Climate Change and Human Responses: A Zooarchaeological Perspective

Gregory G. Monks (ed.)

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Reviewed by DIANE K. HANSON

Department of Anthropology, 3211 Providence Dr., University of Alaska Anchorage, Anchorage, AK 99508, USA; dkhanson@alaska.edu

This collection of papers addressing past climate change using zooarchaeological data comes from the 2010 meeting of the International Council for Archaeozoology in Paris, France. The book covers human responses to paleo-environmental change from the Pleistocene-Holocene Transition, the early to mid–Holocene, and finally the recent Holocene (2500 years ago through the Little Ice Age). The geographic extent is broad, covering projects from Greenland to Patagonia, and from the Philippines to the Adriatic Sea.

Terry O'Connor begins the discussion in a Forward that covers many of the larger topics that concern zooarchaeologists when addressing paleo-environments. O'Connor notes that zooarchaeologists can contribute to understanding the relationship of long-term and repeated episodes of climate change to human adaptations, but that archaeologists are not able to deliver the precision biologists crave given error ranges associated with radiocarbon dating. Biologists trade the precision in their research for a baseline data-set that begins in the twentieth century, a period already severely affected by industrial harvesting and environmental alterations associated with exponential human population growth. He also questions the definition of a "natural environment," that does not include humans. Humans are part of the environment, and archaeological data come from remains collected by humans. He argues that the environmental system is dynamic, and modern attempts to restore environments to some imagined pristine state "may be seeking to impose stability on inherently unstable systems" (p. ix) or recreating an environment that can no longer survive beside modern human populations.

Monk reiterates some of O'Connor's points in the Introduction. He emphasizes that the objective of the volume is to demonstrate the value of archaeologists' contributions to climate change through the analysis of animal remains, to demonstrate to other disciplines "that humans affected past ecosystems, so that the assumptions of pristine conditions may not apply," and to extend the chronology of human/environmental interactions as they relate to climate change (p. 2).

Four papers confront cherished hypotheses concerning the Pleistocene-Holocene transition. Belmaker (*The Southern Levant during the Last Glacial and Zooarchaeological Evidence for the Effects of Climate-Forcing on Hominin Population Dynamics*) tests contradictory hypotheses that Neanderthals in the Levant became extinct during a dramatic global climate change 45,000 years ago, or that frequent shifts in climate caused habitat fragmentation that reduced Neanderthal numbers and contributed to their extinction. She uses presence/absence data from sites with different environmental attributes in the southern Levant dating between ca 191,000 and 27,000 years ago. Animal vulnerability to climate change varied with size and trophic level. She notes that the environmental effects were different, depending on the period and the amplitude of climate shifts. Only during extreme amplitudes was there a change in faunal representation and community structure. She observes that only Neanderthals became extinct after 50-45,000 years ago and those changes in the southern Levant were not an "*effective climate* change" for other animals (emphasis Belmaker's, p.21).

Ferrusquía-Villafranca and colleagues (*Quaternary Mammals, People, and Climate Change: A View from Southern North America*) face equally controversial assumptions about the impact of human migrations into Mexico at the end of the Pleistocene on the fauna. They compare 200,000 to 11,000-year-old Pleistocene mammal remains with Holocene fauna. The effect of environmental change during the Holocene varied with the ecological regions or morphotechtonic provinces, and animal size. Many animals moved to another latitude or elevation depending on their physical requirements, or occupied refugia. While taxa might be absent locally, most were not extinct. Medium and large mammals were affected most. Humans appear in Mexico by 13,000–12,000 years ago, and based on remains from late Pleistocene sites, their hunting focus was on small and medium mammals. Of 100 mammoth skeletons, "few show evidence of human interaction" (p. 54). The authors conclude that it is unlikely that humans were responsible for mammoth extinctions or for the faunal changes in Mexico at the end of the Pleistocene. The greater impact of environmental change was to alter the ecological zones, causing the development of "new and different faunal and floral communities" (p.57).

Ochoa and Piper (*Holocene Large Mammal Extinctions in Palawan Island, Philippines*) investigate Palawan Island in the southwest Pacific. During the Pleistocene, Borneo was part of Sundaland, an extension of mainland Southeast Asia, but it appears there was always an open strait between the mainland, Palawan Island, and the Philippine archipelago. They use data from two cave sites at the north end of Palawan Island. Ille Cave has basal deposits ca 14,000-years-old, and Pasimbahan Cave is younger, with basal deposits dating to 10,500 years ago. Ochoa and Piper identify a shift

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from abundant deer near the end of the Pleistocene, to assemblages dominated by wild pig. They assume that pigs became more abundant during the mid-Holocene as jungle expanded at the expense of savannah starting in the south and moving northward (p.71). Other changes were shoreline stabilization and increasing shellfish use by humans. The reduced land mass associated with rising sea levels, a shift in vegetational overstory, and human hunting are credited for reduced faunal diversity on Palawan during the mid- to late-Holocene.

