ANALYSIS OF VASCULAR PLANT SPECIES DIVERSITY OF THE PACIFIC COAST ISLANDS OF ALTA AND BAJA CALIFORNIA

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ABSTRACT

Each of the Pacific coast islands of southern California and Baja California is unique with its own particular attributes. They vary greatly in size and distance from the mainland. Traditional analysis of island species diversity is based on the relationship between area and the number of species. However the widely different topography, climatic conditions, and geology also have a very strong influence of the diversity of plant species. The islands are also home to a large number of species which are endemic to one or more of the islands, and not found on the mainland. The existence of these plants in the flora of the islands is the result of biogeographical effects. Many of the endemic species were once common on the mainland as evidenced by fossils. Certain genera of plants, particularly *Dudleya, Cryptantha, Galium, Malva, Malacothrix, Phacelia, Quercus, Arctostaphylos, Lotus, Hemizonia*, and *Eschscholtzia* are well represented in the endemic flora. Unfortunately, most of the islands have been subjected to serious environmental damage from long periods of vegetation destruction by feral herbivores. Recent successes in feral animal removal provides hope, but there is still a need for the removal of rabbits from Todos Santos, and San Benito, and goats from Los Coronados and Guadalupe where they have caused the extinction of plants and bird species.

Keywords: Coronado Islands, Guadalupe Island, Cedros Island, California Islands, Baja California, Mexico, flora, vegetation, botany, feral animals.

INTRODUCTION

The California Channel Islands of both southern California and Baja California, including some in the state of Baja California Sur, create an island archipelago of unique and diverse features. The archipelago extends six degrees of latitude from near 28°N latitude to 34°N latitude. The islands range in size from rocks less than 0.5 km^2 to 348 km^2. These islands vary greatly in distance from the mainland, ranging from as close as 6 km to 252 km. Each island has distinct topography, ranging upwards to 1,298 m in elevation, though most are much lower. An additional physical feature that affects the diversity of species on these islands is that they are within the southern end of a Mediterranean climatic regime typified by rainfall in winter, though the amount and percentage of summer rainfall on these islands increases near the lower latitudes. Mediterranean climates are known to sustain vascular plant species diversity (Wilson 1992).

The diversity of the flora of these islands is a manifestation of all of these factors. The whole archipelago supports approximately 920 native taxa, 174 of which are endemics (including 12 which are thought to be extinct), on a total of 1,517 km^2. This is roughly one-seventh the area of San Diego County which supports approximately 2,000 species with around 25 endemics (Beauchamp 1986).

MATERIALS AND METHODS

Evaluation of Factors that Affect Diversity in the Pacific Coast Islands of Alta and Baja California

The physical attributes including distance from the mainland, area, elevation, and approximate rainfall were compared with the total number of native species and number of endemics for each of the islands. In addition, an analysis evaluated the percentage of shared species between each of the islands. Sources for this information are listed at the end of the sections for each group of islands.

Each of the islands contains a number of elements that affect the number of species present. Due to geographic relationships, the Alta California Islands have often been divided into a northern and southern group. The northern group are mostly trending in a linear, east-west pattern, parallel to the Transverse Ranges of California, while the southern group are scattered in a north-south direction, with varied distances from the mainland.

Table 1 summarizes the attributes of the islands. See Philbrick (1967) for a map of the islands. Table 2 lists some of the physical characteristics of the islands as well as major conservation problems to be discussed later. These tables provide a summary of the diversity of the geologic formations that make up the islands, their climates, elevation and distances from the mainland. The tables are intended to demonstrate the individuality of each of the islands.

Table 1. Attributes of California Pacific Islands.

Island	Area (km^2)	No. Plants/ (Endemics)	Plants/area	Elev. (m)	Rainfall	Distance to Mainland
Cedros	348	224 (19)	0.64	1194	63-200 mm	23 km
Guadalupe	249	156 (34)	0.69	1298	100-300 mm	252 km
Santa Cruz	244	480 (6)	1.95	660	400-560 mm	30 km
Santa Rosa	217	387 (5)	1.70	480	300-430 mm	44 km
Santa Catalina	194	427 (8)	2.15	631	250-400 mm	32 km
San Clemente	145	272 (14)	1.79	589	150-300 mm	79 km
San Nicolas	58	139 (3)	1.97	277	250 mm	98 km
San Miguel	37	198 (1)	4.62	262	340 mm	42 km
Natividad	7.2	63 (0)	7.22	148	63 mm	7 km
San Benito	6.4	42 (4)	6.50	20	63 mm	66 km
Anacapa	2.9	191 (2)	57.24	284	325 mm	20 km
Santa Barbara	2.6	88 (3)	27.69	193	300 mm	61 km
Los Coronados	2.5	96 (3)	38.00	190	180 mm	13 km
San Martin	2.3	80 (1)	28.26	146	130 mm	5 km
Todos Santos	1.2	108 (0)	71.67	100	130 mm	6 km
San Geronimo	0.4	4 (0)	10.00	40	80 mm	9 km

Islands listed in order of area. Island area and distance to mainland from Philbrick (1967), elevations for California Islands from the USGS topographic maps. Elevations for Baja California islands from Bostic, 1975, and nautical charts. Number of endemics and number of plants from California islands from Raven (1963), Foreman (1967), Thorne (1967), Philbrick (1972), Wallace (1985), Junak et al. (1995), for Baja California Islands from Oberbauer (1993 and 1999), Junak and Philbrick (1994a, 1994b, 1999a, and 1999b), and Moran (1996). Rainfall data from Hastings (1964) and Hastings and Humphrey (1969) as well as estimates from personal observation.

