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Robert I. Lonard

Frank W. Judd

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## PHYTOGEOGRAPHY OF SOUTH PADRE ISLAND, TEXAS

ROBERT I. LONARD AND FRANK W. JUDD

*Department of Biology, Pan American University,  
Edinburg, TX 78539*

**ABSTRACT.** The phytogeographic affinities of the native flora of South Padre Island, Texas, are analyzed and the probable dispersal agent(s) for each species identified. The native flora consists of 99 species and 44% of the species also occur on the adjacent Texas mainland; 28% of the native species have tropical affinities. Only three species have probably dispersed from the island to the mainland. Two species may be endemic to Padre Island and the Tamaulipan barrier islands. Most of the tropical species have reached the island by oceanic drift, but birds are the most important dispersal agent for the native species. Man is responsible for the introduction of 117 species.

A series of barrier islands comprise the predominant land form along the Gulf Coast of Texas. Padre Island is the longest of these barrier islands. It extends approximately 182 km from Corpus Christi on the north to the Brazos-Santiago Pass at Port Isabel on the south. The Mansfield Channel separates the northern two-thirds of the island from South Padre Island.

The flora and vegetation of South Padre Island is relatively well known compared to other areas of the barrier island chain (Dahl et al. 1974, Judd et al. 1977, Lonard et al. 1978). Lonard et al. (1978) reported that the vascular flora consisted of 209 species in 47 families and suggested that much of the floral diversity is due to the presence of a large number of species that are represented by small populations. Judd et al. (1977) provided information on the pattern of vegetation in relation to topography and reported that the vegetation occurs in distinct zones that correspond closely to topographic facets. Information on the geographic affinities of the flora is currently lacking.

Although the mechanism(s) involved in the origin of the barrier islands is a subject of considerable controversy, workers agree that Padre Island began forming about 4,500 years ago (Dahl et al. 1974). Thus, the flora is post Wisconsin glaciation. Because of the proximity of Padre Island to the Texas mainland (maximum width of the Laguna Madre is about 16 km) and because of the length of the island, one might reasonably expect that many of the species present have been derived from the mainland. However, similar islands occur in the Gulf of Mexico south of Padre Island to Altamira, Tamaulipas, Mexico, 402 km south of Brownsville, Texas. These islands provide an avenue of northward dispersal for numerous organisms. Also, the longshore current is from south to north along South Padre Island and the Mexican barrier islands. Thus, species dispersed by drift would likely have tropical

affinities. Furthermore, South Padre Island is situated in the flyway of many migratory birds that winter in Mexico and Central America.

The purpose of this paper is to analyze the phytogeographic affinities of the flora of South Padre Island and to identify the major dispersal agents. This information should facilitate understanding the floristic relationships of Gulf Coast barrier islands in particular and contribute to knowledge of barrier island ecology in general.

**SOURCE MATERIAL.** Description of the area, climate, and soil is provided in Dahl et al. (1974) and Judd et al. (1977). The flora of South Padre Island catalogued by Lonard et al. (1978) formed the basic list of taxa. Seven additional species have been collected subsequent to publication of that paper and have been included. Designations of topographic zones follow Judd et al. (1977).

Much of the information on the distribution of the species found on South Padre Island was obtained from Correll and Johnston's *Manual of the Vascular Plants of Texas* (1970). Gould's (1975) *Grasses of Texas* provided information on the distribution of grasses. Ranges of continental taxa were taken from several sources, but McGregor et al.'s (1977) *Atlas of the Flora of the Great Plains* was used extensively. Distributions of Gulf and Atlantic Coast species were primarily obtained from Duncan's (1974) review of coastal halophytes. Britton and Millspaugh's (1920) treatment of the Bahaman flora was consulted for taxa of Caribbean occurrence. Checklists of Taylor (1950) and Chippendale (1972) were consulted to determine the occurrence of pantropical or subcosmopolitan distributions.

