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Floristic Diversity and Long-Term Vegetation Dynamics of San Pedro Nolasco Island, Gulf of California, Mexico

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ABSTRACT.—San Pedro Nolasco Island, isolated for about 2 to 3 million years, is a north–south mountain rising to 315 m elevation from deep water 14.6 km west of the Sonora mainland. The island is about 3.5 km long, not more than 1.5 km wide, and embraces about 3.45 km^2. It lies within Shreve's Central Gulf Coast subdivision of the Sonoran Desert. It is not known to have been occupied by people, and there is only one tiny source of fresh water. The island supports habitats not duplicated anywhere else in the Gulf of California region. Fifty-eight species of plants in 52 genera and 27 families are found on the island, most of which have distributions that straddle Sonora and the Baja California Peninsula. Four endemic species represent, along with Ángel de la Guarda Island, the highest level of single-island plant endemism for the Gulf of California (three small cacti, two species of *Mammillaria* and an *Echinocereus*, and one composite, *Coreocarpus sanpedroensis*). The vegetation comprises species of desert scrub in unique communities segregated according to slope exposure and elevation, demonstrating significant zonation even on this small island. The diversity of species is greatest at higher elevations, above ca. 200 m, especially on the east side of the island ridge in places sheltered from the hot afternoon sun. Eleven species, or 19% of the flora, occur only at the highest elevations. Grasses, which may support low-intensity fires, dominate north- and northeast-facing slopes on the eastern side of the island. These sites feature soil that is deep and rich with humus built up by the decay of the grasses, which in turn promotes the recruitment of grasses and slows erosion. The Poaceae, with 14 species, comprise 24% of the flora, the highest grass diversity of any gulf island, in contrast to an average of 8% ± 2.4% for all major gulf islands. Two of the endemic small cacti occur from near the shore to the summit and in some places blanket the ground, making the island a unique and magnificent cactus garden. Botanical collections beginning in 1921 and vegetation data from 1966 and 2008 provide the bases for long-term, specimen-based, quantitative assessment of the flora and vegetation.

San Pedro Nolasco has a surprisingly low floristic diversity in relation to its size, elevation, and habitat diversity. Over-water colonization is the only plausible means for colonization of this geologically isolated island. Yet the flora includes several species with limited capacity for long-range dispersal; *Simmondsia chinensis*, for example, is dioecious and has one of the largest seeds of any Sonoran Desert plant. At this time we can attribute the low species richness only to the long isolation of the island, the steep sea cliffs that surround the island and limit opportunities for over-water colonization, and episodes of extreme aridity. Non-native species are absent, yet the island, especially its north-facing grassy slopes, could support invasive species present on the nearby mainland. Vigilant monitoring is needed to maintain the natural integrity of the island. San Pedro Nolasco Island, with its diverse vegetation and relatively small and now well-known flora, essentially without human influence, offers an unparalleled opportunity for the study of climate change.

RESUMEN.—La Isla San Pedro Nolasco, ha estado aislada cerca de 2 a 3 millones de años, es una montaña alargada, orientada de norte a sur que se eleva 315 m desde las aguas profundas y a unos 14.6 km al oeste del territorio continental de Sonora. La isla mide aproximadamente 3.5 km de largo por 1.5 km de ancho, tiene un área de 3.45 km^2. La isla se encuentra dentro de la subdivisión de Shreve de la Costa del Golfo Central del Desierto Sonorense. No se sabe si ésta tuvo ocupación humana alguna vez. La isla tiene un pequeño manantial de agua dulce y hábitats que no tienen igual en ninguna otra parte de la región del Golfo de California. Cincuenta y ocho especies de plantas con 52 géneros y 27 familias se encuentran en esta isla, la mayoría de las cuales también ocurren en Sonora y la Península de Baja California. Cuatro especies endémicas representan, junto con Isla Ángel de

la Guarda, los niveles de endemismo más altos observados en una sola isla dentro del Golfo de California (tres pequeños cactus, dos de *Mammillaria* y un *Echinocereus*, y una compuesta, *Coreocarpus sanpedroensis*). La vegetación está formada por especies de matorral desértico en comunidades singulares segregadas, de acuerdo a la exposición de la pendiente y la elevación, lo cual demuestra una significativa zonificación aún en este pequeña isla. La mayor diversidad de especies ocurre en las elevaciones más altas de la isla, por encima de los 200 m, especialmente en el lado este de la cresta de la isla, en lugares resguardados del caliente sol de la tarde. Once especies, que representan el 18% de la flora, se distribuyen únicamente en las mayores elevaciones. Los pastos, que pueden sostener fuegos de baja intensidad, dominan las laderas orientadas hacia el norte en el lado este de la isla, en sitios con suelo profundo y rico en humus producto de la descomposición de los pastos, que a su vez, promueve el reclutamiento de pastos y disminuye la erosión. Las Poaceae, con 14 especies, comprenden el 24% de la flora, la diversidad de pastos más alta de todas las islas principal del golfo, que tienen un promedio de 8% ± 2.4%. Dos de los pequeños cactos endémicos se distribuyen desde cerca de la costa hasta la cumbre, y en algunos sitios tapizan el suelo haciendo de la isla un magnífico y único jardín de cactos. Las colectas botánicas, comenzaron en 1921, y los datos de la vegetación desde 1966 y 2008, proveen las bases para estudio a largo plazo de tipo florístico cuantitativo y de evaluación vegetacional basado en ejemplares.

San Pedro Nolasco posee una sorprendentemente baja diversidad florística en relación a su tamaño, elevación y diversidad de hábitat. El transporte a través del agua es el único medio plausible de colonización para esta isla geológicamente aislada. Sin embargo, la flora incluye varias especies con capacidad limitada de dispersión a larga distancia; por ejemplo, *Simmondsia chinensis*, es una planta dioica y posee una de las semillas más grandes de cualquier planta del Desierto Sonorense. En este momento, sólo podemos atribuir la baja riqueza de especies al largo aislamiento de la isla, a los empinados acantilados que rodean la isla y que limitan la colonización a través del agua, y a episodios de extrema aridez. Las especies no-nativas se encuentran ausentes, aunque la isla, y ciertamente las laderas con orientación norte cubiertas de pastos, podrían mantener especies invasoras presentes en el continente cercano. Es necesario un monitoreo perseverante para mantener la integridad natural de la isla. La Isla San Pedro Nolasco esencialmente libre de la influencia humana, con su diversa vegetación y relativamente pequeña y bien conocida flora, ofrece una oportunidad sin paralelo para estudiar el cambio climático.

INTRODUCTION

San Pedro Nolasco is a rugged and precipitous island situated in deep water about 30 km northwest of Guaymas, Sonora, and 14.6 km west of Bahía San Pedro, the closest mainland location (Figure 1). The channel between San Pedro Nolasco and the Sonora mainland is 244 m deep (Murphy et al. 2002). "Nolasco is mainly composed of granodiorite, apparently of the same petrographic type as that cropping out near Guaymas, and may be related to the granitic rocks of Cretaceous age in Baja California" (Carreño and Helenes 2002:26–27). The island is the outcrop of an uplifted block termed the Pedro Nolasco High, bounded by the East Pedro Nolasco and West Pedro Nolasco faults, which constitute the southernmost segments of the Tiburón Fault system. Seismostratigraphic analysis by Aragón-Arreola et al. (2005) showed that the Pedro Nolasco High is not covered by the oldest marine sediments in the adjacent Yaqui Basin. Marine rocks draping the Pedro Nolasco High date to when activity of the Yaqui Fault and associated subsidence of the basin were waning. This waning subsidence is dated to the late Pliocene, at which time deformation in the northern Gulf of California migrated from the east to the west (Aragón-Arreola and Martín-Barajas 2007). The correlation of the sequences that bound the Pedro Nolasco High with the termination of active faults in the east-central Gulf of California and migration of activity to the western gulf yield a best estimate of separation of San Pedro Nolasco Island from the Sonora mainland between ca. 2 and 3 Ma (Michael Oskin, personal communication 2009). For this reason we consider San Pedro Nolasco a "geologically isolated" island.

The island consists of a narrow mountain 3.5 km long, oriented north–south, and not more than 1.5 km wide; it covers about 3.45 km^2 (Figure 2). A prominent crest, reaching a peak of 315 m, runs along most of the length of the island (Figure 3). On either side of the crest, the terrain quickly falls away into the sea. There are many short, steep canyons but no alluvial developments or fans. The shore is abrupt, and the only beach, at Cala Güina, a tiny cove at the southeast side of the island, consists of cobbles. Sheer cliffs and steep slopes of barren rock reach directly down to the water, so halophytic shore plants are absent. Along the entire east side of the island there are only two landfalls: the cove at Cala Güina and the other at approximately one-third the distance from the north end of the island. The northeastern landfall, recently named Cañón El Farito, provides the best access to the island, and most botanical collections have been made in this area. There is also limited access from the sea to canyons on the west-central side of the island.

The island lies within the Central Gulf Coast subdivision of the Sonoran Desert (Shreve 1951), close to its southern boundary on the Sonora side of the Gulf of California. The general appearance of the island and its vegetation are unique and do not closely match that of the opposite Sonora mainland or anywhere else in the Gulf of California region. Because of the island's long isolation from the mainland, we assume that the present-day animals and plants must have reached it over water.

The most serious threat to the island's ecosystem is the introduction of exotic fauna and flora. In 2006, honeybees (*Apis mellifera*) were well established on San Pedro Nolasco in addition to occurring on the Midriff Islands (Bowen et al. 2006). We assume the honeybees are displacing native pollinators on San Pedro Nolasco, but their actual effect is unknown. Gallo-Reynoso and associates found feral domestic cats on the island and, together with Area de Proteccíon de Flora y Fauna del Golfo de California, are attempting to eradicate them—if indeed cats are still present on the island. No other non-native species are known from San Pedro Nolasco, but there has long been a potential for human visitors to introduce exotic species as well as species native to the nearby mainland. The effect of humans on this uninhabited island is of biological conservation concern (Bowen 2004; Velarde and Anderson 1994).

The island is not known to have been occupied by people but has been visited probably since prehistoric times (Bowen 2009). The Comcáac (Seri people) name for the island is *Hast Heepni It Iihom*, "cerro donde están las iguanas" or "mountain where the iguanas are" (Moser and Marlett 2005), indicating familiarity with the island. Modern visitors include fishermen, tourists, researchers, and workers installing the beacon at Cañón El Farito. San Pedro Nolasco is a favorite destination for sport fishing, scuba diving, maritime ecotourism, and commercial fisheries, and for such purposes the island is visited by small vessels almost daily except during stormy weather. Although these visitors seldom go ashore, they do so often enough to be a concern for conservation. All of these activities have an effect on the marine life, sea birds, and the interconnected terrestrial life.

Since the early decades of the 20th century, San Pedro Nolasco has been a prime destination for small- and large-scale commercial fishing. Fishermen sometimes camp at the place now known as Ensenada El Farito. For example, in his field notes for 3 May 1952, Reid Moran mentioned, "three Mexican fisherman camped on the beach" (Moran field book 3:111; the "beach" would be a rocky ledge or canyon bottom at Ensenada El Farito). Since the latter part of the 20th century, fishermen have rarely camped on the island because with powerful outboard motors on their *pangas* (small fishing boats)

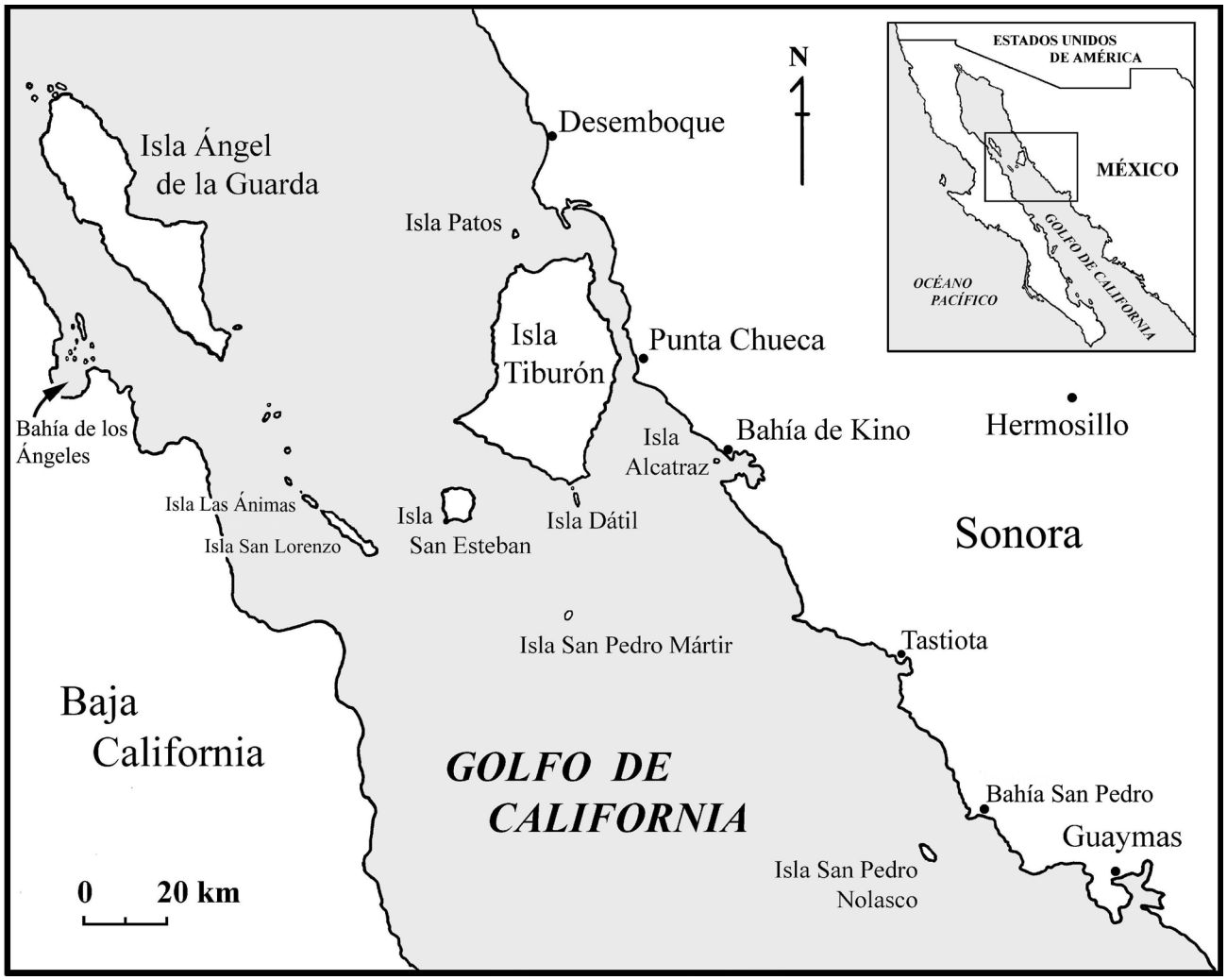

FIGURE 1. San Pedro Nolasco Island and the Midriff Islands. Map by Cathy Moser Marlett.

they can reach the coast in only half an hour. The sea adjacent to San Pedro Nolasco is fished commercially and legally year round, but it is illegal to set gill nets near rookeries of the California sea lion (*Zalophus californianus*). Nevertheless, fishermen sometimes do so, resulting in the killing of many sea lions, especially juveniles. The fishermen also use hookah dive gear to obtain a wide variety of sea life (clams, fishes, lobsters, octopi, sea cucumbers, etc.), mostly during daylight but sometimes at night by using powerful lights.

Gecarcinus (*Johngarthia*) cf. *planatus* (red land crab) was identified by Richard C. Brusca and José Luis Villalobos-Hiriart from a photo taken by Oscar Rangel at Cañón de las Guacamayas on the west side of the island on 8 November 2002 (see the species account for *Perityle californica*; positive identification of species awaits the obtaining of an actual specimen). These bright red crabs are apparently widespread on the island but have been seen only at night. Gallo-Reynoso and associates found them at 20 m or more above sea level at Cañón de las Guacamayas and also above Ensenada El Farito on 5 May 2005. These land crabs may be significant herbivores on the island (e.g., see Sherman 2002). *Gecarcinus* (*Johngarthia*) *planatus* is an eastern tropical Pacific island species ranging from Colombia to Mexico, including Baja California Sur and Sinaloa (Cuesta et al. 2007).

Seven species of terrestrial reptiles live on the island (Grismer 1999; Murphy and Aguierre-Léon 2002), including five lizards: *Aspidoscelis bacata* (*Cnemidophorus bacatus*, San Pedro Nolasco whiptail), *Ctenosaura nolascensis* (San Pedro Nolasco spiny-tailed iguana, the source for the Seri name for the island; Davy et al. 2011), *Phyllodactylus homolepidurus* (Sonoran leaf-toed gecko), *Sceloporus clarkii* (Clark's spiny lizard), and *Uta nolascensis* (San Pedro Nolasco side-blotched lizard). Clark's spiny lizard is not taxonomically different from mainland populations. Dixon (1966) although not Grismer (1999, 2002) recognized the gecko as the endemic subspecies *P. h. nolascoensis*. The other three lizards are endemic to San Pedro Nolasco. Two snakes are known from the island: the geographically widespread *Lampropeltis getula* (common kingsnake) and *Hypsiglena* sp. (night snake, discovered by Gallo-Reynoso). No rattlesnake (*Crotalus*) is known from San Pedro Nolasco, making it one of the very few major gulf islands without a rattlesnake.

The terrestrial mammals are represented by two endemic mice, *Peromyscus boylii glasselli* and *P. pembertoni* (San Pedro Nolasco deer mouse), and feral house cats (possibly no longer present), as well as several species of bats. *Peromyscus pembertoni* has not been found on the island since the type was collected in 1931 on a steep, grass-covered hillside on the east side of the island (Burt 1932, 1938). Because enormous efforts aimed at trapping *P. pembertoni* were unsuccessful, it is generally accepted that this species is now extinct and was likely outcompeted by *P. boylii glasselli* (Álvarez-Castañeda and Cortés-Calva 2003; Álvarez-Castañeda and Ortega-Rubio 2003).

FIGURE 2. San Pedro Nolasco Island, in view to the north-northwest, 14 January 2006. Photo by J. P. Gallo-Reynoso.

Marine mammals frequent the island's waters. There is a substantial sea lion colony, and many kinds of maritime birds have breeding colonies on the island. Despite the large number of seabirds found on the island, significant amounts of guano—which affect the composition of an island's flora, as seen on San Pedro Mártir Island (Wilder and Felger 2010) and other guano islands in the gulf—are not found on San Pedro Nolasco. However, many of the lower cliffs on San Pedro Nolasco, especially on the south end, are white with a thin veneer of bird guano. The largest populations (more than 1000 individuals) of birds on the island are those of the Brown Pelican (*Pelecanus occidentalis*), Magnificent Frigatebird (*Fregata magnificens*), Blue-footed Booby (*Sula nebouxii*), and Brown Booby (*S. leucogaster*) (Gallo-Reynoso, unpublished data).

San Pedro Nolasco is readily visible from the mainland, and the channel would offer no barrier to many birds. Two Military Macaws (*guacamaya verde*, *Ara militaris*) arrived on San Pedro Nolasco in 2000. Their migration to the island may be related to large-scale environmental alterations following the intense fires in the Sierra

FIGURE 3. Crest of island, in view to the south from ridge crest above Cañón de Mellink, summit at center, 29 September 2008. Photo by B. Wilder.

Madre Occidental in the early summer of 1998. Five macaws were seen in 2001, feeding on fig fruits (see *Ficus petiolaris* in the Species Accounts) and undoubtedly subsisted on various other plants. Two macaws were still on the island in 2006. Only one remained in 2008 and was still there in 2009. The macaws were often seen flying overhead, their loud calls unmistakable.

On 2 August 1978, the Mexican government declared all Gulf of California islands an Area de Protección de Flora y Fauna (Flora and Fauna Protection Zone). In 1995, San Pedro Nolasco and the other Gulf of California islands were made a biosphere reserve registered in the Man and Biosphere Program of UNESCO. In July 2005, these islands were declared a UNESCO natural heritage site (World Heritage Nomination 2005). The islands are managed by the Comisión Nacional de Áreas Naturales Protegidas (CONANP) of the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT) of the Mexican federal government. The Sonoran islands are managed by the Guaymas office directed by Ana Luisa Figueroa-Carranza. The office of the reserve, founded in 1995, addresses protection, management, restoration, knowledge, culture, and administration.

METHODS

We compiled the floristic list for San Pedro Nolasco Island from collections beginning with those of Ivan Murray Johnston in 1921 (Johnston 1924; see Collectors and Researchers below) and previous species lists for the island (Felger and Lowe 1976; Moran 1983; Rebman et al. 2002). We searched for specimens from the island at the herbaria of the University of Arizona (ARIZ), San Diego Natural History Museum (SD), and other regional collections including the California Academy of Sciences, San Francisco (CAS), and the University of California, Berkeley (UC). We also made use of pertinent information regarding San Pedro Nolasco specimens from databases at SD and elsewhere. Information has also been provided for selected species of special interest housed at other herbaria. We made multiple collecting trips, which were done under a Mexican federal collecting permit, depositing specimens at ARIZ and duplicates at the herbaria of the Centro de Investigaciones Biológicas del Noroeste in La Paz, Baja California Sur (HCIB), the Instituto de Biología, Universidad Autónoma de México, Mexico City (MEXU), SD, the Universidad de Sonora (USON), and others in Mexico and the United States.

Felger first recorded quantitative field data in January 1965 (Felger 1966) in five quadrats (not permanently marked). In early February 2008, Felger and Wilder recorded data in two ways: a quadrat and transects. We established a single 0.1-ha (50 m × 20 m) quadrat at middle elevation on the east side of the island in the vicinity of Felger's quadrat 16 at Cañón El Farito and marked it permanently with angle-iron stakes. We recorded the coordinates of the four corners by GPS (Table 1). The same methods used by Felger in his earlier work were repeated in 2008: within the quadrat all species were identified and recorded, and the number of individuals for each perennial species was tallied. We established six 50-m line-intersect transects at three different elevations on the east side of the island (3 at the site of our permanent quadrat at ca. 100 m, middle elevation, two at ca. 215 m near the top of the east slope, and one at near the base of the east slope, at ca. 70 m elevation). Each transect was permanently marked at each end with a metal stake, and GPS points were taken (Table 1). For all species encountered along the 50-m tape line, the distance a species covered was recorded and then summed to provide a sense of the vegetation coverage. The assessment of the coverage looks at the contribution of each species to total ground coverage, allowing coverage totals greater than 100%. Heights of species in the quadrat and transects were determined in one of three ways: the first was direct measurement in the field, though this was not done for all species. In those cases in which species were not directly measured, height was ascertained by notes of the species' height from individuals collected or by estimation from photographs of the transect and quadrat area, so that the average heights of all species is known.

TABLE 1. GPS points that mark the corners of the permanent vegetation quadrat and transects on San Pedro Nolasco Island. Datum for points is WGS 84.

	Latitude	Longitude	Elevation (m)
Quadrat[a]			
SE corner (Q1 SE)	27.97115	–111.37923	98
NE corner (Q1 NE)	27.97129	–111.37930	95
NW corner (Q1 NW)	27.97101	–111.37967	126
SW corner (Q1 SW)	27.97092	–111.37955	127
Transects			
Middle elevation[b]			
Line 1, from Q1 NW to Q1 NE, along line of 57º/237º			
W end	27.97101	–111.37967	126
E end	27.97129	–111.37930	95
Line 2, from Q1 SE to Q1 SW, along line of 57º/237º			
E end	27.97115	–111.37923	98
W end	27.97092	–111.37955	127
Line 3, middle of quadrat, from E to W, along line of 57º/237º			
E end	27.97120	–111.37925	94
W end	27.97101	–111.37964	118
High elevation, top of E-facing slope of Cañón El Farito			
Line 1, from T1N (transect 1 north) to T1S, along line of 155º/335º			
N end	27.96966	–111.38035	212
S end	27.96934	–111.38009	215
Line 2, from T2S to T2N, along line of 155º/335º			
S end	27.96935	–111.37994	213
N end	27.96969	–111.38021	217
Low elevation, E-facing slope near base of Cañón El Farito			
Line 1, from LT1W (low transect 1 west) to LT1E, along line of 40º/220º			
W end	27.97222	–111.37832	80
E end	27.97255	–111.37809	68

[a]At middle elevation in vicinity of Felger's 1965 quadrat 16.
[b]Corners same as those of the quadrat.

Floristic Discussion

The 58 species of vascular plants documented for the island are classified into 52 genera and 27 families, and only 5 genera have more than 1 species (Table 2). Four species are endemic to the island, three small cacti, *Echinocereus websterianus*, *Mammillaria multidigitata*, and *M. tayloriorum* (Figure 4A–C; see Wilder et al. 2008 for discussion of radiation of small cacti on gulf islands), and one composite, *Coreocarpus sanpedroensis*. San Pedro Nolasco and Ángel de la Guarda share the title for highest single-island plant endemism for a gulf island (Rebman 2002). The vegetation of the island is generally dense and shows sharp differences in vegetation structure and species distributions that correlate with different slope exposures and soil characteristics (see vegetation structure section below).

A strong relationship exists between the flora and vegetation of San Pedro Nolasco and Tiburón Island, the largest and most diverse island in the Gulf of California. Sixty-six percent (38 species) of the flora of San Pedro Nolasco is also found on Tiburón, 32 of which occur on the Sierra Kunkaak of Tiburón, among other locations on the island (see Wilder et al. 2007). The higher elevations on the east side of San Pedro Nolasco have dense populations of *Agave chrysoglossa* and *Acacia willardiana*, which are also abundant at the higher elevations of the Sierra Kunkaak. Neither of these species, in addition to *Aristida ternipes* var. *ternipes* and *Cyperus elegans,* occurs on gulf islands other than Nolasco and Tiburón, and *Notholaena lemmonii* also occurs on Tiburón, San Pedro Nolasco, and Cerralvo but not on other islands.

The 58 species on San Pedro Nolasco can be grouped into six

TABLE 2. The 58 plant species of San Pedro Nolasco Island, with growth forms and biogeographical affiliations.

