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The Monkey's Skull

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A primate skull found during archaeological survey in the White Mountains of eastern California in 1986 provides a new perspective on the early years of the U.S. space program. The individual, a pig-tailed macaque (Macaca nemestrina)*, probably a young male, was part of a research program to understand the likely physiological effects of space flight on primates. Among several possible scenarios, the most likely is that this animal managed to escape from laboratory captivity, only to be killed by a coyote or mountain lion. I presented this paper in the 2011 SAA session honoring the accomplishments of my close friend and colleague C. William Clewlow, Jr. While Billy and the primate described here were both pioneers, they were more importantly rebels, unwilling to accept limits others wanted to impose upon them. This turned out well for Billy; for the macaque not so much.*

On the Fourth of July, 1986, while returning from a short hike to gather some scientific information about the dolomite barrens that lie north-northeast of Paiute Mountain, about two miles south of the Nello Pace Laboratory on Mt. Barcroft, I noticed a small, partly buried skull lying upside down in the surface duff a short distance off my route. My initial thought was that it was that of a marmot, being roughly that size, with prominent dentition. I routinely collect such specimens to add to the U.C. Davis comparative faunal collection, and so wandered over to retrieve it. My first thought, upon picking it up, was that this was a very strange looking marmot. In fact, on closer inspection it didn't look much like a marmot at all. The teeth and eyes were all wrong–indeed, everything about it was wrong–for a marmot. It looked more human, and yet it didn't look human either. After a bit more confusion, it finally dawned on me that this was the cranium of a non-human primate (Fig. 1). I was wholly unprepared for this. At the time, I had been doing archaeology—excavating and surveying—all across the western United State for more than twenty years, and I had never once run across a non-human primate—and never expected to, since the native primates of the New World have not ranged north of southern Mexico since the end of the Tertiary. To my knowledge, this specimen was the first, and remains the only, instance of such a primary find in the continental United States. The question, of course, was what was this thing, and how did it manage to find its way here, 11,500 feet up in the White Mountains? The possibilities were predictably exotic.

BIGFOOT?

Stories of Bigfoot, or Sasquatch, abound in both native legend and the contemporary media of western North America. The opinions are varied, but the more serious modern Bigfoot scholars, most notably the physical anthropologist Grover S. Krantz (e.g., 1999), opine that Bigfoot is a very large primate, possibly a close relative of the giant ape, *Gigantopithecus blacki*, of Pleistocene Southeast Asia. While stories of Bigfoot are concentrated in the Pacific Northwest (the home of modern Bigfoot lore is Bluff Creek, Humboldt County, California), Bigfoot appears in the form of gorillas, cannibal giants, and something actually called "Big Foot" in Native American legends and early pioneer accounts of the Inyo region, as set down by Guy Earl (1980), an Owens Valley pioneer. If the White Mountains primate skull was that of a Bigfoot, it would be major news indeed—Krantz spent his whole life looking for fossil evidence and ended up sorely disappointed, and quite bitter to boot. He maintained to the end that absence of evidence was not evidence of absence—that skeletal evidence