Thorne (1972) emphasized the importance of consulting recent monographic revisions and range extension reports when phytogeographic affinities are considered. Therefore, the following monographic treatments were examined for changes in nomenclature and for species ranges: Kral (1971), Sauer (1972), Lewis and Oliver (1974), Gillis and Stearn (1974), Graham (1975), Palmer (1975), Rodman (1976), Smith (1976), Hopkins and Blackwell (1977), and Semple and Semple (1977). Nomenclature, in general, follows Correll and Johnston (1970) and Gould (1975).

**RESULTS AND DISCUSSION.** Seven species have been added to the list of vascular species occurring on South Padre Island subsequent to publication of Lonard et al.'s (1978) flora. These species are: *Atriplex pentandra*, *Suaeda tampicensis*, *S. torreyana*, *Malva parviflora*, *Orobanche multiflora*, *Cooperia drummondii*, and *Dichanthium aristatum*. Thus, 216 species of flowering plants are known to occur on South Padre Island.

Judd et al. (1977) recognized six topographic zones on South Padre Island: Foreshore (FS), Backshore (BS), Primary dunes (PD), Secondary dunes and vegetated flats (SDVF), Tidal flats (TF), and Washovers (WO). Lonard et al. (1978) added Disturbed sites (DS) and noted the distribution in these zones for each species. One hundred seventeen species comprising 54.2% of the total flora are found in disturbed sites (Appendix). These areas are limited to the southernmost 8 km of the island and are associated with buildings, residences, and roads. Because we are primarily interested in the geographic affinities and the dispersal agents of the naturally occurring flora, the species introduced by man are not considered further. It should be emphasized, however, that man has been the single most important dispersal agent.

Our survey indicates that 99 species comprise the naturally occurring flora of South Padre Island. Table 1 provides an inventory of the geographic affini-

ties and dispersal agents for these species. Because direct observations of plant dispersal to islands other than via drift are highly improbable (Carlquist 1974), we identified the most probable dispersal mechanism(s) for each species. In some species, especially those occurring in moist depressions or on the margins of pools, more than one dispersal agent is likely. Table 2 provides a comparison of the relative importance of dispersal agents for the total flora.

TABLE 1. Comparison of the geographic affinities and dispersal agents of the native flora of South Padre Island. \*indicates species that also occur on Laguna Atascosa National Wildlife Refuge of the adjacent mainland. B - birds, OA - other animals, WA - water, WI - wind.

Geographic Affinity		Dispersal Agent
Species		
Widespread Inland		
<i>Agalinus heterophylla</i>		B
<i>Aristida longispica</i>		B, OA
* <i>Asclepias oenotheroides</i>		WI
* <i>Calylophus berlandieri</i>		B
* <i>Commelina erecta</i> var. <i>angustifolia</i>		B
<i>Dichanthelium angustifolium</i>		B
* <i>Eleocharis montevidensis</i>		B
<i>Eleocharis obtusa</i>		B
* <i>Eragrostis oxylepis</i>		B
<i>Eragrostis spectabilis</i>		B
* <i>Eustoma exaltatum</i>		B
<i>Fuirena simplex</i>		B
* <i>Gaillardia pulchella</i>		B, WI
* <i>Houstonia nigricans</i>		B
<i>Hydrocotyle bonariensis</i>		B
* <i>Iva angustifolia</i>		B
<i>Lythrum alatum</i> var. <i>lanceolatum</i>		B
* <i>Lythrum californicum</i>		B
* <i>Oldenlandia boscii</i>		B
<i>Opuntia macrorhiza</i>		B, OA
* <i>Orobanche multiflora</i>		B
* <i>Paspalum setaceum</i>		B
* <i>Polygala alba</i>		B
<i>Polypogon monspeliensis</i>		B
* <i>Polypremum procumbens</i>		B
<i>Schizachyrium scoparium</i> var. <i>littoralis</i>		B, WI
<i>Scirpus americanus</i> var. <i>longispicata</i>		B
<i>Spiranthes vernalis</i>		B, WI
* <i>Sporobolus wrightii</i>		B
<i>Triplasis purpurea</i>		B
Tropical Maritime		
* <i>Agalinus maritima</i>		B
<i>Andropogon glomeratus</i>		B, WI
<i>Avicennia germinans</i>		WA
* <i>Bacopa monneri</i>		B
* <i>Batis maritima</i>		WA

