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STRANDED SEEDS AND FRUITS FROM THE YUCATAN PENINSULA[1]

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RESUMEN

Las playas de la Península de Yucatán reciben regularmente semillas y frutos (disemínulos) a la deriva, de Centroamérica, el nordeste de Sudamérica y posiblemente el área del Caribe. Los disemínulos producidos localmente también pueden ser encontrados en estas plyas. Muestras de unas 150 especies fueron recolectadas de 24 sitios a lo largo de la Península de Yucatán durante 1973, 1974 y 1975. Cerca del 35% de los disemínulos identificados son de especies establecidas en la Península de Yucatán. Los disemínulos identificados están enlistados alfabéticamente por género con anotaciones sobre familia a la que pertenece, tipo de disemínulo, mecanismo de flotación, ilustraciones y cacteres diagnósticos, existencia de la especie en la Península de Yucatán y playas donde fueron recolectados o vistos los disemínulos. Por lo menos un disemínulo de cada especie, incluyendo la mayoría de los no identificados, es ilustrada.

SUMMARY

Beaches of the Yucatan Península regularly receive tropical drift seeds and fruits (disseminules) from Central and northeastern South America and possibly the Caribbean area. Locally produced disseminules also may be found on these beaches. Disseminules from ± 150 species were collected along the Yucatan Peninsula coast from 24 collecting sites during 1973, 1974, and 1975. About 35% of the identified disseminules are from species known to be established on the Yucatan Peninsula. Identified disseminules are tabulated alphabetically by genus with notations about family, type of diseminule, buoyancy principle, illustrations and key characters, status of species on the Yucatan Peninsula, and beaches where collected or seen. At least one disseminule of each species, including most unknowns, is illustrated.

INTRODUCTION

Stranded tropical seeds and fruits (disseminules) found on beaches of the North Atlantic Ocean and of adjacent Caribbean Sea are produced by terrestrial plants. Most of these plants are members of the flora of the Caribbean Islands, eastern Mexico and Central America, and northeastern South America. They may be part of the littoral flora, or less frequently part of the inland flora. In the latter case, the disseminules are transported to the ocean via rivers. Buoyant

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disseminules produced by these plants are carried by sea currents (Fig. 1) as far north ah the Norwegian coast and Spitzbergen (Colgan, 1919; Gunnerus, 1765; Lindman, 1882). Intervening beaches that regularly receive tropical disseminules include Scotland and related island to the north and west, Ireland, England, Holland, Iceland, Greenland, and the United States from Cape Cod to Texas (Colgan, 1919; Dennis and Gunn, 1974; Gunn, 1968; Gunn and Dennis, 1972, 1973; Gunn, *et al.,* 1976; Guppy, 1917; Leenhouts 1968). It is possible, though not likely, that some of these disseminules have their origin in East Africa and are carried by the South Atlantic Equatorial Current to the New World and then northward. There is no reverse transport current from the New World to East Africa

Although literature for stranded disseminules arising in the New World may be traced to Pena and L'Obel (1570) and Clusius (1605), we know of no published data on disseminules stranded on eastern beaches of Mexico. We understand from personal communication that Mario Sousa of the Instituto de Biología, Universidad Nacional Autónoma de México is studying stranded disseminules from a beach near Los Tuxtlas, Veracruz. The most relevant recent report is Gunn and Dennis, 1973, which lists disseminules of 34 tropical and 24 temperate species collected along the U.S. coast of the Gulf of Mexico, from Padre Island, Texas to Santa Rosa Island, Florida. Two small collections (listed below) have been made on Alacran Reef and at Nautla, Veracruz.

On the west coast of Mexico, the cold, south-flowing California Current continues only as far south as Cabo San Lucas, at the tip of Baja California, before veering out to sea (Fig. 1). The only record of a tropical disseminule found on a beach served by the California Current is Gibbons (1967), who reported finding a stranded *Terminalia catappa* endocarp on an Oregon beach. However, on the mainland of Mexico, the north-flowing southern Equatorial Current, sweeping up the coast from Costa Rica and El Salvador, does not veer out to sea until it passes Cabo Corrientes. Beaches south of Cabo Corrientes display tropical marine shells and disseminules. Mario Sousa has recently established a collecting post near Chamela, Jalisco, where a wide range of disseminules has already been gathered. The construction of new coastal highways in Jalisco, Colima, Guerrero, Oaxaca, and Chiapas will encourage more collecting.

BUOYANCY PRINCIPLES

We estimate that only one percent of the tropical spermatophyte species produce diseminules that are capable of floating in seawater for at least one month. Disseminules that drift do so because their specific gravity is less that the specific gravity of seawater. The five types of buoyancy with examples are:

Type 1. Buoyancy due to cavity within the disseminule. Seed: Intercotyledonary cavity (*Entada* spp., *Ipomoea* spp., and *Merremia* spp.). Cavity formed by diminished endosperm or embryo development (some seed of *Caesalpinia* spp.). Fruit: cavity within fruit wall (*Juglans jamaicensis* and *Sacoglottis amazonica*). Cavity more or less central (most palms).

Type 2. Buoyancy due to low density cotyledonary tissue (*Dioclea reflexa* and *Erythrina* spp.).

Type 3. Buoyancy due to a fibrous or corky coat, or a combination of both (*Hippomane mancinella* and *Terminalia catappa*).

Type 4. Buoyancy due to thinness of disseminule (*Avicennia germinans* and *Peltophorum inerme*).

Type 5. Buoyancy due to a combination of the above factors (*Barringtonia asiatica, Cocos nucifera,* and *Grias cauliflora*).

ARRECIFE ALACRAN AND NAUTLA, VERACRUZ BEACHES

The six cays of the Alacran Reef are the northeasternmost emergent land on the Campeche Bank, in the Gulf of Mexico, 46.5 km NE of the mainland (Millspaugh, 1916). During Ray Fosberg's visit to the cays in July, 1961 (Fosberg, 1962), he collected these stranded disseminules (numers ob disseminfules collected are in parentheses): *Acrocomia mexicana* Karw. (01), *Calatola costaricensis* Standley (01), *Entada gigas* (L.) F. & R. (04), *Manicaria saccifera* Gaertner (12), *Omphalea diandra* L. (01), *Sacoglottis amazonica* Martius (06), and *Terminalia catappa* L. (03). All of these diseminules have been found on Yucatan beaches. None of these species grow on the six cays of Arrecife Alacran.

Elaine Norman, Stetson University, collected disseminules of 26 species from a beach at Nautla, Veracruz, Mexico on June 29, 1974. These disseminules have been identified: *Acrocomia mexicana* Karw., *Annona* sp., *Cæsalpinia* sp., *Calatola costaricensis* Standley, *Citrus* sp., cocoid palms, *Cocoloba uvifera* L., *Entada gigas* (L.) F. & R., *Mastichodendron* sp., *Myristica fragrans* Houtt., *M. surinanmensis* H. & T., *Pistacia* sp., *Pourteria hypoglauca* (Standley) Hoehni, *Psidium* sp., *Quisqualis* sp., and *Terminalia catappa*. Of these, *Citrus* sp., *P. hypoglauca* and *Quisqualis,* sp., have not been collected from Yucatan beaches.