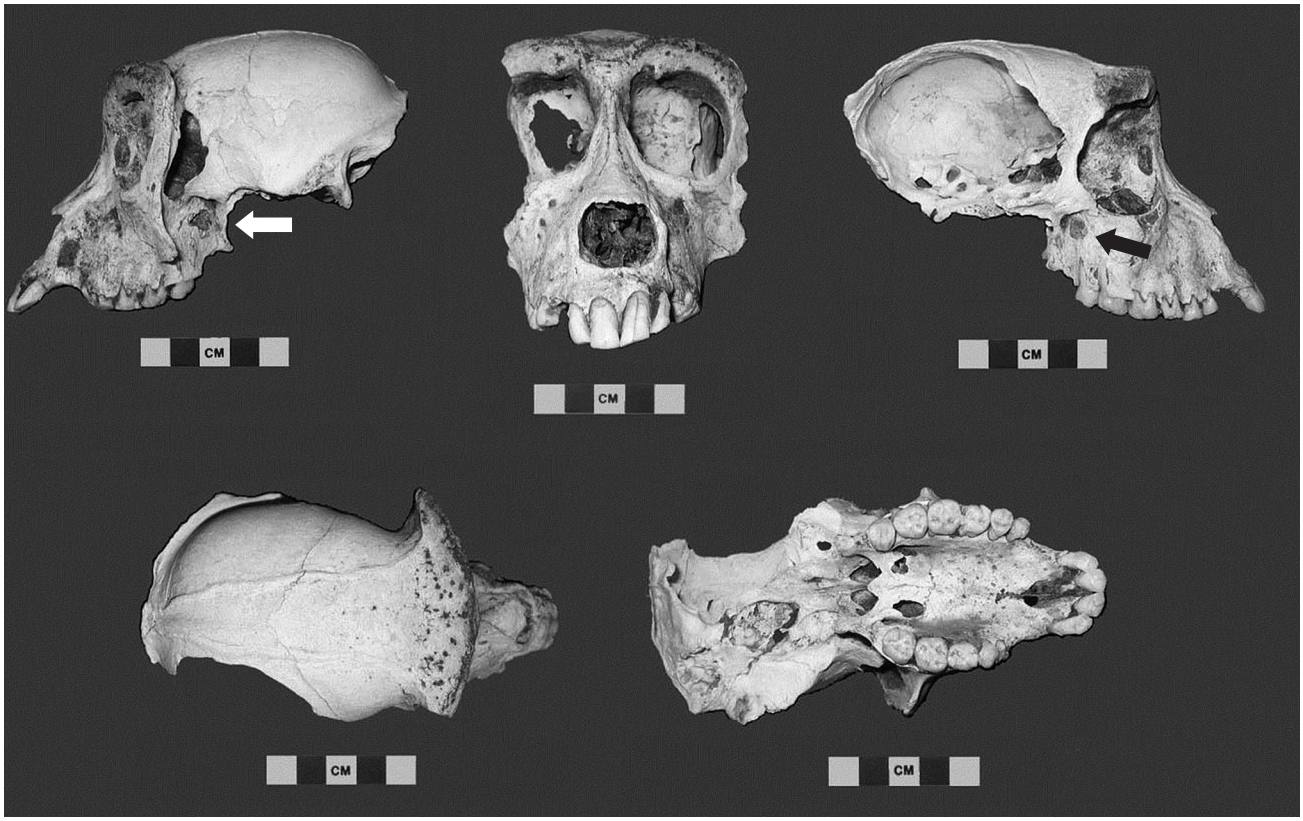

Figure 1. Views of skull identified as pig-tailed macaque (*Macaca nemestrina*): left side, front, right side, superior, inferior. Left, right, and inferior views clearly show gap left by canine extraction. Inferior view shows supernumerary fourth right molar. Damage most visible in the right, superior, and inferior views is consistent with consumption. Arrows on the left side and right side views indicate puncture wounds consistent with the killing bite of a coyote or cougar.

was just hard to come by, that people should keep an open mind, and that people should keep looking—which many continue to do.

NOT BIGFOOT

Sadly, however, for me, with glimmering visions of world fame and notoriety, the White Mountains skull could not belong to Bigfoot–at least not the Bigfoot of legend. It was surely not a close relative of *Gigantopithecus*, said to weigh in somewhere between 500 and 1,000 pounds. With fully erupted dentition, the White Mountains skull belonged to an adult animal that could not have weighed more than 15—and probably closer to 12—pounds. It was the size of a large monkey, not a great ape. Consultation with my good friend and colleague, the noted primatologist Dr. Peter Rodman, who helped me browse through various type specimens in the comparative primate collection housed in the Department of Anthropology at the University of California, Davis, quickly established that the skull was that of a pig-tailed macaque, *Macaca nemestrina*, an Old World Monkey (family Cercopithecidae, subfamily Cercopithecinae), native to Southeast Asia, the Malay Peninsula, Sumatra, and Borneo. Measurements for the White Mountains specimen were recorded by my graduate student Adie Whitaker, following a list of standard primate cranial measures furnished by Rodman. These measurements (Table 1), and the dentition, skull morphology, and only partly-fused cranial sutures, suggest it was a young male.

