STATE OF FLORIDA
STATE BOARD OF CONSERVATION
DIVISION OF GEOLOGY

FLORIDA GEOLOGICAL SURVEY
Robert O. Vernon, *Director*

SPECIAL PUBLICATION NO. 10

FOSSIL VERTEBRATES OF VERO, FLORIDA

By
Robert D. Weigel

TALLAHASSEE

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PREFACE

The finding of extinct vertebrates associated with human remains at Vero Beach (formerly Vero), Indian River County, Florida, in 1915 occasioned considerable interest on the part of paleontologists, geologists, and archaeologists. Questions prompted by the nature of the bone beds, various estimates of their probable age, and inconsistencies in the faunal data have been widely discussed by many authors, mainly on a conjectural basis, because little excavation has been done at this important fossil site subsequent to its discovery 40 years ago.

The smaller vertebrates of Vero were heretofore little known, and the taxonomic status of a number of species described from the site was uncertain. In view of these facts, and because the rapid encroachment of civilization may make further research at this important site difficult or impossible, extensive field work was carried out during the summers of 1956 and 1957. The following report presents the results of this project.

ACKNOWLEDGMENTS

The astute guidance, helpful suggestions, and inspiration afforded by Dr. Pierce Brodkorb, who supervised the work, are deeply appreciated. Doctors Coleman J. Goin, E. Lowe Pierce, Robert M. DeWitt, and Harold K. Brooks critically read the manuscript in its original form, as submitted to the Graduate School of the University of Florida, as partial fulfillment for the Ph.D. degree.

Mr. John Beidler, director of the Indian River Mosquito Control District, generously provided tools, trucks, and other facilities which aided the work. Mr. Joe O'Neill, of Vero Beach, helped excavate the site.

Dr. John M. Goggin, of the University of Florida Department of Sociology, identified artifacts, and Doctors Rolland F. Hussey, Frank N. Young, T. H. Hubbell, Kenneth Cooper, and Mr. Karl Krombein identified insect specimens, and Dr. C. Lewis Gazin identified the cetacean teeth. Dr. J. Alan Holman was especially helpful in checking the identification of amphibian and reptile specimens.

The efforts of Mr. Stanley J. Olsen in making available the Florida Geological Survey collections and checking the identification of some of the mammals are gratefully appreciated.

Dr. Albert M. Laessle, of the University of Florida Department of Biology, has generously supplied information on plant ecology, and Doctors James N. Layne, Pierce Brodkorb, and J. Alan Holman have graciously loaned comparative material.

Dr. Robert O. Vernon and the Florida Geological Survey provided financial assistance.

Without the generous help of the Exploration Department and Geochemical Laboratory of the Humble Oil and Refining Company, radiocarbon dates for this important site would not have been possible.

The many aids and help rendered by the above have contributed immeasurably to the consummation of this study.

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INTRODUCTION

The first New World discovery of human bones and artifacts which is associated with extinct Pleistocene vertebrates occurred at Vero through the digging of an east-west drainage canal by the Indian River Farms Company. The first fossils were found in 1913, the first human remains in 1915. The majority of the material was collected in 1915 and 1916 (Sellards, 1917a).

During the latter part of October 1916, E. H. Sellards, O. P. Hay, G. G. MacCurdy, A. Hrdlicka, T. W. Vaughan, and R. T. Chamberlin held a field conference at the locality (Sellards, 1917a). A second field conference was held in March 1917, with E. W. Berry, E. H. Sellards, R. T. Chamberlin, and H. Gunter participating. A number of other workers visited the locality subsequent to its discovery but only for brief periods. A list of papers concerning Vero Beach and other Florida vertebrate fossil localities has been compiled by Ray(1957).

A list of species described as new from Vero Beach is given in table 1.

Table 1. List Of Species For Which Vero Is The Type Locality

Species	
Chelydra laticarinata Hay 1916	= *C. serpentina*
Chelydra sculpta Hay 1916	= *C. serpentina*
Terrapene innoxia Hay 1916	= *T. carolina*
Terrapene antipex Hay 1916	= *T. carolina*
Pseudemys floridana persimilis Hay 1916	= *P. floridana*
Testudo sellardsi Hay 1916	= *Geochelone sellardsi*
Testudo luciae Hay 1916	= Species inquirenda
Gopherus praecedens Hay 1916	= Species inquirenda
Ardea sellardsi Shufeldt 1917	= *Meleagris gallopavo*
Jabiru weillsi Sellards 1916	= *Ciconia maltha*
Querquedula floridana Shufeldt 1917	= *Lophodytes cucullatus*
Larus vero Shufeldt 1917	= *Nyctanassa violacea*
Canis ayersi Sellards 1916	= Valid species
Canis riviveronis Hay 1917	= *Canis latrans*
Vulpes palmaria Hay 1917	= Species inquirenda
Tapirus veroensis Sellards 1913	= Valid species
Odocoileus sellardsiae Hay 1917	= *O. virginianus*

STRATIGRAPHY

The fossil-bearing deposit is located within the present limits of the city of Vero Beach (fig. 1, 2). It lies in the center of the SE¼ sec. 35, T. 32 S., R. 39 E., and bears the State archeological number IR9 (Rouse, 1951). The Florida East Coast Railroad and Vero Beach Municipal Airport borders the site on the northwest. The North Relief Canal (fig. 3) empties into the Indian River at a point where Royal Palm Boulevard crosses the river. For a distance of about 1,500 feet, the canal coincides with the former drainage pattern of Van Valkenburg Creek, the present eastern remnant of which empties into the Indian River about half a mile north of the canal discharge. The eastern remnant of the creek is known locally as Mockingbird Creek. It is in this area, between the spillway and the highway, that most of the fossils occur.

The fossil-bearing deposits at Vero consist of three distinct beds of sedimentary materials, designated, from top to bottom, as beds 3, 2, and 1 (stratum 3, 2, and 1 of Sellards, 1917a). Throughout most of the deposit these beds are distinct and easily distinguished. They fill a shallow but relatively wide basin whose width is about 300 feet (fig. 4). The sediments have been referred to by Sellards (1917a) and Chamberlin

Figure 1. Aerial photograph of Vero site and surrounding area. Bone beds lie between the railroad and spillway.

(1917a) as a stream-channel fill, the basin having been attributed to erosion by a former stream. At the time the drainage canal was dug, sluggish Van Valkenburg Creek flowed intermittently across the southern edge of the deposit, passing over Locality 1 (Chamberlin, 1917b). This creek was joined by two tributaries, one from the north, the other from the south, each entering the main stream about 220 feet east of the present spillway.

During the present study the extent of the basin was determined by cutting sections along all tributary canals and by use of a soil auger. Its limits agree with those of Chamberlin's map (1917a, fig. 2). The northern boundary, in the region of Locality 3a, extends 157 feet north of the present canal; the southern boundary has been obscured in most places by the digging of the drainage canal; the western boundary is 160 feet east of the spillway. The eastern limit is more difficult to ascertain since the area east of the railroad and highway are under settlement. However, test borings here indicate that the basin does not extend east of the railroad. At the edge of the basin the beds thin out, and in cross section the basin is saucer-shaped.

Bed 3, the uppermost bed, consists of loose white sands, muck, vegetable debris, and bones. The top of bed 3 is mostly composed of a layer of muck.

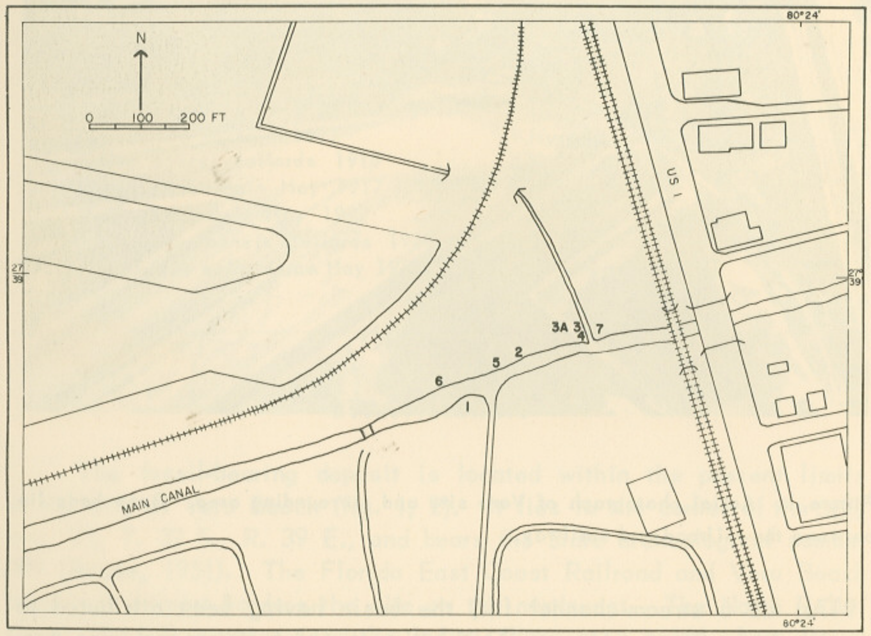

Figure 2. Map of the Vero fossil deposit with excavation locality numbers.

Bed 2, at its base, consists of white beach sands containing horizontal bands of heavy minerals. The white sands grade upward into a homogeneous mixture of coarse and fine brown stained sands which become increasingly dark toward the top. This bed also contains vertebrate fossils. The relatively light colored sands of bed 3 contrast strikingly with the dark brown upper part of bed 2 upon which bed 3 unconformably lies. The presence of fresh water vertebrates, the increasingly dark brown stain due to vegetation, and the absence of crossbedding throughout bed 2 suggest a pond or marsh deposit.

Figure 3. North bank of drainage canal at point of entrance of north tributary stream.

Underlying bed 2 and separated from it by an erosional surface is a Pleistocene marine shell marl, designated bed 1 and referred to the Anastasia Formation by Sellards (1916). The contact between beds 1 and 2 is not as distinct as that between 2 and 3, and the lower beach sands contain inclusions of shell derived from bed 1. The abundance of *Donax*, *Arca*, and other marine pelecypods in bed 1 and the beach type sands with heavy minerals at the base of bed 2 indicate shore or beach conditions during the initial stages of bed 2 deposition. No fresh water or terrestrial fossils occur in bed 1.

The typical relationship between beds 2 and 3 is shown in figure 5, which represents the west wall of Locality 3a following the completion of excavation. The contact is relatively uniform and horizontal. That this contact represents an interval of erosion is indicated by the proportionately larger amount of fossils at the contact and by the sharpness of demarcation. At all localities presently investigated, except Locality 1, no remains of extinct Pleistocene forms were found in bed 3. This is in contrast to the original findings of Hay (1917a) and Sellards (1916).

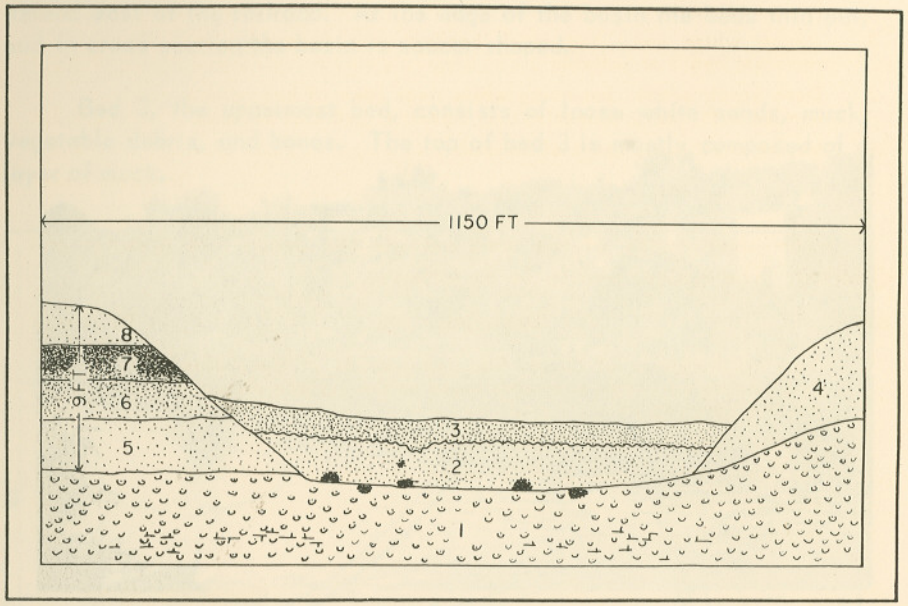

Figure 4. East-west cross section through fossil deposit. (1) Anastasia Formation; (2) Bed 2; (3) Bed 3; (4) Silver Bluff dune; (5), (6), (7), (8) Pamlico sands. Bed 7 is hardpan.