THE YUCATAN PENINSULA AND COLLECTING BEACHES

The Yucatan Peninsula is a recently emerged limestone platform, bordered on its northern and western coasts by the Gulf of Mexico and on its east coast by the Caribbean Sea. A karst surface of Pleistocene origin, the northern part of the peninsula is remarkably flat and is barely above sea level. Sinkholes, locally known as *cenotes,* dot the landscape and vast caves form extensive underground water networks. The most striking feature of the peninsula is the absence of surface rivers and streams, except in the extreme southern section. This geological phenomenon has probably impeded a wider dispersal of the peninsular flora.

Along the northern and northwestern coasts of the peninsula, part of the irregular limestone platform, known as the Campeche Banks, is under water but some areas are barely visible as shoals of reefs. Wave action is slight or almost absent, except during the autumn hurricane season and during the *nortes* when strong winter

winds from the north whip up the sea. Along the central Campeche coast, older limestone strata extend to the sea, creating a bay-like topography with a thin sandy or muddy seashore and occasional outcropping of beach rock. As the coast turns northward and the rock disappears, mangrove swamps extend to the shoreline. Along the northern coast of Yucatan, there are a series of long barrier beaches, backed by extensive lagoons and tidal swamps. These swamps, locally known as *cienagas,* are inundated with seawater during the occasional hurricanes and the more frequent *nortes.*

The east coast of the peninsula, in the state of Quintana Roo, is quite different from the Gulf shoreline. In contrast to the expansive Campeche Banks, the Caribbean shelf is only a few kilometers wide and in the northern part is dominated by swift currents of the Yucatan Channel. On the shore, jagged limestone ridges alternate with sandy coves. The second largest barrier reef in the world stretches intermittently southward for about 650 kms from the southern tip of Isla Cancun almost to the Gulf of Honduras. Areas immediately behind the rocky sea cliffs and pocket beaches consist of plant-covered sand dunes.

The peninsula can be divided into various natural regions, influenced greatly by rainfall and soil conditions and significantly altered by occupation patterns and agricultural use. In northwestern Yucatan, where the rainfall level does not support tropical forest vegetation, centuries of slash and burn agriculture have turned the area into a thicket of low thorny trees, scrubs, and a wide variety of flowering plants, tenaciously subsisting on the thin rocky limestone soil. The area supports yearly corn crops and vast henequen fields. In the deeper soils with heavier rainfall in the southwester and northeastern parts of Yucatan and in Campeche, tall savanna grass flourishes and a recently introduced cattle industry is prospering. The southern two-thirds of the peninsula is still dominated by a dense tropical rain forest, but intensive lumber exploitation and government-sponsored colonization in the area are rapidly altering the landscape.

Even though rainfall diminishes perceptibly on both the north and east coasts, these areas are floristically diverse. Coastal species dominate the shorelines, with xerophytic scrub vegetation found next to the narrow beaches. A major portion of the flora has been identified by Sauer (1967) as American and West Indian species. *Coccoloba uvifera, Ipomoea pes-caprae,* and *Canavalia rosea* are among the most visible along the beaches. Long stretches of untended coconut groves border beaches on both the Gulf and Caribbean coasts.

The surface currents around the peninsula for the four seasons are presented in Fig. 2. Although the currents near the United States and eastern Mexico vary with the seasons, the current in the environs of the Straits of Yucatan varies little with the seasons. From the current pattern, it is likely that most of the exotic disseminules arose from Central America and northeastern South America. Possibly a few could have come from Cuba by a countercurrent. There is also a slight chance for disseminules to cross the Atlantic from Africa and strand on the Yucatan coast.

Yucatan beaches where the collections were made during 1973-75 are located in Figure 3 and described below. The caption for Figure 3 also includes the state

name for each beach, as well as the beach symbol used in the Catalog. Several other beaches on the central coast of Yucatan were visited but no drift disseminules were encountered. These included Chelem, near Yukalpeten; Dolores, near El Porvenir; and Punta Piedras, near Sisal. No record was kept of *Cocos nucifera* fruit, which is ubiquitous to all Gulf and Caribbean beaches. *Mangifera indica* seeds, when collected on popular beaches, were probably discarded by visitors who had enjoyed their luscious fruits.

Costa Blanca, Campeche: The beach is composed of carbonate mud and sand and broken shells. Because of a large protective bay, the water is calm. Ninety percent of the shells on the beach are *Anomalocardia cuneimeris* Conrad. Creeping vines extend down the flat slope to the high tide line.

Siho Playa, Campeche, Fig. 4: The headland of the beach is between two shallow bays, and the wave action is stronger than at Costa Blanca. The edge of the coast is formed of beach rock and cemented sand with occasional sparse sandy spots. *Coccoloba uvifera* grows in erosion-pitted rocks and on the narrow beach.

Sisal, Yukalpeten, Chixchulub, Uaymitun, Telchac Puerto, Chavihau, El Porvenir, Yucatan, Fig. 4: These beaches, all located on the central coast of Yucatan, are similar in composition. The shorelines are recently built beach ridges overrunning the mangroves. These ridges are flat and slope gently into the Gulf, and are composed primarily of calcareous sand. They have only slight berm and range from three to five meters in width. Patch reefs composed of wormtubes lie offshore. Back of the shore, there are mangroves in the swales between a series of parallel beach ridges or *cheniers.*

San Felipe, Yucatan: A predominantly calcareous barrier island with a lagoon behind it, San Felipe is typical of the series of bars building up along the Gulf shoreline. The beach dips gently under the water and the difference between high and low tide is rarely more than one-half meter.

Isla Holbox, Quintana Roo: Like San Felipe, Isla Holbox is a barrier island composed of fine calcareous sand. Some drift disseminules that are found on the east coast have been retrieved here. There is a wide mangrove-bordered lagoon connected to the Gulf in back of the beach.

Cabo Catoche, Quintana Roo: A mangrove clay swamp is being exhumed here. The beach consists of calcareous sand and shell fragments. As the current curves to the north and northwest, Cabo Catoche is left as its backwash.

Puerto Juarez, Quintana Roo, Fig .5: The shoreline, in the lee of Isla Mujeres, is a partially protected narrow beach composed of calcareous sand with nearby beach ridges of Pleistocene eolianites.

Isla Mujeres, Quintana Roo, Fig. 5: On the leeward side, the beach of calcareous sand is fairly protected. Back of the coast, there are lagoons of muddy carbonate sediment. The windward coast of pitted beach rocks and sandy pockets is subjected to frequent heavy winds and high surf. The vegetation is sparse and composed of typical beach species. The southern ridge of Pleitocene eolian limestone rises 50 meters above sea level and is almost without vegetation.

