FOSSIL VERTEBRATES FROM PLEISTOCENE TERRESTRIAL DEPOSITS ON THE NORTHERN CHANNEL ISLANDS, SOUTHERN CALIFORNIA

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ABSTRACT

The record of Pleistocene fossil vertebrates from terrestrial deposits on the northern Channel Islands, southern California, is reviewed. Most material is from Santa Rosa and San Miguel Islands. The Santa Rosa material is found in sediments deposited by stream flow toward the northwest margin of the island and consists of numerous mammoth remains, rodents, and a few birds, mostly species to be expected inland on the island. The San Miguel material is found in deposits of wind-blown sand along the north coast of the island and consists of numerous remains of seabirds which once nested on San Miguel and the remains of the prey of nesting and roosting raptors. One rodent from the deposits on San Miguel island, *Microtus miguelensis*, is described as a new species. Both types of deposits provide information not only about the past fauna of the islands but also about the islands' geologic history during the past 40,000 years. A small deposit on Anacapa Island contains a primitive fauna and is probably older than previously suspected.

INTRODUCTION

Twenty years ago, our knowledge of the fossil terrestrial vertebrates from the northern Channel Islands of southern California was based almost entirely on material from two major areas, one on Santa Rosa Island and the second on Anacapa Island. The most important of these areas, extending along the northwest coast of Santa Rosa Island, was collected briefly by Chester Stock in 1928 and more extensively by Philip Orr between 1947 and 1968 in conjunction with his archaeological surveys on the island (Orr, 1968). Most prominent among the fossils from these deposits are the remains of elephants, including both an extinct dwarf mammoth (*Mammuthus exilis*; Stock and Furlong, 1928) and a few bones of the Columbian mammoth (*Mammuthus columbi*; Madden, 1981), and these early collecting efforts were centered on recovery of material of these species.

Among non-mammoth material collected were the remains of an extinct "giant" mouse, described as *Peromyscus nesodytes* by Wilson (1936), and several bones assignable to birds that were studied by Hildegard Howard (Orr, 1968). Most of the bird bones assignable to living species were from water birds and raptors, but Howard also identified an extinct owl (*Asio priscus*), an extinct caracara (*Caracara prelutosa*), an extinct gannet (*Morus reyanus*), and an extinct flightless goose (*Chendytes lawi*). A single skull of the extant island fox (*Urocyon littoralis*) was also found. Most of the recovered material came from deposits dated as 12,000 - 37,000 BP (before present), but some material came from deposits thought to date as early as 200,000 BP (Orr, 1968).

The second area from which material had been recovered was at Frenchy's Cove on the eastern end of West Anacapa Island. This deposit was collected in 1960 (Miller et al., 1961) and its geology described by Lipps (1964). The deposit yielded numerous bones of *Chendytes lawi* and the bones of a new species of rodent, described as *Peromyscus anyapahensis* (White, 1966). In subsequent years this locality was used as a site for the construction of a building by the National Park Service. When I visited the site in 1985 the structure had been removed but almost no fossiliferous sediments remained. The deposit was thought to date from about 37,000 BP (Lipps, 1964).

RECENT WORK

During the last 20 years, our knowledge of the ancient faunas of the northern Channel Islands has increased greatly with the exploration of two types of deposits on San Miguel Island. The first of these, Daisy Cave, is a cliff shelter on the eastern end of the island, originally excavated by Charles Rozaire between 1964 and 1968 and from which column samples were subsequently taken by Pandora Snethkamp in 1985 and by Jon Erlandson between 1992 and 1996 (see Erlandson et al.,1996 for a chronology of this deposit). Cultural material from the cave was originally thought to extend back no more than 5,000 BP (Glassow, 1980), but new work on the cave has ex-

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tended the period of human occupancy to at least 11,700 ± 70 BP (Erlandson et al., 1996).

