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Analysis of Avifaunal and Bat Remains from Midden Sites on San Miguel Island

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INTRODUCTION

Remains of birds were recovered from four sites on San Miguel Island excavated by Charles Rozaire for the Los Angeles County Museum of Natural History between 1964 and 1968. This paper reports on the information this excavated material provides on the past avifauna of San Miguel Island, as well as on the role of birds in the subsistence of the aboriginal inhabitants. Preliminary ages, based on artifacts and on information provided by Charles Rozaire, are also reported here. I also describe material from a cave deposit that includes bones referable to *Desmodus stocki*, an extinct species of vampire bat.

The four San Miguel Island deposits are:

SMI 1.—A large village site located on the bluffs overlooking Cuyler Harbor on the north coast of San Miguel. This site was subdivided on a grid and 68 random squares were excavated. Artifacts date occupation of this site from 4770 B.P. to no later than 1400 B.P.

SMI 525.—This excavation consisted of a 5 x 10-ft (1.5 x 3.0 m) test pit sunk along the face of a cliff where several midden and soil layers were exposed on the northwest shore of San Miguel. This site was occupied from 2000 to 400 B.P., with the major period of occupation from 2000 to 1200 B.P.

SMI 261.—This site is a cave at the base of a cliff near Bay Point on the northeast side of San Miguel. The whole interior of the cave was excavated and a trench dug perpendicular to the cave entrance, extending outward about 50 ft (15.2 m). Artifacts indicate that this site and 261A were occupied from 3150 B.P. to no later than 980 B.P.

SMI 261A.—Material from this locality is from a trench along the floor of a vertical fissure in the cliff near SMI 261. At its base, the fissure is about 5 ft (1.5 m) wide.

METHODS

All sites were excavated in 5-ft (1.5 m) squares, 6 inches (15.3 cm) at a time, and sieved with a quarter-inch (6.4 mm) mesh screen. Avian remains were identified with the aid of collections from the University of California at Los Angeles, the Los Angeles County Museum of Natural History, and the Joint Science Department of the Claremont Colleges. Minimum numbers of individuals (MNI) were calculated per level of excavation by summing the frequencies of the most commonly occurring unique skeletal element of each age class for each species. MNI values are biased upward, in that their calculation assumes no vertical scattering of faunal remains as might have occurred due to digging by pot hunters.

Skeletal completeness values (CSI) were calculated using the formula of Thomas (1971) where, for each species:

$$\text{CSI} = \frac{\text{number of bones found} \times 100}{\text{MNI} \times \text{estimated number of identifiable elements}}$$

The estimated number of identifiable elements for small birds, where vertebrae and phalanges are lost by sieving, was taken as 25. This is an overestimate for individual species of passerines and for this reason a CSI value is given for passerines as a group. For larger species, where

TABLE 1. Bird remains from SMI 1 (number of bones/MNI).

Species	Depth in inches							
	0-6	6-12	12-18	18-24	24-30	30-36	Totals	CSI
Common Loon	-	-	-	4/1	1/1	-	5/2	5.0
Arctic Loon	-	-	-	1/1	3/1	-	4/2	4.0
Eared Grebe	-	-	-	1/1	-	-	1/1	4.0
Short-tailed Albatross	-	1/1	5/1	-	-	-	6/2	6.0
Northern Fulmar	-	-	1/1	-	-	-	1/1	4.0
Brown Pelican	-	1/1	1/1	-	-	-	2/2	2.0
Brandt's Cormorant	1/1	16/3	33/4	24/3	1/1	1/1	76/13	11.7
Pelagic Cormorant	-	4/1	4/2	1/1	-	-	9/4	9.0
Double-crested Cormorant	-	1/1	1/1	-	-	-	2/2	2.0
Snow Goose	-	-	3/1	-	-	-	3/1	6.0
Chendytes sp.	-	8/3	13/3	19/3	3/2	-	43/11	7.8
Surf Scoter	-	1/1	-	-	-	-	1/1	4.0
Heerman's Gull	-	-	1/1	-	-	-	1/1	4.0
Common Murre	-	-	1/1	-	-	-	1/1	4.0
Pigeon Guillemot	-	1/1	-	-	-	-	1/1	4.0
Cassin's Auklet	-	-	-	1/1	-	-	1/1	4.0
Rhinoceros Auklet	-	-	2/1	-	1/1	-	3/2	6.0
Tufted Puffin	-	-	1/1	-	-	-	1/1	4.0
Raven	-	1/1	-	-	1/1	12/1	14/3	18.6

vertebrae and phalanges were not lost in screening, the number of identifiable elements per species was taken as 50 (see Ziegler 1973).

Evidence of human use was noted, including butcher marks, burning, and working of bone. The degree of breakage of skeletal elements was also noted. Finally, the number of each skeletal element recovered for each species was recorded, as were the horizontal and vertical distributions of bones at each site.