Isla Cancun, Quintana Roo: The island, a complex of Pleistocene and Holocene eolianites, hugs the mainland. The windward side, where stranded disseminules

were collected, is composed of the finest white oolitic sand. Sand dunes behind the beaches cover Holocene lithified dunes. Various vines overrun the beaches to the high tide mark. The dunes are covered with low shrubs, grasses, stubby palms, vines and the beach orchid, *Schomburgkia tibicinis* Bateman.

Isla Cozumel, Quintana Roo, Fig. 6: This island is a limestone block, separated from the mainland by faulting. The windward side is a series of alternating sandy beaches and lithified beach rocks. Vegetation is similar to the mainland coast and to the other islands. At the southern point of the windward side, the beach is commonly littered with a wide variety of sponges, drift wood, disseminules and, of course, the ubiquitous plastic artifacts of man.

Puerto Morelos, Playa del Carmen, Akumal, Xelha, Tancah and Tulum, Quintana Roo: These beaches all located on the central east coast share similar geographical features: Protected coves with little wave action and fine calcareous sand alternating with pitted limestone beach ridges and lithified dunes. In spite of the barrier reef paralleling the beach, waves crash on the ridges. Sponges, disseminules and other flotsam are cast up by the waves and caught in the pitted limestone. These pits also harbor vines and low shrubs.

Punta Hogna, Quintana Roo: This is the last rock shore in Mexican waters. Very near the Belize frontier, the beach can only be reached by boat. The composition and vegetation of the beach are similar to the central coast.

Xcalak, Quinta Roo: A few kilometers south of Punta Hogna, Xcalak is a flat sandy beach protected by a reef. Back of it lies an extensive swamp area.

CATALOG

The catalog is two parted. The first part is an alphabetical and annotated list of stranded disseminules. The second part is a series of figures depicting one or more representative specimens, shown at times one, except when noted. The genera are presented by families and the families are alphabetized.

Disseminules are listed alphabetically by their scientific names with these notations (in order to their occurrence): Author, family, type of disseminule, type of buoyancy, figure number and notes about the illustration, status of species on the Yucatan Peninsula, and state and beaches were disseminules were collected and number of disseminules collected or noted. Each entry in the annotated list is separated from the next by a period and each is discussed in turno. Adams, et al. (1972), is our primary reference for scientific names and authors. Following the practice of having family names derived from generic names and ending in "aceae", we are using Arecaceae for Palmae, Asteraceae for Compositae, Clusiaceae for Guttiferae, Fabaceae for Leguminosae, and Poaceae for Gramineae. Disseminules may be fruits and seeds, rarely seedlings or tubers. Because fruits may have more than one layer, they are recorded as exocarps, mesocarps, or endocarps, depending on the layer exposed when collected. Buoyancy tpyes, recorded as numbers from 1 to 5, are defined in the Buoyancy Principles section at the beginning of this paper. Illustration notes amplify the illustrations and enumerate

important characters. Gunn, et al. (1976) present additional characters and illustrations and a key to frequently collected disseminules. If a species is known from the Peninscula based on Barrera-Marin. *et al.*, 1976; Bequaert, 1933; Lundell, 1934; Millspaugh, 1895, 1896, 1898, 1903; Souza-Novelo, 1950; Standley, 1930; Steggerda, 1943, then the notation is "YP" (Yucatan Peninsula). If the species is unknown from the Peninsula, the notation is "exotic". One should refrain from extrapolating origins of stranded disseminules from these data. Most stranded disseminules drift to the Peninsula beaches from Central and northern South America. The beaches are discussed and the beach symbols defined in the caption of Figure 3. Beach symbols are listed from north to south after their state names. Numbers following the beach symbols are real numers. The symbols S and + represent less than 10 and 10 or more respectively. The counts are separated from a beach symbol by an equal mark (=), whereas the collector's numbers have a dash (-) between the number and the beach symbol. Dates of collections, areas of beaches covered, and time spent on beaches are available from the authors. None of these data were standardized, thus the number of disseminules seen or collected on one beach may not be equivalent to another beach. Representive specimens listed in the catalog have been deposited in the United States National Herbarium (US).

ACROCOMIA MEXICANA Karw. Arecaceae. Endocarp. 1. Fig. 8: Blackish to gray or tan, usually bearing 3 equatorial pores. YP. Yucatan: CH=1; Quintana Roo: HO=S, PJ=1, CN=S, PM=1, CZ=+, AK=+, XE=1, TA=+, TU=S, XC=1.

ALFONSIA OLEIFERA H.B.K. Arecaceae. Endocarp. 1. Fig. 8: Blackish with longitudinal striations, usually 3 nearly basal pores. Exotic. Quintana Roo: CZ=2, XC=1.

AMOMUM sp. Zingiberaceae. Fruit. 1. Fig. 23: Blackish with longitudinal striations, pores absent. Exotic. Quintana Roo: TA=1.

ANDIRA GALEOTTIANA Standley. Fabaceae. Exocarp or mesocarp. 3. Fig. 16: Left - large brown fruit partially eroded, right - transection of exocarp. YP. Campeche: CB=S.

ANDIRA INERMIS (W. Wright) H.B.K. Fabaceae. Exocarp or mesocarp. 3. Fig. 16: Left - small and large brown mesocarps, note fibrous surface and encircling ridge, right - transection of endocarp. YP. Quintana Roo: CN=S, CZ=S, AK=+, XE=+, TA=+, PH=S, XC=S.

ANNONA GLABRA L. Annonaceae. Seed. 3. Fig. 7: Two common shapes, note corky margin, tan, brown, gray. YP. Campeche: CB=+; Quintana Roo: CN=2, CZ=6, AK=+, XC=1.

ANNONA spp. Annonaceae. Seed. 2. Fig. 7: One species shown, brown. Probably YP. Quintana Roo: AK=2, XE=1.

ASTROCARYUM ALATUM Loomis. Arecaceae. Endocarp. 1. Fig. 8: Black, much larger than next, usually 3 nearly basal pores. Exotic. Quintana Roo: HO=1, CZ=1, PH=3, XC=1.

ASTROCARYUM sp. Arecaceae. Endocarp. 1. Fig. 8; Black, as above but smaller.

Exotic. Yucatan: SS = 1, YU = 1, SF = 1: Quintana Roo: HO = 5, PJ = S, CN = S, PC = S, CZ = +, AK = +, XE = S, TA = +, TU = 1, PH = 2.

AVICENNIA GERMINANS (L.) L. Avicenniaceae. Seedling. 4. Figs. 10: Three seedlings, note root hairs and cotyledons. YP. Yucatan: SS = 1, CH = +, TP = +, CV = +, SF = +: Quintana Roo: HO = +: CC = +, PJ = S.

BACTRIS spp. Arecaceae. Endocarp. 1. Fig. 8: One of several spp. found, black, usually 3 nearly equatorial pores. Exotic. Quintana Roo: PC = 1, CZ = 2, AK = 2, TA = 4, XC = 1.

