History of the Mediterranean Ecosystem in California

DANIEL I. AXELROD

This Study is Dedicated to the Memory of RALPH WORKS CHANEY, Paleobotanist and Conservationist

Introduction

Similar physical environments, acting on organisms of dissimilar origins in different parts of the world, have produced structurally and functionally similar ecosystems. The fossil record provides a reliable basis for understanding how this occurred because all modern ecosystems are the result of the interaction between evolving lineages and changing environments during long spans of geologic time. Since many woody plants similar to those still living have left a fossil record, it is possible to reconstruct the ecosystems they represent, and to discern the development of the modern descendant vegetation which has survived in modified form.

In evaluating the record, we must keep in mind that mixed evergreen forest, oak woodland-savanna, and chaparral, which constitute the typical broadleaved sclerophyllous vegetation zones of the mediterranean climate of California, are not restricted to it. They also inhabit regions with ample summer rainfall, extending from Arizona to Texas and far south into Mexico. Not only is the vegetation similar structurally, but the floras are also similar. Identical and vicarious species link these areas with similar kinds of vegetation in California. For example, species common to the chaparral of southern California and central Arizona include Arctostaphylos pungens, Ceanothus greggii, Cercis occidentalis, Cercocarpus betuloides, Fremontia californica, Garrya flavescens, Quercus palmeri, Q. turbinella, Rhamnus californica, R. ilicifolia, Ribes quercetorum, and Schmaltzia (Rhus) ovata. There are, of course, species in the Arizona chaparral that are not now in California. The Arizona and Coahuila chaparral also have many taxa in common and some of these are in California, though there are others that are distinctive of each area. Similar relations are displayed by mixed evergreen forest and oak woodland-savanna vegetation. Clearly, the vegetation of the typical mediterranean climate of California is not unique to it, nor are all of its taxa.

The fossil record indicates that the summer rainfall regime from Arizona to Texas and southward into Mexico approximates the conditions under which these kinds of vegetation lived during most of their recorded history, which can be traced back into Oligocene time at least. The evidence suggests that the homologous vegetation zones in

---

1 This chapter incorporates the results of current and earlier work on Tertiary floras from Nevada and border areas, a research project made possible by grants from National Science Foundation which are gratefully acknowledged. Thanks are also extended to Profs. Michael Barbour, Ralph W. Chaney, Jack Major and Peter Raven whose helpful suggestions improved an early draft of this chapter.
each region were segregated from ancestral Tertiary communities that were richer in taxa. The gradual development of regional differences in the distribution of seasonal rainfall and in temperature relations over southwestern North America during Miocene and later times, and changes in taxa to produce both ecotypes and vicarious species, account for the differences now seen in the mixed evergreen forest, oak woodland-savanna, and chaparral vegetation of California (winter rain, summer drought), Arizona to west Texas (winter and summer rain), and Mexico (summer rain), and also in other vegetation zones marginal to them.

The thesis to be developed here is that the mediterranean climate of California is not old, but very young. The sclerophyllous plants that now typify the area are survivors of a richer flora that persisted here as summer rainfall gradually disappeared in the late Cenozoic. To show that mixed evergreen forest, oak woodland-savanna and chaparral have lived here under regional summer-dry climate only since the first glacial, the history of sclerophyllous vegetation in California and adjacent areas from Miocene down to the present will be reviewed. Following this, the history of sclerophyllous vegetation in the Mediterranean area will be considered because the fossil floras there indicate a similar history for its sclerophyllous vegetation. By contrast, the origins of sclerophyllous vegetation in the mediterranean climates of Chile, South Africa and southern Australia can not be assessed accurately because the fossil record there is too incomplete. However, the general sequence of events that applies to the evolution of sclerophyllous vegetation in the California and Mediterranean areas appears applicable to the austral regions of mediterranean climate, though the taxa are very different in each of those areas inasmuch as they have largely originated in isolation.

Mixed Evergreen Forest

Today, mixed evergreen forest\(^2\) is distributed from southwestern Oregon through the Coast Ranges to southern California (San Marcos Pass), and it also occurs discontinuously on the west slope of the northern to central Sierra Nevada at moderate altitudes. With increased moisture it grades into Douglas fir-redwood (\textit{Pseudotsuga-Sequoia}) forest in the milder parts of the north Coast Ranges, and into mixed coniferous (\textit{Pinus-Abies-Calocedrus}) forest in the cooler, higher parts of the Coast Ranges and in the Sierra Nevada. In drier areas it is replaced by oak woodland-savanna and chaparral vegetation, as in the inner Coast Ranges, the foothills of the Sierra Nevada and in southern California.

A number of fossil floras from Oregon, Idaho, Nevada and California provide evidence of the gradual development of the modern vegetation from a richer, ancestral community. In the following paragraphs, some of the representative floras that reveal its history are referred to briefly, commencing with sites in the north and progressing southward and thence to the west (Fig. 1, Table 1).

\(^2\) Also termed border-redwood forest, oak-madrone forest, tanoak-madrone forest, mixed evergreen forest.