Cultural Dispersal of Plants and Reptiles to the Midriff Islands of the Sea of Cortés: Integrating Indigenous Human Dispersal Agents into Island Biogeography

GARY PAUL NABHAN

Long before the eclectic biologist E. O. Wilson (1997) sought *consilience* through his attempts to unify biological and social sciences into one corpus of knowledge, Wilson collaborated with mathematical ecologist Robert MacArthur on a theory of island biogeography that all but ignored the ancient influences of seafaring cultures in shaping the biota of various archipelagos. While numerous biologists have followed MacArthur and Wilson's (1967) lead by charting the natural processes shaping the island biogeography of the Midriff islands (Soule and Sloan 1966; Case and Cody 1983), the *cultural* dispersal of native plants and animals across the Sea of Cortés has hardly been taken into account in these "pattern analyses" of the region's biota.

In recent years, new opportunities to examine cultural dispersal have emerged. Analyses made possible by novel genetic tools can now be combined with recent revelations of oral history from Seri seafarers who have frequented the Midriff islands and who know of their ancestors' activities on the islands. Archaeologists have found indigenous remains on San Esteban, Ángel de la Guarda, San Lorenzo Norte y Sur and Tiburón islands, with dateable occupation sequences on San Esteban for a minimum of 350 years (Bowen 2000). We can now begin to reconcile data from cultural geography, genetics, and biogeography to track cultural dispersal with an unprecedented level of precision. A cohesive but curious story has begun to emerge from this unlikely partnership of genetic analyses performed in laboratories and oral history documentation in the field: *historic seafarers of this arid region have carried with them flora and fauna which became established on islands other than those accessible by natural routes of dispersal* (Nabhan in press; Petren and Case, 1996, 1997; Grismer 1994).

This should come as no surprise to scientists who read beyond their own area of interest: similar cultural dispersal dynamics have been documented in Polynesia and Melanesia (McKeown 1978; Fisher 1997;

Austin 1999), and in Central America and the Caribbean (Bennett 1992; Case 1996). Factoring indigenous cultural dispersal into island biogeography has led to very different views of biotic origins and migrations than are offered by a purely biological perspective. Sophisticated genetic analyses of culturally dispersed biota on various islands now open the way for a *quantitative* ethnoscience, through which hypotheses regarding the timing and routes of intentional and accidental cultural dispersal of biota, as well as the probability of establishment of small populations can be rigorously tested (Austin 1999). I will call this new subdiscipline *island ethno-biogeography*, for as an ethnoscience, it may potentially explain some of the discrepancies between predictions based on MacArthur and Wilson's (1967) island biogeographic theory and the widely varying results reported by various collaborators in Case and Cody's (1983) test of the theory in the Midriff islands of the Sea of Cortés.

The very premise of island ethno-biogeography flies in the face of assumptions implicit in how island biogeographic theory has been tested to date. Until now, human influences on island biota have largely been treated as "environmental noise" which has kept the sets of biota observed on islands from being closer to the theoretically expected number and mix of species. In other words, purists have treated any human influences, however ancient, as *outside* their theoretical domain, as if they are uninteresting phenomena that obscure the patterns worthy of concerted scientific inquiry.

Most biogeographers can admit intellectually that no island in the world is pristine in the sense that it is truly isolated from human influences. However, with the notable exception of zooarchaeologist and biogeographer Steadman (1995), they often assume that most of these influences are recent, or that they obscure the tests of their theory within any archipelago. In Case and Cody's (1987) synopsis of lessons learned from the collective effort to characterize biogeographic patterns in the Sea of Cortés region, they conceded that "in practice, it is next to impossible to find a set of islands without environmental change or evidence of the severe impact of man's activities. The islands of the Sea of Cortés probably come closer than any to fulfilling the requisite conditions. There was never any permanent aboriginal population except on Tiburón, and the presence of modern man is restricted to a few settlements in three of the larger islands. Relatively few islands have any plants or animals introduced from elsewhere."

