Introduction

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Table 1. Map legend for Biotic Communities of the Southwest (scale 1:1,000,000), Brown and Lowe, 1978, 1980).

Tundra Formation		
	Alpine Tundra	
Forest Formation		
	Petran Subalpine Conifer Forest	
	Sierran Subalpine Conifer Forest	
	Petran Montane Conifer Forest	
	Sierran Montane Conifer Forest	
	Sinaloan Deciduous Forest	
Woodland Formation		
	Great Basin Conifer Woodland	
	Madrean Evergreen Woodland	
	Californian Evergreen Woodland	
Scrub Formation		
	Great Basin Montane Scrub	
	Californian Chaparral	
	Californian Coastalscrub	
	Interior Chaparral	
	Sinaloan Thornscrub	
Grassland Formation		
	Subalpine Grassland	
	Plains and Great Basin Grassland	
	Californian Valley Grassland	
	Semidesert Grassland	
Desertscrub Formation		
	Great Basin Desertscrub	
	Mohave Desertscrub	
	Chihuahuan Desertscrub	
	Sonoran Desertscrub	
		Lower Colorado subdivision
		Arizona Upland subdivision
		Plains of Sonora subdivision
		Central Gulf Coast subdivision
		Vizcaíno subdivision
		Magdalena subdivision
Wetlands		

This publication is one part of a two-part work. This part accompanies the revised color map (scale 1:1,000,000)—Biotic Communities of the Southwest, (Brown and Lowe, 1980) and is coordinated with the map so that the table of contents corresponds to the map legend (Table 1). Also, wetlands are included.

This publication is explanatory and descriptive, not exhaustive. Selected references are provided without presenting an extensive literature review. Major references are included for the states of Arizona and New Mexico as well as for the half of the Southwest which occurs in Mexico in the states of Sonora, Chihuahua, Coahuila, and Baja California del Norte.

The chapters on the biotic communities tend to be more uniform than diverse in matters of content and style, with greater emphasis on community ecology than physiological ecology. Both floristics and faunistics are used in characterizing the biotic communities. Thus, in addition to information on the vegetation and flora, authors have made an effort to provide information on the animal taxa relevant to the biomes for the area shown in Figure 1—the North American Southwest. In addition, summaries of scientific and common names for characteristic plant and animal taxa discussed in each biome chapter are given in a separate appendix.

Insofar as possible the scientific names for plants and animals conform with those accepted by recent authorities. These authorities include the American Ornithologist's Union (1973, 1975, 1976), Birkenstein and Tomlinson (1981), Collins et al. (1978), Correll and Correll, (1972, 1975), Correll and Johnston (1970), Critchfield and Little (1966), Gentry (1972), Harrington (1964), Hitchcock and Chase (1971), Jones et al. (1975), Kearney and Peebles (1960), Lehr (1978), Lehr and Pinkava (1980), Martin and Hutchins (1980), Munz and Keck (1968), Nickerson et al (1976), Patton (1978), Peterson and Chalif (1973), Shreve and Wiggins (1964), Smith and Smith (1976), Standley (1920-1926), Taylor and Patterson (1980), White (1949) and Wiggins (1980).

Following zoological custom common names for animals when derived from personal names generally have a possessional ending ('s), e.g. "Lucy's Warbler" or "Gambel's Quail." On the other hand, following botanical custom for plants with similar derivation from personal names, possessional endings are not used, e.g. "Jeffrey Pine" or "Gambel Oak." Common names in English or Spanish are capitalized when they refer to a specific plant or animal at the species, subspecies or variety level but are not capitalized when used in a general sense, e.g. "Gooding Willow" and "Fremont Cottonwood" are capitalized whereas "willows" and "cottonwoods" are not.

Unless otherwise indicated, photographs, captions, and introductory passages are by David E. Brown.

The System

A comparative evolutionary approach to plant communities is consistent with an open-ended hierarchical system of classification (in contrast to a classless system). Moreover, it is capable of producing more stable and meaningful classification over time by permitting orderly accumulation of more information (Brown and Lowe, 1974a; 1974b; Brown, Lowe, and Pase, 1979, 1980; Brown, 1980). A summary of this classification system as it pertains to North America and the Southwest is presented in Appendix I.

