THE BIOLOGY OF THE SUBTROPICAL AND PANTROPICAL SHRUB, *SOPHORA TOMENTOSA* L. (FABACEAE), IN COASTAL DUNE ENVIRONMENTS

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ABSTRACT

Sophora tomentosa family Fabaceae, is a world-wide subtropical and tropical species with buoyant seeds that is distributed in coastal sites of five continents including remote islands and atolls. It may occur in pioneer strand vegetation, in coastal swamps, on the margins of mangrove habitats, and in semi-stabilized secondary dunes. *Sophora tomentosa* is a shrub with alternate, pubescent, odd-pinnately compound leaves, an unspecialized floral structure, and a legume that is constricted between the seeds. It tolerates low soil nutrients and high substrate temperatures. Seeds are toxic and contain numerous alkaloids. This species has a minor role in coastal geomorphology, but may be used as a sand-stabilizer in protected secondary dunes. It has horticultural value in coastal landscaping.

Key words: *Yellow sophora, taxonomy, morphology, geographical distribution, habitats, communities, reproduction, physiology, dispersal.*

INTRODUCTION

The genus *Sophora*, family Fabaceae, is represented by 40 to 60 species in the tropics, subtropics, and temperate zones (Heenan 2004; Hurr et al. 1999; Peña et al. 2000). The fossil record indicates the genus originated in New Zealand (Heads 2005), and the oldest dated fossil of *S. tomentosa* is from Oligocene deposits (Hurr et al. 1999). *Sophora tomentosa* is a world-wide littoral species with buoyant seeds that are dispersed by oceanic currents (Sykes and Godley 1968). Buoyancy is enhanced by air spaces between folds in the cotyledons, and seeds are buoyant in seawater for up to three months (Nakanishi, 1988). Seeds germinate readily after being scarified. Seeds contain toxic alkaloids, but extracts from roots and leaves have been used to treat cholera in folk medicine (Vines, 1960). Insect communities apparently have a significant impact on seed survival (Alhgren, 2009).

Sophora tomentosa occurs on tropical and subtropical coastlines of five continents as well as remote islands and atolls in the Pacific Ocean. It typically occurs in secondary dune habitats in the leeward protection of a primary dune complex (Judd et al. 1977). It is usually not a dominant species in any coastal community. Seeds readily germinate. Herein, we review the biology of this wide-spread coastal species.

1. TAXONOMY AND VARIATION

Classification and common names for *Sophora tomentosa* L. are as follows: family Fabaceae (Leguminosae), subfamily Papilionoideae, tribe Sophoreae, section Aegialodes, synonyms none; yellow sophora, Eve's necklace, necklace pod, yellow necklace pod, silver bush, and tambalisa. *Sophora tomentosa* is the nomenclatural type species for the genus *Sophora*.

The following taxonomic description has been derived from Correll and Johnston 1970; Lehman et al. 2005; Lonard et al.1991; Long and Lakela 1971; Tucker 1994.

Sophora tomentosa is an erect shrub 1 to 3 m tall. Petioles are tomentose and 2.5 to 6.4 cm long. Leaves are alternate, odd-pinnately compound, are up to 15 cm long, and have 13 to 21 leaflets; the rachis is pubescent; leaflets are usually ovate, 1 to 2.5 cm long, 1 to 1.6 cm wide, leathery, densely pubescent, but becoming glabrate on the upper epidermis; apices are acute or rounded; stipules are 1 to 1.5 mm long and are deciduous. Yellow sophora has a taproot and numerous thick adventitious roots (Fisher 2008; Lonard and Judd, personal observations).

The inflorescence of *Sophora tomentosa* is a terminal, elongated raceme 10 to 40 cm long (Figure 1). Pedicels are 8 to 9 mm long and pubescent. The floral structure is unspecialized. The five- lobed calyx is united above the hypanthium and is 6 to 8 mm long. The corolla is bilaterally symmetrical and consists of 5 bright yellow petals. The upper petal is 1.8 to 2.5 cm long and the laterally arranged petals are fused. The androecium includes 10 nearly identical stamens that are free above the apex of the hypanthium. Anthers are about 1.5 mm long and are copper-colored; filaments are about as long as the ovary. The gynoecium consists of one hypogynous carpel that has marginal placentation. The ovary is superior and densely pubescent.

