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Mystery of the First Americans
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Welcome to the companion Web site to "Mystery of the First Americans," scheduled for broadcast on February 15, 2000. The film documents the discovery and ensuing controversy over the Kennewick Man, a well-preserved, 9,000-year-old human skeleton found in Washington State in 1996. Here's what you'll find online:

- **Does Race Exist?**
  Anthropologists George Gill of the University of Wyoming and Loring Brace of the University of Michigan square off on the issue. After reading their opposing viewpoints, decide for yourself.

- **Meet Kennewick Man (QTVR)**
  Archeologist Jim Chatters, the only scientist able to study the bones before federal authorities impounded them, tells how he put a face to Kennewick Man. Includes a striking QuickTime VR of the ancient man's reconstructed head.

- **Claims for the Remains**
  Eight scientists have filed suit against the U.S. government for the right to study the Kennewick Man remains. Here, all eight speak out about why they feel they should be allowed to do so and what they hope to learn if they get the chance.

- **The Dating Game** (Hot Science)
  Scientists have long relied on carbon-14 analysis to determine the age of organic remains such as ancient seeds, bits of charcoal, even human remains. In this feature, learn how this widely used process works.

Plus Resources.

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Does Race Exist?

The concept of race is one of the most intellectually and emotionally charged subjects, not only in society but in science as well. NOVA Online asked two leading anthropologists, Dr. Loring Brace of the University of Michigan and Dr. George Gill of the University of Wyoming, who fall on either side of the debate about whether race exists, to state their points of view. Interestingly, while these two researchers differ radically in how they define race, they readily joined together -- along with six other top anthropologists -- to file suit against the federal government for the right to study Kennewick Man (see Claims for the Remains).

Dr. C. Loring Brace

An antagonist's perspective

Dr. George W. Gill

A proponent's perspective

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Does Race Exist? An antagonist's perspective

By C. Loring Brace

Dr. C. Loring Brace

I am going to start this essay with what may seem to many as an outrageous assertion: There is no such thing as a biological entity that warrants the term "race."

The immediate reaction of most literate people is that this is obviously nonsense. The physician will retort, "What do you mean 'there is no such thing as race'? I see it in my practice everyday!" Jane Doe and John Roe will be equally incredulous. Note carefully, however, that my opening declaration did not claim that "there is no such thing as race." What I said is that there is no "biological entity that warrants the term 'race'." "You're splitting hairs," the reader may retort. "Stop playing verbal games and tell us what you really mean!"

And so I shall, but there is another charge that has been thrown my way, which I need to dispel before explaining the basis for my statement. Given the tenor of our times at the dawn of the new millennium, some have suggested that my position is based mainly on the perception of the social inequities that have accompanied the classification of people into "races." My stance, then, has been interpreted as a manifestation of what is being called "political correctness." My answer is that it is really the defenders of the concept of "race" who are unwittingly shaped by the political reality of American history. [Read a proponent's perspective, that of anthropologist George Gill.]

Brace challenges the notion that his position on race is a manifestation of "political correctness."

But all of this needs explaining. First, it is perfectly true that the long-term residents of the various parts of the world have patterns of features that we can easily identify as characteristic of the areas from which they come. It should be added that they have to have resided in those places for a couple of hundred thousand years before their regional patterns became established. Well, you may ask, why can't we call those regional patterns "races"? In fact, we can and do, but it does not make them coherent biological entities. "Races" defined in such a way are products of our perceptions. "Seeing is believing" will be the retort, and, after all, aren't we seeing reality in those regional differences?

I should point out that this is the same argument that was made against Copernicus and Galileo almost half a millennium ago. To this day, few have actually made the observations and done the calculations that led those Renaissance scholars to challenge the universal perception that the sun sets in the evening to rise again at the dawn. It was just a matter of common sense to believe that the sun revolves around the Earth, just as it was common sense to "know" that the Earth was flat. Our beliefs concerning "race" are based on the same sort of common sense, and they are just as basically wrong.

Until Copernicus challenged the notion, common sense said the sun revolved around the Earth. Should we be challenging our common-sense notion of "race"?

The nature of human variation

I would suggest that there are very few who, of their own experience, have actually perceived at first hand the nature of human variation. What we know of the characteristics of the various regions of the world we have largely gained vicariously and in misleadingly spotty fashion. Pictures and the television camera tell us that the people of Oslo in Norway, Cairo in Egypt, and Nairobi in Kenya look very different. And when we actually meet natives of those separate places, which can indeed happen, we can see representations of those differences at first hand. But if one were to walk up beside the Nile from Cairo, across the Tropic of Cancer to Khartoum in the Sudan and on to Nairobi, there would be no visible boundary between

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one people and another. The same thing would be true if one were to walk north from Cairo, through the Caucasus, and on up into Russia, eventually swinging west across the northern end of the Baltic Sea to Scandinavia. The people at any adjacent stops along the way look like one another more than they look like anyone else since, after all, they are related to one another. As a rule, the boy marries the girl next door throughout the whole world, but next door goes on without stop from one region to another.

While in skin color Europeans and Chinese are closer to each other than either is to Africans, the distribution of blood groups indicates that Europeans and Africans are closer to each other than either is to Chinese.

We realize that in the extremes of our transit -- Moscow to Nairobi, perhaps -- there is a major but gradual change in skin color from what we euphemistically call white to black, and that this is related to the latitudinal difference in the intensity of the ultraviolet component of sunlight. What we do not see, however, is the myriad other traits that are distributed in a fashion quite unrelated to the intensity of ultraviolet radiation. Where skin color is concerned, all the northern populations of the Old World are lighter than the long-term inhabitants near the equator. Although Europeans and Chinese are obviously different, in skin color they are closer to each other than either is to equatorial Africans. But if we test the distribution of the widely known ABO blood-group system, then Europeans and Africans are closer to each other than either is to Chinese.

Then if we take that scourge sickle-cell anemia, so often thought of as an African disease, we discover that, while it does reach high frequencies in some parts of sub-Saharan Africa, it did not originate there. Its distribution includes southern Italy, the eastern Mediterranean, parts of the Middle East, and over into India. In fact, it represents a kind of adaptation that aids survival in the face of a particular kind of malaria, and wherever that malaria is a prominent threat, sickle-cell anemia tends to occur in higher frequencies. It would appear that the gene that controls that trait was introduced to sub-Saharan Africa by traders from those parts of the Middle East where it had arisen in conjunction with the conditions created by the early development of agriculture.

Every time we plot the distribution of a trait possessing a survival value that is greater under some circumstances than under others, it will have a different pattern of geographical variation, and no two such patterns will coincide. Nose form, tooth size, relative arm and leg length, and a whole series of other traits are distributed each in

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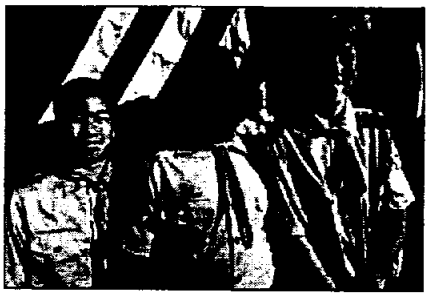
accordance with its particular controlling selective force. The gradient of the distribution of each is called a "cline" and those clines are completely independent of one another. This is what lies behind the aphorism, "There are no races, there are only clines." Yes, we can recognize people from a given area. What we are seeing, however, is a pattern of features derived from common ancestry in the area in question, and these are largely without different survival value. To the extent that the people in a given region look more like one another than they look like people from other regions, this can be regarded as "family resemblance writ large." And as we have seen, each region grades without break into the one next door.



