higher plants (13), should lead to the cloning of more clock components. Will some of these contain PAS domains, making the use of this motif universal? Second, are proteins such as WC-1 and WC-2 (or even PER) also photoreceptor molecules themselves? Macino and his colleagues have speculated this could be so, on the basis of the homology of the PAS region to part of the chromophore-binding region of PYP (7). Modeling of PAS domains based on the PYP structure may indicate whether the domain is at least a structurally, if not evolutionarily, conserved motif. Whatever the answers one thing is clear: The study of photosensory processes and the the circadian clock must now proceed hand-in-hand.

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ANTHROPOLOGY

Monte Verde and the Pleistocene Peopling of the Americas

David J. Meltzer

The publication of the second and final volume on the Monte Verde site in southern Chile by Dillehay of the University of Kentucky (1) marks a milestone in American archaeology. For over half a century, and with increasing rancor over the last few decades, archaeologists have sought and disputed evidence of a human presence in the Americas that predates the Clovis archaeological culture (~11,500 years before the present). Scores of pre-Clovis contenders have come forward, only to wither under critical scrutiny. So many have failed that the archaeological community has grown highly skeptical of any and all pre-Clovis claims (2, 3). Few archaeologists would exclude the possibility that earlier evidence might be found, but most were unwilling to take such claims at face value. In the face of that accumulated skepticism, it was clear that the first site to break the Clovis barrier would have to effortlessly hurdle the traditional criteria by which early sites are judged (4): unambiguous artifacts or human skeletal remains in unimpeachable geological and stratigraphic context, chronologically anchored by secure and reliable radiometric dates.

The Monte Verde site was excavated from 1977 to 1985 and subsequently analyzed by Dillehay and an international and interdisciplinary team of nearly 80 collaborators. The remains they recovered are extraordinary. The Pleistocene occupants of Monte Verde camped on the sandy banks of Chinchihuapi Creek. Soon after their departure, water and fibrous peat spread over the site, blanketing the living surface, slowing the normal processes of decay and richly preserving many organic remains. Excavations recovered parts of nearly 70 species of plants (most unusually, in the form of chewed leaves), many of which have economic or medicinal value and were gathered from sources up to 400 km distant. Other remains included mastodon (Gomphothere) meat and bone with soft tissue adhering; wooden lances and mortars, as well as planks and stakes that formed the foundation of a tentlike structure evidently draped with mastodon hide; and hundreds of stone artifacts, including distinctive projectile points, spherical stones interpreted as bolas, and cutting and scraping tools that lack inherent attributes marking them as obviously the work of human hands but occur in a context bespeaking a cultural origin (1).

Signs of life. Stone implements found at the Monte Verde site dating to 12,500 years ago.

This material was found on a complex occupational surface representing the activities of a group living on site for what Dillehay estimates was roughly 1 year. Nearly 30 radiocarbon ages were obtained from charcoal, wood, and ivory materials on the occupational surface and from the strata bracketing that layer. These securely place the age of the occupation at ~12,500 before present (5).

Since finishing the excavations, Dillehay has directed a painstaking analysis of the site materials and spatial patterning, reported in a volume of over a thousand pages (1). The effort was analytical overkill. Yet, overkill was necessary, given the great skepticism facing this (or any) potentially early site and the doubts about Monte Verde's antiquity that have been expressed since the site's discovery was announced over a decade ago. The first volume (6) on the site resolved some of those initial concerns; the second volume puts the remainder to rest. These volumes, and an examination of the site and its collections in January of 1997, convinced a group of Paleoindian specialists—staunch skeptics among them—that the Monte Verde site is indeed archaeological and ~12,500 years old.

As such, its implications are profound. Although only slightly more than a thousand years older than Clovis, the site's great distance from the Bering Land Bridge (the entry route from Siberia) indicates initial arrival in the Americas must have occurred much earlier than 12,500 years ago. How much earlier depends partly on obstacles encountered along the way: Interior and coastal routes south from Alaska, for example, were impassable for long periods (~20,000 to after ~13,000 years before present on current evidence), as continental glaciers formed a physical and, for several millennia after their retreat, an ecological barrier to migration (7). It also depends on how quickly these groups adapted to the diverse and (as they moved south) increasingly exotic and unfamiliar New World, how easily they coped with novel pathogens and diseases (8), and how they maintained their population size and reproductive viability, contended with the potential genetic costs of inbreeding, all while living in relatively small numbers spread thinly over large and apparently unpopulated continents (3). On the basis of

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what is currently known of these variables, Monte Verde would imply an arrival in the New World before 20,000 years ago.