This hierarchical system for North American biomes is

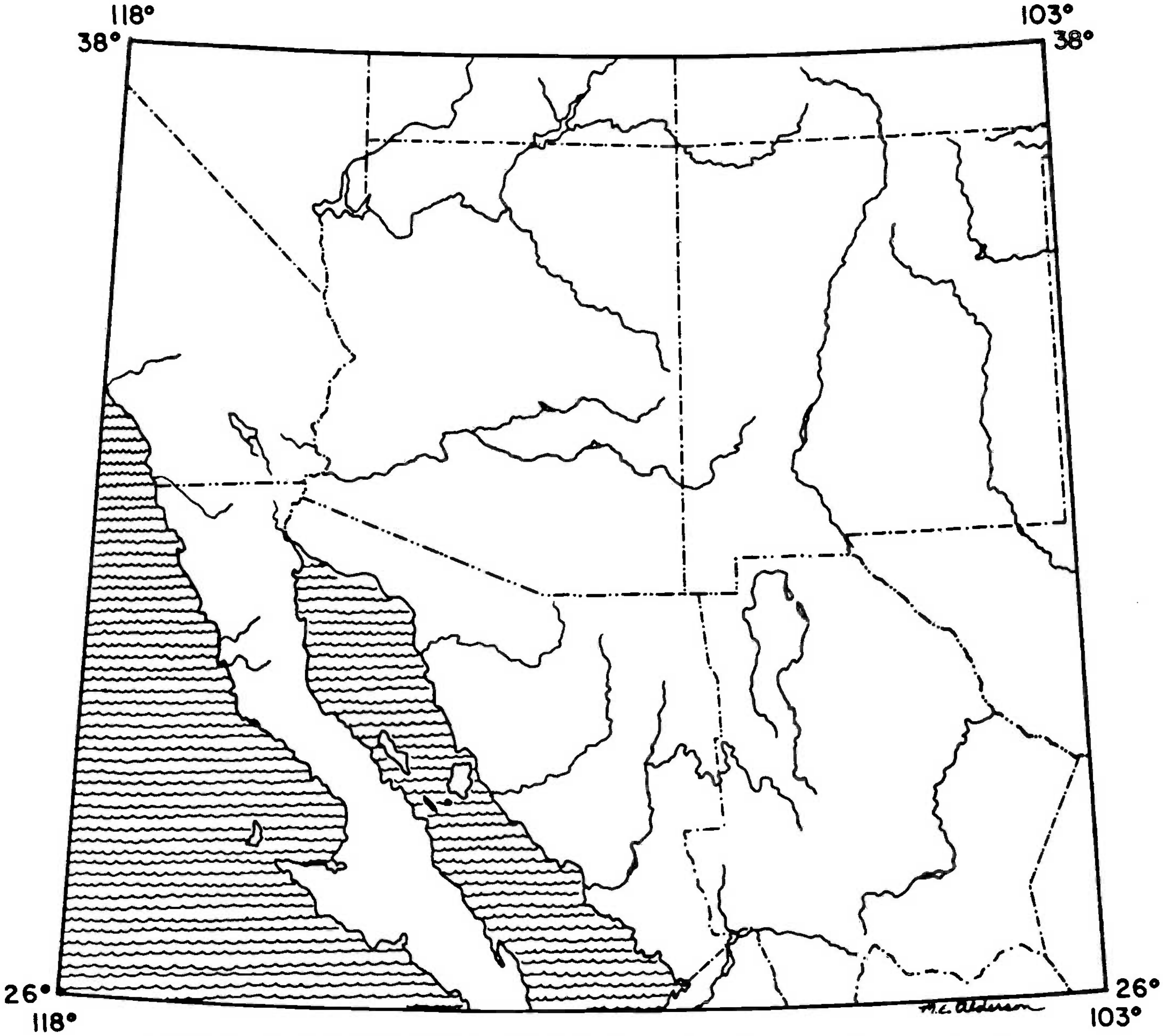


Figure 1. *The North American Southwest. In delineating a* natural *Southwest region, approximately one half of the area falls in the Republic of Mexico and one half in the United States; the U.S. States of Arizona and New Mexico constitute less than half of the "American Southwest." Parts or all of the following states are included: Arizona, Baja California Norte, Baja California Sur, Chihuahua, Coahuila, Colorado, Nevada, New Mexico, Sonora, Texas, and Utah.*

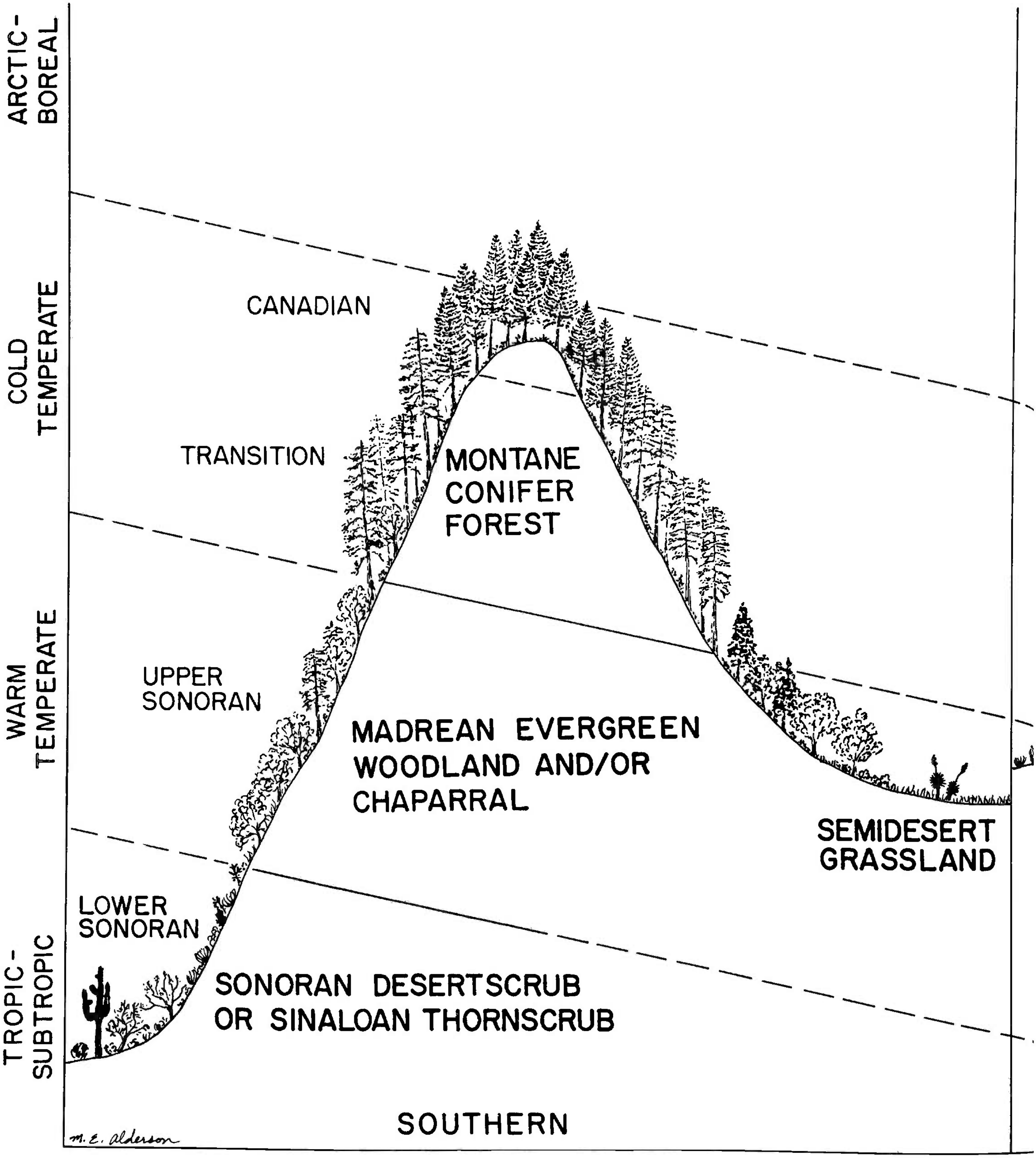
ecosystem-based and is concordant with the life-zone concept of Merriam (1890, 1898; Figure 2) and with the more encompassing geography-based system of North American biotic provinces (Fig. 2 in Appendix I); this is reflected in the legend of the map units in Table 1. However, the structure of biomes is based on vegetation, and they are not provinces *per se*, which are biotic, faunistic, or floristic in structure, function, or other aspects (Shreve, 1915; Dice, 1943; Pitelka, 1941, 1943; Miller, 1951; Munz and Keck, 1959; Whittaker and Niering, 1964; Daubenmire and Daubenmire, 1968; Udvardy, 1975; Barbour and Major, 1977; Franklin, 1977; Bailey, 1978[1]). Part or all of 11 biotic provinces occur in the Southwest, as delimited here (Fig. 3).

