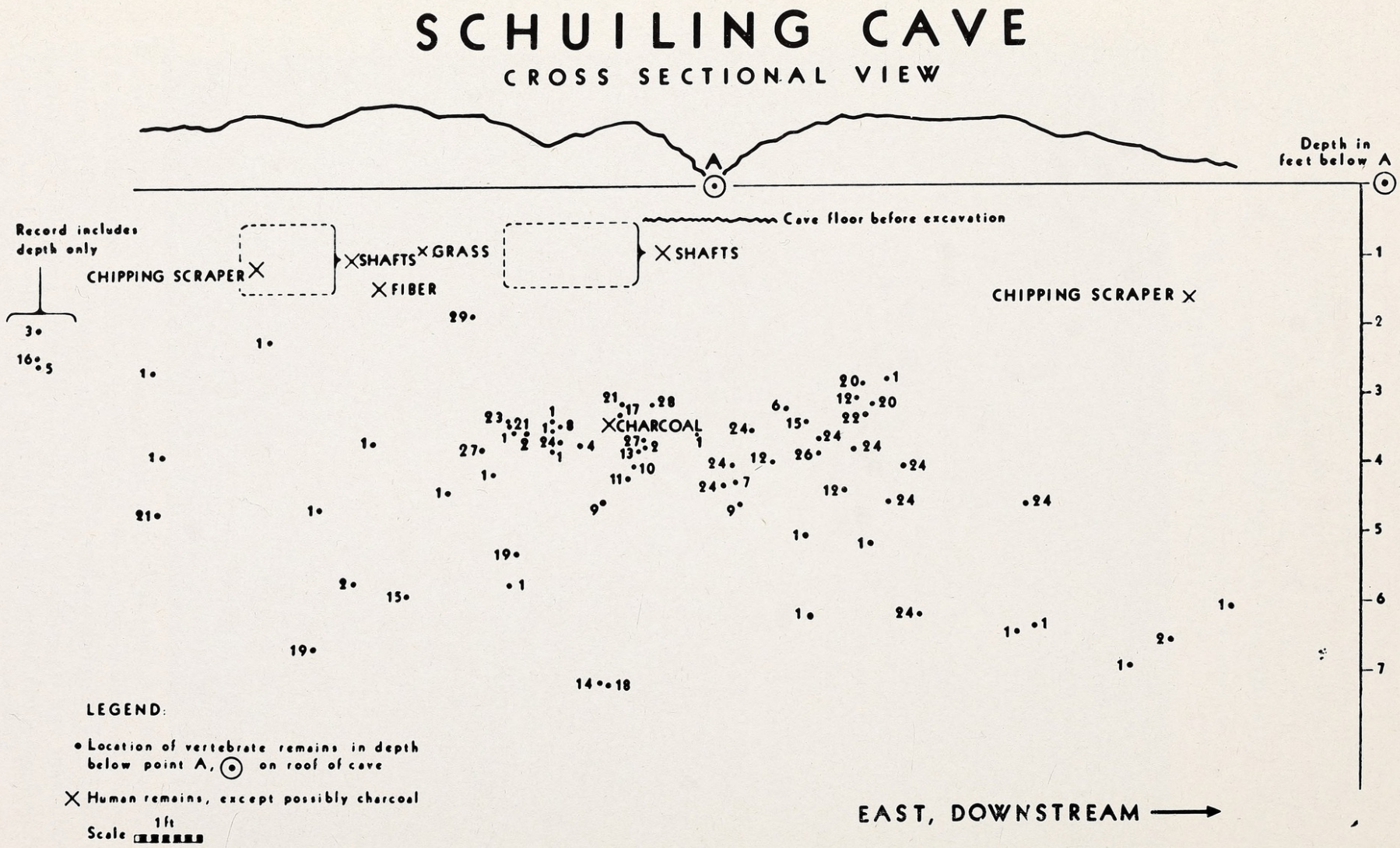


Fig. 7. Distribution of critical human cultural and vertebrate skeletal remains in Schuiling Cave.