Pollen grains are typical of dicot species. They are dispersed as monads, are prolate, spheroidal, or tricolporate, and have a microreticulate patterned, thin-walled exine (Magalhães e Silva and Ribeiro dos Santos 2009; Hurr et al. 1999).

The woody, tomentose legume is strongly constricted between the seeds. Seed placentation is marginal. Legumes are subtended by the persistent calyx and are 5 to 13 cm long with a persistent beak 5 to 20 mm long. Five to 10 seeds are contained within the slowly dehiscent legume. Seeds emerge one by one (Wickens 1979).

Seeds are hard-walled, subglobose, glossy, dark brown and are approximately 5 to 8 mm in diameter (Wickens 1979). Seeds are buoyant due to air spaces between folds of the cotyledons and float after at least 104 days in seawater (Hnatiuk 1979; Nakanishi 1988).

Sophora tomentosa seedlings have gelatinous G-fibers or tension wood fibers scattered in the phloem zone of the vascular system (Fisher 2008). This feature keeps cotyledons and some lower nodes at or below the soil level. Seedlings emerge from mechanically scarified seeds 6 to 10 days after treatment. Growth is extremely slow, and seedlings are only 6 to 8 cm tall 52 days after emergence.

Sophora tomentosa is represented by var. *occidentalis* (L.) Isely in Florida, Puerto Rico, and Texas, and by var. *truncata* T. & G. in Florida. Leaflets of var. *occidentalis* are densely pubescent on both epidermal surfaces whereas var. *truncata*, which occurs with var. *occidentalis* in Florida, has a dark green, glabrate upper epidermis and a pubescent lower epidermis. *Sophora tomentosa* has a chromosome number of 2*n* = 28 (Palomino et al. 1993).

2. GEOGRAPHIC DISTRIBUTION AND RANGE OF HABITATS

Sophora tomentosa is a world-wide littoral species with buoyant seeds that are dispersed by ocean currents (Sykes and Godley, 1968). It occurs on tropical and subtropical coastlines of five continents and on remote islands and atolls in the Pacific Ocean (Ahlgren 2009; Drake et al. 1996; Dunlop 1987; Espejel 1986; Febles et al. 2008; Fisher 2008; Fosberg 1953; Gillespie 1976; Heenan et al. 2004; Judd et al. 1977; Kienholz 1926; Kirch 1996; Lehman et al. 2005; Long and Lakela 1971; Magalhães e Silva and Ribeiro dos Santos 2009; Nakanishi 1988; Negrete et al. 1999; Nelson et al. 2001; Peña et al. 2000; Pringle 1982; Smith 1990; Stalter et al. 1999; Taylor, 1950; Wunderlin 1982) (Figure 2). Yellow sophora apparently is cultivated in protected sites in Central Pakistan (32°25'N) (Ahmad et al. 2009).

Sophora tomentosa is rare on semi-stabilized secondary sand dune habitats located in the leeward protection of a primary dune complex on South Padre Island, Texas (Judd et al. 1977). This low shrub and *Opuntia engelmannii* Salm-Dyck *ex* Engelm. var. *lindheimeri* (Engelm.) Parfitt & Pinkava are the only woody plants in the topographic zone dominated by herbaceous perennials (Judd et al. 1977). On Sanibel Island, Florida, yellow sophora occurs in a transition zone that has been invaded by shrubs 1.8 to 2.4 m above mean sea level (Cooley1955; Stalter 1993). Kuki et al. (2009) stated that *S. tomentosa* lends stability to secondary dune habitats in the "restinga", a tropical coastal ecosystem in Brazil of Quaternary origin.

Yellow sophora is common in pioneer strand vegetation, in coastal

swamps, and on the margins of mangrove habitats. Smith (1990) noted that *S. tomentosa* seeds germinate in debris deposited at the high tide mark on the beaches of Fiji, and Drake et al. (1996) indicated that mature shrubs occur in the pioneer strand habitat on Tonga. Nakanishi (1988) found seedlings in high tide debris in the landward herbaceous habitat in the Ryukyu Islands, and Fosberg (1953) found that *S. tomentosa* occurs in a beach-shrub zone transitional with landward forests in the Marshall Islands. On the northern coast of Mindoro, Philippines, yellow sophora occurs on the upper sandy beach habitat in a luxuriant complex of herbs, shrubs, and trees (Kienholz 1926).