[1]*Bailey (1976, 1978) has recently reworked Dice's original concepts and contributions (biotic pronvices) and proposes them as "ecoregionsl"*

The Biome Approach

Because biotic provinces have distinctive evolutionary histories, their occurrence is genetically based. Biomes (biotic communities) are natural formations, characterized by a distinctive vegetation physiognomy, within a biotic province. They are plant and animal community responses to integrated climatic factors, more or less regional in scope.

The limits of a particular biome or biotic community are determined by climate (i.e., minimum seasonal temperatures, minimum seasonal precipitation). The actual boundaries, therefore, are often tenuous and commonly determined by local phenomena—elevation, longitude, slope exposure, geomass, temperature inversions, cold air drainages, soil


ARCTIC-
BOREAL
COLD
TEMPERATE
WARM
TEMPERATE
TROPIC-
SUBTROPIC
CANADIAN
TRANSITION
MONTANE
CONIFER
FOREST
UPPER
SONORAN
MADREAN EVERGREEN
WOODLAND AND/OR
CHAPARRAL
SEMIDESERT
GRASSLAND
LOWER
SONORAN
SONORAN DESERTSCRUB
OR SINALOAN THORNSCRUB
SOUTHERN
M. E. Alderson

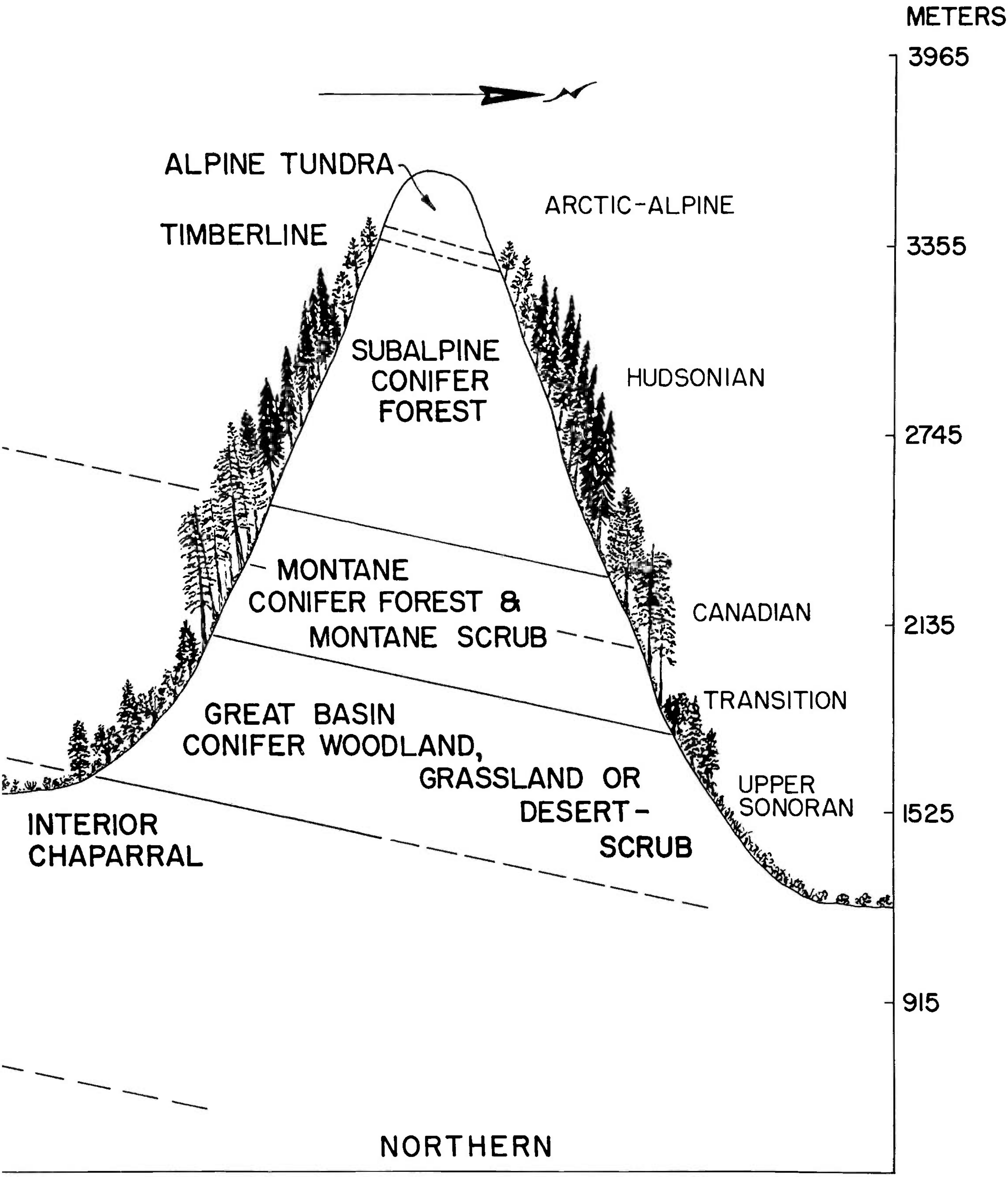


Figure 2. *Diagrammatic profiles of hypothetical mountains in the southern and northern portions of the Southwest indicating the vertical climatic zonation and concordance of biotic communities with Merriam's (1890, 1898) Life-zones.*

porosity, etc. (Lowe, 1964:84–91). Accordingly, local microclimates may result in the unusual occurrence of one or more biomes in an area, contributing to the overall diversity.