The cranium, various views of which are shown in Figure 1, had sustained substantial trauma at or after the time of death. The zygomatic, occipital, and parietal bones, and part of the frontal bone, were missing on the right side; on the left side, the zygomatic bone was missing and the sphenoid bone was heavily damaged. This is the kind of damage that occurs to the skull during the consumption of a killed or scavenged animal. The

Table 1

CRITICAL MEASUREMENTS FOR PIG-TAILED MACAQUE SKULL RECOVERED IN THE WHITE MOUNTAINS, CALIFORNIA

measurement	mm.
maximum mid-saggital length from the nasion	90.0
cranial breadth	nd
cranial height	50.3
maximum breadth of skull	nd
post-orbital breadth	37.6
biorbital breadth	nd
inter-orbital breadth	5.8
bizygomatic breadth	nd
basion-nasion length	67.6
basion-prosthion length	93.4
prosthion-nasion length	56.0
palate length	56.5
palate breadth	23.1
palate breadth	23.1

*nd = no data (unmeasurable).

predator or scavenger initially targets the fleshier parts on the outside of the head, concentrating on the major chewing muscles (masseter and temporalis); this causes damage to the zygomatic and sphenoid bones. It then opens the cranial vault to consume the fatty brain tissue inside, damaging the occipital, parietal, and frontal bones. Apart from this, the skull displays two dental anomalies. There are four upper left molars, rather than the usual three, and the upper incisors are missing, having been surgically extracted well before the animal died, as shown by the completely healed and sealed-over canine sockets. According to Rodman, neither of these features is particularly remarkable; supernumerary molars occur in low frequency in both the great apes and large monkeys, and incisor extraction is routinely performed on monkeys kept as either pets or as laboratory animals; extracting the fang-like incisors, or alternatively clipping them short, makes them much safer to handle.

MACAQUES IN THE WHITE MOUNTAINS

The White Mountain skull belonged a pig-tailed macaque that was once in the care of humans, but not likely as a pet. Too large and too rambunctious, macaques have never been popular as pets. Beyond that, it was quite difficult to credit a scenario that would have casual sightseers take an excursion into the White Mountains, during which the cherished family pet macaque goes out for a stroll, never to return. The more likely possibility was that this was a laboratory animal.

I was well aware that Nello Pace, the renowned physiologist who directed the University of California White Mountain Research Station from 1950 to 1977, had done extensive research with primates to study the physiological effects of altitude. Most of this work was conducted in what is now the Nello Pace Laboratory, on the slopes of Mt. Barcroft (12,470 ft.). This connection with primate research had earned the Barcroft facility a footnote in film history as the setting of the 1973 television film, *A Cold Night's Death* (Christopher Knopf, ABC), a 1974 Edgar Award Best Mystery TV Feature or Mini-series Nominee, that starred Robert Culp and Eli Wallach as two scientists experimenting with intelligent primates at an isolated cold weather research facility where things mysteriously keep going wrong—with tragic results. The film set was a near-perfect duplicate of the original Mt. Barcroft laboratory, but the script made the starring primate a chimpanzee, whereas Pace used pig-tailed macaques for nearly all of his experiments, which were much more significant than depicted in the film. They were an integral part of early space research. Pace was connected with the NASA space program, and was a major participant in an early mission known as Biosatellite III, which used a pig-tailed macaque as a test subject to study the effects of space flight on various physiological functions, including calcium balance (which was Pace's part of the project). The Biosatellite III capsule, containing a heavily instrumented, 13.2 pound, male pig-tailed macaque named Bonnie, whose incisors had been removed, was delivered into orbit on 28 June 1969 by a Thor Delta N launch vehicle. Designed to orbit for 30 days, Biosatellite III was returned early to earth, on July 7, after only nine days (actually 8.5 or 8.8 days, depending on which account you read), when sensors indicated an abrupt decline in the health of the subject macaque, which died shortly after the capsule was recovered (Adey et al. 1969).

According to his colleague F. Duane Blume, Pace studied colonies of pig-tailed macaques at what is now the Nello Pace Laboratory, on the slopes of Mt. Barcroft (12,470 ft.), beginning around 1968 or 1969 (roughly coinciding with Biosatellite III) and