TABLE 1. Continued

## Geographic Affinity

Species	Dispersal Agent
* <i>Borrichia frutescens</i>	B, WA
<i>Cladium jamaicense</i>	B
<i>Crotalaria incana</i>	B
<i>Croton punctatus</i>	B
<i>Dichromena colorata</i>	B
<i>Euphorbia ammannioides</i>	B
<i>Fimbristylis castanea</i>	B
<i>Ipomoea pes-caprae</i> var. <i>emarginata</i>	WA
<i>Ipomoea stolonifera</i>	WA
* <i>Monanthochloe littoralis</i>	WA
<i>Oenothera drummondii</i>	B, WA
<i>Panicum amarum</i>	B, WA
* <i>Paspalum vaginatum</i>	B, WA
<i>Philoxerus vermicularis</i>	WA
* <i>Rhynchosia minima</i>	B
* <i>Salicornia bigelovii</i>	WA
<i>Samolus ebracteatus</i>	B, WA
* <i>Sesuvium portulacastrum</i>	WA
* <i>Sophora tomentosa</i>	WA
* <i>Sporobolus virginicus</i>	WA
* <i>Suaeda linearis</i>	WA
<i>Uniola paniculata</i>	B, WA
<i>Vigna luteola</i>	B, WA
Temperate Maritime	
<i>Baptisia leucophaea</i> var. <i>laevicaulis</i>	B
<i>Buchnera floridana</i>	B
<i>Cakile fusiformis</i>	WA
<i>Cakile geniculata</i>	WA
* <i>Cassia fasciculata</i> var. <i>ferrisiae</i>	B
<i>Erigeron myrionactis</i>	WI
<i>Euphorbia cordifolia</i>	B
<i>Heterotheca subaxillaris</i>	B, WI
* <i>Limonium nashii</i>	WA
* <i>Lycium carolinianum</i> var. <i>quadrifidum</i>	B
* <i>Machaeranthera phyllocephala</i>	B, WI
<i>Paspalum monostachyum</i>	B
<i>Physalis viscosa</i> var. <i>spatulifolia</i>	B
<i>Sabatia arenicola</i>	B
* <i>Salicornia virginica</i>	WA
<i>Spartina alterniflora</i>	WA
* <i>Spartina patens</i>	WA
* <i>Spartina spartinae</i>	WA
<i>Solidago sempervirens</i> var. <i>mexicana</i>	B, WI
Coastal Prairies and Marshes (of southern Texas and northern Mexico)	
<i>Agalinus strictifolia</i>	B
* <i>Atriplex matamorensis</i>	WA

TABLE 1. Continued  
Geographic Affinity

Species	Dispersal Agent
<i>Calylophus australis</i>	B
<i>Eragrostis silveana</i>	B
<i>Eupatorium betonicifolium</i>	B, WI
<i>Flaveria brownii</i>	B
<i>Linum alatum</i>	B
<i>Opuntia lindheimeri</i> var. <i>lehmanni</i>	B, OA
* <i>Prosopis reptans</i> var. <i>cinerascens</i>	B, WA
* <i>Ratibida peduncularis</i>	B
* <i>Rhynchosia americana</i>	B
* <i>Schrankia latidens</i>	B
<i>Sisyrinchium biforme</i>	B
* <i>Sporobolus tharpitii</i>	B
<i>Stemodia tomentosa</i>	B
<i>Suaeda tampicensis</i>	WA
<i>Vaseyochloa multinervosa</i>	B
Subcosmopolitan	
<i>Phragmites australis</i>	WA
* <i>Ruppia maritima</i>	B
* <i>Typha domingensis</i>	WI
Widespread Inland - Maritime	
* <i>Distichlis spicata</i>	B, WA
<i>Suaeda torreyana</i>	WA