America has a leading role in generating and perpetuating the concept of "race," Brace says.

There is nothing wrong with using geographic labels to designate people. Major continental terms are just fine, and sub-regional refinements such as Western European, Eastern African, Southeast Asian, and so forth carry no unintentional baggage. In contrast, terms such as "Negroid," "Caucasoid," and "Mongoloid" create more problems than they solve. Those very terms reflect a mix of narrow regional, specific ethnic, and descriptive physical components with an assumption that such separate dimensions have some kind of common tie. Biologically, such terms are worse than useless. Their continued use, then, is in social situations where people think they have some meaning.

America and the race concept

The role played by America is particularly important in generating and perpetuating the concept of "race." The human inhabitants of the Western Hemisphere largely derive from three very separate regions of the world -- Northeast Asia, Northwest Europe, and Western Africa -- and none of them has been in the New World long enough to have been shaped by their experiences in the manner of those long-term residents in the various separate regions of the Old World.

It was the American experience of those three separate population components facing one another on a daily basis under conditions of manifest and enforced inequality that created the concept in the first place and endowed it with the assumption that those perceived "races" had very different sets of capabilities. Those thoughts are very influential and have become enshrined in laws and regulations. This is why I can conclude that, while the word "race" has no coherent biological meaning, its continued grip on the public mind is in fact a manifestation of the

power of the historical continuity of the American social structure, which is assumed by all to be essentially "correct."

Finally, because of America's enormous influence on the international scene, ideas generated by the idiosyncrasies of American history have gained currency in ways that transcend American intent or control. One of those ideas is the concept of "race," which we have exported to the rest of the world without any realization that this is what we were doing. The adoption of the biologically indefensible American concept of "race" by an admiring world has to be the ultimate manifestation of political correctness.

Dr. C. Loring Brace is professor anthropology and curator of biological anthropology at the Museum of Anthropology, University of Michigan, Ann Arbor.

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Does Race Exist?
A proponent's perspective

By George W. Gill

Dr. George Gill (and Jaime Stuart)

Slightly over half of all biological/physical anthropologists today believe in the traditional view that human races are biologically valid and real. Furthermore, they tend to see nothing wrong in defining and naming the different populations of *Homo sapiens*. The other half of the biological anthropology community believes either that the traditional racial categories for humankind are arbitrary and meaningless, or that at a minimum there are better ways to look at human variation than through the "racial lens."

Are there differences in the research concentrations of these two groups of experts? Yes, most decidedly there are. As pointed out in a recent 2000 edition of a popular physical anthropology textbook, forensic anthropologists (those who do skeletal identification for law-enforcement agencies) are overwhelmingly in support of the idea of the basic biological reality of human races, and yet those who work with blood-group data, for instance, tend to reject the biological reality of racial categories.

Where does George Gill stand in the "great race debate?" Read on.

I happen to be one of those very few forensic physical anthropologists who actually does research on the particular traits used today in forensic racial identification (i.e., "assessing ancestry," as it is generally termed today). Partly this is because for more than a decade now U.S. national and regional forensic anthropology organizations have deemed it necessary to quantitatively test both traditional and new methods for accuracy in legal cases. I volunteered for this task of testing methods and developing new methods in the late 1980s. What have I found? Where do I now stand in the "great race debate?" Can I see truth on one side or the other -- or on both sides

– in this argument?

Findings

First, I have found that forensic anthropologists attain a high degree of accuracy in determining geographic racial affinities (white, black, American Indian, etc.) by utilizing both new and traditional methods of bone analysis. Many well-conducted studies were reported in the late 1980s and 1990s that test methods objectively for percentage of correct placement. Numerous individual methods involving midfacial measurements, femur traits, and so on are over 80 percent accurate alone, and in combination produce very high levels of accuracy. No forensic anthropologist would make a racial assessment based upon just *one* of these methods, but in combination they can make very reliable assessments, just as in determining sex or age. In other words, multiple criteria are the key to success in all of these determinations.

I have a respected colleague, the skeletal biologist C. Loring Brace, who is as skilled as any of the leading forensic anthropologists at assessing ancestry from bones, yet he does not subscribe to the concept of race. [Read Brace's position on the concept of race.] Neither does Norman Sauer, a board-certified forensic anthropologist. My students ask, "How can this be? They can identify skeletons as to racial origins but do not believe in race!" My answer is that we can often *function* within systems that we do not believe in.

While he doesn't believe in socially stipulated "age" categories, Gill says, he can "age" skeletons with great accuracy.

As a middle-aged male, for example, I am not so sure that I believe any longer in the chronological "age" categories that many of my colleagues in skeletal biology use. Certainly parts of the skeletons of some 45-year-old people look older than corresponding portions of the skeletons of some 55-year-olds. If, however, law enforcement calls upon me to provide "age" on a skeleton, I can provide an answer that will be proven sufficiently accurate should the decedent eventually be identified. I may not believe in society's "age" categories, but I can be very effective at "aging" skeletons. The next question, of course, is how "real" is age biologically? My answer is that if one can use biological criteria to assess age with reasonable accuracy, then age has some basis in biological reality even if the particular "social construct" that defines its limits might be imperfect. I find this true not only for age and stature estimations but for sex and race identification.

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"I am *more* accurate at assessing race from skeletal remains that from looking at living people standing before me," Gill says.

The "reality of race" therefore depends more on the definition of reality than on the definition of race. If we choose to accept the system of racial taxonomy that physical anthropologists have traditionally established -- major races: black, white, etc. -- then one can classify human skeletons within it just as well as one can living humans. The bony traits of the nose, mouth, femur, and cranium are just as revealing to a good osteologist as skin color, hair form, nose form, and lips to the perceptive observer of living humanity. I have been able to prove to myself over the years, in actual legal cases, that I am *more* accurate at assessing race from skeletal remains than from looking at living people standing before me. So those of us in forensic anthropology know that the skeleton reflects race, whether "real" or not, just as well if not better than superficial soft tissue does. The idea that race is "only skin deep" is simply not true, as any experienced forensic anthropologist will affirm.

Position on race

Where I stand today in the "great race debate" after a decade and a half of pertinent skeletal research is clearly more on the side of the reality of race than on the "race denial" side. Yet I do see why many other physical anthropologists are able to ignore or deny the race concept. Blood-factor analysis, for instance, shows many traits that cut across racial boundaries in a purely *clinal* fashion with very few if any "breaks" along racial boundaries. (A cline is a gradient of change, such as from people with a high frequency of blue eyes, as in Scandinavia, to people with a high frequency of brown eyes, as in Africa.)

"Clines" represent gradients of change, such as that between areas where most people have blue eyes and areas in which brown eyes predominate.

Morphological characteristics, however, like skin color, hair form, bone traits, eyes, and lips tend to follow geographic boundaries coinciding often with climatic zones. This is not surprising since the selective forces of climate are probably the primary forces of nature that have shaped human races with regard not only to skin color and hair form but also the underlying bony structures of the nose, cheekbones,

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etc. (For example, more prominent noses humidify air better.) As far as we know, blood-factor frequencies are *not* shaped by these same climatic factors.

So, serologists who work largely with blood factors will tend to see human variation as clinal and races as not a valid construct, while skeletal biologists, particularly forensic anthropologists, will see races as biologically real. The common person on the street who sees only a person's skin color, hair form, and face shape will also tend to see races as biologically real. They are not incorrect. Their perspective is just different from that of the serologist.