Family and species	Growth form[a] [season[b]]	Biogeographical group[c]
Pteridaceae		
Notholaena lemmonii	HP	3d
Achatocarpaceae		
Phaulothamnus spinescens	S	3c
Amaranthaceae		
Amaranthus fimbriatus	A [HS]	3c
Apocynaceae		
Metastelma californicum	V	3d
Asparagaceae		
Agave chrysoglossa	XS	5
Asteraceae		
Bahiopsis triangularis	S	4
Bebbia juncea	S	3c
Coreocarpus sanpedroensis	A [NS]	1
Hofmeisteria crassifolia	XS	2
Perityle californica	A [CS]	3b
Pleurocoronis laphamioides	HP	3b
Porophyllum pausodynum	HP	2
Trixis californica	S	6
Burseraceae		
Bursera microphylla	S	3c
Cactaceae		
Cylindropuntia fulgida	XS	5
Echinocereus websterianus	XS	1
Mammillaria multidigitata	XS	1
Mammillaria tayloriorum	XS	1
Opuntia bravoana	XS	3c
Pachycereus pringlei	XS	3c
Stenocereus thurberi	XS	3c
Convolvulaceae		
Cuscuta corymbosa	A [HS]	6
Cucurbitaceae		
Vaseyanthus insularis	V [CS]	3b
Cyperaceae		
Cyperus elegans	A [NS]	6
Cyperus squarrosus	A [NS]	6
Euphorbiaceae		
Bernardia viridis	S	3d
Euphorbia lomelii	XS	3b
Euphorbia magdalenae	S	4
Jatropha cuneata	S	3c
Fabaceae		
Acacia willardiana	T	5
Fouquieriaceae		
Fouquieria diguetii	S	3b
Lamiaceae		
Salvia similis	S	3a
Loasaceae		
Eucnide rupestris	A [NS]	3d
Malpighiaceae		
Galphimia angustifolia	HP	3d
Malvaceae		
Gossypium davidsonii	S	3a
Molluginaceae		
Mollugo verticillata	A [HS]	6
Moraceae		
Ficus petiolaris	S	6
Nyctaginaceae		
Boerhavia triquetra	A [HS]	3d
Plantaginaceae		
Gambelia juncea	S	3b
Pseudorontium cyathiferum	A [NS]	3c
Poaceae		
Aristida adscensionis	A [NS]	6
Aristida divaricata	HP	6
Aristida ternipes	HP	6
Bothriochloa barbinodis	HP	3d
Bouteloua aristidoides	A [HS]	6
Cenchrus palmeri	A [NS]	3b
Chloris crinita	HP	6
Digitaria californica	HP	6
Eragrostis pectinacea	A [HS]	6
Heteropogon contortus	HP	6
Leptochloa panicea	A [HS]	6
Muhlenbergia microsperma	A [NS]	6
Setaria liebmannii	A [HS]	6
Setaria macrostachya	HP	3d
Rhamnaceae		
Colubrina viridis	S	3d
Simmondsiaceae		
Simmondsia chinensis	S	3c
Solanaceae		
Nicotiana obtusifolia	HP	6
Urticaceae		
Parietaria hespera	A [CS]	6

[a]A, annual (ephemeral); HP, herbaceous perennial; S, shrub; T, tree; V, vine; XS, xerophytic succulent.

[b]CS, cool season (winter–spring); HS, hot season (summer–fall); NS, nonseasonal.

[c]1, endemic to San Pedro Nolasco; 2, endemic to the Guaymas region; 3, distribution includes Sonora and the Baja California Peninsula; 3a, widespread on the Baja California Peninsula and only in the Guaymas region on the mainland; 3b, wide distribution in western Sonora and larger distribution on the Baja California Peninsula; 3c, across most of the Sonoran Desert and the Cape Region of Baja California Sur; 3d, Baja California Peninsula and portions of the large arid province of Megaméxico 1 (Rzedowski 1991) and elsewhere in the southwestern United States; 4, common on the Baja California Peninsula and gulf islands but not occurring in mainland Mexico; 5, primarily western Sonora and southern Arizona but not occurring on the Baja California Peninsula; 6, widespread in the Sonoran Desert and regions beyond, often New World or cosmopolitan or nearly so.

generalized biogeographical groups (Table 2): (1) Four species are endemic to the island. (2) Two species are endemic to the Guaymas region, *Hofmeisteria crassifolia* and *Porophyllum pausodynum*. Taken together, 10% of the flora is endemic to the Guaymas region and San Pedro Nolasco. (3) The largest biogeographical group, 28 species (48% of the flora), is composed of species with distributions including both sides of the Gulf of California in Sonora and the Baja California Peninsula. These species are relatively widespread on the peninsula and their populations on the Mexican mainland range from small to relatively large and widespread: (3a) *Salvia similis* and *Gossypium davidsonii* are widespread in Baja California Sur and Baja California to 26ºN but in Sonora have limited distributions only in the Guaymas region; (3b) *Euphorbia lomelii* (*Pedilanthus macrocarpus*) and *Fouquieria diguetii* are examples of species with relatively wide distributions in western Sonora and western Sinaloa and larger distributions on the Baja California Peninsula; (3c) many San Pedro Nolasco species occurring both on the mainland and on the Baja California Peninsula have distributions across much of the Sonoran Desert and into the Cape Region of Baja California Sur but not beyond, e.g., *Jatropha cuneata* and *Pachycereus pringlei*; (3d) several species,

in addition to being on the Baja California Peninsula, are similarly widespread in the Sonoran Desert but extend farther in Mexico and the southwestern United States and can be classified as occurring in Baja California and the large arid province of Megaméxico 1 of Rzedowski (1991), e.g., *Colubrina viridis*. (4) Other connections to the peninsula are *Euphorbia magdalenae* and *Bahiopsis triangularis*, which are common on the peninsula but are not known to occur in mainland Mexico. This mainland/peninsular biogeographical theme on San Pedro Nolasco, which is over 1° of latitude south of the Midriff Island chain, mirrors similar phytogeographic connections that are seen in the "stepping stone" Midriff Islands (Cody et al. 2002; Wilder et al. 2007). (5) Three species occur in mainland Mexico and not the Baja California Peninsula: *Agave chrysoglossa* in mountains in west-central Sonora, mostly in coastal ranges, *Cylindropuntia fulgida* from southern Arizona through much of Sonora, especially the western part of the state, to northwestern Sinaloa, and *Acacia willardiana* also in western Sonora and northwestern Sinaloa. (6) The final biogeographical group is composed of 19 species (33%) that are widespread in the Sonoran Desert and regions beyond, often being widespread in the New World or nearly cosmopolitan, e.g., *Aristida adscensionis*, *Heteropogon contortus*, and *Nicotiana obtusifolia*.

A captivating enigma of the flora is that despite San Pedro Nolasco's high degree of topographic heterogeneity and relatively close proximity to a rich source pool of species in the Sierra El Aguaje north of Guaymas (e.g., Felger 1999), only 58 species are known from the island, a number that we predict will increase only subtly (if at all) with further botanical exploration. Comparing San Pedro Nolasco to Dátil Island, an island roughly equal in size, elevation, and orientation that is just to the south of Tiburón and has 102 species (Moran and Rebman 2002; Felger and Wilder unpublished data), provides an insight into the factors that may be driving San Pedro Nolasco's relatively depauperate flora. Dátil, like San Pedro Nolasco, has high topographic diversity with many niches and is oriented north–south, yet the islands have very different geologic histories. Dátil is a land-bridge island that has been connected to the mainland off and on through the Pleistocene as part of the Tiburón complex (Carreño and Helenes 2002) and is thus directly linked to a large flora on a major landmass, while San Pedro Nolasco has been separated from the mainland for several million years.

It is not clear if isolation is the leading cause for San Pedro Nolasco's relatively low floristic diversity. Island biogeography theory holds that oceanic islands (those never connected to the mainland) are poorer in species than are land-bridge islands (islands connected to mainland during the Quaternary ice ages) because of diminished opportunities for immigration (e.g., Rosenzweig 1995). More distant islands are predicted to have fewer species than closer ones, again because of a decreased rate of immigration. While San Pedro Nolasco is not strictly an oceanic island, it is geologically isolated, although situated not far from the mainland (14.6 km). A number of species with relatively large seeds, not readily dispersed by wind or birds, occur on the island, e.g., *Acacia willardiana*, *Bernardia viridis*, *Colubrina viridis*, *Euphorbia lomelii*, *Jatropha cuneata*, and *Simmondsia chinensis*. In addition, both *B. viridis* and *S. chinensis* are dioecious (male and female flowers borne on different plants), so colonization requires establishment of at least two individuals flowering at the same time. (The endemic *Mammillaria multidigitata* is dioecious or possibly gamodioecious.) Theoretically it should be more difficult for dioecious species to become established on a geologically isolated or oceanic island. The floras of the Galápagos (McMullen 1987) and the Canaries (Francisco-Ortega et al. 2000) support this concept by having very low levels of dioecy, but the Hawaiian flora sustains extremely high levels of dioecy (Bawa 1980, 1982; Sakai et al. 1995). Whittaker and Fernández-Palacios (2007) concluded that patterns of dioecy in island floras remain poorly understood, yet the fact that several large-seeded plants, two of them dioecious, occur on San Pedro Nolasco is intriguing. Wilder and Felger (2010) did not consider isolation the principal factor for the even more depauperate flora of the most isolated gulf island, San Pedro Mártir—instead, soil characteristics (guano), low topographic diversity, and aridity seem to be more significant.

A number of taxa are conspicuously absent from San Pedro Nolasco, such as the family Acanthaceae, which is represented by at least 16 species in the Guaymas region (Felger unpublished data) and 9 species on Tiburón (Rebman et al. 2002; Wilder et al. 2007). This absence is especially surprising given the presence of sheltered habitats on San Pedro Nolasco and the otherwise strong floristic affinity with Tiburón as shown above. There are no prostrate species of *Euphorbia* (*Chamaesyce*), although all the Sonoran Midriff Islands except Patos have at least one. Besides *Acacia willardiana*, there are no legumes (Fabaceae) on San Pedro Nolasco, while they are abundant and diverse on the opposite mainland (Felger 1966, 1999; Ray Turner, personal observation, see Collectors and Researchers below).

The chances for colonization of San Pedro Nolasco by mainland species have been limited by intervening water for several million years, which has promoted single-island endemism for three species of cacti and one composite, one mammal, and four reptiles. The opportunity for plants to reach and gain a presence on the island via rafting has likely been limited by the steep sea cliffs that surround the island and by the absence of colonizable beaches. The island episodically experiences severe droughts that may act as a barrier to establishment by species that are not highly adapted to aridity, as is much of the source pool of species on the mainland (e.g., Felger 1999). The rich vegetation and unique sheltered habitats on San Pedro Nolasco would logically support a larger flora, yet this is not the case. San Pedro Nolasco presents a fascinating system in which the various factors that affect the diversity of islands can be investigated. At present we conclude that the island's isolation, steep perimeter, and periods of extreme drought are major factors controlling the number of species , resulting in a flora relatively depauperate in comparison to the floristically rich adjacent mainland.

Another unique aspect of the flora is the large number of grass species, all of which are native. The flora of San Pedro Nolasco has the highest percentage of the family Poaceae of any island in the Gulf of California (24% vs. an average of 8% ± 2.4% for the islands listed by Rebman et al. 2002). Dense fields of grasses principally *Setaria macrostachya*, are seen on the eastern side of San Pedro Nolasco on north-facing slopes, on sites where the soil is deep and rich with humus (Figure 5). In January 2008, we found charred nubs of grasses and wood on a north-facing slope. The continued presence of cacti and the absence of substantially burned shrubs suggest it was a low-intensity fire that spread across only a portion of the island. The biomass and density of grasses on these north-facing slopes is certainly enough to carry a fire (see discussion below for vegetation structure on these slopes), especially during dry seasons. Whether the source of this fire is natural or anthropogenic is unknown, yet it is possible that low-intensity fires have been a part of the island's history. This is the only known evidence for a wildland fire on a gulf island, and one of the few examples of a fire having been carried by a native perennial grass in a Sonoran Desert habitat [*Hilaria rigida* (Thurber) Bentham ex Scribner has burned in the Pinacate Region of northwestern Sonora, where it grows in dense stands; Turner 2007]. In the Sonoran Desert, fire has been historically rare and limited to dry seasons following above-average winter rainfall that produces an abnormal buildup of winter annuals (Felger et al. 2007; Humphrey 1974; McLaughlin and Bowers 1982; Turner et al. 2003). This situation is changing as invasive Old World annual and perennial grasses expand their ranges and increase fuel loads (e.g., Felger et al. 2007). More information is needed about the role of fire on the island, but it might be worthwhile to consider fire ecology in any attempt to understand the ecological dynamics of San Pedro Nolasco.


A


B

FIGURE 4. Cacti endemic to San Pedro Nolasco Island. (A)*Echinocereus websterianus*, vicinity of Cañón El Farito, May 1952. Photo by George Lindsay, courtesy San Diego Natural History Museum. (B) *Mammillaria multidigitata* and *Echinocereus websterianus*, Cañón El Farito, mid-elevation on a south-facing slope, 3 February 2008. We have termed these dense communities of cacti "Mammapolis." Photo by B. Wilder. (C) *Mammillaria tayloriorum*, ridge crest above Cañón El Farito, 3 February 2008. Photo by B. Wilder.

Non-native plant species continue to be absent on San Pedro Nolasco, which is somewhat surprising in view of the numerous times people have visited and camped on the island. This system seems ideal to support the establishment and expansion of non-native grass species such as buffelgrass (*Cenchrus ciliaris* Linnaeus) and natal grass [*Melinis repens* (Willdenow) Zizka] that could drastically increase the intensity of fires on the island, rapidly transforming the island's ecosystem. Both of these grasses are abundant on the opposite mainland of Sonora. *Melinis repens* has even been found in substantial quantities in nearly pristine, never-grazed areas opposite San Pedro Nolasco (e.g., Cañón las Barajitas, vicinity 28° 03′ 03.6″ N, 111° 11′ 01.7″ W, 100% cover on many sand bars in the canyon bottom, 18 Feb 1995, *Felger 95-188* et al., ARIZ). In addition, the island's perennial and ephemeral water sources should be monitored for potential arrival of wetland or quasi-wetland invasives such as *Tamarix chinensis* Loureiro. A few tamarisk plants could devastate the tiny spring at Agua Amarga with its isolated *Cyperus* population. Early detection and removal of any invasives will be critical, although potentially difficult.

Vegetation Structure

The vegetation comprises desert scrub that is sharply delimited into unique communities, segregated according to slope exposure (Felger 1966; Felger and Lowe 1976). Corresponding with abrupt topographic changes, the general pattern of the vegetation is like a mosaic. Contrasts in the vegetation on different exposure gradients are among the most striking encountered anywhere along the gulf coast of Sonora. At higher elevations on both sides of the island, there is a general trend toward less xerophytic vegetation and a substantial increase in number of species. A number of species occur only at higher elevations on the east and west sides of the island.

We recognize six major growth forms on the island (Table 2): annual (ephemeral) species (18), shrubs (15), herbaceous perennials (12), xerophytic succulents (10), vines (2), and a single tree, *Acacia willardiana* (*Pachycereus pringlei*, a xerophytic succulent, attains tree size and *Ficus petiolaris* and *Fouquieria diguetii* are large shrubs that approach tree sizes). The 18 species of ephemerals represent 31% of the flora (*Vaseyanthus insularis*, both a vine and an ephemeral, is counted as a vine). The annual flora is split between hot-season (summer–fall; 8) and nonseasonal (9) species, and there are only two strictly cool-season (winter–spring) ephemerals, *Perityle californica* and *Parietaria hespera*.

The majority of species on the island have small, simple leaves, and some are aphyllous. There are only two species with compound leaves: *Bursera microphylla* and *Acacia willardiana*. Most of the leaf-bearing species are drought deciduous. *Agave chrysoglossa*, the only truly evergreen-leafed species present, has thick, succulent leaves. Several species may be evergreen during years of high rainfall but are eventually drought deciduous in extended dry periods, e.g., *Ficus petiolaris*, *Hofmeisteria crassifolia*, and *Simmondsia chinensis*.

The following discussion of the vegetation is based largely on the earlier work of Felger (1966) and our combined field work since 2000. Vegetation coverage as assessed in Felger's earlier work was only of all species amalgamated, whereas our assessment in 2008 quantified each species' contribution to ground coverage, allowing coverage totals greater than 100%.

East side of the island; north-facing slopes: The north and northeast-facing slopes on the east-central side of the island sea-

FIGURE 5. Northeast-facing slope along Cañón El Farito, 115 m, supporting dense stand of grasses, principally *Setaria macrostachya*, 3 February 2008. Photo by B. Wilder.

sonally are covered with dense fields of grasses and forbs. In fact, even during drought seasons there may remain a dense cover of dry, mostly dead, vegetation. One of the most evident features of these north slopes is the unbroken and continuous cover of topsoil, often even on steep slopes (up to 45º). This soil can be relatively deep, rich in humus, and loose. Comparable communities do not exist elsewhere in the Gulf of California region (Felger and Lowe 1976). It is evident that the dense herbaceous fields not only build up the soil but also prevent its erosion, and the north slopes are noticeably less steep than adjacent south-facing slopes (Felger and Lowe 1976). Yet, the substratum is so loose and steep that many major perennials, including larger cacti if present, would probably topple over long before reaching maturity. In 1965, the total coverage of herbaceous species at various quadrat sites was approximately 90 to 100%, while nonherbaceous perennials accounted for less than 5% coverage. In 2008, the coverage of herbaceous species was nearly the same, 85%, but nonherbaceous perennials had increased locally, covering ca. 24% (Table 3, Figure 6). In 1965, nine of the 16 species present were herbaceous, and in 2008, ten of the 18 present were herbaceous. In 1965, all nonherbaceous perennials were weakly established as stragglers from adjacent slopes, e.g., *Euphorbia lomelii*, *Simmondsia chinensis*, and *Bahiopsis triangularis*. The same situation was found in 2008, except that *Bahiopsis triangularis* was a locally established and common shrub, having a coverage of 17% including living and dead individuals. It is evident that the greatest biomass productivity (per unit area per unit time) on the island occurs on these north slopes, mostly seasonal and attributed to only several species, e.g., *Coreocarpus sanpedroensis*, *Muhlenbergia microsperma*, *Setaria macrostachya*, and *Vaseyanthus insularis*.

East side of the island; south-facing slopes: At lower elevations on the east side, at about 75 m, some south-facing slopes have gradual relief, ca. 15º slope, and support large stands of *Mammillaria multidigitata* and dense populations of shrubs (*Bahiopsis triangularis* and *Jatropha cuneata*). A transect in this area in 2008 bisected 11 species with 4 more within 5 m of the line, and their combined coverage was 112%; *M. multidigitata* constituted 6% and *Jatropha cuneata* 55%. Ephemeral species accounted only for 12% coverage (Figure 7).

The south-facing slopes above about 200 m are rugged, greatly eroded, and with much exposed bedrock. Although little soil has built up, the rock surface is sufficiently weathered to allow ample root penetration. In fact, this fractured rock seems ideal for many succulents and other xerophytic species (Figure 4B). South-slope vegetation consists largely of columnar cacti (*Pachycereus pringlei* and *Stenocereus thurberi*), a sparse understory of desert shrubs (e.g., *Bahiopsis triangularis* and *Jatropha cuneata*), and extensive and dense populations of smaller cacti (*Echinocereus websterianus* and *Mammillaria multidigitata*). Ephemerals tend to be represented by relatively few species, such as *Boerhavia*, *Coreocarpus*, and *Vaseyanthus*, all of which reach greater development (density and size) on other slopes and generally are mere stragglers here.

TABLE 3. Tenth- (0.1) ha quadrats on the east-central side of San Pedro Nolasco Island. The 1965 quadrat is plot 16, table 16 in Felger (1966), 18 January 1965, ca. 100 m elevation, north exposure, slope 45%, soil loose, rocky, relatively deep, with much humus. Coverage ca. 95% including grasses and forbs, ca. 5% excluding grasses and forbs. The 2008 quadrat, 2 February 2008, ca. 110 m elevation, northeast exposure, east–west boundaries along line of 237º and the north–south boundaries along a line of 325º, slope 30º, soil rich deep humus; coverage ca. 90% (annuals and perennials). The two quadrats are approximate the same locality and habitat. NR, not recorded; NA, not applicable; numbers in brackets, dead individuals.

	1965			2008		
Species	Number	Max ht. (m)	Mean ht. (m)	Number	Max ht. (m)	Mean ht. (m)
Bahiopsis triangularis	9	1.8	1.5	99 [17]	2.60	1.87
Cylindropuntia fulgida var. *fulgida*	NR	—	—	18 [1]	0.68	?
Echinocereus websterianus	NR	—	—	2	0.36	?
Euphorbia lomelii	6	1.04	0.73	NR	—	—
Fouquieria diguetii	NR	—	—	1	1.97	NA
Hofmeisteria crassifolia	NR	—	—	1	?	NA
Jatropha cuneata	1	0.55	NA	3	0.46	?
Mammillaria multidigitata	7	0.09	NA	42	0.24	0.15
Opuntia bravoana	2	1.16	0.82	15 [3]	1.66	1.19
Pachycereus pringlei	1	0.49	NA	NR	—	—
Simmondsia chinensis	9	1.65	1.55	1	1.43	NA
Total	35			203		
Present but not counted						
	Coreocarpus sanpedroensis			*Coreocarpus sanpedroensis*		
	Muhlenbergia microsperma			*Muhlenbergia microsperma*		
	Perityle californica			*Perityle californica*		
	Setaria macrostachya			*Setaria macrostachya*		
	Vaseyanthus insularis			*Vaseyanthus insularis*		
	Amaranthus fimbriatus			*Boerhavia triquetra*		
	Pseudorontium cyathiferum			*Cenchrus palmeri*		
	Cuscuta corymbosa			*Leptochloa panicea*		
	Parietaria hespera			*Setaria liebmannii*		
Total species in quadrat	16			18		

East side of the island; east-facing slopes: The richest and most diverse vegetation on the island occurs on east-facing slopes. The east slopes consist primarily of broad ridges that separate north- and south-facing canyon slopes; the slopes are seldom as steep as other slope exposures. Erosion is evident, and where the soil is not held in place by rocks and roots, it is quickly carried away, leaving barren rock. Erosion frequently undermines the larger columnar cacti as well as other plants, and such uprooted plants are rather common. East slopes are characterized by a rich growth of stem and leaf succulents, desert shrubs, and herbs. *Agave chrysoglossa* and *Opuntia bravoana* are concentrated on these east slopes.

In 1965, two quadrats were completed on eastern slopes, one 0.1-ha quadrat at ca. 140 m elevation where 20 species were present, and one 500-m^2 quadrat at ca. 270 m elevation where 24 species were present (Table 4). In 2008, two 50-m line-intercept transects were established in the area of the higher-elevation quadrat; one of these transects intercepted 17 species with another 6 within 5 m of the line. Total combined coverage of all species present averaged 161%, the highest seen on the island. Four main strata or layers were evident: (1) an herbaceous cover including *Boerhavia triquetra* and *Setaria macrostachya* (3 species; 57% coverage), (2) xerophytic succulent species, e.g., *Agave chrysoglossa* and *Mammillaria multidigitata* (7 species; 16% coverage), (3) shrub cover, e.g., *Bursera microphylla* and *Fouquieria diguetii* (6 species; 74% coverage), and (4) the cover of the one tree, *Acacia willardiana* (14% coverage; Figure 8). In 1965, major perennials together with the herbaceous species produced more

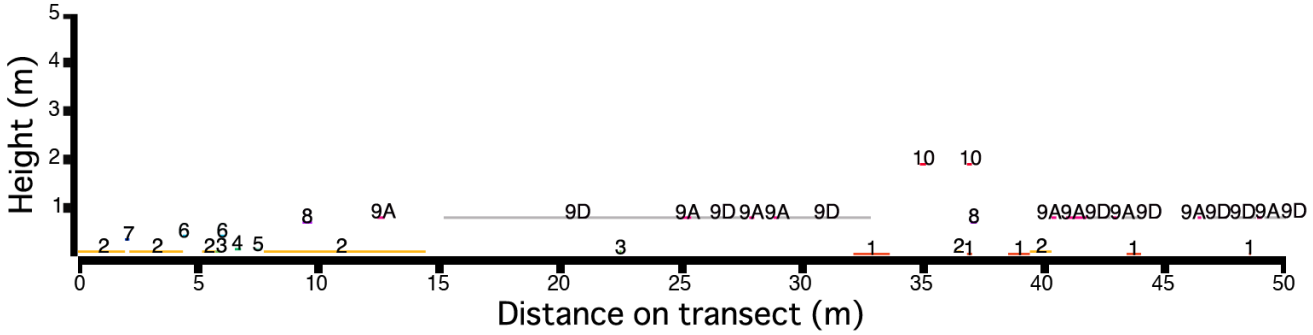

FIGURE 6. Vegetation structure of transect line 2 on a north-facing slope at middle elevation in Cañón El Farito, 3 February 2008. Transect runs west (98 m elevation) to east (127 m), on the line of 57º/237º (compass bearings at each end of transect), on a steep 30º slope, with rich deep humus soil. The symbol # signifies that the height was determined by direct measurement in the field at this site. (1) *Vaseyanthus insularis*. (2) Dead annual grasses: *Aristida adscensionis* and *Muhlenbergia microsperma*. (3) *Perityle californica*. (4) #*Mammillaria multidigitata*. (5) *Bouteloua aristidoides*. (6) *Coreocarpus sanpedroensis*. (7) #*Echinocereus websterianus*. (8) #*Cylindropuntia fulgida* var. *fulgida*. (9A) Live and (9D) dead *Setaria macrostachya*. (10) #*Bahiopsis triangularis*.