The relationship between the two strata along the north and south banks of the canal has been described by Sellards (1917a). The contact line along the north bank is level and distinct, whereas the contact along the south bank is locally irregular. It should be kept in mind that the exposure on the south bank of Locality 1 coincides with the channel of Van Valkenburg Creek. After the deposition of bed 3, the stream cut through beds 2 and 3, in some places removing bed 2 entirely and gouging into bed 1.

At Locality 3a, the profile is as follows:

Bed	Description	Thickness (feet)
1	Spoil from drainage ditch containing mixed debris of underlying sediments	4-10
2	Loose white sand and muck banded with decayed plant remains; bed 3 of Sellards	1.3-2.0
3	Dark beach sands, becoming white near base of bed, where banded with heavy minerals; unit massive; bed 2 of Sellards .	2.0-2.5
4	Marine shell marl; bed 1 of Sellards	4.0-? (to water table)

The stratigraphy of the area outside the deposit is distinct and different. The typical profile is as follows:

Bed	Description	Thickness (feet)
1	Varying thickness of loose, fine, gray sands of Immokalee or St. Johns soil type, commonly found at the surface throughout the Vero region	0-2
2	Organic hardpan, rather firmly indurated	2-3
3	Reddish brown sand grading below to orange and white	2-3
4	Fine buff sands	2
5	Marine shell marl	4-?

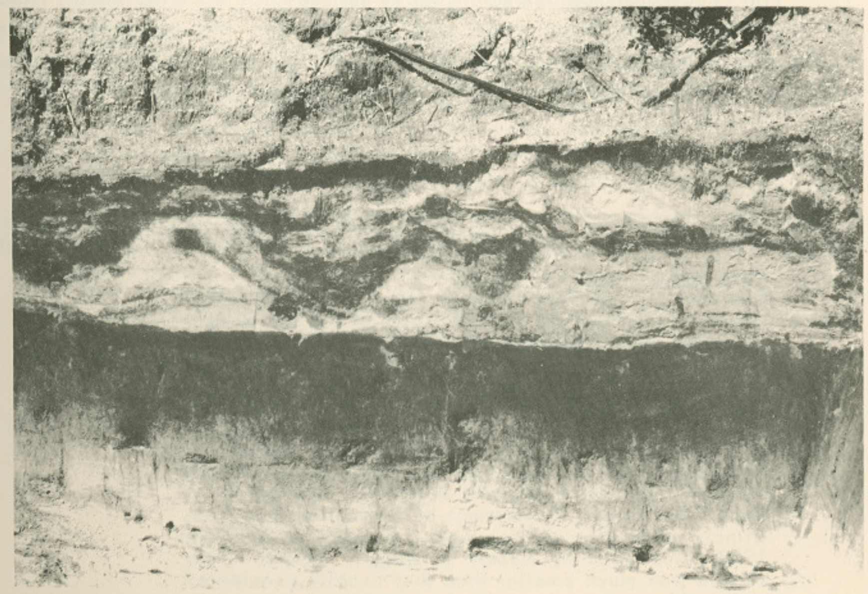

Figure 5. West wall of Locality 3a after completion of excavation. From bottom to top of section, top of bed 1, bed 2, bed 3, spoil.

The sandy strata listed above represent the Pamlico terrace of Cooke (1945) and MacNeil (1950).

The organic hardpan in the Pamlico is of special interest. It is well indurated and does not disassociate readily when soaked in water. Nodules and large lumps of this hardpan were observed in bed 2 by Chamberlin (1917a) and the author. H. K. Brooks (personal communication), of the University of Florida Geology Department, states that he also found such lumps at the contact between beds 1 and 2. The inclusion of these lumps of hardpan in bed 2 can only be explained by assuming an age younger than Pamlico for bed 2. The great width of the basin contrasted with its shallow depth, the presence of beach type sands with heavy minerals and the occurrence of whale teeth at the base, and the imperceptible gradation from marine to fresh water conditions indicate scouring of an inlet by tidal action of a sea at least 8 feet higher than present.

AGE OF THE DEPOSIT

The results of radiocarbon assays for several samples taken from the Vero beds have been made available through the courtesy of the Exploration Department and Geochemical Laboratories of the Humble Oil and Refining Company. They are reproduced in table 2.

Table 2. Vero Radiocarbon Dates

Run No.	Sample description	Age, years before present
1057	Vero Beach site, Vero Beach: Charcoal sample from Vero Beach site, Indian River County, Florida, from the basal part of bed 2. Sample separated from medium coarse sand overlying a shell marl. Vertebrate fossils, including *Paramylodon harlani, Megalonyx jeffersonii, Dasypus bellus, Holmesina septentrionallis, Synaptomys australis, Hydrochoerus* sp., *Canis ayersi, Smilodon* sp., *Mammut* sp., *Mammuthus* sp., *Equus* sp., *Tapirus veroensis, Mylohyus* sp., *Tanupolama mirifica,* occur in the stratum from which sample obtained. Collected by Robert D. Weigel, Department of Biological Sciences, Illinois State Normal University, Normal, Illinois, in 1958. Submitted by Robert D. Weigel. (Note: This sample was much smaller than that usually considered acceptable, and as a result, the statistical uncertainty in age is abnormally large.)	>30,000

Run No.	Description	Age, years before present
1064	Vero Beach site, Vero Beach, Florida: Charcoal from the basal part of bed 2 of the Vero Beach site, Indian River County, Florida. Sample presumably from the same bed as that of run 1057. Collected by E. H. Sellards, Texas Memorial Museum, Austin, Texas, in 1952. Submitted by E. H. Sellards.	2,500 ± 110
1065	Vero Beach site, Vero Beach, Florida: Wood fragments (uncharred) from the basal part of bed 2 of the Vero Beach site, Indian River County, Florida. Uncharred wood comprising this sample separated from charcoal of run 1064. Collected by E. H. Sellards, Texas Memorial Museum, Austin, Texas, in 1952. Submitted by E. H. Sellards.	1,625 ± 200
1112	Vero Beach site, Vero Beach, Florida: Charcoal from top part of bed 2 of Vero Beach site, Indian River County, Florida. Sample obtained from a medium coarse sand somewhat above sea level. Collected by E. H. Sellards, Texas Memorial Museum, Austin, Texas, and Robert D. Weigel, Illinois State Normal University, Normal, Illinois, December 29, 1959. Submitted by E. H. Sellards and Robert D. Weigel.	3,550 ± 120
1114	Vero Beach site, Vero Beach, Florida: Carbonaceous material (uncharred) from basal part of bed 2 of Vero Beach site, Indian River County, Florida. Sample presumed to be equivalent to samples of runs 1057, 1064, and 1065. Collected by E. H. Sellards, Texas Memorial Museum, Austin, Texas, and Robert D. Weigel, Illinois State Normal University, Normal, Illinois, December 29, 1959. Submitted by E. H. Sellards and Robert D. Weigel. (Note: This sample was much smaller than that usually considered acceptable, and as a result, the statistical uncertainty in age is abnormally large).	8,200 ± 960
1109	Vero Beach site, Vero Beach, Florida: Marine shells from basal bed (Pleistocene) of the Vero Beach site, Indian River County, Florida. This bed consisting of various types of marine shells, is of undetermined thickness and is barren of artifacts. Collected by E. H. Sellards, Texas Memorial Museum, Austin, Texas, and Robert D. Weigel, Illinois State Normal University, Normal, Illinois, December 29, 1959. Submitted by E. H. Sellards and Robert D. Weigel.	>37,000

Evident inconsistencies among some of the dates require clarification. In 1952 Dr. Sellards collected charcoal and wood samples from sands supposed to be bed 2 at Locality 1, an area which is now known to have suffered drastic alteration by stream action. It was here that the stream mixed fossils from beds 2 and 3 with Recent animal remains and Recent Indian artifacts. These samples were not assayed at the time of collection because of suspected contamination (Sellards, personal communication). For the above reasons dates for runs 1064 and 1065 are not valid for any of the Vero beds. A similar situation exists regarding the abnormal Recent date for a Seminole Field fauna at St. Petersburg, Florida (Broecker, Kulp, and Tucek, 1956).

The dates >30,000 years and 8,200 ± 960 years for bed 2 are noteworthy. Material used in run 1057 was taken from the very bottom of bed 2 at Locality 3a, and the carbonaceous material represented in run 1114 came from the lower one-third of bed 2 about 20 feet north of Locality 3a near the limits of the basin. Due to the saucer-shaped nature of the basin, the lower and older portions of bed 2 thin out at the edge of the basin and are absent at its extreme limits. This latter sample, therefore, does not represent the oldest part of bed 2. Despite the statistical uncertainty in age for run 1057, the sample is at least 30,000 years old; how much older is indeterminable. Deposition of bed 2 ceased about 3,500 years ago.

The stratigraphic control employed at Locality 3a makes it possible to determine the percentage of extinct mammalian species in each 6-inch level of bed 2. As shown in table 3 the percentage of extinct forms increases toward the bottom of bed 2. This bed clearly appears to represent a period of continuous deposition from something over 30,000 years ago until about 3,500 years ago and embraces that period during which many Pleistocene forms became extinct in Florida.

Table 3. Percentage of Extinct Mammals in Each of Five Levels of Bed 2, Locality 3a

Top	6"	5%
2nd	6"	19%
3rd	6"	33%
4th	6"	33%
5th	6"	50%

The difficulties involved in establishing correlations of Florida Pleistocene fossil deposits with stages of the Pleistocene were reviewed by Bader (1957). The age of the Vero bone beds is relevant to these problems and to the chronology of Florida Pleistocene shorelines. Two of the shorelines, the Pamlico and Silver Bluff, are closely associated with the Vero beds. The Pamlico shoreline lies about 25 miles west of Vero and its terrace surrounds the bone beds. The Silver Bluff shoreline lies a few feet east of the railway at Vero and shoreline features indicate a sea level about 10 feet higher than present (MacNeil, 1950). The contact between beds 2 and 3 is somewhat less than 10 feet above present sea level; thus the deposit area was subject to tidal action of the Silver Bluff sea.

As far as is known, there has been only one shoreline higher than present since Pamlico time, namely the Silver Bluff. According to MacNeil (op. cit.) it is post-Wisconsin in age. There has been general agreement that the Silver Bluff resulted from the effects of the hypsithermal interval (post-glacial maxium) which began, according to Deevey and Flint (1957), about 9,000 years ago. Recent evidence, however, suggests that a higher than present sea level during hypsithermal time is improbable (Flint, 1957, p. 263). In view of this and the age of bed 2 the Silver Bluff must be older than was previously thought.