So, yes, I see truth on both sides of the race argument.

Those who believe that the concept of race is valid do not discredit the notion of clines, however. Yet those with the clinal perspective who believe that races are not real do try to discredit the evidence of skeletal biology. Why this bias from the "race denial" faction? This bias seems to stem largely from socio-political motivation and not science at all. For the time being at least, the people in "race denial" are in "reality denial" as well. Their motivation (a positive one) is that they have come to believe that the race concept is socially dangerous. In other words, they have convinced themselves that race promotes racism. Therefore, they have pushed the politically correct agenda that human races are not biologically real, no matter what the evidence.

Consequently, at the beginning of the 21st century, even as a majority of biological anthropologists favor the reality of the race perspective, not one introductory textbook of physical anthropology even presents that perspective as a possibility. In a case as flagrant as this, we are not dealing with science but rather with blatant, politically motivated censorship. But, you may ask, are the politically correct actually correct? Is there a relationship between thinking about race and racism?

Does discussing the concept of race promote racism?

Race and racism

Does discussing human variation in a framework of racial biology promote or reduce racism? This is an important question, but one that does not have a simple answer. Most social scientists over the past decade have convinced themselves that it runs the risk of promoting racism in certain quarters. Anthropologists of the 1950s, 1960s, and early 1970s, on the other hand, believed that they were combating racism by openly discussing race and by teaching courses on human races and racism. Which approach has worked best? What do the intellectuals among racial minorities believe? How do students react and respond?

Three years ago, I served on a NOVA-sponsored panel in New York, in which panelists debated the topic "Is There Such a Thing as Race?" Six of us sat on the panel, three proponents of the race concept and three antagonists. All had authored books or papers on race. Loring Brace and I were the two anthropologists "facing off" in the debate. The ethnic composition of the panel was three white and three black scholars. As our conversations developed, I was struck by how similar many of my concerns regarding racism were to those of my two black teammates. Although recognizing that embracing the race concept can have risks attached, we were (and are) more fearful of the form of racism likely to emerge if race is denied and dialogue about it lessened. We fear that the social taboo about the subject of race has served to suppress open discussion about a very important subject in need of dispassionate debate. One of my teammates, an affirmative-action lawyer, is afraid that a denial that races exist also serves to encourage a denial that racism exists. He asks, "How can we combat racism if no one is willing to talk about race?"

Who will benefit?

In my experience, minority students almost invariably have been the strongest supporters of a "racial perspective" on human variation in the classroom. The first-ever black student in my human variation class several years ago came to me at the end of the course and said, "Dr. Gill, I really want to thank you for

"How can we combat racism," asks an affirmative-action lawyer, "if no one is willing to talk about race?"

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changing my life with this course." He went on to explain that, "My whole life I have wondered about why I am black, and if that is good or bad. Now I know the reasons why I am the way I am and that these traits are useful and good."

A human-variation course with another perspective would probably have accomplished the same for this student if he had ever noticed it. The truth is, innocuous contemporary human-variation classes with their politically correct titles and course descriptions do not attract the attention of minorities or those other students who could most benefit. Furthermore, the politically correct "race denial" perspective in society as a whole suppresses dialogue, allowing ignorance to replace knowledge and suspicion to replace familiarity. This encourages ethnocentrism and racism more than it discourages it.

Dr. George W. Gill is a professor of anthropology at the University of Wyoming. He also serves as the forensic anthropologist for Wyoming law-enforcement agencies and the Wyoming State Crime Laboratory.

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Meet Kennewick Man

By Jim Chatters

The face of Kennewick Man, as reconstructed by Jim Chatters and Thomas McClelland.

See the full object QTVR of the Kennewick Man reconstruction; 340K. (Requires QuickTime.)

Rarely do the ravages of time allow us to gaze directly upon the faces of our remote predecessors. Except for those few who have been frozen in the arctic, pickled in the peat bogs of Northern Europe, or sculpted by their skilled contemporaries, all we have of earlier peoples' visages are their bare, often fragmentary skulls. These skulls, however, hold valuable clues to the physiognomy of the dead. The superstructure on which the soft tissues of the face hung during life, each provides a map of the face it once supported. Facial-reconstruction artists can read this map and produce an approximation of the deceased's appearance.

Forensic scientists and others conduct facial approximation for two quite distinct but related purposes: to identify the recently dead so that they can be reunited with their kin, and to give the people of today a glimpse of our forebears as they might have appeared in life. Either way, facial approximation is a closely integrated blending of science and art, the result of a fruitful collaboration between scientists and sculptors. In the NOVA film "Mystery of the First Americans," for example, sculptor Thomas McClelland and I produced Kennewick Man's image, while artist Sharon Long and anthropologist Douglas Owsley created the approximations of the Spirit Cave mummy. The best known facial-approximation team is led by Richard Neave of the University of Manchester, England, who, with John Prag, co-authored the book *Making Faces: Using Forensic and Archeological Evidence* (Texas A&M University Press, 1997). Neave's team includes not only a medical artist and archeologist, but also specialists in medicine, dentistry, and genetics.

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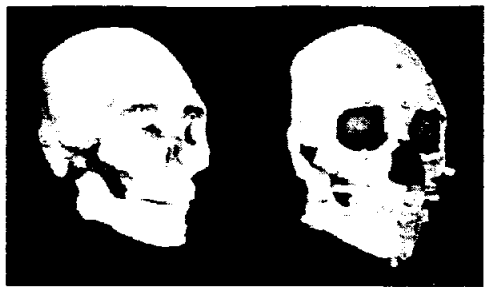

A model of the Kennewick skull (left) and the model with marker pegs in place (right).

Such teams fashion approximations either sculpturally or by computer. Sculptural methods such as those documented in the NOVA film allow the artist a freer hand than computer techniques. Specialists using the sculptural approach belong to two schools, which I will call the Gerasimov and American schools. (The Gerasimov method was developed by the late Russian paleontologist Mikhail Gerasimov.)

Both schools follow similar basic protocols. Practitioners begin with a skull or, in the case of ancient specimens, a model of a skull, and, at standard locations on its surface, place a set of pegs cut according to average tissue thicknesses. These thicknesses vary according to the ancestry and health of the individual and differ for males and females; people of emaciated, average, or obese condition; and Europeans (or white Americans), Africans (African Americans), or Asians (Japanese). (Experts have not yet developed measurements of average tissue thicknesses for other peoples.) The artist chooses these thicknesses according to information the anthropologist provides based on clues gleaned from the skeleton and any associated clothing and/or preserved soft tissue.

Jim Chatters carefully places clay onto the burgeoning face of Kennewick Man.

With the markers in place, the artist centers the eyes in the sockets and roughs out the size of the nose and mouth. The sculptor determines the profile of the nose by one of two means. One approach, used primarily by the American school, estimates the projection of the nose at three times the length of a bony spur located beneath the nasal opening in the skull. The width of the nostril wings is a set distance from the lateral edges of the nasal openings, six millimeters for Europeans and Asians and eight millimeters for Africans. The Gerasimov school, as practiced by Neave's team, creates the outline of the nose by extending one line from the bridge of the nose and a second line from the floor of the nasal opening, and then rounding their point of intersection to make the tip of the nose. They estimate nose width as 1.67 times the width of the nasal opening. The width of the mouth is either the

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distance between the inner edges of the irises in the eyes or the distance between the lateral edges of the canine teeth -- measurements that are typically very close to the same.