RESULTS

Agencies of Accumulation

Material at SMI 1 and SMI 525 (Tables 1 and 2) was, in all probability, brought there by humans or agencies associated with them, such as domestic dogs (a single dog bone was found at SMI 261). Both sites seem far from caves or suitable den sites for the only carnivore on the island, the Island Fox (*Urocyon littoralis*). Although there is evidence of human occupation, much of the material at SMI 261 and 261A (Tables 3 and 4) was collected by owls. Barn Owl (*Tyto alba*) remains are numerous at these sites; their distribution at the mouth of the cave at SMI 261, rather than in its interior, corresponds to the distribution of bones of small mammals and small birds. Petrels and murrelets are a major component of the prey of Barn Owls on other islands off the west coast of California (see Banks 1965, Bennett 1928). Given the high percentage of small prey species at SMI 261 and SMI 261A, and their virtual absence at SMI 525 and SMI 1 (Table 5), it seems likely that nearly all the passerines, murrelets, small auklets, and petrels, as well as some shorebirds and small grebes, at SMI 261 and SMI 261A were brought in by owls. The high CSI values for these species and low figures for bone breakage

TABLE 2. Bird remains from SMI 525 (number of bones/MNI).

Species	Depth in inches											Totals	CSI
	0-12	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	108-120	120-132	132-140		
Red-throated Loon	-	-	-	-	1/1	-	-	-	-	-	-	-	1/1	2.0
Short-tailed Albatross	-	-	-	2/1	1/1	1/1	2/1	-	-	-	2/1	-	8/5	3.2
Sooty Shearwater	-	-	-	-	-	-	-	-	-	-	8/2	-	8/2	16.0
Brown Pelican	-	-	-	3/1	-	-	4/1	1/1	-	1/1	-	-	9/4	4.5
Brandt's Cormorant	-	-	2/1	9/2	6/1	-	4/2	3/1	-	-	-	1/1	24/8	6.0
Pelagic Cormorant	-	-	-	-	-	-	1/1	-	-	1/1	-	-	2/2	4.0
Osprey	-	-	-	-	-	-	1/1	-	-	-	-	-	1/1	4.0
Western Gull	-	-	-	-	-	1/1	-	-	-	2/1	1/1	-	4/3	5.3
Cassin's Auklet	-	6/2	3/1	-	-	-	-	-	-	-	-	-	9/3	13.0
Tufted Puffin	-	-	-	-	-	-	-	1/1	-	-	-	-	1/1	4.0
Raven	-	-	-	-	-	-	-	1/1	-	-	-	-	1/1	4.0
Common Murre	-	-	-	-	-	-	1/1	-	1/1	-	-	-	2/2	4.0

TABLE 3. Bird remains from SMI 261 (number of bones/MNI).

Species	Depth in inches							
	0-12	12-24	24-36	36-48	48-60	60-72	Total	CSI
Common Loon	1/1	-	3/2	27/3	5/1	-	36/7	10.3
Arctic Loon	3/1	9/1	6/2	13/2	5/1	2/1	35/8	8.8
Red-throated Loon	-	1/1	-	-	1/1	-	2/2	2.0
Red-necked Grebe	1/1	-	-	-	-	-	1/1	4.0
Horned Grebe	-	1/1	-	1/1	-	-	2/2	4.0
Eared Grebe	12/2	10/4	26/5	20/5	4/1	-	72/17	16.9
Western Grebe	-	-	4/1	-	-	-	4/1	16.0
Short-tailed Albatross	8/2	3/2	14/3	13/3	2/1	-	40/11	7.2
Northern Fulmar	4/1	-	1/1	-	-	-	5/3	6.7
Sooty Shearwater	-	-	1/1	1/1	-	-	2/2	4.0
Manx Shearwater	7/2	2/2	2/1	1/1	19/3	7/2	38/11	13.8
Leach's Storm Petrel	5/2	3/1	7/3	1/1	-	-	16/7	9.1
Ashy Storm Petrel	-	1/1	3/1	3/1	-	-	7/3	9.3
Black Storm Petrel	1/1	1/1	-	-	-	-	2/2	4.0
Brown Pelican	4/2	1/1	-	-	-	-	5/3	3.3
Brandt's Cormorant	231/16	90/6	13/1	12/2	5/2	-	351/27	26.0
Pelagic Cormorant	91/13	30/8	5/1	1/1	-	-	127/23	11.1
Black Brant	1/1	-	-	1/1	-	-	2/2	4.0
Snow Goose	18/3	7/2	6/1	29/3	6/1	6/3	72/13	13.1
Chendytes sp.	1/1	8/2	10/2	23/4	7/2	2/1	51/12	8.5
Ross' Goose	-	1/1	-	-	-	-	1/1	4.0
Surf Scoter	-	-	2/1	-	-	-	2/1	8.0
White-winged Scoter	-	-	-	1/1	-	-	1/1	4.0
Northern Shoveller	1/1	-	-	-	-	-	1/1	4.0
California Condor	-	1/1	-	-	-	-	1/1	2.0
Red-tailed Hawk	-	-	1/1	2/1	-	1/1	4/3	5.3
Rough-legged Hawk	1/1	1/1	-	2/1	-	-	4/3	5.3
Kestrel	-	-	1/1	-	-	-	1/1	4.0
Sandhill Crane	1/1	-	-	-	-	-	1/1	2.0
Coot	-	-	-	2/1	-	-	2/1	8.0
Sanderling	-	-	-	1/1	-	-	1/1	4.0
Black-bellied Plover	-	1/1	-	-	-	-	1/1	4.0
Wandering Tattler	-	1/1	-	-	-	-	1/1	4.0
Willet	-	1/1	-	1/1	-	-	2/2	4.0
Red Phalarope	1/1	-	1/1	-	-	-	2/2	4.0
Northern Phalarope	-	-	1/1	-	-	-	1/1	4.0
Western Gull	1/1	-	4/1	5/1	-	-	10/3	6.7
California Gull	-	1/1	-	-	-	-	1/1	4.0
Bonaparte's Gull	-	-	-	1/1	-	-	1/1	4.0
Black-legged Kittiwake	1/1	2/1	2/1	3/2	-	-	8/5	6.4
Common Murre	-	1/1	-	2/1	-	-	3/2	6.0
Pigeon Guillemot	1/1	4/1	1/1	-	-	-	6/3	8.0
Xantus' Murrelet	23/8	21/8	44/9	29/6	6/3	-	123/34	14.7
Cassin's Auklet	42/8	56/9	77/12	68/10	15/3	1/1	259/43	24.1