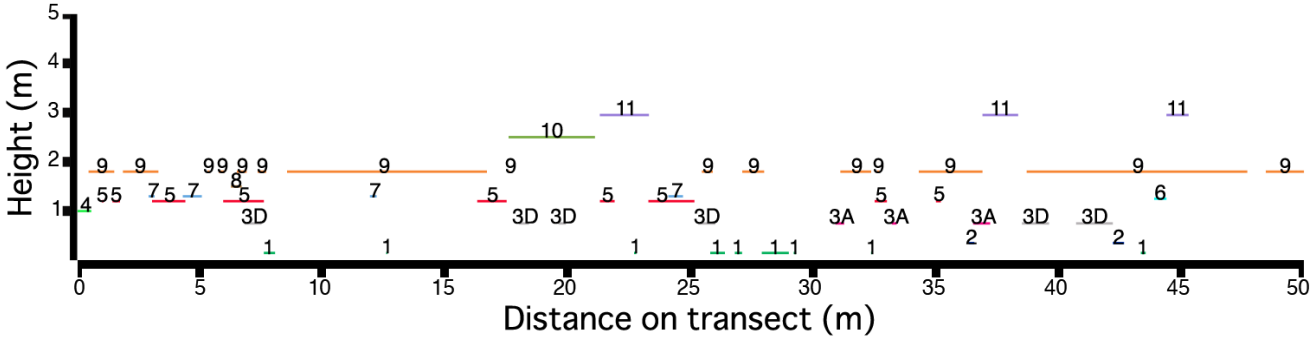

FIGURE 7. Vegetation structure of transect line 1 on a south-facing slope at low elevation near base of Cañón El Farito, 3 February 2008. Transect runs west (80 m elevation) to east (68 m) on the line of 40º/220º, on a moderate 13º slope, with shallow soil. The symbol # signifies that the height was determined through direct measurement in the field at this site. (1) *Mammillaria multidigitata*. (2) *Echinocereus websterianus*. (3A) Live and (3D) dead *Setaria macrostachya*. (4) *Agave chrysoglossa*. (5) #*Bahiopsis triangularis*. (6) *Cylindropuntia fulgida* var. *mamillata*. (7) *Opuntia bravoana*. (8) *Bursera microphylla*. (9) #*Jatropha cuneata*. (10) #*Simmondsia chinensis*. (11) #*Stenocereus thurberi*.

than 50% cover, and much of the open area was exposed bedrock. The sum of each species' coverage as sampled in 2008 was greatly above 50%, but general ground coverage still was ca. 80%, and the open area was likewise exposed bedrock.

Five species present in 1965 at the 270-m site were not found there in 2008: *Amaranthus fimbriatus*, *Coreocarpus sanpedroensis*, *Euphorbia lomelii*, *Pachycereus pringlei*, and *Vaseyanthus insularis*. In addition, four species present in 2008 were not seen in 1965: *Aristida ternipes*, *Leptochloa panicea*, *Mammillaria tayloriorum*, and *Salvia similis*. The *P. pringlei* seen in 1965 was a single young individual that likely perished, and *M. tayloriorum* is locally rare, with one individual in the transect in 2008. However, that no *E. lomelii* was seen in the area in 2008 when there was a robust population in 1965 is surprising. Overall, the vegetation at the higher elevations of the east side of the island seems not to have changed much in four decades.

A number of species occur as isolates at high elevations on the east and west sides of the island because of more favorable conditions, such as the shelter provided against the strong year-round afternoon sun on the east side of the ridge and increased soil moisture, perhaps in part from condensed fog. Some of these species extend onto the ridge crest. The crest that runs the length of the island reaches ca. 315 m at the peak just south of the center of the island (Figure 3). Vegetation along the crest of the island (Table 5) closely resembles that of the east-facing slopes at higher elevations (e.g., Table 4). Rich communities of shrubs (e.g., *Bernardia viridis*, *Bursera microphylla*, and *Colubrina viridis*) are strewn along the ridge. Species characteristic of these places include

Aristida divaricata
Bernardia viridis

TABLE 4. Results from 500-m² quadrat on the upper east-central side of San Pedro Nolasco Island, 18 January 1965, ca. 270 m elevation, ca. 25 m below crest, east exposure, slope 57%, with shallow rocky soil; coverage ca. 35% (plot 18, table 18 in Felger 1966). For comparison with 2008 information, see Figure 8 and text for discussion.

Species	Number	Max ht. (m)	Mean ht. (m)
Acacia willardiana	2	5.12	NA
Agave chrysoglossa	2	0.82	NA
Bahiopsis triangularis	62	1.89	NA
Bernardia viridis	0	1.55	NA
Bursera microphylla	9	1.21	NA
Colubrina viridis	2	3.14	1.46
Cylindropuntia fulgida var. *fulgida*	4	0.88	NA
Echinocereus websterianus	22	NA	NA
Euphorbia lomelii	66	0.82	0.79
Fouquieria diguetii	13	3.72	3.66
Jatropha cuneata	1	0.94	NA
Mammillaria multidigitata	85	NA	NA
Opuntia bravoana (dead)	1	0.67	NA
Pachycereus pringlei	1	4.54	NA
Simmondsia chinensis	15	1.62	NA
Stenocereus thurberi	5	3.26	2.19
Trixis californica	13	0.73	NA
Total	303		
Present but not counted			
Amaranthus fimbriatus			
Aristida adscensionis			
Coreocarpus sanpedroensis			
Muhlenbergia microsperma			
Perityle californica			
Setaria macrostachya			
Vaseyanthus insularis			
Total species in quadrat	23		
Total species in stand	24		

TABLE 5. Results from 500-m² quadrat on the west-central side of San Pedro Nolasco Island, 18 January 1965, ca. 270 m elevation, ca. 25 m below crest, southwest exposure, slope 58%, with shallow rocky soil; coverage ca. 20% (plot 19, table 19 in Felger 1966).

Species	Number	Max ht. (m)	Mean ht. (m)
Bahiopsis triangularis	2	1.10	1.04
Bursera microphylla	8	1.31	1.07
Colubrina viridis	2	1.98	1.65
Cylindropuntia fulgida var. *fulgida*	10	1.34	1.22
Echinocereus websterianus	27	NA	NA
Euphorbia lomelii	30	1.00	0.91
Fouquieria diguetii	5	3.05	NA
Jatropha cuneata	12	1.16	1.01
Mammillaria multidigitata	433	0.15	NA
Pachycereus pringlei	5	4.51	3.87
Simmondsia chinensis	25	1.46	1.31
Stenocereus thurberi	17	3.29	3.05
Trixis californica	1	0.61	NA
Total	577		
Present but not counted			
Aristida ternipes			
Coreocarpus sanpedroensis			
unidentified grass (3 spp.)			
Vaseyanthus insularis			
Total species in quadrat	18		
Total species in stand	19		

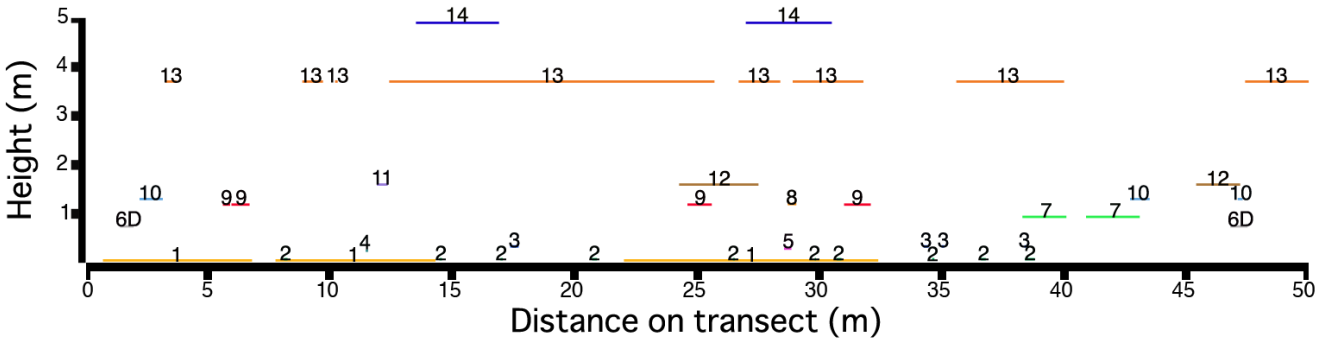

FIGURE 8. Vegetation structure of transect line 2 at high elevation in Cañón El Farito, 3 February 2008. Transect runs south (from 213 m elevation) to north (at 217 m), on the line of 155º/335º, nearly level elevation perpendicular to a steep, east-facing slope, with substantial but highly eroded soil. The symbol # signifies that the height was determined by direct measurement in the field at this site. (1) Dead annual grasses: *Aristida adscensionis* and *Muhlenbergia microsperma*. (2) *Mammillaria multidigitata*. (3) #*Echinocereus websterianus*. (4) *Leptochloa panicea*. (5) #*Mammillaria tayloriorum*. (6D) Dead *Setaria macrostachya*. (7) *Agave chrysoglossa*. (8) *Bernardia viridis*. (9) #*Bahiopsis triangularis*. (10) *Opuntia bravoana* (11) #*Stenocereus thurberi*. (12) *Bursera microphylla*. (13) #*Fouquieria diguetii*. (14) #*Acacia willardiana*.

Bothriochloa barbinodis
Euphorbia magdalenae
Galphimia angustifolia
Gambelia juncea
Heteropogon contortus
Metastelma californicum
Notholaena lemmonii
Porophyllum pausodynum
Salvia similis.

Robust populations of two lichens are found draping the exposed cliffs on the east side of the ridge crest, adding an additional layer

FIGURE 9. West side of island, Cañón de Mellink. *Fouquieria diguetii* in center foreground, *Pachycereus pringlei* and *Stenocereus thurberi* prominent on steep west-facing slope, 29 September 2008. Photo by R. Felger.

of uniqueness to the upper elevations of the island: *Ramalina* cf. *leptocarpha* Tuckerman (11 Nov 2009, *Wilder 09-131*) and *Rocella decipiens* Darbishire (11 Nov 2009, *Wilder 09-130.5*, both deposited at UCR and identified by Kerry Knudsen).

West side of the island: The vegetation on much of the west side of the island closely resembles that of the south-facing slopes of the east side of the island (Figure 9). The west side is generally more rugged and eroded than the east side and appears to be without unique species. The vegetation is generally not as dense, except in canyons just below the upper ridge of the island. In 1965 a quadrat was located on a small, steeply sloping "bench" near the top and west side of the island (Table 6). The most conspicuous elements were columnar cacti (*Pachycereus pringlei* and *Stenocereus thurberi*), desert shrubs (e.g., *Bahiopsis triangularis* and *Jatropha cuneata*), and small cacti (*Echinocereus websterianus* and *Mammillaria multidigitata*).

However, the larger canyons on the west-central to northwest side of the island rather closely resemble their counterparts on the east side. Cañón de las Guacamayas and the adjacent Cañón de Mellink support a diverse flora that becomes richer towards the ridge crests. Notable dense patches of *Acacia willardiana* and *Opuntia bravoana* were seen above middle elevation in Cañón Mellink. Prominent species in these canyons include

Acacia willardiana
Agave chrysoglossa
Aristida ternipes
Bahiopsis triangularis
Bursera microphylla
Cenchrus palmeri
Coreocarpus sanpedroensis
Cylindropuntia fulgida
Digitaria californica
Echinocereus websterianus
Euphorbia lomelii
Fouquieria diguetii
Hofmeisteria crassifolia
Jatropha cuneata
Mammillaria multidigitata
M. tayloriorum
Pachycereus pringlei
Simmondsia chinensis
Stenocereus thurberi
Vaseyanthus insularis.

Summary of vegetation studies: The vegetation on San Pedro Nolasco is varied and sharply segregated according to slope exposure, each exposure supporting regionally unique communities of desert scrub. The island often experiences intense drought, and accordingly most species have simple leaves and/or are drought deciduous. The east side of the island supports three distinct communities: (1) The grassy meadows of north-facing slopes on the east side are probably the most productive community and show evidence of being stable and long established. The deep soil, rich in humus, is consistently built up by the death and decay of the dense grasses, which in turn promote the recruitment of diverse grasses and slower erosion rates. The data taken in 2008 show an increase in shrub coverage on north-facing slopes. It is possible that occasional low-intensity fires reduce the presence of shrubs, maintaining the dense grass stands, the situation across the grasslands of the Southwest prior to the control of fire (Turner et al. 2003). (2) South-facing slopes support dense populations of cacti and shrubs but with considerably reduced vegetation cover, and ephemerals play a minor role. (3) East-facing slopes have the most diverse communities on the island, and vegetation here often has four distinct strata: herbaceous cover, xerophytic succulent species, shrubs, and one tree species. Erosion seems to be a significant force on these slopes, and within a specified area changes in species composition may thus be seen over decades while the general vegetation structure is maintained. The west side of the island is greatly dissected by steep canyons. Steep slopes support communities of cacti and shrubs, and except in large canyons, vegetation cover and species richness are reduced in comparison to those on south-facing slopes on the east side of the island.

TABLE 6. Results from 0.1-ha quadrat on the ridge crest of San Pedro Nolasco Island, 18 January 1965, ca. 300 m elevation, on nearly level terrain, with rocky soil; coverage ca. 50% (plot 20, table 20 in Felger 1966).

Species	Number	Max ht. (m)	Mean ht. (m)
Acacia willardiana	0	5.18	NA
Bahiopsis triangularis	76	1.71	1.55
Coreocarpus sanpedronensis	8	NA	NA
Cylindropuntia fulgida var. *fulgida*	124	1.28	1.25
Echinocereus websterianus	24	NA	NA
Euphorbia lomelii	96	0.88	0.76
Fouquieria diguetii	24	3.08	NA
Jatropha cuneata	4	2.47	NA
Mammillaria multidigitata	724	NA	NA
Pachycereus pringlei	8	3.44	NA
Simmondsia chinensis	24	1.31	1.28
Stenocereus thurberi	4	2.80	NA
Trixis californica	20	0.88	0.70
Total	1140		
Present but not counted			
Aristida adscensionis			
Aristida ternipes			
Bouteloua aristidoides			
unidentified grass			
Total species in quadrat	17		
Total species in stand	18		

COLLECTORS AND RESEARCHERS

Many botanists and scientists visited this unique island through the 20th century, some of whom specialized in cacti and were drawn by the reports of an island covered in cacti large and small, some of which occur nowhere else. The flora of the island has been documented at nearly regular intervals of collecting at least once every decade since 1921, except no collections are known between 1979 and 2000. Here we list noted observers and people who collected plants on the island, providing brief biographical information and summarizing their trips.

Fred Cooper

11 August 1964. He collected 10 numbers above the cobble-beach cove (Cala Güina) at the southeast side of the island. These specimens were collected for Felger and processed and catalogued as *Felger 10399* to *10408*. Cooper was a student at the University of Arizona and friend of Ike and Jean Russell (see Bowen 2002).

Elmer Yale Dawson (1918–1966)

6 February 1940. Yale collected six numbers on the island (Gentry 1949:99). He collected specimens and information for his dissertation as a member of Captain Allan Hancock's expedition on the *Velero III* to the Gulf of California; it was published as *The Marine Algae of the Gulf of California* (Dawson 1944).

Richard Felger

The information is paraphrased from Felger's field notes, deposited at the University of Arizona herbarium.

26 November 1963, with Alexander "Ike" Russell and Alice Thomas; *Felger 9633* to *9675*. I climbed the cliffs above the cove (Cala Güina) at the southeast end of the island, traversed the crest of the island, and descended the canyon later known as Cañón El Farito. I collected 42 numbers that day.

12 November 1964. Northeast side, above the landfall (Cañón El Farito), with Oda Kleine and Alexander Russell; *Felger 11431* to *11453*. Early in the morning we went to San Pedro Nolasco. Oda and I explored the area, collecting specimens, while Ike kept the boat nearby offshore. We left for the mainland in the late afternoon.

18 January 1965. Northeast side, above the landfall (Cañón El Farito) with Alexander Russell and Robin Thomas; *Felger 12066* to *12089E*. We went to the island early in the day, and Robin and I spent a long day recording data from quadrats we set up between the shore and summit on the east side of the island and one on the west side. (These quadrat studies are included in my dissertation and re-evaluated here.) The vegetation was luxuriant and green from recent rains.

11 February 2000. Cañón El Farito to the ridge crest, with Horacio Cabrera-Santiago, Juan Pablo Gallo-Reynoso, Gabriela Suarez-Gracida, and Jeffrey A. Seminoff; *Felger 2000-1* to *2000-4*. We arrived at the island at 9 a.m. and went first to the southeast cove (Cala Güina), but we did not find vascular plants at the small cobble "beach" and, seeing the cliffs and difficult ascent, went instead to the northeast landfall at Cañón El Farito. We collected and explored the region to the ridge crest. Drought conditions prevailed.

28 November 2006. Cañón El Farito to the ridge crest, with Alberto Búrquez, Florentino Cota-Moreno, and Jesús Ventura-Trejo; *Felger 06-73* to *06-111*. The island was green from recent rains. We saw many honeybees visiting flowers of *Bahiopsis* and other species, and Costa's Hummingbirds (*Calypte costae*) visiting *Salvia similis*. The dense growth of *Vaseyanthus* made for slippery climbing over rocks.

2 and 3 February 2008. With Florentino Cota-Moreno, Jesús Ventura-Trejo, and Benjamin Wilder. Both days we left from Bahía San Carlos about 7:30 A.M. and spent much of the day in the vicinity of Cañón El Farito. We set up permanent sites for monitoring and obtained quantitative vegetation data and a collection of voucher specimens. The vegetation was rather dry but not extremely so. (See Wilder's description for collection numbers.)

29 September 2008. With Juan Pablo Gallo-Reynoso and Benjamin Wilder. We hired José Luis Ramirez-Zuñiga, from La Manga (northwest of San Carlos), to take us to the island. Travel time from La Manga to the southern tip of San Pedro Nolasco was about 35 minutes. Sr. Ramirez told us that about eight days earlier there was a *resaca* (described as a big tide) drifting onto and west of San Pedro Nolasco, bringing "trash" from tropical storm Lowell, which had made landfall at the Sonora–Sinaloa border. He described the *resaca* containing flotsam that included even part of a house, chairs, tables, plastic, and tree branches. Much of the "trash," including tree branches containing a large green iguana (probably *Iguana iguana*) and another branch with a large black snake, drifted on past San Pedro Nolasco. Further verification of such events could be significant for biological colonization of this and other gulf islands.

We proceeded northward along the west side of the island, photographing and recording plants seen from the boat, arriving at Cañón de Mellink at 10 A.M. Ben, Juan Pablo, and I went ashore and climbed to 115 m in the canyon, then Ben went on to the upper ridge while Juan Pablo and I went to the next small canyon to the north and explored steep slopes high above the sea. The island was verdant due to recent rains, and the day was hot (36–39 ºC) and humid with a high, scattered cloud cover. We encountered adult as well as some hatchling iguanas (*Ctenosaura nolascensis*) and sideblotched, spiny, and whiptail lizards. Adult iguanas were active, numerous, and easily approached (see *Acacia willardiana*). We also saw numerous desiccated carcasses of adult iguanas along the canyon bottom. We did not see honeybees on this day. We left Cañón de Mellink at 4 P.M. This trip provided the first plant collections from the west side of the island. Collections from the base and middle elevation of the canyon are catalogued as *Felger 08-135* to *08-148*. See Wilder, 29 September 2008, for the rest of the collections from this trip.

Juan Pablo Gallo-Reynoso

Gallo-Reynoso is an ecologist specializing in the avifauna and mammals of northwestern Mexico, especially aquatic mammals and seabirds. He has conducted extensive studies on San Pedro Nolasco Island involving more than 30 field trips to the island since 1995. He has collaborated with many researchers and arranged four expeditions during 2002 and 2003 to search for the elusive *Peromyscus pembertoni*, all of which failed to find a single specimen (Eric Mellink and Gallo-Reynoso, unpublished data). Fieldwork on the island on 11 February 2000 was with Felger and on 29 September 2008 with Felger and Wilder.

Howard Scott Gentry (1903–1993)

Recognized as the leading authority on the agaves, Gentry worked for the United States Department of Agriculture. His publication on Gulf of California plants (Gentry 1949) is one of the cornerstones of botanical research in the region. He visited San Pedro Nolasco on 16 December 1951 and collected eight numbers (*Gentry 11351* to *11358*), as evidenced by his collection notebook at ARIZ. He collected on the east side of the island in the vicinity of Cañón El Farito, as shown by a photo on his herbarium specimen of *Agave chrysoglossa*. His extensive herbarium collections are at ARIZ, the Desert Botanical Garden, Phoenix (DES), and elsewhere.

Charles E. Glass (1934–1998) and Robert Foster

November 1975. They collected the type specimen of *Mammillaria tayloriorum* and named the species, differentiating it from *M. evermanniana* (see Mitich 1993).

Ivan Murray Johnston (1898–1960)

Johnston served as the botanist on the expedition of the California Academy of Sciences to the Gulf of California between 13 April and 13 July 1921. His findings from the expedition (Johnston 1924) remain one of the finest publications on the botany of the islands of the Gulf of California. His collections from the expedition are primarily at CAS and UC.

The party visited San Pedro Nolasco on 17 April 1921, when he collected 13 numbers. He described two new taxa based on these collections: *Agave chrysoglossa* and *Hofmeisteria pluriseta* var. *pauciseta* (= *Pleurocoronis laphamioides*).

George Edmund Lindsay (1916–2002)

Lindsay was director of the San Diego Natural History Museum from 1956 to 1963 and director of the California Academy of Sciences from 1963 to 1982. In the 1950s and 1960s, he organized a series of explorations to gulf islands and helped lay the groundwork for major conservation efforts by the Mexican federal government (Ezcurra et al. 2002). He published a number of works on cacti and succulents, especially of the Baja California Peninsula and Gulf of California islands.

24 February 1947. Collected on San Pedro Nolasco with Herbert Bool. After several attempts at reaching the island, Lindsay and Bool finally made it and avidly collected cacti and photographed for a brief period of time, not making it to the crest of the island (Lindsay 1947). To Lindsay's great exhilaration, "it seemed that every foot of the island capable of supporting a cactus had one!" (Lindsay 1947:75). This visit resulted in collections of *Echinocereus websterianus* and *Mammillaria multidigitata*, which Lindsay described as new species. He visited the island again on 27 March 1947 (Lindsay 1955).

2 and 3 May 1952. This trip was part of the Sefton Foundation–Stanford University Expedition to the Gulf of California and included an array of biologists collecting specimens (Lindsay 1955). Also on board were Reid Moran and Jon Lindbergh, then an undergraduate student at Stanford University. Photos at the San Diego Natural History Museum show Lindbergh and others collecting *Ctenosaura* specimens. The expedition was out 61 days and collected at 23 gulf islands. Lindsay collected 152 numbers of cacti by the end of the expedition.

Lindsay also made a trip to San Pedro Nolasco on 30 December 1961 with John and Priscilla Sloan and Chris Parrish (Lindsay 1962).

Armando (Jaime) Maya

1 November 1963. Maya collected plant specimens above Cala Güina at the southeast side of the island during field work for his Ph.D dissertation on the natural history of the fishing bat *Myotis* (*Pizonyx*) *vivesi* (Maya 1968). He was accompanied by Robert Russell, son of Alexander Russell (Bowen 2002).

Reid Venable Moran (1916–2010)

Reid Moran was the single most intrepid botanical collector ever to work on the gulf islands and Baja California Peninsula. His extensive collections are primarily at the San Diego Natural History Museum (SD), where he was curator of the herbarium. Numerous duplicates of his collections are at other herbaria. On many expeditions to the islands, he would climb to the highest peaks to search for interesting specimens.

He collected on San Pedro Nolasco on 2 May 1952 as a member of the Sefton–Stanford Gulf of California Expedition (see notes for George Lindsay). Moran collected 13 numbers (*4040* to *4052*) in the vicinity of Cañón El Farito on the east side of the island. In his field notes he wrote, "the flora is rather poor but is in good shape at present, the cacti flowering" (Moran 1952, field book 3:111).

H. Ronald Pulliam

20 to 22 March 1974. Pulliam and Michael Rosenzweig led a University of Arizona advanced field class to the island to see how different an island could be from a nearby mainland (Michael Rosenzweig, personnel communication 2008). They made a collection of 18 plant specimens of 17 species above Cala Güina to the island crest and west side, including some of the rare species on the island. Pulliam was then on the faculty of the University of Arizona and later became Regents Professor at the Odum School of Ecology, University of Georgia.

William R. Radke

21 March 1979. He collected a specimen of *Vaseyanthus insularis*.

Peter J. Rempel

29 March 1937. He collected 10 numbers on San Pedro Nolasco as a member of the Hancock Pacific Expedition in 1937 (Gentry 1949:99). Rempel was at the University of Southern California, associated with the Allan Hancock Foundation.

Michael Rosenzweig

20 to 22 March 1974. Rosenzweig collected specimens with Ron Pulliam (see above). He is professor in the Department of Ecology and Evolutionary Biology, University of Arizona, and a noted quantitative theoretical ecologist. He told us that San Pedro Nolasco is one of the few places he has experienced "true wilderness" (personal communication 2008).

Wade Cutting Sherbrooke

Sherbrooke was a graduate student at the University of Arizona when he visited the island. Later, he became the director of the Southwestern Research Station of the American Museum of Natural History at Portal, Arizona. He made two plant collections for Felger at the southeast side of the island above the site later known as Cala Güina. He was on the island 28 March 1964 with Armando (Jaime) Maya and Robert Russell; the plants were pressed on the 29th and catalogued as *Felger 9852* and *9853*. Wade was again on the island 30 October 1964 with Maya, Oscar Soule, Bill Eger, Jean Russell, and Alexander Russell; the plants were pressed on the 31st and and catalogued as *Felger 11232* to *11247*.

Marjorie L. Stinson

29 April 1974. She collected several valuable specimens, now at SD, with Michael David Robinson.

Raymond Marriner Turner

Turner taught at the University of Arizona (1954–1962) before joining the U.S. Geological Survey in Tucson and "retiring" in 1989. His interest in the dynamics of desert vegetation has resulted in long-term studies, and he is author or co-author of many publications on vegetation changes and Sonoran Desert plants.

He was on San Pedro Nolasco from 28 to 30 September 1979, when he took photographs and collected nine numbers in the vicinity of Cañón El Farito (*79-248* to *79-255*), mostly of the rich grass flora. He was on the island with Matt Gilligan, Richard Inouye, Rodrigo Medellín (then a graduate student at Universidad Nacional Autónoma de México), Jim Munger, Bernardo Villa (of the Instituto de Biología, Universidad Nacional Autónoma de México), and Oscar G. Ward.