*Widespread inland species.*—Thirty species comprising 30.3% of the naturally occurring flora are widely distributed over much of continental North America and have reached the island primarily by transport of migratory birds (Table 1). At least 29 species, or 96.7%, of the species in this category have likely been carried to the island by birds. Wind and drift are unlikely dispersal agents for most species because the fruits or seeds are either not adapted for dispersal by wind and/or do not readily float or survive exposure to the salinity of sea water.

TABLE 2. Comparison of the relative importance of dispersal agents.

Probable dispersal agent/agents	Number of taxa	Percent of the naturally occurring flora
Birds	54	54.5
Water	22	22.2
Wind	3	3.0
Combination of dispersal agents	20	20.2

Prevailing winds are from the southeast and hence are "onshore" winds during most months of the year. Periodically, during late fall and winter strong cold fronts or "northers" cause a shift in winds to offshore from the Texas mainland. During these times wind dispersal may be important for a few continental species; for example, the plumed seeds of *Asclepias oenotheroides* are undoubtedly carried from the mainland by wind. Wind dispersal may also occur in *Gaillardia pulchella*, *Schizachyrium scoparium* var. *littoralis* and *Spiranthes vernalis*.

A combination of dispersal agents has probably contributed to the widespread distribution of *Gaillardia pulchella*. Radford et al. (1974) noted that it is a North American-South American disjunct species.

All species that have widespread inland distributions occur in the SDVF zone. Twelve (40%) of the species in this category are wetland species and on South Padre Island they occur on the margins of marshes or in depressions where water stands after rains.

*Tropical maritime species.*—There are 28 species comprising 28.3% of the total flora in this category (Table 1); thus, tropical maritime species are of considerable importance because of the subtropical climate that prevails on South Padre Island. The species are derived from New World tropical coast lines and from pantropical beaches. Sixteen species in this category occur in the BS, PD, TF, or WO, which suggests that they are primarily dispersed by oceanic drift.

Seven species occur in the SDVF and are found in moist depressions or on the margins of freshwater pools, which suggests dispersal by birds. Only the pantropical species *Sophora tomentosa*, *Vigna luteola*, and *Crotalaria incana* are present on dry sands of the secondary dunes. Seeds of these species may have been carried to the island by drift and then moved from the berm crest to the secondary dunes by resident mammals or birds.

Gunn and Dennis (1973) have documented the stranding of numerous tropical and temperate seeds on Padre Island, but we have not observed germination or establishment in any sites on South Padre Island. Low species diversity is typical of strand environments; for example, Good (1964) suggested that the number of strand species in the world is less than 100, and Breckon and Barbour (1974) listed only 46 species for the beach zone of the entire Pacific Coast of North America.

*Temperate maritime species.*—The temperate maritime element consists of Gulf Coast, Atlantic Coast, and amphi-Atlantic species. There are 19 species comprising 19.2% of the total flora in this category (Table 1). The distributional ranges of these species do not ordinarily extend inland or into tropical latitudes.

Thirteen (68.4%) of these species occur in the SDVF and have reached the island by the migratory activities of birds. *Cakile fusiformis*, *C. geniculata*, *Spartina alterniflora*, *S. patens*, *S. spartinae*, and *Salicornia virginica* are the only temperate maritime species that are presumably dispersed by drift, and they occur in zones other than the SDVF.

The only temperate maritime species that occur in the harsh environment of the BS and the windward slopes of the PD are *Cakile fusiformis* and *C. geniculata*. Breckon and Barbour (1974) hypothesized that the low incidence of annual species such as *Cakile* in beach environments was related to prob-

lems of seedling establishment. Barbour and Rodman (1974) suggested that *Cakile* occupies its present range on the Pacific Coast of North America as a result of introduction in ship ballast.