The "Southwest"

The latitudinal limits for the Southwest in Figure 1 are 26°N at the south, and 38°N on the north. The area for the vegetation color map (Brown and Lowe, 1980) is slightly less—27°N and 37°30′N, respectively. The expanded area for the Southwest addressed here, both north and south of the USA–Mexico border, gives a still too restricted geographic and ecologic representation for this subcontinental region, especially in time as well as in space. The landscape evolution of the American Southwest during the past 100 million years derived out of the major Tertiary Geofloras over a much greater subcontinental area. Even the most pristine conditions within the derivative biomes are, for the most part, remnants of once-greater biotic communities of a greatly expanded geographic "Southwest."

Southwest Landscape Evolution

Important evolutionary sequences in the Cenozoic history of southwestern landscapes are now reasonably accurately inferred from the paleobotanical record. California and Nevada especially have yielded abundant fossil-bearing rocks of Tertiary age, permitting greater detail in evolutionary analysis there than possible further east (Axelrod, 1950, 1956, 1957, 1958a, 1958b, 1966, 1967, 1970, 1972, 1973, 1975, 1976, 1979a, 1979b).

During the early Tertiary, the vegetation of North America was composed of three great Geofloras—roughly equivalent to grand subcontinental provinces—(a) a mesophytic broad-leafed evergreen (Neotropical-Tertiary) Geoflora in the south half of the continent; (b) a temperate conifer and mixed-deciduous Arcto-Tertiary Geoflora at the north, and between them; (c) an emerging sclerophyllous and microphyllous Madro-Tertiary Geoflora, appearing on drier sites within and bordering the Neotropical Tertiary Geoflora. Southwest forests of relict conifers, montane conifers, subalpine conifers, and riparian deciduous trees are today relatively simplistic and depauperate modern derivatives out of the more generalized and diverse temperate Arcto-Tertiary Geoflora.

At the other end of the present regional moisture-temperature gradient, Southwest deserts are relatively simplistic modern derivatives out of the newer and enormously more generalized and ecologically diverse Madro-Tertiary Geoflora. Madro-Tertiary evolution has yielded Southwest evergreen woodlands, evergreen sclerophyllous scrublands (=chaparral), microphyllous desertscrub, as well as the drought-deciduous thornscrub and subtropical deciduous forest out of which thornscrub was derived. The dominant species in Southwest semidesert grasslands appear ecologically polyphyletic; Madro-Tertiary dry-tropic shrubs and grasses share dominance with Arcto-Tertiary grasses.

Subsequent to the Eocene epoch, dry climates expanded throughout the second half of the Tertiary, culminating in their greatest geographic area and severity during Mio-Pliocene time. By the close of the Tertiary, more than 75 million years after the period began, the dry-adapted Madro-Tertiary Geoflora had spread over southwestern North America. This was accomplished with concomitant retreats, under expanding aridity, of the northern temperate Arcto-Tertiary Geoflora and the southern mesophytic Neotropical-Tertiary Geoflora from which Madro-Tertiary species and communities evolved. The major families, genera, and species in Southwest communities of essentially modern aspect were in place at the end of the Tertiary—at the beginning of the Quaternary and Pleistocene events (≈2 million years before present). For reconstruction of Quaternary Southwest environments see Wells (1976, 1978, 1979) and Van Devender et al. (1977) and Van Devender and Spaulding (1979).

Current mapping and reporting involves natural vegetation *in situ* during the current Holocene interglacial following the close of the Pleistocene at 11,000 ybp. The mixing of species compositions into present biotic communities under strong secular climatic changes characterized the Pleistocene and Holocene in the Southwest (2 mybp to present). During this time, there were significant biogeographic shifts of taxa in both elevation and latitude. Quaternary glacial periods were on the order of 100,000 years duration, and interglacials on the order of 10,000 to 20,000 years. There is much speculation and some knowledge on their Pleistocene and early to middle Holocene whereabouts of the elements present and available for floristic and physiognomic characterization of modern communities in the Southwest. Although questions remain on what species stayed or went, and to where, there is wide consensus on many points.

Alpine tundra and present subalpine forests reached their greatest extent in the recent Pleistocene. Although it remained too warm in most of the Southwest for glaciation, many smaller glaciers captured the high mountains. Lower temperatures reduced evapotranspiration and accompanied a southward extension of the polar air mass. Storms and precipitation were greater than at present. Modern boreal and cold temperate conifer forests, which are primarily disjunctive island-like features in the Southwest, reached their present elevated positions during post-Wisconsinan time, sometime during the past 10,000 years.

Southwest riparian deciduous forests and woodlands are modern water-controlled relicts once part of the western late Tertiary mixed deciduous forests. The populations of large winter-deciduous trees in the dominant gallery stratum, and the subdominant trees and shrubs in lower strata in these riparian communities, have been conspecific taxa throughout the Southwest for several million years—since well before the close of the Tertiary. The species in these unique communities are among the most misunderstood taxa, partially because of insufficient ecological investigation. For example, the nomenclature in such plant manuals as Kearney and Peebles (1960) is characteristic in not adequately reflecting the paleo-botanical evidence (see Little, 1950 for further detail on the botanical synonyms of species and subspecies in *Juglans, Platanus,* et al.).