This, in turn, raises the question of why traces of the initial migrants have not proven more evident in North America, through which they must have passed en route to South America. There are hints of an early presence, but agreement has not been reached on these sites, and none have been as thoroughly documented as Monte Verde. Importantly, the acceptance of Monte Verde and its demonstration of a deeper antiquity in the Americas is not warrant to accept previously rejected pre-Clovis claims from the Americas. If a site was not old before Monte Verde, it will not become any older because of Monte Verde. Meadowcroft Rockshelter (Pennsylvania), with human occupations apparently from more than 14,250 years ago (*9*), may prove the exception to that rule (*3*).

That more traces of early peoples have yet to be found raises the possibility that the initial migrants were so few and widely scattered they were for a considerable time archaeologically invisible (*10*). It also suggests that archaeologists may not have looked in the right places or in the right way for potentially early sites (*11*). But if history is a guide, more early sites will soon emerge, as they did on the heels of the Folsom (New Mexico) discovery in 1927, which first proved humans had arrived in the Pleistocene (*12*). Discoveries such as these yield important leads in the search for other sites, which in turn help fill in the archaeological details of the colonization process. Those details will be of considerable general interest in understanding migration, adaptation, and population dynamics (*13*), as this case is one of the few instances in which fully modern humans radiated into a previously uninhabited continent.

Monte Verde's acceptance will also reverberate beyond American archaeology. Geneticists and linguists have actively sought, through analysis of modern Native American populations, clues to the number, timing, and antiquity of migratory pulses into the Americas (*14*). The Monte Verde evidence may ultimately help refine the currently varied mitochondrial DNA mutation rates used in molecular clocks (*15*). It also raises questions about the number of populations in the New World at the end of the Pleistocene, such as whether the groups at Monte Verde and Clovis represent the same or separate migratory pulses. Resolving these questions will have implications for our understanding of the diversity of the founding population (or populations) and the debate over the phylogenetic history of contemporary Native American populations (*16*).

Some 70 m away from the 12,500-year-old deposits, Dillehay's team recovered traces of a separate occupation that appears to date to >33,000 years before present. Dillehay (*1*) remains noncommittal about those materials. He feels further excavations are required to confirm this occupation. If confirmed, its implications will be even more profound. Until then, however, those interested in the peopling of the Americas have plenty to occupy themselves, in the effort to fully explore the ramifications of the 12,500-year-old occupation at the site.

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17. I thank J. M. Adovasio, T. D. Dillehay, and D. K. Grayson for their comments.

MEDICINE

Quenching the Spark in the Heart

David T. Yue

The human heart is a marvel of inspired engineering that faithfully supplies blood to the body by contracting over 3 billion times in a lifetime. Most of us blissfully ignore its smooth functioning until this biological pump begins to fail, with lethal consequences apparent in any intensive-care unit. What goes wrong in heart failure remains unclear, in part because there are so many potential problem spots in heart excitation-contraction (EC) coupling—the complex choreography of Ca^{2+} signaling and chemomechanical transduction that underlies each heart beat. On page 800 of this issue, Gómez *et al.* (*1*) use high-resolution, intracellular Ca^{2+}-imaging techniques to reveal that much of the problem resides at a single step in the EC coupling of hypertrophied and failing hearts. This discovery promises to simplify understanding of heart dysfunction. But the result is all the more satisfying because the nature of the defect would not have been recognized without insight from fundamental studies of EC coupling.

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Our understanding of EC coupling has changed dramatically over the past few years. In older, "common-pool" (*2*) theories, each cardiac contraction was thought to occur as follows (see figure, part A): (i) Electrical excitation sweeps across the surface of a heart. (ii) This depolarization opens voltage-gated, dihydropyridine-sensitive Ca^{2+} channels (DHPRs), allowing an influx of Ca^{2+} that modestly increases a common pool of intracellular Ca^{2+} (Ca_{common}). (iii) This increase in Ca_{common} triggers the opening of ryanodine-sensitive intracellular Ca^{2+} channels (RyRs) (*3*). The resulting efflux of Ca^{2+} from the sarcoplasmic reticulum causes a far larger increase of Ca_{common}. (iv) This increase activates the contractile machinery, causing contraction.

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Recently, a growing body of data (*2, 4–6*)