California Islands — Northern Group

The northern group of islands consists of San Miguel, Santa Rosa, Santa Cruz, and Anacapa islands. This group contains two of the larger islands, and the islands with the highest seasonal rainfall of all of the California Channel Islands. All of the islands in this northern group are included in the Channel Islands National Park.

For many years, the status of these islands relative to connections to the mainland was unclear. During the Pleistocene pluvial periods when the sea level was 140 m lower than present (Vedder and Howell 1980), it is now generally accepted that the northern group, though connected together, were still separated from the mainland by a relatively narrow channel. Fossil pygmy mammoths have been found on Santa Rosa and San Nicolas islands (Thorne 1969), and a display in the Channel Islands National Park visitor center depicts the Santa Rosa Island fossil site. This indicates that they were not beyond the dispersal abilities of large, non-amphibious mammals. See Wallace (1985), Clark et al. (1990), Skinner and Pavlick (1994), Wehtje (1994), and Junak et al. (1995) for more specific information about these islands.

California Islands — Southern Group

The southern group of the California Channel Islands consists of Santa Barbara, San Nicolas, Santa Catalina, and San Clemente islands. Geographically, these islands are not as closely allied to one another as are the Northern Channel Islands. While the northern group consists of a regular chain of islands in an east-west line, the southern group islands are scattered in divergent locations. None of these islands have been connected to the mainland, though Santa Barbara and San Nicolas islands were probably submerged during the dry interglacial periods (Philbrick 1972; Vedder and Howell 1980). For more specific details of these islands, see also Raven (1963), Foreman (1967), Thorne (1967), Davis (1980), Philbrick (1980), Westec Services (1978), Wallace (1985), Clark and Halverson (1990), and Oberbauer (1994).

Baja California Islands

The Baja California Islands consist of Islas Los Coronados, Todo Santos, San Martin, San Geronimo, San Benito, Cedros, Natividad, and Guadalupe islands. They extend more than 500 km down the coast of the northern

Table 2. Physical conditions of islands and their conservation problems.

Island	Geological Characteristics	Major Vegetation	Conservation Issues
San Miguel	Sandstones	CU, CHP, CSS, G	Revegetation of areas eroded by past feral animals. Protected by National Park.
Santa Rosa	Sandstones, metamorphosed	DU, CHP, CSS, G, OW, CF, LY	Revegetation of areas grazed by cattle, deer, and elk. Designated part of National Park.
Santa Cruz	Sandstones, mudstones, metamorphosed	DU, CHP, CSS, G, OW, CF, LY, RIP	Natural revegetation of areas overgrazed sheep and pigs. Proected by Nature Conservancy and National Park.
Anacapa	Indurated sedimentary, mudstones	CHP, CSS, G, MS	Some revegetation. Protected by National Park.
Santa Barbara	Indurated sedimentary	CSS, G, MS	Natural revegetation of areas formerly impacted by rabbits. Protected by National Park.
San Nicolas	Sandstones	DU, CSS, G, MS, RIP	Natural revegetation of areas grazed by sheep and remove feral cats.
Santa Catalina	Metamorphic, volcanic, sedimentary	CHP, CSS, G, MS, OW, LY, RIP	Control of feral pigs, goats, and bison. Protected by private conservancy.
San Clemente	Volcanic, sedimentary	DU, CHP, CS, G, MS, LY	Under Navy ownership and efforts are underway to restore natural habitats.
Los Coronados	Mudstones and indurated sandstones	MS, CSS, B	Control of feral animals. Protection of important bird colonies.
Todos Santos	Metamorphosed volcanics	DU, MS	Control of feral animals. Contains bird colonies.
San Martin	volcanic	DU, MS	Prevention of introduction of feral animals and weedy plants. Historically contained important bird colonies.
San Geronimo	Sedimentary	Mostly B	Prevention of introduction of weedy plants.
Natividad	Sedimentary, metamorphosed sediments	LD	Control of off road vehicles, expansion of village. Contains important bird colonies.
Cedros	Sedimentary, metamorphosed sediments	DU, CHP, CSS, G, MS, CF, UD, LD, SB, B, J	Control of feral cats, potential introduction of feral animals, recurring fires.
San Benito	Sedimentary, metamorphosed	LD, B	Continued control of feral animals. Contains important bird colonies.
Guadalupe	Volcanic	(CHP), (CSS), G, MS, CF, (OW), LD, B, P, J	Control of feral goats, cats, and dogs.