While it is obvious that the Midriff islands are not yet overrun by plant and animal introductions, there are at least twelve introduced vascular plant species and eight vertebrate species that have become established on one or more of the islands over the last few centuries (West and Nabhan, in press; Mellink, in press). It has been abundantly documented that Tiburón was not the only island aboriginally inhabited for some time depth (Bowen 1976, 2000; Villalpando 1989), that Europeans as well as the Seri had been visiting and foraging on the many Midriff islands for centuries (Bahre 1983; Sheridan 1999), and that the Seri had probably moved animals between the islands (Lowe and Norris 1955; Grismer 1994; Lowe et al. 1995; Soule and Sloan 1966; Petren and Case 1997).

Bahre (1983) commented that "to the casual observer, the flora and fauna of the Midriff islands seem little affected by man. Although that is largely true for the terrestrial flora and fauna, it is not for seabirds and marine mammals." His claim that human influences affected seabirds and marine vertebrates, but not the terrestrial flora and fauna is curious, because it can easily be argued that Seri hunting of mule deer, jackrabbits, chuckwallas, tortoises, iguanas, and game birds affected the interaction ecology of many floral and faunal inhabitants of the islands (Felger and Moser 1985; Bowen 2000).

I will focus this discussion on just two culturally dispersed groups of organisms, iguanids and cacti. Other than the Seri, or *Comcáac,* an indigenous population whose numbers may have ranged from 180 to 3,500 individuals through time, knowledge of other prehistoric cultures who visited the islands is limited (Bowen 2000; Aschmann 1967). I will therefore limit my discussion to historic Seri practices and oral histories consistent with what is known of their archaeological record (Bowen 2000; Villalpando 1989). In the conclusions, I will return to the issue of what other organisms may have been affected by historic cultural management and use of the islands, and where the Seri themselves may have come from.

CULTURAL DISPERSAL OF CACTI

To understand the potential magnitude of cultural dispersal of cacti to various Midriff islands, I will first review translocation practices affecting mainland as well as island populations of certain cacti and ele-

phant trees (*Bursera* spp.) The most frequent reason offered to me by contemporary Seri for transplanting and translocating these plants is to mark the place where a newborn's placenta is buried, using a live specimen that is likely to persist at least as long as a human lifespan. The Seri use the term *hant haxp m-ihiip* 'place/time (commemorating) birth' to describe where a child's placenta is buried by his or her parents, then covered with ashes and herbs and marked with a long-growing succulent plant brought to that spot by godparents or grandparents. While earlier ethnographers did not recognize that some of these living birthmarkers were translocations, Felger and Moser (1985) did document in detail how cardón (*Pachycereus pringlei*) and saguaro (*Carnegiea gigantea*) could be used to mark the place of placental burials: "The placenta of a newborn was buried at the base of a cardón or saguaro. Five small plants of any species were buried with it. Ashes were put on top of the burial to keep coyotes from locating it. The cactus served to mark the spot. In later years, one might visit the spot of his placenta burial to put green branches on it for good luck."

In addition, my own interviews with Seri elders have confirmed that (1) they often mark the growth tip of these plants with a wooden or metal rod, so that the growth of the cactus can later be compared with the growth of the child; and (2) the cacti and elephant trees to be transplanted are often carried as 0.3–0.6 m tall dry-rooted plantlets unearthed from the *ihizitim* or 'ancestral grounds' of the newborn's grandparents, in a metaphorical gesture connecting the child with that place and his or her family legacy within it.