Turner recorded the following observations in his field notebook, "San Pedro Nolasco seems remarkable in two respects: (1) the dense coverage of grass (mainly *Setaria palmeri* [*S. macrostachya*]) and annuals (*Vaseyanthus* and *Perityle* are the main ones and mostly dead now) and (2) the absence of all woody legumes, save *Acacia willardiana*, although at the same latitude on the mainland they are abundant. These two features may be related to absence of many herbivores. Also, *Opuntia* (*bravoana*?) has weak spine development. The dominant shrub species is probably *Viguiera deltoidea* [*Bahiopsis triangularis*] with *Simmondsia* and *Jatropha cuneata* subdominants."

Oscar G. Ward

6 October 1974. A faculty member of Department of Ecology and Evolutionary Biology at the University of Arizona (1966–1995), Ward worked on genetics and small Sonoran Desert mammals. He collected several plant specimens on San Pedro Nolasco. He also visited the island with Ray Turner in September 1979.

Benjamin T. Wilder

(Paraphrased from Wilder's field notes.) After several days of botanizing on the southern portion of Tiburón Island in late Jaunary 2008, Richard and I headed to San Carlos, from where we departed for San Pedro Nolasco. Ana Luisa Figueroa-Carranza, director of the Guaymas CONANP Islas office, kindly arranged for its boatman Florentino Cota-Moreno and biologist Jesús Ventura-Trejo to take us to the island and assist with field work. The goals of the trip were to re-establish the quadrats that Richard had previously made on the island (see Felger, 18 January 1965, above), permanently mark them, establish additional transects, and make collections of the flora.

2 and 3 February 2008. We spent two days working on the east side of the island in the vicinity of Cañón El Farito. We established permanent sites for vegetation monitoring and collected 32 numbers: 2 February 2008, *Wilder 08-153* to *08-171*, and 3 February 2008, *Wilder 08-172* to *08-185*.

29 September 2008. With Richard Felger and Juan Pablo Gallo-Reynoso (see entry for Felger). In addition to exploring the lower half of Cañón de Mellink with Richard and Juan Pablo, I ascended the canyon to the upper ridge at 260 m and was rewarded by finding a number of species that occur only at high elevations on the island. My collections from this day are numbered as *Wilder 08-344* to *08-361*.

11 November 2009. With Jesús Ventura-Trejo in the panga of Javier Cordoba of La Manga. In early September the tropical storm Jimena settled over the San Carlos–Guaymas region and delivered ca. 700 mm of rainfall in 36 hours, a record for the state of Sonora. I made a trip to explore the island as well as the neighboring canyons of the Sierra el Aguaje to take advantage of the verdant vegetation. On Nolasco we landed at Cañón el Farito and ascended to the crest and negotiated our way along the precipitous upper crest to the summit of the island. The canyon had a jungle-like appearance with *Vaseyanthus insularis*, covered in dodder (*Cuscuta corymbosa*), blanketing the ground. Occasional rock depressions still contained water. The slopes above the canyon had a dense cover of ephemerals (e.g., *Boerhavia triquetra, Muhlenbergia microsperma*, and *Perityle californica*) that were already dry. Hummingbirds were zooming in between the bright blue flowers of *Salvia similis* and repeatedly approached my red hat. The mass flooding that occurred in the opposing mainland canyons was in no way evident on the island. *Heteropogon contortus*, on the upper ridge of the island, was a new record for the island. Collections from the canyon and ridge crest are numbered *Wilder 09-122* to *09-142*.

SAN PEDRO NOLASCO PLACE NAMES
(Figure 10)

Agua Amarga (Figure 11)

This tiny freshwater seep emerges from about 5 m above high tide line on high sea cliffs on the east-central side of island. This is the only perennial freshwater source on the island and has sustained fisherman and others in trying times of misfortune. 27.96853º N, 111.37302º W (this and other coordinates based on WGS 84 datum). The water is highly alkaline, as indicated by the name *amarga* ("bitter"). It supports the island's only wetland plant, *Cyperus elegans*.

Cala Güina

A small cove at the southeast side of the island. *Cala* is a Spanish term for a place to set an anchor and *güina* is a chigger, applied to this cove because it is very small and narrow like a chigger (trombiculid mites, common on the mainland but not encountered on the island). The cove is at approximately 27.95914º N, 111.36856º W.

Cala Güina has a short and narrow cobble-rock "beach." It is not suitable for camping, as there is no dry place at high tide. Cliffs rise directly above the high tide line. It is possible to ascend the cliffs, and a number of biologists have done so, although it is dangerous and not recommended. This cove and Cañón El Farito are the only landfalls on the east side of the island. Cala Güina is the locally used place name but during the 20th century was not known to most biologists, who often referred to the locality as the southeastern cove or southeastern side of the island.

Cañón el Farito (Figure 12)

Canyon at the northeast side above the most accessible landfall on the island, which is a small, rock-walled cove or inlet. For access to the landfall, a small boat is brought up close to the rocks, onto which one needs to jump, being careful of the slippery seaweeds and usual sea lion feces. The canyon is steep and rocky but easily traversed and leads to the top of the island. This is the most frequented collecting locality over the last century. Fishermen and researchers have camped here. Nowadays fishermen and tourists occasionally come ashore, sometimes illegally camping, leaving trash, feces, and toilet paper, and sometimes building small cooking fires. For example, we noted a fire pit and fire-blackened rocks near the shore on 11 February 2000 and 3 February 2008.

The name is derived from a colloquial Spanish word for a position light. The original *farito* was a lighthouse beacon on a scaffold at the southeast corner of the inlet, known as Ensenada El Farito. The beacon was installed in the 1980s to serve the tankers that go between Guaymas and Puerto Libertad and the ferry between Guaymas and Santa Rosalía. The *farito* was destroyed by Hurricane Juliette in late September 2001 and was replaced with a small provisional one powered by solar cells. Tropical Storm Jimena destroyed the provisional *farito* in early September 2009. A large metal sign, warning visitors not to bring exotic animals or trespass on the island because of conservation issues, had been installed on the rock landing site by CONANP, but it rusted and was sunk by Hurricane Juliette with waves about 5 meters high. The sign was recovered from the sea, and a new one is scheduled to be installed by CONANP.

The rock landing at the cove is 27.97318º N, 111.37748º W at several meters above sea level. Mid-elevation at ca. 215 m in the canyon is 27.97135° N, 111.37863° W. The ridge crest above the canyon at ca. 280 m is 27.96854º N, 111.37981° W. The locally used place name Cañón El Farito (Cañón El Faro on some of Felger's herbarium labels) was not known to most biologists during the 20th century.

Cañón de las Guacamayas (Arroyo de las Guacamayas)

Canyon at the west-central side of the island. Gallo-Reynoso named this large, broad canyon for the macaws (*guacamayas*) that arrived on the island in 2000. Vicinity of 27.96661º N, 111.38358º W in the lower part of the canyon.

Cañón de Mellink (Figure 13)

Canyon at the west-central side of the island. It is the next canyon north of Cañón de las Guacamayas and was named by Gallo-Reynoso and associated researchers for Eric Mellink, noted expert on the vertebrate fauna of northwestern Mexico. Vicinity of 27.96930º N, 111.38517º W in the lower part of the canyon.

La Lobera

This site, on the southwest side of the island, was named by Gallo-Reynoso and associated researchers for the *lobo marino*, or California sea lion. A series of high cliffs rises above sea caves and

FIGURE 10. Localities on San Pedro Nolasco Island. Map by Kyle Hartfield and Juan Pablo Gallo-Reynoso.

FIGURE 11. Agua Amarga. *Cyperus elegans* at seep in center; high-tide line just below view of photo, 3 February 2008. Photo by B. Wilder.

rock ledges used by sea lions as a rookery. More than 50% of their population on the island is found in this area (Gallo-Reynoso, unpublished data). Vicinity of 27.95885º N, 111.37883º W at the largest cave occupied by sea lions.

Punta los Nacapules

The northwest point of the island at a very narrow, steep, and short canyon, named for the relatively large *tescalamas* (*Ficus petiolaris*). There is no suitable landfall or safe access to the canyon. The place is incorrectly named by fishermen and tourist operators, since *nacapule* is the name for *Ficus pertusa*, which occurs in canyons in the Guaymas region (Felger 1999; Felger et al. 2001). In 2003, Military Macaws fed on figs of the *tescalamas* growing in the shadow of large boulders (Gallo-Reynoso, personal observation; see *Ficus petiolaris* in the Species Accounts). Vicinity of 27.983713º N, 111.390903º W in the lower part of the canyon.

SPECIES ACCOUNTS

The nomenclature represents our interpretation of the literature and identifications of experts as indicated for specimens cited. The one fern is listed first, followed by the flowering plants listed alphabetically by family, genus, and species. At the end of the species accounts is a listing of doubtful and excluded species previously reported or listed from San Pedro Nolasco. We follow the APG III (Angiosperm Phylogeny Group; Stevens 2008) arrangement of families and give cross-references where there are changes from classical family arrangements. Identification keys are provided for families with multiple genera and genera with multiple species.

The current scientific name is in bold, and selected synonyms are listed after it in brackets. Five species and one variety have been described from specimens collected on San Pedro Nolasco—place and date of publication are provided for these taxa. Selected common names are provided, first in Spanish (in italics) and then in English. Unless otherwise stated, the brief descriptions are based on San Pedro Nolasco specimens or populations.

We provide information on the nearest known mainland populations and, in some cases, the distributions of the nearest known close relatives of the island population. Following this information is the known geographic distribution of the taxon. Other Gulf of California islands where a species is known to occur are listed, by latitude, following Rebman et al. (2002) and our knowledge of the flora, especially of other the Sonoran islands (Tiburón, San Esteban, Dátil, Cholludo, Patos, Alcatraz, and San Pedro Mártir).

All specimens cited are at the University of Arizona Herbarium (ARIZ) unless otherwise indicated by the standardized abbreviations for herbaria (Index Herbariorum 2009) or as identified. We have seen all specimens cited unless noted as "not seen." If a specimen is at ARIZ or cited for another herbarium, we generally do not cite duplicates at other herbaria. In cases where more than one collector is

FIGURE 12. Cañón El Farito, 3 February 2008. Photo by B. Wilder.

listed on the label, generally only the first collector's name associated with the collection number is cited. Cited specimens are arranged in order of date of collection, except type specimens, which are listed first. The herbarium accession number follows the herbarium abbreviation of type specimens. More detailed information for the specimen cited can usually be found on the actual herbarium labels and often on line, e.g., at http://swbiodiversity.org/seinet/index.php.

PTERIDACEAE—Brake Fern Family

Notholaena lemmonii D.C. Eaton var. ***lemmonii***. Lemmon's cloak fern.

Small tufted ferns. Leaves 10–18 cm long, the blades usually about 3 times longer than wide, twice divided, olive-green and glabrous adaxially and with golden-yellow farina abaxially.

East side of the island, sheltered among rocks on north- and east-facing exposures at higher elevation.

General distribution: The nearest mainland population is in the Sierra El Aguaje, including on the opposite shore at Bahía San Pedro. Arizona, Sonora, and Chihuahua to Jalisco, and Baja California Sur. A second variety is disjunct in south-central Mexico and may represent a distinct species (Windham 1993).

Specimens from western Sonora and Tiburón Island have white farina, as do most specimens from northwestern Mexico. The yellow form is rare. Farina, a powdery waxlike exudate on the abaxial ("lower") surface of the fronds of various cheilanthoid ferns, is formed by glandular trichomes and consists almost exclusively of flavonoid aglycones. In dry periods, when the fronds are desiccated and "rolled up," the abaxial surface is exposed, and the farina reportedly reduces transpiration by being lipophilic as well as by reflecting excess insolation. The biogeographic significance of the golden form on San Pedro Nolasco is that "all the flavonoids exude[d] by a certain fern form a flavonoid pattern which often is rather consistent, i.e. subjected to quantitative variation only, and can be characteristic for a species, for a variety or for a distinct chemical race" (Wollenweber 1984:4).

Other islands: Tiburón, Cerralvo.

E side, talus area, 900–1000 ft, E exposure, 21 Mar 1974, *Pulliam and Rosenzweig s.n.* (annotated as "rare form with golden farina, George Yatskievych 1994").

Sonora: San Pedro Bay, locally abundant about rocks on a north-facing hillside, 7 Jul 1921, *Johnston 4336* (CAS, UC, white farina).

ACHATOCARPACEAE—Achatocarpus Family

Phaulothamnus spinescens A. Gray. *Putilla*; snake eyes.

Spinescent, *Lycium*-like woody shrubs to ca. 2.5 m tall. Leaves more or less narrowly spatulate, semifleshy, and often glaucous. Flowers small and inconspicuous, the fruits globose, 5 mm in diameter, fleshy, translucent white, 1(2?)-seeded.

Occasional along the bottom of larger canyons on both sides of the island, locally common along the ridge crests.

FIGURE 13. Cañón de Mellink. *Bursera microphylla*, *Fouquieria diguetii*, and *Simmondsia chinensis* in near foreground; *Stenocereus thurberi* and some *Pachycereus pringlei* in middle foreground, 29 September 2008. Photo by B. Wilder.

General distribution: Common on the opposite mainland. Northern Mexico, including Sonora and Baja California Sur, and southern Texas.

Other islands: Tiburón, Alcatraz, Cholludo, Dátil, Coronados, Monserrat, Santa Catalina, Santa Cruz, San José, San Francisco, Cerralvo.

E side, shrub, 26 Nov 1963, *Felger 9641*. Cañón El Faro, one large shrub seen, ca. 2.5 m tall and about as wide, canyon bottom at ca. 6 m elev, 28 Nov 2006, *Felger 06-78*. Cañón de Mellink, 29 Sep 2008, *Felger 08-145*.

AGAVACEAE—see ASPARAGACEAE

AMARANTHACEAE—Amaranth Family

Amaranthus fimbriatus (Torrey) Bentham. *Bledo*, *quelitillo*; fringed amaranth.

Warm weather annuals, sometimes persisting until December or even spring. Glabrous; leaves narrowly lanceolate. Male and female flowers on the same plant; flowers green and white; pistillate bracts and sepals fringed (fimbriate).

Seasonally abundant, especially on the east side on grassy, northeast-facing slopes.

General distribution: Sinaloa and Baja California Sur northward to southwestern United States.

Other islands: Ángel de la Guarda, Patos, Tiburón, Dátil, Alcatraz, Carmen, Monserrat, San Diego, San José, Espíritu Santo, Cerralvo.

E side, N-facing slope, mid-elevation, 26 Nov 1963, *Felger 9656*. NE side, abundant on N-facing grassy slopes, 12 Nov 1964, *Felger 11449*. N-facing slopes, common, 18 Jan 1965, *Felger 12068*. Base of Cañón El Faro, scattered, not common, mostly at lower elevations near canyon bottom, 28 Nov 2006, *Felger 06-75*. Base of Cañón El Farito, not common, 2 Feb 2008, *Wilder 08-168*.

APOCYNACEAE—Dogbane Family (includes Asclepiadaceae)

Metastelma californicum Bentham

Small vines, forming densely twining and tangled mats on shrubs such as *Bernardia*. Stems slender, with a longitudinal line of usually curved hairs. Flowers white, 2.2–2.5 (3) mm long; corona scales comparatively long, the terminal appendage on anthers nearly transparent and as broad as or slightly broader than long; the tip of terminal appendage is broadly obtuse, almost truncate. Inner surfaces of corolla lobes moderately hairy and nearly naked medially. Flowers recorded in September and November.

Ridge crest of the island, found in slightly shaded and sheltered sites among boulders.

On 29 Sep 2008, we saw queen butterflies, *Danaus gilippus thersippus*, visiting *Bahiopsis* flowers. Since the larvae are known to feed only on milkweeds, we presume *Metastelma* is the host plant—if these butterflies are resident on the island.

General distribution: Coastal southwestern Sonora south of the desert, both states of Baja California, northwestern Sinaloa, and Islas Revillagigedos.

This species has not been found on the opposite mainland, where instead one finds *M. arizonicum* A. Gray, which is distinguished in part by its floral morphology including larger flowers. The report of *M. pringlei* A. Gray on the island (Felger and Lowe 1976; Rebman et al 2002) was based on the specimens cited here.

Other islands: Santa Catalina.

E side, common vine, forming dense mats on shrubs, especially in slightly shaded and protected sites, 26 Nov 1963, *Felger 9635*. E-central side, N exposure below crest of island, ca. 270 m, covering a large *Bernardia* shrub; flowers white, seen only at higher elevations, 28 Nov 2006, *Felger 06-99*. E-central side, ca. 280 m, localized on the E-sheltered face of crest, 3 Feb 2008, *Wilder 08-180*. Ridge above Cañón de Mellink, 260 m, 29 Sep 2008, *Wilder 08-360*.

ASPARAGACEAE—Asparagus Family (includes Agavaceae)

Agave chrysoglossa I.M. Johnston, Proc. Calif. Acad. Sci. IV, 12:998, 1924. *Amole*. Figure 14.

Medium-sized agaves, mostly solitary or with a few offsets. Leaves narrow, thick, and green or slightly glaucous, the margins entire except the stout terminal spine; however, seedlings and very young plants have conspicuous marginal teeth. Flowering stalks including inflorescences 2.5–4 m tall; inflorescences cylindrical and densely flowered. Flowers bright yellow; mostly in April.

This species was described by Ivan Johnston, who wrote, "This very beautiful species grows on San Pedro Nolasco Island (*3123*). When found it was enlivening the rocky mid-slopes of the island with spectacular, bright yellow tongues of color. The plants grew singly and produced dense elegant spicate floral clusters 1–2 m. long and 8–10 cm. broad which, due to their weight, almost invariably bent over with their tips nearly touching the ground" (1924:999).

Abundant, often growing from rock crevices, especially at higher elevations; from low to high elevations on the east side of the island, in canyons on the west side mostly at elevations above ca. 70 m.

General distribution: Mountains in western Sonora including the Sierra El Aguaje and farther north in the Sierra Seri; a large population in the Sierra Kunkaak of Tiburón Island. Populations in eastern Sonora, near Bacanora and Sahuaripa, appear intermediate between *A. chrysoglossa* and *A. vilmoriniana* Berger (Gentry 1982; Turner et al. 1995).

Other islands: Tiburón.

Rocky slopes, 17 Apr 1921, *Johnston 3123* (holotype, CAS). 29 Mar 1937, *Rempel 300*. Steep granitic mountain slope with scattered trees and giant cactus; cespitose in old clones, with short caudex; leaves green, few,

FIGURE 14. *Agave chrysoglossa*, Cañón de Mellink, 29 September 2008. Photo by B. Wilder.

open, ascending to porrect, with tip die-back, 5–10 dm long; spikes thick, 3–4 m tall, all old and dry; homogeneous population, 16 Dec 1951, *Gentry 11349*. Near middle of east side, old flower stalks 3–4 m tall, ca. 5 cm diam., rosettes subcaulescent erect to ½ m, leaves ca. 25, 2 May 1952, *Moran 4042* (SD). E side, common, 26 Nov 1963, *Felger 9664*. E side, very common, beautiful studding the extremely granitic slopes; the central flower stalk long, swooping in contorted curves generally toward the ocean, weighted down by literally hundreds of yellow flowers; thick central rosettes of leaves, 29 Apr 1974, *Stinson s.n.* (SD). Ridge between Cañón de las Guacamayas and Cañón de Mellink, 3 May 2005, *Gallo-Reynoso* (photo).

ASTERACEAE (COMPOSITAE)—Aster or Composite Family

San Pedro Nolasco supports eight genera and eight species of composites, representing 14% of the total flora. Growth forms range from cool-season annuals to shrubs.

1. Perennials; stems and leaves conspicuously succulent; flowers all disk-like and lavender-pink. *Hofmeisteria*
1′. Annuals or perennials; plants not succulent (sometimes semisucculent); flowers not lavender-pink.
2. Leaves scabrous (rough like sandpaper when you rub your finger backward on the leaf).
3. Conspicuously leafy shrubs; flower heads with well-developed rays; pappus bristles not plumose. *Bahiopsis*
3′. Foliage sparse; flowers discoid (rays not present); pappus bristles plumose. *Bebbia*
2′. Leaves not scabrous.
4. Leaves dissected into filiform (thread-like) segments; rays white with dark longitudinal lines. *Coreocarpus*
4′. Leaves entire or lobed but the segments not filiform; rays or ray-like florets yellow or absent.
5. Annuals; leaves palmately lobed and coarsely toothed; achenes laterally compressed with smooth black faces. *Perityle*
5′. Perennials, shrubs or subshrubs; achenes not flattened and not as above.
6. Leaf blades about as wide as long. *Pleurocoronis*
6′. Leaves blades at least twice as long as wide.
7. Plants dotted with prominent oil glands, especially the phyllaries, and pungently aromatic. *Porophyllum*
7′. Plants not dotted with oil glands and not pungently aromatic. *Trixis*

Bahiopsis triangularis (M.E. Jones) E.E. Schilling & Panero [*Viguiera triangularis* M.E. Jones]. Figure 15.

Shrubs (0.5) 1–2 (2.5) m tall. Leaves 2.5–14 cm long, bright green, usually scabrous, highly variable in size, shape, and thickness depending on soil moisture, season, and position on stems, usually reduced upward and largest on vigorous new shoots, lanceolate to broadly ovate to triangular ovate, the margins entire to toothed. Flowers in panicles, generally held above the foliage, the panicles many-

FIGURE 15. *Bahiopsis triangularis* and dried *Vaseyanthus insularis*. Cañón El Farito, 2 February 2008. Photo by B. Wilder.

flowered on larger shrubs and simple or with few heads on smaller shrubs, such as on south-facing slopes or when drought stressed; rays bright yellow, the disk yellow to yellow-orange; flowering at almost any time of year except during extreme drought. The flowers attract honeybees (*Apis mellifera*).

This is the most common and ubiquitous shrub across the island, from canyon bottoms to exposed slopes at all elevations and exposures. It is probably not long-lived, or at least it is capable of flowering at a small size. The leaves ultimately become drought deciduous. The plants and the leaves are often notably large and robust in comparison with those of *B. chenopodina* (Greene) E.E. Schilling & Panero on Tiburón Island and the Sonora coast. On 29 Sep 2008, we saw queen butterflies, *Danaus gilippus*, frequently visiting *Bahiopsis* flowers in Cañón de Mellink (see *Metastelma*).

General distribution: Central Baja California to the Cape Region in Baja California Sur, and some gulf islands. Replaced on various other gulf islands by *B. chenopodina*.

Other islands: Ángel de la Guarda, San Esteban.

Very common on all parts of the island, loose erect shrub, 4–5 ft high, 17 Apr 1921, *Johnston 3127* (CAS, UC, det. *V. triangularis*, "not typical," E. E. Schilling 1985). In a rock draw near sea, shrub with very numerous stems, 4–5 ft high and nearly as wide, growing with *#3127*, 17 Apr 1921, *Johnston 3141* (CAS; det. *V. triangularis*, E. E. Schilling 1985). 6 Feb 1940, *Dawson 1033* (CAS; det. *V. triangularis*, E. E. Schilling). Near middle of E side, 2 May 1952, *Moran 4050* (det. *V. triangularis*, E. E. Schilling 1985). SE side, above landfall cove, 1 Nov 1963, *Maya s.n.* E side, near summit between the two landfalls, abundant shrub, 26 Nov 1963, *Felger 9646*. Above SE cove, 11 Aug 1964, *Cooper* [*Felger 10407*]. SE side, 31 Oct 1964, *Sherbrooke* [*Felger11234*]. NE side, very common and widespread shrub, 12 Nov 1964, *Felger 11432*. NE side, mid-elevation above landfall cove, 18 Jan 1965, *Felger 12067*. E side, 250 ft, 20 Mar 1974, *Pulliam and Rosenzweig s.n.* NE side, 11 Feb 2000, *Felger 2000-2*. N-facing slope above Cañón El Farito, 1.7 m tall, 2 Feb 2008, *Wilder 08-165*. Cañón de Mellink, common at all elevations, 29 Sep 2008, *Wilder 08-344*.

Bebbia juncea (Bentham) Greene var. ***aspera*** Greene. *Hierba ceniza*; sweetbush.

Rounded bushes to about 1 m tall with rough, scabrous herbage. Stems slender and brittle. Leaves sparse and quickly drought deciduous. Heads with disk florets only, yellow and fragrant. Pappus bristles plumose. Flowering almost any time of the year except during extreme drought.

Documented from the southeast and east-central parts of the island.

General distribution: Baja California Norte and northwestern Sinaloa to southwestern United States. Variety *aspera,* the more widespread of the two varieties, is replaced by the often leafier var. *juncea* in southern Baja California Norte, Baja California Sur, and adjacent islands.

Other islands: Var. *aspera*: Ángel de la Guarda, Tiburón, Dátil, San Lorenzo, San Esteban, San Marcos, Santa Catalina. Var. *juncea*: San Marcos, Coronados, Danzante, Monserrat, Santa Catalina, Santa Cruz, San Francisco.

Above SE cove, 11 Aug 1964, *Cooper* [*Felger 10399*]. E side, mid-elev, 26 Nov 1963, *Felger 9638*.

Coreocarpus sanpedroensis E.B. Smith, Amer. J. Bot. 72:626, 1985 [*C. arizonicus* (A. Gray) S.F. Blake var. *sanpedroensis* (E.B. Smith) B.L. Turner, Phytologia 80:136, 1996].

Nonseasonal annuals to bushy herbaceous perennials to ca. 50 cm tall, essentially glabrous; herbage sometimes becoming semisucculent. Leaves opposite, the lower and larger leaves to ca. 15 cm long; petioles shorter than the blades; blades pinnately dissected into 3–5 linear segments. Flower heads widely spaced on slender-stemmed cymose panicles; heads 8–10 mm wide including the rays; rays 4 or 5 per head, pistillate, the ligules (rays) 3–5 mm long, white with 4 purplish lines or veins on the ventral side; disk florets yellow. Achenes 2.3–3 mm long, obovate to spatulate, compressed, usually awnless, with a pale line near each margin and straw-colored corky wings dissected into several separate minute teeth; the teeth may be nearly absent.