BARRINGTONIA ASIATICA (L.) Kurz. Barringtoniaceae. Fruit. 5. Fig. 11: Three fruits drawn at $\times 1/2$, usually square from apical view, occasionally six-sided, lateral view of small fruit showing typical top shape. Exotic. Quintana Roo: TA = 2, PH = 2, XC = 1.

BERTHOLLETIA EXCELSA H. & B. Leycthidaceae. Seed. 5. Fig. 21: Grayish black and triangular in cross section. Exotic. Quintana Roo: CZ = 2, TA = 1.

BLIGHIA SAPIDA Koenig. Sapindaceae. Seed. 1. Fig. 23: Brown, shiny surface (damaged). YP. Yucatan: YU-1: Quintana Roo: PM = 1, AK = 1, XE = 1, TA = 1.

CACOUCIA COCCINEA Aublet. Combretaceae. Fruit. 3. Fig. 13: Tan, fusiform, somewhat winged. Exotic. Quintana Roo: AK = 1, CZ = 1, TA = 1, TU = 1.

CAESALPINIA BONDUC (L.) Roxburgh. Fabaceae. Seed. 1. Fig. 16: Left 2 seeds subglobose, gray, with faint concentric fracture line, right - transection of seed. YP. Yucatan: SF = S: Quintana Roo: HO = 1, IM = 1, PJ = S, CN = S, CZ = +, AK = 4, TA = S, TU = 1, XC = 1.

CAESALPINIA sp. Fabaceae. Seed. 1. Fig. 16: Subglobose, brown, with faint concentric fracture lines. Probably exotic. Quintana Roo: TA = 1, XC = 1.

CALATOLA COSTARICENSIS Standley. Icacinaceae. Endocarp. 1. Fig. 20: Tan with sculptured surface. Exotic. Quintana Roo: XE = 1, TA = 1, PH = 1, XC = 1.

CALOPHYLLUM CALABA. L. Clusiaceae. Fruit. 5. Fig. 12: Globose, grayish ochre. Exotic. Quintana Roo: PJ = S, CN = 2, PC = +, CZ = 4, AK = +, XE = 5, TA = +, TU = S, XC = 1.

CANAVALIA NITIDA (Cav.) Piper. Fabaceae. Seed. 2. Fig. 17: Left - lateral view, right - hilar view, note hilum length, seed coat red, black, or tan. Exotic. Quintana Roo: AK = 1.

CANAVALIA ROSEA (Swartz) DC. Fabaceae. Seed. 2. Fig. 17: Lateral view, short hilum and darker brown mottles on brown background. YP. Yucatan: CH = +, SF = S; Quintana Roo: PM = S, CZ = +, AK = +, XE = +, TU = 1, XC = 1.

CARAPA GUIANENSIS Aublet. Meliaceae. Seed. 1. Fig. 21: Compressed to triangular in cross section, tan to blackish, with hilum often large and irregularly shaped. Sxotic. Quintana Roo: PJ = 2, CN = +, PM = S, PC = S, CZ = +, AK = +, XE = S, TA = S, TU = S, XC = S.

CARICA PAPAYA L. Caricaceae. Seed. 1. Fig. 12: Two seeds, brown to gray, reticulate. YP. Yucatan: SS = 1, CV = S: Quintana Roo: HO = +, CC = 4, PM = 1.

CARYOCAR spp. Caryocaraceae. Endocarp. 1. Fig. 12: Three species are shown, note spines, knobs, or roughened surface, usually black. Exotic. Quintana Roo: CZ = 1, AK = 1, TA = 1, XC = 1.

CHRYSOBALANUS ICACO L. Chrysobalanaceae. Endocarp. 1. Fig. 12: Tan, ribbed. YP. Campeche: CB = 1; Quintana Roo: HO = 3, PJ = 1, AK = 1, TA = 1, XC = 2.

COCCOLOBA UVIFERA L. Polygonaceae. Fruit. ? Fig. 22. Two fruits, right one with broken exocarp, tan to blackish with thin prominently nerved exocarp. YP. A ubiquitous littoral species on most studied beaches.

COCOID PALMS. Arecaceae. Endocarps. 1. Fig. 8: Cocoid palms usually have three pores. All in Figs. 8 and 9 are cocoid palms and most cocoid palms cannot be identified by their isolated endocarps. Exotic. Yucatan: CH = 1; Quintana Roo: CZ = 1, TA = 1, XC = 2.

COCOS NUCIFERA L. Arecaceae. Fruits and buds. 5. Fig. 9: Left - more or less mature fruit at $\times \frac{1}{2}$, right - immature fruit at $\times 1$. YP. Ubiquitous either as back beach trees or stranded fruits.

COMBRETUM LAXUM Jacquin. Combretaceae. Fruit. 3. Fig. 13: Tan and winged. Exotic. Quintana Roo: TU = 1.

CONOCARPUS ERECTUS L. Combretaceae. Fruit. 5. Fig. 13: Three more or less entire fruits and single seed. YP. Campeche: CB = 1; Quintana Roo: HO = +, AK = 1.

CORDIA SEBASTENA L. Boraginaceae. Fruit and endocarp. 1. Fig. 11: Left - eroded fruit, right - eroded endocarp. YP. Yucatan: SS = 1, CH = 2, CV = S; Quintana Roo: HO = 2, PJ = 2, CN = S.

CRESCENTIA CUJETE L. Bignoniaceae. Fruit. 1. Fig. 11: Large smooth fruit sometimes with pinpoint dots, not rim around stem scar $\times \frac{1}{2}$. YP. Quintana Roo: CZ = 2, TA = 4.

CYRTOCARPA sp. Anacardiaceae. Mesocarp. 3. Fig. 7: Tan and fibrous. Exotic. Yucatan: CV = 1.

DALBERGIA ECASTAPHYLLUM (L.) Taubert. Fabaceae. Fruit. 5. Fig. 17: Left - brown, right - very compressed in transection. Exotic. Quintana Roo: HO = 2; PJ = S, CN = +, PM = +, PC = +, CZ = +, AK = +, XE = S, TA = +, TU = S, XC = S.

DALBERGIA MONETARIA L.f. Fabaceae. Fruit. 5. Fig. 17: Left - brown and a little larger than preceding, right - thicker than preceding in transection. Exotic. Quintana Roo: HO = 2, CC = S, PJ = S, CN = +, AC = S, CZ = +, AK = +, XE = S, TA = +, TU = +, AC = S.

DIOCLEA REFLEXA Hooker f. Fabaceae. Seed. 2. Fig. 17: Three seeds and one transection, tan to blackish brown monochrome to motteld, note long narrow hilum. Exotic. Yucatan: SS = 1; Quintana Roo: HO = 1, IM = 1, PJ = 1, CN = S, PM = 1, CZ = 2; AK = +, XE = S, TA = +; TU = S, PH = 1, XC = S.

