Spirit Cave Man

Biological Aspects

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INTRODUCTION

This report, "Spirit Cave Man: Biological Aspects," contains the inventory, general observations and an evaluation of the available data regarding the biological aspects of the human skeletal remains known as "Spirit Cave Man," as well as, a review of the pertinent literature. This work was undertaken with the purpose of informing the Bureau of Land Management (BLM) affiliation determination concerning Spirit Cave Man under the Native American Graves Protection and Repatriation Act (NAGPRA 1990 (25 USC 3001-3013)). NAGPRA requires federal agencies and museums receiving federal funds to locate, inventory and determine the ultimate disposition of cultural items, that is, Native American human remains, funerary objects, sacred objects and objects of cultural patrimony under their possession or control.

This report does not constitute an exhaustive scientific study, but rather provides a general characterization of the materials. It is also not intended to assert nor defend a specific point of view. Additional miscellaneous bones noted to be from Spirit Cave (AHUR 748, 752/773, 770) are not treated here as they were very fragmentary and/or had poor provenience and therefore cannot contribute to a determination of affiliation. Inventories of these bones are summarized in Appendices 2 and 3. A discussion and photographs of 752/773 are presented in Owsley & Jantz 1999:82-83.

Various terms are often used to refer to the same subject leading to possible confusion for the reader. This report uses the term "skeletal biology" instead of terms such as biological anthropology, physical anthropology, bioarchaeology, or biological anthropology, to refer to the scientific study of the physical aspects of man, that is hair, bones, teeth, genetic material, etc. in archaeological contexts. Also, the term "Paleoamerican" is used instead of Amerindian or Paleoindian to refer to ancient skeletal remains from the late Pleistocene to early Holocene (approximately 11,350-8,000BP). Clearly, the various alternative terms must be employed when quoting specific authors.

Section I presents a background discussion of the field of skeletal biology generally and, skeletal biology of the Great Basin, specifically. A description of the observations and measurements and resulting conclusions concerning the skeletal biology of Spirit Cave Man follow in Section II. Section III deals with biological affiliation as a general subject followed with cranial metric and non-metric analysis, dental morphology and hair analysis as it applies to Spirit Cave Man. Possible studies considered but not performed dealing with discussions on DNA, serum albumin and radiographs are presented in Section IV. A summary and evaluation of the findings is presented in Section V with a discussion of the importance of this highly significant Paleoamerican in section VI.

All references used in the preparation of this report are represented in the "References" section and constitute a record of all references consulted to date. However, they may not be specifically cited in the text unless directly relevant to the particular aspects under discussion.

I. BACKGROUND

Skeletal Biology

Skeletal biology studies, as is true of human biology studies generally, do not produce unequivocal conclusions for a number of reasons. Fundamentally, human biology changes as the result of genetic and non-genetic (nutrition, disease and other environmental influences) factors. Additionally, there is great biological variation within any given population so that a single individual may not possess any, much less all, of the traits that define the population/group. When attempting to deal with population affinities and differences, "...only 10-15% of the total genetic variation in our species can be ascribed to between-group differences" (Zegura 1985:1). There is also variation between the sexes of the same population so that, the "...morphological differences between the males and females of one population can markedly exceed the morphological differences between individuals of the same sex of different populations" (Van Vark & Schaafsma 1992:246). What is more, not all populations have been thoroughly studied or described in order to provide data against which to compare an unknown. These problems are compounded when one is dealing with a single unknown individual, such as Spirit Cave Man, who may have been very typical or atypical of the population to which he belonged.

"Skeletal and dental tissues are remarkably sensitive to the environment, including dietary practices, subsistence technology, nutritional quality, chronic disease, physical activity, and life-style in general, thus serving as a retrospective 'memory' of an individual's biological history" (Larsen & Hutchinson 1999:185). Though unequivocal conclusions are not possible, general overall trends and inferences may be derived using the data from skeletal biology studies.

Great Basin Skeletal Biology

The Great Basin is defined in numerous ways (cultural groups, vegetation, geographic features, etc.). There is no general agreement as to the territory it comprises, however the definition of the area used in this report is the core area (Figure 1) after Hemphill and Larsen (1999:2). It includes most of Nevada, the eastern half of Utah, small portions of southern Oregon, Idaho, and Wyoming, as well as eastern California. The Great Basin is comprised of highly differentiated micro clines (i.e., marshland, lake shore, sage grasslands, plateau and high altitude environments) which have changed over time. This variation and change has forced the human populations of the area to develop differing subsistence patterns, though not necessarily diverse biological make up.

Early on, Kennedy (1959:19) noted, "the population of the Great Basin shows a basic homogeneity, but minor regional differences occur." Recently, in his study of prehistoric Great Basin populations, Ruff (1999:320), noted that "...the 3 Great Basin samples-Stillwater, Malheur, and Great Salt Lake-are very similar in morphology, as they are in inferred behavioral patterns..." Therefore, due to the lack of a large data base and/or conclusive proof of distinctly diverse biological make up in different areas of the Great Basin, the data discussed in this section include several areas of the Great Basin, rather than simply the western portion. This approach increases the comparable sample population and provides a regional biological perspective.