Responding to rainfall and soil moisture at any season; seasonally abundant on both sides of the island at all elevations and exposures. Especially common on the east side of the island in deeper soil pockets and sometimes growing from rock crevices.

Endemic to San Pedro Nolasco. In flower "head characters it resembles *C. sonoranus* Sherff . . . but has a more reduced achene wing and more dissected leaves with much narrower leaf segments" (Smith 1985:627–628). The smaller achene wing is in line with reduced dispersal characteristic of island plants (Carlquist 1965). *Coreocarpus sonoranus* occurs on the opposite Sonora mainland and various other gulf islands.

6 Feb 1940, *Dawson 1034* (holotype, UC 945977). Frequent on rocky slopes near sea, 17 Apr 1921, *Johnston 3144* (CAS). Steep granitic mountain slope with scattered trees and giant cactus, shaded slope, annual, 16 Dec 1951, *Gentry 11353*. Near middle, E side, 2 May 1952, *Moran 4049* (SD, CAS, UC). E side, 26 Nov 1963, *Felger 9661*. Vicinity of SE cove, steep slopes, 29 Mar 1964, *Sherbrooke* [*Felger 9853*]. Above SE cove, ca. 100 ft on cliff, 11 Aug 1964, *Cooper* [*Felger 10401*]. SE side, 31 Oct 1964, *Sherbrooke* [*Felger 11236*]. NE side of island, 12 Nov 1964, *Felger 11434*. NE side, 18 Jan 1965, *Felger 12083*. Cañón de las Guacamayas, 14/15 Apr 2003, *Gallo-Reynoso* (photo). Base of Cañón El Faro, 28 Nov 2006, *Felger 06-76*. N-facing slope above Cañón El Farito, 2 Feb 2008, *Wilder 08-154*. Cañón de Mellink, ca. 40 m, 29 Sep 2008, *Wilder 08-349*.

Hofmeisteria crassifolia S. Watson.

Mound-shaped perennials with highly succulent stems and leaves. Nearly evergreen, the number and size of the leaves become greatly reduced during drought. Leaves crowded at stem tips; leaf segments thick, terete, and glaucous. Flower heads solitary on long stalks; flowers fragrant, the ray florets lavender-pink, the disk florets white. Flowering nonseasonally except during the one or two mid-winter months, recorded in flower February–April and in October.

Growing from crevices on exposed rock surfaces and cliffs on both sides of the island, mostly near the shore; scarce at higher elevations.

General distribution: Endemic to the Guaymas region and San Pedro Nolasco. *Hofmeisteria fasciculata* occurs in similar habitats on the Midriff Islands.

Other islands: none.

A brittle succulent perennial growing in rock crevices near ocean, 17 Apr 1921, *Johnston 3142* (CAS, UC). Above SE cove, cliffs ca. 100 ft, 11 Aug 1964, *Cooper* [*Felger 10405*]. SE side, sea cliffs and crevices in rocks, somewhat less common on S-facing slopes than others, 26 Nov 1963, *Felger 9648*. N- and S-facing slopes, common on N-facing slopes, 18 Jan 1965, *Felger 12076*. N exposure, 20 ft elev, common in area, 22 Mar 1974, *Pulliam and Rosenzweig s.n*. E side, 6 Oct 1974, *Ward s.n*. Cañón de las Guacamayas, near shore, July 2003, *Gallo-Reynoso* (photo). Cañón El Faro, exposed rock surfaces, mostly N- and E-facing, near shore, 28 Nov 2006, *Felger 06-80*. Cañón El Farito, common just above water on cliff faces, rare elsewhere, 2 Feb 2008, *Wilder 08-157*. Cañón de Mellink, 29 Sep 2008, *Felger* (photo).

Perityle californica Bentham.

Cool-season annuals, the plants highly variable in size, often with delicate stems. Leaves opposite or alternate. Ray and disk flowers bright yellow.

Seasonally common and often abundant at all elevations, especially on the east side of the island. Gallo-Reynoso observed *Gecarcinus* cf. *planatus* (red land crab) grazing on *Perityle* (identified by Gabriela Suarez-Gracida) and taking it into its burrow at Cañón de las Guacamayas on the night of 8 November 2002.

General distribution: Central Sonora to Sinaloa, both Baja California states, and gulf islands adjacent to Baja California Sur. This species is similar in appearance to *P. aurea* Rose, which occurs along the gulf coast of Baja California Sur and on many other gulf islands; they are generally distinguished by characters of the achene (Powell 1974).

Other islands: Coronados, Santa Catalina, Santa Cruz, San Francisco, Cerralvo.

Near middle of E side, 2 May 1952, *Moran 4046* (SD, UC, and CAS, det. M. Powell 1970). E side, abundant, yellow flowers, 26 Nov 1963, *Felger 9653* (duplicate det. M. Powell). SE side of island, 31 Oct 1964, *Sherbrooke s.n*. NE side, very common on N-facing slopes, less common on other slopes, rare on SW slopes, disk and ray corollas yellow, 18 Jan 1965, *Felger 12071* (det. M. Powell). E side, ray and disk corollas bright yellow, 21 Mar 1974, *Pulliam and Rosenzweig s.n.* Base of Cañón El Faro, various exposures, rays and disk yellow, 28 Nov 2006, *Felger 06-77*. N-facing slope above Cañón El Farito, 2 Feb 2008, *Wilder 08-153*.

Pleurocoronis laphamioides (Rose) R.M. King & H. Robinson [*Hofmeisteria laphamioides* Rose. *H. pluriseta* var. *pauciseta* I.M. Johnston, Proc. Calif. Acad. Sci. IV, 12:1187, 1924. *H. laphamioides* var. *pauciseta* (I.M. Johnston) S.F. Blake].

Globose shrubs to ca. 80 cm across, tardily drought deciduous. Leaf blades green, semisucculent, broadly ovate to orbicular with toothed or crenulate margins. Flowers whitish to pale yellow with purple stigmas; various seasons.

Mostly on cliffs and crevices on rock slopes and canyon walls on the east side of the island, often north-facing.

General distribution: Arizona in the Ajo Mountains and western Sonora south to the Guaymas region, gulf islands, and gulf coast of both states of Baja California.

Variety *pauciseta*, distinguished in part by having fewer pappus bristles and scales, is reported for southern Baja California Sur and the Guaymas region. Its taxonomic status has not been studied in depth, but most authors treat it as a synonym.

Other islands: Tiburón, Alcatraz, Dátil, San Esteban, San Pedro Mártir, Tortuga, San Marcos, San Ildefonso, Danzante.

Frequent on ledges, particularly near the sea, 17 Apr 1921, *Johnston 3134* (holotype of *H. pluriseta* var. *pauciseta*, CAS 8723). Near middle, E side, 2 May 1952, *Moran 4043* (SD, CAS). E side, 26 Nov 1963, *Felger 9647*. Above SE cove, 11 Aug 1964, *Cooper* [*Felger 10408*]. NE side, 12 Nov 1964, *Felger 11445*. SE side, 31 Oct 1964, *Sherbrooke* [*Felger 11237*]. E side, small shrub, generally on N-facing slopes, leaves bright green, semisucculent, 18 Jan 1965, *Felger 12077* (2 sheets).

Porophyllum pausodynum B.L. Robinson & Greenman, 1896 [*P. seemannii* S. Watson, 1889, not *P. seemannii* Schultz-Bipontinus, 1857. *P. brachypodum* B.L. Robinson, 1900].

Short-lived perennial herbs or subshrubs to ca. 1 m tall, probably also reproductive in the first season; pungently aromatic with conspicuous oil glands. Stems slender, often erect, and sparsely branched. Leaves linear and bright green. Flower heads in dense clusters (cymes) at stem tips; flowers pale yellow.

Known from the southeast and east-central side of the island, especially at higher elevations. The plants might not be seen during dry years or seasons, either dying back to their bases or surviving as seeds.

General distribution: Endemic to the Guaymas region including the Sierra Libre and San Pedro Nolasco.

Other islands: none.

SE side, 1 Nov 1963, *Maya s.n*. E-central side of island, 26 Nov 1963, *Felger 9655*. Above SE cove, 11 Aug 1964, *Cooper* [*Felger 10402*]. Ridge on E-facing slope of island, one canyon S of Cañón el Farito, occasional, 11 Nov 2009, *Wilder 09-134*.

Trixis californica Kellogg var. ***californica***. *Plumilla, arnica*; trixis.

Small shrubs or subshrubs, probably not long-lived and potentially flowering in the first season. Leaves thin, gradually drought deciduous, the leaf bases persistent. Flowers bright yellow; foliage and flowers appearing at various seasons.

Widely scattered and one of the more common perennials at all elevations across the eastern side of San Pedro Nolasco and scattered on the west side mostly in canyons above ca. 110 m.

General distribution: Common on the opposite mainland and across most of Sonora below the oak zones. Southeastern California to Texas and south to Baja California Sur, Sinaloa, and north-central Mexico. A second variety occurs in the Cape Region of Baja California Sur.

Other islands: Ángel de la Guarda, Tiburón, Dátil, San Esteban, San Lorenzo, San Pedro Mártir, Tortuga, San Marcos, Coronados, Carmen, Danzante, Monserrat, San Francisco.

Infrequent, small, little branched shrub 1.5 ft high on N-facing cliff near island crest, 17 Apr 1921, *Johnston 3135* (CAS). E side, common, 26 Nov 1963, *Felger 9644*. E side, 29 Mar 1964, *Sherbrooke s.n*. SE side, 31 Oct 1964, *Sherbrooke* [*Felger 11232*]. W side, W exposure, 700 ft, 21 Mar 1974, *Pulliam and Rosenzweig s.n.* E-central side, N exposure, below crest of island, 270 m, 28 Nov 2006, *Felger 06-106*. Cañón El Farito, occasional, 2 Feb 2008, *Wilder 08-156*. Cañón de Mellink, 190 m, 29 Sep 2008, *Wilder 08-354*.

BURSERACEAE—Frankincense Family

Bursera microphylla A. Gray. *Torote blanco*, *torote colorado*, *torote prieto*, *copal*; elephant tree.

Shrubs or dwarf trees, sometimes to ca. 3 m tall. Sap and leaves especially rich in terpenes and highly aromatic. Trunk short, the limbs and trunk fat and semisucculent, the wood soft and pithy. Leaves bright green, drought deciduous and facultatively produced at any time of year. Flowers white, minute, probably in early summer. (Mainland populations are generally polygamodioecious, and isolated plants with bisexual flowers may be able to reproduce; Becerra and Venable 1999.) Fruits dull purple-brown, 7–9 mm long, 1-seeded, the seeds enveloped in a thin red aril.

Widely scattered on both sides of the island; upper elevations of canyons on the west side and largest and best developed near the summit on the east side.

General distribution: A Sonoran Desert species also extending into the Cape Region of Baja California Sur, western Sonora from the southern limits of the Guaymas region to southwestern Arizona, most of the Baja California Peninsula, southeastern California, and most gulf islands.

Other islands: Ángel de la Guarda, Tiburón, Alcatraz, Dátil, San Esteban, San Lorenzo (observation), Tortuga (observation), San Marcos (observation), Coronados, Carmen, Danzante, Monserrat, Santa Catalina, Santa Cruz, San Diego (observation), San José, San Francisco, Espíritu Santo, Cerralvo.

NE side, mid-elevation, rare shrub, 26 Nov 1963, *Felger 9637*. Saddle at middle of island, 875–900 ft, not common, 18 Jan 1965, *Felger 12089b*. SE side, 31 Oct 1964, *Sherbrooke* [*Felger 11240*]. NE side, about 5 m below crest of island, ca. 250 m elevation, shrubs 2–2.5 m tall, common near the ridge crest, 28 Nov 2006, *Felger 06-110*. E-central side, just below island crest, ca. 215 m, occasional shrub ca. 1.6 m tall, 3 Feb 2008, *Wilder 08-178*. Cañón de Mellink, 110 m, 29 Sep 2008, *Felger 08-144*. Summit of island, occasional, 11 Nov 2009, *Wilder 09-137*.

CACTACEAE—Cactus Family

Cacti are amazingly prominent throughout San Pedro Nolasco except on the north-facing slopes on the east side of the island, where they are relatively scarce. There are 7 species in 6 genera, ranging from small mammillarias to tree-sized columnar cacti, representing a wide range of diversity with little taxonomic cohesion. Three cacti are endemic to the island: *Echinocereus websterianus*, *Mammillaria multidigitata*, and *M. tayloriorum*.

1. Leaves present on new growth, the spine clusters bearing glochids (small spines deciduous at a touch, in addition to the larger persistent spines, or larger spines sometimes absent).
   2. Chollas; stem segments (“joints”) more or less rounded in cross-section (cylindroid), often tuberculate, fruits green, perennial, and usually forming chains. *Cylindropuntia*
   2′. Prickly-pears; stem segments (“pads”) flattened or compressed, the surfaces relatively flat, not tuberculate; spines not sheathed; fruits solitary, developing and falling in one season. *Opuntia*

1′. Leaves and glochids not present.
   3. Stems less than 1 m tall; not columnar; flowers diurnal.
      4. Stems erect, often more than 20 cm tall; areoles arranged on ribs, the spines mostly 1–1.5 cm long; flowers more than 3 cm long, the bases and fruits spiny. *Echinocereus*
      4′. Stems less than 20 cm tall; areoles on more or less conical tubercles arranged more or less in spirals, the spines to 1 cm long; flowers less than 2 cm long, the flowers and fruits spineless. *Mammillaria*
   3′. Stems becoming more than 1 m tall, columnar; flowers opening at night.
      5. Stems bluish glaucous, dimorphic, the juvenile and adult stems markedly different (e.g., distance between areoles, spine lengths and morphology, and rib numbers), the areoles of adult growth coalesced or close together and spineless, or with smaller, bristly spines. *Pachycereus*
      5′. Stems green, not noticeably dimorphic, the areoles and spines similar on juvenile (lower or sterile portion) and adult (upper or fertile portion) stems. *Stenocereus*

Cylindropuntia fulgida (Engelmann) F.M. Knuth var. ***fulgida*** and ***C. fulgida*** var. ***mamillata*** (Schott ex Engelmann) Backeberg [*Opuntia fulgida* Engelmann. *O. fulgida* var. *mamillata* (Schott ex Engelmann) J.M. Coulter]. *Choya*; jumping cholla.

Trunks seldom straight, with several major branches from about mid-height. As in most chollas, the spines are armed with tiny reverse barbs, which inflict a painful wound when you try to pull them out. Joints of this cholla readily break off or fall away. Stems and fruits green all year, the fruits proliferating in pendulous chains. Flowers 4.0–4.5 cm wide. Inner tepals, filaments, and style deep pink-purple; stigma and anthers white. Propagation is vegetative from readily rooting fallen joints and fruits; apparently does not reproduce by seed.

Widespread and common across the island at all elevations but generally not on north-facing slopes on the east side or at high elevations on the west side.

General distribution: Southern Arizona through much of Sonora, especially the western part of the state, to northwestern Sinaloa. Two varieties are described, and plants with features of both occur on San Pedro Nolasco. Var. *fulgida* has inflated papery-sheathed large spines densely covering the stems. Var. *mamillata* has fewer and shorter spines not obscuring the stem surface and tight-fitting sheaths. Var. *fulgida* apparently does not occur south of the Guaymas region, whereas var. *mamillata* ranges south to Sinaloa. Because of their vegetative propagation, these forms can be sympatric. However, many of the San Pedro Nolasco chollas show intermediate features, and our observations indicate that individual plants resembling

var. *mamillata* might develop characteristics of var. *fulgida* as they become larger.

Cylindropuntia fulgida is closely related to *C. cholla* F.A.C. Weber of the Baja California Peninsula and islands on the west side of the Gulf of California (Rebman 1995). *Cylindropuntia cholla* differs from *C. fulgida* by its single or short-chained and larger, more globose fruits and broader and shallower floral scar on the fruits. Some Sonoran island populations, however, show intermediate features and may be difficult to place.

Other islands: Patos, Tiburón, San Esteban, Cholludo, Alcatraz.

Var. *fulgida*: Cañón de las Guacamayas, vicinity of cave near shore, flowers pink, 3 May 2005, *Gallo-Reynoso* (photo). Intermediate between var. *fulgida* and var. *mamillata*: 18 Jan 1965, *Felger 12074*; Cañón de Mellink, 29 Sep 2008, *Wilder* (photo). Resembling var. *mamillata*: E side, common, 16 Nov 1963, *Felger 9665*; E side, 18 Jan 1965, *Felger 12074*.

Echinocereus websterianus G.E. Lindsay, Cactus and Succ. Jour. (U.S.) 19:153–54, figs. 102 and 103, 1947. Figure 4A.

Plants often 50–60 cm tall, producing several to sometimes 40 or more stems, the stems arising from the base to about 1/3 the way up from the base of the parent stem. Spines pale golden yellow, 9–14.7 mm long. Flowers 4.5–6 cm long (about half as large as those of *E. scopulorum*), the major tepals pink to rose. Flowering ovary ca. 25 mm long, the floral tube ca. 18 mm long. Filaments green, the anthers bright yellow. Stigma lobes green. Fruits succulent, spiny, the spine clusters falling away from ripe fruits. Flowering late April and early May.

Endemic to San Pedro Nolasco and abundant on steep, rocky slopes, especially at higher elevations on east-facing slopes on the east side of the island and in steep canyons and slopes on the west side of the island. Often grows with *Agave chrysoglossa*, *Mammillaria multidigitata*, and *Opuntia bravoana*.

General distribution: This distinctive *Echinocereus* shares features with *E. grandis* Britton and Rose, endemic to the islands of San Esteban, Las Ánimas ("San Lorenzo Norte"), and San Lorenzo. Both species have unusually large, thick, multiple stems arising from the base and the lower 1/3 of the plant and flowers reduced in size and brightness of color as compared with those of *E. scopulorum* Britton and Rose, their presumed closest relative (Wilder et al. 2008). However, *E. websterianus* may be more closely related to mainland populations of *E. scopulorum* than to *E. grandis*. Lindsay named *E. websterianus* in honor of Gertrude Divine Webster, founder of the Desert Botanical Garden in Phoenix.

27° 50′ N, 111° 24′ W, ca. 50 m, 24 Feb 1947, *Lindsay and Bool 498* (holotype, DS 314191; isotype, SD 45130). Common on steep slopes of island, 17 Apr 1921, *Johnston 3137* (CAS). 29 Mar 1937, *Rempel 301*, *303*. 6 Feb 1940, *Dawson 1040*. E side near middle, 2 May 1942, *Moran 4041* (CAS). 3 May 1952, *Lindsay 2228* (SD, CAS). Cañón de las Guacamayas, 100+ m, 14/15 Apr 2003, *Gallo-Reynoso* (photo). Ridge above Cañón de las Guacamayas, in flower, 3 May 2005, *Gallo-Reynoso* (photo).

Mammillaria Two unrelated endemic species occur on the island.

1. Plants forming clusters of numerous stems branching from various places along the parent stem, the stems mostly 5 cm or less in width and generally longer than wide; sap watery; tubercle axils with bristles but not woolly; flowers whitish. *M. multidigitata*

1′. Plants solitary or forming dense, cespitose clusters of several mostly globose stems, the stems more than 10 cm wide; sap milky; tubercle axils woolly; flowers bright pink-purple. *M. tayloriorum*

Mammillaria multidigitata W.T. Marshall ex G.E. Lindsay, Cactus and Succ. Jour. (U.S.). 19:152, figs. 99–100, 1947. Figure 4B.

Many-stemmed, low, cespitose spreading plants. Stems elongated, reaching ca. 4–5 cm in diameter, often somewhat flaccid, the tubercles and spines short, the spines straight, or rarely a few areoles have the central spine curved or moderately hooked at the tip. Male and female flowers on different plants (see below). Tepals white to cream; outer tepals ciliate-fringed, greenish with a faint, pale pink midstripe; inner tepals with entire or essentially entire margins, the tips broadly obtuse except the 3 or so innermost tepals have acute tips. Stigma lobes 5 or 6, green; pistillate flowers with relatively thick lobes, the staminate flowers with slender stigma lobes. Anthers of pistillate plants small and indehiscent, those of the staminate plants larger, dehiscent, and golden yellow. Fruits clavate, bright red to orange, and not very sweet. Flowering in early summer, beginning mid- to late May.

Endemic to San Pedro Nolasco. Abundant on rocky ridges and slopes on both sides of the island. Especially abundant on east-facing slopes and cliffs on the east side of the island and in major canyons on the west side of the island.

In places, *M. multidigitata* grows extremely densely: "this plant was often so thick and in such large clumps as to make it difficult to avoid stepping on them" (Lindsay 1947:75). We decided to call these places "Mammapolis" (Figure 4B). This species often is found growing with *Agave chrysoglossa*, *Echinocereus websterianus*, and *Opuntia bravoana*. The axillary bristles and flower color and structure point to a relationship with the Baja California and gulf island complex of *M. dioica* K. Brandegee, including *M. estebanensis* G.E. Lindsay. The dozen or so living plants in cultivation and specimens with flowers appear to be dioecious (male and female flowers on different plants); however, most other members of the *M. dioica* complex are gynodioecious (Jon Rebman, personal communication 2009).

27° 50′ N, 111° 24′ W, ca. 50 m, 24 Feb 1947, *Lindsay 499* (holotype, DS/CAS). Very common all over the island in dense mats of 30–40 heads, 17 Apr 1921, *Johnston 3122* [as *3112* in Johnston 1924:1115] (CAS). 29 Mar 1937, *Rempel 302*. 27° 58′ N, 111° 24′ W, 2 May 1952, *Moran 40440*. 3 May 1952, *Lindsay 2227* (SD). From SE side, cultivated in Tucson, 5 Jul 1966, *Felger s.n.* Cañón de las Guacamayas, 100+ m, 14/15 Apr 2003, *Gallo-Reynoso* (photo). Ridge above Cañón de las Guacamayas, with flower buds, 3 May 2005, *Gallo-Reynoso* (photo). Ridge between Cañón de las Guacamayas and Cañón de Mellink, 3 May 2005, *Gallo-Reynoso* (photo). Cañón El Farito, 60 m, abundant on S-facing rock slopes, and some on other exposures, in places free of *Vaseyanthus* or mostly so, fruits bright red or orange, 28 Nov 2006, *Felger 06-82* (photos).

Mammillaria tayloriorum C. Glass & R. Foster, Cact. Succ. Jour. (U.S.) 47:175, 1975. Figure 4C.

Plants single-stemmed or cespitose with several heads, branching from the base, stems nearly globose to cylindrical, 15–25 cm tall, with milky sap. Areoles woolly when young, the tubercle axils densely woolly in the flowering zone at the stem apex. Spines to about 1 cm long. Observed in flower in mid-February and March when no other cactus on the island was seen in flower. Fresh flowers (3 Feb 2008) 18–19 mm long, ca. 15 mm wide; outer, smaller tepals with margins short-fringed (fimbriate-ciliate); inner tepals bright pink-purple at base, with a broad, fuchsia-colored (dark pink) midstripe and translucent colorless margins; tepal margins entire or mostly entire with a few very small shallow teeth and a pronounced apiculate tip. Filaments and style white below, fuchsia-colored above (dark pink same as tepal midstripe). Anthers yellowish white. Stigma lobes 5–7, pale amber (perhaps greenish when fresher). Fruits 1–1.5 cm long, elongated (clavate), succulent, and red.

Endemic to San Pedro Nolasco. Common on canyon slopes at the west-central side of the island, especially at higher elevations near and along the ridge crest, and scattered along the east-facing side of the island near the ridge crest (see Johnston 1924:1115). Often growing from crevices on rock faces and in semishade beneath shrubs, especially in places with mid- to late-afternoon shadow. Glass and Foster (1975) postulated that this species is most closely related to the *M. sonorensis* complex of montane east-central and southeastern Sonora

and adjacent Chihuahua. They also suggested a relationship with *M. johnstonii* (Britton & Rose) Orcutt of the Guaymas–San Carlos region and *M. bocensis* Craig, which replaces the latter to the south. We suggest that the San Pedro Nolasco species might be most closely related to *M. bocensis*. The San Pedro Nolasco species is named for "Bob and Suzanne Taylor of El Cajon, California, in recognition of their knowledge of Mexican cactus habitats" (Glass and Foster 1975:175). In earlier publications *M. tayloriorum* was known as *M. evermanniana* (Britton & Rose) Orcutt, which is found on Cerralvo Island and adjacent Baja California Sur and differs in part from the San Pedro Nolasco cactus by having larger and yellowish-green flowers.

"San Pedro Nolasco Island . . . near the highest points of the island along with *Mammillaria multidigitata* and *Echinocereus websterianus*. Note: in the original description the color plates were inadvertently transposed, and fig. 3, supposedly of *M. tayloriorum*, is *M. evermanniana*, and figure 4, listed as *M. evermanniana*, is *M. tayloriorum*," Nov 1975, *Glass and Foster 2686* (holotype, POM 325135/RSA). Seen only near summit crest, rock crevice of a ledge, lactiferous, 17 April 1921, *Johnston 3121* (CAS). 6 Feb 1940, *Dawson 1039* (RSA); [6] Feb 1940, *Dawson s.n.* (UC). Found . . . only along rocky crest, 27 Mar 1947, *Lindsay 502* (CAS). 3 May 1952, *Lindsay 2228* (SD). Above Cañón El Farito, 11 Feb 2000, *Felger and Seminoff* (photos). Above Cañón El Farito, top of W slope, crest above drop off, group of 6 heads, flowers pink with yellow/amber/greenish 5–7 parted stigma, multiple white/yellow stamens, 3 Feb 2008, *Wilder 08-185* (photo). Cañón de Mellink, 90 m, 29 Sep 2008, *Wilder* (photo).

Opuntia bravoana E.M. Baxter. *Nopal*; prickly-pear. Figure 16.