This cultural ritual would at first seem to have little to do with island biogeography, until one begins to relate it to the many disjunct populations of cacti found on the Midriff islands and adjacent mainland areas. Given that there were only about 180 Seri surviving at the beginning of the twentieth century, and 650 living at the end of the twentieth century, perhaps 1,000 to 2,000 Seri births have been marked with living succulents (not all of them transplanted) over the last hundred years. But because columnar cacti such as cardón might persist as long as 300 years (Yetman and Búrquez 1996; Turner, Bowers, and Burgess 1995), there are potentially 3,000 to 5,000 living birthmarkers still persisting around Seri camps in central gulf coast habitats, including the Midriff islands. We still do not know whether these translocations established cactus species on islands where they had not previously been disseminated via natural modes of dispersal. Nevertheless, this cultural dispersal process may help explain the many disjunct pop-

ulations of cacti found on the Sonoran mainland and the Midriff islands. Even if the cultural dispersals only increased the number of cactus populations found on certain islands, they may have altered the availability of cactus flowers and fruits for pollinators and dispersers migrating along stepping-stone corridors, thereby altering the ***interaction diversity*** evident in the Midriff islands (Thompson 1999).

The distributions of cacti on mainland Sonora and adjacent islands have only recently been elaborated in a general manner, and few species have had detailed maps of their distributions drawn (Paredes-Aguilar et al. 2000; Turner, Bowers, and Burgess 1995). However, Felger and Moser (1985) noted the peculiar distributions of several columnar cacti, prickly pears, and chollas. The organpipe, *Stenocereus thurberi*, is common on the mainland and on Tiburón, but extremely rare on San Esteban Island. The sina, *Stenocereus alamosensis*, seldom reaches into the coastal plains beyond Hermosillo and San Carlos, but the Seri know of disjunct populations "near Tastiota" on the coast and "at Siete Cerros," 50 and 125 km away from other (natural) populations. The Siete Cerros population appears to be a single clone, intermixed with a single clone of a hybrid pencil cholla, *Opuntia arbuscula* × *thurberi*, with extremely large, tart, edible fruit. The Seri call this cholla *heem icös cmasl* and use the same name for the chollas on San Esteban Island sometimes referred to as *Opuntia burrageana* vel aff.

The cholla-like cactus *O. marenae* is considered "relatively rare" in Seri territory, occurring at widely scattered localities from Caborca south to Bahía Kino. A related species, *O. reflexispina*, is known only at coastal fishing camps near Los Arrieros, El Sahuaral, and Tastiota, where its thick roots "were cooked in ashes and eaten as a cure for diarrhea." The disc-shaped prickly pear, *O. engelmanni* var. *engelmanni*, "is uncommon and highly localized, e.g., on Alcatraz Island and in sandy places near the base of Punta Sargento." Felger and Moser (1985) added that the latter prickly pear was one of the species "planted at Punta Sargento by the people of that region," although elsewhere they repeatedly refer to the Seri as non-agricultural and non-horticultural.

In speculating on the origins of disjunct cactus populations in the Sierra Libre of central Sonora, Yetman and Búrquez (1996) have added the cardón or sagueso (*Pachycereus pringlei*) and the pitahaya agria to the list of plants possibly translocated by the Seri. They point out that the cardón in the Sierra Libre are more than forty kilometers inland from any other known population, under climatic conditions aberrant for them, but in an area where the historic Seri spent several decades as

refugees more than two centuries ago. The population is uniform in its age, which they take as evidence that the entire cohort germinated at the same time, perhaps during a period when the Seri were still actively occupying this isolated mountain range. Yetman and Búrquez (1996) did not attempt to confirm their speculations with the Seri, simply stating, "Whether the plants sprouted from randomly scattered (lost or spilled) seeds, germinated from seeds imbedded in fecal matter, or were deliberately planted by Seris who anticipated an extended stay in the Sierra Libre and wanted some of the conveniences of home, we can only imagine."

While Yetman and Búrquez (1996) are convinced that the reason the Seri seeded or transplanted the cacti was because the direct consumption of the fruits was so important to their diet (Felger and Moser 1974), I doubt that they would have had their nutritional needs as their primary intent, since it would have taken hundreds of cacti as well as many decades to obtain a sizeable crop of fruit. Instead, I find it more plausible that they translocated a single cactus whenever a newborn needed a birthmarker and that these living birthmarkers gradually accumulated around their camps.