In addition to the faunal remains at this site accumulated through human activities, the cave was a roosting site for barn owls during periods of human absence and contains a large sample of their prey items. Notable among these are numerous remains of the giant mouse, *Peromyscus nesodytes*. This species disappears from the deposit at approximately 8,000 BP and is replaced by the extant *P. maniculatus*, which probably was accidentally brought to the island by humans (Guthrie, 1993). Although the single jaw of ornate shrew (*Sorex ornatus*) recovered by Rozaire's excavations was originally thought to have been brought to the island from the mainland by an owl (Walker, 1980), more recent collecting has indicated that this species is common throughout the midden, especially toward the top. The shrew may not have died out on San Miguel until historic times.

Remains of an extinct vampire bat, *Desmodus stocki*, were also recovered from this site, but only in the sterile layers below human occupancy, which are dated to 13,030 ± 135 BP (Erlandson, 1996). This species was previously known only from older mainland sites in northern California and Mexico (Guthrie, 1980). The avifauna from Daisy cave deposits is extensive, including both larger species probably used by humans and smaller species that served as prey for barn owls (Table 1).

The second source of information about past life on San Miguel comes from extensive collecting during the last 15 years in the unconsolidated sediments deposited along the north coast of the island (Guthrie, 1992, 1993). These deposits had two sources. One is sand blown up from the beaches along the north coast of the island. The other is soils on the island washed down towards the coast during rains. The mixture of these two types of sediments fills a wave-cut bench along the north coast of the island and was deposited on a slope rather than horizontally. Dating of the older layers of these sediments has proven difficult as most bone within the sediment has had all organic material leached away. However, dates obtained are mostly either around 12,000 BP or about 30,000 to 35,000 BP (Guthrie, 1993). It is believed that at these two periods the shoreline of San Miguel was near its current position, while during much of the intervening period sea level was lower and the shoreline was several miles north of its present location (Guthrie, 1993).

These deposits have yielded a wide array of vertebrate fossils, which, because of their burial by wind-blown sand rather than stream deposition, are remarkably well preserved. *Peromyscus nesodytes* is common at all levels as are vertebrae assignable to the Pacific rattlesnake (*Crotalus viridis*), a species not previously known from the northern Channel Islands. Bones of ornate shrew and vampire bat, while present, are rare. Rare too is a hitherto undescribed species of the rodent *Microtus*, which will be described later in this paper.

Most numerous in these deposits are the remains of four species of seabirds that once nested on San Miguel. These are *Chendytes lawi*, Cassin's auklet, ancient murrelet, and an as yet undescribed species of auklet that is almost identical to the living rhinoceros auklet but with a much thicker bill. All of these species are represented by egg shell fragments, bones of young individuals, and, in the case of the latter three species, complete skeletons from individuals that probably died in nesting burrows. At places along the north coast of San Miguel, bones of these species form an almost solid layer. As only the best specimens were collected, the numbers of these four species in Table 1 do not reflect their true density.

Raptor remains are also fairly common on San Miguel and include California condor, red-tailed hawk, bald eagle, barn owl, and the extinct species of caracara and owl known previously from Santa Rosa. All of these species, with the exception of the condor, once nested on San Miguel. Remains of larger sea birds are fairly common, especially near sites containing bald eagle bones, and many of these birds were probably the prey of eagles.

A complete list of the avifauna recovered from San Miguel deposits, both midden and late Pleistocene, is presented in Table 1. Sixteen species (bold in Table 1) have been added since the last study of this material (Guthrie, 1993). Of these, *Arenaria melanocephala* and *Calidris alba* are first records for late Pleistocene deposits and *Fratercula cirrhata*, *Larus philadelphia*, *Calidris canutus* and *Haematopus bachmani* are first records for the late Pleistocene of California. Two of the new species, *Puffinus tenuirostris* and *Fratercula cirrhata*, today have ranges along the Pacific Coast mostly to the north of San Miguel, as do several other previously known members of the avifauna.

Because the San Miguel Island deposits include remains of nesting birds, prey of both hawks and owls, and individuals washed up on the beach and then blown inland to be buried in the deposits, this is the most complete avifauna from a West Coast late Pleistocene deposit and gives us a good indication of coastal bird life during the last 35,000 years.