Until recently there have been relatively few studies or reports involving human skeletal materials from the Great Basin (Brooks & Brooks 1979, Brooks et al 1977, Dansie 1974, Galliher 1978, Gifford 1926, Hardesty 1969, Heizer 1951, Kennedy 1959, Leavitt 1974, Loud & Harrington 1929, Morbeck 1970, Orr & Berger 1965, Reed 1967, Reichlen & Heizer 1966, Romney 1957, Stedt 1979, Tuohy & Clark 1979, Tuohy & Stein 1969, Warren 1974, Wheeler 1997, 1943, 1940a,b, Wheeler & Wheeler 1969, 1944). With the exception of

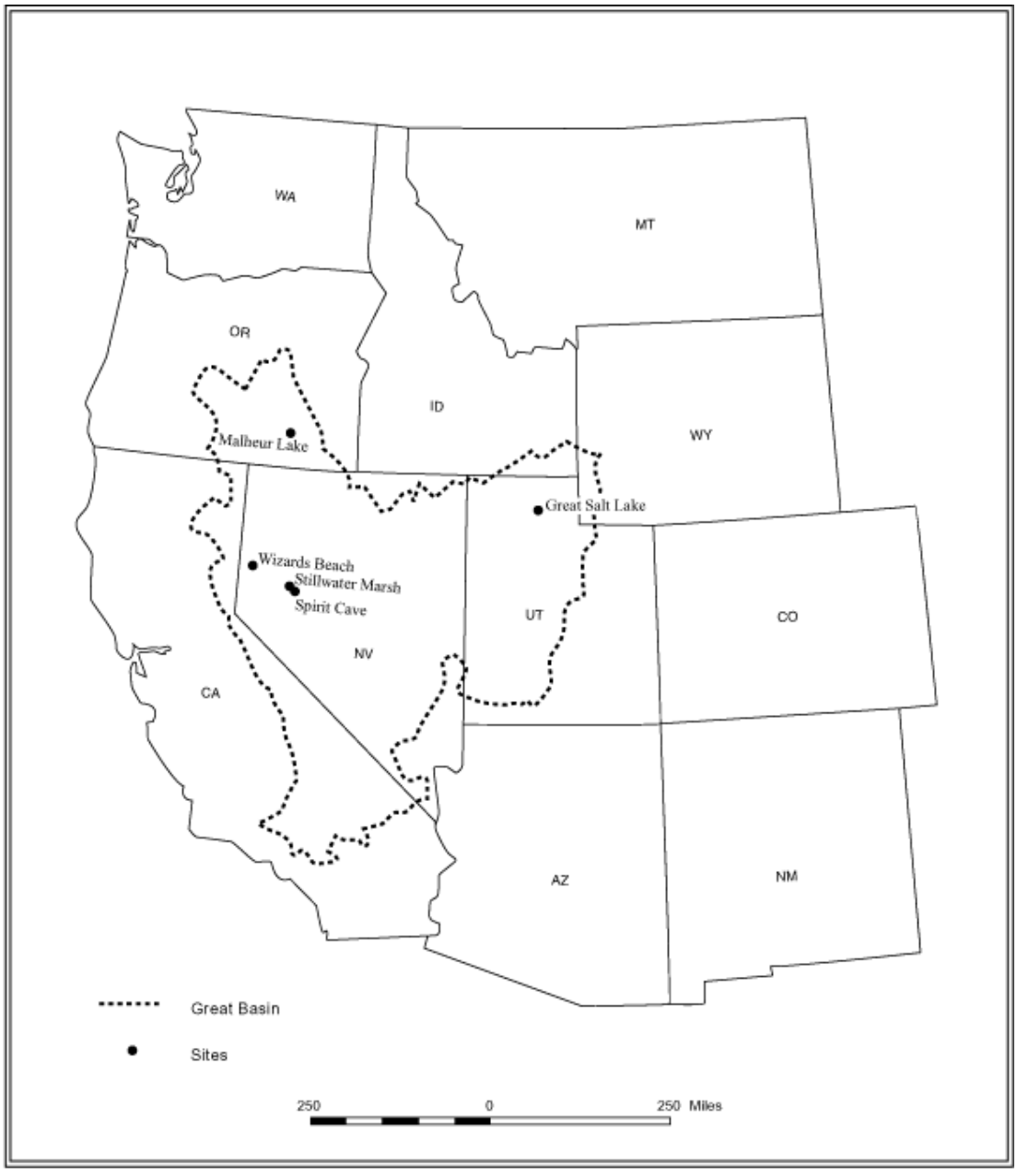

Figure 1. The Great Basin and referenced site locations.

the Kennedy, Galliher and Stedt works, studies consisted of few skeletons and often as little as one. Some materials were located and subsequently reburied or returned to tribes (Brooks & Brooks 1979:459, Dansie 1997b:17, Hattori et al 1987:1). Great Basin materials have consisted of isolated randomly distributed or fragmentary skeletons, some cremated; located in caves, crevices, rock shelters, cairns or pits; in flexed or extended positions, with or without associated artifacts (Kobori 1981, Pendleton et al 1982). Few burials were associated with diagnostic artifacts and many sample populations were small and inadequately documented.

However, extensive flooding occurred in the region in the early to mid 1980s, exposing archaeological materials spawning numerous salvage projects that "...more than doubled the number of known precontact human skeletal remains" (Hemphill & Larsen 1999:2) in the Great Basin. This, along with increased research interest in the area, resulted in several new studies (Brooks & Brooks 1990, Brooks et al. 1988, Crownover 1984, Hattori et al. 1987, Hemphill 1999, Kaestle 1998, 1997; 1995, Kaestle et al. 1999, Kobori et al. 1980, Larsen 1985a,b,c, Larsen & Hutchinson 1999, Larsen et al. 1996, 1995a,b, Loveland 1991, O'Rourke et al. 1999, 1997, Parr et al. 1996, Ruff 1999, Smith et al. 1995, Stark 1983, Stark & Brooks 1985, Stevens 1982, Thomas 1985a,b, Tuohy & Haldeman 1987).