Low, spreading to shrub-sized prickly-pears, often reaching 1–1.5 m tall, a few to nearly 2 m in favorable niches along canyon bottoms. Cladodes (pads) bright green, relatively flat, very succulent, glabrous, often shiny green, and sometimes purplish at the areoles and margins of the pads. Many or most areoles on each cladode spineless, or some areoles with 1–few usually deflexed spines. Cladodes become rather desiccated during extended drought and yellowish or yellowish and green. Flowers monochromatic, bright yellow, and relatively large, mostly in spring. Fruits very succulent, pulp and epidermis red-purple, glabrous, with glochids only; some glochids rather long.

This prickly-pear is abundant on the east and west sides of the island and is best developed on relatively deep soil as well as rock faces. On the west side it is found mostly at higher elevations, where a very dense population occurs in the upper reaches of Cañón de Mellink. The population on the island seems to be dynamic. George Lindsay recorded the following information on the label of a herbarium specimen (*Lindsay 2225*): "a platyopuntia which in 1947 covered large areas of the island in impenetrable thickets, but at the present time [1952] is rare, possibly due to infestations of dodder and insects, the large areas of dead opuntias are now covered with *Vaseyanthus insularis*, a few of the opuntias are left, one of which was in flower." Dodder (*Cuscuta corymbosa*) is sometimes abundant on San Pedro Nolasco but is not known to parasitize cacti. Most likely Lindsay found *Cuscuta* on *Vaseyanthus*, which in turn often covers the prickly-pears. We found the prickly-pears abundant and healthy during all of our visits to the island, although some at low elevations on exposed rock were rather scraggly.

General distribution: Islands at Guaymas and San Carlos, some rock slopes at Bahía San Carlos, the coastal plain from near Las Guasimas south to northern Sinaloa, and the Cape Region of Baja California Sur.

Other islands: Cerralvo.

3 May 1952, *Lindsay 2225* (DS). E side, common in granitic steep ravines, commonly observed *Ctenosaura* lizard feeding on flowers, 29 Apr 1974, *Stinson and Robinson s.n.* (SD). 29 Mar 1937, *Rempel 306*, *307* (AHFH/RSA). E side, spreading prickly-pear to 1 m tall, common on E-, SE-and NE-facing rocky slopes and steep arroyos, fruit red and fleshy, 26 Nov 1963, *Felger 9663*. Cañón de Mellink, 29 Sep 2008, *Wilder 08-356*.

Pachycereus pringlei (S. Watson) Britton & Rose. *Cardón*, *sahueso*. Figure 9.

Large columnar cacti with very thick stems. Stems bluish glaucous, with (12) 13–15 ribs. Immature (juvenile or sterile) portion of stems with stout spines. Mature, flower-bearing (fertile) or upper part of the stems with coalescent areoles and generally spineless, or with few short, weak spines. Flowers white, opening at night and usually remaining open most of the next day; spring. Fruits densely covered with felt-like golden brown hairs; ripening in early summer, splitting open to reveal vividly colored crimson-purple pulp, sweet and delicious.

Common at all elevations on the west side of the island and generally less numerous on the east side, generally not on north-facing slopes. Near the top of island above Cañón El Farito on 28 Nov 2006, some cardons 1–1.2 m tall had blackened, necrotic stem tips, but the meristems seemed intact. However, these blackened stem tips do not seem to be the ailment termed "flat top decay" reported for cardons elsewhere (Bashan et al. 1995).

General distribution: Endemic to the Sonoran Desert: western Sonora, most gulf islands, and most of the Baja California Peninsula.

Other islands: Ángel de la Guarda, Patos, Tiburón, Alcatraz, Dátil, Cholludo (photos), San Esteban, San Lorenzo (observation), San Pedro Mártir, Tortuga, San Marcos (observation), San Ildefonso (observation), Coronados (observation), Carmen, Danzante (observation), Monserrat (observation), Santa Catalina, Santa Cruz (observation), San Diego (observation), San José, San Francisco (observation), Espíritu Santo, Cerralvo.

See quadrat studies (Tables 2, 3, 4, and 5). Multiple observations and photos (e.g., Felger 1966; Lindsay 1962). Cañón de las Guacamayas, Jul 2003, *Gallo-Reynoso* (photo).

Stenocereus thurberi (Engelmann) F. Buxbaum [*Lemaireocereus thurberi* (Engelmann) Britton & Rose]. *Pitahaya dulce*; organpipe cactus. Figures 9 and 13.

Columnar cacti with several to many stems, the stems with 13–18 shallow, rounded ribs. Flowers medium-large and showy, nocturnal, closing rapidly at dawn, the inner tepals white. Fruits fleshy, the rind thin, red when ripe; pulp of mature fruits sweet, juicy, and bright red; spines on fruits (the areoles) readily falling from mature fruits. Flowering and fruiting mostly in summer.

Abundant and widespread on the island, including the west side, but generally not on north-facing slopes.

General distribution: Southwestern Arizona and most of Sonora to Sinaloa and southwestern Chihuahua; southern Baja California Norte and Baja California Sur.

Other islands: Tiburón, Alcatraz, Dátil, Cholludo, San Esteban, Tortuga (observation), San Marcos (observation), San Ildefonso (observation), Coronados (observation), Carmen (observation), Danzante (observation), Monserrat (observation), Santa Catalina, Santa Cruz (observation), San Diego (observation), San José, San Francisco, Espíritu Santo, Cerralvo.

See quadrat and transect studies (Tables 3, 4, and 5; Figures 8 and 9). Multiple observations and photos (e.g., Lindsay 1962; Figures 3, 10, and 14). Cañón de las Guacamayas, July 2003, *Gallo-Reynoso* (photo). Cañón de Mellink, 29 Sep 2008, *Felger and Wilder* (photos).

CONVOLVULACEAE—Morning Glory Family

Cuscuta corymbosa Ruiz & Pavón var. ***grandiflora*** Engelmann. *Fideo*; dodder.

Annual vines; stems orange, semisucculent, and stringy. Flowers white, 4.5–6.5 mm long; calyx broadly obtuse, shorter than the corolla tube; stamens shorter than the corolla lobes. Capsules circumscissile, globose. Seeds 4 per capsule, 1.1–1.3 mm long.

Seasonally common, at least on the east side of island; parasitic on *Vaseyanthus insularis* as well as many shrubs, grasses, and herbaceous annuals and perennials.

General distribution: Also on the opposite Sonora mainland.

FIGURE 16. *Opuntia bravoana* and *Vaseyanthus insularis*. Cañón El Farito, 2 February 2008. Photo by B. Wilder.

Mexico to South America. Four varieties are recognized; var. *grandiflora* extends across most of the range of the species.

Other islands: San Esteban.

Steep granitic mountain slope with scattered trees and giant cactus, flowers whitish, 26 Dec 1951, *Gentry 11354* (det. M. Costea 2005). Near middle, E side, 2 May 1952, *Moran 4047* (SD). E side, N-facing slope, mid-elev, 12 Nov 1964, *Felger 11443*. NE side of island, N-facing slope, on shrubs and herbs, many on *Peritylе californica*, also on *Vaseyanthus insularis*, intermediate between var. *stylosa* and var. *grandiflora*, but closer to *grandiflora* because calyx not reaching beyond middle of corolla tube and corolla bulging, but these are dried, 8 Jan 1965, *Felger 12082* (det. M. Costea 2005). NE side, halfway to summit, ca. 150 m, abundant at all elevations, mostly on *Vaseyanthus insularis*, also on grasses and many shrubs, 28 Nov 2006, *Felger 06-91*.

CUCURBITACEAE—Gourd Family

Vaseyanthus insularis (S. Watson) Rose [*V. insularis* var. *inermis* I.M. Johnston] Figures 15 and 16.

Herbaceous, annual vines. Growing luxuriantly with late summer–fall to spring rains and dying with early summertime drought and heat; often carpets otherwise barren rocky slopes, forming dense intertwining, sprawling mats and festooning other plants in green curtains and blankets. The plants quickly form a thick, carrot-shaped, fleshy, and white taproot. Stems often to 2 m long or more, 4- or 5-angled or ribbed and relatively tough; tendrills usually forked. Leaves prominently petioled, the leaf blades pale green, relatively thin, and highly variable, shallowly to deeply palmately lobed and parted.

Flowers unisexual; male and female flowers occur on the same plant; flowers small and fragrant, the male flowers white. Fruits with a globose body, prickly or smooth, and a slender, smooth, seedless beak longer than the body or base; newly ripe or near ripe fruits bright green and fleshy, the body 12.7–14.3 × 11.1–12.4 mm, the beak green and succulent.

The fruits are mostly spiny (echinate), some are smooth, and some are intermediate; they appear to be variable on the same or different plants. As the fruits mature, the beak falls away, and the fleshy fruit body dries as a brown, globose, and corky structure with one or two light seeds and large, well-sealed air pockets. The dry fruits ultimately break apart around the middle. The dry fruits, which readily float, are well-adapted to dispersal by sea (Gentry 1964).

Vaseyanthus is often seasonally abundant on San Pedro Nolasco, occurring throughout the island at all elevations, but it is generally less dense or common on south-facing slopes. It often blankets the ground and rocks, sometime making it slippery and dangerous to climb over rocks. It is apparent that this rank-growing vine can smother other plants and substantially influence their local distributions. Seabirds seem to avoid nesting among rank-growing *Vaseyanthus*.

General distribution: Coastal Sonora from the vicinity of El Desemboque San Ignacio to the vicinity of Guaymas, most of the islands in the Gulf of California, and Baja California Sur.

Gentry (1950; 1964:1428) recognized three varieties:

1. Fruits smooth or slightly echinate, globose to oblong (peninsular and insular). Var. *inermis*
1′. Fruits echinate, globose.
   2. Beak deciduous or slightly persistent on mature fruits; leaf lobes mostly triangular, acute, thickish (peninsular and insular). Var. *insularis*
   2′. Beak conspicuously persistent on mature fruits; leaf lobes usually acuminate, thin, and aristate (mainland and San Pedro Nolasco). Var. *palmeri.*

These distinctions seem to be responses to differences in soil moisture, shade conditions, position on the stem, and age of the plant. On San Pedro Nolasco, most or all of the key features of the three "varieties" can be found at one site or even on the same plant (also see Johnston 1924:1181). A second species, *V. brandegeei* (Cogniaux) Rose, occurs in the southern part of Baja California Sur.

It seems strange that *Vaseyanthus* is restricted to the Gulf of California and the Pacific shore of the southern part of Baja California Sur. The ocean-dispersed fruits would seem to allow wider dispersal. One possibility may relate to the species' winter–spring or cool-season habitat. Cool-season rains become reduced south of the Guaymas region, but suitable conditions seem available farther north on the Pacific side of the Baja California Peninsula, where *Vaseyanthus* does not occur.

Vaseyanthus and *Brandegea* seem to be sister genera. *Brandegea* is a small genus of the southwestern United States and northwestern Mexico. It generally replaces *Vaseyanthus* to the north in the Sonoran Desert in Baja California and in areas surrounding the northern part of the Gulf of California. Both genera thrive with cool-season rains, succumb or cease growing during the hottest time of the year, and are similar in the general size and habits of the root, stems, and leaves. They have similar-sized flowers, are monoecious, and have small, beaked fruits. *Brandegea* has thin-walled, dehiscent fruits while *Vaseyanthus* fruits are essentially indehiscent and substantially different in shape.

Other islands: Ángel de la Guarda, Tiburón, San Esteban, San Lorenzo, San Pedro Mártir, Tortuga, San Marcos, Coronados, Monserrat, Santa Catalina, Santa Cruz, San Diego, San José, Espíritu Santo, Cerralvo.

Growing in dense masses over shrubs and rocks in a gulch near sea, associated with spiny-fruited *3132*, 17 Apr 1921, *Johnston 3131* (UC, image). In a gulch near sea, covering rocks and shrubs with a very dense thick mat of stems, growing interlaced with *3131*, a smooth-fruited plant, 17 Apr 1921, *Johnston 3132* (UC, image). Steep granitic mountain slope with scattered trees and giant cactus, green ground vine and low climber, smooth and bristly fruits intertwined, apparently annual, 16 Dec 1951, *Gentry 11351*. SE side, 1 Nov 1963, *Maya s.n*. NE side, 26 Nov 1963, *Felger 9642*. SE cove, steep slopes, 29 Mar 1964, *Sherbrooke* [*Felger 9852*]. Above SE cove, cliff at ca. 100 ft, 11 Aug 1964, *Cooper* [*Felger 10404*]. SE side, 31 Oct 1964, *Sherbrooke* [*Felger 11239*]. NE side, abundant, rank-growing vine covering shrubs and sprawling over rocks, 12 Nov 1964, *Felger 11438*. NE side, fruits echinate and smooth, some with only few spines or intermediate, 18 Jan 1965, *Felger 12066*. E side, W exposure, 250 ft, 21 Mar 1974, *Pulliam and Rosenzweig s.n.* (2 sheets, one says fruits spiny, the other says fruits not spiny). E side, rocky wash barely above sea level to 50 ft, very common vine on ground or in shrubs, 21 Mar 1979, *Radke s.n*. E side, above landfall, 25 m, 30 Sep 1979, *Turner 79-254*. NE side, canyon, ca. 5 m elev, 11 Feb 2000, *Felger 2000-1*. Cañón de las Guacamayas, dry, dead plant, 3 May 2005, *Gallo-Reynoso* (photo). Base of Cañón El Faro, the most abundant and extensive ground cover on the island, 100% cover in arroyo bottom and on some slopes, in many places covering a dense, decaying mat of perennial grasses, fruits smooth or echinate, 28 Nov 2006, *Felger 06-73*. N-facing slope above Cañón El Farito, 2 Feb 2008, *Wilder 08-155*. Cañón de Mellink, 29 Sep 2008, *Felger 08-141*.

CYPERACEAE—Sedge Family

Cyperus—Sedge

1. Plants sticky-viscid; mostly (15) 30+ cm tall; spikelet scales straight, awnless and not recurved. *C. elegans*
1′. Plants not sticky-viscid; mostly ca. 10 (18) cm or less in height; spikelet scales with a recurved awn tip. *C. squarrosus*

Cyperus elegans Linnaeus. Sticky sedge. Figure 11.

Probably annuals or possibly perennials (generally perennials elsewhere), tufted, rather pale in color, and notably sticky-viscid, even the spikelets. Inflorescence bracts leafy. Spikelets in dense, sometimes globose clusters, the scales eventually deciduous. Stamens 3. Style branches 3, the achenes 3-angled, black with a whitish cellular covering.

On February 2008, using binoculars, we clearly viewed this sedge from a boat just below the Agua Amarga water seep and obtained photos. This is the only record for this species on the island since Dawson collected it in 1940. It is highly unlikely that Dawson got it from Agua Amarga. Cañón El Farito, where we presume he collected, is about 700 m north of Agua Amarga. Since the seeds/disseminules are presumably dispersed by birds, it is plausible that one or more sticky sedges grew in a water catchment along the canyon bottom like the one reported by Ray Turner in 1979 (see *Eragrostis pectinacea*, *Turner 79-248*).

General distribution: The nearest known localities are from the nearby mainland in the vicinities of Bahía San Carlos and Tastiota. This species occurs in scattered wetlands, natural and disturbed, in western Sonora from near Ures (on the Río Sonora) and near Tastiota south, as well as at several waterholes on Tiburón Island. Southern United States (New Mexico to Florida) to South America.

Other islands: Tiburón.

6 Feb 1940, *Dawson 1036* (CAS; also LCY, NY, verified by Gordon Tucker, personal communication 2007; *also see* Tucker 1994 and Wilder et al. 2007). Agua Amarga, ca. 30 cm tall, clustered at seep, 3 Feb 2008, *Wilder 08-184* (photos).

Cyperus squarrosus Linnaeus [*C. aristatus* Rottbøell. *Mariscus squarrosus* (Linnaeus) C.B. Clarke] Dwarf sedge.

Nonseasonal annual, 1.5–10 (18) cm tall and tufted (this is the smallest *Cyperus* in the Sonoran Desert). Leaves few, soft, basal or nearly so, usually less than 1 mm wide. Each spikelet scale has a prominent recurved awnlike tip giving a "fringed" appearance to the spikelets; scales often reddish bronze to yellowish with green margins. Stamen 1, sometimes with an additional 1 or 2 stamens or staminodes. Style branches 3, the achene 3-sided.

Two localized populations have been found on the island, both after exceptional rainfall and in areas free of *Vaseyanthus* vines.

General distribution: Widespread in the Sonoran Desert, including the Guaymas region, in permanently to temporarily wet soils. Worldwide in temperate and tropical regions.

Other islands: San Pedro Mártir, Espíritu Santo (Tucker 1994:90).

Cañón El Faro, ca. 60 m, 27° 58′ 24″ N, 111° 22′ 48″ W (WGS 83), open area near canyon bottom, E-facing exposure in local area mostly free of *Vaseyanthus*, with *Boerhavia*, *Coreocarpus*, *Eragrostis*, *Setaria liebmannii*; localized population with several hundred plants (not seen elsewhere), 28 Nov 2006, *Felger 06-87*. Cañón de Mellink, ca. 75 m, steep N-facing slope, loose soil and rock, locally abundant (not seen elsewhere today), with *Acacia willardiana*, *Aristida ternipes*, *Cylindropuntia fulgida*, *Eragrostis pectinacea*, *Euphorbia lomelii*, *Fouquieria diguetii*, *Leptochloa panicea*, *Muhlenbergia microsperma*, and *Stenocereus thurberi*, 29 Sep 2008, *Felger 08-147*.

EUPHORBIACEAE—Spurge Family

This large family is represented on the opposite mainland by more than 40 species of diverse growth forms, from annuals to small trees. The four species on San Pedro Nolasco are shrubs or subshrubs, and

only one, the *Jatropha*, is common on the nearby opposite mainland. The remaining three do not occur at the nearest mainland localities or have unusual patterns in relation to their nearest populations.

1. Stems white-waxy, thick, succulent, and terete, without spur-branches, the leaves few and quickly drought deciduous. *Euphorbia lomelii*

1′. Stems not as above, not succulent or if so then with spur branches; stems leafy except in dry seasons.

2. Sap milky; leaves opposite; flowers enclosed in a cup-like, gland-bearing involucre (cyathium). *Euphorbia magdalenae*

2′. Sap various but not milky; leaves alternate; flowers not enclosed in a cyathium.

3. Stems not thick and succulent; herbage with stellate or lepidote hairs; leaves widest at middle. *Bernardia*

3′. Stems thick and semisucculent; glabrous or with few simple or basifixed hairs; leaves widest above middle. *Jatropha*

Bernardia viridis Millspaugh.

Shrubs 1.6–2 (2.2) m tall, with rigid, woody branches. Leaves and young stems densely covered with stellate hairs. Leaves drought deciduous, short petioled, the blades about as wide as long and with toothed margins. Male and female flowers on separate plants. Flowers small and inconspicuous. Seeds thick and obovoid, about 6.7–7.5 mm long × 5.5–6.7 mm wide, without a caruncle.

East and west side of the island on steep slopes near the crest, occasionally along canyon bottoms at lower elevations on the east side, but not seen below 110 m on the west side.

General distribution: The closest known populations are in thornscrub and tropical deciduous forest in southern Sonora (Steinmann and Felger 1997); also Baja California Sur, southwestern Chihuahua, and Sinaloa.

Like the jojoba (*Simmondsia chinensis*), this shrub is dioecious, so colonization would require establishment of at least two individuals flowering at the same time. This species has been previously treated as a synonym of *B. mexicana* (Hooker and Arnott) Müller Argovensis (e.g., Wiggins 1964:790). However, they seem to be distinct species, and *B. mexicana* does not range north of central Sinaloa (Steinmann and Felger 1997).

Other islands: Monserrat, Santa Cruz, Espíritu Santo, Cerralvo.

E side, near top of island, protected N-facing cliff base, not common, 26 Nov 1963, *Felger 9643*. NE side, canyon near crestline on NE-facing slope, shrubs to 2 m tall, 11 Feb 2000, *Felger 2000-3*. NE side, higher elevation on N- and NE-facing slopes, some also in canyon bottom at lower elev, 28 Nov 2006, *Felger 06-104*. E-central side, just below crest of island, 215 m, scattered shrubs, 3 Feb 2008, *Wilder 08-177*. Cañón de Mellink, 29 Sep 2008, *Wilder 08-355*. Cañón El Farito, one of several large shrubs in canyon, 11 Nov 2009, *Wilder 09-125*.

Euphorbia lomelii V.W. Steinmann [*Pedilanthus macrocarpus* Bentham] *Candelilla.*

Rhizomatous perennials; stems often 0.5–1+ m tall, several to many, thick and succulent, mostly straight, upright, and unbranched or few-branched, with a white-waxy coating and copious white latex. Leaves few and sparse, ca. 1 cm long, and very quickly drought deciduous. Cyathia about 2–2.5 cm long, bilateral, the cyathia and flowers bright red or red-orange, visited by hummingbirds. (Costa's Hummingbird, the only one recorded for the island, is often abundant.) The gland chamber of the involucre overflows with nectar that often drips down the flowers. Female flower one per cyathium, appearing before the male flowers; when emerging it sticks straight out, but later it bends downward and out of the way as the many male flowers emerge in the former position of the female flower. Fruits angled, spurred, and indehiscent. Seeds often 8.0–8.5 mm in diameter, nearly round, without a caruncle.

Common on steep, rocky slopes at all elevations along the east side of the island and in larger canyons and on ridges on the west side, especially on south-facing slopes with *Echinocereus websterianus* and *Mammillaria multidigitata*.

General distribution: The nearest populations are in western Sonora on fine-textured soils of the coastal plain southeast from Guaymas to northwestern Sinaloa. A northern population occurs on the alluvial plain abutting Estero Tastiota and bottomlands south along the coast as well as on rocky slopes to the vicinity of the village of El Cholludo. Also Baja California and Baja California Sur.

Other islands: Carmen, Espíritu Santo, Cerralvo.

E side, common, 26 Nov 1963, *Felger 9634*. Cañón El Faro, 60 m, forming colonies on S- and E-facing rock slopes, seen at all elevations, especially on S-facing rock slopes, 28 Nov 2006, *Felger 06-85*. Cañón El Farito, locally common in colonies, 2 Feb 2008, *Wilder 08-163*. Cañón de Mellink, dense population, 29 Sep 2008, *Wilder* (photo).

Euphorbia magdalenae Bentham [*Chamaesyce magdalenae* (Bentham) Millspaugh].

Small shrubs, glabrous or essentially so, the branches numerous and mostly erect and not intricately branched. Leaves oblong-obovate, often about twice as long as wide, the margins entire or sometimes faintly serrulate.

Local at the top of the island: above the Cala Güina cove, on the summit at the center of the island, and on the ridge crest above Cañón de Mellink.

General distribution: The nearest known population occurs locally at the southeast side of Tiburón Island (Felger and Lowe 1976). It is otherwise known from the Baja California Peninsula and associated islands, where it is rather widespread. Johnston (1924:1069) reported it from the Sonora mainland at Bahía San Pedro, but it has not been found there in spite of intensive botanical surveys (e.g., Felger 1966, and subsequent fieldwork by Felger, Ray Turner, and others). No herbarium specimen from the mainland has been located. This species and *E. tomentulosa* S. Watson are the only shrub species in the subgenus *Chamaesyce* in northwestern Mexico; *E. tomentulosa* is common at Bahía San Pedro and on Tiburón and is distinguished in part by its toothed leaf margins.

Other islands: Tiburón, San Marcos, Coronados, Carmen, Danzante, Monserrat (observation), Santa Catalina, Santa Cruz, San Diego, San José, San Francisco, Espíritu Santo, Cerralvo.

SE side of island, rocky ridge ca. 20 m below summit, small shrub, only two plants seen, 26 Nov 1963, *Felger 9657*. E exposure 900–1000 ft, in steep talus slope, 20 Mar 1974, *Pulliam and Rosenzweig s.n*. E exposure, in talus at 900–1000 ft, rare, 0.6–1 m tall, 21 Mar 1974, *Pulliam and Rosenzweig s.n*. Ridge top of island, highest point on the N side of the island, NW-facing slope above Cañón de Mellink, 260 m, small shrubs ca. 30–40 cm tall, population of ca. 50 plants, 29 Sep 2008, *Wilder 08-358*. Summit of island, 11 Nov 2009, several hundred plants, *Wilder 09-138*.

Jatropha cuneata Wiggins & Rollins. *Sangrengrado.*

Trunkless, many-stemmed shrubs often 1–2+ m tall. Stems thick, semisucculent, flexible, and beset with knobby short-shoots. Glabrous or glabrate, or young stems and leaves with short white hairs. Roots and stems ooze blood-like sap when cut or bruised; the sap stains clothing permanently. Leaves quickly drought deciduous: short-shoot leaves are relatively smaller and sessile, appearing after rains at almost any time of the year; long shoots, or primary growth including seedlings, develop with sufficient soil moisture during warm weather, and produce mostly larger, lobed, and short-petioled leaves. Flowering and fruiting occurs during the hot, humid summer rainy season. Fruits rounded, 1-seeded, the seed rounded, ca. 1 cm wide, with a minute white-waxy caruncle.

Common on exposed ridges on the east side and widely scattered elsewhere on the island, including dense stands in the upper elevations of canyons on the west side of the island.

General distribution: Northwestern Sinaloa, western Sonora,

and southwestern Arizona, most of the Baja California Peninsula, and gulf islands.

Other islands: Ángel de la Guarda, San Lorenzo (observation), Tiburón, Dátil, San Esteban, Tortuga, San Marcos (observation), Coronados (observation), Carmen, Danzante, Monserrat (observation), Santa Catalina, Santa Cruz, San Diego, San José, San Francisco, Espíritu Santo, Cerralvo.

E-central side of island, common shrub, 26 Nov 1963, *Felger 9662*. NE side of island, shrub, 12 Nov 1964, *Felger 11441*. Center of island, W side near top, ca. 800 ft, 18 Jan 1965, *Felger 12089*. Above SE cove, 1 Nov 1963, *Maya s.n*. Cañón El Faro, ca. 60 m, shrubs ca. 1 m tall, S-facing slope, also seen on exposed ridges at all elevations, 28 Nov 2006, *Felger 06-83*. N-facing slope above Cañón El Farito, few juvenile plants, 2 Feb 2008, *Wilder 08-162*. Cañón de Mellink, 190 m, abundant, 29 Sep 2008, *Wilder 08-352*.