2.1 SUBSTRATE CHARACTERISTICS AND CLIMATIC REQUIREMENTS

Sophora tomentosa occurs on sandy coastlines. It occurs in the secondary dunes and vegetated flats on South Padre Island where 85.9% of the sand particle sizes range from 0.18-0.25 mm. At a depth of 25 cm mean water content of sand samples was 11%, and the mean depth to the water table was only 34 cm (Judd et al.1977).

The geographic distribution of *S. tomentosa* extends from the equator to approximately 24° 20'N in the Ryukyu Islands, Japan, and to 31° 40' S latitude at Port Macquarie, New South Wales, Australia. Its geographical distribution is limited by the frequency, duration, and severity of freezing temperatures. Occasional freezes of short duration on South Padre Island damage exposed shoots. Lonard and Judd (1989) noted that a severe freeze in 1983 delayed flowering and fruiting for 11 months.

2.2 PLANT COMMUNITIES AND HABITATS

Sophora tomentosa usually is not a dominant species in any coastal community or habitat. Communities often are defined by topographic facets and distance from the shoreline. Nakanishi (1988) described a shrub community in the Ryukyu Islands where *S. tomentosa* is associated with *Clerodendron inerme* (L.) Gaertn., *Messerschmidia argenta* (L.F.) Johnston, *Pandanus odoratissimus* Linn. f. and *Scaevola frutescens* (Mill.) Krause. He did not designate a dominant species.

On 'Eua Island, Kingdom of Tonga, strand vegetation in the *Cocos nucifera* L. tree canopy includes *Tournefortia argentea* L.f., *Acacia simplex* (Sparrm.) Pedley, and *S. tomentosa*. Apparently, *S. tomentosa* is a tree-like shrub in the canopy. Common shrubs include *Wollastonia biflora* DC. *ex* Decne. and *Scaevola sericea* Vahl, and the ground cover is dominated by the stoloniferous *Ipomoea pes-caprae* (L.) Sweet (Drake et al.1996). On Mangaia Island in the Cook Islands chain, Kirch (1996) noted that *S. tomentosa* occurred historically in forest vegetation that included *Ficus* sp., *Erythrina* sp. and *Cyathea* sp., but temporally is dominated by *Pandanus tectorius* Parkinson and the ferns *Cyclosorus interruptus* (Willd) H Itô and *Dicranopteris linearis* (Burm. f.) Underw.

Sophora tomentosa is an important species in the coastal restinga ecosystem of Espirito Santa State, Brazil (Kuki et al. 2009). It is associated with the large shrub *Schinus terebinthifolius* Raddi and a perennial ground layer of *I. pes-caprae* and *Canavalia rosea* (Sw.) DC. (Kuki et al. 2008).

At Puerto Galera on the northern

coast of Mindoro Island in the Philippines, *S. tomentosa* occurs in a dense tangle of trees, shrubs, and herbaceous species in a Barringtonia-Pandanus Community (Kienholz 1926). Species present in this community are listed in Table 1.

At Sanibel Island, Florida, *S. tomentosa* occurs in a shrub community with *Baccharis halimifolia* L., *Capraria biflora L., Ernodea littoralis* Sw., *Eugenia axillaris* (Sw.) Willd., *Forestiera* sp., *Jacquinea keyensis* Mez. *Lantana involucrata* L., *L. depressa* Small, and *Morella cerifera* (L.) Small (Cooley 1955; Stalter 1993). Long and Lakela (1971) indicate that yellow sophora occurs in coastal strand and hammock communities in southern Florida. Species associated with yellow Sophora in Florida and the West Indies are presented in Table 2.