LEGEND: DU=dune; CHP=chaparral; CSS=coastal sage scrub; G=grassland; MS=maritime sage scrub; CF=coniferous forest; OW=oak woodland; LY=Lyonothamnus/Prunus woodland; UD=upper desert scrub; LD=lower desert scrub; SB=sea-bluff succulent; B=naturally barren; RIP=riparian; J=junipers; P=palms. Parentheses denotes communities that are extirpated.

half of Baja California. They are more varied than the islands of Alta California. Several of the groups, Los Coronados, Todo Santos, and San Benito, consist of more than one island. Each group has different geologic origins ranging from volcanic to metamorphic marine sediments and each has relatively distinct vegetation communities. Most support forms of maritime desert scrub or maritime succulent scrub with differences in the dominant species although Cedros and Guadalupe islands support or supported northern coniferous forest communities as well as patches of chaparral and coastal sage scrub.

With the publication of the proceedings from this symposium, published species lists exist for all of the islands except San Geronimo Island. Species list references for the Baja California Islands include Oberbauer (1993), Junak and Philbrick (1994a, 1994b, 1999a and b, this volume), Moran (1996), and Oberbauer (1999, this volume). For more information on the physical and natural history of each of the

islands please see Blake (1961), Cohen et al. (1963), Hastings (1964), Hastings and Humphrey (1969), Bostic (1975), Axelrod (1977), Batiza (1977), Wiggins (1980), Moran (1983 and 1996), Kilmer (1984), Lamb (1992), Oberbauer (1992), and Hickman (1993).

RESULTS

Plant Species Diversity

The relationship between the area of an island and the number of species which inhabit it is a well-known concept as is the fact that distance from the mainland correlates with the number of endemic species which are restricted to that island (MacArthur and Wilson 1967). Raven (1969) assessed the floras of the California Channel Islands in terms of their conformance to a mathematical model that predicts that the number of species of any group of organisms increases in approximate logarithmic manner in relation to the area of sampling. Such analysis assumes some degree of uniformity between the islands in order to predict with any accuracy, the number of vascular plant species that are likely to inhabit them. As is described in Tables 1 and 2, except for a few of the northern California islands, both the California and Baja California Islands lack uniformity of major features.

Figure 1 graphs the log of the number of species against the log of the area of the island. Figure 2 graphs the island area with the number of endemics. The diversity of species present and the number that are endemic are actually the result of a combination of all of the attributes of an area, be it island surrounded by ocean or mountain surrounded by lowland. Figure 3 shows that the number of endemics is related both to distance from the mainland and the area of the island.

Among other factors that affect the diversity of species and the number of endemics, the topography of an island is extremely significant. The topography also has influenced the length of time that an island has been exposed above sea level. Several of the lower islands, Santa Barbara, San Nicolas, and San Geronimo, would have been completely submerged during the interglacial and xerothermal period. This could have an effect on lowering the diversity, though in the case of the Santa Barbara and San Nicolas islands, this effect appears to be slight. An island like Cedros would have a much lower diversity if it were simply a tableland rather than a mountainous island with rolling dunes, deep canyons, and high cliffs. Another factor that seems to have a direct bearing on the number of species in the Channel Islands of California and Baja California is the average rainfall. Figure 4, which depicts the simple total species/area relationship, shows the island groups falling along two linear relationships. The northern islands generally have more total plant species, regardless of their size. The more xeric southern islands with major areas which generally receive less than 200 mm rainfall have a lower diversity of species overall. This probably reflects conditions on the adjacent

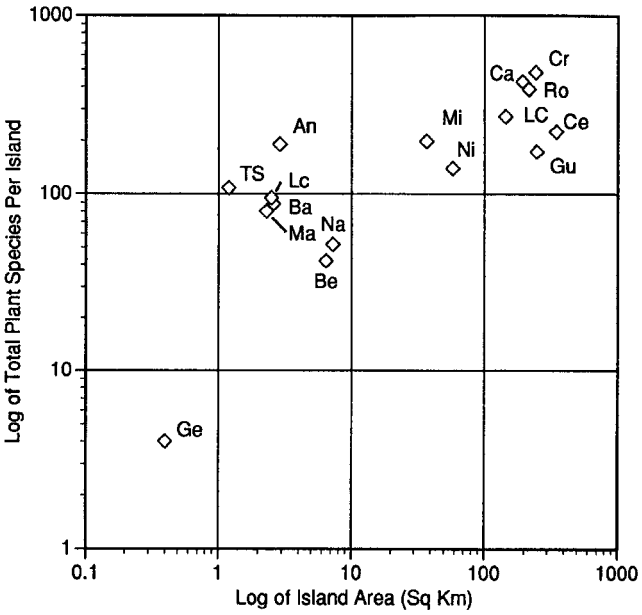

Figure 1. Log of total species of plants per island versus log of island area.

