A Prehistoric, Noncultural Vertebrate Assemblage from Tutuila, American Samoa

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Abstract: Ana Pē'a's is a small cove on the southern shore of Tutuila, American Samoa. Excavations at Ana Pē'a's yielded 13,600+ bones of small vertebrates, dominated (>95%) by the nonnative Pacific Rat, Rattus rattus. Represented in the owl-derived bone deposit are two species that no longer occur on Tutuila, the Pacific Boa (Candoia hibernum) and the Sooey Crane (Porphyrula汰苏).
Basing on bone counts, C. hibernum was the most common species at the site. The third most common, the Sheath-tailed Bat (Emballonura semiaudata), is extremely rare on Tutuila today. Compared with bone records in nearby Tonga, we believe that the deposit at Ana Pē'a's, with a radiocarbon date of A.D. 445 to 640, is at least 1,000 yr too young to be dominated by extinct species.

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615
prehistoric vertebrates. Our findings also generate a limited discussion of the historic biogography of Samoan reptiles and birds.

**MATERIALS AND METHODS**

Ana Pepe'a's (14° 18' 24" S, 170° 41' 00" W) is a small (ca. 24 m² of horizontal passage), seaward-facing cave of erosional origin at Ana Pepe'a Point (alternative name Manu'e Point) on the south-central coast of rugged Tuna'a (Figure 1). It lies 200 m SSW of Manu'e Village and is visible from the coastal highway (Figure 2). Only ca. 25 m inland from and ca. 10 m above the sea, Ana Pepe'a presumably formed through wave action at a time when the beach escarpment was lower relative to sea level.

The bones in Ana Pepe'a's are mostly from Excavation Unit 1 and 2 (166 cm long by 30-40 cm wide by 18-40 cm deep), in a small deposit of dry sediment on a ledge along the cave's northern wall. Excavation Unit 3 (100 by 100 by 33-56 cm deep) was on the main, central floor of the cave. Excavation Unit 4 (100 by 100 by 8-10 cm deep) was on a ledge on the cave's northeastern wall. Each Excavation Unit reached the basaltic bedrock of the cave. All excavation was by trowel. Levels are arbitrary vertical designations, whereas Layers reflect natural stratigraphic changes. During the excavations, on 22-23 April 1999, all sediment was dry-sieved in the field with screens of 1.25, 6.4, 3.2, and 1.6-mm mesh, thereby ensuring recovery of the smallest identifiable specimens.

The bones are mostly dark reddish brown but vary in color from yellow to orange to black. In the field they were stored dry, sealed in plastic bags (Whirl-pac, Nasco), and then shipped to the Florida Museum of Natural History (inv) to be cleaned, identified, and curated. Identification of the bones was based on comparisons with modern skeletons in v1 and the National Museum of Natural History, Smithsonian Institution (v2), supplemented for reptiles by specimens from the San Diego Natural History Museum (v3). Although D.W.S. scored all of the non-carnivorous bones from Ana Pepe'a, he did
not pick out every bone of Rana esculile from the concentrated sediment matrix. Thus the numbers of bones in Table 1 are accurate for every species except R. esculile, for which at least several thousand additional bones were recovered but not counted.

**RESULTS**

**Stratigraphy and Chronology**

The sediment at Ana Pepe’a consists of poorly stratified, pebbly, cobbly silt. In Excavation Units 1 and 2, it is loose, light reddish brown to dark brown, whereas in Excavation Unit 3 it is compacted and grayish brown in Layer I, becoming less indurated and variably more reddish in Layer II. The sediment in Excavation Unit 4 is light to dark yellowish brown. We found no artifacts or other cultural evidence, with the possible exception of some wood charcoal and a single fragmentary premolar of a pig (Sus sp.) in the top of Layer II in Unit 3, and a calvarium of a dog (Canis familiaris) in Unit 4.

Based on the radiocarbon (14C) chronology of human arrival in the Fiji-Tonga-Samoa region (Kirch and Hunt 1993, Anderson and Clark 1999, Burley et al. 1999, Steadman et al. 2002), the presence of bones of the non-native Rana esculile throughout the deposit at Ana Pepe’a should indicate an age of less than 2,000-2,500 cal a.d. An accelerator-mass spectrometer (AMS) 14C date (Beta-134472 [Figure 12]) is 1,595 to 1,310 cal a.d. (cal A.D. 945 to 660), based on purified collagen (acid-alkali pretreatment, followed by ultrafiltration) from the forearm of a juvenile chicken (Gallus gallus). This age is reasonable in light of the 19 taxa of vertebrates identified at Ana Pepe’a, which include at least four that are introduced...
Of the three bones referred to *Emissia* spp., the largest (a maxilla) came from a medium-large skink with an estimated snout-vent length (SVL) of 110 mm. Three species of *Emissia* in that size range now inhabit American Samoa: *Emissia tenser*, *E. nigra*, and *E. suauanci* (Brown 1941). The last two occur today on Tutuila. Our skeletal material of these three skinks is limited to *E. nigra*, which corresponds in general morphology with the fossil maxilla. An incomplete fossil dentary differs from that of *E. nigra* in details of dentition; it came from an individual ca. 91 mm SVL and probably represents one of the other two species. *Emissia suauanci* is common on Tutuila (Schwaner 1982), whereas *E. tenser* is a cryptic, territorial species confined to coastal strands of coral rubble. Because it occurs on Ofu and Ta'u, and *Emissia*...
Schwenter and Brown (1984), the absence of E. arenstii from Tuvalu is peculiar if it is not a result of local extinction.