Sophora tomentosa is rare in the secondary dunes and vegetated flats topographic complex on South Padre Island, Texas, and on dredge reclamation islands in the upper Laguna Madre of Texas. Yellow sophora and the low-growing succulent cactus *Opuntia engelmannii* var. *lindheimeri* are the only woody species in a community dominated by *Schizachyrium littorale* (Nash) E.P. Bicknell (Judd et al. 1977). *Sophora tomentosa* is confined to the crests of low secondary dunes and is associated with *Paspalum monostachyum* Vasey, *Heterotheca subaxillaris* (Lam.) Britt. & Rusby, and *Chamaecrista fasciculata* Michx. Forty-seven species, mostly grasses and sedges, occur in this zone (Lonard et al. 1999).

3. PHYSIOLOGICAL ECOLOGY

Information is limited related to metabolic processes in *S. tomentosa*. Leaf anatomical features are indicative of a C_3 plant in its manner of carbon fixation in the light-independent reactions of photosynthesis. Histologically, the leaf thickness is about 270 µm, and stomata are present only on the lower epidermis. Both leaf surfaces are invested with a dense concentration of simple hairs ranging from 20 to 33 hairs per mm^2 for the upper and lower epidermis, respectively (Kienholz 1926). A well-developed palisade layer is present near the upper epidermis and a poorly differentiated palisade zone occurs below the spongy mesophyll (Kienholz 1926).

Sophora tomentosa tolerates low levels of soil nutrients and high substrate temperatures. Kuki et al. (2008a) noted that chlorophyll content in leaves is unaffected by iron ore dust and high levels of atmospheric sulfur dioxide. Densely pubescent leaflets apparently trap and sequester pollutants. Shoot production and elongation coincides with the rainy season which also may reduce levels of pollutants on leaflets, and antioxidant enzyme systems may partially neutralize oxidative stress to pollutants (Kuki et al. 2008a). However, iron ore dust has a detrimental effect on *S. tomentosa* by reducing germination rates and increasing substrate acidity to as low as pH 3.0 (Kuki et al. 2008b). Shoot length, leaf area, and nodule dry weights also were reduced significantly. High levels of iron dust may reduce root growth by destroying symbiotic *Rhizobium trifolii* Dangeard mycorrhizal populations (Kuki et al. 2009).

Tanaka et al. (1997) noted that *S. tomentosa* has numerous flavonoids in roots and stems including sophoraisoflavanone, isosophoranone, sophoronol, sophoraflavanone A, B, C, D, E, tomentosanol B,C,D,E, irisolidone, iristectorigenin, 3'-isoprenylgenstein, and

glabranin. Xingming et al. (2009) reported the presence of prenylflavonones. Flavonoids have antimicrobial properties, and prenylflavones have antimicrobial activity and tumor-specific cytotoxic activity (Tanaka et al 1997; Xingming et al. 2009). Seeds contain numerous alkaloids some which are toxic (Vines 1960).

4. PHENOLOGY

Flowering events for yellow sophora occur from March to November on the barrier islands of the lower Texas coast (Correll and Johnston 1970; Gillespie 1976; Lehman et al. 2005; Lonard and Judd 1989; Vines 1960). Lonard and Judd (1989) noted that shrubs on South Padre Island had an almost continuous flowering and fruiting cycle. Mature legumes are retained on plants for extensive periods. Dehiscence of legumes is slow. In southern Brazil, Nogueira and de Arruda (2006) noted that anthesis occurs during daylight hours; 2 to 5 flowers open in the racemes per day. Each flower lasts 4 to 5 days. Kuki et al. (2008a) reported a peak in shoot production during the rainy season and a secondary peak early in the dry season in Brazil.

5. POPULATION BIOLOGY

Sophora tomentosa is a shrub with a single taproot and numerous thick adventitious lateral roots (Fisher 2008). Populations of yellow sophora occasionally are frost damaged on South Padre Island and are slow to recover. Plants survive mild winters in the subtropics.

Pringle (1982) noted that *S. tomentosa* survived the storm track of a major hurricane that struck Belize. Other species did not recover or were slow to recover from the storm. No reports have been found that discuss susceptibility of the species to sand coverage. Fisher (2008) indicated that the lowest buds of yellow sophora are at or below ground level as a result of hypogeal germination He suggested that this parameter may have adaptive value to the effects of drought, fire, and freezing conditions.