Based on paleotemperatures, a reasonably accurate chronology of Pleistocene events seems fairly well established for at least the last 100,000 years (Emiliani, 1955). A warm period occurred about 90,000 years ago and a moderate period about 45,000 years ago (Emiliani, 1956; Suess, 1955). The warm period 90,000 years ago has been correlated with the Sangamon interglacial stage by Emiliani (op. cit.). Inasmuch as the scouring of the Vero basin occurred sometime before 30,000 years ago and the most recent moderate period older than the hypsithermal occurred about 45,000 years ago, it was probably during this latter period that sea level rose sufficiently to scour the inlet at Vero.

MacNeil (1950) recognized four marine shorelines as follows:

Shoreline	Altitude	Age
Okefenokee	150 feet	Yarmouth interglacial stage
Wicomico	100 feet	Sangamon interglacial stage
Pamlico	25-35 feet	Mid-Wisconsin glacial recession
Silver Bluff	8-10 feet	Post-Wisconsin

Because conditions at Vero preclude a post-Wisconsin age for the Silver Bluff, each shoreline should be moved back one stage. Based on the above data, the following correlations are suggested:

Shoreline	Altitude	Age
Okefenokee	150 feet	Aftonian interglacial stage
Wicomico	100 feet	Yarmouth interglacial stage
Pamlico	25-35 feet	Sangamon interglacial stage
Silver Bluff	8-10 feet	Unnamed warm period

METHODS OF COLLECTION

As pointed out by Rouse (1951), much of the previous work at the Vero site was carried out without stratigraphic control, nor were any of the practiced methods of archaeology employed. Instead, bones and artifacts were picked from the sides of the canal banks. The only extensive removal of matrix was done at the original site at the south bank of the canal about 500 feet west of the railway bridge. This site will here be referred to as Locality 1. During the present work seven such localities, noted in figure 2, were investigated at various places in the fossil-bearing deposits. The most extensive excavation was made at Locality 3a, 15 feet north of the main canal in the west bank of a small drainage ditch which parallels the railway. Most of the collecting was done in the summers of 1956 and 1957.

At Locality 3a, spoil from the drainage ditch was removed from an area 9 by 9 feet, exposing the horizontal surface of bed 3. The plot was divided into sections 3 feet square, the matrix being removed one square at a time from the top downward in 6-inch levels (fig. 6). All of the matrix was passed through a 1/8-inch mesh screen and the bones from each squzre and level kept separate. Although the horizontal and vertical distribution of specimens in each bed has not been noted for species in the faunal list, this and all other pertinent information is on file at the Florida Geological Survey in Tallahassee, should this be useful to anyone in the future. For example, the assumption that a single individual of the American bittern, *Botaurus lentiginosus*, as represented in the deposit is based on the presence of several elements in two contiguous squares of the same level. The fossil amphibians, reptiles, and mammals are in the Florida Geological Survey collections at Tallahassee and the birds are in the collection of Pierce Brodkorb, University of Florida at Gainesville.

Figure 6. Locality 3a during excavation.

PRESERVATION OF FOSSILS

Vertebrate remains, human artifacts, coprolites, insects, plants, and fresh water and marine mollusks occur in the fossil beds at Vero.

Complete and articulated fossil skeletons are rare in Florida deposits. This lack of completeness has often been attributed to reworking and redeposition. Because of fragmentary and incomplete nature of many of the Vero fossils, Chamberlin (1917a) and others first suggested that they were secondarily deposited from another area. During his second visit to Vero, Chamberlin searched the upland section for fossils but could find none. The author also investigated the surrounding area but no fossil-bearing deposits were in evidence from which the bones might have been derived. On reconsideration, Chamberlin (1917b) agreed with Sellards (1917b) that the fossils were primary in the deposit.

Ordinarily, bones do not preserve well in sandy matrix unless the sands are saturated with or covered by water. This suggests that the Vero fossils were deposited in an aquatic environment. Another fact which argues for a primary aquatic deposition in shallow or marshy water is the presence of coprolites or fossil excrement. Many of the coprolites recovered from beds 2 and 3 are complete and uneroded, yet they are fragile and easily broken when handled. It is doubtful that they could have been transported any distance, either as fossils or in the fresh condition.

Although not complete, articulated skeletons have been found in place, several forms are represented by a number of elements from single individuals recovered from one place. Sellards (1917c) noted 30 or more bones of 1 individual *Canis ayersi*, 6 elements of *Ciconia maltha* representing 1 individual, a nearly complete skull of *Tapirus veroensis*, and some complete turtle carapaces.

During the present study three teeth and numerous broken fragments of postcranial elements of a mammoth were found associated at Locality 3a, and most of the small rodents are represented by nearly all identifiable elements.

Several factors may explain the incompleteness of fossils. Brodkorb (1955) has pointed out the scattered and disassociated condition of the skeletons of birds which die in the Everglades rookeries. Many Florida fossils occur in sandy matrix which may lie above shell beds as at Vero. Solution of the shells could cause slight movement in the overlying sands and thus tend to separate to some extent the elements of a skeleton. This might also initiate shearing stresses on large bones causing them to crack. Bones also become scattered or broken through the activities of predators and scavengers or through the action of minor currents in bodies of water.

Heizer and Cook (1952) state that the organic components of bone tend almost invariably to diminish with the age of the bones independently of the chemical nature of the matrix in which the bones lay. For a number of years paleontologists have used the "fire test" to determine roughly whether or not bone fragments are of Recent origin. Fresh bone emits an acrid odor when burned. Recently Quinn (1957) suggested that approximate age limits might be established if this test were applied to fossils of known age. Because the Vero fossils represent different time periods, the test was applied to some fossil fragments. Fossils from bed 2 did not char when heated. Bones from bed 3 char lightly and emit a slightly pungent ammonia odor, but not that of Recent material. Some specimens taken from Locality 1 near the bottom of bed 3 and resting almost on the shell gave the characteristic odor of Recent bone. This was true of several nearly complete unfossilized specimens of a Barred Owl. Also present here were charred, broken long bones of deer. The presence of bones, apparently younger in age than typical bed 3 material are found associated with artifacts and remains of extinct forms which do not appear in other localities at this horizon. This is further indication of disturbance of the beds here. It is through this locality that Van Valkenburg Creek flowed. The stream had obviously cut through both strata, mixing bones from beds 2 and 3 with Recent artifacts and bone. The pottery and charred bone suggest a fairly Recent Indian encampment in close proximity to the main stream and its southern tributary.

LIST OF FOSSIL VERTEBRATES FROM VERO

CLASS CHONDRICHTHYES

Aetobatis narinari Spotted duckbill ray

CLASS OSTEICHTHYES

Lepisosteus platyrhincus Florida spotted gar
Amia calva Bowfin
Caranx hippos Common jack

CLASS AMPHIBIA

Siren lacertina Greater siren
Ambystoma sp. Mole salamander
Amphiuma means Amphiuma
Scaphiopus holbrookii Eastern spadefoot toad
Bufo sp. Toad
cf. *Rana pipiens* Leopard frog
cf. *Rana catesbeiana* Bullfrog

CLASS REPTILIA

Chelydra serpentina Snapping turtle
Kinosternon bauri Striped mud turtle
Kinosternon subrubrum Mud turtle
Sternotherus odoratus Stinkpot
Sternotherus minor Musk turtle
Terrapene carolina Box turtle
Pseudemys scripta Pond slider
cf. *Pseudemys floridana* Coastal plain slider
Geochelone sellardsi Extinct land tortoise
Gopherus polyphemus Gopher tortoise
Chelonia mydas Atlantic green turtle
Caretta caretta Atlantic loggerhead
Alligator mississippiensis American alligator
Anolis carolinensis Green anole
Sceloperus undulatus Fence lizard
Ophisaurus compressus Glass lizard

Eumeces **sp.** Skink
Natrix taxispilota Brown water snake
Natrix sipedon Water snake
Thamnophis **sp.** Garter snake
Farancia abacura Mud snake
Coluber **sp.** Racer
Drymarchon corais Indigo snake
Pituophis melanoleucus Pine snake
Lampropeltis getulus Kingsnake
Micrurus fulvius Coral snake
Crotalus adamanteus Eastern diamondback rattlesnake

CLASS AVES

Podilymbus podiceps Pied-billed grebe
Phalacrocorax auritus Double-crested cormorant
Ardea herodias Great blue heron
Casmerodius albus Common egret
Florida thula Snowy egret
Butorides virescens Green heron
Nyctanassa violacea Yellow-crowned night heron
Botaurus lentiginosus American bittern
Ciconia maltha Extinct stork
Anas fulvigula Mottled duck
Aix sponsa Wood duck
Aythya **sp.** Duck
Lophodytes cucullatus Hooded merganser
Cathartes aura Turkey vulture
Coragyps atratus Black vulture
Buteo jamaicensis Red-tailed hawk
Colinus virginianus Bobwhite
Meleagris gallopavo Turkey
cf. ***Rallus elegans*** King rail
Rallus limicola Virginia rail
Rallus **sp.** Rail
Porzana carolina Sora
Ectopistes migratorius Passenger pigeon
Tyto alba Barn owl
Otus asio Screech owl
Strix varia Barred owl
cf. ***Colaptes auratus*** Flicker
cf. ***Centurus carolinus*** Red-bellied woodpecker
Sphyrapicus varius Yellow-bellied sapsucker
Cyanocitta cristata Blue jay
Turdus migratorius Robin
cf. ***Vermivora*** Warbler
cf. ***Geothlypis*** Warbler
Agelaius phoeniceus Red-winged blackbird
Quiscalus quiscala Common grackle
Cassidix mexicanus Boat-tailed grackle
Pipilo erythrophthalmus Towhee

CLASS MAMMALIA

Didelphis marsupialis Opossum
Blarina brevicauda Shorttail shrew
Cryptotis parva Least shrew
Scalopus aquaticus Mole
Myotis **sp.** Bat
Eptesicus **sp.** Bat
Lasiurus **sp.** Bat
Homo sapiens Man
Paramylodon harlani Harlan's ground sloth

Megalonyx jeffersonii Jeffersonian ground sloth
Dasypus bellus Extinct armadillo
Holmesina septentrionalis Extinct armadillo
Sylvilagus palustris Marsh rabbit
Sciurus carolinensis Eastern gray squirrel
Geomys pinetis Pocket gopher
Oryzomys palustris Rice rat
cf. ***Reithrodontomys humulis*** Harvest mouse
Peromyscus gossypinus Cotton mouse
Peromyscus polionotus Oldfield mouse
Sigmodon hispidus Cotton rat
Neotoma floridana Eastern woodrat
Synaptomys australis Extinct bog lemming
Neofiber alleni Florida water rat
Pitymys pinetorum Pine vole
Hydrochoerus **sp.** Capybara
Odontoceti **2 species** Toothed whales
cf. ***Canis niger*** Florida wolf
Canis ayersi Extinct wolf
Canis latrans Coyote
Vulpes palmaria Extinct fox
Urocyon cinereoargenteus Gray fox
Ursus americanus Black bear
Procyon lotor Raccoon
Spilogale ambarvalis Spotted skunk
Lutra canadensis River otter
Panthera augusta Extinct jaguar
Smilodon **sp.** Saber-tooth cat
Lynx rufus Bobcat
Mammut **sp.** Mastodon
Mammuthus **sp.** Mammoth
Equus **sp.**
Tapirus veroensis Florida tapir
Mylohyus **sp.** Peccary
cf. ***Tanupolama mirifica*** Extinct camel
Odocoileus virginianus Virginia deer
Bison **sp.** Extinct bison

ANNOTATED FAUNAL LIST

CLASS CHONDRICHTHYES

Order Batoidei

Family Myliobatidae

Aetobatis narinari Euphrasen

Hay (1917a) referred a section of a tooth plate from bed 3 to this species. Ray teeth are common in beds 2 and 3 but show considerable erosion.

CLASS OSTEICHTHYES

Order Ginglymodi

Family Lepisosteidae

Lepisosteus platyrhincus Dekay

A right dentary from bed 3 was referred to this species by Hay (1917a).