How does this relate back directly to island biogeography? At least nine species of cacti and one species of elephant tree were live-transported by the Seri for distances of 50 to 100 km, and translocated at temporary camps on the mainland and the Midriff islands; at least six of these species have peculiar distributions on Tiburón and San Esteban Islands, often being found "out of typical habitat" in even-aged stands. For instance, two small patches of organpipe cacti were found around two prehistoric or protohistoric Seri camps on San Esteban Island in the 1960s and 1970s by archaeologist Tom Bowen, the largest being in the northwestern corner of the island known as *Cofteocl Lifa*, 'Chuckwalla Peninsula.' These patches were reported to Richard Felger, who confirmed that they were the only ones on the entire 4.5-sq.-km island (Felger and Moser 1985). In December 1999, I relocated one cluster of ancient organpipes persisting in the middle of San Esteban in an area separate from the small population in the northwestern corner of the island described by Bowen (2000). Despite the remarkable thoroughness of his work in general, Moran (1983) did not list organpipes on San Esteban in his checklist of the vascular plants of the Midriff islands, although he did include other cacti which the Seri translocated (e.g., cardón and pitahaya agria).

Such culturally influenced anomalies were not at all taken into account by the first set of biogeographic analyses of the Midriff islands. The probability that nine species were intentionally dispersed, and the possibility that additional species were accidentally dispersed by prehistoric and protohistoric seafarers, is not a minor point when one realizes that the vast majority of the Midriff islands have floras of fewer than one hundred species. Even distributional anomalies should be re-evaluated. For example, consider that the boojum or cirio (*Fouquieria columnaris*) population on Ángel de la Guarda Island occurs only above 700 m, whereas the peninsular populations less than 20 km away are found all the way down to sea level. Could these plants have been culturally dispersed to the summit of the island by the presumed *cachanilla* relatives of the Seri living in the Bahía de los Ángeles area (Aschmann 1967)? Because the Seri believe boojums to be "a kind of people"—as they do chain-fruit chollas and leatherback turtles—they attribute to them supernatural powers which relate to Seri origins among mythic giants of Baja California. Imbedded in such legends may be some recognition of cultural dispersal that could explain the disjunct populations on both Ángel de la Guarda Island and the Sonoran mainland (the latter being at Punta Cirio in the Sierra Bacha).

CULTURAL DISPERSAL OF IGUANIDS

In a recent survey of the herpetofauna of Seri Indian homelands on the Sonoran mainland and the Midriff islands, I have documented forty-nine terrestrial reptile species, at least five of which now dwell in locations where they do not necessarily appear to be "naturally occurring" (Nabhan in press). Perhaps the most notable examples of these distributional anomalies are (1) the hybrid swarm of chuckwallas (*Sauromalus* spp.) on Alcatraz Island in Bahía Kino (Lowe and Norris 1955; Lowe et al. 1995); (2) the co-occurrence of two large iguanids (the piebald chuckwalla [*Sauromalus varius*] and the spiny-tailed iguana [*Ctenosaura hemilopha*]) on San Esteban Island (Case and Cody 1983); and (3) the peculiar distribution of leaf-toed geckoes (*Phyllodactylus* spp.) throughout the Midriff islands (Grismer 1994), which I will put aside for the moment. It is worth introducing the issue of cultural dispersal of iguanids with Lowe and Norris's (1955) early speculation that both chuckwallas and spiny-tailed iguanas "probably reached these is-

lands [San Esteban, Alcatraz, and Cholludo] by transport by man or by birds. The Seri Indians and some Mexicans eat both of these lizards."

Lowe, his former students, and Desert Museum collaborators later documented that the Alcatraz Island populations of chuckwallas involved genetic exchange between three species of *Sauromalus* (*S. varius*, *S. ater*, and *S. hispidus*) and speculated that all three species were introduced as an emergency food reserve by either Seri or Mexican fishermen (Lowe et al. 1995). This hypothesis has gained favor not only with Grismer (1994) and others, but with Petren and Case (1997), who argue that cultural dispersal is the most plausible explanation for *S. hispidus* populations found on small islets up-current from source populations on the Baja California side of the gulf.