TABLE 1. AVIFAUNA FROM ARCHAEOLOGICAL AND PALEONTOLOGICAL SITES ON SAN MIGUEL ISLAND

Species	Archaeological sites: Number of bones from Daisy Cave	Paleontological sites: Localities*	Paleontological sites: Number of bones recovered
Gavia stellata	2	-	-
Gavia pacifica	35	5	7
Gavia immer	**36**	**1**	**1**
Podiceps grisegena	1	-	-
Podiceps auritus	**2**	**1**	**1**
Podiceps nigricollis	72	4	4
Aechmophorus sp.	4	2	2
Diomedea albatrus	40	5	17
Fulmarus glacialis	5	5	16
Puffinus griseus	2	6	27
Puffinus tenuirostris	**-**	**4**	**17**
Puffinus opisthomelas	38	6	18
Oceanodroma leucorhoa	16	-	-
Oceanodroma homochroa	7	1	1
Oceanodroma melania	2	-	-
Pelecanus occidentalis	5	1	1
Phalacrocoras penicillatus	351	5	22
Phalacrocoras pelagicus	127	2	3
Ardea herodias	-	1	4
Plegadis chihi	-	1	1
Anser albifrons	**-**	**2**	**3**
Chen caerulescens	72	6	14
Chen rossii	1	-	-
Branta bernicla	2	-	-
Branta canadensis	-	4	24
Chendytes lawi	51	13	1268
Anas clypeata	1	-	-
Melanitta perspicillata	2	4	5
Melanitta fusca	1	4	6
Mergus serrator	-	1	1
Gymnogyps californianus	1	6	8
Haliaeetus leucocephalus	-	7	23
Buteo jamaicensis	4	6	21
Buteo lagopus	4	-	-
Polyborus plancus	-	4	14
Falco sparverius	1	1	1
Falco peregrinus	**-**	**1**	**1**
Fulica americana	2	-	-
Grus canadensis	1	-	-
Pluvialis dominica	1	-	-
Charadrius sp.	-	2	2
Haematopus bachmani	**-**	**1**	**1**
Catoptrophorus semipalmatus	2	-	-
Heteroscelus incanus	1	-	-
Numenius phaeopus	**-**	**2**	**2**
Limosa fedoa	**-**	**1**	**1**
Arenaria melanocephala	**-**	**1**	**1**
Calidris*, cf. *C. canutus	**-**	**1**	**1**
Calidris alba	**1**	**1**	**1**
Phalaropus lobatus	1	-	-
Phalaropus fulicarius	**2**	**2**	**12**
Larus philadelphia	**1**	**1**	**1**
Larus*, cf. *L. canus* or *L. delawarensis	**-**	**1**	**2**
Larus californicus	1	3	5
Larus, sp. (large)	10	2	7
Rissa tridactyla	8	1	1
Uria aalge	3	6	41
Cepphus columba	6	1	1
Synthliboramphus antiquus	-	11	1296
S. hypoleucus	23	2	2
Ptychoramphus aleuticus	259	12	2041
Cerorhinca monocerata	14	-	-
Cerorhinca undesc. sp.	-	7	6361
Fratercula cirrhata	**-**	**2**	**2**
Tyto alba	42	3	8
Athene cunicularia	**12**	**2**	**2**
Asio flammeus	2	-	-
Asio, cf. *A. priscus*	-	3	3
Eremophila alpestris	-	1	1
Corvus corax	8	2	6
Sturnella neglecta	10	-	-
Euphagus cyanocephalus	4	-	-
Passerella iliaca	1	-	-
Melospiza melodia	-	1	1
Zonotrichia leucophrys	-	1	1
Zonotrichia sp.	6	-	-
Passeriformes	-	2	3

*Localities - number of sites from which fossil material was recovered.
Bold type indicates species added to the avifauna since 1993.

Recent work on Santa Rosa Island has resulted in location of a rich site near the mouth of Arlington Canyon which contains the remains of numerous barn owl pellets. Two dates have been obtained on charcoal from this site. The top of the site dates at 10,240 ± 180 BP (Beta Analytic sample 22184), while a sample near the base dates at 28,240 ± 940 BP (Beta 51844). The owl pellets contain *Peromyscus nesodytes*, as well as the first records of ornate shrew and Pacific rattlesnake for Santa Rosa Island. Many of the pellets are burned and the deposit is full of charcoal bits indicative of widespread fire on the island.