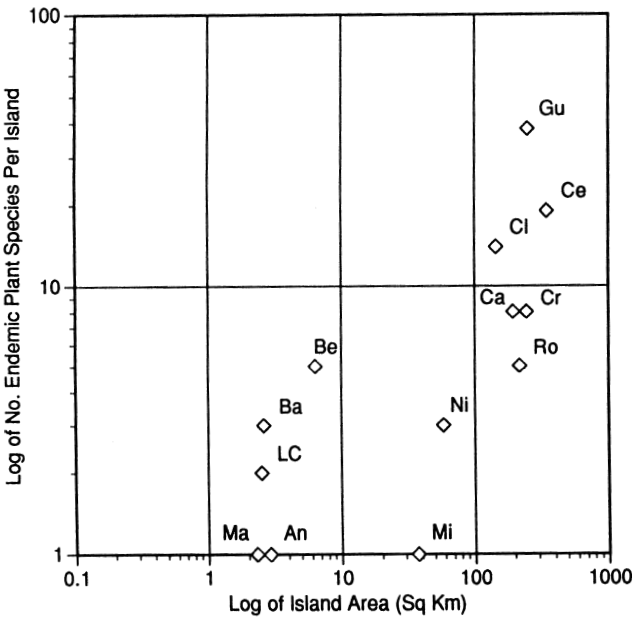

Figure 2. Log of endemic plant species per island versus log of island area.

mainland. A lower number of species likely occurs per area in Baja California than occurs in southern California, hence, fewer mainland species are available to disperse to the islands.

It is of use to compare these relationships with the relationships of the islands in the Gulf of California (Sea of Cortez) where the climate is more uniform in at least in the northern half of the Peninsula where, the average annual rainfall is approximately 50 to 75 mm. Cody et al. (1983, Figure 4.6a) created plant species-area plots for islands in the Sea of Cortez and the California Channel Islands.

Similar to the graph depicted in Figure 6, the drier Sea of Cortez Islands have an overall diversity than the more mesic California Channel Islands. In the Sea of Cortez, the area to numbers of species would be predicted to be more regular due to the greater uniformity in the climate as well as the closer proximity of all of the islands to the mainland (Cody et al. 1983; Moran 1983). The uniformity of the linear species area relationship depicted by Cody et al. (1983) is a reflection of this.

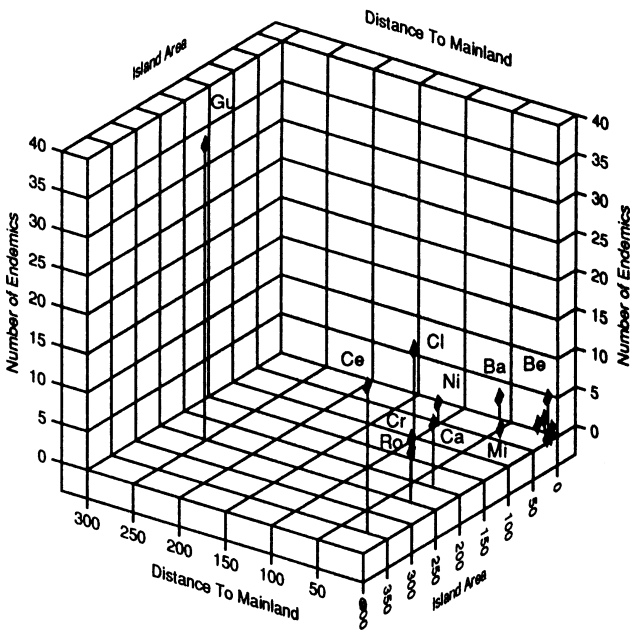

Figure 3. Three-dimensional graph depicting the relationship between number of endemics, area of the islands, and distances from the mainland.

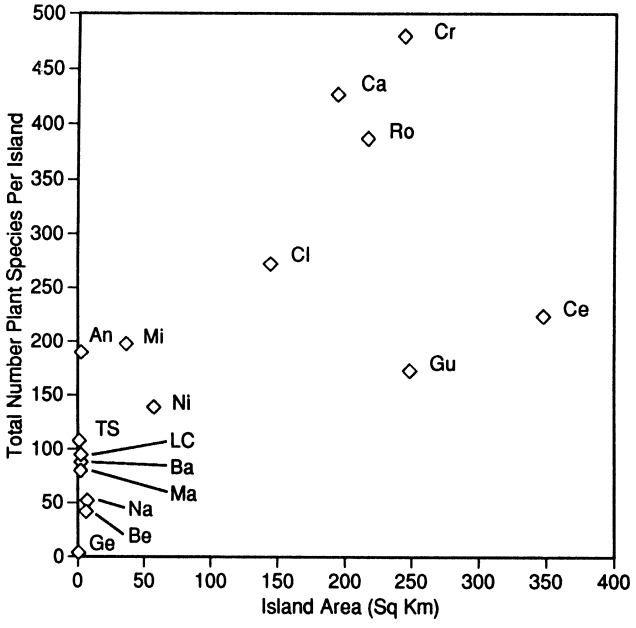

Figure 4. Total number of plant species versus island area.

Relationships of floras of the islands

Several of the islands are very close in their floral affinities. Table 3 lists the percentage overlap in native flora for all of the islands. This is a simple percentage relationship and not a Sorensen index for diversity because the size of the islands and size of the floras have a major influence on the percent overlap. Obviously, smaller islands have larger percentages of their floras shared with larger islands than the larger islands share with the smaller islands.