FABACEAE (LEGUMINOSAE)—Legume Family

Acacia willardiana Rose [*Mariosousa willardiana* (Rose) Seigler & Ebinger]. *Palo blanco*. Figure 17A.

Unarmed, thin graceful trees to 4+ m tall, the trunk and major limbs slender and flexible, the crown high and rather sparse, and leafy twigs drooping. Bark smooth, whitish to pale cream-orange colored, and peeling away in papery sheets. Leaves with 1 (or 2) pair(s) of small, terminal pinnae, the leaflets and pinnae soon drought deciduous, leaving the long, slender leafstalk like a phyllode. Flowers pale yellow. Pods flat, straw-colored, tardily dehiscent and dry (without mesocarp). Flowering at least February–May and sometimes in fall. Seeds lens shaped, 9–10 mm wide, readily germinating without scarification (Felger et al. 2001).

Widespread on the island, especially at higher elevations. East side of island in canyons, on slopes, and on cliffs including south-facing slopes to the ridge crest; on west side of island most common at higher elevations and locally in small but dense stands in canyon bottoms.

While exploring Cañón de Mellink on 29 September 2008, we encountered numerous, severely trimmed *palos blancos*, often less than 50 cm tall, with green twigs and leaves looking as if they had been repeatedly clipped with pruning shears (Figure 17B). We saw scats of the spiny-tailed iguana (*Ctenosaura nolascensis*) on rocks next to the pruned shrubs, and indeed the iguana is the only large herbivore on the island. At about 1 P.M., we took a rest break, sitting on large rocks in the filtered shade of a small grove of *palos blancos* in the canyon bottom at 110 m elevation. Two adult iguanas were in the canopies of different acacias, eating the fresh green leaflets and pinnae but not the leafstalk rachises. We watched them for about half an hour. The larger one, a male, was climbing about chomping down the fresh new foliage (Figure 17C). It seemed doubtful that the iguanas could climb the smooth trunks. The male was in a canopy touching a large *Colubrina* shrub that looked like the only point of access to the *palo blanco* canopy. The female was in a canopy close to a canyon-cliff wall and had probably jumped off the ledge into the canopy. We apparently spooked her, and she came crashing down to the ground, then ambled off, seemingly unperturbed. We returned about 45 minutes later and observed the male still greedily feeding in the canopy.

General distribution: *Palo blanco* is common on the adjacent mainland. Western Sonora and northwestern Sinaloa.

Other islands: Tiburón.

Common over higher parts of the island, 17 Apr 1921, *Johnston 3125* (CAS, UC). Middle, E side, 2 May 1952, *Moran 4052* (SD, UC). E side, 26 Nov 1963, *Felger 9651*. E side, eastern exposure, 700–800 ft, 21 Mar 1974, *Pulliam and Rosenzweig s.n*. Cañón El Faro, ca. 60 m, 28 Nov 2006, *Felger 06-86*. Cañón de Mellink, 110 m, 29 Sep 2008, *Felger 08-143*.

FOUQUIERIACEAE—Ocotillo Family

Fouquieria diguetii (Van Tieghem) I.M. Johnston. *Palo Adán*. Figures 9 and 13.

Large shrubs or small trees to 4 m tall and often about as wide as tall. Leaves appearing facultatively with rains and quickly drought deciduous. Flowers red and tubular, few to many, in mostly near-terminal clusters. Seeds thin, papery, and winged.

Widespread throughout the island, but generally not on north-facing grassy slopes. Best developed at higher elevations on both sides of the island, especially common on the east side.

General distribution: Coastal Sonora from the vicinity of Tastiota south to Puerto Yavaros, southern Baja California Norte, and Baja California Sur.

Other islands: Ángel de la Guarda, Tortuga, San Marcos, San Ildefonso, Coronados (observation), Carmen (observation), Danzante (observation), Monserrat (observation), Santa Catalina, Santa Cruz, San Diego (observation), San José, San Francisco, Espíritu Santo, Cerralvo. Also reported for Tiburón and San Lorenzo but it does not seem to occur there; the two known ocotillo plants on San Esteban might be this species or *F. splendens* (Wilder et al. 2008).

E side, 26 Nov 1963, *Felger 9654*. Middle of island, saddle at top, 850–900 ft, small tree, 18 Jan 1965, *Felger 12081*. Cañón de las Guacamayas, near shore, Jul 2003, *Gallo-Reynoso* (photo). Cañón de las Guacamayas, 3 May 2005, *Gallo-Reynoso* (photo). E-central side, S-facing canyon slope, ca. 150 m, ca. 2.5–3+ m tall, 28 Nov 2006, *Felger 06-90*. Cañón El Farito, occasional, ca. 3 m tall, 2 Feb 2008, *Wilder 08-171*. Cañón de Mellink, 190 m, 29 Sep 2008, *Wilder 08-353*.

LAMIACEAE (LABIATAE)—Mint Family

Salvia similis Brandegee. Figure 18.

Shrubs often 1–1.6 m tall with slender stems, grayish white herbage, thin leaves, and dark blue corollas. Recorded flowering in March and November. The flowers are frequented by Costa's Hummingbirds, vigorously zooming into the corollas. Probably flowering any season with sufficient rainfall.

North- and northeast-facing slopes near the summit on the east side of the island and upper elevations of canyons on the west side. Often in aggregations of several plants.

General distribution: Apparently rare on the mainland, where it is known from a single record at San Carlos, the site since destroyed. The mainland and San Pedro Nolasco populations are both on north- and east-facing granitic (granodiorite) slopes above the water; there are very few mainland habitats where these conditions are duplicated. Widespread in Baja California Sur.

Other islands: none.

E side, near summit, ca. 800 ft, localized, not common, 26 Nov 1963, *Felger 9636*. SE side, above the cove, 31 Oct 1964, *Sherbrooke* [*Felger 11235*]. Just below crest, 800 ft, E exposure, 21 Mar 1974, *Pulliam and Rosenzweig s.n*. E side, 6 Oct 1974, *Ward s.n.* E-central side, N exposure below crest, 270 m, 28 Nov 2006, *Felger 06-98*. E side, below crest of island, 215 m, 2 Feb 2008, *Wilder 08-173*. Cañón de Mellink, occasional, 190 m, 29 Sep 2008, *Wilder 08-351*.

Sonora mainland: Peninsula on S side of Algodones Bay, 2 km W of Cerro Teta de Cabra summit, N-facing granite slope, elev 5–20 m, desert scrub with *Stenocereus thurberi, Jatropha cuneata, Bursera microphylla, Fouquieria diguetii*, uncommon shrub, about 1 m tall, 17 Mar 1983, *Burgess 6361*.

LOASACEAE—Stickleaf or Loasa Family

Eucnide rupestris (Baillon) Thompson & Ernst [*Sympetaleia rupestris* (Baillon) S. Watson]. Velcro plant.

Nonseasonal annuals, the roots unusually small for the size of the plants; stems and petioles semisucculent. Leaves and stems stick like Velcro as a result of the minutely barbed hairs. Petioles 2–13 cm long, the leaf blades 3–14 cm long, relatively thin, glistening, and bright yellow-green. Corollas yellow and green, about 1 cm long, the stamens shorter than the corolla.

Mostly on rocks and cliffs, including sea cliffs, at all elevations on both sides of the island; sometimes seasonally common.

FIGURE 17. *Acacia willardiana*, Cañón de Mellink, 29 September 2008. (A) Tree with Ben Wilder, south-facing slope, ca. 100 m. Photo by R. Felger. (B) Plant severely grazed by iguanas, with iguana scats on the rock, ca. 80 m. Photo by R. Felger. (C) Male iguana feeding in the crown of a tree (*Felger 08-142*) at 110 m. Photo by J. P. Gallo-Reynoso.

General distribution: Gulf side of Baja California Sur to southeastern California, islands in the Gulf of California, and northwestern Sinaloa and western Sonora to southern Arizona.

Other islands: Ángel de la Guarda, Tiburón, Dátil, San Esteban, San Marcos, Espíritu Santo.

Very common in sheltered rock crevices on cliffs near the sea, 17 Apr 1921, *Johnston 3143* (CAS, US). Steep granitic mountain slope with scattered trees and giant cactus, annual with shiny dark green leaves, flower tube pale yellowish, limb green, 16 Dec 1951, *Gentry 11352*. Near middle E side, 2 May 1952, *Moran 4044* (CAS). NE side, 12 Nov 1965, *Felger 11435*. NE side, among rocks, generally N-facing, 18 Jan 1965, *Felger 12084*. Above SE cove, cliffs 100 ft, 11 Aug 1964, *Cooper* [*Felger 10406*]. E side, on cliffs including near ocean, fairly common, 26 Nov 1963, *Felger 9658*. Just below crest, ca. 900 ft, in rocks, 21 Mar 1974, *Pulliam and Rosenzweig s.n.* E-central side, N exposure below crest of island, 270 m, 28 Nov 2006, *Felger 06-105*. E-central side, just below crest of island, 215 m, 3 Feb 2008, *Wilder 08-175*. Cañón de Mellink, 29 Sep 2008, *Wilder 08-346*.

MALPIGHIACEAE—Malpighia Family

Galphimia angustifolia Bentham [*Thryallis angustifolia* (Bentham) Kuntze].

Low herbaceous or suffrutescent perennials. Flowers attractive, the corollas yellow, sometimes orange after opening, often becoming reddish with age; probably flowering in any season with sufficient rainfall.

Known from the island by a single collection.

General distribution: Western Sonora (from the mountains opposite Tiburón Island southward), northwestern Sinaloa, Baja California Sur, northeastern Mexico, and southern Texas. A number of herbarium specimens are annotated as "*G. brasiliensis* (Linnaeus) Adr. de Jussieu subsp. *angustifolia* (Bentham) Bruce MacBryde, 1970," but the combination was not published. *Galphimia brasiliensis* is a species of South America (Anderson 2007).

Other islands: Tiburón, Danzante, Monserrat, Santa Catalina, Santa Cruz, San José, Espíritu Santo.

E-central part of island, 700 ft, bottom of steep rocky canyon, only one plant encountered, perennial, bushy with dense foliage, ca. 1 m high and 1.3 m across, base scarcely woody, stems herbaceous, in full flower, flowers yellow, 26 Nov 1963, *Felger 9633*.

MALVACEAE—Mallow Family

Gossypium davidsonii Kellogg [*G. klotzchianum* var. *davidsonii* (Kellogg) J.B. Hutchinson].

Broad, low-branching shrubs often 1–1.8 m tall. Leaf blades often 4–8 cm long, ovate, cordate at the base. Flowers in lateral inflorescences; floral bracts 1.5–2.8 cm long with several large, often ragged teeth, the bracts persistent even on the fruits. Corollas 2.5–3 cm long, bright yellow, often with a dark center. Flowering at least October and November.

Locally on steep rocky slopes above Cala Güina at the southeastern side of the island.

General distribution: Sonora on rocky slopes in the Guaymas region and the Baja California Peninsula south of 26˚N. *Gossypium davidsonii* is not primarily a desert plant but rather a member of a subtropical group that scarcely extends into the desert margin.

Other islands: Coronados, Carmen, Monserrat, Cerralvo.

SE side, above cove, 1 Nov 1963, *Maya s.n.* Above SE cove, ca. 50 ft, low spreading bush, in crevices of steep rock slope, not common, 26 Nov 1963, *Felger 9659*. Above SE cove, ca. 100 ft, 11 Aug 1964, *Cooper* [*Felger 10400*].

MOLLUGINACEAE—Carpetweed Family

Mollugo verticillata Linnaeus. Carpetweed.

Hot weather annuals; glabrous. Stems threadlike. First leaves in a basal rosette (the genus is unusual among hot-weather annuals in having a basal rosette of leaves). Leaves small and spatulate. Flowers very small, without petals, the sepals green and white. Seeds 0.54–0.63 mm wide, kidney-shaped, with conspicuous snail-shaped dark ridges (striae) on their flattish sides, the ridges dark brown and grooves between them (sulci) lighter brown.

Seasonally common on the east side of the island.

General distribution: Western Sonora, from near Tastiota and the Guaymas region including Ensenada Grande and Nacapule southward; common in regions of subtropical scrub south and east of the desert. Nearly worldwide; probably native in the New World.

Other islands: San Diego, San José, Espíritu Santo.

E side, common on rocky slopes, 26 Nov 1963, *Felger 9652*.

MORACEAE—Fig Family

Ficus petiolaris Kunth subsp. ***palmeri*** (S. Watson) Felger & Lowe [*Ficus palmeri* S. Watson]. *Tescalama*; cliff fig.

Shrubs and small trees, the larger ones 3–4 m tall, growing on rock surfaces. Root and stem bark whitish. Seedlings establish themselves on rocks and cliffs. Twigs, leaves, and figs densely to sparsely pubescent. Leaves gradually and facultatively drought deciduous, 6–28 cm long, the blades often relatively firm, broadly ovate or less often oval, the base moderately cordate or not, often becoming glabrate with age. Figs 1.6–1.8 cm in diameter, globose-obovoid, paired or single when one fails to develop (or falls away).

Sparsely scattered across the island in canyons, on cliffs, and on ridges; most common near the ridge tops. Rather large *tescalamas* are found in the canyon at Punta Los Nacapules (see Place Names).

General distribution: This species ranges south to Guatemala. Subspecies *palmeri* is endemic to the Sonoran Desert: gulf coast of western Sonora, gulf islands, and the Baja California Peninsula.

FIGURE 18. *Salvia similis*, Cañón de Mellink, 29 September 2008. Photo by B. Wilder.

The young plants produce many slender adventitious roots that cascade over the rock surfaces to the soil and eventually coalesce to form irregularly shaped roots that look like they were poured over rock. This is the largest-leaved plant on the island apart from the agave. Gallo-Reynoso observed three Military Macaws in the canyon at Punta Los Nacapules feeding on *tescalama* figs on 30 May 2003.

Other islands: Ángel de la Guarda, Tiburón, Alcatraz, Dátil, Cholludo, San Esteban, San Lorenzo, San Pedro Mártir (type locality), Tortuga, San Ildefonso, San Marcos, Carmen, Danzante, Monserrat, Santa Catalina, Santa Cruz, San Diego, San José, San Francisco, Espíritu Santo, Cerralvo.

Growing from rock on a N slope near crest of island, 17 Apr 1921, *Johnston 3139* (UC). NE side, small tree, on rocks in canyon bottom, 12 Nov 1964, *Felger 11439*. E exposure, below crest, ca. 800 ft, 21 Mar 1974, *Pulliam and Rosenzweig s.n*. Cañón de las Guacamayas, ca. 20 m elev, 14/15 Apr 2003, *Gallo-Reynoso* (photo). Ridge between Cañón de las Guacamayas and Cañón de Mellink, 3 May 2005, *Gallo-Reynoso* (photo). E-central side, N exposure below crest of island, 270 m, ca. 5 m tall × 6 m wide, scattered individuals of similar size on cliff faces below ridge, 28 Nov 2006, *Felger 06-101*. E-central side, crest of island, 280 m, occasional small tree, 3.5 m tall, mostly in drainages, smaller individuals on cliffs, 3 Feb 2008, *Wilder 08-183*. Southwest and west-central side of island, sea cliffs 10+ m elevation, scattered large shrubs, 29 Sep 2008, *Felger and Wilder* (observation).

NYCTAGINACEAE—Four-O'clock Family

Boerhavia triquetra S. Watson [*B. intermedia* M.E. Jones. *B. triquetra* var. *intermedia* (M.E. Jones) Spellenberg].

Ephemerals growing mostly with hot-weather rains. Leaves oblong to narrowly lanceolate. Inflorescence branches slender. Flowers mostly solitary at branch tips or in reduced subumbellate clusters. Perianths pink, open in the early morning, wither with mid-morning to midday heat. Anthocarps ("fruits") 2.4–2.8 m long, with 5 angles forming short wings; the wings and fruit surfaces melt into copious mucilage when wet and adhere tenaciously upon drying.

Seasonally, one of the most common and widespread annuals on the island; found almost throughout the island at all elevations. In February 2008, we found abundant gray mats of old anthocarps cemented together, due to dried mucilage, covering substantial areas between rocks—this being a significant factor holding the soil together.

General distribution: This species occurs in northwestern Mexico and the southwestern United States, including the Sonoran Desert surrounding the Gulf of California and on gulf islands (Spellenberg 2007). Two varieties are described but are only weakly segregated. The Nolasco population with 5-angled fruits would be var. *intermedia*. However, Richard Spellenberg (personal communication to Felger, 2 June 2008) wrote, "var. *intermedia* is common at low elevations in and around Guaymas, and it is the most common plant around the var. *triquetra* type locality [Guaymas]. One simply has to pull var. *triquetra* specimens out of the general population there. There is no difference in habit or habitat. I doubt these varieties will hold—they will be only transitional to general acceptance that all in this group be simply called *B. triquetra*, without vars."

Other islands: Ángel de la Guarda, Tiburón, San Esteban, Dátil, San Ildefonso.

SE side, 1 Nov 1963, *Maya s.n*. E side, abundant, 26 Nov 1963, *Felger 9650*. NE side, 12 Nov 1964, *Felger 11450*. E-central side, 270 m, abundant in open areas with little or no *Vaseyanthus*, 28 Nov 2006, *Felger 06-107*. N-facing slope above Cañón El Farito, dense mats of dried anthocarps adhered together in areas between rocks, no living plants seen at this time, 2 Feb 2008, *Wilder 08-172a*. Cañón de Mellink, 29 Sep 2008, *Felger 08-146*.

PLANTAGINACEAE—Plantago Family
(includes Scrophulariaceae in part)

1. Bushy perennials or subshrubs; corollas bright red. *Gambelia*
1′. Annuals corollas blue, lavender, or purple. *Pseudorontium*

Gambelia juncea (Bentham) D.A. Sutton [*Galvezia juncea* (Bentham) Ball. *G. juncea* var. *pubescens* (Brandegee) I.M. Johnston. *G. juncea* var. *foliosa* I.M. Johnston].

Bushy perennials, 80 (100) cm tall. Herbage moderately glaucous; leaves drought deciduous, the foliage often sparse. Flowers tubular and bright red, attracting hummingbirds.

East side of the island, most numerous toward the summit, often growing from rock crevices.

General distribution: Gulf coast of western Sonora south to the Guaymas region; the Baja California Peninsula.

Other islands: Ángel de la Guarda, Tiburón, San Esteban, San Lorenzo, San Marcos, Carmen, Danzante, Monserrat, Espíritu Santo.

17 Apr 1921, *Johnston 3133* (not seen, cited by Johnston 1924:1161). SE side, 31 Oct 1964, *Sherbrooke* [*Felger 11241*]. E exposure, just below crest at 800 ft, 21 Mar 1974, *Pulliam and Rosenzweig s.n*. E-central side, N exposure below crest of island, 270 m, seen only at higher elevations on N-facing slopes in aggregations of several plants, 28 Nov 2006, *Felger 06-100*. E-central side, 215 m, occasional, 3 Feb 2008, *Wilder 08-174*. Ridge top of the island, highest point on the N side of the island, 260 m, 29 Sep 2008, *Wilder 08-357*.

Pseudorontium cyathiferum (Bentham) Rothman [*Antirrhinum cyathiferum* Bentham] Desert snapdragon.

Nonseasonal ephemerals, but found mostly during cooler times of the year; prominently viscid-glandular and foul smelling. Flowers 1 cm long, corollas purplish with two yellow spots at throat. Seeds 2–2.5 mm long with a wide cup-shaped wing.

Observed on the east side of island at middle elevations.

General distribution: Sonoran Desert: western Sonora from the Guaymas region north, both Baja California states, southwestern Arizona, and southeastern California.

Other islands: Ángel de la Guarda, Tiburón, Dátil, Cholludo, San Esteban, Tortuga, San Marcos, San Ildefonso, Coronados, Danzante, Monserrat (observation), San José, San Francisco, Espíritu Santo, Cerralvo.

E-central side of island, N-facing slope, ca. 300 ft, 18 Jan 1965, *Felger* (observation, cited in Felger 1966:98).

POACEAE (GRAMINEAE)—Grass Family

There are 11 genera and 14 species of grasses on San Pedro Nolasco, making it the most diverse family on the island. *Aristida divaricata* and *Eragrostis pectinacea* are not known from any other gulf island. The diversity of the grasses on the island is almost twice that of the composites (Asteraceae), these being the two largest families on the island as well as in the entire Sonoran Desert.

1. Annuals (ephemerals).
  2. Inflorescences with sharp-spined burs. *Cenchrus*
  2′. Inflorescences not forming burs.
    3. Spikelets with slender bristles below the spikelets; spikelets breaking off above the bristles. *Setaria liebmannii*
    3′. Spikelets not subtended by bristles.
      4. Spikelets not awned.
        5. Spikelets with more than 5 florets. *Eragrostis*
        5′. Spikelets with 1–3 florets.
          6. Spikelets more than 5 mm long, 1-flowered. *Aristida adscensionis* (drought-stressed plants)
          6′. Spikelets less than 3.5 mm long, with (1) 2 or 3 florets (mature spikelets may appear 1-flowered). *Leptochloa*
      4′. At least some spikelets with awns.
        7. Inflorescence branches or spikes 1-sided; spikelets with 1 basal fertile floret and 1 or more reduced sterile florets (rudiments) above; one or more florets with 3 awns to 6 mm. *Bouteloua*
        7′. Inflorescence branches not 1-sided; spikelets clearly 1-flowered, without rudiments; awns mostly more than 10 mm long.
          8. Plants not forming cleistogenes; spikelets with 3 prominent terminal awns. *Aristida adscensionis*
          8′. Lower leaf axils with cleistogenes; spikelets 1-awned. *Muhlenbergia*
1′. Perennials.
  9. Spikelets subtended by bristles; spikelets breaking off above the bristles. *Setaria macrostachya*
  9′. Spikelets not subtended by bristles.
    10. Spikelets not awned. *Digitaria*
    10′. At least some spikelets awned.
      11. Florets 3-awned.
        12. Spikelets 1-flowered, without white hairs. *Aristida divaricata*
        12′. Spikelets with 2 dissimilar florets and with tufts of white hairs. *Chloris*
      11′. Florets 1-awned.
        13. Inflorescences with diffusely flowered spreading branches; spikelets with awns to ca. 1.5 cm long. *Aristida ternipes*
        13′. Inflorescences compact, the flowers densely crowded; awns 2 or more cm long.
          14. Inflorescences cottony and whitish; spikelets with awns ca. 2 cm long. *Bothriochloa*
          14′. Inflorescences not cottony, not whitish; awns 4.5–7 cm long. *Heteropogon*

Aristida—*Tres barbas*, threeawn

1. Spikelets with only one awn, or the two lateral awns present but very short and stubby.
  2. Annuals, roots weakly developed; inflorescences compact, the branches, if present, not spreading. *A. adscenionis* (drought-stressed plants)
  2′. Perennials, the roots tough and wiry; inflorescences open and diffuse, the branches spreading at right angles. *A. ternipes*
1′. Awns three and well developed.
  3. Annuals; awn column short and not twisted, the awns flattened. *A. adscensionis*
  3′. Perennials; awn column rather long and twisted, the awns terete. *A. divaricata*

Aristida adscensionis Linnaeus. *Zacate tres barbas*, *zacate de semilla*; six-weeks threeawn.

Nonseasonal ephemerals. Awns 3, the lateral awns sometimes reduced or aborted in drought-stressed plants.

Widespread and seasonally common across much of the island.

General distribution: Ubiquitous across the Sonoran Desert and worldwide, mostly in warmer and dry regions.

Other islands: Ángel de la Guarda, Tiburón, Dátil, San Esteban, San Lorenzo, San Pedro Mártir, Tortuga, San Marcos, Coronados, Carmen, Monserrat, Santa Catalina, San José, San Francisco, Espíritu Santo, Cerralvo.

NE side, very common, 12 Nov 1964, *Felger 11453*. NE side, 18 Jan 1965, *Felger 12089-D*. E-central side, N exposure below crest of island, 270 m, open, exposed ridge-top with *Mammillaria multidigitata, Fouquieria diguetii*, etc, locally common, 28 Nov 2006, *Felger 06-95*.

Aristida divaricata Humboldt & Bonpland ex Willdenow. Poverty grass.

Tufted perennials to about 60 cm tall, the branches of the inflorescence often spreading at 90°. Awn column often relatively long and twisted, the awns 3, the lateral awns often shorter than the central one. Reproductive during warmer months.

Soil pockets and crevices on large rock outcrops and other open areas near the summit on the east side of the island, also locally common on the ridge crest above Cañón de Mellink. *Aristida divaricata* seems to require relatively open microhabitats free from dense vegetation.

General distribution: The nearest known populations are in the northern part of Sierra El Aguaje (north of San Carlos) and at higher elevations in the Sierra Libre (northeast of San Carlos). This species is not known elsewhere within the Sonoran Desert. Guatemala to the southwestern United States (Kansas to Texas and southern California), including mountains above the desert in Baja California (Norte), Sonora, and Arizona.

Other islands: none.

E-central side, 26 Nov 1963, *Felger 9673b* (det. J. R. Reeder 1996). E-central side, N exposure about 15 m below crest of island, 250 m, open, exposed ridge, localized, 28 Nov 2006, *Felger 06-96* (det. J. R. Reeder 2006). E-central side, just below crest of island, 215 m, not common, 3 Feb 2008, *Wilder 08-179*. Ridge, highest point on the N side of the island, 260 m, 29 Sep 2008, *Wilder 08-359*.

Aristida ternipes Cavanilles var. ***ternipes***. *Zacate araña*; spidergrass.

Tufted perennials, often 30–80+ cm tall. Panicles with an open branching pattern, the branches usually spreading at about 90º. The central awn often moderately curved, the two lateral awns absent or greatly reduced.

Common across most of the east side of the island, especially along canyons and grassy slopes, and in major canyons on the west side of the island.

General distribution: Widespread across the Sonoran Desert region. Arizona to Texas and through Mexico to South America and the West Indies.

Other islands: Tiburón, Cerralvo.