The schools differ most in how they place tissue on the face. The American school relies heavily on the skill of the artist and less on the underlying structure of the skull. The artist first connects tissue-thickness markers with walls of clay pressed against the skull, tapering each bar so that its height is even with the markers at both ends. This creates an open, grid-like pattern. The artist then fills the spaces between the grid lines with clay, and a mannequin-like face begins to take shape. Finally, the artist uses personal experience and input from the scientific members of the team to humanize the face and decide what eye-form and lip characteristics the person should have. In the hands of a skilled artist such as Sharon Long, this approach has proven highly effective, particularly as an aid to identification of the recently dead.

Part of the method's effectiveness in the forensic realm lies in the nonspecific appearance that it produces. When the police broadcast faces approximated in this manner, they are likely to stimulate a large number of responses from people missing friends or loved ones. From this large pool of possible identities, the authorities have a good chance of determining the actual identity of the deceased. If the face looked like only one particular individual, the police might get fewer calls and may never identify the subject.

Continue: The Gerasimov school's very specific image

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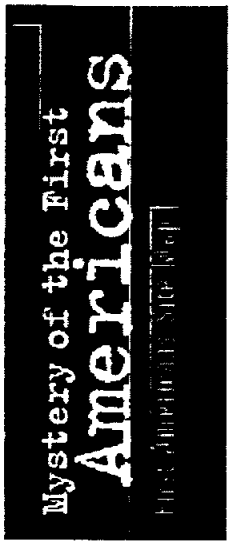

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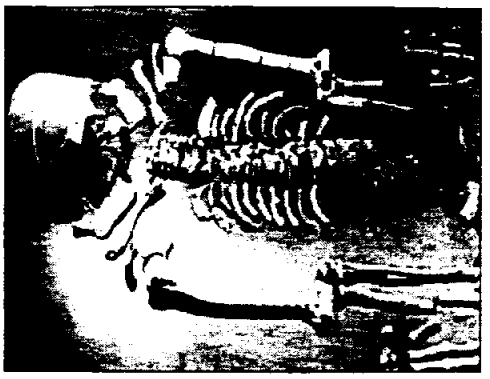

The bones that launched a thousand articles in the press -- and a scientists' lawsuit.

Within months after the well-preserved skeleton of Kennewick Man turned up along the banks of the Columbia River in eastern Washington in 1996, the U.S. Army Corps of Engineers, on whose land the bones were found, impounded the remains. Since then, the Corps has kept Kennewick Man locked up under tight security in a museum at the University of Washington, pending the outcome of court battles over what should be done with the bones.

Several Indian tribes on the Columbia Plateau, led by the Umatilla, hope to win the right to rebury the skeleton, which they consider an ancestor. When it seemed likely that the Indians would achieve their goal under the Native American Graves Protection and Repatriation Act -- a law that enables tribes to file claims to remains to which they can demonstrate a cultural affiliation -- a group of eight leading American anthropologists, fearful that invaluable information on the first peopling of the Americas could potentially be lost, sued the federal government for the right to study the remains. The court case is expected to be decided sometime in 2000.

NOVA Online asked each of the eight plaintiffs to explain his case as to why he believes scientists should be able to examine Kennewick Man and what he hopes to learn if given the chance. Please note that NOVA holds no position regarding Kennewick Man.


Robson Bonnichsen


Loring Brace


George Gill


Vance Haynes


Richard Jantz


Douglas Owsley


Dennis Stanford


Gentry Steele

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Claims for the Remains

Dr. Robson Bonnichsen

Director, Center for the Study of the First Americans and Professor of Anthropology, Oregon State University

Rob Bonnichsen

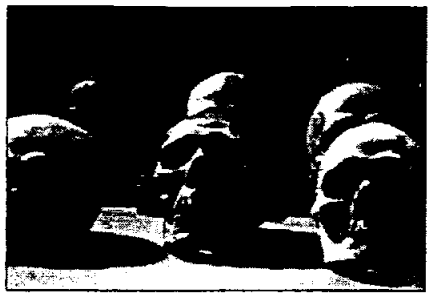
The significance of the Kennewick Man discovery should be understood in light of scientific developments occurring in the field of First Americans studies. For more than 40 years, most specialists seeking to explain Paleo-American origins have supported the Clovis-first model. This model proposes that the Americas were peopled once by a biological population from Siberia possessing a single culture and language. It envisions that the founding population moved across the Bering Land Bridge, traveled down the Ice-free Corridor between the Cordilleran and Laurentide ice sheets, and expanded into what is now the United States about 11,500 years ago. By use of a new and efficient hunting technology, these early hunters and gatherers and their immediate descendants were supposedly able to prosper and multiply as they spread across North America and throughout South America in about a thousand years.

Many believe that this initial colonization event explains the peopling of the Americas. Over the next 11 millennia, descendants from this initial founding population evolved and were responsible for the enormous diversity of biological populations, cultural groups, and languages found among modern Native Americans at the time of European contact.

First Americans specialists are now reconsidering the Clovis-first model in light of new discoveries and scientific developments that suggest the peopling of the Americas is much more complicated than originally anticipated. Many now believe that the old, simple, unilinear evolutionary model is incorrect and that a multilinear evolutionary model that envisions multiple colonization events must replace it. Some specialists are now considering the possibility that different colonizing groups from Asia and possibly Europe are required to account for the biological, cultural, and linguistic diversity found at the time of European contact and in the archeological record. Many specialists believe

DOI 07887

that the future of First Americans research must focus on exploring the validity of this new paradigm.



Many specialists in First Americans studies now suspect that not one but multiple colonization events occurred in America's earliest prehistory.

New discoveries and scientific developments have caused many leading specialists to question the validity of the Clovis-first model. In addition to archeological research, genetics and skeletal studies are providing important new lines of evidence for understanding Paleo-American origins. Advances in our understanding of the archeological record suggest humans were in the Americas well before Clovis. Important pre-Clovis data have been recovered from the Meadowcroft Rockshelter, Pennsylvania; the Cactus Hill site, Virginia; the La Sena site, Nebraska; the Monte Verde site, Chile; and the El Jobo site, Venezuela. These and many others support the proposition that humans were in the Americas before Clovis.

Other research suggests a series of regional cultures developed in the Americas that were contemporary with Clovis. For example, the Stemmed Point from the Great Basin, Snake River Plains, and the Plateau as well as the Goshen complex from along the flanks of the Rocky Mountains and Great Plains have radiocarbon ages as early as those from Clovis sites. In summary, the picture that is emerging from the archeological record indicates cultural variability existed in the Americas by Clovis times.

Genetic research conducted by Theodore Schurr, Douglas C. Wallace, and others provides compelling evidence for multiple colonization events. Modern Native American populations fall into four mitochondrial DNA haplogroups, A-D, and a fifth founding group is genetically linked to an Eurasian haplogroup X. (Transmitted solely along the female line, mtDNA can help identify individuals to haplogroups, or genetic groupings.) Haplogroups A, C, and D were brought to the Americas perhaps as early as 30,000 years ago. A second immigration may have brought haplogroup B possibly between 13,000 and 17,000 years ago, either along the coast or overland, or both. An additional haplogroup X that shared affinities to European or possibly Eurasian populations may have also entered the Americas prior to the last glacial maximum and is absent in modern Siberian populations. Ancient Beringian populations isolated during the last glacial period evolved by post-glacial times into a large North Pacific Rim branch of haplogroup A, which includes Eskimos and Na-Dene Indians.