FUTURE WORK

Despite these recent advances in our knowledge, many unanswered questions remain about the terrestrial faunas of the northern Channel Islands. A few of these are summarized below.

Extinction of Island Forms

There is good evidence that humans were present on San Miguel Island by 11,700 BP (Erlandson et al., 1996). Bones of *Chendytes lawi* are found in the Daisy Cave midden, showing survival on San Miguel Island until approximately 4,000 BP. That a flightless bird coexisted with humans for thousands of years seems unusual, but Morejohn (1976) has shown similar survival of *Chendytes* to about 4,000 BP along the central California coast.

No bones of either rattlesnakes or vampire bats are found in midden deposits on San Miguel and both of these species probably were extinct before human arrival. This may also be true of the dwarf mammoth. Many mammoth bones from Santa Rosa show signs of burning and Orr (1968) believed that this provided evidence of human cooking. However, except for a few bones from later archaeological sites that were believed by Orr to have been collected by the inhabitants as bones from the island, none of the mammoth bones show butcher marks or clear association with tools. Although Orr (1968) stated that mammoth material occurred throughout the Tecolote Member of the Santa Rosa Formation, the top of which he dated at 10,400 BP, the dates were obtained on wood within the deposit and not on mammoth bone. I know of no mammoth material for which a date has been obtained younger than about 15,000 BP. Although Orr believed humans arrived on the northern Channel Islands much earlier than this date, this view is generally discounted (Glassow, 1980). There is currently no solid evidence that mammoth and man ever met on the northern Channel Islands (but see Johnson, 1981).

Careful dating of mammoth material should be done to determine the youngest occurrence of mammoth on the northern Channel Islands.

Origin of the Island Fauna.

The specimens of *Peromyscus nesodytes* from deposits dated at 12,000 BP are nearly identical in size to those from deposits dated at 33,000 BP. The few fossils of the island fox (*Urocyon littoralis*), also from strata dated at about 33,000 BP, are identical in size to living forms of this species. Material of *Chendytes lawi* from San Miguel Island dated at 12,000 and 33,000 BP is slightly larger in size than material from elsewhere in southern California, including the material from Anacapa island. However, the Anacapa material is about the same size as material from San Pedro and Newport, generally considered late Pleistocene, and dated about 100,000 BP (Miller, 1971). This date is not unreasonable for the Anacapa fauna as *Peromyscus anyapahensis* from the same Anacapa deposit is generally considered ancestral to *P. nesodytes*. To allow time for *P. anyapahensis* to diverge from mainland forms, its time of arrival on the northern Channel Islands must be earlier than 100,000 BP.

Although no terrestrial deposits are known on San Miguel that date much earlier than 35,000 BP, extensive deposits exist on Santa Rosa thought to date to at least 100,000 BP and perhaps earlier. Unfortunately, these are stream deposits in which bones of small mammals and birds are extremely scarce. Further collecting here, however, might shed light on the date of origin of the various members of the fauna of the northern Channel Islands.

Climate

The fossil fauna provides a confusing picture of past climate. The presence of birds in San Miguel deposits that today have a more northerly distribution would seem to be an indication of cooler climate. However, the main depositional periods are thought to have occurred when sea levels were near present positions rather than during glacial advances when sea levels were lower. Vampire bat material from Daisy Cave is associated with a date of 13,000 BP and with pollen indicative of a pine forest (Erlandson et al., 1996). Although vampire bats are restricted to warmer climates today, *Desmodus stocki* was larger than living vampire bats, and this larger size, combined with the

ameliorating effect of the ocean on climate may have allowed this species to survive on the island long after its extinction on the mainland. Although the avifauna of San Miguel is mostly from deposits dated at 12,000 BP and around 35,000 BP, sediments of intermediate age do occur on the island (Johnson, 1980). Although generally unfossiliferous, a collecting effort in these deposits might show whether a different avifauna from that described here occurred on the islands during glacial times.

