



Creating the Nation's first BioPark

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Letter from the Desk of David Challinor  
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Most of us take the weather for granted, especially when living in one place for a long time. Variations in annual weather cycles seem relatively minor; we often have only vague memories of particularly snowy winters or cold snaps when the local river unexpectedly froze over. Even the brief period during which humans could write is too short to record accurately major climate changes which occur over more than a few thousand years.

Scientists nonetheless have developed many remarkable techniques to interpret paleoclimates from several sources, among which are: 1) ice cores; 2) pollen grains; 3) tree rings; and 4) soil cores. They can now tell with remarkable accuracy what European and North American climates were like hundreds of thousands of years ago.

Since the evolution of Homo sapiens, the major climatic perturbations were the Ice Ages when vast continental glaciers advanced and retreated in the northern hemisphere; the last retreat was only 10 or 12 thousand years ago. Imbedded in the ice of glaciers, for example, are gases and particles of dust that are laid on the surface annually. These elements can be dated and thus provide a record of climate back for tens of thousands of years. During the peaks of glaciation, so much of the globe's water was locked up as ice that the ocean level dropped significantly and a land bridge formed across the Bering Straits, linking Asia to the New World.

Climatic extremes accounted for the migration between continents of many large mammals that still exist today. Fossils of early fox-sized "horses" have been found in both North America and Europe, but although various branches of this group disappeared from Europe by the end of the Eocene (40 million years ago), horses continued to evolve in North America and eventually migrated to Europe about 20 million years ago. Ironically, horses became extinct in the New World towards the end of the Ice Age, about the time humans arrived. One hypothesis for their disappearance is that they were extirpated by paleohunters.

Besides using fossils (especially of teeth, which are unique to mammal species) to trace the evolution of mammals and the impact of climate changes on their migration between continents, the study of pollen grains or palynology also provides evidence of paleoclimates. Pollen grains are unique to tree species, and stratified layers of pollen laid down each spring on the surface of an undisturbed bog over millennia can be retrieved by coring.



By identifying the tree species that produced the various kinds of pollen retrieved, palynologists can plot the tree species growing in the area over time and thus extrapolate the ancient climate. Thus Black spruce, which grows in and around bogs today from northern New England to Alaska, used to grow as far south as Tennessee according to pollen grain found in the depth of a bog there. By dating the level of Black spruce pollen grains, we deduce that about 50,000 years ago it was cold enough for this tree to grow that far south.

In addition to palynology, former climates can be studied by dendrochronology or the analysis of variation in tree growth as reflected in the pattern of growth ring variation. Wet and dry climate cycles are accurately recorded in temperate zone trees that grow annually in spurts and lay down a growth ring each growing season. As growing seasons vary in the amount of rainfall, so does tree ring width. The more favorable the growing season, the faster the tree grows and the wider the rings produced, and vice versa. Thus where trees have grown and been harvested for lumber over thousands of years, the precise date of wooden structures can be determined by taking a thick pencil lead-sized core across the grain and then plotting the growth ring sequence pattern of the local timber used. German researchers have extended tree ring chronology back 9,000 years and are gradually pushing it even further back as the excavation of ancient buried timbers are cored and their tree ring sequence correlated with existing known ones. Wood material buried a meter or more below the surface of either water or soil will endure almost indefinitely because at that depth there is insufficient oxygen for wood destroying bacteria to survive. Ring width sequences can therefore reflect wet and dry cycles over thousands of years.

Another method of determining ancient climates is described in a recent paper by two Smithsonian sedimentologists, Dan Stanley and Andrew Warne (SCIENCE 30 April 1993). They have studied the structure of the Nile delta for eight years by taking about 100 earth cores there to depths ranging from 10m to over 50m. From these cores they took nearly 4,000 samples to determine the composition and texture of the soil. By carbon dating some 340 of these samples, they determined the changes in the structure of the Nile delta over the past 35,000 years. They found that sea level variation was about as expected and was controlled by expansion and contraction of continental glaciers. Sea levels were low during the Pleistocene Ice Age (30 to 12 thousand years ago) and the delta's edge then extended as far as 50 km north of the present coastline. From 12 to 8 thousand years ago, the melting glaciers raised sea level rapidly. For the next few thousand years, short-time climate changes (100 to 1,000 years) become evident in the character of the sediment deposited in the

delta. From 7 to 4.5 thousand years ago, it was wetter than today; thus floods were higher, and more and coarser sediment was carried to the delta. The historic record begins from the time of the Pharaohs (5 thousand years ago), and climatic variations can be determined in increments from decades to centuries. The scientists conclude with a pessimistic assessment of the delta's future. Although the completion of the Aswan high dam in 1964 allows year round irrigation, the cost is the absence of downstream sediment deposition. Little of the Nile's water actually reaches the Mediterranean Sea, and what does is very polluted and tends to be concentrated in coastal lagoons. The shoreline is rapidly eroding, and salt water is intruding into formerly irrigated farm land as increasing amounts of fresh water is pumped from shallow wells for irrigation. The changes in the delta's physical characteristics now threaten to be as great as those caused by ancient floods and by drastic sea level changes. Thus the overwhelming demands of humans can change the landscape as rapidly and perhaps as violently as many natural events.

The study of presently available evidence on past climates has been advanced by some of the techniques I have discussed. Climate change is inevitable. However, we are all responsible for not exacerbating climate changes such as might be accelerated by the greenhouse effect. Civilizations need time to adjust to new climatic conditions. The threat of global warming is probably real, and we can be thankful that intelligent people and governments are beginning to take the threat seriously and to initiate measures to slow the process. Our current knowledge of past climates has taught us that extremes have occurred, and they can do so again. As scientific techniques improve, we can isolate these climate swings and slowly begin to understand what causes them.