TABLE 3. (Cont.)

Species	Depth in inches							
	0-12	12-24	24-36	36-48	48-60	60-72	Total	CSI
Rhinoceros Auklet	10/4	2/2	2/2	-	-	-	14/8	7.0
Barn Owl	-	2/1	5/2	8/3	20/4	7/2	42/12	14.0
Burrowing Owl	-	-	3/1	2/1	4/1	3/1	12/4	12.0
Short-eared Owl	1/1	-	1/1	-	-	-	2/2	8.0
Raven	3/1	-	3/1	-	2/1	-	8/3	10.6
Passerines	21/5	9/4	51/11	15/4	3/1	4/1	103/27	15.3
Western Meadowlark	-	-	3/1	2/1	3/1	2/1	10/4	-
Brewer's Blackbird	3/1	-	1/1	-	-	1/1	4/3	-
Zonotrichia sp.	-	2/2	4/2	-	-	-	6/4	-
Fox Sparrow	-	-	1/1	-	-	-	1/1	-

TABLE 4. Bird remains from SMI 261A (number of bones/MNI).

Species	Depth in inches								
	0-6	6-12	12-18	18-24	24-30	30-36	36-48	Total	CSI
Common Loon	-	2/1	-	1/1	-	-	-	3/2	3.0
Horned Grebe	-	-	-	1/1	-	-	-	1/1	4.0
Eared Grebe	4/1	3/1	5/2	1/1	-	-	-	13/5	10.4
Short-tailed Albatross	-	-	-	1/1	-	-	-	1/1	2.0
Manx Shearwater	-	-	-	1/1	-	-	-	1/1	4.0
Leach's Storm Petrel	1/1	3/1	1/1	-	-	-	-	5/3	6.3
Ashy Storm Petrel	1/1	2/1	2/1	1/1	-	-	-	6/4	6.0
Brandt's Cormorant	3/1	-	-	5/1	-	1/1	1/1	10/4	5.0
Snow Goose	-	-	-	-	-	1/1	-	1/1	2.0
Chendytes sp.	-	3/1	1/1	-	-	-	-	4/2	4.0
Red-tailed Hawk	2/1	1/1	-	-	-	-	-	3/2	7.0
Rough-legged Hawk	1/1	-	-	-	-	-	-	1/1	4.0
Swainson's Hawk	-	1/1	-	-	-	-	-	1/1	4.0
Western Gull	-	-	-	2/1	-	1/1	-	3/2	3.0
California Gull	-	-	1/1	-	-	-	-	1/1	4.0
Black-legged Kittiwake	1/1	-	-	-	-	-	-	1/1	4.0
Common Murre	1/1	-	-	-	-	-	-	1/1	4.0
Xantus' Murrelet	7/2	17/4	15/3	3/1	-	1/1	-	43/11	15.6
Cassin's Auklet	57/5	177/10	62/7	11/2	-	-	-	307/24	51.2
Rhinoceros Auklet	2/2	-	-	-	-	-	-	2/2	4.0
Barn Owl	-	3/1	2/1	-	-	-	-	5/2	10.0
Burrowing Owl	-	4/1	2/1	-	-	-	-	6/2	12.0
Raven	-	8/2	-	1/1	-	-	-	9/3	12.0
Passerines	3/4	80/18	13/5	20/4	-	-	-	120/31	15.5
Western Meadowlark	-	2/1	-	-	-	-	-	2/1	-
Zonotrichia sp.	2/2	6/5	-	1/1	-	-	-	9/8	-
Fox Sparrow	-	11/4	1/1	-	-	-	-	12/5	-

TABLE 5. Summary of owl and bird remains from San Miguel Island localities.

Species groups	Localities			
	1	525	261	261A
Small birds (MNI)	2	3	149	81
Large birds (MNI)	48	30	153	24
Barn Owl remains (MNI)	-	-	12	2

TABLE 6. Distribution of skeletal elements for common species for SMI 261 and 261A.