Pilar Birch and Miracle (*Human Response to Climate Change in the Northern Adriatic during the Late Pleistocene and Early Holocene*) consider the effect of an encroaching sea on the human populations in the Mediterranean. Cave sites that once overlooked plains and open woodlands faced a seascape 4000 years later. Using an assemblage from Vela Špilja Lošinj, a cave site in Croatia on the east side of the Adriatic Sea, the authors test a hypothesis that early Holocene populations increased dietary breadth and processed carcasses more thoroughly than did late Pleistocene hunters to compensate for habitat loss and reduction in preferred species. While mammal species richness remained the same between Paleolithic and Mesolithic sites, red deer (*Cervus elaphus*) dropped to half while smaller ungulates increased, and by the Neolithic, the assemblage was primarily sheep and goat bone with small numbers of fox, hare, and pig. Bone fragmentation and carcass butchering intensity was similar during the Paleolithic and Mesolithic. Shore-dwelling birds, fish, and shellfish were incorporated into the diet during the Mesolithic in greater numbers, supporting their hypothesis that diet breadth would increase as preferred prey were less accessible, but they acknowledge that it may be more efficient to gather marine foods as they become accessible and this is not necessarily an indication of dietary stress (p 97). In the end, they could not determine if there was intensification as a result of dietary stress, given adjustments to a changing environment.

Only two papers represent the mid-Holocene hypsithermal or Holocene Thermal Maximum (HTM). Yacobaccio, Morales, and Samec (*Early to Middle Holocene Climatic Change and the Use of Animal Resources by Highland Hunter-Gatherers of the South Central Andes*) use a combination of camelid representation and nitrogen and carbon isotopic analysis of the animals to identify dietary changes from early and middle Holocene sites in the Puna region of Argentina and Chile. The authors conclude that an increasingly fragmented habitat during an arid middle Holocene period led to changes in camelid behavior as they congregated in ideal and predictable patches. Larger hunting groups reduced search time for a highly productive prey as they exploited the same patches.

Magnell (*Climate Change at the Holocene Thermal Maximum and its Impact on Wild Game Populations in South Scandinavia*) is likewise working through the effects of environmental changes during the same period on medium and large cervids in Denmark and southern Sweden. Wild boar and aurochs are also briefly discussed. Taxon abundance comparisons are based on the relationship of species NISP to all ungulate NISP partly because he is using assemblages collected over the past 100 years with variable retrieval methods. Cervid size was estimated using astragali and distal humeri. Magnell also compared coastal sites and inland sites, then applied his data to concerns about the effects of climate change on modern northern fauna. He found that climate change affected the HTM ungulates differently depending on diet and hunting pressures and suggested that modern descendant populations of these highly adaptable ungulates may be able to adjust to increasing temperatures.

Studies from Nicaragua, Patagonia, the Canadian West Coast, and Greenland undertake changes during the recent Holocene. Despite the late period, only one paper addressed domesticated animals. This may be partly because the cultural variables of artificial breeding and borrowing domestic animals from other regions can confound attempts to identify environmental influences.

Colonese, Clemente, Gassiot, and López-Sáez (*Oxygen Isotope Seasonality Determinations of Marsh Clam Shells from Prehistoric Shell Middens in Nicaragua*) attempt to identify fluctuations in precipitation in Pearl Lagoon on the east coast of Nicaragua using an estuarine bivalve (*Polymesoda arctata*). By analyzing oxygen isotopes from annuli of this small clam, they are able to identify a shift in lagoon resource use as agriculture and sedentism became more common. The sample size from the archaeological site of Karoline is small (n=14), but their results are intriguing. They note rapid changes in the lagoon salinity in the archaeological shell that is not apparent in the modern shell. The authors offer several explanations for this including increased storminess and changes in land use, although they recognize that their small sample makes it difficult to identify the source for the shifts.