DOI 07888

Kennewick Man, whose discovery in a riverbank in 1996 is recreated in this still from the NOVA film "Mystery of the First Americans," is one of the most complete early skeletons ever found in the Americas.

Paleo-American researchers have opened a whole new intriguing field of paleobiology research by taking advantage of advances in radiocarbon dating such as carbon-14 accelerated mass spectrometry, which allows specialists to precisely date tiny amounts of carbon from individual skeletons. Physical anthropologists from North and South America have observed that Paleo-American cranial forms older than 8,000 years have distinctive features that share more similarities with Pacific Rim and southern Asian populations than with either modern northeast Asian or modern Native American populations. One possible interpretation of these data is that more recent groups replaced late Ice Age peoples who had a discretely different ancestry.

Our knowledge of America's earliest biological and cultural heritage remains amazingly thin. For example, there are fewer than 35 dated human skeletal remains in the New World older than 8,000 years old. Most of these early remains are fragmentary. The Kennewick Man skeleton is one of the most complete early skeletons from the Americas, and its study by competent scientists is essential to understanding his morphology, genetics, health, diet, lifestyle, etc., and his relationship to other New and Old World populations. Only through the study of important individual skeletons, such as Kennewick Man, from different regions and different times will the scientific community be able to build a coherent picture of America's past.

In First Americans studies, specialists can contribute to the scientific goal of developing an understanding of America's earliest cultural and biological heritage only through the comparative study of archeological remains, human skeletons, and genetics. This research, based on the foundation of integrated studies by multiple independent observers, promises to benefit all peoples by providing knowledge about the diversity of our species, a mirror of our ancestry, and America's contribution to world prehistory. It is imperative that public decision-makers charged with implementing the Native American Graves Protection and Repatriation Act of 1990 recognize the importance of preservation and study of early human remains. Only through scientific study of important discoveries such as Kennewick Man can an objective knowledge America's rich and diverse past be developed and fully appreciated by all communities who have a stake in the past.

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Claims for the Remains

C. Loring Brace

Curator of Biological Anthropology and Professor of Anthropology, University of Michigan

Loring Brace

The questions "Why do scientists want to study Kennewick Man" and "What would I personally hope to learn from the study of Kennewick Man" are essentially the same from my point of view.

The Kennewick skeleton is one of the oldest and most complete human specimens found in the Western Hemisphere and the only one from the northwest edge of the continent, which was almost certainly close to the route taken by the earliest humans to enter the continent. All the archeological and biological evidence points to a Northeast Asian origin for the original human occupants of the Western Hemisphere, but there is increasing reason to believe that different entrants came at different times and derived from different Asian sources. Who were those sources? When did their offshoots come to the Americas? And which Native Americans are derived from which of those sources? Only by studying the remains of the earliest Americans and comparing them to recent and living Native Americans and to recent Asians can we ever provide answers to these questions.

While Cohanim priests can trace their male lineage back several thousand years using Y-chromosome analysis, no one alive today can trace his or her heritage back as far as the 9,000-year-old Kennewick Man.

Just because some government officials claim that any ancient skeleton is Native American by their definition does not justify turning it over to one or more groups of modern Native Americans, who may have no close relationship (or any at all) to the skeleton. The old European-American assumption that "if you've seen one Indian, you've seen them all" is

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a gross misrepresentation of reality. Although both the Navajo and the Hopi are Native American groups in the American Southwest, when Harvard University returned the burials from Pecos Pueblo that had been in the Peabody Museum in Cambridge, Massachusetts, it did not turn those skeletons over to the Navajo but only to Pueblo groups related to the Hopi, because in that particular case, the historical knowledge of who was related to whom was known. In the case of Kennewick, however, such information is not known.

In Polynesia, oral traditions preserve a general knowledge of population relationships going back some 2,000 years. Where written records are kept, one can trace actual relationships back even further than that, as with the descendants of Confucius. Y-chromosome records have shown the continuity of the Cohanim, the Jewish priesthood, via the founding priests of migrant Jewish settlements. But none of these forms of evidence goes back as far in time as the date of Kennewick Man or the roots of the initial settlers in the New World. If we simply bury the evidence, we will never be able to answer the questions of origins and relationships.

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Claims for the Remains

George W. Gill

Professor of Anthropology, University of Wyoming

George Gill (with Jaime Stuart)

Why do we feel we should be able to study Kennewick Man? Ancient human skeletal remains are a valuable source of scientific information and are protected as archeological resources under federal law (the Archaeological Resources Protection Act). As a trained physical anthropologist at a state institution, I have the legal and ethical responsibility to curate, study, protect, and sometimes repatriate the human skeletons that come to my laboratory. From human skeletons, we can derive information relating to human diseases, injury, warfare, origins, migrations, and gene flow. The more ancient skeletons as well as the better preserved ones tend to be more important skeletons scientifically because of the vast amount of new information that they can provide.

Kennewick Man may be one of the most important skeletons ever unearthed in North America. It is a very ancient skeleton and therefore not a close relative of any human alive today. Thus, claims of cultural or biological affinity by any group existing today are so tenuous that they should not be allowed to prevent scientific study of this important find. The skeleton should remain in the domain of all humanity and not be claimed by any single federal agency or any single religious or cultural group. It should be studied by all qualified scientists whose research might be able to provide new knowledge from the secrets that these ancient bones contain.

DOI 07893

Kennewick Man, whose reconstructed skull is shown here, should remain in the public domain, Gill feels.

What do I personally expect to learn from studying the Kennewick skeleton? I am a forensic anthropologist with a research focus on skeletal race attribution (learning ancestry from bone traits). Most of the successful methods that I have developed and published in leading journals relate to distinguishing American Indians from whites skeletally. Certain single approaches are over 90 percent accurate in separating modern whites from modern American Indians. Interestingly, traits of both of these populations are found among individuals of the early Archaic and Paleo-Indian period. Certainly the Kennewick skeleton should be assessed with regard to these trait occurrences.

These are not the multivariate, cranial-measurement approaches used by most other physical anthropologists who study ancestry. They constitute a somewhat independent approach. My approach would provide another independent means of determining ancestry through a combination of different kinds of trait evaluations. In short, my approach will hopefully provide us with insight to help answer the question of who Kennewick Man's closest relatives were in regard to the major racial elements of today.

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Claims for the Remains

C. Vance Haynes, Jr.

Regent's Professor, Department of Anthropology and Geosciences, University of Arizona

Vance Haynes

On October 3, 1996, upon hearing about the Army Corps of Engineers intention of repatriating the Kennewick Man bones, I wrote to Maj. Gen. Ernest J. Harrell, Commander of the North Pacific Division. I pointed out that if it really is as old as the radiocarbon age indicated, "its value to science, and therefore to better understanding the peopling of the Americas, is paramount. Our knowledge regarding this important and fascinating question is based upon the scientific study of less than a dozen specimens found over the last 100 years. Furthermore, most of the specimens over 8,000 years old are either poorly preserved or are subadults and, therefore, much less informative than well preserved specimens."

For these reasons, the Kennewick skeleton should be studied by some highly qualified physical anthropologists before it is reburied. Furthermore, the population affinities of the skeleton are very important questions that, even if morphological data are inconclusive, may be answerable by DNA testing if the bone is adequately preserved. This could also determine to whom the remains should be repatriated.