Order Protospondyli

Family Amiidae

Amia calva Linnaeus

Hay (1917a) reported this species from bed 3 on the basis of a left articular and dentary.

Order Percomorphi

Family Carangidae

Caranx hippos (Linnaeus)

According to Hay (1917a), an "inflated bone belonging beneath the clavicle" represents this species in bed 3.

CLASS AMPHIBIA

Order Urodela

Family Sirenidae

Siren lacertina Linnaeus

Bed 2: Locality 3a. Bed 3: Locality 3a, several hundred vertebrae.

Siren is almost as abundant as *Amphiuma.* Both are common at Vero, having turned up in large numbers at all sites investigated. *Siren* was reported from bed 3 by Hay (1917a) and by Goin and Auffenberg (1955).

Family Ambystomidae

Ambystoma sp.

Bed 2: Locality 3a, a single thoracic vertebra.

Although unquestionably an ambystomid salamander, specific determination is impossible on the basis of this one specimen.

Family Amphiumidae

Amphiuma means Garden

Bed 2: Locality 3a. Bed 3: Locality 3a, several hundred vertebrae.

Amphiuma is one of the most abundant fossils in the Vero deposits. Vertebrae were reported from bed 3 by Hay (1917a) and from both strata by Brattstrom (1953).

Order Anura

Family Pelobatidae

Scaphiopus holbrookii (Harlan)

Bed 2: Locality 3a, two right and one left ilia. Bed 3: Locality 3a, left ilium.

Family Bufonidae

Bufo sp.

Bed 2: Locality 3a, right ilium. Bed 3: Locality 3a, left ilium.

Diagnostic characters useful in separating species of *Bufo* from other anurans have been discussed by Tihen (1951) and Auffenberg (1956a, 1957). Because no cranial crests were found in the Vero deposits, specific determinations were not made. Brattstrom (1953) mistakenly referred a vertebra from bed 3 to *Bufo woodhousei* (Auffenberg, 1957).

Family Ranidae

Rana cf. *Rana pipiens* Schreber

Bed 2: Locality 3a. Bed 3: Locality 3a, several dozen ilia.

According to Auffenberg (1957) frogs of the *R. pipiens* may be separated from those of the *R. catesbeiana* group by the shape and angle of the dorsal crest of the ilium.

Rana cf. *Rana catesbeiana* Shaw

Bed 2: Locality 3a. Bed 3: Locality 3a, several dozen ilia.

Based on size and shape of dorsal crest these specimens belong to the group containing *R. catesbeiana, heckscheri,* and *grylio.* Their state of preservation does not permit more positive identification.

CLASS REPTILIA

Order Chelonia

Hay (1916) described, on inadequate and mainly undiagnostic material, a number of supposed new turtles from Vero. In view of the variability displayed in series of modern turtles it seems advisable to consider the following as *species inquirendae* until such time as the types can be studied in greater detail: *Chelydra laticarinata, Chelydra sculpta, Pseudemys floridana persimilis, Gopherus praecedens,* and *Testudo luciae.* In the following pages they are noted under the species of which they are probable synonyms.

Family Chelydridae

Chelydra serpentina Linnaeus

Bed 2: Locality 3a, costal plate.

Hay (1916) described two new species of snapping turtles, *Chelydra laticarinata* on a sixth left marginal (FGS 7094) from bed 2, and *Chelydra sculpta* on a ninth right marginal (FGS 5510) from bed 3.

Family Kinosternidae

Kinosternon bauri Garman

Bed 2: Locality 3a, two left hypoplastra; Locality 3, left hypoplastron. Bed 3: Locality 3a, two left hypoplastra.

This is the first fossil record of this species.

Kinosternon subrubrum (Lacépède)

Bed 2: Locality 3a, right hypoplastron.

Sternotherus odoratus (Latreille)

Bed 3: Locality 3a, left hypoplastron, nuchal.

Sternotherus minor (Agassiz)

Bed 2: Locality 3, nuchal.

Large numbers of indeterminable kinosternid carapace elements were recovered from all levels of beds 2 and 3 so that *Kinosternon* and *Sternotherus* are more abundant in the deposit than is indicated by the referred specimens.

Family Emydidae

Terrapene carolina (Linnaeus)

Bed 2: Locality 2, right anterior marginals 1-2, left anterior marginals 3-5, costals, anterior end of carapace; Locality 3, posterior lobe of plastron. Probably bed 3: Locality 1, complete carapace, anterior carapace.

Two other species of *Terrapene, T. innoxia* and *T. antipex,* were described from Vero by Hay (1916). These were synonomized with *T. canaliculata* by Barbour and Stetson (1931). Auffenberg (1958) synonomized all Florida Pleistocene specimens with *T. carolina.*

Pseudemys scripta (Schoepff)

Bed 2: Locality 3, nuchal; Locality 3a, nuchal.

Both of these nuchals are highly sculptured and are inseparable from modern specimens of *P. scripta.*

Pseudemys cf. *Pseudemys floridana* (Le Conte)

A number of indeterminable carapace elements of *Pseudemys* were found at nearly all levels of both beds.

Hay (1916) described an extinct subspecies, *Pseudemys floridana persimilis,* from bed 3 on a pair of epiplastrals.

Family Testudinidae

Geochelone sellardsi (Hay)

The type, part of a xiphiplastron (FGS 1831) recovered from bed 2 at Vero, was described in 1916 by Hay. This large extinct land tortoise has since turned up in a number of Florida Pleistocene localities. The type of *Testudo luciae* Hay(1916), part of a right hypoplastral (FGS 1807), was not found in place but is attributed to bed 2.

Gopherus polyphemus (Daudin)

Bed 2: Locality 3, costal plate.

Gopherus polyphemus was reported from bed 3 by Hay (1917a). *Gopherus praecedens* Hay (1916) was based on FGS 5463, a left xiphiplastral thought to be from bed 2.

Family Chelonidae

Chelonia mydas (Linnaeus)

A humerus of *Chelonia mydas* is recorded from bed 3 by Hay (1917a). This and the following species were probably brought in by the Indians.

Caretta caretta (Linnaeus)

This species is represented from bed 3 by a right squamosal (Hay, 1917a).

Order Crocodilia

Family Crocodilidae

Alligator mississippiensis (Daudin)

Bed 2: Locality 3a. Bed 3: Locality 3a, numerous teeth, dermal plates, and jaw fragments.

Hay (1917a) recorded this species from bed 3 on the basis of the same elements as above. Sellards (1916) lists a nearly complete skeleton of this species from bed 2.

Order Squamata

Suborder Lacertilia

Family Iguanidae

Anolis carolinensis Voigt

Bed 2: Locality 3a, very large right maxilla. Bed 3: Locality 3a, two left dentaries, three right dentaries.

Sceloperus undulatus (Latreille)

Brattstrom (1953) recorded two dentaries from bed 3.

Family Anguidae

Ophisaurus compressus Cope

Bed 2: Locality 3a, three vertebrae. Bed 3: Locality 3a, two vertebrae.

An apparently reliable method for separating the species of *Ophisaurus* is the length-width ratios of the centra (Auffenberg, 1955). There is, however, an error in the legend of his graph (fig. 1, p. 134), which should be corrected by adding 1.0 to each ratio (Etheridge, 1961).

Family Scincidae

Eumeces sp.

A dentary from bed 3 is recorded by Brattstrom (1953).

Suborder Serpentes

Family Colubridae

Natrix taxispilota (Holbrook)

Bed 2: Locality 3, two thoracic vertebrae.

Natrix sipedon (Linnaeus)

Bed 2: Locality 3a, two thoracic vertebrae. Bed 3: Locality 3a, thoracic vertebrae.

Natrix sp.

Beds 2 and 3: Locality 3a, several dozen vertebrae.

The genus *Natrix* is represented throughout the deposit, but the majority of the specimens lack those parts which permit specific determination. Brattstrom (1953) lists two vertebrae each from beds 2 and 3.

Thamnophis sp.

A number of *Thamnophis* vertebrae were recovered from beds 2 and 3. Because the species of this genus are difficult, if not impossible, to separate (Auffenberg, 1956b, p. 212), no attempt was made to do so with the Vero specimens.

Farancia abacura (Holbrook)

Beds 2 and 3: Locality 3a, several dozen thoracic vertebrae.

As pointed out by Auffenberg (1956b), the vertebrae of *Farancia* and *Abastor* are also difficult to separate. It is possible that both genera were present at Vero. Hay (1917a) lists an articular of *Farancia* from bed 3 but the specimen is missing (Brattstrom, 1953).

Coluber or *Masticophis*

Beds 2 and 3: Locality 3a, numerous vertebrae.

Vertebrae of these two genera are indistinguishable. Carr and Goin (1955, p. 272) consider *Coluber* and *Masticophis* congeneric.

Drymarchon corais (Daudin)

Bed 2: Locality 3a. Bed 3: Locality 3a, numerous vertebrae.

Hay (1917a) lists several vertebrae from bed 3. Brattstrom (1953) lists four vertebrae from bed 3.

Pituophis melanoleucus (Daudin)

Brattstrom (1953) recorded a vertebra from bed 3.

Lampropeltis getulus (Linnaeus)

Brattstrom (1953) recorded a vertebra from bed 3.

Family Elapidae

Micrurus fulvius (Linnaeus)

Bed 2: Locality 3a, two thoracic vertebrae.

Family Crotalidae

Crotalus adamanteus Beauvois

Bed 2: Locality 3a. Bed 3: Locality 3a, numerous vertebrae.

Hay (1917a) listed vertebrae from bed 3. Brattstrom (1953) recorded vertebrae from beds 2 and 3 and later (Brattstrom, 1954) referred them to an extinct subspecies, *Crotalus adamanteus pleistofloridensis*. According to Auffenberg (1956b) this race is not valid.

CLASS AVES

Order Podicipediformes

Family Podicipedidae

Podilymbus podiceps (Linnaeus)

Bed 2: Locality 3a, distal end right ulna and distal end right humerus.

This species was not previously found at Vero.

Order Pelecaniformes

Family Phalacrocoracidae

Phalacrocorax auritus (Lesson)

Wetmore (1931) records a humerus of the cormorant from bed 2.

Order Ciconiiformes

Family Ardeidae

Ardea herodias Linnaeus

Bed 3: Locality 3a, two cervical vertebrae. Bed 3: Locality 5, distal end of left tarsometatarsus.

Casmerodius albus (Linnaeus)

Bed 3: Locality 1. FGS V2787 (6931), left proximal half tarsometatarsus. This bone, listed by Shufeldt (1917) as possibly belonging to a common egret, was checked and found to be definitely that of the above species.

Florida thula (Molina)

Bed 3: North bank, 380 feet west of railroad bridge, FGS V2797 (7552) nearly complete right humerus, lacking proximal tip.

Shufeldt (1917, p. 39-40) listed this element as possibly belonging to some anserine form such as *Dendrocygna*. In the same paper (legend to fig. 20, pl. 2), he describes it as possessing characters of a small heron.

Butorides virescens (Linnaeus)

Bed 3: Locality 3a, right coracoid, two distal ends left coracoid, distal right coracoid, distal end right tarsometatarsus, distal end left tibiotarsus. Recent: Locality 1, left humerus.

Not previously reported from Vero.

Nyctanassa violacea (Linnaeus)

Bed 3: FGS 6933 (USNM 8832) left carpometacarpus.

This specimen is the type of *Larus vero* Shufeldt (1917). It was synonomized with *N. violacea* by Wetmore (1931).

Botaurus lentiginosus (Rackett)

Bed 2: Locality 3a, cervical vertebra, left coracoid, proximal tip right humerus.

These specimens, found within a few feet of one another, probably represent a single individual. Not previously reported from Vero.