Species	Number of bones	Number of complete bones/total number of bones								
	MNI	CSI	Humerus	Ulna	Femur	Tibia	Tarso-metatarsus	Coracoid	Pelvis	Sternum
Cassin's Auklet	566/67	33.79	79/110	79/101	41/44	51/66	41/41	42/43	25/29	13/25
Xantus' Murrelet	155/45	14.7	49/59	27/31	13/15	12/18	3/4*	12/12	4/4*	0/5
Passerines	223/58	15.4	30/34	12/17	10/12	9/16	6/6	0/0	3/3	0/3
Snow Goose	56/14	8.0	3/13	0/9	0/0	0/2	0/2	0/1	0/0	0/2
Brandt's Cormorant	361/31	23.3	1/52	2/42	17/22	2/37	15/30	40/47	2/9	0/6
Pelagic Cormorant	127/23	11.1	2/24	0/7	4/7	0/12	6/12	8/13	3/5	4/6
Short-tailed Albatross	41/12	6.8	0/5	0/2	1/6	1/5	1/4	-	-	-
Manx Shearwater	38/12	13.0	3/7	6/17	1/2	1/3	2/3	4/4	-	0/2
Arctic Loon	35/8	8.7	0/4	0/3	1/1	1/2	3/6	4/4	2/2	0/1
Eared Grebe	85/23	14.8	11/35	4/12	6/8	2/11	4/9	5/6	2/2	0/3
Chendytes sp.	55/14	15.7	1/2	-	8/10	0/2	2/3	0/0	1/4	1/3
Barn Owl	47/14	13.4	0/6	0/1	1/11	1/5	2/13	1/3	1/2	1/1

*Values may be low due to problems of identification.

TABLE 7. Breeding marine birds on San Miguel Island and their abundance in archaeological sites.

Species	Current status (in breeding pairs)	MNI from sites			
		SMI 261	261A	525	1
Cassin's Auklet	10,000-20,000	43	24	3	1
Brandt's Cormorant	1,300	27	4	8	13
Ashy Storm Petrel	200-400	3	4	-	-
Pigeon Guillemot	200-300	3	-	-	1
Western Gull	200	3	2	3	-
Pelagic Cormorant	150	23	-	2	4
Common Murre	100	2	1	2	1
Xantus' Murrelet	50	34	11	-	-
Double-crested Cormorant	15	-	-	-	2
Tufted Puffin	formerly small numbers	-	-	1	1
Brown Pelican	? none today	3	-	4	2
Chendytes sp.	? extinct	12	2	-	11
Manx Shearwater	? none today	11	1	-	-
Black Storm Petrel	? none today	2	-	-	-
Leach's Storm Petrel	? none today	7	3	-	-

(Table 6) also support this conclusion. Some of the large birds at SMI 261 and SMI 261A could have been brought in by foxes, as the caves provide good den sites.

Frequency of Recovery of Avian Species

All sea bird species currently breeding on San Miguel or its offshore islands were recovered from the sites (see Table 7). Among the small-sized species (believed accumulated by owls), the surface-nesting Xantus' Murrelet (*Endomychura hypoleuca*) is more abundant than the petrels and auklets that nest underground. Presumably, murrelets were easier prey for owls. Among the larger species believed to have been killed by man, there seems to have been a preference for Pelagic Cormorants (*Phalacrocorax pelagicus*). That this species and Pigeon Guillemots (*Cepphus columba*) breed on San Miguel proper, while all other breeding marine birds occur only on the small islands off the coast of San Miguel, may account for its abundance.

Species that winter on or near San Miguel—the loons, grebes, geese, and ducks—are also fairly abundant in the deposits, with the frequency of occurrence generally reflecting present or historic wintering numbers. Short-tailed Albatross (*Diomedia albatrus*) was a common offshore species before 1900 and Snow Geese (*Chen hyperborea*) wintered on the Channel Islands in large numbers before the 1930s (H.L. Jones, pers. comm.).

Despite the seasonal abundance of such migratory species as the Sooty Shearwater (*Puffinus griseus*) and phalaropes, bones of these species are rarely recovered. Remains of the Manx Shearwater (*Puffinus puffinus*) and Leach's Storm Petrel (*Oceanodroma leucorhoa*) are more frequently recovered than would be expected if these species had been only occasional visitors to San Miguel, as they are today. This suggests that these species once bred on San Miguel. Leach's Storm Petrel currently nests both to the north (Farallon Islands) and south (Mexico) of San Miguel, while Manx Shearwater breeds only to the south of the island today.

Although not all passerine bones have been identified, the absence of House Finch (*Carpodacus*

podacus mexicanus) remains in the collection supports Johnson's (1972) view that this species is a recent addition to the island avifauna.

Season of Human Occupation

The data reveal little about the seasonality of human occupation of the sites. Loons, geese, ducks, and albatross are species that are present only during the winter at San Miguel and are found at all sites. Summer use of the sites is more difficult to determine, as most breeding species on the island are also present on or near the island throughout the year.

Human Uses of Birds

Artifacts recovered from the sites include three awls made from the radii of Brandt's Cormorant (*Phalacrocorax penicillatus*), seven bone tubes fashioned from the ulni of geese, albatross, and a gull, a whistle made from the ulna of a Black-legged Kittiwake (*Rissa tridactyla*), and a scraper made from the ulna of an albatross or goose. Also recovered was a cache of feathers of Brandt's Cormorant.

