Introductory Overview

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Elias argues (chapter 18, p. 370) that ecosystems are shaped by environmental changes that have occurred over thousands of years so that the century to millennial timescale is of particular significance because "it is on these timescales that ecosystems form, break apart, and reform in new configurations." Within this context, the authors for the three chapters in part IV evaluate evidence for climate variability since the Last Glacial Maximum (LGM) to the present. They evaluate the biological responses to these longer term changes and highlight the importance of past climatic conditions on current ecosystem function. If we view, as Elias does, glacial climate as a filter through which ecosystems have passed, then variability since the LGM comprises a significant fraction of the biotic history that shaped current ecosystems. This is an overriding theme for this section.

Fountain and Lyons (chapter 16), examining a dry valley ecosystem in Antarctica (MCM), evaluate various proxy records to establish the historic context of their landscape. They argue that this historical context is important for a full understanding of ecosystems and that it is especially important for the MCM ecosystem. Providing an excellent example of legacy, the effect of past imprints on current ecosystem function, they present evidence that past climatic variations truly dictate current ecosystem status. During the LGM, ice blocked the current Taylor Valley, forming a lake that contained phytoplankton and algal mats. Subsequent warming eliminated the blockage, drained the large lake, forming several smaller ones, and established the current landscape. The former large lake supplied nutrients to the soil and current lakes. Fountain and Lyons (p. 334) state that "the vital importance of climatic legacy in the dry valleys is due to its extreme environment, low biodiversity, and short food chains." They also observe a "polar amplification," whereby

the sharp solid/liquid phase transition of water allows small changes in climate to produce relatively large variations in ecosystem response.

The Jornada Long-Term Ecological Research site (JRN) is representative of the desert shrubland and desert grassland ecosystems of the southwestern United States. Monger (chapter 17) makes use of a range of biotic (packrat middens, fossil pollen), abiotic (chronological data on lake levels, position of alpine glaciers and rock glaciers) and soil-geomorphic evidence to create a working hypothesis of the bioclimatic changes during the last 20,000 years. There is a remarkable consistency in these proxy estimates given their diversity. This proxy evidence is merged with historical and measured climate variability to address the question, How has this ecosystem responded to climate variability? Evidence points to both climate and human land use as having important, and interacting, impacts on this ecosystem.

Elias (chapter 18) discusses millennial and century climate changes in the Colorado Alpine (NWT). Using remains of beetles as indirect evidence for past environmental conditions, Elias constructs a temperature history of the Colorado Alpine since the LGM. Based on the assumption that the present climatic tolerance range of a species can be applied to its Quaternary fossil record, he builds a technique such that a fossil occurrence of a given species is used to imply a paleotemperature within the same tolerance range. This evidence provides a temperature reconstruction for this area during the past 24,000 years. Elias notes that there are conflicting interpretations of insect, pollen, and archeological data during the mid-Holocene interval, and he suggests the need for additional regional studies to clarify reconstruction of this period.

The three chapters in this section, although they represent a diverse set of ecosystems, provide climatic reconstructions since the Last Glacial Maximum. They thereby describe regional biotic and landscape history that leads to the postglacial environments of the Holocene and our current ecosystem conditions.

CLIMATE VARIABILITY AND ECOSYSTEM RESPONSE AT LONG-TERM ECOLOGICAL RESEARCH SITES

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OXFORD
UNIVERSITY PRESS
2003