Family Ciconiidae

Ciconia maltha Miller

Ciconia maltha was first described from Vero by Sellards (1916, p. 146) as *Jabiru weillsi*. The type specimen is a right humerus, with right and left carpometacarpals and the proximal end of a right coracoid as paratypes. In his original description, Sellards noted that the metacarpi resembled *Ciconia* more than *Jabiru*. Wetmore (1928) questioned the distinctness of *J. weillsi* from *J. mycteria*. Later the same author (1930) stated that available material did not indicate any difference from the living *J. mycteria*. Hildegard Howard (1942) referred all of the eastern stork bones to *Ciconia maltha*, first described by Miller (1910, p. 10) from the Quaternary asphalt deposits of Rancho La Brea. She suggested that the name *weillsi* be retained to designate the slightly larger eastern subspecies. With the exception of the recently extinct passenger pigeon (*Ectopistes migratorius*) *C. maltha* now becomes the only extinct bird from Vero, as all the supposed new species described by Shufeldt have proved to be synonyms of modern forms.

Order Anseriformes

Family Anatidae

Anas fulvigula Ridgway

Probably bed 3: Locality 1, distal end left tarsometatarsus.

Not previously reported from Vero.

Aix sponsa (Linnaeus)

Recent: Locality 1, left carpometacarpus.

Aythya sp.

Bed 3: Locality 1, proximal end left carpometacarpus.

Not previously reported from Vero.

Lophodytes cucullatus (Linnaeus)

Bed 2: Locality 7, distal moiety right humerus. Bed 3: Locality 3a, proximal end right tibiotarsus.

Shufeldt (1917) described a supposed teal from bed 2 under the name *Querquedula floridana*. Brodkorb (1953) examined a cast of the type (FGS 6773) and referred it to *Lophodytes cucullatus*. Wetmore (1955) re-examined the type, agreeing with its reference to the genus *Lophodytes*, but maintaining it as a distinct species, *L. floridana*. After carefully studying the cast of the type and the additional material collected during the present study, the writer concurs with Brodkorb that the Vero specimens are identical with *L. cucullatus*.

Order Falconiformes

Family Cathartidae

Cathartes aura (Linnaeus)

Bed 2: Locality 2, proximal end of a right tibiotarsus. Probably bed 3: south bank, west of bridge, FGS V3202, right tarsometatarsus.

The left ulna, reported by Shufeldt (1917), from bed 2, actually came from bed 3 (Wetmore, 1940, p. 29). The specimen referred to above is the only representative of *C. aura* from bed 2, and corresponds in size to *C. aura septentrionalis*. Wetmore (1931, p. 23) has recorded the smaller *Cathartes a. aura* from Seminole Field.

Coragyps atratus (Bechstein)

Bed 3: Locality 1, proximal end of a right coracoid.

This species has not previously been reported from Vero.

Family Accipitridae

Buteo jamaicensis (Gmelin)

Bed 3: Locality 3a, distal end of a right humerus.

Not previously reported from Vero.

Order Galliformes

Family Phasianidae

Colinus virginianus (Linnaeus)

Bed 2: Locality 3a, proximal end of a left coracoid, proximal end of a tibiotarsus, distal end of a right humerus, distal end of a left humerus, left ulna; west of bridge, FGS V2410, left humerus; Locality 1, probably Recent, proximal end right tibiotarsus, distal end of a left humerus.

Not previously reported from Vero.

Family Meleagrididae

Meleagris gallopavo Linnaeus

Bed unknown: north of canal between Florida East Coast Railroad and Dixie Highway (U.S. Highway 1), FGS V3909 distal part of left tarsometatarsus, FGS V3908 right carpometacarpus, collected December 1, 1925.

The type of *Ardea sellardsi* Shufeldt, a distal third of a right tibiotarsus FGS 7551, was found to represent *Meleagris gallopavo* (Wetmore, 1931).

Order Gruiformes

Family Rallidae

Rallus cf. *Rallus elegans* Audubon

Bed 3: Locality 6, right scapula.

Rallus limicola Vieillot

Bed 3: Locality 3a, distal end of a left tarsometatarsus.

Not before reported from Vero.

Rallus sp.

Locality 1, Recent; proximal end right ulna.

Porzana carolina (Linnaeus)

Bed 3: Locality 3, distal end left tarsometatarsus.

Not before reported from Vero.

Order Columbiformes

Family Columbidae

Ectopistes migratorius (Linnaeus)

Bed 3: Locality 3a, distal portion of a left carpometacarpus.

Although extinct, this species has been extirpated only in Recent times. Not previously reported from Vero.

Order Strigiformes

Family Tytonidae

Tyto alba (Scopoli)

Bed 3: south bank, 460 feet west of railroad bridge, distal moiety of a right tibiotarsus.

This is the same element reported by Shufeldt (1917).

Family Strigidae

Otus asio (Linnaeus)

Recent: Locality 1, proximal end of a left tibiotarsus.

Strix varia Barton

Bed 2: Locality 2, left quadrate. Bed 3: Locality 3a, proximal part of a right ulna, proximal part of a right carpometacarpus. Recent: Locality 1, left humerus, distal fourth left ulna, right ulna, part of sacrum, phalanx 1 of digit II, both ends right radius.

Not previously listed for Vero.

Order Piciformes

Family Picidae

Colaptes cf. *Colaptes auratus* (Linnaeus)

Bed 3: Locality 3a, proximal half of left humerus.

Not previously reported from Vero.

Centurus cf. *Centurus carolinus* (Linnaeus)

Bed 2: Locality 3a, right coracoid.

Not previously reported from Vero.

Sphyrapicus varius (Linnaeus)

Bed 3: Locality 3a, proximal end of a right humerus.

Not previously reported from Vero.

Order Passeriformes

Family Corvidae

Cyanocitta cristata (Linnaeus)

Bed 3: Locality 3a, distal part of a right tarsometatarsus; Locality 1, probably Recent, distal part of a left tibiotarsus.

Not previously reported from Vero.

Family Turdidae

Turdus migratorius Linnaeus

Bed 2: Locality 3a, distal part of a left tarsometatarsus, proximal end of a left carpometacarpus.

First fossil record from Florida.

Family Parulidae

cf. *Vermivora* sp.

Bed 2: Locality 3a, distal part of a right humerus.

cf. *Geothlypis* sp.

Bed 3: Locality 3a, proximal end of a left humerus.

Family Icteridae

Agelaius phoeniceus (Linnaeus)

Recent: Locality 1, right humerus.

Quiscalus quiscula (Linnaeus)

Bed 2: Locality 3a, distal end of a left tarsometatarsus.

Not recorded before from Vero.

Cassidix mexicanus (Gmelin)

Probably Recent: Locality 1, proximal half of a right humerus.

Family Fringillidae

Pipilo erythrophthalmus (Linnaeus)

Recent: Locality 1, nearly complete mandible.

CLASS MAMMALIA

Order Marsupialia

Family Didelphidae

Didelphis marsupialis Linnaeus

Bed 2: Locality 3a, left M_1, left M_2, left and right M_3, left and right mandibles, supraoccipital, atlas, axis, five vertebrae, left innominate. Bed 3: Locality 3a, right P^2, one left M^3, two right M^3, left and right M_1, left M_3, supraoccipital, frontal, four vertebrae, distal epiphysis of right femur.

Recorded by Sellards (1916) from beds 2 and 3.

Order Insectivora

Family Soricidae

Blarina brevicauda (Say)

Bed 2: Locality 3a, left and six right mandibles, two left maxillae, two right humeri, one left femur. Bed 3: Locality 3a, 11 left and 17 right mandibles, one left and one right maxilla, three left and three right humeri, two left and two right femora, one skull.

Sellards (1916) recorded a single jaw from bed 2.

Cryptotis parva (Say)

Bed 2: Locality 3a, four left and five right mandibles. Bed 3: Locality 3a, five left and five right mandibles, one right maxilla, two right humeri.

This species was also previously represented by only a single lower jaw (Sellards, 1916).

Family Talpidae

Scalopus aquaticus (Linnaeus)

Bed 2: Locality 3a, one left and four right mandibles, nine left and ten right humeri, five left and five right radii, three left and two right ulnae, one left and two right femora. Bed 3: Locality 3a, six left and nine right mandibles, 21 left and 22 right humeri, six left and six right radii, seven left and five right ulnae, five left and three right femora.

Previously represented by a single lower jaw from bed 3 (Sellards, 1916).

Order Chiroptera

Family Vespertilionidae

Myotis sp.

Bed 3: Locality 3a, right humerus.

Eptesicus sp.

Bed 2: Locality 3a, left mandible with M_3.

Lasiurus sp.

Bed 3: Locality 3a, left femur, left humerus.

Order Primates

Family Hominidae

Homo sapiens Linnaeus

Bed 2: Locality 3a, several flint spawls. Bed unknown: portions of two skeletons, numerous artifacts.

The human bones and artifacts were reported by Sellards (1916).

In point of discovery the Vero deposit is the first reported occurrence of man with extinct mammals in the New World. Considerable controversy ensued regarding the interpretation of the find, since certain anthropologists were reluctant to accept a Pleistocene Age for man in the New World.

Several factors contributed to the confusion. (1) Hay (1917b) argued for an early Pleistocene Age even for bed 3, largely on the basis of a number of supposed extinct species which he and Shufeldt (1917)

described as new in a flurry of misguided overenthusiasm. The difference attributed to the supposed new species of bed 3 have, on further study, proved to be imaginary, and the names are synonyms of living forms. (2) Hrdlicka's bitter opposition to a great age for man in North America led him to interpret the skull as that of a modern Indian (Hrdlička, 1918). Stewart (1946) has accurately reconstructed the skull and concludes that it is paleo-Indian. (3) At the original site bones of extinct mammals were found in association with preceramic artifacts and sherds. According to Rouse (1951), pottery representing several cultural types and levels occur, namely: Glades plain, Malabar I (St. Johns plain), and Malabar II (St. Johns check-stamped). The chronology of these cultures has been worked out by Goggin (1949, 1950). The present interpretation of the preceramic age is previous to 1600 B.C. Glades plain represents the period 400 B.C. to A.D. 25. Malabar I represents the period 400 B.C. to A.D. 1150. Malabar II occurs between A.D. 1150-1650.

Sherds are never found in bed 2, although a number of flint spawls were recovered well within the upper part of that bed during the present excavations. According to Dr. Goggin, who kindly examined them, they represent an Archaic or preceramic culture. At the original site, as pointed out elsewhere, the occurrence of artifacts of various ages with bones of extinct vertebrates is the result of reworking of the sediments by Van Valkenburg Creek, and since sherds do not occur in areas where bed 2 is undisturbed, their presence together need cause no further concern.

Chemical analysis of human bones and those of extinct mammals from Vero by Sellards (1916) indicates contemporaneity. At the similar deposit at Melbourne, Florida, Heizer and Cook (1952) ran fluorine tests on human, Pleistocene horse, and mammoth bones from bed 2 and state that they are all of the same order of antiquity. In view of these facts, it is not improbable that man and extinct Pleistocene vertebrates were contemporaneous at Vero, at least during the closing phase of bed 2 deposition. Based on the radiocarbon date for the top of bed 2, man must have inhabited this region as long as 4,000 years ago.

Order Edentata

Family Mylodontidae

Paramylodon harlani Owen

Bed 2: Locality 2, four anterior teeth.

This species is listed by Hay (1923) for bed 2.

Family Megalonychidae

Megalonyx jeffersonii (Desmarest)

Sellards (1916) listed this species from bed 2 on the basis of a part of a lower jaw, right upper canine, molar, hyoid, axis, astragalus, and a median phalanx. It has never been attributed to bed 3.

Family Dasypodidae

Dasypus bellus (Simpson)

Bed 2: Locality 3a, numerous casque, anterior and posterior buckler scutes.

Sellards (1916) lists *Dasypus* from beds 2 and 3, but the dermal scutes attributed to bed 3 were derived from bed 2.