II. SPIRIT CAVE MAN

On August 11, 1940, S.M. and Georgia Wheeler discovered the human remains now known as "Spirit Cave Man." "The burial pit consisted of an excavation four feet wide, six feet long, and two feet ten inches deep. This pit was lined with sage brush and the bundle set in place. The latter was then covered with sage brush and the pit filled with rocks." (Wheeler 1940:3) (Figures 2 & 3). "The head, slightly higher than the hips, was oriented 55 degrees east of true north. It lay on its right side on a fur blanket, the legs being semi-flexed, with the knees opposite the hips. The bones of the lower portion of the body were exposed but, from the hips upward, it was partly mummified. The scalp was complete with a small tuft of hair remaining" (Wheeler and Wheeler 1969, Wheeler 1997) (Figure 4). Wheeler (1940:3) also states "...the head and trunk were wrapped in a finely-woven twined mat of split tule which was sewn together around the head. A similar mat was next wrapped around the lower portion of the body and a large sleeping mat of whole tule stems was laid over the whole bundle, the two lower corners being tied together under the feet."

Today the remains consist of a complete skeleton (minus a left patella and a few phalanges) including all teeth, with some desiccated skin, ligaments, cartilage and hair and nails present (Appendix 1). The skeleton is that of a small gracile, adult male, that was approximately 40-50 years of age at death. Occasionally, Spirit Cave Man is referred to as a mummy, however, as the term mummy refers to "...well preserved dead bodies," (Cockburn et al. 1998:1), this report will not refer to the remains as a mummy.

An early Holocene date of around 9430+/-60 BP (Kirner et al 1997), makes Spirit Cave Man one of the oldest dated remains in the Great Basin and the fourth oldest in North America (Kirner et al 1996:3). Publications, articles, reports and data have been generated from studies of the skeleton which, provide a non-technical overview (Wright 1999), present general comment on possible studies (Kaestle 1999, Walker 1999), furnish general descriptive measurement and/or observations (Gill 1998a, Goodman & Martin 1999, Steele 1997), provide specific information or data (Dansie 1997a,b, Owsley 1996, Tuohy & Dansie 1997, Turner 1998, Wheeler 1997, 1943, 1940a, Wheeler & Wheeler 1969, 1944), answer specific research questions (Edgar 1997, 1996, Jantz and Owsley 1997) or as part of overall studies of Paleoamericans (Jantz and Owsley 1998, in press-2000, Owsley & Jantz 1999, Ozolins 1997 et al., Ozolins 1999, Powell 1999, Powell & Neves 1999, Steele & Powell 1999). These publications and their findings will be discussed in the pertinent sections of this report.

Observations

General observations regarding indicators of sex, age, stature, signs of trauma, pathology and markers of occupational stress present in Spirit Cave Man were made by the author using recognized methods and standards (Bass 1995, Haas et al 1994, Ortner & Putschar 1981, Steinbock 1976, White & Folkens 1999).

Sex

Based on the morphology of the pelvis (overall size and shape generally, sciatic notch, auricular area, pre-auricular sulcus, acetabulum, pubis, and sacral width and curvature), cranium (mastoids, supraorbital ridges, muscle attachments) and the diameter of the femoral and humeral heads, this individual appears to be a small gracile male.

Age

Observations regarding the degree of tooth wear, the degree of arthritic changes throughout the skeleton, and changes in pubic morphology and auricular surfaces, indicate an age at death of between 40-50.

Figure 4. Original position of Spirit Cave Man. (*Illustration by T. Whitney*)

Stature

Measurements of the lengths of the long bones of Spirit Cave Man, indicate a stature in life of approximately 5'4" using the regression equations of Genoves (1967:76) and Trotter and Glesser (1958:120).

Signs of Trauma

The cause or manner of death is difficult to determine in an archaeological context as many causes of death leave no indications on bone. Some may have involved only soft tissue which is no longer present. Indications of cause or manner of death in skeletal material are usually signs of certain types of diseases, pathologies and/or trauma. Some trauma or injuries allow conclusions about the type of force used. Blunt force is that which is applied with a blunt instrument such as a rock or a heavy stick.

Spirit Cave Man shows signs of blunt force trauma on the left side of the skull. Signs of trauma consist of an oval defect measuring 6x5 mm in diameter on the left frontal bone of the skull. A second oval defect measuring 40x30mm, spans the frontal and parietal bones. A fracture, generally slightly anterior of the coronal suture measuring 83 mm, runs through the left sphenoid, frontal and parietal showing signs of healing. The location and character of the trauma could indicate an accidental occurrence or may have been the result of interpersonal violence. Spirit Cave Man appears to have suffered a severe cranial fracture on the left side of his head but evidence of healing would indicate it was not the immediate cause of death. It is always possible that complications from the injury may have ultimately led to his death but there is no evidence present to support such a conclusion.

A healed fracture of the right fourth and a possible old fracture of the right third metacarpal are present. Generally, fractures to hand bones may be indicative of fractures occurring as a result of an accident or incurred in an attempt to defend the face and head from interpersonal violence.

Pathology

Disease processes may leave indications on bone providing information on health and disease patterns of prehistoric groups. Some pathologies are more common in some groups and less common in others. Caution must be exercised in any conclusions based on evidence of pathology as different diseases or conditions may leave similar evidence or may leave no indication whatsoever on the bone. Pathologies include infections, congenital disorders, degenerative disease, tumors, metabolic disorders, endocrine disturbances, and dysplasias. Dental pathologies include caries, abscesses, periodontal disease and malocclusion.