Southwestern evergreen woodlands were derived out of a more generalized Madro-Tertiary woodland vegetation before the Pleistocene. In the late Pleistocene, during middle to late Wisconsinan time (40,000 to 11,000 ybp), mesophytic evergreen woodland communities predominated across landscapes presently in the Chihuahuan, Sonoran, and Mohave Deserts, before, during, and after the glacial maximum (22,000 to 17,000 ybp). This environmental domination by winter climate did not provide critical summer requirements for germination, establishment, and growth for many subtropical taxa that now characterize modern derivative com-

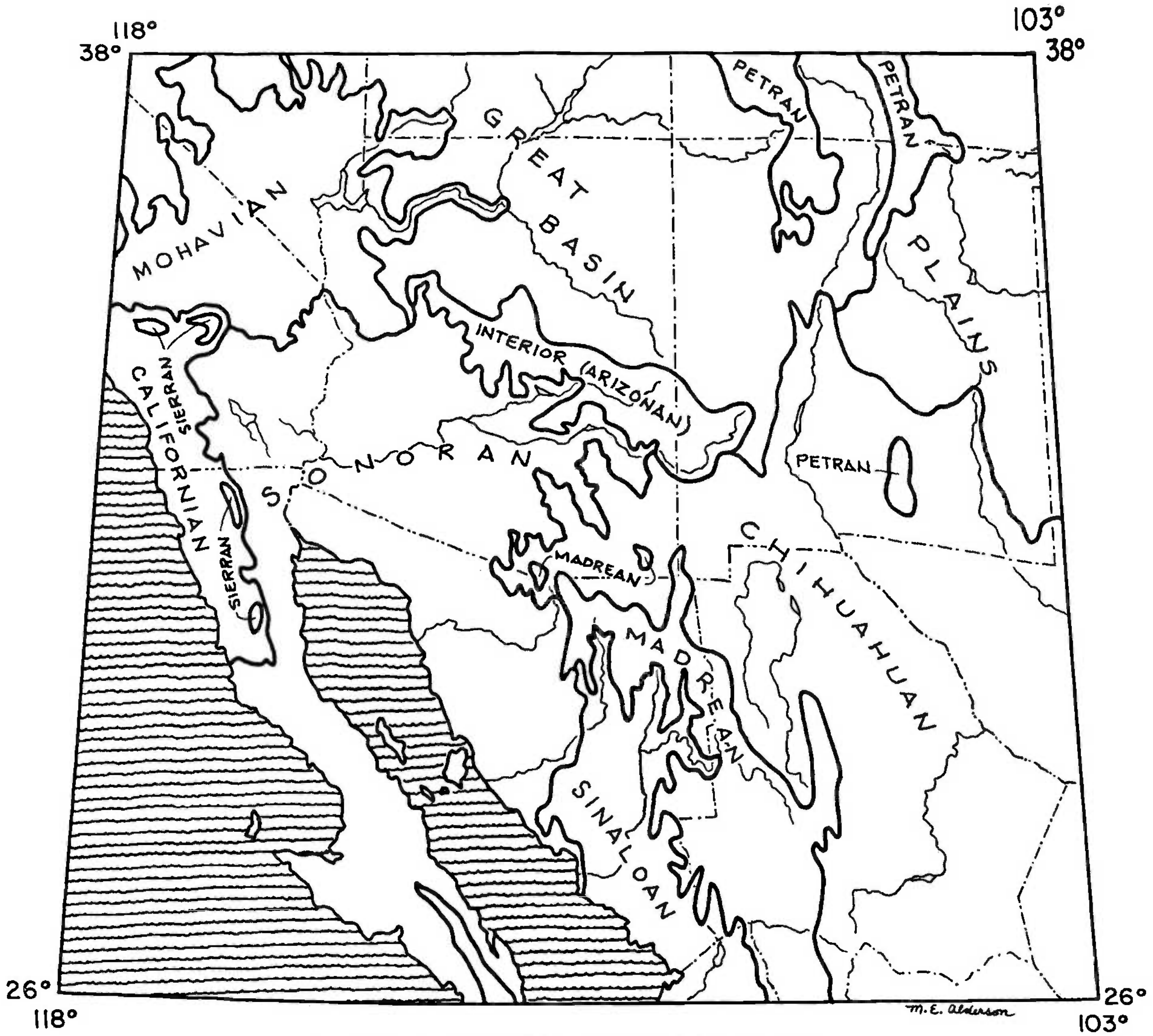


Figure 3. *Biogeographic Provinces of the Southwest.*

munities in Southwest subtropical ecosystems. Such subtropical components, depending on moderate temperatures and significant summer rainfall, were isolated in oases south of the retreating woodland perimeter, or pushed into geographic areas occupied today by Sinaloan deciduous forest on the Pacific side and homologous Tamaulipan communities on the Atlantic side of the continent.

By the early Holocene (11,000 to 8,000 ybp), decreasing temperatures and precipitation minima had resulted in the widespread persistence of xeric pinyon-juniper woodlands and included many Southwest landscapes formerly and presently occupied by vegetation established under dominant warm-season monsoon rainfall. By the middle to late Holocene (8,000 ybp to present), further significant reductions in summer as well as total precipitation resulted in the present assemblages of diverse subtropical and warm-temperature scrub communities inclusive of present Great Basin, Mohave, Sonoran, and Chihuahuan desertscrub. Rapid northward and upward deployment of floral and faunal elements into modern subtropical and warm temperate desertscrub assemblages was accelerated by melting of the ice sheets and stronger development of the Azores (Bermuda) high—with increased and expanded summer precipitation—favored by warmer global temperatures. The result is the Southwest landscape visible today—relict conifer woodlands, subalpine and montane forests, warm temperate grasslands, evergreen woodlands, sclerophyll chaparral, and most recently, North American deserts.

Maps depicting biotic communities are based primarily on natural vegetation.* Although animal constituents are an important factor in the determination and classification of biomes, it is the vegetative structure and components of biomes that provide the readily observable and, therefore, measureable manifestation of these natural ecosystems. Delineation of biomes requires knowledge of their identity; mapping biotic communities, therefore, requires the recognition and delineation of classified vegetation. It is a taxonomic effort, separating one evolutionary-derived entity from others of the same rank.