Holmesina septentrionalis (Leidy)

Bed 2: Locality 3a, two dermal scutes. Bed 2: Locality 7, ten dermal scutes.

H. septentrionalis, as was the case with *Dasypus*, was erroneously reported from beds 2 and 3 by Sellards (1916).

Order Lagomorpha

Family Leporidae

Sylvilagus palustris (Bachman)

Bed 2: Locality 3a, right acetabulum and part of innominate.

Sylvilagus sp.

Bed 2: Locality 3a, one right I_1, one right P^1, five upper molars, eight lower molars, two right maxillae, parts of three right mandibles, left tibia, right astragalus. Bed 3: Locality 3a, six left and four right I^1, left and right I_1, four left and one right P^1, six upper molars, eight lower molars, parts of four left humeri, part of a left mandible, a right maxilla, left astragalus, and right ulna.

Although *S. palustris* and *S. floridanus* may be separated on the basis of characters delineated by Holman (1959), none of the above

specimens possessed the parts necessary for their specific determination. Many and possibly most of the above represent *Sylvilagus palustris*.

Order Rodentia

Family Sciuridae

Sciurus carolinensis Gmelin

Bed 2: Locality 3a, right and left I^1, left M_1, left M^2. **Bed 3:** Locality 3a, two right and one left I^1, right M^1.

Not previously found at Vero.

Family Geomyidae

Geomys pinetis Rafinesque

Bed 2: Locality 3a, numerous teeth, one left and two right humeri, two left ulnae. Bed 3: Locality 3a, numerous teeth two left and two right humeri, two left and one right ulnae, two left femora, one left and one right innominate, two left and two right mandibles.

Not found before at Vero, but Gazin (1950) states this is the second most abundant species at Melbourne.

Family Cricetidae

Oryzomys palustris (Harlan)

Bed 2: Locality 3, one left and two right mandibles; Locality 3a, numerous teeth, left and right humeri, two right maxillae. Bed 3: Locality 3a, numerous teeth, two left mandibles, right maxilla, three right humeri, one left femur, two left tibiae.

Until the present study, *Oryzomys* has been found only in bed 3.

cf. *Reithrodontomys humulis* (Audubon and Bachman)

Bed 2: Locality 3a, left I^1.

Simpson (1930) reported *Reithrodontomys humulis* from bed 2 at Vero, but Bader (1959), on re-examination of the jaw, referred it to *Peromyscus polionotus*. This placed *Reithrodontomys* among the few living mammalian species of Florida which have not been found fossil. There is a possibility that the above mentioned incisor represents *Zapus*, however, incisors of these two genera are distinguishable and the bed 2 incisor corresponds exactly with those of modern *R. humulis.*

Peromyscus polionotus (Wagner)

Bed 2: Locality 3, right mandible; Locality 3a, left mandible.

Peromyscus gossypinus (Le Conte)

Bed 2: Locality 3a, right mandible. Bed 3: Locality 3a, right mandible. Several other specifically indeterminate elements of *Peromyscus* were recovered from beds 2 and 3.

Sigmodon hispidus Say and Ord

Bed 2: Locality 3a. Bed 3: Locality 3a, numerous teeth, mandibles, and postcranial elements.

Sigmodon hispidus is one of the more common species in beds 2 and 3. Sellards (1916) recorded several teeth from bed 2 and a number of teeth and jaws from bed 3.

Neotoma floridana (Ord)

Bed 2: Locality 3a, numerous teeth, one left mandible. Bed 3: Locality 3a, numerous teeth, one left mandible, one left maxilla.

Sellards (1916) listed a mandible from bed 3.

Synaptomys australis Simpson

Bed 2: Locality 3a, right M^1, right M_1.

This species, first described from Saber-Tooth Cave by Simpson (1928), has been found in the Pleistocene of Arredondo, Reddick, and Melbourne (Bader, 1957; Brodkorb, 1957; Ray, 1958). It has not been previously reported from Vero.

Neofiber alleni True

Bed 2: Locality 3a, numerous teeth, mandibles, and postcranial elements. Bed 3: Locality 3a, numerous teeth, mandibles, and postcranial elements.

Heretofore *Neofiber* was represented in bed 3 by a number of jaws and parts of skulls and in bed 2 by a few teeth (Sellards, 1916).

Pitymys pinetorum (Le Conte)

Bed 2: Locality 3a, left mandible, right and left M^1, one right and seven left M_1. Bed 3: Locality 3a, two right M_1.

In size, these specimens correspond most closely with Recent material of *P. pinetorum* from Illinois and are slightly larger than the Florida form, *Pitymys parvulus.* The present known range of the genus does not extend as far south as Vero. Not previously recorded from Vero.

Hydrochoerus sp.

Sellards (1916) records the presence of cheek teeth of a capybara, not found in place but attributed to bed 2, and assigned to the genus *Hydrochoerus.* Two species of capybara occur in the Florida Pleistocene (Simpson, 1928, 1930).

Order Cetacea

Suborder Odontoceti

A large and small tooth, representing two different species of toothed whale, were taken from the very bottom of bed 2 at Locality 7. The material is too meagre to permit further classification. These are the first cetacean specimens from Vero.

Order Carnivora

Family Canidae

Canis cf. *Canis niger* Bartram

Bed 2: Locality 3a, left P^1, Bed unknown: Locality 1, anterior half of a left P^4.

Once found in peninsular Florida, *C. niger* has become extinct here in Recent times. The difficulty in separating *C. niger* and *C. lupus* was discussed by Ray (1958). The material represented here is too meagre to permit positive identification.

Canis ayersi Sellards

Bed 2: Locality 3a, left and right C_1, right I^3, and a piece of premaxilla. Bed 2: Locality 3, right I^3, right C_1, left M^1, left P^2, left femur.

The type skull, FGS 7166, was collected by Frank Ayers and Isaac Weills from bed 2 in the south bank of the drainage canal 100 feet west of the Florida East Coast Railroad bridge. In addition to the skull, paratypes left premaxillary FGS 4389, left upper carnassial FGS 5146, canine FGS 4410, left tibia FGS 5912, left femur FGS 5449, right ulna FGS 5451, and right scapula FGS 5182, were also found (Sellards, 1916).

Canis latrans Say

Sellards (1916) referred a part of a right maxilla with P^4 (FGS 7036) to *C. latrans*. The specimen later became the type of *Canis riviveronis* Hay (1917a). It was found in bed 3 in the north bank of the canal, opposite the original site. The type locality was disturbed by Recent stream action of the north tributary, and the specimen could have been derived from bed 2. Hay (op. cit.) named this species after comparison with four Recent specimens of *C. latrans*. The differences are not striking and Ray has justifiably synonomized it with *C. latrans*.

Vulpes palmaria Hay

Sellards (1916) referred a part of a right dentary, including the P_3 and P_4, from bed 3 to *Vulpes pennsylvanicus (Vulpes fulva)*. This specimen later became the type of *Vulpes palmaria* Hay (1917a). Comparison of the description of the fossil with 13 Recent specimens of *Vulpes fulva* bears out Hay's description, however, the differences between the two are not striking. As suggested by Ray (1958) the Vero specimen may merely represent a larger Pleistocene subspecies of *V. fulva*. The type may have been derived from bed 2.

Urocyon cinereoargenteus (Schreber)

Bed 2: Locality 3a, left M_2.

Not previously found at Vero.

Family Ursidae

Ursus americanus Pallus

Bed 2: Locality 7, left M^3, right P^4.

In the original collections made at Vero, *Ursus americanus* was represented in bed 3 only.

Family Procyonidae

Procyon lotor (Linnaeus)

Bed 2: Locality 7, left P_4, right M_1; Locality 3a, left M_1, left P^3. Bed 3: Locality 5, right P_4.

Sellards (1916) lists this species from beds 2 and 3.

Family Mustelidae

Spilogale ambarvalis Bangs

Bed 2: Locality 3a, right C^1. Bed 3: Locality 3a, left M^3, right P^3; Locality 5, left mandible.

Not previously found at Vero.

Lutra canadensis (Schreber)

Bed 2: Locality 3a, right I^3, left C_1, right P^1, left P_2, left and right P_3, left M_1; Locality 3, left P^4, right mandible with P_3 and M_1. Bed 3: Locality 3a, right I^1, right I^2, left P^4, left mandible without teeth.

Recorded from beds 2 and 3 by Sellards (1916).

Family Felidae

Panthera augusta (Leidy)

While visiting Vero in October, 1917, Hay (1919) collected a left P^4 of a cat from bed 2, which he described as a new species, *Felis veronis*. This has been synonomized with *Panthera augusta* by McCrady, Kirby-Smith, and Templeton (1951).

Smilodon sp.

Sellards (1916) referred a canine and upper carnassial from bed 2 to the genus *Smilodon*. Hay (1919) examined the carnassial and made the specific determination *Trucifelis floridanus* (Leidy). *Trucifelis* is now a synonym of *Smilodon* (Simpson, 1945) and it seems best to leave the Vero specimens as *Smilodon* sp. until additional material is available for study.

Lynx rufus (Schreber)

Bed 2: FGS V1878 distal end of a left radius; Locality 3a, anterior part of P^2.

The radius had been tentatively identified as a bird bone and although slightly smaller than typical *L. rufus*, it does not differ from corresponding Recent specimens. Simpson (1929a) mentions a small *Lynx* from Seminole Field which is not morphologically different from *L. rufus*. Hay (1917a) listed *Lynx rufus* from bed 3 on a left mandible and right tibia.

Order Proboscidea

Family Mammutidae

Mammut sp. (= Mastodon)

Bed 2: Locality 2, left M_3.

Partial teeth have been found throughout bed 2 at Locality 3a. Sellards (1916) described *Mammut* from bed 2 on a lower jaw, teeth, and parts of the skull. Specimens of this species and other extinct forms previously attributed to bed 3 were derived from bed 2.

Family Elephantidae

Mammuthus sp.

Bed 2: Locality 3, two upper and one lower molar.

The three molars and fragments of limb bones were found together and probably represent a single individual.

Sellards (1916) records this as a common species in bed 2. The records from bed 3 based on tooth fragments (Hay, 1917a) are accidental to this horizon.

Order Perissodactyla

Family Equidae

Equus sp.

Bed 2: Locality 3, left M_1, right M^2, right M^3; Locality 2, left femur; Locality 7, right femur.

Although Hay (1923) lists three species of *Equus* from bed 2, the present status of Pleistocene horses is too confused to permit specific determinations of these few specimens.

Family Tapiridae

Tapirus veroensis Sellards

Bed 2: Locality 3, left M_2, deciduous right P^3; Locality 7, deciduous right P^2, right M^1, right P_4.

In Sellards' original list (1916) of mammals from bed 2, several detached teeth and parts of two lower jaws were referred to *Tapirus haysii*. Later, Sellards (1918) described a new species of tapir, *Tapirus veroensis*, from bed 2 at Vero, and this is probably the only species which occurs in Florida (Bader, 1957).

Order Artiodactyla

Family Tayassuidae

Mylohyus sp.

Bed 2: Locality 7, unworn left P_4, unworn left M_1, worn left P_4, worn left M_1.

Hay (1917a, 1923) referred several peccary teeth from beds 2 and 3 to *Mylohyus lenis*. The above specimens may represent *Mylohyus gidleyi* Simpson.

Family Camelidae

Tanupolama cf. *Tanupolama mirifica* Simpson

Bed 2: Locality 3, fragmental upper molar, left calcaneum, left astragalus.

The indeterminable camelid remains mentioned by Sellards (1916) probably belong to the above species.

Family Cervidae

Odocoileus virginianus (Zimmerman)

Bed 2: Locality 3a, two left I_2, right P^1, pieces of antler. Bed 3: Locality 3a, two left P^1, right P^1, two left P^2, right P^2, left P^3, right P_1, right P_3, left M^1, right M^1, pieces of antler.