Skeletal pathologies present in Spirit Cave Man include an extra thoracic vertebra (13th) with the corresponding extra right rib, some arthritic lipping through out the skeleton, particularly on the left proximal radius and ulna and the vertebrae, and spondylolysis (degenerative disease) of the 5th lumbar vertebra.

Dental pathologies present include three large aveolar abscesses located at the maxillary (upper) right and left first molars and the right mandibular (lower) first molar. The occlusal surfaces of the teeth exhibit the heavy wear typical of aboriginal populations consuming foods which have high grit or ash content due to food grinding or preparation techniques.

Using teeth as tools can also contribute to heavy wear (Hinton 1981, Molnar 1972, Molleson 1994, Schultz 1977). The presence of possible "string" grooves on the incisal (chewing) surface of six teeth of the anterior dentition of Spirit Cave Man were noted by Edgar (1996), Goodman (1999) and Turner (1998). String grooves have been noted in other Great Basin material (Brooks et al 1988:138-143, Larsen 1985c, 1997:258-

260). Larsen (1985c), in his study of prehistoric Great Basin material, felt that the grooving of anterior teeth was the result of sinew and plant fiber preparation using teeth to produce string or lines. However, the "...use of teeth as tools is...a rather common practice among peoples living in traditional societies throughout the world," (Milner & Larsen 1991:364-365).

Hair

Ancient objects, paintings, carvings and monumental sculpture depict hair - its style, length, texture and even color in the case of pigment survival. The gross form of head hair was an important group affiliation criteria in early anthropological studies. The macroscopic appearance of hair was the fundamental method of study until the early 1800's. With the development and refinement of microscopic techniques that is no longer the case and mounted hairs are generally observed microscopically under 40x-250x magnification.

A quantity of hair is present with Spirit Cave Man and was approximately shoulder length. The current color of the hair is reddish-brown. Hair present in an archaeological context, regardless of its original color, is often brown or reddish-brown which is generally due to the interaction over time with surrounding chemicals in the soil or ground water.

Markers of Occupational Stress

Markers of occupational stress (MOS) are indicators of activity-induced change on bones which include musculoskeletal stress markers and robusticity markers (Kennedy 1998). These markers can represent a broad spectrum of lifestyle repetitive activities rather than the diagnosis of specific behaviors. MOS in an archaeological context are generally used to infer types of activities associated with subsistence strategies. Spirit Cave Man had no highly distinctive MOS which would support any assumptions regarding specific lifestyles or regional origins (Bridges 1990, Capasso et al. 1999, Hawkey & Merbs 1995, Kennedy 1989, 1983, Wilczak & Kennedy 1998).

III. BIOLOGICAL AFFINITY DISCUSSION

Overview

"Many problems in comparative biology and biological anthropology require meaningful definitions of the 'relative size' and 'shape'" (Jungers et al. 1995). Comparative studies of the morphology of different organisms (Darroch & Mosimann 1985) can address problems such as "...evolutionary short-term dispersals and/or gene flow" (Holliday 1997), and fossil affinities (Albrecht 1992), among others.

Human skeletal biology often attempts to characterize relationships between human populations using biological data (i.e., measurements and/or observations) (Brooks et al. 1990, Brues 1990, Gill 1998b, 1984, Gill & Rhine 1990, Haas et al. 1994, Holliday 1997, Ossenberg 1994, Rhine 1990, Sauer 1992, Van Vark & Schaafsma 1992). Using multivariate and biological distance statistics, measurements taken throughout the skeleton and/or dentition, provide data for quantitative (metric) means to assess biological distance or affinity (Brace & Hunt 1990). On the other hand, "qualitative methods involve comparisons of frequencies or proportions..." (Scott & Turner 1997:256) of various observable traits throughout the skeleton and/or dentition, providing a non-metric means to assess biological distance or affinity.

Several problems are inherent in both metric and non-metric methods. One of the most important is that no single morphological feature has been documented as completely free from non-genetic influences (nutrition, disease and other environmental factors). Also, no single individual or small group of individuals is likely to possess the entire suite of traits that appear to define the population. Thus, there is variation within populations (Darwin 1975, Johnston & Schell 1979). There is also the problem of inter and intra observer error to consider. That is, no single researcher makes measurements or observations in the same exact manner each time and no two individual researchers make measurements or observations in the same exact manner on the same material. Though highly useful tools exist involving biological data, the group affinity of a single individual may be impossible to identify using the current state of knowledge of non-genetic influences and the lack of comparable databases and possible error factors introduced by inter or intra observer error.

The foundation of many biological affiliation discussions regarding the New World is best summarized by Lahr (1995:165). "At issue is whether Amerindians represent a relatively late population diversion from East Asians that entered the American continent at the very end of the Pleistocene, and were thus relatively homogenous in biological terms, or whether the continent was originally occupied by more than one group and possibly earlier in time, before and during the last glacial maximum."

Studies conducted in an attempt to answer the question of the peopling of the Americas have used various techniques (Anderson & Gillam 2000, Ossenberg 1994) but have principally involved measurements and observations of crania and dentition and the analysis of mitochondrial DNA (mtDNA) evidence. As Powell (1999:224) notes, "A number of models of New World colonization and dispersal have been suggested by researchers using genetic, dental, and craniofacial databases, including one, three, or four waves of migration from the Old World."

In the case of Spirit Cave Man, hair was present as well, adding an additional dimension to the customary lines of evidence usually available in the study of ancient materials.