Detailed study and analysis of the geologic context of the Kennewick find site is important for confirming the age indicated by radiocarbon dating and for determining the nature of the occurrence, i.e., accidental burial by river processes or interment via human activity. Geological strata are like pages in the book of time and need to be read by qualified experts to learn what happened at the Kennewick find site.

DOI 07895

Was Kennewick Man buried by nature or by his compatriots? Only detailed study of the riverside site where he was found will tell, says Haynes.

I have tremendous respect for American Indians and their culture. In regard to those whose understanding of nature is prescribed by tribal mythology and religion, I respect their concern for proper treatment of their dead, but there must be clear genetic or cultural connection for repatriation. For skeletal remains that are thousands of years old, demonstration of an actual genetic connection may be possible but requires detailed scientific study.

For me and many scientists, the understanding of nature is based upon scientific investigations that add to humankind's ever increasing fund of knowledge. The fund is ever changing as new generations of scientists add to, debate, and reinterpret the data. For those who have devoted their lives to better understanding the peopling of the New World, the Kennewick find is a rare opportunity for a significant increase in knowledge about who the early Americans were and how they relate to living tribes.

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Claims for the Remains

Richard L. Jantz

Department of Anthropology, University of Tennessee, Knoxville

Richard Jantz

Why should scientists be allowed to study the Kennewick skeleton?

The study of human skeletal remains has been a component of biological anthropology since its origins 200 years ago. Human skeletons provide information about the past that is unobtainable from any other source, e.g., specific dietary components, activities, health, and genetic relationships.

Kennewick Man in particular provides a window into a little-known time and place, and it is important in defining the early populations of the Americas. Of the 10 or so skeletons in the United States dating to 9000 before present or older, it is one of the best preserved. As such it constitutes over 10 percent of the evidence nationally. But in the Northwest-Plateau area, it constitutes well over 50 percent of the evidence.

Skeletal remains help tell the story of human history; it is a history to which everyone is entitled. Access to human history should not be restricted by the government, nor should it be controlled by small groups of people.

What would I personally hope to learn?

My interest is in the patterns of skeletal variation temporally and geographically in prehistoric North America. Kennewick Man represents a time period from which there are few skeletons, so patterns are difficult to ascertain. Kennewick Man can contribute to two major questions in which I have an interest:

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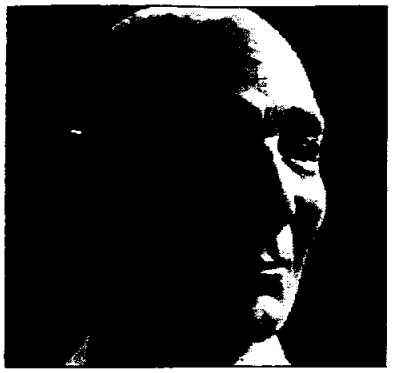

Certain ancient skeletons, such as Spirit Cave Man (reconstructed above) and Kennewick Man, appear to represent different regional populations -- a finding that is forcing anthropologists to rewrite the history of the first Americans.

Geographic variation among early populations. Limited evidence suggests the existence of regional groups. For example, the Minnesota specimens, Browns Valley and Pelican Rapids, are markedly different from Great Basin groups represented by Spirit Cave and Wizards Beach. The western skeletons seem to exhibit greater similarities to Pacific populations, suggesting coastal migration routes rather than the more commonly postulated Bering Land Bridge route. Preliminary evidence indicates Kennewick Man is differentiated from other ancient skeletons, suggesting another population.

Relationships between early populations and recent Native Americans. Current evidence demonstrates that early populations differ markedly from recent ones. The reason for these differences has yet to be determined. Possibilities include: (a) substantial evolutionary change took place, or (b) early populations contributed little to the ancestry of recent Native Americans. Kennewick Man can make a substantial contribution to answering these questions.

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Claims for the Remains

Douglas W. Owsley

Division Head for Physical Anthropology, National Museum of Natural History, Smithsonian Institution

Doug Owsley

Deciding to initiate a lawsuit is rarely easy, particularly one that sues the federal government. But, in the case of Kennewick Man, there was no alternative.

Everything I was told about him suggested that Kennewick Man did not have physical features characteristic of Native Americans. I've been measuring, analyzing, and evaluating Native American remains, particularly those from the western half of North America, for the 25 years of my professional career. The database I've developed in that time with Dr. Richard Jantz of the University of Tennessee is comprehensive and detailed. Our cranial measurements allow us to trace population movements and draw conclusions about tribal affiliation. Kennewick Man's description didn't fit any group I knew of. My requests to study the skeleton (to the Army Corps of Engineers and to the Umatilla tribe to whom the Corps had assigned the remains) went unanswered; the skeleton was to be returned and likely reburied in less than a few weeks. In order to learn, scientifically, who Kennewick Man was, immediate intervention was necessary.

Kennewick Man has been dated to about 9,000 years ago. Few securely dated, well-preserved Paleo-American skeletons have been discovered. Some of them have been reburied, notably a 10,675-year-old female found near Buhl, Idaho and an 8,000-year-old skeleton found in Hourglass Cave in the Colorado Rockies. Neither was adequately studied by scientists. Yet, there's nothing in the NAGPRA regulations that prevents study. [NAGPRA is the Native American Graves Protection and Repatriation Act, under which tribes may file claims to remains if they can show a cultural affiliation to them.] To keep Kennewick Man above ground until some of the unresolved issues brought about by ambiguous NAGPRA terms and restrictive interpretations of them could be addressed, we sued.

DOI 07899

Nothing in the NAGPRA regulations, Owsley says, prevents scientific study of early Americans such as Kennewick Man.

What do we hope to learn from Kennewick Man? That's not easy to answer until many scientists from different backgrounds have a chance to examine him. It's remarkable how much can be learned from a skeleton; bones can tell us a great deal about a person's life. I'm reminded of the Ice Man, found in an Italian glacier and only half as old as Kennewick Man. His story is of great pride and interest not only to the people in the region where he was found, but also internationally. Information gained through the multidisciplinary study of him has greatly enhanced our understanding of this ancient culture and people of Europe. For example, scientists noted puncture marks in his leg and ankle and referred to them as "tattoos." Another scientist, noting the location of the tattoos, correlated them with acupuncture points. So now, instead of a single individual with body markings, we have indications of a different behavior.

That kind of building upon bits of basic data is what science is all about. The more scientists who are able to examine a skeleton, the more likely we are to arrive at the truth. Even now, the few scientists who have seen Kennewick Man disagree on whether he had three broken ribs or six, whether his right arm was broken or his left elbow, whether the stone point in his hip hastened his death or was fully healed over when he died.

Owsley discovered that five skeletons unearthed at Jamestown Colony are not Native American as originally supposed, but African. This exemplifies why scientists should be able to thoroughly study early skeletal remains, he says.

That's why I believe that Kennewick Man should be available for further study. We can easily miss what we aren't looking for. It takes all of us, coming from our different perspectives and using our various expertise to learn everything we can from a skeleton and to resolve the differences we find. We are now able to learn much more than scientists could a generation ago; our techniques are better, our technology more sophisticated. For example, using current databases, I was able to determine that five skeletons unearthed at Jamestown Colony are not Native American as they were identified in the 1950's; they are African. Historic documents

DOI 07900

confirm their presence in Jamestown colony, but the record is limited. Valuable evidence of Black History would have been lost if the remains had been given to local tribes for burial. In the same way, scientists in the future will be able to learn much more than we now can. Furthermore, they will have new questions because scientific interests evolve and theoretical paradigms shift.