5.1 REPRODUCTION

Nogueira and de Arruda (2006) reported that cross pollination, self pollination, and agamospermy occur in *S. tomentosa* in southern Brazil. Bees (*Pseudocentron* sp.and *Xylocopa* sp.) are typical pollinators. Other floral visitors are butterflies (*Panoquina panoquinoides*), beetles (*Lystronychus* sp. and *Horistonotus* sp.), and the ant (*Camponotus rufipes*). Ants likely promote self pollination (Nogueira and de Arruda 2006). Anther dehiscence is extrose, and no floral odor is detectable.

Sophora tomentosa seeds are produced in a slowly dehiscent torulose legume that may be up to 12.7 cm long. Seeds are subglobose and slightly flattened on the sides, lustrous, brown, and up to 5 mm in diameter (Vines 1960; Wickens 1979). Up to 10 seeds may be present in a legume.

Sophora tomentosa is a pantropical and subtropical species that has been widely dispersed by ocean currents (Gunn and Dennis 1973, 1999); Lonard and Judd,1980; Heenan et al. 2004; Sykes and Godley 1968). Nakanishi (1988) noted that legumes typically dehisce in the sea, and seeds remain buoyant for 90 to 104 days. He found no significant difference in percent germination of control seeds to those floating in sea water for three months.

Buoyancy is a result of air spaces between the folds of the two cotyledons (Nakanishi 1988). Smith (1990) found *S. tomentosa* seeds germinating in the high tide drift line on beaches in Fiji. He found at least one seed per meter of strandline. Nakanishi (1988) noted a 5% frequency of seeds on transects in the drift line in the Ryukyu Islands, Japan, yet he found no seeds at the high tide mark on the beaches.

Yellow sophora seeds are about 5 mm in diameter; mean dry weight is 112.2 mg; seed volume is 0.30 cm^3, and estimated density is 0.37 g/cm^3 (Nakanishi 1988). Data on the occurrence of *S. tomentosa* in seed banks have not been reported.

6. GERMINATION ECOLOGY AND ESTABLISHMENT OF SEEDLINGS

Hnatiuk (1979) noted high germination rates for *S. tomentosa* seeds from the Aldabra Atoll in the western Indian Ocean. At least 90% of seeds germinated within four days after scarification, and at least 85% of seeds germinated without a scarification treatment. Lonard and Judd (personal observations) noted emergence of the radicle with no pre-treatment after 5-6 days with or without scarification. The epicotyl extended about five days later. No germinating seeds or seedlings have been found on South Padre Island (Lonard and Judd personal observations).

Stalter germinated seeds from South Padre Island, Texas, which were subjected to the following treatments: (1) scarified seeds were placed in full strength sea water for 7 days, then moved to potting soil; (2) scarified seeds were placed directly in potting soil; (3) whole unscarified seeds were placed in full strength sea water for 7 days, then placed in potting soil and; (4) whole seeds were placed directly in potting soil. Pots containing 35 seeds from each of the aforementioned treatments were placed in a glass house at 25-33°C. After 14 days four scarified seeds placed in sea water germinated, two whole seeds placed in sea water germinated, 13 scarified seeds sown directly in soil germinated, but none of the intact seeds directly seeded in soil germinated. Germination rates for all treatments were slow. After 60 days the following results were observed. (1) Seven scarified seeds placed in full strength sea water germinated (20%). (2) Thirty seeds placed directly in potting soil germinated (85%). (3) Four unscarified seeds placed in sea water for 7 days, then placed in potting soil germinated (11%) (4) Twenty unscarified seeds placed directly in potting soil germinated (57%). Germination results from the present study support long-term observations (60 days) to accurately asses seed germination of *S. tomentosa* seeds when subjected to scarification, no treatment and sea water treatment.

Smith (1990) found *S. tomentosa* seeds germinating in the high tide drift line on beaches in Fiji. He found at least one seed per meter of strandline, and Nakanishi (1988) noted a 5% frequency of seeds on transects in the drift line in the Ryukyu Islands, Japan. However, he found no seeds at the high tide mark on the beaches.