Bones showing evidence of having been worked include a tibia and humerus of Brandt's Cormorant and an ulna of a Brown Pelican (*Pelecanus occidentalis*). Only a few bones of the Pelagic Cormorant (four bones), Brandt's Cormorant (two bones), and Barn Owl (one bone) show any evidence of burning. Thus, out of a total of 2,204 bones recovered, only 22 show definite evidence of working or burning.

Distribution of preserved elements, breakage patterns, and CSI values for the more common species from SMI 261 are presented in Table 6. All elements of the skeleton are present for such species as Cassin's Auklet (*Ptychoramphus aleutica*), Xantus' Murrelet, and passerine birds—species preyed upon by owls. Most of the bones of these species are unbroken. Although the numbers of different skeletal elements vary, these differences seem attributable to either the size of the bone (smaller bones being lost more readily in sieving) or to the fragility of individual bones. Thus, there are fewer femora and tarsometatarsi than humeri (due to size difference), and fewer pelvi than femora, and a higher percentage of whole femora than tibia (due to differences in fragility).

Among species usually believed to serve as food for humans, only remains of the Snow Goose are common. In this species, most of the bones are broken and, although a large number of wing bones were recovered, nearly all body and leg bones are absent. This suggests preparation of Snow Geese as food items by removal of the wings, which have little meat, and destruction or removal from the site of the remainder of the skeleton.

The pattern of skeletal preservation for cormorants is different than that found for Snow Geese; there is a higher degree of bone breakage among the larger bones, but less breakage of smaller bones. All elements of the skeleton are present, however, and the frequencies for the occurrence of each element are generally correlated with size or fragility. The presence of complete skeletons and the low frequency of butcher marks or burned bone suggest that cormorants were used for some purpose other than food. Although there are records of immature cormorants serving as food items (Howard 1929), there is little evidence that adult birds were taken for food on the California coast. Certainly, marine, fish-eating birds are not known for their palatability, at least by modern standards.

It seems likely that cormorants were killed for their feathers. Reports of the discovery of the "lost woman" of San Nicolas Island state that she was clothed "in a robe of bird's plumage, made of small squares neatly matched and sewed together" (Heizer 1973:23-24). The collection of breast feather patches from sea birds would result in some breakage of long bones, but not in the destruction of skeletal elements, as might result from cooking.

Remains of other fish-eating species (*e.g.*, albatrosses, shearwaters, loons, and larger alcids)

are too fragmentary to show clearly the pattern of skeletal preservation. However, the few remains that have been recovered seem to follow the pattern for cormorants rather than for Snow Geese. The distribution of recovered skeletal elements for *Chendytes*, an extinct, flightless, diving duck, more nearly resembles that of cormorants than that of Snow Geese and may indicate that this species also served as a source of feathers rather than food. The pattern of skeletal preservation for the Eared Grebe (*Podiceps caspicus*), especially in the number of unbroken bones, is intermediate between that of species that were prey for owls and those believed killed for their feathers by man. Use of the Eared Grebe for its feathers is more likely, the greater number of unbroken elements possibly being due to the smaller size of this species.

Although the number of skeletal elements from SMI 525 and SMI 1 is too small to feel confident about applying the foregoing type of analysis, there seems to be no indication that any differences in type of skeletal preservation pattern exist among the four sites.

Almost all skeletal elements recovered are from adult birds. Partially developed bones were found only for the Raven (*Corvus corax*), Barn Owl, Manx Shearwater, and Western Grebe (*Aechmophorus occidentalis*). These bones from immature individuals are, however, at a stage of development which permitted flight. No bones of immature cormorants or pelicans were found. No eggshell fragments are preserved in this collection.

Horizontal and Vertical Distribution Patterns

Horizontal patterns of skeletal distribution are clear only at site SMI 261, where a large contiguous area was excavated. At this site, smaller-sized species of birds tend to be distributed across the mouth of the cave and along the cliff face near the cave entrance. This distribution correlates well with Barn Owl remains (Fig. 1). Larger birds, such as cormorants, are distributed more randomly over the site.

Remains from SMI 1 and SMI 525 are too fragmentary to allow differences in distribution by depth to be analyzed. However, *Chendytes* is absent from SMI 525, the youngest of the four sites. This may indicate that *Chendytes* died out before 2000 B.P. and that its inclusion in younger levels at other sites is due to post-depositional disturbance of these sites. Careful examination of undisturbed sites will be necessary to determine if this is the case. At site SMI 261, there is a significant increase in cormorant bones in the top 24 inches of the site; fewer remains of owls and their prey occur in this interval (Table 3). Rozaire (pers. comm.) indicates that the top 2 ft of this deposit represent the last 2,000 years and that during this period there occurred a shift in fishing techniques, as indicated by fishhook type. This and the shift to cormorants, species that nest primarily on the offshore rocks, may correlate with advances in seamanship. Earliest evidence for use of the plank canoe by Chumash Indians dates from about 1300 B.P. (Walker in press).