Owsley fears that if scientists in this country find they are legally unable to study ancient skeletons, the study of early peoples in North America may suffer, while investigations of ancient people in other parts of the world -- including South America, where Luzia (above) was found - will proceed apace.

But this case is much larger than Kennewick Man and the plaintiff scientists who have asked to study him. Other old skeletons have been found and new discoveries of old bones will occur. If Kennewick Man had been reburied without study, and if other ancient skeletons and future discoveries follow him into the ground, I'm afraid the field of American physical anthropology that studies ancient populations will slowly die. New researchers, seeing only restricted areas of investigation here, are likely to turn their attention to other countries. In the future, then, we may learn a great deal about ancient migration patterns and populations in South America, Asia, Africa, and Europe, but North America may become a question mark -- an unknowable area that leaves a great gap in the total picture.

As a scientist, I care intensely about each of these issues. But personally, the whole subject is much closer to my heart than that. I've lived my whole life with a deep interest in the prehistoric peoples of North America. I want their story to be told completely and accurately. Unless we study Kennewick Man, the story of the native peoples, the story of America, and the story of his people will forever be unclear and inaccurate.

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Claims for the Remains

Dennis Stanford

Chairman, Department of Anthropology, Smithsonian Institution

Dennis Stanford

It is my view that many roads lead toward knowledge, and the unexpected is often encountered along the journey. Discovery of the remains of a man who lived along the Columbia River 9,000 years ago was itself a surprise. A further wonder is the marvelous story this individual can tell about life in prehistoric America. Should this elder be silenced because people in modern times presumed they already understood all he could teach?

The process by which the Americas were peopled, initially and through time, is a multifaceted story with many chapters. Much of this narrative is not well understood. No particular group -- be it governmental, ethnic, or scientific -- can respectfully claim that their path to understanding this story is paramount. Should a single interpretation or understanding of the course of events thousands of years ago become the accepted truth for all concerned? Such issues were at stake when we challenged the decision by the Army Corps of Engineers to rebury the Kennewick individual without study.

Reburial without scientific study and verification by interdisciplinary researchers would deny present and future generations the opportunity to learn and to benefit from significant new information. Preliminary studies indicate that Kennewick Man may tell a different story about the origins and lifestyles of early peoples in North America than that written in textbooks. He may illuminate a past more rich and complex than currently imagined.

DOI 07902

Kennewick Man, a cast of whose skull appears here, has the potential to force anthropologists to revise textbooks on the early peopling of North America, Stanford says.

Although publicity by the popular press has often cast the Kennewick case as an adversarial conflict between scientists and Native Americans, there are precedents whereby the religious concerns of Native groups and the respectful study of prehistoric peoples by anthropologists have proceeded in a cooperative, collaborative manner. Researchers of many ethnic backgrounds, having special expertise in unraveling biological, genetic, linguistic, and archeological clues regarding prehistoric populations and technological advances, are providing researchers with unprecedented tools for learning about the past. Likewise, American Indian religious systems, oral traditions, and culturally based understanding can be brought to bear in interpretations of archeological remains that are older than the experience of any living person. By respectfully combining both approaches to knowledge, we will be able to gain greater insights regarding the significance of the Kennewick find.

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Claims for the Remains

D. Gentry Steele

Department of Anthropology, Texas A&M University

Gentry Steele

I strongly believe in the importance and value of the scientific examination of our earliest prehistoric ancestors. Today's study of humanity's natural history has clearly documented the recency of human conquest of the last of Earth's landmasses. While we can trace our human lineage more than two million years back in time, the colonization of the New World, and the islands of the Pacific Rim -- the last chapters in our global dispersal -- are relatively much more recent events, having occurred within the last several thousand years in the case of the Pacific islands.

The actions of these last pioneers were inexorably interwoven with and dependent upon those who went before, and because of this, are an integrated part of our life history. When and how the last of the Earth's landmasses were occupied, by whom, and how the processes of biological change marked humanity's last global pioneers are questions of interest to all. I also strongly believe that understanding our shared life history will ultimately help us appreciate our commonality.

Without scientific investigation of early remains such as Kennewick Man (part of whose skull is shown above), we would have no knowledge of our prehistory, Steele maintains.

The recovery and interpretation of our prehistory has been accomplished through scientific investigation of those biological and cultural remains that have survived the erosion of time. Without the scientific investigation of this first line of evidence, we would have no knowledge of our prehistory, yet the most ancient remains are too few, and typically incomplete or even fragmentary. Because we view our

DOI 07904

ancient past through the destructive filter of time, each new site where human remains are recovered is of incalculable importance. Therefore, the scientific study of remains such as Kennewick Man, Wizard's Beach, and Spirit Cave should be thorough, carefully done, and verified by other scholars.

Verifying our analyses is the foundation upon which all science is built. Without verification, the analyses are suspect at best, and at worst, ignored. This process of verification does not imply a lack of confidence in the work of the initial scholars. Rather, it is recognition that scientists gather and interpret scientific evidence within the context of a particular theoretical framework and perspective. Verification of a scientist's studies provides assurance that data supportive of alternative interpretations are gathered. Without this verification, scientific analysis is incomplete.

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Expand your mind with "Hot Science," a fun, interactive way to delve into the world of science.

The Dating Game

By Rick Groleau

So what's the story behind radiocarbon dating? It's not a love story, to be sure. Rather, it's a way to determine the age of organic remains such as bone, teeth, and seeds by finding out how much carbon-14 is left in the remains.

How do scientists date skulls such as Kennewick Man's? Bone up on the topic below.

Check it out for yourself. At the very least you'll find out what it's like to date a 9,000-year-old skeleton such as Kennewick Man's.

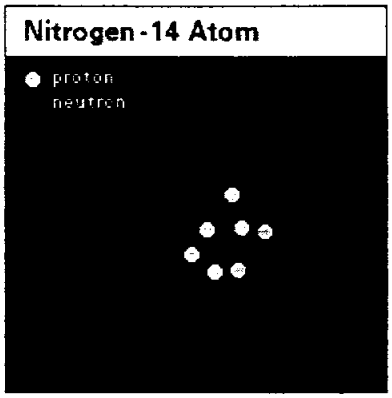
- **Close Encounters (of the Cosmic Kind)**
  Our dating game begins with, what else? -- cosmic rays.
- **Eating It (as in Yum) and Eating It (as in Bye-Bye)**
  Everything you eat is radioactive, so watch out!
- **(My So-Called) Half-Life**
  But theoretically, this half-life never dies. (Requires Shockwave.)
  Non-Shockwave version
- **Detection Section (What's Your Deflection?)**
  Sorting those atoms with mass acceleration.

DOI 07906

Close Encounters (of the Cosmic Kind)

Back to The Dating Game

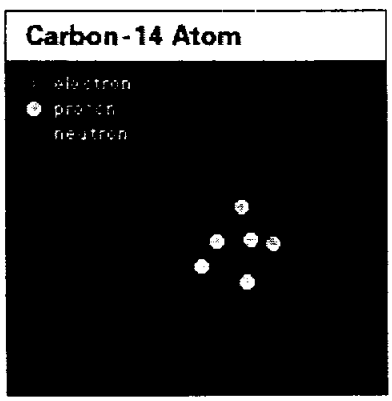
Right now, in our atmosphere, there are countless numbers of nitrogen atoms floating high above the Earth's surface. These atoms are, in a sense, vulnerable.