*Coastal prairie and marsh species.*—There are 17 species comprising 17.2% of the total flora in this category (Table 1). Most of the species are restricted to the coastal prairies and marshes of southern Texas and northern Mexico. The exception is *Prosopis reptans* var. *cinerascens*, which has a disjunct range and also occurs in Argentina. All species, with the possible exceptions of *Flaveria brownii* (A. M. Powell, pers. comm.) and *Sporobolus tharpüi*, occur in coastal mainland sites.

Most of the species were likely carried to the island by birds (Table 1). Only *Atriplex matamorensis* and *Suaeda tampicensis* may have reached the island exclusively via drift. These species occur in the TF as does *Prosopis reptans*. All other species in this category occur in the SDVF.

*Subcosmopolitan species.*—Thorne (1972) referred to taxa that are not primarily either tropical or temperate and are represented on all the continents as subcosmopolitan. The number of these species is low. Thorne (1972) stated that only 125 genera of seed plants are subcosmopolitan in their distribution. Only three species comprising 3.0% of the flora of South Padre Island are referable to this category. Most subcosmopolitan taxa are aquatic as is the case for the three species on South Padre Island (Table 1). All three species occur in moist depressions in the SDVF and they have been dispersed by wind (*Typha*), drift (*Phragmites*), or birds (*Ruppia*).

*Widespread inland-maritime species.*—Breckon and Barbour (1974) characterized the widespread inland-maritime phytogeographic element as similar to that of temperate maritime and tropical maritime elements. However, due to their ability to occupy saline or alkaline habitats inland, these species have dispersal routes unavailable to coastal species limited to typical maritime locations. Only two species comprising 2.0% of the flora are referred to this category (Table 1). *Distichlis spicata* var. *stricta*, which occurs in wet alkaline or saline areas inland, can be distinguished from the island ecotype of *D. s.* var. *spicata*. Both species in this category occur along the margins of tidal flats and likely have been carried to the island by birds.

**CONCLUSIONS.** The naturally occurring flora of South Padre Island is comprised of only 99 species. As is frequently the case with insular floras, the number of species on South Padre Island is lower than expected in an area of comparable size on the adjacent mainland (Johnston 1949). For example, Fleetwood (1973) recorded 451 species from Laguna Atascosa National Wildlife Refuge which occurs opposite South Padre Island on the Texas mainland. Forty-four species comprising 44.4% of the native flora of South Padre Island also occur on the refuge (Table 1). Thus, almost half of the native flora of South Padre Island is probably derived from the adjacent Texas mainland. We think that only *Batis maritima*, *Sesuvium portulacastrum*, and *Sophora tomentosa* have dispersed from the barrier island to the mainland. Twenty-eight percent of the native species have tropical affinities. There are few endemic species, but *Flaveria brownii* and *Sporobolus tharpüi* apparently occur only on Padre Island and on barrier islands off the coast of Tamaulipas. *Sporobolus tharpüi* is morphologically similar to the widespread species *S. wrightii*.



Inland species occur primarily in the SDVF where they are protected from the effects of winds, salt spray, and sand scouring and deposition. Temperate maritime species are also primarily limited to the SDVF. Most tropical species are found in zones near the Gulf of Mexico and the Laguna Madre and reach the island primarily via drift. Birds are the most important dispersal agent and oceanic drift is second in importance (Table 2).