There are a number of key points that can be assessed with these figures. First, the northern islands have a close relationship with several shared insular endemics (Attachment 1) and a high percentage of shared species, but not as close as one might expect. Anacapa shares 82%, Santa Rosa shares 81%, and San Miguel shares 75% with Santa Cruz Island. It may seem surprising that Santa Cruz Island, which has a large flora and diverse topography, does not contain all the species of the adjacent Anacapa and Santa Rosa islands. This demonstrates the individual differences between each of the islands.

In the northern islands, Santa Cruz Island contains the most species and other islands share the most with it indicating the importance of its flora. In the southern group, the other islands share the most species with Santa Catalina. San Clemente, its closest neighbor shares 77%, not as high a percentage as one might expect given their close proximity to one another. San Martin, Los Coronados, Cedros, and Guadalupe islands respectively share 64%, 78%, 39% and 55% with Santa Catalina Island.

Other islands share many species with Cedros Island. In the very south, San Benito and Natividad islands share 70% and 67% respectively with Cedros Island. San Martin, Todos Santos, and Los Coronados islands share 50%, 45%, and 46% with Cedros Island.

The relationship between Guadalupe and the other islands is also noteworthy. Fifty-five percent of Guadalupe's plants occur on Santa Catalina Island, and 49% occur on San Clemente Island. Although 30% of the species that occur on Cedros also occur on Santa Cruz, 47% of the species that occur on Guadalupe also occur on Santa Cruz. Unexpectedly only 28% of the species on Guadalupe also occur on Cedros even though Cedros is much nearer to Guadalupe than Guadalupe is to Santa Cruz. A number of plants on Guadalupe do not occur on any of the other islands but are found farther north in central California. This may be due to the cool north-south flowing California current and may also be affected by the paleogeologic history which will be discussed further below.

As one might expect, there is a low relationship between the very southern islands — San Benito and Natividad — and the Alta California Channel Islands. It is noteworthy that San Benito and Natividad islands share a higher percentage with Catalina and San Clemente islands than they do with Todos Santos and Los Coronados islands. In reverse, the northern islands share a small percentage of their floras with the relatively small floras of the southern Baja

California islands because of the more desert-like conditions in the south as well as the distance separating them.

The individual nature of the islands is further indicated by the fact that relatively few species occur on all or nearly all of them (Attachment 1). These species include *Opuntia prolifera, Aphanisma blitoides, Oligomeris linifolea, Phyllospadix scouleri, Phyllospadix torreyana, Eschscholzia ramosa*, and *Lepidium oblongum* var. *insulare.* Furthermore, the endemic species that are confined to individual islands in the northern group also provides an indication of the unique nature of each of the islands (Attachment 2). Of particular note are the endemics confined to the small islands such as Santa Barbara, Los Coronados, San Martin and San Benitos.

Table 3. Percentage overlap between floras of the islands of California and Baja California. Numbers in columns represent the percentage of the flora of the island listed in the heading for a row that is also found on the island.

Island which is basis for comparison	Percentage of compared island's native flora which also occurs on island listed below.															
	Mi	Ro	Cr	An	Ba	Ni	Ca	Cl	Le	To	Ma	Ge	Be	Na	Ce	Gu
San Miguel (Mi)	-	76	75	48	20	35	58	46	18	21	13	0.5	2.0	2.5	19	22
Santa Rosa (Ro)	39	-	81	38	13	21	61	42	14	15	9.5	0.5	2.6	2.6	14	19
Santa Cruz (Cr)	31	65	-	32	11	17	63	38	13	14	9	0.4	2.5	2.5	14	17
Anacapa (An)	50	77	82	-	28	34	70	59	31	31	20	1.6	7.4	6.8	31	28
Santa Barbara (Ba)	45	58	64	61	-	52	70	70	41	42	28	3.4	14	14	36	45
San Nicolas (Ni)	50	58	60	46	33	-	60	58	19	20	17	2.1	7.2	8	23	27
Santa Catalina (Ca)	27	55	71	31	14	20	-	49	17	19	12	0.7	4.0	4.2	20	22
San Clemente (Cl)	33	59	68	41	23	30	77	-	23	25	17	1.1	6.2	6.2	24	31
Los Coronados (Lc)	38	58	64	61	38	28	78	66	-	67	37	3.2	16	16	46	36
Todo Santos (To)	39	55	64	54	34	26	74	63	59	-	40	1.9	13	15	45	39
San Martin (Ma)	33	46	55	48	31	30	64	59	44	54	-	2.5	17	21	50	29
San Geronimo (Ge)	25	50	50	75	75	75	75	75	75	50	50	-	75	75	100	50
San Benito (Be)	9.5	24	2.8	33	28	24	40	40	36	33	33	7.1	-	57	70	33
Natividad (Na)	9.6	19	23	25	23	21	35	33	29	31	33	5.8	46	-	67	27
Cedros (Ce)	17	24	31	26	14	14	39	30	20	22	18	1.8	13	16	-	22
Guadalupe (Gu)	25	43	47	31	23	22	55	49	20	24	13	1.2	8.1	8.1	28	-