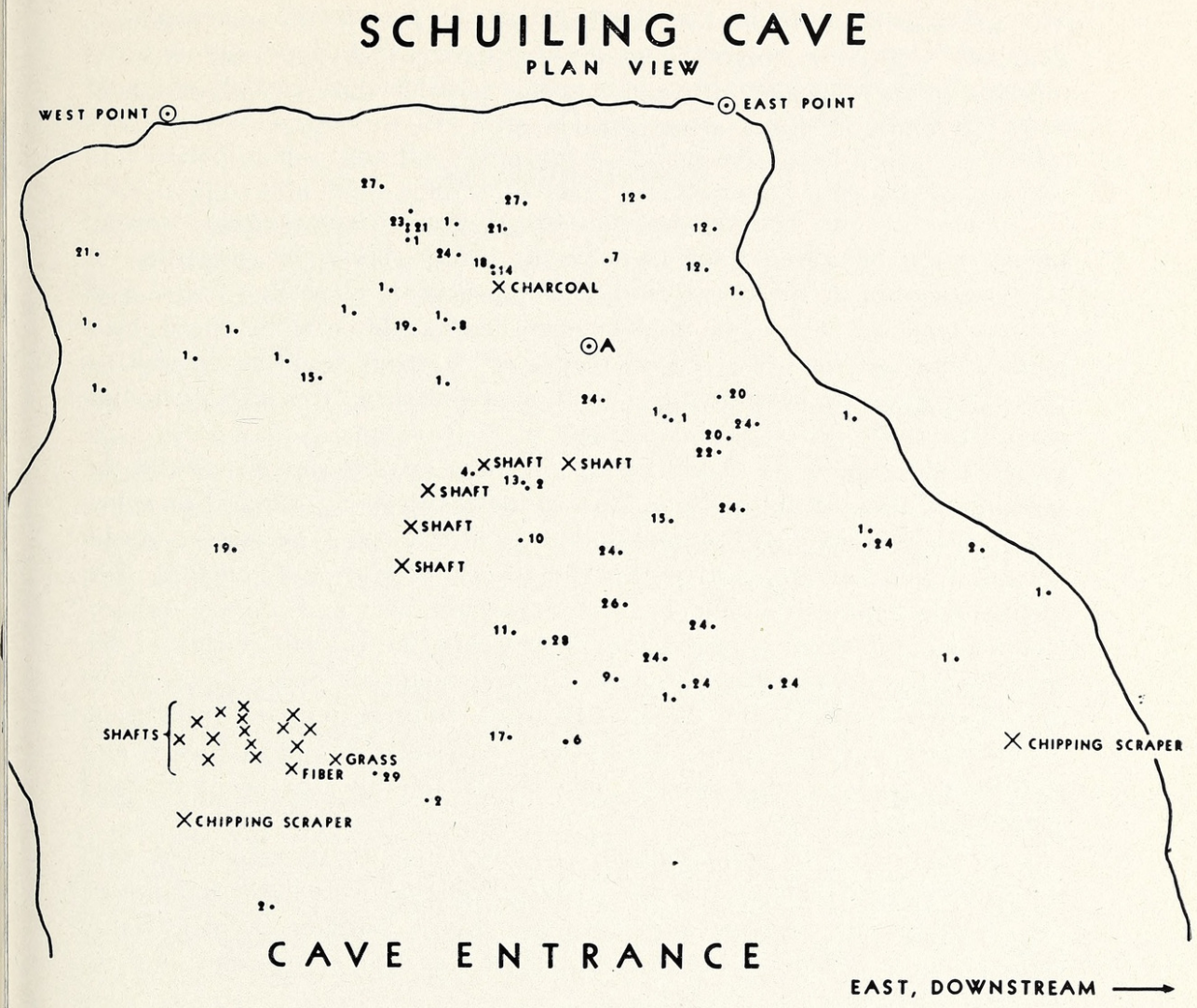


Fig. 8. Distribution of critical human cultural and vertebrate skeletal remains in Schuiling Cave. Plan view of the position of the specimens in the cave.