Rindel, Goñi, Bautista Belardi, and Bourlot (*Climatic Changes and Hunter-Gatherer Populations: Archaeozoological Trends in Southern Patagonia*) compare hunter-gatherer mobility during the Medieval Climatic Anomaly (MCA) of the mid-Holocene using guanaco (*Lama guanicoe*) elements from high and low elevation sites in southern Patagonia. They predict that desiccation should be associated with decreased hunter-gatherer mobility because of "extensification" or expanding the subsistence area while concentrating seasonally in lowland areas. Rindel and colleagues compare existing data from mid-Holocene (4000 to 3000 BP) sites with data they collected from sites dating from 2500 years ago to pre-European contact. About every piece of information possible is squeezed from the 10,000 bones analyzed for evidence of mobility shifts. The authors demonstrate that during the late Holocene there was an expansion of seasonal hunting sites and greater sedentism in the lowlands. They conclude that the climatic change, the shift of lakes to meadows and grasslands, and resulting differences in guanaco movements led to a significant shift in hunter-gatherer subsistence decisions and behavior.

Monks (*Evidence of Changing Climate and Subsistence Strategies among the Nuu-chah-nulth of Canada's West Coast*) tackles a change in fish consumption during the Little Ice Age (LIA) on the west coast of Vancouver Island in British

Columbia, Canada. Using modern fisheries data, he demonstrates a correlation between water temperature, precipitation, and fish abundance. He then draws an analogy to the conditions that would have been prevalent during the consistently warm conditions of the MCA and the more volatile and less predictable LIA with periodic cooling and high precipitation interrupted by MCA-like warmth. He then includes the modern environmental effects for two important subsistence fish families in Barkley Sound, with different behaviors, and requiring different acquisition technologies and scheduling. Rock fish (*Sebastes* spp.), with their long lifespans, are likely to be more prolific and represented by more diverse species during the consistently warmer waters of the MCA, while salmon (*Oncorhynchus* spp.) are better adapted for the wetter, short-term, unpredictable conditions of the LIA. Zooarchaeological data from the T'ukw'aa Village Site show a shift from abundant rockfish during the MCA to salmon during the LIA. Halibut (*Hippoglossus stenolepsis*) also were more common during the MCA; cabezon (*Scorpaenichthys marmoratus*) and herring (*Clupea harengus pallasii*) during the LIA; and, shellfish showed a marked increase during the LIA supporting the proposal that there was a subsistence shift. Monks argues that while families or lineages owned or controlled high-value resource patches before and through the MCA and the LIA, there was more emphasis on harvesting and storing large quantities of salmon and herring, and redistributing the surplus during the LIA that was not present earlier, and this may be partly responsible for the complex social organization described ethnographically.

Cussans (*Biometry and Climate Change in Norse Greenland: The Effect of Climate on the Size and Shape of Domestic Mammals*) attempts to identify a cooling climate in Greenland between the MCA and the LIA using length and breadth measurements of sheep and goat bones. While the objective is reasonable, she struggles with trying to control the many variables that affect bone growth while using an assemblage too small to assess the source(s) of the change. Cussan mostly uses length/breadth measurements of sheep and goat astragali from a Western Settlement site on the western side of Greenland near Nuuk (Gården under Sandet or GUS) and Ø34 on the southern tip or the Eastern Settlement near modern Qaqortoq. She collected most of her data from the GUS site and used already analyzed material from Ø34. Despite the small assemblage size, her data did show size reductions, and she suggested other methods to improve the study to determine the source for the size change.

In the summary chapter, Sandweiss (*Zooarchaeology in the 21st Century: Comments on the Contributions*) highlights the themes in this volume. It is an excellent summary of the papers, sampling issues, and approaches used in interpretations and applications of the data. I appreciated his caution that archaeologists "need to understand past cultural logic that would have conditioned responses to such stimuli" (p. 222) as climates and environments changed.

All the authors address issues of sample size and interpretation, although as Sandweiss notes, there does not seem to be much attention to the effect of sampling methods. The peer reviewers and the editor did an excellent job of identifying logic gaps that sometimes appear. The authors usually addressed any perceived data gap or soon after I identified one while reading their papers. Some figures suffered when transferred from a color presentation to a gray-scale figure or after being reduced to a standard page size. A strength of the papers is the investigators' integration of independent tests or sources of climate information, such as isotopes, pollen, and geological sources of information. This is a valuable collection for anybody contemplating a climate change study using archaeological materials. The volume provides excellent examples for people trying to articulate the value and the limitations of zooarchaeological data for providing an extended paleo-environmental baseline for interpreting modern climate anomalies.

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