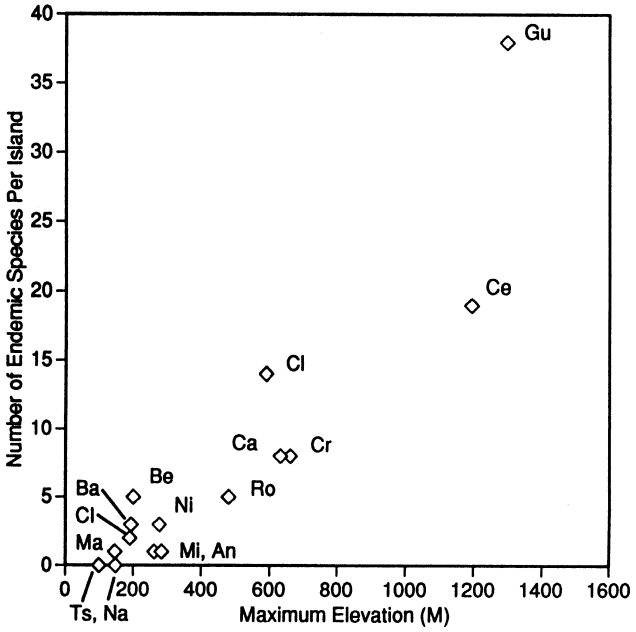

Figure 5. Number of endemic species versus maximum island elevation.

Paleogeographic History

Dunkle (1950), Stebbins and Major (1965), Axelrod (1977), Raven and Axelrod (1978), and Philbrick (1980) discussed the paleobiological history of the plants that inhabit the islands, particularly the endemics. The consensus is that the majority of the endemics are relicts from previous times when they occurred on the mainland as well as the islands. One striking example is *Lyonothamnus floribundus* fossils of which have been found on the mainland into Nevada (Axelrod 1977). Several of the species that are near-endemics may also be relictual. For many years, *Crossosoma californica* was thought to be endemic to San Clemente, Santa Catalina and Guadalupe islands. However, it was also found on the mainland on the Palos Verdes Peninsula in Los Angeles County (Hickman 1993). *Chaetopappa lyoni* was thought to be a Santa Catalina endemic until it was found on the Palos Verdes Peninsula (Philbrick 1980), which itself was an island during the xerothermal period when the sea level was higher due to polar ice melt. *Prunus ilicifolia* ssp. *lyonii* appears on a number of the California islands and is also found in deep canyons in central Baja California. A

similar distribution exists for *Salvia brandegei,* which occurs on Santa Rosa Island and near the coast in north-central Baja California.

It is thought that one of the reasons that species persist on islands is that island climates, even those that receive relatively low rainfall, are very equitable (Carlquist 1974). The moderating influence of the ocean limits the temperature extremes. The cool, moist air that results from the condensation over the cold water of the California current produces fog on any land mass that is high enough to raise an obstruction to air flow. Because of this fog, Cedros and Guadalupe islands are able to support remnant pine forest and chaparral communities even with little rainfall. Other factors that allow many species to endure on islands include the absence of herbivores and possibly less competition from more wide-ranging species for microhabitats.

On the other hand, a few of the endemic groups appear to be relatively new species. "New" species are usually members of widespread genera with great diversity, especially annuals, and which have many species adapted to specific conditions (Stebbins and Major 1965). The *Cryptanthas* endemic to Guadalupe, San Clemente, Catalina, and San Nicolas islands may represent more recent species as well as the *Malacothrix, Phacelias*, and *Gilias* that are found in various forms on several of the islands. Most of these are annuals or short-lived perennials.

One of the most interesting genera on all of the islands and many of the adjacent mainland bluffs and headlands, is the genus *Dudleya*. They are highly diversified and appear to be either extremely adaptable to particular locations or were very diverse at one time on the mainland and later found refuge on the islands and coastal bluffs. Island species in this genus range from small, narrow-leaved species to large, succulent, almost woody plants.

The genus *Hemizonia* is also well represented on the islands, particularly the perennial species. On the mainland, the perennial species are quite restricted, but on the islands *H. greeneana, H. palmeri*, and others are woody endemics. In general, woody perennials are considered to be more primitive than their annual relatives (Stebbins and Major, 1965). It appears that the perennial species of *Hemizonias* are older and survive on islands and other coastal headlands where the even temperatures have allowed them to remain.

DISCUSSION

Effects of Man

All of the islands have been subjected to human effects, mostly indirectly through feral herbivores. The California islands have recently been the subject of feral animal eradication programs to eliminate goats and pigs and mule deer on San Clemente, sheep on Santa Cruz and San Nicolas, burros on San Miguel, and rabbits on Santa Barbara. There have been efforts to reduce goats, deer, and bison on Santa Catalina (See Table 2). The recovery effects have been remarkable.