Even when one recognizes prescribed units of natural vegetation, it may be difficult to draw a line separating them. Moreover, it soon becomes apparent that the various classifications of vegetation often form broad ecotones, intergrading over a considerable area. Disturbances, past and present, may make it difficult to recognize an area's potential natural vegetation (=pnv). Each classification effort requires the interpretation of criteria. The delineation of biomes is, therefore, somewhat subjective; although not usually deter-

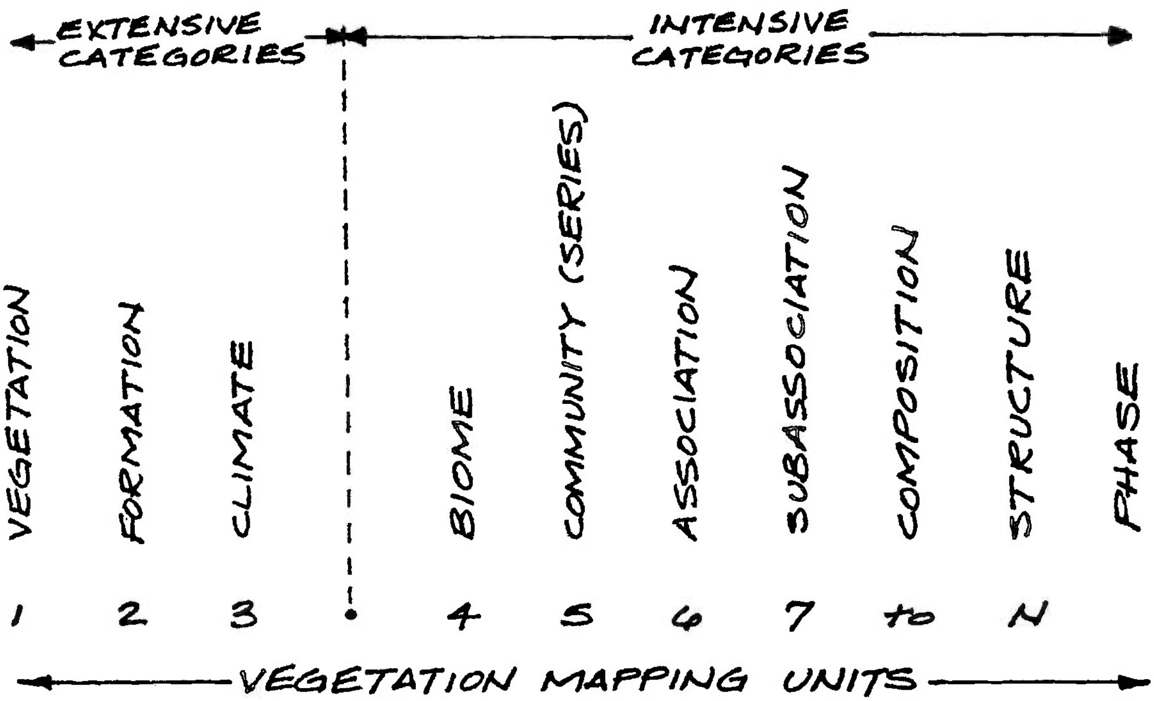


Figure 4. *The digit component in the hierarchy of the Southwest system for vegetation classification. Vertical dash line indicates the position of the decimal point that anchors the system.*

mined through measured criteria, the communities depicted are based on natural criteria and are subject to quantitative assessment.

The 27 biotic communities identified here are those in the digitized hierarchical classification system developed by Brown and Lowe (1974a,b), primarily for Southwest ecosystems. The multiple levels and open-ended arrangement of hierarchical components in the system provides for sensitivity to scale (Fig. 4). The system, therefore, permits classification and mapping at any scale, the classification was recently expanded for continental North America (Brown, Lowe, and Pase, 1977, 1979, 1980). The classification system is a workable blueprint for world ecosystems; the fourth level of the classification is the basis for the Southwest color map at scale 1:1,000,000.

The delineation of biotic communities in the Arizona portion of the Southwest was largely based on an earlier effort (Brown, 1973a) that incorporated several revisions. The 1973 Arizona map was itself greatly facilitated by the earlier vegetation map of A.A. Nichol (1937, 1952), and the Arizona range maps of R.A. Darrow (1944) and R.R. Humphrey (1950, 1953, 1960). Maps and publications of E. Little (1950) and E.F. Castetter (1956) were particularly helpful for New Mexico. Although the useful map of potential natural vegetation in New Mexico by Donart et al. (1978a, 1978b) has only recently been available, the Brown and Lowe (1980) map is in agreement with its classifications and major delineations. The excellent 1935 map by Morris in Gregg (1963) provides much of the basis for mapping that portion in Colorado. Smith's *Range Types of Utah* (in Vallentine, 1961) was the major source of consultation for that state and was used along with Utah Department of Natural Resource Game Range Resource Inventories.

West Texas, southern Nevada, and Baja California were without suitable statewide reference; the national treatments of Küchler (1964) and of Flores Mata et al. (1971), and the regional maps of Buechner (1950), Bradley (1964), Allred et al. (1963), and others, were consulted and modified where deemed appropriate and when based on fieldwork. The valuable map produced by the Comisión Técnico Consultiva para la determinación Regional de los Coeficientes de Agostadero (1974) in conjunction with Shreve's (1951) classic treatment of the Sonoran Desert greatly assisted the mapping of Sonora. Of the published maps of Chihuahua, those by Brand (1936), Lesuer (1945), and Shreve (1939) proved most useful. Information for Coahuila was obtained from Muller (1947), Flores Mata et al. (1971), and from field work there, as in Chihuahua, Sonora, and Baja California.

Jensen's (1947) map of California, while of value, was at too large a scale to be of great benefit. Particularly useful for southern California and worthy of special mention are the truly remarkable vegetation maps produced between 1934 and 1940 under the direction of E.A. Wieslander (Wieslander, 1935). These maps, while showing vegetation unequal in rank (desertlands and grasslands are not differentiated further), accurately depict forest, woodland, and chaparral vegetation at the equivalent of association level. Küchler's (1977) work on California natural vegetation, while published too late to be incorporated here, shows a marked similarity in the difficult delineation of the Sonoran-Mohave Desert boundary, as well as between some other biomes. The major difference with Küchler for California is with chaparral and evergreen woodland communities, and is a result of interpretive differences of climax vegetation.