continuing at least until 1972, or possibly until 1977, when Pace retired as director of the White Mountain Research Station. During this time Pace was working on the development of an automated primate research laboratory (APRL) for use in space. The APRL research heavily influenced NASA, but never went to space, a casualty of the Biosatellite III mishap. Blume recalls that Pace was particularly interested in the effect of altitude on blood pressure, fitting the laboratory animals with instruments monitoring these functions internally. Pace found that while both systemic and pulmonary blood pressure increase when subjects are first exposed to altitude, the systemic blood pressure subsequently decreases, but pulmonary blood pressure stays high, this being a major cause of pulmonary edema. Blume, who conducted some research with Pace's macaques, stated that in order to avoid putting them through the stress of the rough trip up the mountain by road, which would compromise the value of their observed physiological response, the experimental animals were flown directly to Barcroft by helicopter. One of Pace's resulting publications (Buderer and Pace 1972), describing a study of blood cell development in six young male pig-tailed macaques, provides a glimpse into the nature of this ground-breaking research. The subject animals were first monitored at Berkeley (at sea level) for 90 days, taken to the Mt. Barcroft facility, where they were monitored for 180 days, and then returned to Berkeley and monitored for 90 days. Keeping six male macaques at the Barcroft facility for six months would obviously have required a heavy investment in trained staff and specialized facilities. Even today, with better facilities, line power, and road access, the Barcroft facility is not operated during the winter months, so one presumes this experiment ran from about April to September, and almost certainly no later than October. Pace's demonstrated preference for pig-tailed macaques as experimental subjects, the number of animals involved in individual experiments, and the amount of time they were kept in residence at Mt. Barcroft, makes it virtually certain that the pig-tailed macaque skull I recovered in the White Mountains belonged to one of his animals. The obvious question remains, "Why did it end up where it did, more than two miles away from the Barcroft facility?

There would seem to be just two possibilities: (1) it escaped from the laboratory on Mt. Barcroft that now bears Pace's name, or (2) it died while in residence there and was placed in trash later raided by a scavenger, most likely a coyote. With so little to go on, both explanations require a good deal of imagination, but of the two, the second seems less likely. I do not know whether any of Pace's macaques died while at Mt. Barcroft, but if one did, it would most certainly not have been placed in the trash. Any macaque serving as a test subject represented a substantial research investment to Pace, even (perhaps especially) a dead one. The death of an experimental animal calls experimental protocols, and the data they are designed to provide, immediately into question. The death of the Biosatellite III macaque, for example, raised questions about whether the subject had been too heavily instrumented, which would imply that any data it returned were unreliable, capturing the effect of over-instrumentation rather than the effect of weightlessness, which was the point of this costly mission. There was an autopsy to help sort out the possibilities. This confirmed the immediate cause of death to be ventricular fibrillation, but unfortunately did not clearly establish the underlying cause of the animal's demise.

The death of any macaque while housed on Mt. Barcroft would have raised the same kind of doubts and elicited exactly the same response. As Duane Blume affirmed to me, any laboratory animal that died at the station would have been returned to Berkeley for autopsy and pathological study. The possibility that this animal was autopsied on the spot, at Mt. Barcroft, and its remains then discarded, can be dismissed out of hand; the skull lacks the distinctive saw cuts left by the routine extraction of the brain during autopsy, which is done for gross examination and the removal of test samples.

The location of the skull more than two miles south of the laboratory also works against the discard theory. It is highly unlikely that any scavenger would carry so large a carcass so far without consuming it, although one (albeit slim) possibility would involve a female coyote carrying a carcass to her denned pups. Most importantly, however, the skull was damaged in a way that suggests the animal was taken alive, not scavenged as a carcass. In addition to the gross damage connected with consumption mentioned earlier, there are two small, circular penetrations, one on each side of the cranium, at the rear of the maxilla, behind the zygomatic arch, indicated by small arrows in Figure 1. These are about

the size that would be made by the matching upper and lower incisors of a coyote, or less probably, a mountain lion. Their positioning is consistent with a bite to the throat, a predator tactic to choke and immobilize prey. Carried prey is not normally grasped at the throat, but rather in the middle of the back, legs hanging down. The position of these tooth marks, then, strongly suggests that this macaque was not only alive but active enough to pose a threat at the time it encountered the animal that killed and consumed it.

It would appear, then, that this macaque had somehow managed to escape from the Mt. Barcroft laboratory into the wilds of the White Mountains. One can only speculate about how this happened. Neither Duane Blume nor Don Buser, who worked in various capacities (including that of helicopter mechanic) at the White Mountain Research station during most of Pace's tenure, had any recollection of knowing or hearing anything (not even a rumor) about a macaque escaping from the Mt. Barcroft facility. Despite that, all the evidence suggests that this is exactly what happened. This is remarkable in itself, but it is not all there is to the story. There is evidence to suggest that, having made good his escape, this macaque subsequently managed to stay alive for an extended period of time.