ENTADA GIGAS (L.) F. & R. Fabaceae. Seed. 1. Fig. 17: Chocolate brown. Exotic. Yucatan: SS = S CH = 1, SF = 1; Quintana Roo: HO = S, CC = S, IM = 1, PJ = 1, CN = +, PC = S, CZ = +, AK = +, XE = S, TA = +, TU = S, XC = S.

ERYTHRINA sp. Fabaceae. Seed. 2. Fig. 17: Resembles a brown bean seed. Exotic. Quintana Roo: AK = 1.

FEVILLEA CORDIFOLIA L. Cucurbitaceae. Seed. 5. Fig. 14: Ochre to dull sepia gray,

compressed. Exotic. Quintana Roo: CN=S; PM=S, PC=S, CZ=+, AK=+, XE=S, TA=+, TU=S, XC=S.

GRIAS CAULIFLORA L. Lecythidaceae. Mesocarp. 5. Fig. 21: Ribs tan, interstices brown. Exotic. Yucatan: CH=1; Quintana Roo: HO=S, PJ=+, CN=+, CZ=+, AK=+, TA=+, TU=1, PH=S, XC=S.

GUAREA sp. Meliaceae. Endocarp. 1. Fig. 21: Brown. Exotic. Yucatan: CV=3; Quintana Roo: TA=1.

GUAZUMA ULMIFOLIA Lam. Sterculiaceae. Fruit. 1. Fig. 23: Brown, surface knobby, size variable. YP. Quintana Roo: AK=1.

HERNANDIA SONORA L. Hernandiaceae. Endocarp. 2. Fig. 20: Left - part of tan exocarp, right - black endocarp. Exotic. Quintana Roo: CZ=3, AK=S, XE=1, TA=1, TU=1.

HEVEA BRASILIENSIS Muell. Arg. Euphorbiaceae. Seed. 1. Fig. 15: Brown to blackish, note raphe. Exotic. Quintana Roo: CN=1.

HIPPOMANE MANCINELLA L. Euphorbiaceae. Mesocarp, endocarp, exocarp. 5. Fig. 15: Tan, smooth (exocarp); eroded (mesocarp); starlike (endocarp). YP. Quintana Roo: HO=2, PJ=S, CN=+, PM=S, PC=S, CZ=+, AK=+, XE=+, TA=+, TU=S, PH=S, XC=S.

HYPERBAENA VALIDA Meirs. Menispermaceae. Seed. 1. Fig. 21: Dark brown, strongly reticulate, bent so that apex and base are touching. Exotic. Quintana Roo: AK=1.

IPOMOEA ALBA L. Convolvulaceae. Seed. 1. Fig. 14: Three seeds, black to white. ×2. YP. Quintana Roo: HO=1, CN=1, CZ=+, AK=1, TA=1.

IPOMOEA PES-CAPRAE (L.) Sweet. Convolvulaceae. Seed. 1. Fig. 14; Three seeds, black and pubescent to ± glabrous (upper), ×2, and capsule on peduncle, ×1. YP. Yucatan: CV=2; Quintana Roo: CZ=2.

IPOMOEA spp. Convolvulaceae. Seed. 1. Not illustrated but similar to preceding spp., except glabrous and smaller. YP. Yucatan: CV=1; Quintana Roo: CZ=1.

JACQUINIA PUNGENS. A. Gray. Theophrastaceae. Fruit. 1. Fig. 23: Broken and entire, yellowish brown, surface puckered. YP. Quintana Roo: HO=4.

JUGLANS JAMAICENSIS DC. Juglandaceae. Endocarp. 1. Fig. 20: Tan to brown, grooved. Exotic. Quintana Roo: CN=1, CZ=3, AK=S, XE=1, TA=1, TU=2, PH=1, XC=2.

JUGLANS REGIA L. Juglandaceae. Endocarp. 1. Fig. 20: Tan, ridgelike suture (damaged). Exotic. Quintana Roo: TA=1.

LAGUNCULARIA RACEMOSA Gaertner. Combretaceae. Fruit. 5. Fig. 13: Three variations, gray. YP. Yucatan: SS=1, YU=1; Quintana Roo: HO=+, CC=1, CN=1, CZ=1, AK=2.

MACHAERIUM FALCIFORME Rudd. Fabaceae. Meoscarp. 5. Fig. 18: Brown, usually bearing lumen. Exotic. Quintana Roo: CN=1, AK=1, TU=1.

MACHAERIUM LUNATUS (G.F.W. Meyer) Ducke. Fabaceae. Mesocarp. 5. Fig. 18: Brown, usually without lumen. Exotic. Quintana Roo: HO=1, CZ=1, TA=1.

MACROZAMIA sp. Cycadaceae. Seed. 1. Fig. 14: Tan, striate. Exotic. Quintana Roo: AK=1.

MAMMEA AMERICANA L. Clusiaceae. Mesocarp. 1. Fig. 12: Black, fibrous. YP. Quintana Roo: AK = 1.

MANGIFERA INDICA L. Anacardiaceae. Endocarp. 1. Fig. 7: Left - fiber not eroded, right - fibers eroded, size varies, compressed. YP. Yucatan: SS = 1, YU = 3, CH = 1, CV = 1; Quintana Roo: HO – 1, IM = 2, AK = 2, XC = 1. Some may be beach garbage.

MANICARIA SACCIFERA Gaertner. Arecaceae. Endocarp, exocarp. 1. Fig. 10: Left - exocarp with rough surface, righ - top and bottom - endocarps with white or black coats exposed. Exotic. Yucatan: SS = S, YU = 1, CH = +, UA = 1, CV = S, PR = S, SF = 2; Quintana Roo: HO = +, IM = S, PJ = +, CN = +, PC = S, CZ = +, AK = + XE = +, TA = +, TU = S, PH = S, XC = S.

MASTICHODENDRON CAPIRI (A. DC.) Cronquist. Sapotaceae. Seed. 1. Fig. 22: Like *M. foetidissimum,* but larger. Exotic. Quintana Roo: AK = 1, TA = 1.

MASTICHODENDRON FOETIDISSIMUM (Jacq.) H.J. Lam. Sapotaceae. Seed. 1. Fig. 22: Hilar and side views, shiny to dull, brown. Exotic. Quintana Roo: AK = S, TA = 1.

MAMILIANA CARIBAEA G. & W. Arecaceae. Endocarp. 1. Fig. 8: Tan, usually with 3 nearly basal pores and often bearing erosion hole or holes. Exotic. Quintana Roo: CZ = 2, AK = 2, TA = 1, XC = 1.

MERREMIA DISCOIDESPERMA (Donn. Sm.) O'Donell. Convolvulaceae. Seed. 1. Fig. 14: Left - ventral side showing impressed cross, right - dorsal side with seallike hilum, black. Exotic. Quintana Roo: CN = 1, CZ = 4, TA = S, TU = 2.

MERREMIA TUBEROSA (L.) Rendle. Convolvulaceae. Seed. 1. Fig. 14: Subglobose to triangular, black. Exotic. Quintana Roo: AK = 1.