Other regional mapping efforts were also consulted. Those found particularly helpful were Rasmussen's (1941) map of the biotic communities of the Kaibab Plateau, Grinnell's (1908) life-zone map of the San Bernardino Mountains, Grinnell and Swarth's (1913) life-zone map of the San Jacinto Mountains, Hall's (1946) life-zone map of Nevada, and Storer

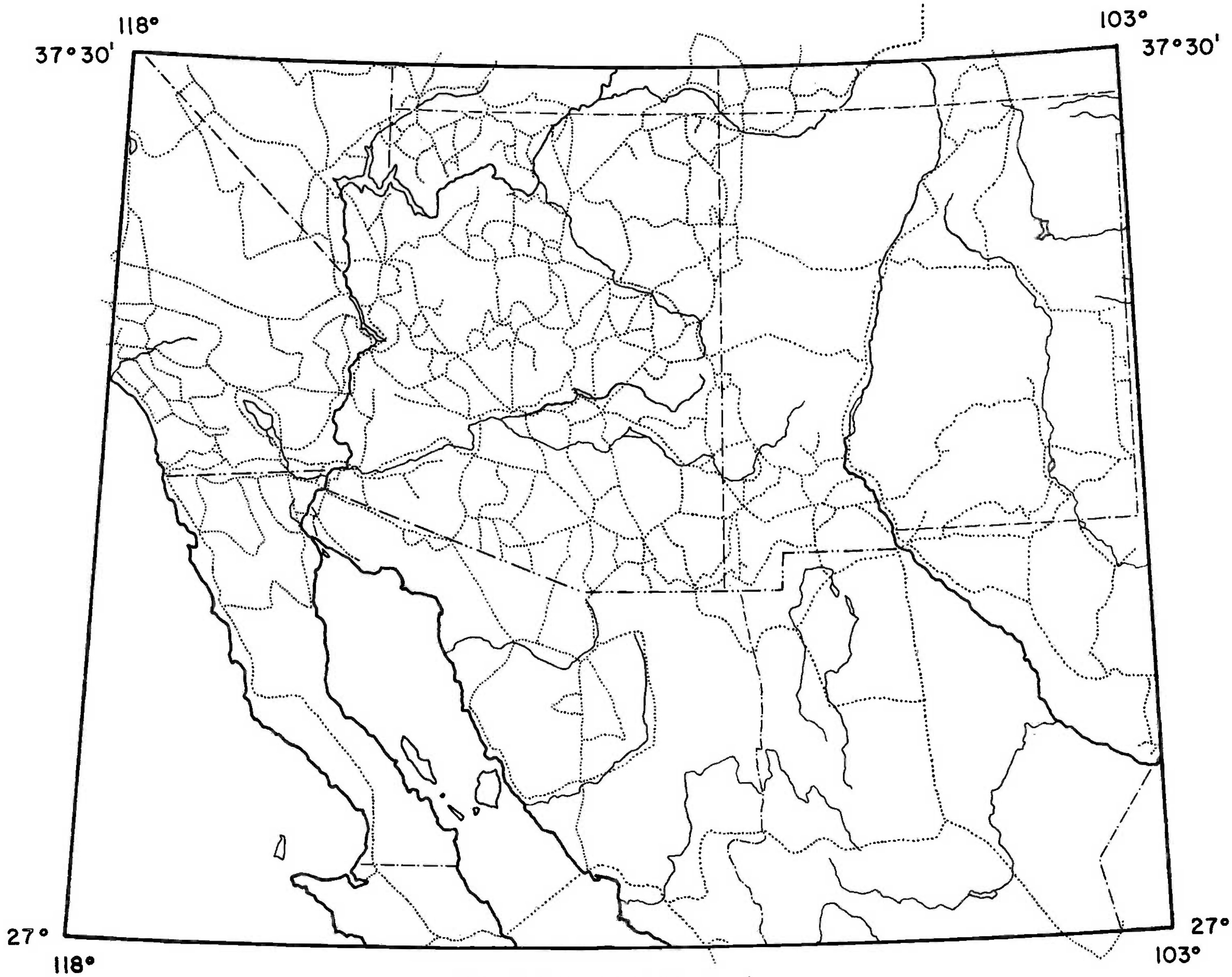


Figure 5. *Routes traveled by the editor.*

and Usinger's (1974) vegetation map of the Sierra Nevada Mountain region.

The lack of maps illustrating vegetation in sufficient detail to enable the interpretation necessary for the delineation of the biomes, required extensive travel and field mapping (Fig. 5). This was especially important for the delineation of communities not heretofore mapped in parts of Mexico, Texas, and New Mexico. The ordinary high altitude imagery available is not greatly useful without on the ground corroboration. Its limitations have indeed inhibited vegetation and biome mapping below formation rank. This has resulted in the "method" dictating the "means" for aerial based classifications, systems, and maps. Aerial photographic techniques, therefore, were rarely used here for interpretive purposes except for delineating formations of known biomes and when used in conjunction with verified ground data.

Alpine tundra (and alpine grassland) was mapped as those treeless areas above approximately 3,500 ± 150 m as indicated on other vegetation maps and/or as described in the literature (Part 1). No attempt was made at 1:1,000,000 to delineate the relatively small areas of alpine scrub and subalpine krummholz. Similarly, no attempt was made to differentiate those relatively minor treeless areas adjacent to alpine tundra that are in early successional stages and/or under edaphic control.