Ironically, no herpetologist seriously entertaining this hypothesis ever went to the contemporary Seri to ask them to explain these distributional anomalies in their own terms. To resolve this oversight, in the winter of 1997–1998 and fall of 1998 I asked several Seri elders to explain their oral history of these introductions. I recorded these oral histories while we were working together on a captive breeding project for piebald chuckwallas (*S. varius*) in Punta Chueca, Sonora. These Seri elders claimed that at least some of the chuckwallas on Alcatraz Island were brought there during the *totoaba* fishing boom in the late 1920s and 1930s. During that time, fish buyers from Hermosillo would buy the Seri catch if it were brought to Bahía Kino, so the Seri established a permanent camp there. But because they would sometimes get stranded on Alcatraz Island during windy or stormy weather, they needed an emergency food supply during their stayovers. While fishing near San Lorenzo Island, which they call *Coof Coopol Itihom* 'Black Chuckwalla's Home Ground,' they went to that island, live-captured black chuckwallas (*S. hispidus*) and brought them over to Alcatraz Island for release.

My Seri consultants did not know whether the translocation of piebald chuckwallas from San Esteban was done much earlier or around the same time, but they knew it had been done. They did not know for sure whether the mainland common chuckwalla (*S. ater*) was culturally or naturally dispersed to the island. They understood that different chuckwallas on Alcatraz expressed a mix of traits derived from these three parent populations, but that overall the body mass of most individuals was much larger than that of the nearby mainland populations of the common chuckwalla. Body masses of the black chuckwalla and

piebald chuckwalla are about five times that of the common chuckwalla (Petren and Case 1997), so translocation of these species to Alcatraz Island resulted in a much greater meat harvest per animal. The Desert Museum is continuing to monitor this hybrid swarm, which might rightly be called a c*ulturally selected breed* (or *raza criolla*) of chuckwallas, one for which the Seri should retain cultural use (or intellectual property) rights.

The Seri also claim that for similar reasons, their ancestors intentionally translocated spiny-tailed iguanas from San Esteban to Cholludo Island on the southeast side of Tiburón. Although no one I have spoken with retains oral history of the translocation of spiny-tailed iguanas from San Pedro Nolasco to San Esteban, they find this hypothesis entirely plausible: their name for San Pedro Nolasco is *Hast Heepni Itihom* 'Rocky (Island) Home Ground of Spiny-tailed Iguanas.' Grismer (1994, pers. com.) has independently arrived at this hypothesis and suggests that genetic evidence is consistent with it in the sense that the San Esteban population is more similar to San Pedro Nolasco's than to other populations sampled to date.

When one factors in Petren and Case's (1997) conclusion that there were also historic translocations of black chuckwallas to several small islands closer to the Baja California peninsula, it opens up the possibility that seafarers in addition to the Seri were involved in such a cultural dispersal process. The contemporary Seri claim that translocated chuckwallas could not survive on all islets where they could be potentially dispersed, and also dismiss the possibility that desert tortoises could have survived on other islands if they had been dispersed there. This suggests a much more rational process than the "casual cultural dispersal" of live-captured chuckwallas which might have escaped when Seri fishermen would toss to the women and children as they returned to camp from San Esteban (Bahre 1983). Because most piebald chuckwallas brought from this island to Tiburón or the mainland for eating had already had their legs broken so they could not escape during transport, they would have provided poor founder populations. In short, it appears that the Seri have articulated a rationale for their translocation efforts and that the satellite populations they established could have been derived from multiple translocation events rather than accidental escapes.

