Dr. William J. Libby: I would like to add my comments to give a little more perspective for those who are not as checked out on pine fights as we are. *Pinus* is a big, well-defined genus; it has somewhere between 80 and 110 species or species complexes, and in general they behave very well. By this I mean that shape and other morphological characteristics of cones, for instance, are relatively uniform, although they do vary in size, heaviness, etc. The California closed-cone pines are an outstanding exception to this rule of relative uniformity; and this is one reason why the island pines on Santa Cruz, Santa Rosa, Guadalupe, and Cedros are of such interest. We have a greater variation in cone type here within single populations on Santa Cruz Island than within some subsections of the genus in other parts of the world.

This is further complicated by the recent work of Mirov and Forde, which has shown that Bishop pine is by no means a simple thing. What was considered to be a relatively good species appears to be at least three quite distinct, genetically separated populations. In our current view, based largely on the work of Linhart, Burr, and Conkle, it appears that *Pinus remorata* may be no more distinct from Bishop pine than the three internal groups are from each other.

Dr. J. R. Haller: The species of the genus *Pinus* may not be so well behaved as Dr. Libby has implied. I have had some first-hand experience with another group of pines, the *P. ponderosa* - *P. washoensis* complex, in which the cone variability within some populations, scattered from Mount Rose, Nevada, to British Columbia, may be of the same order of magnitude as that of the closed-cone pines on Santa Cruz Island. If the *P. ponderosa* - *P. washoensis* complex is considered as a whole, it is probably more variable than the *P. muricata* - *P. remorata* complex; this would be expected from its great geographic range.

Then too, if one considers the Mexican pines, which include a sizeable fraction of the total number of species in the genus, one certainly does not get the impression of uniform, stable taxa. Among the yellow pines, the *Pinus ponderosa* complex, the *P. montezumae* complex, and the *P. pseudostrobus* complex are all highly variable and include a dozen or more smaller units that have been treated by taxonomists as species, varieties, or often ignored because of the continuous variability from one "taxon" to the next. Furthermore, these large complexes are not completely distinct from one another. Among the white pines, *P. flexilis*, *P. monticola*, and *P. strobus*, which are very distinct and relatively stable in the United States, are all morphologically linked together in Mexico through *P. strobiformis*, *P. strobus* var. *chiapensis*, and the highly variable *P. ayacahuite*.

INTRODUCTION TO INSULAR ZOOLOGY

John S. Garth

University of Southern California

The classification of islands for biogeographical purposes was first attempted by Alfred Russell Wallace, who in his "Island Life" (1880) categorized them as Oceanic, Ancient Continental, or Recent Continental. *Oceanic Islands* are of volcanic or coralline formation; they are remote from continents and are separated from them by deep seas; they contain no indigenous land mammals or amphibians, but an abundance of birds and insects, and usually some reptiles. Examples of oceanic islands are the Galapagos and Hawaii. *Continental Islands* are more varied in formation; they contain both ancient and recent stratified rocks; they are rarely remote from continents; they always contain mammals and amphibians; they may be divided into two groups:

Ancient Continental Islands are separated from the continent by 1,000 fathoms or over; they resemble the continent in geological structure; their plants and animals are highly "peculiar" (individualistic); the fauna is fragmentary, with many families and orders not represented; they are sufficiently removed from the continent so that they always contain some plants and animals not allied to it, but to remote parts of the world (in this sense they resemble oceanic islands). Examples of ancient continental islands are Madagascar and New Zealand.

Recent Continental Islands are rarely separated from the continent by over 100 fathoms; they also resemble the continent in geological structure; their plants and animals are almost identical with those of the continent. Examples of recent continental islands are the British Isles and Japan. It is evident that the California Islands belong in this category, although the deep basins separating them from the mainland and from each other provide more than customary isolation for islands of this type.