The Pacific Roa, Damasia biros, is known in American Samoa from about eight specimens, all from Ta'u (Anderson et al. 1980). This makes it known from Savai'i and Upolu, a disjunction of about 210 km from Ta'u. The fossils from Tuvalu represent an extinct population that helps to explain this otherwise illogical geographic hiatus. The Pacific Roa probably occurred throughout Samos before people arrived.

The nine species of birds represent one introduced species (Gallus gallus), one seabird (Pterodroma ofari), and seven indigenous land birds. These land birds vary in habitat preference from forest edge and succulent habitats to mature forest, without any clear trend. The only species of bird no longer found on Tuvalu is the small, violet rail Porzana tabuana. On other Polynesian islands where it no longer occurs, P. tabuana often survived into late prehistoric or historic times rather than being lost in Leptis times (Bradman 1938a, in press). The only native mammal we found is the shorth-tailed bat Emballonura ornata, which is very rare on Tuvalu today (Grant et al. 1999) but probably persisted prehistorically in Ana Pe'a'spe's.

We believe that the barn-owl Tyto alba was responsible for the primary bone deposit (Excavation Units 1 and 2) because: (1) it is the most commonly represented bird, including six bones of nestlings (two thoracic vertebrae, ilioastrus, tarsometatarsus, two pedal phalanges); (2) all other bones recovered are of reptiles, birds, and mammals small enough to be eaten by T. alba (each of the four bones of the largest bird, the chicken, Gallus gallus, are from juveniles); (3) 95% of the bones are of Rattus exulans (Table 1), the preferred prey of T. alba in Oceania when available (R.W.S., pers. obs.); and (4) no cultural evidence (artifacts, charcoal, features, etc.) was found in the bone deposit. The few fish bones found in Units 3 and 4 are very small and could represent food of the pica- vorous tern Procellaria fusiculata, which in turn was consumed by the barn-owls. Three of the 19 bones of P. fusiculata (a humerus, thighbone, and tarsometatarsus) are from juveniles, suggesting that this species nested near the cave. The single bones of dog and pig at Ana Pe'a'spe's are certainly not from predation by Tyto alba but may represent animals whose carcasses, whole or in part, were taken to the cave by people, dogs, or pigs.

**Discussion**

**Vertebrates Prehistoric in Samoa**

Roger Green and Janet Davidson conducted field surveys and excavations on two of the largest and highest Samoan islands, Upolu and Savai'i, from 1957 to 1967 (Green and Davidson 1969, 1974). Their excavations yielded few bones overall (mostly fish, dog, pig, or human), and they reported no reptile or bird bones that could be identified to species (Green and Davidson 1969:241). In the Auckland Museum in 1988, D.W.S. identified 12 bones from their Loloatai site on Upolu as follows: nine from the chicken, Gallus gal- luc, two of the rail Gallirallus philippinus, and one of the tern Sterna antirhida. Each species still exists on Upolu. Subsequent excavations on Upolu in 1974 yielded no bird bones (Jennings et al. 1976).

During 13 days exploring of lava tubes on Upolu in April 1999, the only bird bones that D.W.S. found were a few surface remains of the swiftlet Collocalia nucifraga, which still nests in the same caves. Thus we know nothing at all about prehistoric birds (or reptiles) on two of the largest, highest, most culturally important, and species-rich islands in Poly- nesia. This is one of the most glaring and challenging voids in the historic biogeography of Polynesian vertebrates.