Hay (1917a, p. 50) described a new species of deer, *Odocoileus sellardsiae* from bed 3, the type being a 5th cervical vertebra (FGS 7923). In view of the fact that no other extinct forms belong to bed 3 and no additional *Odocoileus* material has proved to be distinct from *O. virginianus*, it is likely that *O. sellardsiae* is merely a variant of the latter species. Joseph T. Gregory informed Rouse (1951) that Hay's description of *O. sellardsiae* was unconvincing. Ray (1958) agrees with this view.

Family Bovidae

Bison sp.

Bed 2: Locality 7, right P_3; Locality 3a, left P_2, right P_4, right M_2.

The upper premolar, attributed to bed 3 by Hay (1917a), was found at the original site and undoubtedly has been reworked from the underlying bed 2.

PALEOECOLOGY

Since the deposit is of relatively Recent origin, the present physiographic features at Vero were probably about the same during deposition as they are now, although there were undoubtedly changes in the height of the water table, reflecting fluctuations in sea level. In evaluating the paleoecology, therefore, some use can be made of the habitats available in the immediate vicinity of the deposit at the time the drainage canal was dug. The area is now practically devoid of native vegetation, but fortunately Sellards (1917a) gives a brief description of the site as it was at the time the canal was dug. The inlet or basin, cut by the Silver Bluff sea, is surrounded on the north, south, and west by the beach ridge which runs parallel with the Florida East Coast Railroad. The drainage is, therefore, from the higher ground of shoreline origin and the flatwood to the west, into the basin.

The beach ridge supported a growth of spruce pine (*Pinus clausa*) and evergreen shrubs (Sellards, 1917a). The area to the west of the ridge, drained by the two tributary streams, was flatwood consisting of a scattered growth of longleaf pine (*Pinus palustris*) with an undergrowth of saw palmetto (*Serenoa repens*). The basin area itself was a hammock of deciduous hardwood and cabbage palm (*Sabal palmetto*). The results of a study of fossil plants made by Berry (1917) are summarized in table 4. All of the plants, except *Benzoin* and *Zizyphus* are found in peninsular Florida at present. The presence of *Taxodium* indicates that the area contained a cypress pond, at least during the period bed 3 was deposited. Three of the plants, *Pistia*, *Anona*, and *Brasenia*, are obligate pond forms. *Pistia* was recorded on the basis of a leaf. It is doubtful that a leaf from an aquatic plant could be transported far without its identifiable characteristics being altered. A number

Table 4. Habitat of Fossil Plants from Bed 3 at Vero

Species	Principal habitat
Pinus taeda	Mesic situations
Pinus caribaea	Flatwoods
Taxodium distichum	Fresh water shores or swamps
Carex sp.	Widespread
Pistia spathulata	Free floating in still water
Serenoa serrulata	Unflooded soil
Sabal palmetto	Widespread
Cerothamnus ceriferus	Mesic or hydric woods
Leitneria floridana	Swamps
Quercus virginiana	Xeric to mesic hammock
Quercus laurifolia	Mesic hammock (also in bed 2)
Quercus cinerea	Sandhills
Quercus chapmani	Scrubby flatwoods and scrub
Polygonum sp.	Swamp and marshes (emergent)
Magnolia virginia	Bayheads, swamps
Anona glabra	Pond margins, swamps
Brasenia purpurea	Ponds
Ilex glabra	Mesic hammock
Acer rubrum	Swamp
Zizyphus sp.	?
Vitis rotundifolia	Widespread
Benzoin cf. *B. melissaefolium*	Swamps, pond margins
Viburnum nudum	Swamps
Xanthium sp.	Waste places

of the other plants have aquatic tendencies and the remainder can be accounted for by the habitats existing before the canal was dug. On the basis of the fossil plants, bed 3 must have been pond-marsh habitat, developing into a hammock as the basin became filled.

The habitat areas should be reflected in the fauna. Sellards (1916) listed 29 species of fresh water and land invertebrates from bed 2. Marshy conditions for bed 2 are indicated also by the three species of *Paratettix* collected from the base of bed 2 during the present study. These grasshoppers, of which one form is no longer found in Florida, often gather in marshy or moist places. The principal habitats of the vertebrates and of the insects collected by the author and those studied by Wickham (1919) are given in table 5.

Of the vertebrates from bed 2, 53 percent of the reptiles and amphibians are fresh water aquatic forms while 42 percent of the birds are found in fresh water habitats and of the mammals whose habitat is known, 58 percent are fresh water or swamp forms. In bed 3, 50 percent of the reptiles and amphibians, 59 percent of the birds, and 28 percent of the

Table 5. Habitat and Abundance of Insects and Vertebrates at Vero

Species	Bed 2	Bed 3	Habitat
CLASS INSECTA			
Order Orthoptera			
Paratettix rugosus	common		marsh
Paratettix mexicanus	rare		marsh
Paratettix toltecus	rare		marsh
Anisomorpha buprestoides	rare		widespread
Order Homoptera			
Cicadid		rare	widespread
Order Hymenoptera			
Halictus ligatus	rare		widespread
Cerceria sp.	rare		widespread
Order Coleoptera			
Galerucella notulata	rare		widespread
Griburius larvatus	rare		widespread
Cryptocephalus sp.	rare		widespread
Rhynchophorus cruentatus	rare		*Sabal palmetto*
Order Hemiptera			
Podisus cf. *P. sagitta*	rare		widespread
Camirus cf. *C. porosus*		rare	widespread
CLASS CHONDRICHTHYES			
Order Batoidei			
Aetobatis narinari	adventitious		marine
CLASS OSTEICHTHYES			
Order Ginglymodi			
Lepisosteus platyrhincus		rare	fresh water
Order Protospondyli			
Amia calva		rare	fresh water
Order Percomorphi			
Caranx hippos		adventitious	marine
CLASS AMPHIBIA			
Order Urodela			
Ambystoma sp.	rare		?

Table 5. (Continued)

Species	Bed 2	Bed 3	Habitat
Amphiuma means	abundant	abundant	fresh water
Siren lacertina	abundant	abundant	fresh water
Order Anura			
Scaphiopus holbrookii	rare	rare	hammock
Bufo sp.	rare	rare	open woods
Rana cf. *R. pipiens*	abundant	abundant	fresh water
Rana cf. *R. catesbeiana*	abundant	abundant	fresh water
CLASS REPTILIA			
Order Chelonia			
Chelydra serpentina	rare		fresh water
Kinosternon bauri	common	common	fresh water
Kinosternon subrubrum	common	common	fresh water
Sternotherus odoratus	common	rare	fresh water
Sternotherus minor	rare		fresh water
Terrapene carolina	common	common	woodland
Pseudemys scripta	common		fresh water
Pseudemys cf. *P. floridana*	rare		fresh water
Geochelone sellardsi	rare		?
Gopherus polyphemus	rare		high pine, dunes
Chelonia mydas		adventitious	marine
Caretta caretta		adventitious	marine
Order Crocodilia			
Alligator mississippiensis	common	common	fresh water
Order Squamata			
Anolis carolinensis	rare	common	arboreal
Sceloperus undulatus		rare	open woods
Ophisaurus compressus	rare	rare	costal dunes, flatwoods
Eumeces sp.		rare	open woods
Natrix taxispilota	common		fresh water
Natrix sipedon	common	common	fresh water
Thamnophis sp.	common	common	near water
Farancia abacura	abundant	abundant	marsh
Coluber or *Masticophis*	common	common	widespread
Drymarchon corais	common	common	hammock
Pituophis melanoleucus		rare	high pine
Lampropeltis getulus		rare	hammock near water

Table 5. (Continued)

Species	Bed 2	Bed 3	Habitat
Micrurus fulvius	rare		hammock, woodland
Crotalus adamanteus	common	common	prairie
CLASS AVES			
Order Podicipediformes			
Podilymbus podiceps	rare		ponds, lakes
Order Pelecaniformes			
Phalacrocorax auritus	rare		marsh, swamp, lake
Order Ciconiiformes			
Ardea herodias		rare	aquatic
Casmerodius albus		rare	aquatic
Florida thula		rare	aquatic
Butorides virescens		rare	aquatic
Nyctanassa violacea		rare	aquatic
Botaurus lentiginosus	rare		marsh
Ciconia maltha	rare		?
Order Anseriformes			
Anas fulvigula		rare	ponds, marsh
Aix sponsa		rare	wooded swamp
Aythya sp.		rare	aquatic
Lophodytes cucullatus	rare	rare	wooded ponds
Order Falconiformes			
Cathartes aura	rare	rare	widespread
Coragyps atratus		rare	widespread
Buteo jamaicensis		rare	widespread
Falco sparverius		rare	woods
Order Galliformes			
Colinus virginianus	rare	rare	woods, prairie
Meleagris gallopavo		rare	hammock
Order Gruiformes			
Rallus cf. *R. elegans*		rare	marsh
Rallus limicola		rare	marsh
Porzana carolina		rare	marsh

Table 5. (Continued)

Species	Bed 2	Bed 3	Habitat
Order Columbiformes			
Ectopistes migratorius		rare	woods
Order Strigiformes			
Tyto alba		rare	hammock, prairie
Otus asio		rare	woods
Strix varia	rare	rare	woods
Order Piciformes			
Colaptes cf. *C. auratus*		rare	woods
Centurus cf. *C. carolinus*	rare		woods
Sphyrapicus varius		rare	woods
Order Passeriformes			
Cyanocitta cristata		rare	woods
Turdus migratorius	rare		woods
cf. *Vermivora* sp.	rare		woods
cf. *Geothlypis* sp.		rare	marsh, thickets
Agelaius phoeniceus		rare	marsh
Quiscalus quiscula	rare		pond border, streams
Cassidix mexicanus		rare	marsh
Pipilo erythrophthalmus		rare	thickets
CLASS MAMMALIA			
Order Marsupialia			
Didelphis marsupialis	rare	rare	woods, swamp
Order Insectivora			
Blarina brevicauda	abundant	abundant	damp woods
Cryptotis parva	common	common	damp woods
Scalopus aquaticus	abundant	abundant	woods, meadow
Order Chiroptera			
Myotis sp.		rare	widespread
Eptesicus sp.	rare		widespread
Lasiurus sp.		rare	widespread
Order Primates			
Homo sapiens	rare	rare	widespread

Table 5. (Continued)

Species	Bed 2	Bed 3	Habitat
Order Edentata			
Paramylodon harlani	rare		?
Megalonyx jeffersonii	rare		?
Dasypus bellus	rare		?
Holmesina septentrionalis	rare		?
Order Lagomorpha			
Sylvilagus palustris	common	common	swampy woods, thickets
Order Rodentia			
Sciurus carolinensis	rare	rare	arboreal
Geomys pinetis	common	common	open pine woods
Oryzomys palustris	common	common	marsh
cf. *Reithrodontomys humulis*	rare		bottomland, thickets
Peromyscus polionotus	rare		beach, sandy fields
Peromyscus gossypinus	rare	rare	hammock, swamp
Sigmodon hispidus	abundant	abundant	woods, swamp
Neotoma floridana	common	rare	swamp, hammock
Synaptomys australis	rare		?
Neofiber alleni	abundant	abundant	ponds, marsh
Pitymys pinetorum	common	rare	mesic hammock
Hydrochoerus sp.	rare		fresh water
Order Cetacea			
Odontoceti species 1	adventitious		marine
Odontoceti species 2	adventitious		marine
Order Carnivora			
Canis cf. *C. niger*	rare		widespread
Canis ayersi	rare		widespread
Canis latrans		rare	widespread
Vulpes palmaria	?	rare	?
Urocyon cinereoargenteus	rare		swamp, woods
Ursus americanus	rare		swamps
Procyon lotor	rare		swamps
Spilogale ambarvalis	rare	rare	fields, hammock
Lutra canadensis	rare	rare	lakes, marsh
Panthera augusta	rare		?