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#### APPENDIX. *Species occurring only in sites disturbed by man.*

*Acacia smallii*  
*Amaranthus greggii*  
*Amaranthus palmeri*  
*Ambrosia psilostachya*  
*Apium leptophyllum*  
*Aphanostephus skirrhobasis* var.  
*thallasius*  
*Argemone albiflora* subsp. *texana*  
*Arundo donax*  
*Aster subulatus* var. *ligulatus*  
*Astragalus nuttallianus*  
*Atriplex arenaria*  
*Atriplex pentandra*  
*Boerhaavia coccinea*  
*Bothriochloa saccharoides* var.  
*longipaniculata*  
*Bougainvillea glabra*

*Brachiaria reptans*  
*Canavalia maritima*  
*Carissa macrocarpa*  
*Castilleja indivisa*  
*Cenchrus ciliaris*  
*Cenchrus echinatus*  
*Cenchrus incertus*  
*Chloris cucullata*  
*Chloris gayana*  
*Chloris pluriflora*  
*Chloris subdolichostachya*  
*Cirsium texanum*  
*Cissus incisa*  
*Clappia suaedaefolia*  
*Clematis drummondii*  
*Conyza canadensis* var. *glabrata*  
*Cooperia drummondii*

*Coreopsis nucecensis*  
*Croptilon divaricatum* var.  
     *hirtellum*  
*Croton capitatus* var.  
     *lindheimeri*  
*Cynodon dactylon*  
*Cyperus ovularis*  
*Cyperus polystachyos* var.  
     *texensis*  
*Cyperus rotundus*  
*Cyperus uniflorus*  
*Dactyloctenium aegyptium*  
*Dalea emarginata*  
*Dalea lanata*  
*Desmanthus virgatus* var.  
     *depressus*  
*Dichanthium annulatum*  
*Dichanthium aristatum*  
*Digitaria bicornis*  
*Digitaria ciliaris*  
*Digitaria texana*  
*Echinochloa colonum*  
*Eleusine indica*  
*Eriochloa punctata*  
*Euphorbia heterophylla*  
*Euphorbia hypericifolia*  
*Florestina tripteris*  
*Gnaphalium pensilvanicum*  
*Helianthus annuus* subsp. *texanus*  
*Heliotropium curassavicum*  
*Indigofera m. niata*  
*Lepidium custrinum*  
*Lepidium virginicum* var. *medium*  
*Leptochloa nealleyi*  
*Lesquerella lasiocarpa* var.  
     *berlandieri*  
*Leucaena latisiliqua*  
*Leucaena pulverulenta*  
*Malva parviflora*  
*Malcastrum americanum*  
*Margaranthus solanaceus*  
*Medicago polymorpha* var.  
     *vulgaris*  
*Melilotus albus*  
*Melilotus indicus*  
*Mimosa strigillosa*  
*Mirabilis albida*

*Nerium oleander*  
*Nicotiana repanda*  
*Nothoscordum bivalve*  
*Oenothera engelmannii*  
*Oenothera laciniata*  
*Oenothera speciosa*  
*Palafoxia texana* var.  
     *ambigua*  
*Panicum hallii*  
*Panicum maximum*  
*Panicum texanum*  
*Parthenium hysterophorus*  
*Passiflora foetida* var.  
     *gossypifolia*  
*Phyla incisa*  
*Phyla nodiflora*  
*Plantago rhodosperma*  
*Pluchea purpurascens*  
*Portulaca mundula*  
*Portulaca oleracea*  
*Portulaca umbraticola*  
*Prosopis glandulosa*  
*Psoralea rhombifolia*  
*Pyrhophappus multicaulis*  
*Ratibida columnaris*  
*Richardia brasiliensis*  
*Rumex chrysocarpus*  
*Schinus terebinthifolius*  
*Sesbania macrocarpa*  
*Sesuvium erectum*  
*Setaria adhaerans*  
*Setaria leucopila*  
*Solanum elaeagnifolium*  
*Solanum triquetrum*  
*Sonchus asper*  
*Sorghum halepense*  
*Sporobolus cryptandrus*  
*Sporobolus pyramidatus*  
*Stenotaphrum secundatum*  
*Tamarix aphylla*  
*Tidestromia lanuginosa*  
*Tribulus terrestris*  
*Trichoneura elegans*  
*Verbena bipinnatifida*  
*Verbena haleii*  
*Verbesina encelioides*