KEY TO DISTRIBUTION OF CAVE FOSSILS

Shown in Figs. 7 and 8

1. Tortoise
2. Chuckwalla
3. Mallard
4. Teal
5. Baldpate ?
6. Redhead duck
7. Ruddy duck
8. American merganser
9. Ancestral California condor
10. Golden eagle
11. Red-tailed hawk
12. Coot
13. Avocet
14. Mourning dove
15. Horned owl
16. Flicker
17. Raven
18. Rabbit
19. Pocket mouse
20. Wood rat
21. Badger
22. Wolf
23. Gray fox
24. Small horse
25. Large horse (no depth data)
26. Llama-like camel
27. Large camel
28. Diminutive antelope
29. Sheep (?Recent)

The last possibility is the least probable on the basis of present evidence. Fluviatile deposition might be used to explain all of the occurrences of animals in the deposits, although it seems possible that a combination of (1), (2) and (3) above actually occurred.

HUMAN REMAINS

There are no certain associations of human and animal remains known from Schuiling Cave (see Smith, 1955). The only suggestion of such association is the occurrence of the fragments of carbon found with extinct mammal bones at the 48 inch depth. The carbon could have washed into the cave as isolated pieces of charcoal resulting from fires caused by lightning. On the other hand, charcoal from fires of later human occupants could have sifted downward in the cave dust.

The accompanying chart (fig. 7) presents a diagrammatic view of the position of material in the cave. Most of the fossils were found at or below the 2 - 2½ foot level and toward the center of the cave. The fossil material becomes increasingly scarce in the lower limits and only a few identifiable remains (such as tortoise, horse and owl) and some crumbling fragments were taken at the 7 foot level below the present ceiling of the cave. All of the *identifiable* human cultural materials occur at or above the 30 inch level. Smith (1955) has listed cultural remains from these depths which include: cane shafts, cordage and stone chippings (jasper and chalcedony flakes) that would have been suitable for scraping and shaping shafts.

It would not be unreasonable to expect man to be associated with the extinct fossil remains, but the striking zonation of a lower horizon of extinct vertebrate remains and definitely higher horizon of identifiable cultural remains strongly indicates that there was a time difference in these occurrences in this cave assemblage.

ENVIRONMENT

With the exception of the condor, living representatives of all species of the birds recorded occur today in the desert regions of California. Of significance, however, is the large representation of water birds, indicative of the proximity of a lake or pond. There is no body of water in the immediate vicinity of the cave today that would normally support these species, although Troy dry lake, approximately six miles east of the site, could have been a suitable environment during more moist conditions of the past. The alluvial deposits that form the matrix bearing the fossils and continuing in the surrounding area outside the cave, imply the earlier occurrence here of a more abundant water supply.

The mammal specimens collected from this cave lead one to believe that climatic conditions were different from those of today. The mammals surely had varied diets and habitat preferences that could not be satisfied in today's extreme desert conditions. The badger, wolf and fox may have been accustomed to open country but with an occasional bush for

concealment. The horses, no doubt, made use of some grassland areas, whereas the two camels were probably browsers and grazers. *Breameryx*, being so diminutive, may have had to rely on wooded areas for protection and survival. Vertebrate life in the Mojave was apparently more abundant and varied at the time the Schuiling Cave animals lived than it is today. This implies that there was a different environment with possibly cooler summers and a more abundant source of water.

Evidence reported in a recent paper on the climatic record at Searles Lake in California (Roosma, 1958), indirectly substantiates the interpretation of evidence contained in this paper on the environment of Schuiling Cave. Roosma presents palynological data indicating that the environment at or near Searles Lake (which is about 60 miles northwest of Schuiling Cave) in late Pleistocene time was different from today's desert conditions. Roosma states, "The existence of a rather extensive woodland community at times of more favorable moisture conditions seems to be indicated." He further states that this was at the time of the "moisture peak" of the Wisconsin glacial stage.