Comments on the Identification of Individual Species

While many species have bones which are easily identifiable by size and configuration, there are some groups in which the identification of individual bones is difficult, if not impossible. Therefore, a few comments on identification seem in order.

Howard (1929) described methods of identifying bones in some genera (*e.g.*, *Buteo*, *Phalacrocorax*) where species are extremely similar. Through the use of the excellent comparative material available to me, I was able to identify nearly all specimens, exclusive of passerines, to species level. Details of skeletal differences in such groups as alcids and the genera *Buteo* and *Larus* will be published elsewhere. Two identifications are worth commenting on here as they could significantly affect species lists.

Examination of skeletal elements from alcids revealed that, except for the Xantus' Murrelet and Ancient Murrelet (*Synthliboramphus antiquus*), all species could be identified by config-

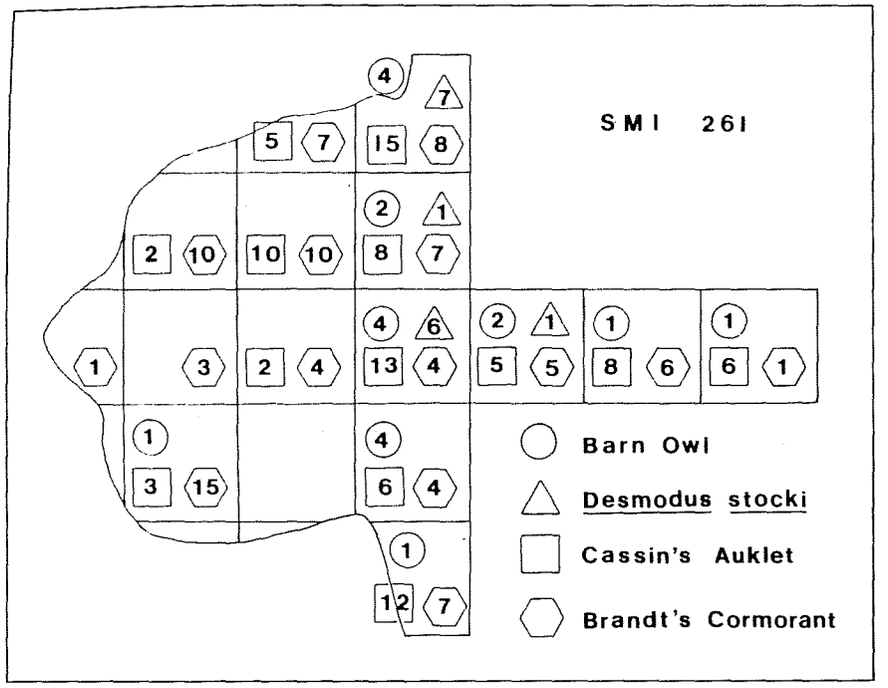

FIGURE 1. *Floor plan of SMI 261, excavated in 5-ft squares. Numbers represent MNI values for species indicated.*

urational differences. These two species are identical in skeletal form and vary only in size. Jehl and Bond (1975) noted this similarity, suggesting that these two species are clinally related on the west coast of North America, with larger individuals farther north.

Bones of this group from San Miguel Island seem slightly bimodal in distribution (Fig. 2), matching the size of modern Xantus' Murrelets and Ancient Murrelets (Table 8). I originally believed, therefore, that both species were represented in the collection. This combined sample, however, contains no more variation than is now found in a single species. It seems unlikely that two such closely related species could coexist on San Miguel. It is more likely that the sample represents a single species, with perhaps some sexual dimorphism (see Jehl and Bond 1975). If this interpretation is correct, the question of why the San Miguel bones are so much larger than modern Xantus' Murrelets from southern California arises. The recent specimens used in this comparison (Table 8) were obtained on southern California beaches in winter and, I believe, represent smaller individuals of more southerly populations of Xantus' Murrelet. Whether this interpretation is correct or not will have to await the collection of osteological material from nesting Xantus' Murrelets on San Miguel.

Bones referable to species of small petrels from San Miguel show a distinct bimodal distribution in size (Fig. 2). The two sizes correspond to measurements taken from recent material of the Ashy Storm Petrel (*Oceanodroma homochroa*) and Leach's Storm Petrel; the two populations are so identified. However, the recent material of Leach's Storm Petrel is from