We know, of course, our escapee survived long enough to put more than two miles between him and the laboratory. Traveling at full speed, however, this would not have taken much time, less than an hour, because macaques are capable terrestrial travelers. While they feed in trees, macaques do well on the ground. They spend a fair amount of the time there, moving between trees and patches of forest, feeding on edible items encountered on the ground along the way. The absence of trees, thus, posed no problem. Still, to survive for more than a few days, our escapee would have had to deal with all the other problems alpine dwellers daily confront: cold, water, food. He could not have wintered here, but he would have had little problem acclimating to temperatures from late spring to early fall, the six-month window during which laboratory experiments involving live subjects were then feasible at Mt. Barcroft, and thus the period during which he had to have escaped. Some hint of the potential ability of this macaque to stand extreme cold is furnished by his close relatives, the Snow Monkeys (*Macaca fuscata*) of Japan. Neither would water be a problem. There are very reliable springs in the area our macaque had to travel across in getting from the Barcroft laboratory to the dolomite barrens below Paiute Mountain, the place of his ultimate repose. The food problem would certainly have been the most critical. I have no idea how long a young male macaque might survive without food in the White Mountains. The teeth of this macaque, however, suggest that he did eat, quite a lot in fact. All four (upper) incisors and the two left premolars are much more worn than one would expect from a laboratory animal maintained on a highly-processed laboratory diet. The distribution and degree of wear, the grooving of the second incisors in particular, suggest the consumption of coarse, fibrous material (leafy stalks, for example) that was pulled through the jaw gap left by incisor removal during the act of eating. Wholly unfamiliar with the harsh alpine environment, the animal would still have found a fair amount of low quality plant material above ground: the leaves and fruits of wild rose and gooseberry and the seeds and stalks of grasses (e.g., wild rye, rice grass). Because pig-tailed macaques are primarily seed and fruit eaters, these alone might well have sufficed. Macaques have very effective nails, however, and it may have used them to get at the much more extensive alpine root growth below ground. Using some combination of these, it might have managed to survive in the alpine fastnesses of the White Mountains for several months, until dropping temperatures forced it to lower elevations, where the abundance of wild rose hips in canyon bottoms alone could have sustained it through the winter. If it lived that long, it is entirely conceivable it could have made the trip back up again to the alpine uplands when temperatures warmed in the spring.

The point is, I really don't know how long this remarkable macaque managed to survive before it was finally taken by a coyote or a mountain lion. I am speculating here, but in good condition, so large and intelligent an animal would not be attractive to a lone coyote; if such a loner killed this macaque, it probably did so within a few weeks of its escape, during which its condition had gradually deteriorated, making it easy prey. Even in good condition, however, a macaque would be no match for a small group of coyotes or a mountain lion. This could have happened at any time. Our macaque might have lasted only a few hours, but

he might have made it much longer, likely more than a month—and maybe, just maybe, a year.

However long he lived in the wild, it seems likely that a vehicle passed within sight of him: someone on their way to the Barcroft facility, to hike White Mountain Peak, or simply to take some pictures. I like to imagine what the reaction of this young macaque might have been upon seeing this vehicle (would he have run to it or away from it?)—and what the reaction of its occupants would have been, had they seen him. If there is a lesson here, it is the one echoed in Jurassic Park, that no matter how we try to contain them, living things have ways of getting away, getting out on their own. If nothing else, the skull I found on the dolomite barrens, north-northeast of Paiute Mountain, tells me this.

The scientific implications are less clear, partly because this find is so clearly "one of a kind." Nevertheless, its discovery underscores what we have always known about a key role of archaeology: to document, via their material (archaeological) record, events and behaviors for which written accounts do not suffice. A substantial fraction of archaeology, of course, is about subject matters predating written record (e.g., Pleistocene subsistence). An equally significant fraction, however, deals with behaviors that could have been recorded, but that no one thought were important enough to record, were selectively reported, or purposely not recorded. It is not clear which applies here. Putting the best face on it, the Pace laboratory may have deemed the escape of this macaque unfortunate but insignificant–not worth mentioning. More darkly, they suppressed any record of it to protect their sterling reputation as a well-run, tightly controlled scientific operation. Whatever the reality, no matter what his keepers wanted, the macaque (actually his skull) had the final say, contributing a small but important datum to our understanding of the early years of the US space program.

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