7. GEOMORPHOLOGICAL INTERACTIONS

Sophora tomentosa usually occurs on semi-stabilized secondary dunes and is not subject to blowing sand. No sand coverage experiments have been reported. *Sophora tomentosa* has a minor role in coastal geomorphology. It serves as a sand stabilizer

in secondary dunes on South Padre Island.

7.1 INTERACTION WITH OTHER SPECIES

No studies related to competition or interactions with other species have been reported for yellow sophora. Van der Valk (1975) indicated that floristic composition and structure of coastal plant communities are essentially determined by the severe local microenvironment and are not the result of biological interactions among species in the habitat. Interactions among species may vary from facilitative, to neutral, to competitive with competition being greatest in the most stressful and disturbed coastal sites including foredunes (Franks 2003). *Sophora tomentosa* typically occurs in semi-stable to stable sites. We assume that interactions of yellow sophora with other species are neutral.

Mealy bugs and caterpillars are listed as pests for yellow sophora. Leaf spot (*Cercospora*), *Fusarium* basal stem rot, *Gloeosprium* stem rot, *Pythium* root rot, *Rhizoctonia* stem rot, and leaf necrosis are fungal diseases that affect plants used in landscaping. Toxic alkaloids in seeds probably reduce predation by vertebrates. Febles et al. (2008) noted that yellow sophora is resistant to a tropical tree ant (*Atta insularis*).

8. ECONOMIC IMPORTANCE

Yellow sophora has a limited role in coastal protection. In the United States it typically occurs on low stabilized or semi-stabilized secondary dunes leeward of the protective primary dune complex. It has not been used in dune restoration projects.

Tanaka et al. (1997) reported that some flavonoid compounds extracted from stems and leaves have antimicrobial activity against resistant strains of *Staphylococcus aureus*. Prenylflavanones extracted from plant tissues show tumor-specific cytotoxic activity and antimicrobial activity (Xingming et al. 2009).

Seeds are reported as toxic, but have been used as a sudorific, diuretic, and purgative in folk medicine (Vines 1960). In Sri Lanka, yellow sophora has been used to treat venereal disease, and extracts from roots and leaves have been used to treat cholera in the West Indies (Vines 1960).

Plants used for pharmaceuticals, landscaping, or ecological restoration are relatively easy to cultivate in deep sandy substrates, but deep sandy soil conditions are most favorable. Cultivation of this attractive shrub should be conducted in frost-free climates.

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Table 1. Species associated with *Sophora tomentosa* in a Barringtonia-Pandanus Community on upper sandy beaches on Mindoro Island, Philippines (1); On the coast of Kenya (2); Coastal, raised ridges on the Andaman and Nicobar islands of the Indian sub-continent (3). Island off Yucatan Coast-Summit Vegetation.

Species	Location			
	1	2	3	
Pemphis acidula	X			**acidula**
Jasminus aculeatum	X			**aculeatum**
Dactyloctenium aegyptium		X		**aegyptium**
Calonictyon album	X			**album**
Opilia amentacea	X			**amentacea**
Ximenia americana	X			**americana**
Tournefortia argentea	X			**argentea**
Barringtonia asiatica	X			**asiatica**
Colubrina asiatica		X		**asiatica**
Crinum asiaticum	X			**asiaticum**
Ochrosia barbarila			X	**barbarila**
Pandanus bidur	X			**bidur**
Jasmium bifarium	X			**bifarium**
Melanthera biflora	X			**biflora**
Terminalia boivinii		X		**boivinii**
Caesalpinia bonduc		X		**bonduc**
Dalbergia candenatensis	X			**candenatensis**
Terminalia catappa	X		X	**catappa**
Morinda citrifolia	X			**citrifolia**
Hyphaene coriacea		X		**coriacea**
Caesalpinia crista	X			**crista**
Casuarina equisitifolia		X		**equisitifolia**
Atriplex farinosa		X		**farinosa**
Cadaba farinosa		X		**farinosa**
Acacia farnesiana	X			**farnesiana**
Cassytha filiformis		X		**filiformis**
Erythrina indica			X	**indica**
Quisqualis indica	X			**indica**
Sideroxylon inerme		X		**inerme**
Sophora inhambanensis		X		**inhambanensis**
Calophyllum inophyllum	X		X	**inophyllum**
Aerva lantana		X		**lantana**