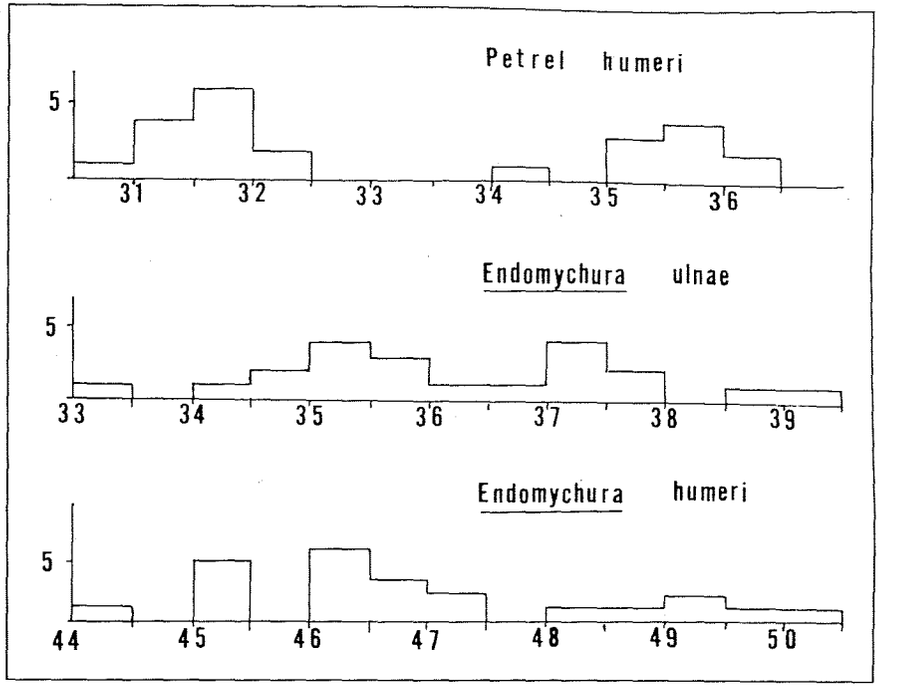

FIGURE 2. *Frequency histograms of maximum length measurements of murrelet and petrel wing bones from San Miguel Island.*

Guadalupe Island. The possibility of clinal variation in these species makes identification of bones tenuous until skeletal material from areas closer to San Miguel Island is obtained.

An Extinct Vampire Bat

Material from the cave deposit SMI 261 includes several bones referable to *Desmodus stocki*, an extinct species of vampire bat. The material (now deposited in the Department of Archaeology, Los Angeles County Museum of Natural History) consists of 12 humeri, five radii, and a partial scapula and is identical in both morphology and size to the type of material of *Desmodus stocki* from San Josecito Cave in Nuevo León, Mexico, described by Jones in 1958 (Table 9).

Distribution of material within the deposit shows that the occurrence of bones of small mammals, small birds, and *Desmodus* is correlated with the presence of the remains of the Barn Owl (*Tyto alba*); such a correlation is not found for the bones of birds such as cormorants, which are too large to serve as prey for owls. The usual prey of Barn Owls on the mainland are voles (*Microtus*), mice (*Peromyscus*), or gophers (*Thomomys*) (Evans and Emlen 1947). On islands, where these prey species are often absent, owls are known to prey on a much wider variety of organisms, including auklets and petrels (Bennett 1928, Banks 1965). Whether the presence of bat bones in the cave is due to owl predation or to use of the cave by living bats, the remains of at least eight individual *Desmodus* indicate a population of this species on the island in the past.

The exact age of the bat material is not known. Based on bead types, the deposit is considered

TABLE 8. Measurements (in mm) of murrelets from SMI 261 and SMI 261A.

Bone	Ancient Murrelet*			Xantus' Murrelet†			Material from 261 and 261A				
	n	Range	Mean	*n*	Range	Mean	*n*	Range	Mean (±S.E.)	S.D. (±S.E.)	C.V. (±S.E.)
Humerus	3	48.7-51.3	50.2	4	44.3-46.6	45.9	24	44.3-50.9	47.57±0.45	2.22±0.32	4.67±0.68
Ulna	3	37.8-39.7	38.9	3	33.6-35.4	34.8	18	34.2-39.1	36.38±0.35	1.47±0.25	4.04±0.67
Femur	3	24.7-26.0	25.4	4	21.0-23.2	22.4	11	22.3-26.1	24.90±0.38	1.27±0.27	5.09±1.09
Coracoid	3	22.3-23.6	23.1	4	20.2-21.8	21.1	13	20.5-24.0	22.35±0.33	1.17±0.23	5.24±1.03

*All Ancient Murrelets are from Del Monte, Monterey County, Calif. (sex unknown).
†All Xantus' Murrelets are females from San Pedro, Calif. (collected in winter).

TABLE 9. Measurements of the humeri of *Desmodus stocki* (in mm).

Measurement	Potter Creek Cave*			San Miguel Island			San Josecito Cave*		
	n	Range	Mean	*n*	Range	Mean	*n*	Range	Mean
Length	1	--	43.8	4	44.30-46.62	45.41	42	39.3-47.5	43.63
Proximal Width	2	6.75-6.8	6.77	5	6.50-6.98	6.80	47	5.8-6.8	6.27
Distal Width	5	6.5-7.1	6.95	4	6.95-7.25	7.08	52	6.4-7.3	6.78
Medial Width	7	2.5-2.8	2.67	12	2.50-2.95	2.72	56	2.0-2.9	2.52

*Measurements for Potter Creek and San Josecito Cave from Hutchison (1967).

no older than 3000 B.P. (C. King, pers. comm.), but beads are found only to a depth of about 54 inches (137 cm). The *Desmodus* material was recovered from depths ranging from 42 to 72 inches (107 to 183 cm). There are no noticeable differences in other parts of the fauna between depths of 40 and 72 inches (102 and 183 cm). The age of the material, then, is probably no younger than 2500 B.P. and no older than 5000 B.P.