The situation is slightly better in American Samoa, where only one site other than Ana Pe'a'spe's has produced bones of indigenous vertebrates. The Tu'aga's archaeological site on Ofu, a small island (0.55 km²) in the Manu'a Group, dates from ca. 2,000 to 1,900 yr B.P. (see various chapters in Kirch and Hunt 1993). No species of lizards or bats were recorded among the bones from Tu'aga (Nagayoka 1993); fishes and birds were the only indigenous vertebrates. The 74 bird bones identified from the Tu'aga site (Osmad-
<table>
<thead>
<tr>
<th>Taxon</th>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Total</th>
<th>% NSIP</th>
<th>Unit 3</th>
<th>Unit 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Gymnarchus sp.</td>
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<td>Batrachoides sp.</td>
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<td>~</td>
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</tr>
<tr>
<td>Natrix natrix</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>&lt;0.04</td>
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<td>Lissotriton sp.</td>
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<td>&lt;0.02</td>
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<tr>
<td>Aneides aeneus</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>&lt;0.01</td>
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<td>Cricetus flavigaster</td>
<td>3</td>
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<td>18</td>
<td>&lt;0.01</td>
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<td>Microtus oeconomus</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>&lt;0.01</td>
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<tr>
<td>Apodemus flavicollis</td>
<td>1</td>
<td>3</td>
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<td>&lt;0.01</td>
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<tr>
<td>Apodemus sp.</td>
<td>1</td>
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<td>4</td>
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<tr>
<td>Voles</td>
<td>10</td>
<td>10</td>
<td>20</td>
<td>&lt;0.01</td>
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<tr>
<td>Total</td>
<td>98</td>
<td>68</td>
<td>166</td>
<td>&lt;0.01</td>
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</tbody>
</table>

The data in the table represent the species richness and abundance of amphibians and reptiles found in various samples. The table shows the total number of species (Total) and the percentage of non-specialist species (% NSIP). The data were collected during various surveys in different locations. The species richness was found to be high, indicating a diverse amphibian and reptile community.
from nearby Tonga (Pregill 1991); it is likely that these six species of terrestrial reptiles are indigenous to American Samoa: Emoia adgraeya, D. cyamara, B. learii, E. nigra, E. sa-
menis, and Candela ibirum. Lipinia maxima probably is a primate introduction (Austin 1999), whereas Chelodina mauii probably ar-
ivited through human agency in historic times (Fisher 1999). Hemidactyulus frenatus has been on central Pacific islands no more than 50 yr (Moritz et al. 1991). Some of the remaining species of lizards may have dispersed natu-
urally, such as G. annees (Zieg 1991, Fisher 1999), but the evidence is inconclusive. For any Pacific island group with indigenous liz-
sakes, the history of colonisation for each spe-
cies of lizard should be considered island by island.

More species of land birds have been re-
corded in historic times (the past two cen-
turies) on Savai'i (31–32) and Upolu (20) than on Tutuala, which has 17 species, more than any other island in American Samoa (Pratt et al. 1987, Steadman in press). The distribution and relative abundance of modern land birds in American Samoa are well documented (Amerson et al. 1982a, Banks 1984, Eng-
tering and Ramsey 1989, Prefeld 1999), but the species composition is obviously artificial, whether compared with that of independent Samoa or evaluated only among islands in American Samoa. Nearly all of the land birds shared between the two Samoas fall into four broad categories: avian/semitropical/grassland species (ducks, rails), predators (raven, kite, owl), passerines (geese, doves, starlings), and canopy saccar-
svores (bats, honeyeaters). The only exception is the ground-dove Gallinula major, although this species is extirpated or extremely rare anywhere in Samoa. Missing from all of American Samoa are 13 species (12 genera) known from independent Samoa (Steadman in press), consisting of two rails (Pternistis cinereus, Pterntisiteria pacifica), two cisticolas (Cisticola vittata, Dolichonyx gru-
igrax), and nine passerines (mostly under-
known inconides). Six of these 12 genera (Dolichonyx and five passerines) occur today or formerly in Tonga (Steadman 1993a, in press).

All or nearly all of the species that now inhabit independent Samoa but not American Samoa probably used to live in both places. From Upolu, Tutuala is easily visible to the east, with only 70 km of ocean separating these large, high islands. That all islands in American Samoa are smaller than Savai'i and Upolu is unlikely to account for the dif-
ferences in species richness. Instead we be-
lieve that habitat modification and predation, perhaps especially the Sivaera, may explain American Samoa's much poorer avifauna.

Evidence for this comes from bird surveys on small islands off Upolu in April 1999 (Prefeld et al. 2001). The only one of these islands with extensive native forest in Nu'utele (Whistler 1983), which also has the richest avifauna. Apolima, with the same land area as Nu'utele, supports a much less rich land bird community because it is inhabited (one vil-
lage of ca. 100 persons) and mostly defor-
mated. Five of the six species of land birds that we found on Nu'utele but on no other off-
shore islands are forest dwellers. These spe-
cies are more common in relatively mature forest than in more degraded habitats on Upolu, and Savai'i (Bellingham and Davis 1989, Evans et al. 1992). Just as in the Vava'u Group of Tonga (Steadman and Prefeld 1999, Frandsen et al. 1999), the cisticolas and passerines that are forest obligates can occur on very small Samoan islands (<1 km²) as long as much of the forest is intact.

Based in part on the age of the bone de-
posit at Ana Pe'apa'i (described here) and the situation in Tonga (Steadman 2002), it is possible that much of the hypothesised ex-
trusion of bird populations on Tutuala (and elsewhere in Samoa) took place within several centuries of human arrival. Thus, although informative, the bones recovered at Ana Pe'apa'i would have been even more so had they been deposited at least a thousand years earlier.

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