Cranial Metric and Non-metric Analysis

Craniometrics is a quantitative attempt to document the morphological similarities or differences between

populations using a series of cranial measurements. These cranial measurements generally assess group identity through morphometric comparisons using multivariate and biological distance statistics (Howells 1989, 1973, 1969). The resulting groups, or clusters, reflect some degree of relationship or lack of relationship. There is an assumption that those populations displaying the most similarities, or affinity, are most closely biologically related. That is, groups that are closely related tend to share similar features and dimensions (measurements).

The lack of comparable data is particularly problematic when dealing with Paleoamerican (late Pleistocene to early Holocene-11,350-8,000BP) materials as there are only approximately 21 known skeletons from North America older than 8,500 BP (Powell & Steele 1992:59). Due to the limited number of ancient materials available, there are relatively few metric and/or non-metric morphological analyses (Breternitz et al. 1971, Fenton 1998, Green et al. 1998, Jantz & Owsley in press-2000, 1998, 1997, Neves & Blum 2000, Owsley & Jantz 1999a,b, Ozolins 1999, Ozolins et al. 1997, Powell 1999, Powell & Neves 1999, Powell & Rose 2000, Powell & Steele 1992, Steele 2000, Steele & Powell 1999, 1994, 1993, 1992). Studies are often based on different measurements due to the fragmentary or incomplete nature of the material. Most ancient remains do not resemble contemporary Native Americans nor each other. "Specifically, the early skulls consistently have longer, narrower faces; longer, narrower braincases; a more projecting, mid-facial region; and cheekbones that slope to the rear," (Steele 2000:61) than Northern Asians and contemporary North American Indians. Jantz and Owsley (1998:128), in a study on 11 ancient crania, found that "...it is critical to recognize the marked heterogeneity among early American crania. This along with the finding that most early American crania are different from recent American Indians means that the history of American populations is much more complex than has generally been supposed."

A well expressed perspective is summarized by Steele and Powell (1994:158) "...the late Pleistocene and early Holocene populations of northern Asia and the Americas differed morphologically, but we are unsure of the cause of these differences. One view is that these differences substantiate that the earliest colonizing populations entering Beringia had a different genetic structure than later northern Asians and their North and South American descendants. The second view is that these differences reflect an adaptation of later populations to a different environment or lifestyle, possibly associated with the origins of agriculture, and that these adaptations were accomplished by the general plasticity of a common genome."

Spirit Cave Man Craniometric and Non-metric Studies

In the Jantz and Owsley craniometric study of Spirit Cave Man (Jantz & Owsley 1997), Spirit Cave Man's cranial dimensions were compared to 39 groups around the world (including eight North American Indian groups) with the number of comparison sample individuals ranging from 22 to 111. Multivariate analysis of individual components included vault profile, vault and face breadth, facial forwardness and prognathism, and face height, breadth and projection.

The Jantz and Owsley analysis identified the Spirit Cave Man cranium closest to "Norse" and "Ainu." It should be noted that the probability for Norse was 0.00084, with Ainu an even lower probability. Table 11 (Jantz & Owsley 1997:80) shows the distances of Spirit Cave Man from all of the comparative samples sorted from the smallest to the largest, showing Zalavar, Blackfeet, Numic, Atayal, and "Egypt" as the next five with a much lower probability. Jantz and Owsley note that the "...major conclusion is that the skull falls outside the range of variation of any modern population represented by currently available samples" (1997:79). That is not to say the measurements fall outside of the range of variation for modern Homo sapiens; more likely the currently available samples are insufficient to cover the range of variation in modern Homo sapiens.

Another craniometric study by Jantz and Owsley (in press-2000) compared 11 Paleoamerican crania (4500 BP-7000 BP or older), including Spirit Cave Man, to Howells' worldwide modern sample and additional historic American Indian samples. They found "...our results are inconsistent with hypothesis of an ancestor-descendent relationship between early and late Holocene American populations."

Steele and Powell found that the "...results of principal component analysis of Spirit Cave and Wizards Beach[1] cranial measurements suggested ...they were distinct from more recent populations, and that no recent population resembled them" (1999:115). They were also found to be distinct from one another. Also, "though they are distinctive from recent American Indian samples, it is also clear that the recent samples most closely resembling these two specimens are Polynesians and Australians, both populations distinguished by their relatively narrow faces, longer crania, and more projecting faces" (1999:116).

Ozolins, in a study using Spirit Cave, as well as other Paleoamerican cranial measurements, found "...that the amount of variation present among Paleoindians is not greater than what would be expected for three individuals drawn at random from a single population..." (1999:216).

Gill, from his metric and non-metric study of Spirit Cave Man (1998:1-2) notes "... a mixture of "typical Amerindian" and "traits that are basically Caucasoid" with a "'generalized Caucasoid' trait constellation.'"

From the cranial metric and non-metric studies performed to date, Spirit Cave Man does not appear to resemble any contemporary American Indian population. The metric and non-metric data and observations available, given the state of the technology and theoretical framework at this time, does not allow the assignment of Spirit Cave Man to an affiliation with a particular tribe.

Dental Morphology

Due to the location, compact structure and relative hardness of teeth, they can be the only hard tissue to remain in ancient burials. Dentition can provide possible indications of individual characteristics, age, habitual behavior and cultural alterations (Hinton 1981, Larsen 1985c, Milner & Larsen 1991, Molnar 1972, Molleson 1994, Schultz 1977), diet, pathology, environmental stress and indications of general group identity (Hilson 1986, Kelley & Larsen 1991, Mayhall 1992, Morris et al 1978, Powell & Steele 1994, Scott & Turner 1997, Turner et al. 1991, Turner 1994, 1990, 1985). "The use of dental morphology and the observation of dental morphological traits have a long history in dental anthropology" (Mayhall 1992:66).