Cosmic radiation, in the form of neutrons, zips through the atmosphere at a high rate of speed. Occasionally, and purely by chance, some of these neutrons collide with the nuclei of some of the nitrogen atoms.

The nucleus of each nitrogen atom contains seven protons and seven neutrons. That is, it does until a collision happens. The incoming neutron hitting the nucleus causes a proton to shoot out of the nucleus, just as a cue ball on a pool table, hitting one of two balls that are touching, might cause the ball that it hits to stay in place and the other ball to shoot off.

The nitrogen atom now has six protons and eight neutrons. This means two things. One, with this arrangement of protons and neutrons, it's unstable. In other words, it's radioactive. And two, it's no longer nitrogen. The reason is that the number of protons an atom contains determines what that atom is. Since it now contains six protons, it's carbon. Carbon usually has six neutrons as well -- in this form it's called carbon-12 (6+6=12). The unstable, eight-neutron version, however, is carbon-14 (6+8=14).



All radioactive atoms will eventually decay, or change, in some way. When a carbon-14 atom decays, one of its eight neutrons turns into a proton, emitting an electron (with a charge of -1) in the process. The atom is now stable. And with seven protons and seven neutrons, it is again nitrogen-14.

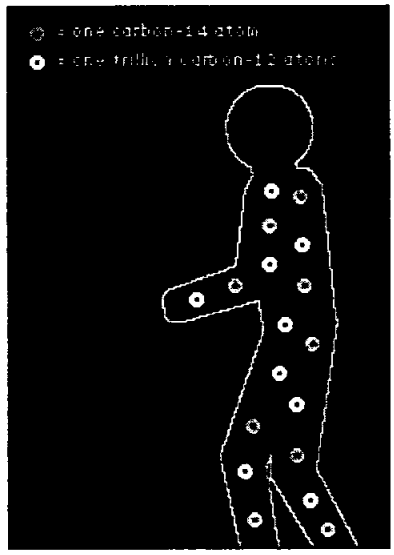
Next: Eating It and Eating It...

DOI 07907

Eating It (as in Yum) and Eating It (as in Bye-Bye)

Back to The Dating Game

So is everything you eat really radioactive? You bet. Should you worry about this? Nah.

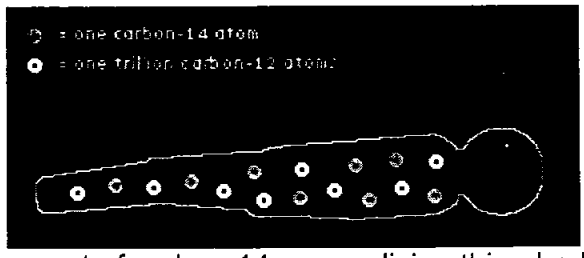


The carbon-14 created by cosmic radiation makes up only a fraction of the carbon in our atmosphere. But it is there, and just like carbon-12, it can be taken in by a growing plant and become a part of that plant. (As you may know, plants take in carbon dioxide, or CO_2, separate the carbon from the oxygen, then release the oxygen back into the atmosphere.)

So every plant contains a certain percentage of carbon-14. And so do those things that eat plants. And so do those things that eat the things that eat plants.

The percentage of carbon-14 in all of these living things is the same as the percentage of carbon-14 in the atmosphere. At least it's the same while they're living. When a plant or animal dies, no carbon (in any form) can enter its system to become a part of it.

Now we get into the nitty-gritty of carbon dating.



The carbon-14 within every once-living thing will someday turn back into nitrogen-14. If we knew the amount of carbon-14 a once-living thing had while it was alive and the rate at which it changed (i.e., how fast it changed) back into nitrogen, then we could figure out how long ago it lived.

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Well, it turns out that we do know. The amount of carbon-14

in the atmosphere (and therefore in living things) has not changed all that much over time. And we do know the rate at which carbon-14 changes back to nitrogen-14, though what this rate is is not as straightforward as it could be.

Thus we move on to the topic of half-life.

Next: (My So Called) Half-Life (Shockwave version)
Non-Shockwave version

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Mystery of the First Americans

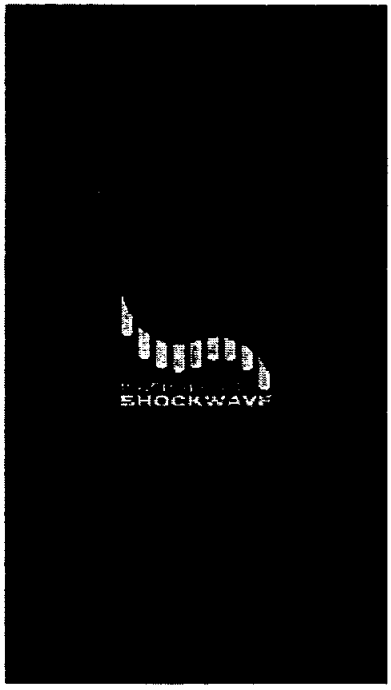
(My So-Called) Half-Life

Back to The Dating Game

Here's an example of how half-life works: Let's say you have 80 ants, and these ants have a half-life of ten days. In ten days, then, 40 of your ants would still be alive. Ten days after that, 20 ants would still be alive. Ten more days, and ten would be alive. You get the picture.

If you took just one of these ants, though, there would be no way to predict when it would die. It might die right away or it might live for a long time. It's only when you have a lot of them that this half-life thing works.

In real life, you can't use the half-life method to determine ant death rates. You can, however, use the method to determine when radioactive atoms will decay into some other form.



Half-lives vary greatly from one radioactive atom to another. The reason is that a highly unstable atom wants to change quickly, whereas a slightly unstable atom is only slightly uncomfortable with its condition. The half-life of highly unstable radon-222 is less than four days. The half-life of the slightly unstable uranium-238 is 4.5 billion years. Carbon-14 has a half-life of 5,730 years.

Use the graph to the left to see how half-life works. Drag the "Time" pointer up and down to move through time. Watch what happens to the level of carbon-14 as you do so.

Next: Detection Section (what's your deflection?)

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Detection Section (What's Your Deflection?)

Back to The Dating Game

If you've been reading the sections of this Hot Science in order, you already know that, to determine the age of an object through radiocarbon dating, you need to know the amount of carbon-14 that the once-living organic specimen started off with as well as the rate that carbon-14 decays, both of which we do know.

All that's left to determine is the ratio between carbon-12 atoms and carbon-14 atoms within the specimen to be dated. How is this done?

One way is to use a particle accelerator. Here's how the method works:

All of the carbon atoms from a small sample of the specimen are fed through the accelerator. The speeding atoms then pass through a magnetic field.

The magnetic field deflects all the atoms, but to varying degrees. A detector -- one that can count any type of carbon atom -- is situated in a position that only the carbon-14 atoms reach. The detector, therefore, counts only the carbon-14 atoms within the sample.

With the total number of carbon-14 atoms counted and the knowledge of the total number of carbon atoms, one can determine the ratio of carbon-12 to carbon-14. How far off this ratio is from the initial carbon-12 to carbon-14 ratio (which is, by the way, about one trillion to one), reveals how much of the carbon-14 has decayed. Then all that's left to be done is to figure out, based on carbon-14's half-life of 5,730 years, how much time has elapsed.

Actually, it's a little more complicated than that. The radiocarbon date doesn't match up exactly with actual years elapsed. One reason is that the amount of carbon-14 in the atmosphere has not always been constant. But one can make adjustments to the date, and if the age of the item is 40,000 years old or younger, one can arrive at a relatively accurate figure.

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