Subalpine and montane forests were mapped in large part from other maps, except in Mexico. Because commercial and resource interest in these biomes is high, their boundaries could often be determined correctly from U.S. Forest Service habitat-type maps, as well as from Wieslander's detailed maps for California, and from several of the more general map sources cited above. In Mexico and outside of the U.S. National Forests, field investigations and literature review aided determination of upper and lower elevational limits, which vary significantly with longitude as well as latitude. Generally, subalpine forests in the Southwest are restricted to north of Mexico and above 2,400-2,600 m, depending on slope exposure. The lower Rocky Mountain, Madrean, and Sierran montane forests come in at elevations from 1,650 m to as high as 2,300 to 2,600 m (Part 2). The lower elevational limits of forest communities were mapped at the elevations of ecotone at which dominant forest tree species (yellow pines, deciduous oaks) were quantitatively more important than characteristic woodland species (pinyons, junipers, evergreen oaks) or otherwise gained major prominence in the community. For mapping purposes, open, woodland-like communities of relatively stunted ponderosa pines were treated as montane forest.

Woodland and chaparral biomes were mapped on the presence of characteristic physiognomic dominants. Many of these characteristic taxa (e.g., species of scrub oak, mountain-mahoghany, pinyon, juniper, evergreen oak) determine the physiognomic structure as well as floristics of the vegetation (Parts 2 and 3). An exception is some more or less open woodlands of single-seed junipers; these communities, where fully identified, were most often considered disclimax grassland (Part 4).

Montane and piedmont communities are commonly subject to strong edaphic control, in addition to being dependent on the precipitation gradient; therefore, they are readily differentiated over relatively short distances from adjacent valley vegetation (e.g., chaparral versus grassland). Such is not necessarily the case between desertscrub and grassland communities in the inland Southwest, both of which may intergrade over broad areas and with many reversions. Desertland and grassland are the two "base" formations, encompassing more than 70% of the Southwest. Slight changes in elevation, slope exposure, available soil moisture, or differences in grazing history often determine the local presence of one or another of these biotic communities.

Particularly difficult to resolve, and to delineate for mapping purposes, are the ecotones (hence "lines") between (i) semidesert grassland and plains grassland, (ii) semidesert grassland and Chihuahuan desertscrub, (iii) Sonoran and Mohave desertscrub, and (iv) Great Basin desertscrub and grassland. These difficulties are resolved in many cases by drawing an arbitrary line through the approximate center of the discontinuous phase between these biomes. Some decisions are necessarily based on judgment as to the reversibility of scrub invasions that are today greatly advanced across wide expanses; the presence of Snakeweed and Burroweed indicate disclimax grassland; Creosotebush, Tarbush, and scrub Mesquite hummocks indicate desertscrub. Indicator plant species were also used to delineate other desertscrub biomes and their natural subdivisions (Part 5). At the fourth digit (biome) level in mapping, floristic criteria are especially important (see e.g., Hastings, Turner, and Warren 1972). Thus, elevation contours determined from field investigation and the literature were used in conjunction with knowledge on the ecology and distribution of indicator plant species and communities, as the basis for mapping the various desertscrub biomes at scale (1:1,000,000).

The most complex, least known, and certainly most misunderstood vegetation and flora in the North American Southwest are tropic-subtropic deciduous forest and thornscrub in northern Mexico. Sinaloan thornscrub and Sinaloan deciduous forest on the Pacific side (Sinaloa-Sonora) are in the mapped area. Their Tamaulipan homologs on the Atlantic side (Tamaulipas-Texas) are not. More equable climate with greater warm-season precipitation increases southward on the complex continental gradient, determining the associated vegetation continuum of increasing stature and of structural and species diversities. On the Pacific gradient southward, the more recently evolved subtropical desertscrub (Sonoran Desert) is derived out of Sinaloan thornscrub, which, in turn, is derived out of Sinaloan deciduous forest (thornforest). Ordination does not resolve the mapping problems encountered on the continuum, where multiple floristic and physiognomic criteria were used for their determination.

Because of the scale involved on the Southwest map, relict conifer sites and many small discontinuous outlier stands in all of the biomes had to be omitted. With some important exceptions, this type of exclusion also pertains to wetland formations, most of which are small in extent even when shown; generally, therefore, wetlands are not further differentiated on the map. It is the primary purpose of the map to provide general location, geographic and areal extent, relative sequential relationship, and other aspects of the biomes of the Southwest. To provide an illustrated record of each biome's actual occurrence would require numerous maps and efforts at different scales over a wider geographic area.

The choice of colors was carefully considered. A color scheme was adapted from Gaussen (1953, 1955) who instituted the use of color for phytocartographic representation of ecological relationships. Arid habitats are presented by light colors. For wetter communities the colors become darker; very wet habitats are represented by dark solid colors. Cold habitats are dull, cold colors—black, grays, cold blues, and purples. As communities become warmer, the colors representing them become brighter until the brilliant warm colors of the tropics—yellows, oranges, reds, magentas—are reached. The color selected for each biome was a result of the combination of the colors representing these two basic environmental gradients—temperature and moisture. Although some selections had to be compromised in some degree to give needed contrast between adjoining biomes, and to keep the number of color plates from being excessive, Gaussen's color principles were not violated.

The only suitable maps covering the Southwest at the same scale both north and south of the border were provided by the 1:1,000,000 aeronautical charts. A base map without aeronautical and navigational enhancement was constructed from these charts, provided by the U.S. Department of Commerce. Both the scale and the base proved ideal. A scale of 1:1,000,000 permits a general overview of the biotic communities of the Southwest region, while allowing enough detail to identify specific areas. It is a convenient scale where 1 mm = 1 km; this simplification for distance with latitude and longitude intersections greatly facilitated plotting the locations of towns, highways, climate stations, mountain ranges, and other landscape features. The scale is increasingly used for natural resource maps (e.g., Comisión Técnico Consultiva Para La Determinación Regional De Los Coeficientes De Agostadero, 1974; Küchler, 1977; Donart et al., 1978b; Brown, Carmony, and Turner, 1979). The aeronautical charts used for base map construction provide much topographic detail including mountains, dune fields, wetlands, and, importantly, 1,000-foot (305 m) elevation contours. Such features greatly increased the serviceability of the base map in facilitating the delineation of biotic communities.

The field maps used were U.S. Geological Survey maps at scale 1:500,000 for Arizona, New Mexico, and southern California. The states of Texas, Colorado, Utah, Nevada, and the Mexican states were mapped on 1:1,000,000 aeronautical charts without navigational enhancement.