DESCRIPTION OF A NEW SPECIES OF *MICROTUS*.

During the summer of 1984, I recovered fragment of lower jaw assignable to *Microtus* from sands on the beach above Cuyler Harbor, San Miguel Island. The jaw is larger than any known *Microtus* material from California and is believed to belong to an extinct "giant" island species. The age of the specimen, however, could not be determined. The deposits along the upper beach at Cuyler Harbor consist of poorly consolidated sand in which are found bones washed and blown down from late Pleistocene deposits above the beach as well as material currently being deposited on the beach. The material thus contains a mixture from various ages from Recent to about 33,000 BP.

Since 1984 San Miguel and Santa Rosa Islands have been extensively collected for fossil material of small birds and mammals. Much of the recovered material was deposited in the form of owl pellets, including a layer of material deposited at 7,000 BP on San Miguel and another deposited at 10,000 BP on Santa Rosa. Despite this collecting effort, no new material of *Microtus* was recovered until recently. During the summer of 1996 I discovered a complete humerus of the California Condor (*Gymnogyps californicus*) almost completely imbedded in sediments along the northeastern coast of San Miguel. This bone was quarried out and wrapped, along with some surrounding sediment. During my removal of this sediment, a second fragmentary jaw of *Microtus*, almost identical to the first, was recovered. An attempt was made to date this deposit using bird bone but was unsuccessful as all carbon content had been removed by leaching through the site. The age of this jaw, based on correlation with other dated sites, is thought to be about 35,000 BP. These two jaws from San Miguel Island form the basis of the following description.

Microtus miguelensis, new species

Type - Santa Barbara Museum of Natural History (SBMNH) No. 191, a fragment of right ramus of mandible with most of m1 (Fig. 1). Type locality is an unknown layer in late Pleistocene sands at the east end of Cuyler Harbor (locality SMI-V-10; locality data on file at Channel Islands National Park headquarters and at SBMNH).

Referred Material - SBMNH No. 425, a fragment of left ramus with m1 damaged at both ends. This specimen is from SMI-V-17, thought to date about 35,000 BP.

Diagnosis - This species is larger than any living *Microtus*, with the possible exception of *M. richardsoni*.

Discussion - First lower molar with a posterior lobe, five closed alternating triangles, and a very small lingual reentrant angle 5 in which there is no cement. Enamel undifferentiated. Maximum length of m1, including estimate of missing crown of posterior lobe, 4.15 mm.

Microtus californicus is the species of this genus common today along the southern California coast. This species is known from several deposits of Rancho La Brean age (Miller, 1971), and a specimen from the Anza Borrego Desert, dated at 1.67 million years, has questionably been assigned to this species (Zakrzewski, 1972). The San Miguel specimens are similar enough to *M. californicus* to be probable descendants from this species.

The rarity of *Microtus miguelensis* in deposits on the northern Channel Islands is surprising. Today *Microtus* is a favorite food of barn owls, yet no specimens were found in the extensive remains of owl pellets from 7,000 BP on San Miguel and 10,000 BP on Santa Rosa. *Microtus* was probably always a rare element in the fauna of the northern Channel Islands, and may have died out before 12,000 BP.

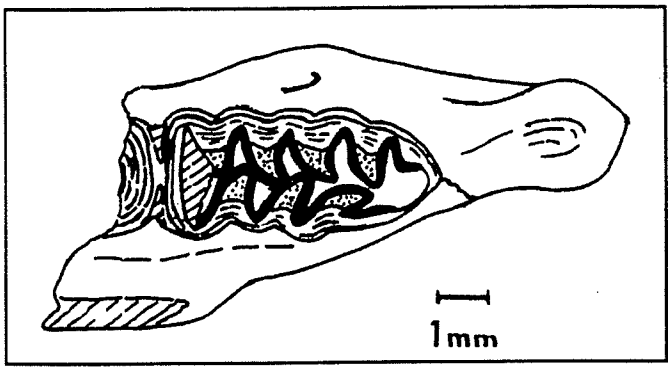

Figure 1. Occlusal view of SBMNH No. 191, type specimen of *Microtus miguelensis*, showing right m1.

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