Innumerable studies have been conducted on teeth, particularly the frequency variation of various traits (e.g., shovel-shaped incisors, molar cusp and groove patterns, Carabelli's trait, protostylid, etc.) regarding general group identity (Scott & Turner 1997) with particular focus on the peopling of the New World (Powell 1999, 1993, Powell & Neves 1998, Turner 1994, 1985) generally or specifically (Kobori et al. 1980, Morris et al. 1978).

Some problems are inherent in this methodology. These problems include an overlap in the frequencies of traits between populations, that the highest values for a specific trait may be very low (e.g., 35% for Carabelli's trait) and, no trait is totally absent in any group (Scott & Turner 1997). Also, as is true in all morphology based observations, a single individual may possess all, some, or none of the traits that appear to

[1] Wizards Beach Man is a Paleoamerican skeleton housed at the Nevada State Museum. Originating from a site at Pyramid Lake, Nevada, the skeleton is from the same time period as Spirit Cave Man.

define the population.

With the exception of the third molars, Spirit Cave Man's teeth are severely worn, limiting the information available. Dental discrete trait observations on Spirit Cave Man were recorded by Edgar (1996), Goodman (1999) and Turner (1998). Edgar, Goodman and Turner noted the presence of incisor shoveling; Turner and Goodman, incisor winging and an interruption groove; Turner observed a shovel shape canine and enamel extensions on molars; and, no Carabelli's trait was noted by any observer. Turner records an overall "impression-Sinodont" (1998:1) for Spirit Cave dentition. Sinodont, a term originated by Turner, specifies a subdivision of the Mongoloid dental complex which generally includes the populations of China, Mongolia, Japan, Korea, Northeast Asia and North and South America (Indian & Eskimo) (Scott & Turner 1997:270-271).

The frequency of the traits noted in the Spirit Cave dentition, and the presence of these traits as a group, is generally higher in Asians and Native Americans. However, for the reasons stated above, this does not address affiliation with a specific contemporary Native American group.

Powell (1999), in a study examining craniofacial and dental traits from North and South American Paleoamericans (including Spirit Cave Man), late Holocene material, and Pacific Rim populations, found that "...Paleoindians are dentally and craniofacially distinct from both European...and modern Native American...populations, but not from northeast Asians... or Polynesians" (1999:224).

The suite of dental traits present or absent in the dentition of Spirit Cave Man does not allow for the assignment of Spirit Cave Man to an affiliation with a particular tribe, given the state of the technology and theoretical framework at this time.

Hair Analysis

Hair has long been used to describe group differences. Group affiliation, in the broadest of terms, White, Black, Mongoloid, can often be assigned to an individual using the microscopic study of head hair, noting the density and distribution of pigment granules, hair shaft diameter and variation, cross sectional shape, and cuticle thickness (Hicks 1977).

A hair sample from Spirit Cave Man was microscopically analyzed by Craig Lahren, then of the Hamilton County Medical Examiner's Office. Lahren (1997:2) reports that the "...density and distribution of the pigment granules, ... a moderate shaft diameter with minimal variation, and an oval cross-sectional shape... are consistent with hair derived from ...a Caucasian individual."

A hair sample was also microscopically analyzed by Joseph DiZinno of the Federal Bureau of Investigation (FBI), who observed "...numerous dark reddish-brown, Asian origin head hairs" (DiZinno 1997:1).

The hair sample analyzed by Lahren, and a sample collected from Spirit Cave Man by BLM, was analyzed by Douglas Deedrick, Chief, Trace Evidence Unit, FBI. Deedrick found "all of the hairs submitted exhibit microscopic characteristics consistent with originating from an individual of Asian (Mongoloid) ancestry" and that the two samples ". ..are consistent with originating from the same individual" (Deedrick 2000:1).

Goodman and Martin observing only gross morphology note, (1999:4) "we now judge the hair to be medium to dark brown and straight. In other words, the hair is exactly the color and form [sic that] is most common in Northern Asian or a Native American."

The hair studies performed to date do not allow the assignment of Spirit Cave Man to an affiliation with a particular tribe.

IV. Possible Studies - Considered But Not Performed

Deoxyribonucleic Acid (DNA)

Genetic studies, many using ancient DNA (aDNA), (Anderson et al. 1981, Andrews 1994, Brown & Brown 1994, Crawford 1998, Hagelberg 1994, Hagelberg et al. 1991, Hagelberg & Clegg 1993, 1991, Heyer 1995, Hoss 2000, Klein 1999, Kolman & Tuross 2000, Labuda et al. 1997, O'Rourke et al. 1996, Ovchinnikov 2000, Paabo 1987, 1986, Paabo et al. 1988, Parr et al. 1996, Relethford 1998, Relethford & Harpending 1994, Rogan & Salvo 1994, Scozzari et al. 1997, Shearin et al. 1989, Shields et al. 1993, 1992, Stone & Stoneking 1993, Szathmary 1994, Torroni et al. 1994, Tuross 1994, Tuross & Kolman 2000, Ward et al. 1991) particularly mitochondrial DNA (mtDNA), are providing substantial new information regarding the peopling of the Americas (Bonatto & Salzano 1997, Easton et al. 1996, Horai et al. 1993, Merriwether et al. 1995, Schurr 2000a,b, Schurr et al. 1990, Starikovskaya et al. 1998, Stone & Stoneking 1998, Torroni et al. 1993a,b, 1992, Williams et al. 1985, Wilson et al. 1985). Many recent studies have involved mtDNA (Bailliet et al. 1994, Forster et al. 1996, Lorenz & Smith 1996, 1994, O'Rourke et al. 1999, Wallace & Torroni 1992, Wallace et al. 1985) which is inherited from mother to daughter (Conroy 1997) generally accumulating mutations in a linear fashion, with many mutations correlating with the geographic region where they first occurred, and, are sensitive to changes in gene frequencies that occur over time (Schurr 2000a,b). Nearly all (~97%, Brown et al. 1998) Native Americans carry one of four mtDNA haplogroups (ABCD). These vary among tribes and are also present in Asian and Tibetan groups. As these four haplogroups characterize most modern Native American groups, it appears to imply a limited number of founding groups from Asia which spread across North and South America. A new haplogroup, X, has been noted (Brown et al. 1998; Smith et al. 1999) in both ancient and contemporary American Indian material as well as contemporary European and Near Eastern populations. It is also possible that diverse groups entered North America but came to genetic dead ends due to disease, accident or war.