SE side of island, 1 Nov 1963, *Maya s.n*. E-central side of island, common, 26 Nov 1963, *Felger 9673*. SE side of island, 31 Oct 1964, *Sherbrooke* [*Felger 11242*]. NE side of island, 12 Nov 1964, *Felger 11436*. NE side of island, 18 Jan 1965, *Felger 12089*. NE side, 150 m, 28 Nov 2006, *Felger 06-103*. E side, NW exposure, 100–200 ft, 20 Mar 1974, *Pulliam and Rosenzweig s.n.* Cañón de las Guacamayas, 14/15 Apr 2003, *Gallo-Reynoso* (photo). NE side, 150 m, open exposed ridge top, S-facing in a local area mostly free of *Vaseyanthus*, 28 Nov 2006, *Felger 06-103*. Cañón de Mellink, 29 Sep 2008, *Wilder 08-345*.

Bothriochloa barbinodis (Lagasca) Herter [*Andropogon barbinodis* Lagasca]. *Zacate popotillo*; cane bluestem.

Robust tufted perennials, growing and reproductive during warm weather. Leaves drying red-brown, at least their bases semipersistent. Panicles with multiple branches clustered at the top of tall, nearly naked stems; nodes and spikelets cottony and white with dense tufts of long, white hairs (longer hairs at nodes often wear off with age). Spikelets mostly paired, dissimilar; fertile (sessile) spikelets with a large, twisted, and bent awn; sterile (stalked) spikelets awnless and reduced to a deciduous linear rudiment.

Seasonally common on mostly north-facing grassy slopes on the east side of the island, from middle to high elevations.

General distribution: Within the Sonoran Desert, *Bothriochloa barbinodis* occurs in usually small populations at widely scattered places of higher soil moisture such as north-facing cliffs, steep slopes, canyons, and waterholes, especially in mountains and not in the open desert. It occurs sparingly on north-facing slopes at Las Barajitas canyon on the opposite mainland. It is common and widespread at elevations above the desert in the eastern part of Sonora and mountains of Baja California Sur. Southwestern United States to southern Mexico, especially in the Mexican highlands, and in South America.

Other islands: San Esteban (Wilder et al. 2007), Espíritu Santo (*Wiggins 15239*, US, not seen, cited in data base).

E-central side, steep N-facing slope, mid-elevation, common, 26 Nov 1963, *Felger 9670*.

Bouteloua aristidoides (Kunth) Grisebach. *Aceitilla, navajita aguja*; six-weeks needle grama.

Summer–fall annuals, the roots are often small and weakly developed; occasionally persist through the winter or occasionally germinate with winter–spring rains, but then the plants small and scrawny. Spikes few-flowered, small and readily falling at maturity, narrow and somewhat arrow shaped, readily lodging in socks and shoes.

Seasonally one of the most common grasses on the island, including exposed and often east-facing slopes on the east side of the island and canyons and slopes on the west side of the island.

General distribution: Southwestern North America to Central America; also Argentina. Several varieties are recognized but are of questionable taxonomic significance.

Other islands: Tiburón, Alcatraz, Dátil, Cholludo, San Esteban, Tortuga, Coronados, Carmen, Danzante, Santa Catalina, Santa Cruz, San Diego, San José, Espíritu Santo.

E-central side of island, 26 Nov 1963, *Felger 9675*. SE side of island, *Sherbrooke 31 Oct 1964* [*Felger 11246*]. NE side, N-facing grassy slopes, 12 Nov 1964, *Felger 11451*. NE side, 18 Jan 1965, *Felger 12089c*. NE side, 250 m, open exposed ridge top, seen at low to high elevations on exposed sites without *Vaseyanthus*, 28 Nov 2006, *Felger 06-97*. Cañón de Mellink, ridge-saddle above NW side of canyon, ca. 80 m elevation, locally abundant, 29 Sep 2008, *Wilder 08-344*.

Cenchrus palmeri Vasey. *Huisapol*; giant sandbur.

Nonseasonal annuals. The obnoxious burs, the largest of any species of *Cenchrus*, persist long after the plants perish, and soil between rocks often is covered with old burs. The fresh burs tenaciously cling together in clusters and adhere to clothing and shoes, and undoubtedly to bird feathers. The mother bur usually remains attached to the adult plant. In September 2008, we found local patches of sandbur plants with blackened, smut-infected inflorescences.

Abundant on both sides of the island from near the shore to the peak.

General distribution: Coastal Sonora, northwestern Sinaloa, both Baja California states, and gulf islands.

Other islands: Ángel de la Guarda (observation), Tiburón, San Esteban, San Lorenzo, San Marcos (observation), Coronados, Carmen, Danzante (observation), Monserrat, San José, San Francisco, Espíritu Santo, Cerralvo.

E-central side, mid-elevation, grassy N-facing slopes, 26 Nov 1963, *Felger 9639*. NE side, N-facing grassy slopes, 12 Nov 1964, *Felger 11447*. E side, above landfall, 25 m, 30 Sep 1979, *Turner 79-253*. Cañón El Faro, 60 m, ridge top with sparse vegetation, on various exposures where *Vaseyanthus* not dense or absent, not seen at higher elevations, 28 Nov 2006, *Felger 06-84*. N-facing slope above Cañón El Farito, no plants seen but the burs abundant, 2 Feb 2008, *Wilder 08-172*. Cañón de Mellink, S-facing canyon slope, 110 m, 29 Sep 2008, *Felger 08–137*.

Chloris crinita Lagasca [*Trichloris crinita* (Lagasca) Parodi. *T. mendocina* (Philippe) Kurtz]. *Zacate escoba*; feather fingergrass.

Large, tufted perennials; growing and reproductive during the warmer months. Panicles of few to many bristly spike-like branches clustered at the top of the stem; spikelets with 3 long awns on both the fertile and sterile florets.

In 1963, *Chloris crinita* was common on grassy slopes on the east side of the island from middle to high elevations, but it was not seen there on later field trips. In 2008, it was locally common in Cañón de Mellink from about 10 to 40 m elevation, growing from rock crevices and small soil pockets in the canyon bottom, and a few were seen to about 110 m elevation.

General distribution: There are few records for this grass in west-

ern Sonora, although it occurs in isolated pockets on the mainland opposite San Pedro Nolasco and in scattered localities elsewhere in the Sonoran Desert; it is more common at elevations above the desert. Texas to Arizona and northern Mexico including Baja California Sur; occurs disjunctly in South America.

Other islands: Tiburón (Wilder et al. 2007).

NE side of island, N-facing slope, mid-elevation, common, 26 Nov 1963, *Felger 9671*. Cañón de Mellink, ca. 10 m elev, 29 Sep 2008, *Felger 08-136*.

Digitaria californica (Bentham) Henrard var. ***californica*** [*Trichachne californica* (Bentham) Chase]. *Zacate punta blanca*; cottontop.

Tufted perennials, also reproductive in first year or season. Stems about 0.5+ m tall and firm, from a hard base. Panicles usually slender (contracted), the branches lying close to the main axis; inflorescences white to purplish because of silvery or purple-tinged silky hairs on the spikelets, giving them a cottony appearance.

Both sides of the island, from low to high elevations, but generally not on south-facing slopes.

General distribution: Southwestern United States to southern Mexico, the Caribbean, and South America. An additional variety occurs in South America.

Other islands: Tiburón, Dátil, Cholludo, San Esteban, San Pedro Mártir, San Marcos, Cerralvo.

E-central side, grassy N-facing slopes at mid-elevation, common, 26 Nov 1963, *Felger 9667*. NE side, steep N-facing grassy slopes, common, 12 Nov 1964, *Felger 11452*. E side, 250 ft, 20 Mar 1974, *Pulliam and Rosenzweig s.n*. E side of island, above landfall, 25 m, 30 Sep 1979, *Turner 79-250*. E-central side, N exposure, 270 m, perennials and some are reproductive in first year or season, scattered at all elevations, 28 Nov 2006, *Felger 06-102*. Cañón El Farito, not common, 2 Feb 2008, *Wilder 08-167*. Cañón de Mellink, ca. 10 m, 29 Sep 2008, *Wilder 08-347*.

Eragrostis pectinacea (Michaux) Nees var. ***pectinacea*** [*E. diffusa* Buckley. *E. pectinacea* var. *miserrima* (E. Fournier) J. Reeder. *E. arida* Hitchcock. *E. tephrosanthos* Schultes]. Carolina lovegrass.

Summer–fall annuals, sometimes growing with winter–spring rains or germinating in fall and persisting through the winter; highly variable in size, to 75 cm tall, the panicles with few to many branches.

Widespread and often common on both sides of the island, in canyon bottoms and on slopes at all elevations, especially on north-facing slopes and in larger canyons.

General distribution: Across much of the Sonoran Desert except the driest areas of the lower Colorado River valley—one of the most widespread hot-weather annual grasses in southern Arizona, Sonora, and Baja California Sur; Canada to Argentina. An additional variety occurs in Florida. Strangely, *Eragrostis pectinacea* is not known from any other Gulf of California island. It is one of the most widespread and abundant New World species of *Eragrostis*, vying only with the Old World *E. cilianensis* for geographic extent.

Other islands: none.

E-central side, 26 Nov 1963, *Felger 9672* (det. J. R. Reeder 1984). NE side, 12 Nov 1964, *Felger 11442* (det. J. R. Reeder 1984). E side of island, above landfall, 25 m, growing near a moist tinaja, 30 Sep 1979, *Turner 79-248* (det. J. R. Reeder 1984). E side of island, above landfall, 25 m, 30 Sep 1979, *Turner 79-252a* (det. J. R. Reeder 1984). Cañón El Faro, 60 m, abundant, highly variable in size, canyon bottom and also on slopes, seen at all elevations, 28 Nov 2006, *Felger 06-88*. Cañón El Farito, common in cracks of rocks, 2 Feb 2008, *Wilder 08-159*. Cañón de Mellink, ca. 10 m, 29 Sep 2008, *Felger 08-140*.

Heteropogon contortus (Linnaeus) P. Beauvois ex Roemer & Schultes. *Zacate colorado*; tanglehead.

Robust tufted perennials; dry leaves rust colored and persistent. Reproductive during warmer months. Inflorescence a solitary spike-like 1-sided raceme, with the awns all on one side.

Known only from the upper ridge and summit of the island, where it is was occasional in 2009.

General distribution: Southwestern United States to South America and warm regions of the Old World.

Other islands: Ángel de la Guarda, Tiburón, San Esteban, San Lorenzo, San Marcos, Carmen, Coronados, Danzante, Monserrat, Santa Catalina, San Diego, San José, San Francisco, Espíritu Santo, Cerralvo.

Upper ridge of the island, E-facing slope, 11 Nov 2009, *Wilder 09-133*. Summit of island, 11 Nov 2009, *Wilder 09-141*.

Leptochloa panicea (Retzius) Ohwi subsp. ***brachiata*** (Steudel) N. Snow [*L. filiformis* (Persoon) P. Beauvois. *L. panicea* subsp. *mucronata* (Michaux) Nowack, in part, but not as to the type]. *Desparramo rojo*; sprangletop.

Summer–fall ephemerals; plants green or reddish, highly variable in size, often small, delicate, and filmy; roots often poorly developed. Spikelets 2–3 mm long, (1) 2- or 3-flowered, awnless.

Seasonally abundant, generally found on north and east exposures and in canyons on both sides of the island.

General distribution: Southern half of the United States to South America. Two other subspecies occur in the southeastern United States and the Old World.

Other islands: Tiburón, San Esteban, Coronados, Carmen, Danzante, Santa Catalina, San Diego.

E-central side, steep grassy slope, 26 Nov 1963, *Felger 9669*. NE side, N exposure, steep grassy slope, 12 Nov 1964, *Felger 11444*. NE side of island, steep E-facing slopes, 12 Nov 1964, *Felger 11440*. E side, above landfall, 25 m, 30 Sep 1979, *Turner 79-252*. E-central side, 150 m, 28 Nov 2006, *Felger 06-92*. Cañón El Farito, 2 Feb 2008, *Wilder 08-170*. Cañón de Mellink, ca. 10 m, 29 Sep 2008, *Felger 08-138*.

Muhlenbergia microsperma (de Candolle) Trinius. *Liendrilla*; littleseed muhly.

Nonseasonal ephemerals, most often encountered during cooler seasons. Roots often weakly developed. Plants soft and delicate. Panicles terminal, longer than wide, filmy, open, and loosely flowered; spikelets 1-flowered with a slender awn. Lower leaf axils bear conical, awnless cleistogenes. *Muhlenbergia microsperma* is the only grass on the island that forms cleistogenes, thus providing two strategies for reproduction.

Seasonally abundant across the east side of the island but generally scarce on south-facing slopes; occasional in canyons on the west side.

General distribution: Widespread across the Sonoran Desert. Southwestern United States to Guatemala; also South America.

Other islands: Ángel de la Guarda, Tiburón, Cholludo, San Esteban, San Lorenzo, San Pedro Mártir, Tortuga, San Marcos, Carmen, Danzante, Monserrat, Santa Catalina, Santa Cruz, San José, Espíritu Santo, Cerralvo.

E-central side, near peak elev, common, 26 Nov 1963, *Felger 9666*. E-central side, steep grassy slope, common, herbage reddish, 26 Nov 1963, *Felger 9669*. SE side of island, 31 Oct 1964, *Sherbrooke* [*Felger 11238*]. NE side, 18 Jan 1965, *Felger 12069*. E side, above landfall, 25 m, 30 Sep 1979, *Turner 79-249*. NE side, 150 m, very common, mostly in open areas on canyon slope, rock substrate, near canyon bottom, south-facing exposure in local area mostly free of *Vaseyanthus*, 28 Nov 2006, *Felger 06-111*. Cañón El Farito, mostly dry dead plants, 2 Feb 2008, *Wilder 08-166*. Cañón de Mellink, ca. 190 m, 29 Sep 2008, *Wilder 08-350*.

Setaria—Bristlegrass

Annuals or perennials growing with warm weather. Each spikelet subtended by a prominent bristle.

1. Summer–fall annuals; roots weak. *S. liebmannii*
1′. Perennials; roots stout and coarse. *S. macrostachya*

Setaria liebmannii E. Fournier. *Cola de zorra*; summer bristlegrass.

Summer annuals, highly variable in size. Leaf blades scabrous on both surfaces. Panicles cylindrical, loosely flowered, usually held well above the few leaves. Spikelets 2.1–2.5 mm long; fertile lemma coarsely rugose with transverse wrinkles.

Seasonally common at all elevations at least on the east side of the island.

General distribution: Common and widespread across much of the Sonoran Desert but not in the driest regions. This species is the only native annual *Setaria* in the lowland desert and thornscrub in western Sonora and northwestern Sinaloa. Both states of Baja California and southern Arizona to Colombia.

Other islands: Tiburón, Carmen, San Diego, Espíritu Santo, Cerralvo.

E-central side, N exposure, 26 Nov 1963, *Felger 9668*. Cañón El Faro, 60 m, canyon bottom and also on adjacent rock slopes, 28 Nov 2006, *Felger 06-89*. N-facing slope above Cañón El Farito, scattered, 2 Feb 2008, *Wilder 08-169*.

Setaria macrostachya Kunth [*S. leucopila* (Scribner & Merrill) K. Schumann]. Plains bristlegrass. Figure 19.

Densely tufted perennials 0.5–1.2 m tall, with hard, knobby bases and well-developed fibrous roots. Leaf blades (3.8) 5.8–12.1 mm wide. Panicles slender, cylindrical, and densely flowered. Spikelets 2.3–3.0 mm long (mean 2.54 ± 0.17, $n = 47$ from 6 plants), fertile lemma transversely rugose. Generally growing and reproductive during warmer months, especially during periods of high soil moisture.

Widespread on the east side of San Pedro Nolasco, abundant on north- and northeast-facing slopes and places with relatively deep soil, often locally forming 100% coverage. The dry remains can persist for a year or more. Also on the west side, mostly in canyon bottoms.

Setaria macrostachya represents a polyploid complex split into five species (Rominger 1962) that are sometimes difficult to distinguish. *Setaria leucopila* is distinguished by narrower leaves, the spikelets are not as fat (gibbous), the fertile palea is flat or not as convex, and the fertile palea is shorter than in *S. macrostachya* sensu stricto. By and large, *S. leucopila* is an aridland expression of the *S. macrostachya* complex. Plants growing under more favorable moisture conditions on San Pedro Nolasco were identified as *S. macrostachya* by the noted agrostologist John Reeder, who also identified as *S. leucopila* plants that had been collected on the island in essentially the same place but at a different time during dryer conditions. McVaugh (1983) discussed the *macrostachya* complex and taxonomic problems succinctly (also see Rominger 2003).

General distribution: Both taxa are widespread in the southwestern United States and northern Mexico, although *S. macrostachya* sensu stricto ranges farther south, into the highlands of south-central Mexico.

Other islands (*S. macrostachya* and/or *leucopila*): Tiburón, San Esteban, San Marcos, San Ildefonso, Santa Catalina, Carmen, San Diego, Espíritu Santo, Cerralvo.

Abundant on N-facing slopes, which look like hay fields because of the plant, 17 Apr 1921, *Johnston 4397* (CAS). Near middle E side, 2 May 1952, *Moran 4051* (UC, CAS). E-central side of island, steep grassy slope, 26 Nov 1963, *Felger 9668*. NE side, especially on steep N-facing grassy slopes, absent on S-facing slopes, 12 Nov 1964, *Felger 11431*. Steep granitic mountain slope with scattered trees and giant cactus, shady slope with soil, *Gentry 11357* (det. as *S. macrostachya* by J. R. Reeder in 1987). SE side, 31 Oct 1964, *Sherbrooke* [*Felger 11247*]. NE side, N-facing slopes, 18 Jan 1965, *Felger 12070*. W exposure, 100 ft, 20 Mar 1974, *Pulliam and Rosenzweig s.n*. E side, 6 Oct 1974, *Ward s.n*. Cañón de las Guacamayas, adjacent to cave near shore, Jul 2003, *Gallo-Reynoso* (photo). Base of Cañón El Faro, canyon bottom, 28 Nov 2006, *Felger 06-81*. N-facing slope above Cañón El Farito, mostly dry, some with reddish/purple leaf blades, with nearly 100% coverage in some areas, 2 Feb 2008, *Wilder 08-160*. Cañón de Mellink, 10 m, 29 Sep 2008, *Felger 08-139*.

RHAMNACEAE—Buckthorn Family

Colubrina viridis (M.E. Jones) M.C. Johnston. *Granadita*, *palo colorado*.

Hardwood shrubs reaching 2–2.5 (3.5) m tall. Branches rigid, the twigs often thorn-tipped. Leaves quickly drought deciduous, bright green, thin, and glabrous or very sparsely pubescent; leaves produced nonseasonally on short-shoots following rains. Flowers small and yellow-green, the floral disk awash in nectar at anthesis; massive flowering during the summer–fall rainy season. Seeds obovoid, 3.8–4.2 mm long, 3.0 mm wide.

Widespread on both sides of the island, in canyons and on slopes but generally not on north-facing slopes. Reaches maximum development at higher elevations near the ridge crests.

General distribution: Common on the adjacent mainland; western Sonora to Sinaloa and both states of Baja California; occurs disjunctly in Durango and Coahuila.

Other islands: Ángel de la Guarda, Tiburón, San Esteban, Dátil, Cholludo, Tortuga, San Marcos, Coronados, Carmen, Danzante, Monserrat, Santa Catalina, Santa Cruz, San José, Espíritu Santo, Cerralvo.

Infrequent in draws about upper part of island, 17 Apr 1921, *Johnston 3136* (CAS). E side, 26 Nov 1963, *Felger 9640*. SE side, 31 Oct 1964, *Sherbrooke* [*Felger 11245*]. NE side, 250 m, 28 Nov 2006, *Felger 06-109*. Cañón de Mellink, 110 m, canyon bottom, shrub 3.5 m tall, 29 Sep 2008, *Felger 08-142*.

SCROPHULARIACEAE—see PLANTAGINACEAE

SIMMONDSIACEAE—Jojoba Family

Simmondsia chinensis (Link) C.K. Schneider. Jojoba.

Shrubs to 2 m tall, sometimes nearly evergreen, or the number of leaves markedly reduced during dry seasons, or all or most of the leaves shed during prolonged drought; the shrubs sometimes die back in severe drought. Leaves often 2–5 cm long, simple, and somewhat leathery. Male and female flowers on separate plants. Fruits of leathery capsules, 1-seeded; seeds 1.5–2 cm long, containing simmondsin, a cyanogenic glucoside, and a high percentage of unique liquid wax. The seeds are among the largest of those of any native Sonoran Desert plant.

Common on both sides of the island, in canyons and on slopes, especially toward higher elevations.

General distribution: Both states of Baja California, southern California, Arizona, and Sonora south to the Guaymas region.

Other islands: Ángel de la Guarda, Tiburón, Dátil, San Esteban, San Marcos (observation), Coronados, Carmen, Danzante, Monserrat (observation), Santa Catalina, Santa Cruz, San José, San Francisco, Espíritu Santo.

A common shrub all over island, 3–4 ft high, 17 Apr 1921, *Johnston 3129* (CAS, UC). Steep granitic mountain slopes with scattered trees and giant cactus, shrub 2 m tall, very scattered, some plants showing drought die-back, 16 Dec 1951, *Gentry 11358*. E side, 26 Nov 1963, *Felger 9660*. Above SE cove, 11 Aug 1964, *Cooper* [*Felger 10403*]. SE side, 31 Oct 1964, *Sherbrooke* [*Felger 11233*]. NE side, 12 Nov 1964, *Felger 11446*. E side, 250 ft, 20 Mar 1974, *Pulliam and Rosenzweig s.n*. E side, E exposure, 21 Mar 1974, *Pulliam and Rosenzweig s.n*. Cañón de las Guacamayas, 14/15 Apr 2003, *Gallo-Reynoso* (photo). E-central side, N exposure, 270 m, shrub 1.6 m tall, staminate, 28 Nov 2006, *Felger 06-93*; pistillate, *Felger 06-94*. Cañón El Farito, staminate, 2 Feb 2008, *Wilder 08-161a*; pistillate, *Wilder 08-161b*. Cañón de Mellink, 110 m, canyon bottom, with young flower buds, pistillate, 29 Sep 2008, *Felger 08-148a*; staminate, *Felger 08-148b*. Summit of island, 11 Nov 2009, *Wilder 09-140*.

SOLANACEAE—Nightshade Family

Nicotiana obtusifolia M. Martens & Galeotti [*N. trigonophylla* Dunal]. *Tabaquillo de coyote*; desert tobacco.

FIGURE 19. *Setaria macrostachya*, Cañón de Mellink, 29 September 2008. Photo by B. Wilder.

Herbaceous leafy perennials, and also flowering in the first season. Herbage sticky glandular-pubescent. Corollas cream white, remaining open all day. Flowering in winter and spring, the plants usually die back severely during drought and often flower again with summer rains. Apparently germinate during the winter–spring season. Fruits of capsules with a persistent glandular-sticky calyx and numerous minute seeds.

Widely scattered nearly throughout the island from just above the high-tide zone to the summit. Often grow in guano deposits at the periphery of the island.

General distribution: Nayarit to southwestern United States.

Other islands: Ángel de la Guarda, Tiburón, Alcatraz, Dátil, Cholludo, San Esteban, San Lorenzo, San Pedro Mártir, Tortuga, San Ildefonso, Carmen, Santa Catalina.

E side, N exposure, in gullies, ca. 20 ft elev, 22 Mar 1974, *Pulliam and Rosenzweig s.n.* On ledges, 29 Apr 1974, *Stinson s.n.* (SD). E side, above landfall, 25 m, 30 Sep 1979, *Turner 79-255*. Base of Cañón El Faro, several plants in canyon bottom near shore, in shade, not seen elsewhere on this trip, corollas cream-white, open during day, 28 Nov 2006, *Felger 06-74*. Base of Cañón El Farito, occasional, 2 Feb 2008, *Wilder 08-164*.

URTICACEAE—Nettle Family

Parietaria hespera B.D. Hinton var. ***hespera***.

Delicate winter–spring annuals. Root systems small relative to the size of the plant. Stems succulent and brittle, the leaves thin and quickly wilting. Flowers small and inconspicuous. Fruits of smooth achenes 0.9–1.2 mm long.

Known from shaded niches among large rocks and at the base of shrubs on the east side of the island.

General distribution: Northwestern Mexico and southern United States.

Other islands: Ángel de la Guarda, Tiburón, Dátil, San Lorenzo, San Esteban.

NE side, on grassy N-facing slope with *Amaranthus fimbriatus*, *Perityle californica*, *Muhlenbergia microsperma*, and *Setaria leucopila*, 18 Jan 1965, *Felger 12075*.

DOUBTFUL AND EXCLUDED TAXA

Asteraceae

Perityle emoryi Torrey.

Two San Pedro Nolasco collections previously identified as *P. emoryi* are almost certainly *P. californica*. *Perityle emoryi* has white rays and *P. californica* has yellow rays; both have a yellow disk and are winter–spring annuals. The two specimens cited here have ambiguously colored rays, and other diagnostic features are not evident.

NE side, especially common on N-facing slopes, yellow disk and rays, 12 Nov 1964, *Felger 11448* (duplicate det. M. Powell as *P. emoryi*). E side, rays yellowish white, 21 Mar 1974, *Pulliam and Rosenzweig s.n.*

Capparaceae

Atamisquea emarginata Miers ex Hooker & Arnott.

Rebman et al. (2002) listed this shrub for San Pedro Nolasco, probably on the basis of Gentry's (1949) listing of it on the island. We have not found this shrub on the island and have not located a specimen. We believe this listing is an error.

Loasaceae

Mentzelia adhaerens Bentham.

This species is reported for San Pedro Nolasco (Felger and Lowe 1976; Rebman et al. 2002), but we have not located a specimen or any direct documentation for it on the island. We believe this listing is an error. Desiccated remains of *Eucnide ruprestris* can be mistaken for dried remains of *M. adhaerens*.

Malvaceae

Melochia tomentosa Linnaeus.

Gentry (1949) reported this species as observed on San Pedro Nolasco, apparently the basis for its inclusion on subsequent checklists (Felger and Lowe 1976; Rebman et al. 2002). We have not found a specimen or any other record for it on the island. We believe this listing is an error.

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