From the standpoint of endemism, islands present a graded series as well. Only in the Oceanic Islands are endemic families found, as with the Drepanididae and Achatinellidae of Hawaii and the Geospizidae of Galapagos (considered a family by the

late Harry Swarth). Endemism is well marked among Ancient Continental Islands, where differences are specific or generic in character. Among Recent Continental Islands, however, endemism is minimal, with nearly all differences being subspecific in degree. It is therefore apparent that we should not expect plants and animals of the Southern California Islands to be strikingly dissimilar from their mainland counterparts, but rather, that our expectations should be attuned to those more subtle differences, often apparent only to the specialist, that denote incipient speciation.

Before proceeding to the papers on the zoology of the California Islands, it might be well to consider further what these islands are not. They are not oceanic in character (and here I include the Ancient Continental Islands that resemble the Oceanic Islands in containing plants and animals from remote parts of the world); they are equally not a tropical archipelago like the Sunda Islands in which one generation follows another without the necessity for winter diapause, and where, as a consequence, evolution proceeds at its most rapid pace, giving rise to highly differentiated forms with a minimum of geographical separation. They are temperate zone islands, although so situated as to partake of both warm-temperate and cold-temperate climates in whole or part, or alternately on a seasonal basis. We would, therefore, not expect individual islands to have evolved different species or subspecies except among their least vagile inhabitants, such as the amphibians, reptiles, and smaller mammals, or the sedentary land snails and curculionid beetles; yet even these have been known to negotiate distances greater than those separating the California Islands by rafting and by other means.

Such diversity as occurs may be attributed, I believe, to one or more of the following circumstances, although others are by no means excluded: (1) The Southern California Islands, eight in number, are separable into a northern and a southern group, each group of four islands having had a somewhat different geological history and probably having been joined to the mainland at different times and in different places. (2) Each group has both inshore and offshore islands, although the trend of the coastline parallel to the northern group obscures this, while the separation of the southern group is more marked. (3) The ridge of the "high" island of each group (Santa Cruz of the northern group; Santa Catalina of the southern), while not sufficiently elevated to produce the vertical life zones or belts found in the coastal mountains, shelters and protects its shoreward slopes, affecting the vegetation by influencing not only fog, but also wind, rain, and sunlight, permitting the development of a more diversified flora and fauna than on the exposed seaward south-facing side.

As to (1), it is apparent to anyone who has visited San Miguel Island in August that this most westerly of the northern islands is under the influence of the cold temperate regime associated with the middle California coast north of Point Arguello. The presence of Steller sea lion and tufted puffin at Richardson Rock, an outlier of San Miguel, testifies to this boreal affinity, as does the presence intertidally of invertebrates more commonly encountered at Monterey. As to (2), it would be expected that the offshore islands would show increasingly fewer mainland forms than the inshore islands of each group; also, that the remote southerly island of San Nicolas might receive forms from the more remote islands of the northern group (the tufted puffin nests at Begg Rock, an outlier of San Nicolas), or even from the more isolated island of Guadalupe, as well as from one of the inshore islands of its own group. As to (3), the presence of pines on Santa Cruz and on Santa Rosa islands, insular extensions of the Santa Monica Mountains, is reminiscent of their presence on Cedros Island, an insular extension of the Sierra Vizcaino, Baja California, and of pines and cypresses that crown the higher 4,000 foot summit of Guadalupe Island, although this island may never have been connected to the mainland.

We are, therefore, ready to discuss the biota of the California Islands, recognizing them as recent continental islands, temperate in climate, separated by deep basins but reposing on the continental shelf, separable into a northern and a southern contingent, each with a somewhat different geological history, each with its inshore and offshore adherents, the higher summits of the inshore islands arresting the lower clouds and providing shelter to their shoreward slopes. Furthermore, since nearly all of these islands were once joined to the mainland, we must think in terms of absence as well as presence of mainland forms, and consider whether this may be the result of possible extinction caused by unsuitability of habitat or, as in the case of Guadalupe, of predation, as well as of failure to arrive. And finally, the contemporaneous presence of man, the arch predator, during at least the last few millennia of plant and animal development, and his responsibility for introduction of new forms and destruction of old, needs evaluating if we are to arrive at a proper understanding of the complex relationships existing in the insular milieu.