Recent improvements in extraction and amplification techniques (Yang et al. 1998, Zierdt et al. 1996) allow for better extraction of DNA; however, extraction and amplification of aDNA is problematic (Handt et al. 1996, 1994, Hoss 2000, Lindahl 1993, Taylor 1996, Tuross & Kolman 2000). When dealing with ancient materials, mtDNA studies are hampered by damaged or contaminated material. "Radiation (mainly UV), temperature, moisture, pH, oxidative agents, and mechanical stress are among the most important factors influencing the survival of DNA under diagenesis" (Herrmann & Hummel 1994:3). Contamination may be "...by either modern DNA of diverse origin and/or ancient microbial DNA," (Herrmann & Hummel 1994:4).

The results of DNA studies on skeletal materials from the eastern and western Great Basin from prehistoric sites thousands of years more recent than Spirit Cave "...suggest a heterogeneous group of ancient populations inhabiting the Great Basin in antiquity. Frequency differences between ancient samples for specific markers may reflect both the diachronic nature of the samples and the well-known occurrence of lineage extinctions in small populations (Avise et al. 1984; Heyer 1995)," (O'Roarke et al. 1999:101-102).

Kaestle (1998, 1997, 1995, Kaestle et al. 1999) performed analyses of mitochondrial haplogroups and albumin phenotypes from various prehistoric skeletons from Western Nevada dated from 860+/-75 to 9,225+/-60B.P. She compared these to several modern groups principally located in Arizona, California, Baja California, Nevada and New Mexico. Relatively low sample numbers make any findings rather preliminary and limited, however, these findings appear to indicate that the Zuni, Washo, Northern Uto-Aztecan speakers and the Great Basin geographic group are generally not related to ancient Western Nevada samples.

DNA analysis was not undertaken with the Spirit Cave remains for a number of reasons. Foremost, it is a destructive technique. Given the unique nature of this material, any destructive techniques must be conservatively considered. Even if sufficient uncontaminated material could be amplified and sequenced, it most likely would fall into one of the four haplogroups (ABCD) which includes American Indians and Asians as well.

Moreover, while DNA studies could possibly rule out certain groups as related to this individual, none of the results possible from DNA testing performed at this time, given the present state of the technology and theoretical framework, would allow the assignment of Spirit Cave Man to an affiliation with a particular tribe.

Serum Albumin

Albumin has been used for detection and species attribution in ancient materials (Borja 1997). "Albumin, a noncollagenous protein, is one of several serum proteins with rare forms that are specific to particular ethnic groups, language stocks, or language families in the New World" (Smith et al. 1995:68). Two variants, albumins Naskapi (Al^{Na}) and Mexico (Al^{Me}) have a high frequency in North and Central American Indians. A high frequency of these variants may provide information on group affinities and origins of Native Americans (Smith et al. 2000, 1995, Johnston et al. 1969, Schell & Blumberg 1988).

Albumin is less studied than mtDNA for a number of reasons and "...it is exceedingly difficult to interpret albumin variant frequencies obtained for single sites or local site complexes in other than a very gross way" (Bettinger 1999:322).

In a study of the prehistoric Stillwater samples (Western Great Basin, approximately 1,000BC to AD 1300), Kaestle et al. found, "...the frequencies of Al^{Me} and haplogroup D are very high and both Al^{Na} and haplogroup C are absent." "Unless sampling error or stochastic evolutionary changes have profoundly influenced the results of this study, the Zuni, Washo, and all Northern (but not Central) Uto-Aztecan language groups, including Numics, and the Great Basin geographic group can also be eliminated from consideration as probable descendants,"(1999:179).

Serum albumin analysis was not undertaken for a number of reasons. Foremost it is a destructive technique. Given the unique nature of the Spirit Cave material, any destructive techniques must be conservatively considered.

While serum albumin studies could possibly rule out certain groups as related to this individual, none of the results possible from serum albumin testing performed at this time, given the present state of the technology and surrounding theoretical framework, would allow the assignment of Spirit Cave Man to an affiliation with a particular tribe.

Radiographs

Radiographs (x-rays) are useful to identify and evaluate pathologies, anomalies, healed fractures, Harris lines and foreign objects imbedded in bone not visible on gross examination. A computed tomography (CT) scan of the skull was performed to produce casts of the skull so that the actual skull would not be subject to additional handling.

Radiographs, although potentially of significant importance in a paleopathology study, were not taken of the postcranial material as it would subject the material to additional handling and would provide no information regarding specific group identity or cultural affiliation.