CONCLUSIONS

In this view of human influences on the island biogeography of the Sea of Cortés, the indigenous seafaring hunter-gatherers have not been passive recipients of local wild resources, but active agents of dispersal for certain culturally significant resources within their regional domain. However, there also exists the possibility that "camp-followers," such as *Amaranthus watsonii* and *Chenopodium murale* were unintentionally dispersed to several islands, where they were then used as wild greens by the Seri (Felger and Moser 1985). In addition, Seri or other aboriginal seafarers may have transported nocturnal "stowaways" such as *Phyllodactylus* geckoes, just as other seafarers have dispersed gekkonid species elsewhere in the world. These are but three genera of organisms which could insinuate their way into fishermen's camping gear and boats.

Such stowaway organisms as these may be potential indicators of cultural dispersal routes followed by the Seri and/or their presumed Hokan-speaking relatives in Baja California. The mitochondrial DNA sequences of anthropophilic species can be sampled and their distribution patterns can be analyzed in much the same way as Austin (1999) did to test the "express train to Polynesia" hypothesis of cultural migration using descendants of *Lipinia noctua* stowaways as his indicators. In addition, the interpretation of distributional patterns of allozymes undertaken by Fisher (1997) for the anthropophilic gecko, *Gehyra mutilata,* could serve as a model for the degree to which leaftoed geckoes' distributions were modified by human dispersal. Through randomly amplified polymorphic DNA analysis of wild chile genomic DNA, we have demonstrated that even after an anthropophilic species undergoes genetic bottlenecks due to long-distance dispersal by humans or other vertebrates, new genetic variation can arise fairly rapidly in disjunct populations where unique selection pressures work on novel mutations (Votava, Nabhan, and Bosland in press).

Using mDNA to determine monophyletic and polyphyletic populations of culturally dispersed species on the islands, it might be possible to refute or confirm whether the Seri migrated by island-hopping from Baja California, as many anthropologists suspect, or alternatively, whether they migrated by land from much farther away as recent genetic analyses suggest. One recent molecular analysis of HLA alleles

suggests that the Seri are more closely related to the Warao Indians in Venezuela and other indigenous groups in Argentina than to extant tribes in Mexico (Infante, Olivo, and Gorodesky 1999). The Seri have long been recognized as a relictual "language isolate group" in a sea of Uto-Aztecan speaking tribes with very different cultural origins. Because of the early extinction of many of the peoples of Baja California who may have shared their peculiar origins, direct linguistic comparison of Seri with languages of nearby groups has not been possible as a means to understand their phylogeny and history.

Finally, biogeographers should not rule out the possibility of finding remains of now-extinct land birds or reptiles in caves and archaeological sites on the Midriff islands. Paleoecologists Jim Mead and Paul Martin still consider it quite plausible that faunal extinctions occurred on these islands prior to 1900 and are certain that the requisite intensity of search efforts has not been made to rule out such extirpations. A more intensive search for zooarchaeological materials on the Midriff islands could help determine if such extirpations occurred, whether humans were a factor in them, and if so, when. Given the extraordinary attention to human-induced extinctions in the Hawaiian Islands (Olson and James 1984; Steadman 1995) and elsewhere around North America (Steadman and Martin 1984), it is remarkable that no one has addressed this issue in the Midriff islands. In Bennett's (1992) view, the biogeography of certain regions in the Americas "can be properly understood only if the anthropogenic elements are included in our investigations. One of the tasks requiring early attention is a typology of ecosystems that jettisons the long-prevailing myth of ecosystem pristineness. In other words, an effort should be made to integrate all information obtainable with reference to current and past human activities in the area along with the [biotic and abiotic] data that are usually collected, [so that the former are] investigated with the same objectivity."

Without due attention to the possible roles humans may have played in the introduction and extirpation of native biota in the Midriff islands, I find it difficult to imagine how island biogeography in the Sea of Cortés can continue to advance. I look forward to the day when cultural dispersal factors can be integrated into a quantitative theorem for predicting the species richness and composition of a particular island, based on its size, distance from source populations, geological history, and human history. ✣

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