MORA sp. Fabaceae. Seed. 5. Fig. 17: Black with puckered surface. Exotic. Quintana Roo: CN = 2, CZ = 2, AK = 1, TA = 1.

MUCUNA FAWCETTII Urban. Fabaceae. Seed. 1. Fig. 18: Upper - hilar view , lower - lateral view, note broad black hilum. Exotic. Yucatán: YU = 1, SF = 1; Quintana Roo: TA = 2, XC = 1.

MUCUNA HOLTONII (O. Kuntze) Moldenke. Fabaceae. Seed. 1. Fig. 18: Upper - lateral view, lower - hilar view, black, surface somewhat puckered. Exotic. Quintana Roo: XC = 1.

MUCUNA SLOANEI F. & R. Fabaceae. Seed. 1. Fig. 18: Upper - lateral view, lower - hilar view, note narrower black hilum. Exotic. Quintana Roo: HO = 1, CN = S, PC = 2, CZ = +, AK = 3, XE = 2, TA = S, PH = S, XC = S.

MUCUNA URENS (L.) Medikus. Fabaceae. Seed. 1. Fig. 18: As preceding. Exotic. Quintana Roo: HO = 3, IM = 1, PJ = 1, CN = S, PC = 2, CZ = S, AK = +, TA = +, TU = 3, PH = 2.

MYRISTICA sp. Myristicaceae. Exocarp, endocarp. 3. Fig. 21: Exocarp black and endocarp brown. Exotic. Quintana Roo: CZ = 1.

OMPHALEA DIANDRA L. Euphorbiaceae. Seed. 1. Fig. 15: Blackish and covered with minute tubercles. Exotic. Yucatan: SF = 1. Quintana Roo: PJ = 1, CN = S, CZ = 2, AK = 1, TA = 2, XC = 1.

ORBIGNYA COHUNE (Martius) Standley. Arecaceae. Endocarp. 1. Fig. 8: Tan to brown with surface striate and usually bearing three basal pores that are

somewhat concealed. YP. Quintana Roo: HO=2, PJ=1, CN=+, PC=S, CZ=S, AK=+, XE=1, TA=S, TU=3, PH=S, XC=+.

ORMOSIA COUTINHOI Ducke. Fabaceae. Seed or legume. 1. Fig. 19: Left - dull reddish brown seed with hilum about 1/3 circumference, right - brown legume. Exotic. Quintana Roo: TU=1.

OXYRHYNCHUS TRINERVIUS (Donn. Sm.) Rudd. Fabaceae. Seed. 2. Fig. 19: Lustrous black to dark brown, hilum with raised margins and about ¾ seed circumference. Exotic. Quintana Roo: AK=1.

PACHIRA sp. Bombaceae. Seed. 2. Fig. 11: Blackish brown, ± triangular to irregularly shape. May be open or closed. (May decay beforme drying). YP? Quintana Roo: HO=1, AK=S.

PASSIFLORA sp. Passifloraceae. Fruit. 1. Fig. 22: Damaged fruit, note seeds. YP. Quintana Roo: CZ=1, AK=1.

PERSEA AMERICANA Miller. Lauraceae. Seed. 2. Fig. 20: Blackish and striated. YP. Yucatan: SS=1.

PISTACIA sp. Anacardiaceae. Endocarp. 1. Fig. 7: Grayish tan, opening along one suture. YP. Quintana Roo: CZ=1.

PITHECELLOBIUM BELIZENSIS Standley. Fabaceae. Seed or cotyledon. 1. Fig. 19: Upper - external view, lower - internal view of one cotyledon. Tan to blackish brown, strongly compressed. Exotic. Quintana Foo: PJ=1, CN=3 PC=+, CZ=S, AK=+, TU=+.

POUPARTIA AMAZONICA Ducke. Anacardiaceae. Exocarp, endocarp. 1. Fig. 7: Left - uneroded and immature fruit, right - endocarp from mature fruit, both grayish. Exotic. Yucatan: TP=2, CV=1; Quintan a Roo: HO=1, PJ=1, AK=1.

PRIORIA COPAIFERA Grisbeck. Fabaceae. Seed. 1. Fig. 19: Left - lateral view, right - hilar view gray-black. Exotic. Quintana Roo: TA=1.

PRUNUS ARMENIACA L. Rosaceae. Endocarp. 1. Fig. 23: Tan, note open suture. Exotic. Quintana Roo: TA=1.

PSIDIUM sp. Myrtaceae. Fruit. 5. Fig. 22: Grayish brown, depressed apex, faint ridge. YP. Quintana Roo: TA=1.

PTEROCARPUS AMAZONICUS Huber. Fabaceae. Fruit. 5. Fig. 19: Grayish brown, not as large and more terete than *P. officinalis*. Exotic. Quintana Roo: CZ=S, AK=S.

PTEROCARPUS OFFICINALIS Jacquin. Fabaceae. Fruit. 5. Fig. 19. Grayish brown, compressed, veined, often eroded. Exotic. Yucatan: SS=1; Quintana Roo: HO=+, PJ=+, CN=+, PM=+, PC=+ CZ=+, AK=+, XE=+, TA=+, TU=+, PH=S, XC=S.

QUEBQUS HUMBOLDTII Bonpland. Fagaceae. Fruit. 1. Fig. 20: Brown, note large circular basal scar. Exotic. Quintana Roo: CZ=1.

RHIZOPHORA MANGLE L. Rhizophoraceae. Seedling. 3. Fig. 22: Upper - flower (note calyx), middle - small seedling, bottom - average size seedling. YP. Found on most surveyed beached.

SACOGLOTTIS AMAZONICA Martius. Humiriaceae. Endocarp. 1. Fig. 20: Brown to grayish brown, surface lumpy (due to cysts). Exotic. Yucatan: CH=2, CV=1,

PR = I, SF = S; Quintana Roo: HO = S, PJ = +, CN = +, PM = +, PC = +, CZ = +, AK = +, XE = +, TA = +, TU = S, XC = S.

SPONDIAS MOMBIN L. Anacardiaceae. Mesocarp. 3. Fig. 7: Part of the exocarp is present over fibrous mesocarp, dark brown. YP. Quintana Roo: XC = 2.

SPONDIAS PURPUREA L. Anacardiaceae. Mesocarp. 3. Fig. 7: Left - major and minor fibers, right - major fibers. Tan. YP. Found on most surveyed beaches.

SWIETENIA MAHAGONI (L.) Jacquin. Meliaceae. Fruit. 5. Fig. 20: Brown, pyriform. YP. Quintana Roo: CZ = 1.

SYAGRUS sp. Arecaceae. Endocarp. 1. Fig. 8: Tan, usually with 3 nearly basal pores. Exotic. Quintana Roo: AK = 1.

TALISIA OLIVAEFORMIS (H.B.K.) Radlk. Sapindaceae. Endocarp. 5. Fig. 22: Tan. YP, Campeche: SP = 2; Yucatan: YU = +, CH = +, CV = S; Quintana Roo: HO = +, IM = S, CN = 1, CZ = 1, AK = 1, XE = S, TA = 1, XC = 3.