V. SUMMARY AND EVALUATION

Given the current state of scientific technology, methodology and theoretical framework, there is no biological information available at this time which would allow the assignment of Spirit Cave Man to an affiliation with a particular tribe. There is no available biological information which clearly supports cultural continuity with contemporary North American Indians. The biological information does not indicate that there is, "a relationship of shared group identity which can reasonably be traced historically or prehistorically between members of the present-day Indian tribe...and an identifiable early group," (Sec 2(2)) as required by NAGPRA . No biological findings to date indicate by a "preponderance of the evidence" that there is an "affiliation" of Spirit Cave Man to a particular tribe.

VI. The Importance of Spirit Cave Man

Spirit Cave Man is of critical importance to the study of ancient humans in North America due to his antiquity, completeness, documented provenience, associated artifacts and the rarity of an individual of this antiquity (Kirner et al. 1996).

This Paleoamerican can provide information on the history and biology of the populations he represents as well as his individual biology and, possibly, the peopling of the New World. Since the human skeleton is a dynamic system throughout the life cycle, the skeleton is the repository of important biological and behavioral information that is otherwise not available. "Skeletal and dental tissues are remarkably sensitive to the environment, ...thus serving as a retrospective 'memory' of an individual's biological history" (Larsen & Hutchinson 1999:185). The study of Spirit Cave Man can provide that "retrospective memory" of this Paleoamerican individual.

Current and future advances in genetics, biochemical and metric analyses may hold the key to modern human origins and the peopling of the New World. Paleoamerican materials address a period of human evolution about which there is still a great deal unknown. As technology advances, the potential development of non-invasive analyses of skeletal remains is promising especially for the rare group of Paleoamerican remains, including Spirit Cave Man. The data derived from the Spirit Cave Man could provide answers to the characterizations of migrational interactions of migrations in both the Old and New World.

Many Americans, African Americans, Hispanic Americans and European Americans, have Native American ancestry. Therefore, all American communities have a right to the knowledge these remains can provide. The antiquity and rarity of Spirit Cave and other Paleoamerican remains and artifacts are critically important to the biological history of contemporary *Homo Sapiens*. These facts make Spirit Cave Man and other Paleoamerican remains National Patrimony.

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SKELETAL INVENTORY - AHUR 2064 (NV STATE MUSEUM)

BONE	LEFT	RIGHT	UNKNOWN
SKULL Frontal	1	1	
Parietal	1	1	
Temporal	1	1	
Occipital	1	1	
Maxilla	1	1	
Mandible	1	1	
POSTCRANIAL Humerus	1	1	
Radius	1	1	
Ulna	1	1	
Femur	1	1	
Tibia	1	1	
Fibula	1	1	
Clavicle	1	1	
Scapula	1	1	
Gladiolus			1
Manubrium			1
Innominate	1	1	
Patella		1	
VERTEBRA Cervical 1			1
2			1
3-7			all
Thoracic 1-9			all
10			1
11			1
12 13th			1 1
Lumbar			5
Sacrum			1
Ribs	7	13	
HAND Navicular		1	
Lunate	1	1	
Triquetral		1	
Pisiform			
G. Multangular	1	1	
L. Multangular	1	1	
Capitate	1	1	
Hamate		1	
Metacarpals 1	1	1	
2	1	1	
3	1	1	
4	1	1	
5	1	1	
H. Phalanges P			7
M			6
D			3
FOOT Talus	1	1	
Calcaneus	1	1	
Cuboid	1	1	
Navicular	1	1	
Cuneiforms 1	1	1	
2	1	1	
3	1	1	
Metatarsals 1	1		
2	1	1	
3	1	1	
4	1	1	

5	1	1	

SKELETAL INVENTORY
AHUR 752/773 (NV State Museum)

BONE	LEFT	RIGHT	UNNOWNK
SKULL Frontal			Fragments
Parietal			Fragments
Temporal	1	1	Petrous Portions
Occipital			Fragments
Maxilla	1	1	
Mandible	1	1	
POSTCRANIAL Humerus	1	1	
Radius	1	1	
Ulna	1		Fragments
Femur	1	1	
Tibia			Fragments
Fibula			Fragments
Clavicle	1	1	
Scapula			Fragments
Innominate	1	1	Fragments
Patella			1
VERTEBRA Cervical 1			1
2			1
3-7			Fragments
Thoracic 1-12			Fragments
Lumbar			Fragments
Sacrum			Fragments
Ribs			Fragments
HAND Navicular	1		
Pisiform			1
Metacarpals 1-5			Fragments
H. Phalanges P			
M			3
D			1
FOOT Talus	1	1	
Calcaneus			Fragments
Navicular	1	1	
Cuneiforms 1-3			Fragments
Metatarsals 1-3			Fragments
4			1
5	1		
Phalanges			6

NOTE:
Appears to be one individual.

SKELETAL INVENTORY

AHUR 770,748 (NV State Museum)

BONE	LEFT	RIGHT	UNKNOWN
Innominate	1	1	
Fibula		1distal	
VERTEBRA Cervical			
2			1
3-7			2
Thoracic 1-12			3
Ribs	5	2	4
HAND Metacarpals 1	1		1
4	1		
H. Phalanges D			1
FOOT Metatarsals 1		1	
2			2
3		1	
5	1		

NOTES:

AHUR 748 - R. Innominate, Male, less than 19 years of age

AHUR 770 - Mixed, non-cremated materials separated by taphonomy, age and robusticity. Maximum # of individuals 5