The Baja California islands have also suffered from feral animals. The impact from goats to Guadalupe Island has been tragic. Unless they are eradicated, the remaining species will become extinct as six of the endemics already have. South Los Coronados Island now has goats, which have impacted the *Malva occidentalis*. Rabbits were introduced to Todos Santos Island in the 1970s. Both burros and rabbits were introduced to West San Benito Island in the late 1980s. Fortunately, Cedros Island is mostly intact and its indigenous (endemic) deer even survive. In addition to the feral herbivores, which denude the islands of endemic vegetation, introductions of feral cats and rodents have contributed to the extinction of endemic birds and to the reduction in populations of ground and burrow nesting birds. Very recently, there have been efforts to reduce feral animals on Baja California islands through the Island Conservation and Ecology Group based in Santa Cruz, California, and Guerrero Negro, Baja California. They have carried out feral animal eradication programs on the Todos Santos and San Benito islands.

As land and resource managers in addition to being concerned citizens, it is vital that we work toward the removal of the feral animals from the islands. The ecosystems of entire islands are being destroyed, in particular with the recent introductions. It would be a great accomplishment to remove feral animals from all of these islands, especially Guadalupe.

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ATTACHMENT 1: PLANTS FOUND ON MULTIPLE ISLANDS BUT NOT THE MAINLAND.

Agave sebastana CE, NA, BE
Arabis hoffmannii RO*, CR
Arctostaphylos tomentosa ssp. *insulicola* RO, CR
Arctostaphylos tomentosa ssp. *subcordata* RO, CR
Artemisia nesiotica NI, BA, CL
Astragalus miguelensis MI, RO, CR, AN, CL
Astragalus traskiae NI, BA
Berberis pinnata ssp. *insularis* RO, CR, AN
Calystegia macrostegia ssp. *amplissima* NI, BA, CL
Calystegia macrostegia ssp. *macrostegia* MI, RO, CR, AN, CA, GU, MA
Castilleja lanata ssp. *hololeuca* MI, RO, CR, AN
Castilleja mollis RO, MI
Ceanothus arboreus RO, CR, CA
Ceanothus megacarpus ssp. *insularis* MI*, RO, CR, AN, CA, CL
Cryptantha traskiae NI, CL
Dendromecon harfordii var. *harfordii* RO, CR
Dendromecon harfordii var. *rhamnoides* CA, CL
Dissanthelium californicum CA*, CL*, GU*
Dudleya albiflora CE, NA, ES
Dudleya candelabrum MI, RO, CR
Dudleya greenei MI, RO, CR, CA
Eriogonum arborescens RO, CR, AN
Eriogonum grande ssp. *grande* AN, CL, CA, CR
Eriogonum grande ssp. *rubescens* MI, RO, CR, AN
Eriophyllum nevinii BA, CA, CL
Erysimum insulare ssp. *insulare* MI, RO, CR, *AN*
Eschscholzia ramosa MI, RO, CR, NI, BA, CA, CL, GU TO, LC, MA, BE, CE, NA
Ferocactus chrysacanthus CE, BE
Galium angustifolium ssp. *foliosum* RO, CR, AN
Galium buxifolium MI, CR
Galium californicum ssp. *miguelense* MI, RO
Galium nuttallii ssp. *insulare* RO, CR, CA
Galvesia speciosa BA*, CL, CA, GU
Gilia nevinii RO, CR, AN, NI*, BA, CA, CL, GU
Hazardia canus CL, GU
Hazardia detonsa RO, CR, AN
Helianthemum greenei MI*, RO, CR, CA
Hemizonia clementina AN, NI, BA, CA, CL
Heuchera maxima RO, CR, AN
Jepsonia malvifolia RO, CR, NI, CA, CL, GU
Malva assurgentiflora ssp. *assurgentiflora* MI, RO, NI
Malva assurgentiflora ssp. *glabra* CA, CL
Malva occidentalis LC, GU
Malva pacifica BE, GE, CE
Linanthus pygmaeus ssp. *pygmaeus* CL, GU
Lomatium insulare NI, CL, GU
Lotus argophyllus ssp. *argenteus* NI, BA, CA, CL, GU
Lotus dendroideus var. *dendroideus* RO, CR, AN, CA
Lupinus guadalupensis CL, GU
Lycium brevipes var. *hassei* CA*, CL*
Lyonothamnus floribundus ssp. *aslpenifolius* RO, CR, CL

Attachment 1: Cont'd.

Malacothrix foliosa AN, BA, NI, CL, LC
Malacothrix indecora MI*, *CR*
Malacothrix saxatilis var. *implicata* MI, RO, CR, AN, NI
Malacothrix squalida CR, AN
Mammillaria pondii CE, NA
Mentzelia hirsutissima var. *nesiotes* CE, NA, BE
Mimulus flemingii RO, CR, AN, CL
Mimulus latifolius CR, GU
Phacelia cedrosensis CE, NA
Phacelia insularis var. *insularis* MI, RO
Phacelia floribunda CL, GU
Phacelia lyonii CA, CL
Quercus X *macdonaldii* RO, CR, CA
Quercus pacifica RO, CR, CA
Quercus tomentella RO, CR, AN, CA, CL, GU
Rhamnus pirifolia MI*, RO, CR, CA, CL, GU
Scrophularia villosa RO, CA, CL, GU
Senecio lyonii CA, CL, MA, GU
Sibara filifolia CR*, CA*, CL
Solanum clokeyi RO, CR
Solanum wallacei CA, GU
Trifolium gracilentum var. *palmeri* NI, BA, CA, CL, GU