TERMINALIA CATAPPA L. Combretaceae. Mesocarp, exocarp. 3. Fig. 13: Upper - entire fruit, lower three - mesocarps, tan, corky. YP. Found on nearly all surveyed beaches.

TERMINALIA sp. Combretaceae. Mesocarp. 3. Fig. 13: Smaller than preceding and winged. Exotic? Quintana Roo: AK = 1, CN = 1.

TOURNEFORTIA GNAPHALODES R. Br. Boraginaceae. Aggregate fruit. 5? Fig. 11: Left - aggregate fruit, right - two individual fruits, black. YP. Yucatan: CH = +; Quintana Roo: CC = 1, PM = 2. Buoyancy has not been tested. These aggregate fruits may be from back beach plants.

TRIBULUS CISTOIDES L. Poaceae. Fruit. 3? Fig. 22. Tan bur. YP. Yucatan: SS = +, YU = +, CH = +, UA = +, TP = +; Quintana Roo: HO = +, AK = 2. Buoyancy has not been tested. These fruits may be from beach plants.

XANTHIUM STRUMARIUM L. Asteraceae. Fruit. 1. Fig. 10: Tan, spiny. YP. Quintana Roo: AK = S. Buoyancy has not been tested. This fruit may be from back beach plants.

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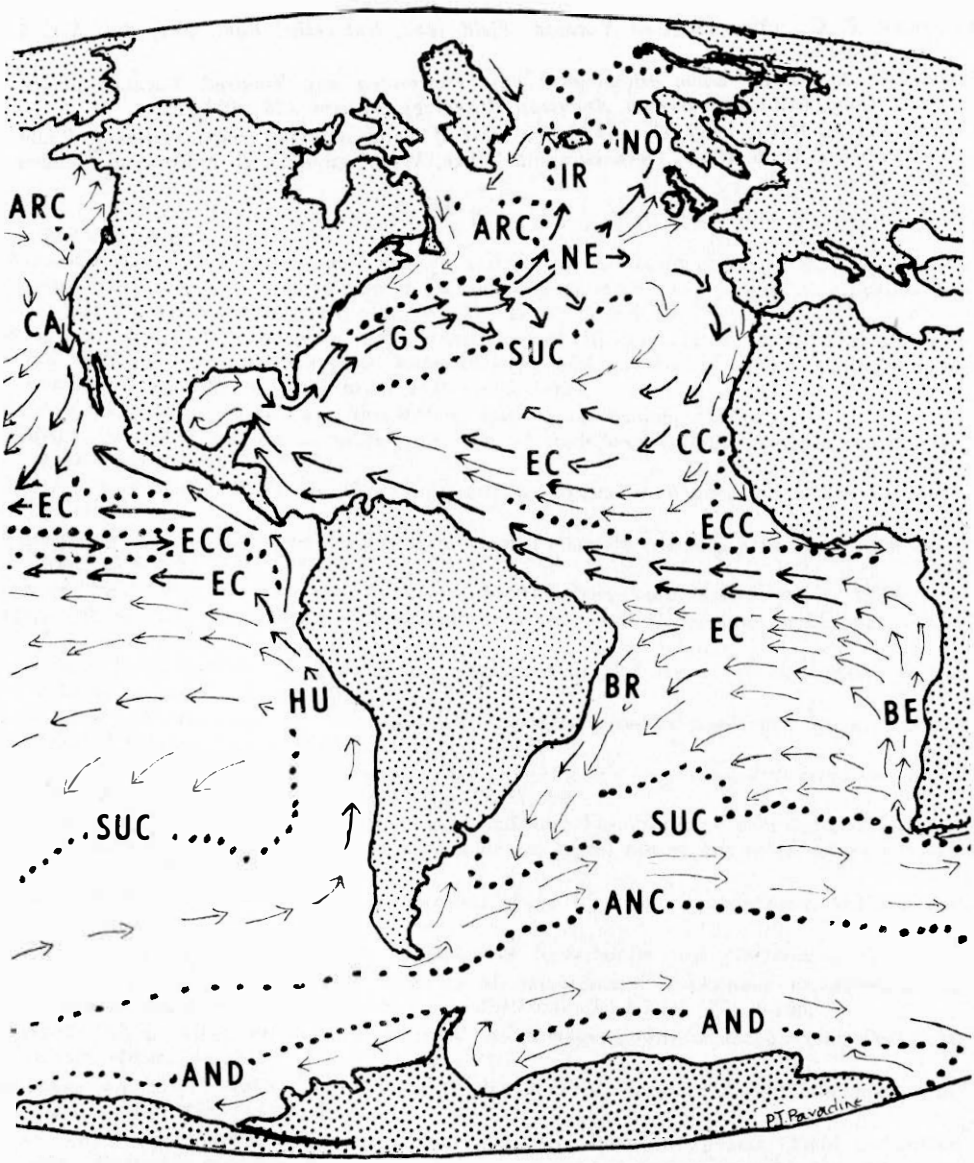


Figure 1. Ocean currents which influence the east and west coasts of the New World and the west coast of the Old World. Darker arrows show the direction of currents with a velocity of more than 36 nautical miles per day, whereas the lighter arrows show the direction of currents with a velocity of 36 or less nautical miles per day. Dots represent current bonudaries. Arrow and dot locations are approximations. Dots: ANC = Antarctic Convergence; AND = Antarctic Divergence; ARC = Artic Convergence; SUC = Subtropical Convergence. Arrows: BE = Benguela Current; BR = Brazil Current; CA = California Current; CC = Canary Current; EC = Equatorial Current; ECC = Equatorial Counter Current; GS = Gulf Stream; HU = Humboldt Current; IR = Irminger Current; NE = Northeast Atlantic Current; NO = Norwegian Current. (Gunn, Dennis, and Paradine, 1976).