AGE RELATIONSHIP

Pleistocene lake beds are known to the northeast of Schuiling Cave in the area of Manix, and it is postulated (Gardner, 1940, p. 290) that the ancient lake south of Daggett and west of Schuiling Cave may have been contemporaneous with Manix Lake. Alluvium, conceivably contemporaneous with that of Schuiling Cave, overlies the Daggett lake beds (Gardner, *loc. cit.*), suggesting the possibility of more recent age for the cave deposits than for Daggett lake. Although a direct comparison cannot be made between the Schuiling Cave deposits and those of Manix Lake, the avian fauna suggests that Manix Lake (in part at least) was older. Three clearly extinct species have been identified from the Manix deposits and a large grebe gives evidence of being the Pleistocene ancestor of the present day Western Grebe (Howard, 1955). Although an exact age determination has not been made for the Manix Lake beds, most of the avian fossils reviewed suggest the late Pleistocene and probable general contemporaneity with the typical late Pleistocene of Rancho La Brea and of Fossil Lake, in Oregon. Possibly, therefore, the Schuiling Cave avifauna suggests slightly younger age than that of Rancho La Brea.

Blackwelder (1954) has mapped a late Pleistocene lake (presumably the Troy Lake area) between Newberry station and Pisgah crater, east of Schuiling Cave. He considers the age of this lake to be probably equivalent to the Tahoe glacial substage (early Wisconsin). Further field work is needed to determine chronologic relationships of this lake and the Schuiling Cave deposits.

Precise age determination is not possible from the study of the mammals, although reasonably conclusive evidence is at hand for assignment of late Pleistocene age for the fauna. As mentioned above, the avian

species are remarkably like the Recent species. The ecologic relationships suggested by both birds and mammals, plus evidence of a period of fluvial deposition, indicate change in climatic conditions since the cave beds were deposited. The occurrence of definitely extinct mammalian species firmly establishes some antiquity for the fauna. None of the extinct mammalian genera is known to be restricted to either early or late Pleistocene age; however, a late Pleistocene age for the Schuiling Cave fauna is strongly indicated by a consideration of other factors, as for example: the resemblance of the small horse from Schuiling Cave to advanced species of *Equus* known from the probable late Pleistocene sediments of Manix Lake, San Josecito Cave, Gypsum Cave, Conkling Cavern and Shelter Cave; the probable contemporaneous occurrence of *Breameryx*, at Rancho La Brea, Shelter Cave and Schuiling Cave; and the presumed contemporaneity of *Tanupolama* at Manix, McKittrick and Schuiling Cave.

It is necessary to emphasize that the particular conditions of preservation at Schuiling Cave may have been responsible for the type of faunal complex represented. Thus some forms may have been excluded from this small cave although they may have been present in the area; for example, the typically late Pleistocene *Bison* (see Savage, 1951).

The meager sampling of charcoal recovered from the center of the cave and at a level near remains of extinct vertebrates was submitted to Yale University laboratories for carbon 14 dating. Unfortunately it was later determined that an insufficient quantity of carbon was available for proper analysis.

SUMMARY

Some of the principal results derived from this study are as follows:

1. This is the first complete account of a southern California Pleistocene cave faunal deposit.

2. A total of approximately 150 fossil vertebrate remains were recovered including 28 species of reptiles, birds and mammals. Five of these species represent clearly extinct animals including: *Equus* sp. small, *Equus* sp. large, cf. *Tanupolama*, Camelid sp. large, and *Breameryx* sp.; *Gymnogyps amplus* and *Bubo virginianus* are probably extinct ancestral forms.

3. The total faunal content and the sequence of geologic and climatic events indicate late Pleistocene age for the cave fauna, at least part of the cave sediments and the alluvial fan remnant.

4. The concentration of definite human cultural specimens stratigraphically above the remains of extinct vertebrates indicates probable difference in time of accumulation of the cultural and fossil material.

5. Considering the small size of the cave area (approximately 18 feet width, and 13 feet depth horizontally), the amount of fossil material recovered is good and suggests that there may have been a fair abundance of animal life in the area. In turn, the record of varied types of life and