ATTACHMENT 2: SPECIES ENDEMIC TO ONE ISLAND

SANTA ROSA
- *Arctostaphylos confertiflora*
- *Dudleya blochmanae* ssp. *insularis*
- *Dudleya* sp. nova
- *Gilia tenuiflora* ssp. *hoffmannii*
- *Pinus torreyana* ssp. *insularis*

SANTA CRUZ
- *Arctostaphylus insularis*
- *Arctostaphylus viridissima*
- *Dudleya nesiotica*
- *Lotus argophyllus* ssp. *niveus*
- *Malacothamnus fasciculatus* var. *nesioticus*
- *Ribes thacherianum*
- *Thysanocarpus laciniatus* var. *conchuliferus*

ANACAPA
- *Malacothrix foliosa* ssp. *crispifolia*
- *Malacothrix junakii*

SAN NICOLAS
- *Eriogonum grande* ssp. *timorum*
- *Lycium verrucosum**
- *Malacothrix foliosa* ssp. *polycephela*
- *Phacelia cinerea**

SANTA BARBARA
- *Dudleya traskiae*
- *Eriogonum giganteum* ssp. *compactum*
- *Malacothrix foliosa* ssp. *philbrickii*
- *Platystemon californica* ssp. *ciliata*

SANTA CATALINA
- *Arctostaphylus catalinae*
- *Cercocarpus traskiae*
- *Dudleya hassei*
- *Eriodictyon traskiae* ssp. *traskiae*
- *Eriogonum giganteum* ssp. *giganteum*
- *Galium catalinense* ssp. *catainense*
- *Lyonothamnus floribundus* ssp. *floribundus*
- *Mimulus traskiae**

SAN CLEMENTE
- *Astragalus nevinii*
- *Brodiaea kinkiense*
- *Camissonia guadalupensis* ssp. *clementina*
- *Castilleja grisea*
- *Delphinium variegatum* ssp. *kinkiense*
- *Delphinium variegatum* ssp. *thornei*
- *Eriogonum giganteum* ssp. *formosum*
- *Galium catalinense* ssp. *acrispum*
- *Lithophragma maxima*
- *Lotus argophyllus* ssp. *adsurgens*
- *Lotus dendroideus* var. *traskiae*
- *Malacothamnus clementina*
- *Stephanomeria blairii*
- *Tritelia clementina*

GUADALUPE
- *Baeropsis guadalupensis*
- *Brahea edulis*
- *Camissonia guadalupensis* ssp. *guadalupensis*
- *Castilleja fruticosa*
- *Castilleja guadalupensis**
- *Cistanthe guadalupensis*
- *Cryptantha foliosa*
- *Cupressus guadalupensis* ssp. *guadalupensis*
- *Dudleya guadalupensis*
- *Dudleya virens* ssp. *extima*
- *Eriogonum zapatoense*
- *Erysimum moranii*
- *Eschscholzia elegans*
- *Eschscholzia palmeri*
- *Galium angulosum*
- *Githopsis diffusa* var. *guadalupensis*
- *Hemizonia frutescens*
- *Hemizonia greeneana* ssp. *greeneana*
- *Hemizonia palmeri*
- *Hesperelaea palmeri**
- *Lavatera lindsayi*
- *Lupinus niveus*
- *Marah guadalupensis*
- *Perityle incana*
- *Phacelia phyllomanica*
- *Pinus radiata* var. *binata*
- *Pogogyne tenuiflora**
- *Satureja palmeri**
- *Senecio palmeri*
- *Sphaeralcea palmeri*
- *Sphaeralcea sulpherea*
- *Stephanomeria guadalupensis*
- *Triteleia guadalupensis*
- Guadalupe unique forms

Arctostaphylos sp. extinct*
Unidentifiable plant without fruit, now extinct
SAN MARTIN
Chenopodium flabellifolium
LOS CORONADOS
Dudleya candida
Galium coronadoense
Malacothrix insularis
SAN BENITOS
Cryptantha patula
Dudleya linearis
Hemizonia streetsii
Mammilaria neopalmeri
San Benito unique form
Senecio benedictus

CEDROS
Cryptantha maritima ssp. *cedrosensis*
Dudleya cedrosensis
Dudleya pachyphyta
Eriogonum molle
Harfordia macroptera var. *fruticosa*
Leptodactylon veatchii
Lotus cedrosensis
Mammillaria goodridgei var. *goodridgei*
Mammillaria goodridgei var. *rectispina*
Monardella thymifolia
Penstemon cedrosensis
Pinus radiata var. *cedrosensis*
Senecio cedrosensis
Verbesina hastata
Xylonagra arborea var. *arborea*
Xylonagra arborea var. *wigginsiae*