Heritiera littoralis			X	**littoralis**
Strychnos luzonensis	X			**luzonensis**
Suriana maritima	X			**maritima**
Cyperus maritimus		X		**maritimus**
Cocos nucifera	X	X		**nucifera**
Planchonella obovata	X			**obovata**
Premna obtusifolia	X			**obtusifolia**
Hernandia ovigera	X			**ovigera**
Hyphaene parvula		X		**parvula**
Hernandia peltata	X			**peltata**
Salvadora persica		X		**persica**
Ipomoea pes-caprae		X		**pes-caprae**
Pongamia pinnata	X		X	**pinnata**
Scaevola plumieri		X		**plumieri**
Asystasia podostachys		X		**podostachys**
Thespesia populnea	X		X	**populnea**
Tephrosia purpurea		X		**purpurea**
Cynometra ramiflora			X	**ramiflora**
Cissus rotundifolia		X		**rotundifolia**
Cycas rumphii	X			**rumphii**
Launea sarmentosa		X		**sarmentosa**
Scaevola sericea	X			**sericea**
Cordia somaliensis		X		**somaliensis**
Cerberas sp.	X			**sp.**
Guettarda speciosa	X			**speciosa**
Ardisia squarosa	X			**squarosa**
Scaevola taccada	X		X	**taccada**
Pandanus tectorius	X			**tectorius**
Azima tetracantha		X		**tetracantha**
Hibiscus tiliaceus	X			**tiliaceus**
Sophora tomentosa	X	X	X	**tomentosa**
Tristera triptera	X			**Triptera**
Desmodium umbellatum	X	X		**Umbellatum**
Erythrina variegata	X			**Variegate**
Prosopis vidaliana	X			**Vidaliana**
Sporobolus virginicus		X		**Virginicus**
Dodonaea viscosa	X			**Viscose**

Table 2. Species associated with *Sophora tomentosa* in Florida and the West Indies.
(1) Transition area, 1.8-2.4 m above sea level; (2) Mixed woods dominated by *Sabal palmetto*; (3) Coastal Slope Ridge, Caribbean Coast; (4) *Coccoloba uvifera-Rhacoma crossopetalum* on limestone terraces.

Species	Location				
	1	2	3	4	
Antirhea acutata				X	**acutata**
Eugenia anthera		X			**anthera**
Jacquinia arborea				X	**arborea**
Ficus aurea		X			**aurea**
Polypodium aureum		X			**aureum**
Eugenia axillaris	X				**axillaris**
Capraria biflora	X				**biflora**
Metopium brownei				X	**brownei**
Myrica cerifera	X				**cerifera**
Bontia daphnoides				X	**daphnoides**
Erithalis fruticosa				X	**fruticosa**
Baccharis halimifolia	X				**halimifolia**
Rivina humilis		X			**humilis**
Lantana involucrata	X				**involucrata**
Pithecellobium keyense			X		**keyense**
Jacquinia keyensis	X				**keyensis**
Vittaria lineata		X			**lineata**
Hymenocallis littorale			X		**littorale**
Ernodea littoralis	X		X	X	**littoralis**
Bumelia obovata				X	**obovata**
L. ovatifolia	X				**ovatifolia**
Thrinax parviflora			X		**parviflora**
Chloris petraea			X		**petraea**
Thespesia populnea				X	**populnea**
Eragrostis prolifera			X		**prolifera**
Parthenocissus quinquefolia		X			**quinquefolia**
Bumelia retusa			X		**retusa**
Crossopetalum rhacoma				X	**rhacoma**
Blechmum serrulatum		X			**serrulatum**
Bursera simaruba		X			**simaruba**
Forestiera sp.	X	X			**sp.**
Psychotria sp.		X			**sp.**
Rapanea sp.		X			**sp.**

Trichostema suffrutescens	X				**suffrutescens**
Smilax tomentosa		X			**tomentosa**
Sophora tomentosa	X		X	X	**tomentosa**
Coccoloba uvifera				X	**uvifera**
Quercus virginiana		X			**virginiana**

FIGURE TITLES AND LEGENDS

Figure 1. *Sophora tomentosa* inflorescence.

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