Table 5. (Continued)

Species	Bed 2	Bed 3	Habitat
Smilodon sp.	rare		?
Lynx rufus	rare		?
Odor Proboscidea			
Mammut sp.	rare		(marsh, meadows?)
Mammuthus sp.	rare		?
Order Perissodactyla			
Equus sp.	rare		?
Tapirus veroensis	rare		?
Order Artiodactyla			
Mylohyus sp.	rare		?
Tanupolama cf. *T. mirifica*	rare		?
Odocoileus virginianus	rare	rare	woods, swamp
Bison sp.	rare		?

mammals are fresh water forms. The two most abundant salamanders from beds 2 and 3, *Amphiuma* and *Siren*, are animals which require fresh water, as is also the *Alligator* found in both beds. One of the most abundant mammals in beds 2 and 3, both in regard to the number of individuals and specimens collected, is *Neofiber alleni*, which is restricted to aquatic habitats. *Sigmodon*, *Scalopus*, and *Blarina*, which live in moist situations, are also very numerous in both beds. The presence of *Lutra* and *Synaptomys* further indicate an aquatic environment. The proximal habitat, or that in which the remains are deposited, should be represented by the largest number of individuals and species. The fauna supports this supposition.

Ophisaurus compressus, which inhabits coastal dunes and islands, must have lived along the beach ridge, while *Bufo*, *Sceloperus*, *Terrapene*, *Eumeces*, *Gopherus*, and *Pituophis*, lived in the flatwoods to the west. Bats flew over the pond and marsh in search of insects while hawks and owls were attracted by the abundance of small mammals in and about the marsh. The wood duck (*Aix sponsa*) and hooded merganser (*Lophodytes cucullatus*) found refuge in the cypress swamps. Such a fauna, abundant in small mammals, attracted the predatory bear, dire wolf, fox, skunk, wildcat, saber-tooth, and jaguar. A variety of habitats have contributed to the fossil fauna in proportion to their proximity to the site of deposition. This variety of habitat is reflected in the large fossil fauna at Vero.

BIOGEOGRAPHY

Many of the extinct animals from Vero have living representatives in other parts of the world. The edentates, *Paramylodon, Dasypus, Holmesina*, and *Megalonyx*, and the capybara, *Hydrochoerus*, have neotropical affinities and migrated into North America during the late Pliocene or early Pleistocene. Living species of *Hydrochoerus* occur in South America. Apparently *Dasypus bellus* differed little except in size from the extant *D. novemcinctus* found in Texas and recently introduced into Florida. It appears in the Pleistocene of Oklahoma and Missouri (Taylor and Hibbards, 1955).

Mammut, Mammuthus, and *Bison* were Eurasian immigrants and were common in the Pleistocene of North America. According to Simpson (1930) the Florida *Bison* was probably *Bison latifrons*. This species had a wide distribution in the Pleistocene, ranging from California to Florida (Hibbard, 1955).

Equus, Tapirus, Mylohyus, Tanupolama, and the carnivores originated in North America. *Equus* became extinct in North America at the end of the Pleistocene but has living representatives in Europe, Asia, and Africa. Tapirs are now found only in the Oriental and neotropical regions. Peccaries occur today in southwestern United States and the neotropical region. Camels are restricted to the Andes, northern Asia, and the Sahara. *Canis niger* is at present only found in Texas and Oklahoma. A close relative of *Canis ayersi, Canis dirus*, was widely distributed in North America during the Pleistocene. *Vulpes* does not occur in Florida at present but living species are found in the north and west. *Panthera augusta* occurs widely in the Pleistocene of North America, where it subsequently became extinct. Closely related species are common in Mexico and Central and South America.

Ciconia maltha had a wide distribution in the late Pleistocene, occurring in Idaho, California, Florida, and Cuba (Wetmore, 1956; Brodkorb, 1958). Living species of *Ciconia* now occur in Europe, Asia, and Africa.

Modern relatives of the giant tortoise, *Geochelone sellardsi*, now inhabit the Mascarene and Galapagos Islands. *Terrapene carolina* occurs in the Pleistocene of Florida and Texas.

Of particular interest are the three species of grasshoppers found at the very bottom of bed 2, with undisturbed bed 3 above. Dr. T. H. Hubbell, who identified the orthopterans, has sent notes on the ranges of these forms. *Paratettix rugosus* is restricted to peninsular Florida and southern coastal Georgia. The range of *P. mexicanus* extends from Florida along the Gulf States to California and from Mexico through Central America. *P. toltecus* is restricted to the coastal plain of Texas and eastern Mexico. This latter species is extinct in Florida although it was present here during early bed 2 time.

The only North American relative of the extinct plant, *Zizyphus*, found at Vero, now occurs from Texas to Arizona.

It thus appears that many of the immigrants from South America may have entered the United States by way of Texas and spread eastward across the gulf to Florida.

In the fossil deposits at Vero there occur only four species which may be considered survivors of glacial maxima. These are the spicebush (*Benzoin*), the pond turtle (*Pseudemys scripta*), the pine mouse (*Pitymys pinetorum*), and the bog lemming (*Synaptomys*). The present southern limits of these forms lie to the north of Vero, namely: 200 miles for *P. scripta*, 250 miles for *P. pinetorum*, 350 miles for *Benzoin*, and 700 miles for the genus *Synaptomys*.

The presence of *Synaptomys australis* in Florida is interesting. Its modern relatives are found no farther south than Tennessee and North Carolina. It was present in the Sangamon interglacial fauna of Kansas (Hibbard, 1955) and had reached Florida even earlier, during the Illinoian glacial stage (Bader, 1957; Brodkorb, 1957; Olsen, 1958). The presence of this species in Kansas during an interglacial stage and its arrival in Florida during a glacial stage suggests that the modified climate of a glacial advance regulated the distributional pattern of *Synaptomys*. The rare occurrence of *Synaptomys* in bed 2, its absence from bed 3, and the relatively Recent age of the deposit suggest the last stages of extinction of a formerly widespread species.

The fossil assemblages of four Florida localities, because of their similarity and completeness, have been termed test faunas by Simpson

(1929b). They are: Seminole Field, Saber-Tooth Cave, Melbourne, and Vero. With a few exceptions their faunas are remarkably alike. Most of the species are still present in Florida or had warm climate preferences. Vero and Melbourne are unique in that at both localities man and extinct Pleistocene forms have been found in association. These faunas may best be compared by considering their differences. At Melbourne, the only form having boreal affinities is an unidentifiable species of elk (*Cervus*). The extinct stork, *Ciconia maltha*, is the only extinct bird from Melbourne and Vero, and among the four localities it is absent only from Saber-Tooth Cave. The porcupine, *Erithizon dorsatum*, found only at Seminole Field, is a northern species. The genus *Thomomys*, peculiar to the Saber-Tooth Cave deposits, occurs only in the west at present. Several birds found only at Seminole Field have southern or western affinities. *Gymnogyps* is now restricted to California, and both it and the extinct *Teratornis merriami* occur fossil in Florida and California. The neotropical genus *Aramides* is recorded only from Seminole Field. Each of these test faunas, then, is composed largely of warm climate animals and each possesses one or two characteristically cool climate elements. The similarity of these test faunas is indicative of their contemporaneity; the few cool climate elements were probably remnants of earlier glacial stage faunas.

There has been a feeling among some that the extinction of Pleistocene forms was accelerated by the presence of man. In this regard it is interesting that man was present at Vero and Melbourne during the final stages of extinction of typically Pleistocene animals. With the exception of *Synaptomys*, all of the extinct forms at Vero were large and as such would have been easy targets for predation by man.

Only a remnant of the once rich fauna of Vero remains today, and the present fauna has not been augmented by additions from other major geographic areas. Of the mammals from bed 2, 40 percent are extinct, yet 82 percent of the nonflying mammals living in the area today are represented by fossils in bed 2. The other vertebrate classes have suffered less severely. Only 3 percent of the reptiles and amphibians (*Geochelone sellardsi*) and 8 percent of the birds (*Ciconia maltha*) from bed 2 are extinct. With the exception of the recently exterminated passenger pigeon (*Ectopistes migratorius*) and Florida wolf (*Canis niger*) no extinct species appear in bed 3, since *Vulpes palmaria*, if a valid species, probably belongs to bed 2.

Osteologically, the Recent fauna differs in no way from its fossil ancestry. Thus the characteristic difference between the fossil and modern fauna is the marked extinction of mammals which occurred during bed 2 time.

SUMMARY

Three distinct fossil-bearing beds occur at Vero. The lowest and oldest is a marine shell marl (bed 1) of Sangamon Age and contains no fresh water or terrestrial vertebrates. Upon this rests bed 2, a bed of organically stained sands containing vertebrate fossils. The youngest and uppermost bed, bed 3, is composed of loose sands, muck, and vertebrate remains and is separated from bed 2 by a distinct erosional unconformity. Extinct Pleistocene forms are confined to bed 2, in contrast to the findings of earlier workers. Bed 2 was deposited in a shallow, saucer-shaped, fresh water basin.

The Pamlico terrace surrounds the basin. A large portion of the terrace consists of well indurated organic hardpan, lumps of which have been found near the contact of beds 1 and 2. This demonstrates an age younger than Pamlico for the bone beds. The basin was scoured out by tidal action of the Silver Bluff sea, whose rise is attributed to the effects of a warm period which occurred about 45,000 years before present. A radiocarbon date for the base of bed 2 indicates that deposition began somethin over 30,000 years before present; thus bed 2 is Wisconsin in age.

The vertebrate fauna consists of 122 species, including 4 species of fishes, 7 species of amphibians, 27 species of reptiles, 37 species of birds, and 47 species of mammals. Of these, 4 species of amphibians, 11 species of reptiles, 29 species of birds, and 14 species of mammals have not been previously recorded from Vero.

Of the 17 species and subspecies which were described as new from Vero, only 3 are now considered valid, namely: *Geochelone sellardsi*, *Canis ayersi*, and *Tapirus veroensis*. The following are now considered synonyms or *species inquirendae*: *Chelydra laticarinata*, *Chelydra sculpta*, *Terrapene innoxia*, *Terrapene antipex*, *Pseudemys floridana persimilis*, *Testudo luciae*, *Gopherus praecedens*, *Ardea sellardsi*, *Jabiru weillsi*, *Querquedula floridana*, *Larus vero*, *Canis riviveronis*, *Vulpes palmaria*, and *Odocoileus sellardsiae*.

The vertebrate fauna of the bone beds is composed principally of fresh water species, supporting the conclusion arrived at from geological evidence that the deposit was formed in a shallow, fresh water

pond or marsh. Species from other habitats contributed to the fossil assemblage in proportion to their proximity to the site of deposition.

Marked similarities occur in the fossil plants and animals of Vero and those of Texas and the southwest. An extinct plant of the genus *Zizyphus* is now represented in North America by a single species occurring from Texas to Arizona. Although the grasshopper, *Paratettix toltecus*, is extinct in Florida, this species still lives in the coastal plain of Texas and eastern Mexico. *Canis niger*, now extinct in Florida, survives in Texas and Oklahoma. *Dasypus bellus* differs little from the smaller *D. novemcinctus*, currently found in Texas and adjacent states.

It is probable that Vero man and the extinct Pleistocene vertebrates were contemporaneous. Thus the possibility that man may have contributed to the extinction of larger forms in late Pleistocene or sub-Recent times is not precluded.

Comparison of the late Pleistocene Vero fauna with three other test faunas of Simpson, namely, Seminole Field, Melbourne, and Saber-Tooth Cave, demonstrates that they all have a large number of warm climate species in common, showing a southwestern influence. Each contains one or two cool climate elements, possibly relicts of earlier glacial stage faunas.

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