Desmodus stocki, recently reviewed by Hutchison (1967), is known from Potter Creek Cave, Shasta County, California, and southern Florida, as well as from the type locality in Nuevo León, Mexico. All these localities are late Pleistocene and indicate a wide distribution for this species at that time. The San Miguel material is much more recent.

Living vampire bats are not migratory, but are adaptable species, occupying a wide variety of habitats. In Mexico, the preferred prey of vampires are horses, cows, and, in some places, domestic fowl (Dalquest 1955). The population of vampires on San Miguel Island was contemporary with man and might also have preyed on the sea mammals breeding there (Elephant Seal, California Sea Lion, and Harbor Seal), the numerous large sea birds (pelicans, cormorants, and gulls), or, at an earlier time, on the Pygmy Mammoths that inhabited the island.

SUMMARY

There is evidence that three species of birds not currently known to nest on San Miguel Island bred there within the last 2,000 years. These are the extinct genus *Chendytes* and the Manx Shearwater and Leach's Storm Petrel. Remains of House Finch are absent from the abundant passerine material from SMI 261, an indication that this species was absent from San Miguel before 500 B.P.

Snow Geese, and probably other granivorous anatids, were eaten by the prehistoric inhabitants of San Miguel. Most marine species of birds found in middens, however, appear to have been killed for their feathers rather than for food. An increase in the use of cormorants, beginning about 2000 B.P., may correlate with advances in boat building. A very small percentage of bird remains seems to have been used as artifacts. There is no evidence that young sea birds were harvested for food.

The analysis of bird remains from archaeological sites on San Miguel Island provides valuable information on the past avifauna of the island, as well as on the uses of birds by early human inhabitants. However, some of this information must be of a tentative nature because of the paucity of good osteological collections of recent birds and the need for large samples of skeletal material from the island.

The presence of the remains of at least eight individuals of *Desmodus* indicates a population of this extinct vampire bat once occurred on the island.

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Archaeological Evidence for the Recent Extinction of Three Terrestrial Mammals on San Miguel Island

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INTRODUCTION

In this paper, evidence is presented concerning the recent extinction on San Miguel Island of western spotted skunks (*Spilogale gracilis*), ornate shrews (*Sorex ornatus*), and a large insular species of deer mouse (*Peromyscus nesodytes*). Skeletal remains from these species are present in a faunal collection made by Charles Rozaire during the excavation of two archaeological middens (4-SMI-261 and 4-SMI-261A) on the northeast coast of the island.

SMI-261 is a small coastal cave located east of Bay Point. The faunal remains from this site were obtained by excavating most of the cave's interior and a 5-ft (1.5 m) wide trench extending 15 ft (4.6 m) into the talus at the mouth of the cave (Fig. 1). The SMI-261A site is located at the bottom of a vertical fissure in the cliff, a few meters below SMI-261. Both sites were excavated in arbitrary 6-inch (15.2 cm) levels and all faunal remains retained by a quarter-inch screen were collected. These deposits contained disc-shaped beads made by grinding the wall portion of purple olive shells (*Olivella biplicata*). *Olivella* beads of this type are characteristic of Middle Period (*ca.* 400 B.C. to 300 A.D.) occupations of the Santa Barbara Channel mainland (Gibson 1975).

Stratigraphic profiles indicate that SMI-261 is composed of a complex series of well-defined, more or less horizontal, interbedded strata (C. Rozaire, pers. comm.). According to Rozaire, the SMI-261A midden is comparatively homogeneous and lacks the obvious stratification that characterizes SMI-261. It is evident from this dissimilarity in midden structure that differences exist in the depositional histories of the two sites.

Human skeletal remains were present in the sites and it is probable that both middens were disturbed prehistorically by intrusive burial pits. Apparently, additional mixing of deposits occurred due to recent digging by grave robbers. This is evidenced by the concentration of highly fragmented, completely disarticulated human skeletons on the surface and in the zero to 6-inch levels of SMI-261 and SMI-261A (Table 1).

SPECIES ACCOUNTS

Peromyscus nesodytes and *Peromyscus maniculatus* (Deer Mice)

The faunal collections from SMI-261 and SMI-261A contain numerous remains of *Peromyscus nesodytes* (Fig. 2), a large species of deer mouse previously reported only from late Pleistocene deposits on Santa Rosa Island (Wilson 1936, White 1966). *P. nesodytes* is larger than any modern *Peromyscus* from the United States (White 1966). The mean molar row length of the Santa Rosa Island specimen is 5.95 mm (Table 2). This value does not differ significantly from those of *P. nesodytes* from either SMI-261 ($x = 6.06$, $t = 1.21$, $P > 0.50$) or SMI-261A ($x = 5.75$, $t = 0.753$, $P > 0.50$). Mean mandibular molar row dimensions of the San Miguel Island *P. nesodytes* do differ significantly from those of *P. anyapahensis*, a small species of extinct deer mouse from late Pleistocene deposits on Anacapa Island ($t = 7.41$, $P < 0.05$).

In addition to *Peromyscus nesodytes*, the archaeological collections also contain bones of *Peromyscus maniculatus* that are, in most respects, comparable to *P. m. streatori*, the only