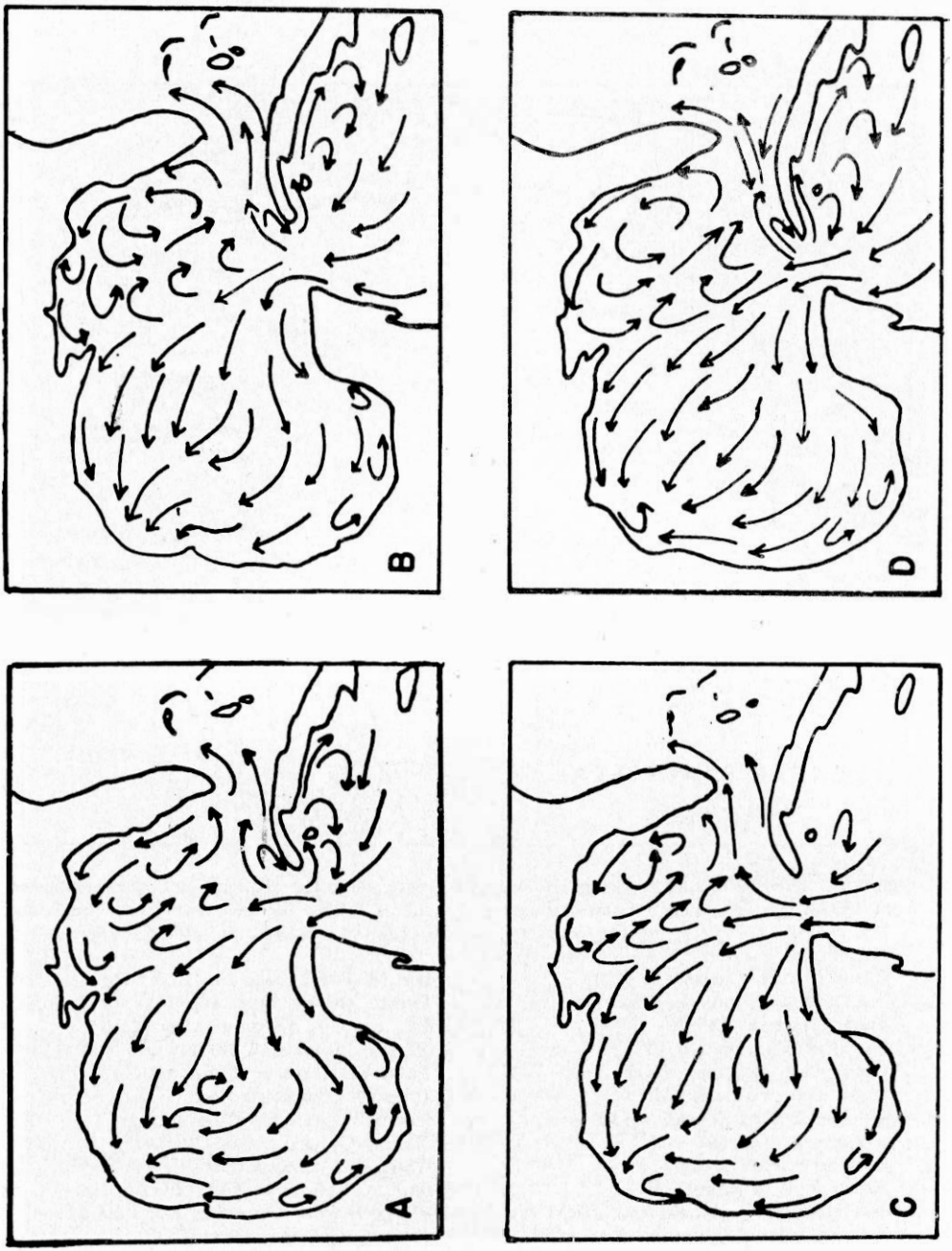


Figure 2. Surface currents in the Gulf of Mexico. A = Autumn (Oct., Nov., Dec.); B = Winter (Jan., Feb., Mar.); C = Spring (Apr., May, June), and D = Summer (Jul., Aug., Sep.). Redrawn from United States Navy, 1965).

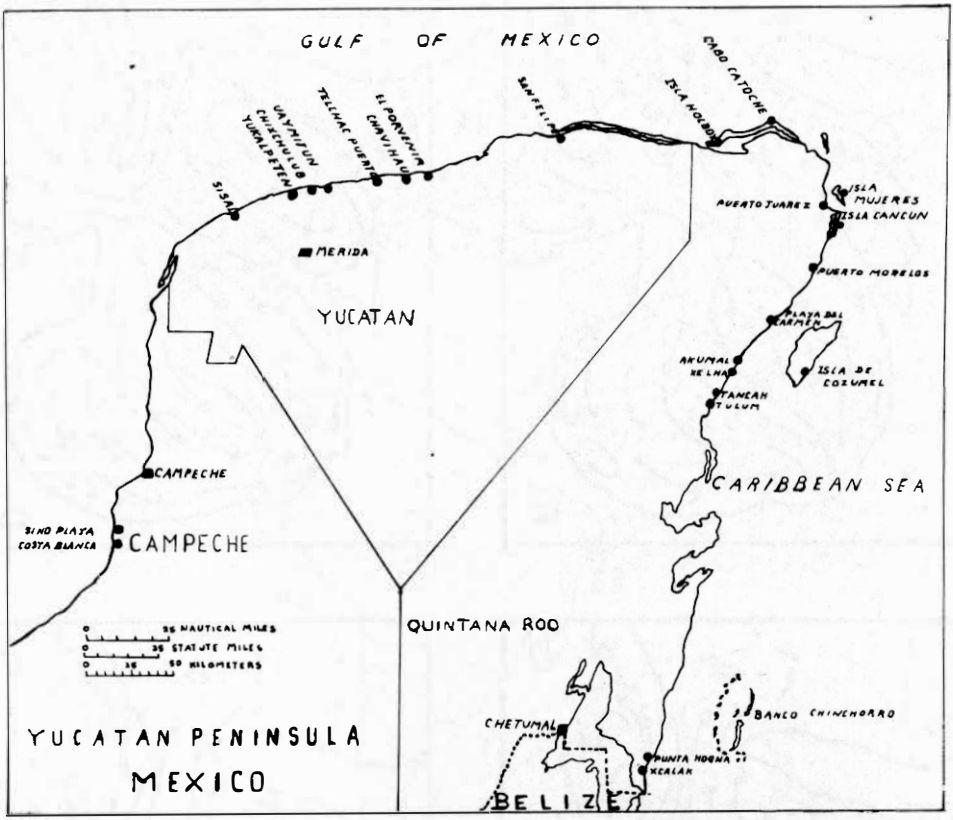


Figure 3. The 24 Yucatan Peninsula beaches where stranded disseminules were collected from 1973-1975. The beach names, states, and symbols follow the coastline from Campeche to the southern tip of Quintana Roo:

Costa Blanca, Campeche (CB)
Siho Playa, Campeche (SP)
Sisal, Yucatan (SS)
Yukalpeten, Yucatan (YU)
Chixchulub, Yucatan (CH)
Uaymitun, Yucatan (UA)
Telchac Puerto, Yucatan (TP)
Chavihau, Yucatan (CV)
El Porvenir, Yucatan (PR)
San Felipe, Yucatan (SF)
Isla Holbox, Quintana Roo (HO)
Cabo Catoche, Quintana Roo (CC)
Isla Mujeres, Quintana Roo (IM)
Puerto Juárez, Quintana Roo (PJ)
Isla Cancun, Quintana Roo (CN)
Puerto Morelos, Quintana Roo (PM)
Playa del Carmen, Quintana Roo (PC)
Cozumel, Quintana Roo (CZ)
Akumal, Quintana Roo (AK)
Xelha, Quintana Roo (XE)
Tancah, Quintana Roo (TA)
Tulum, Quintana Roo (TU)
Punta Hogna, Quintana Roo (XC)
Xcalak, Quintana Roo (XC)

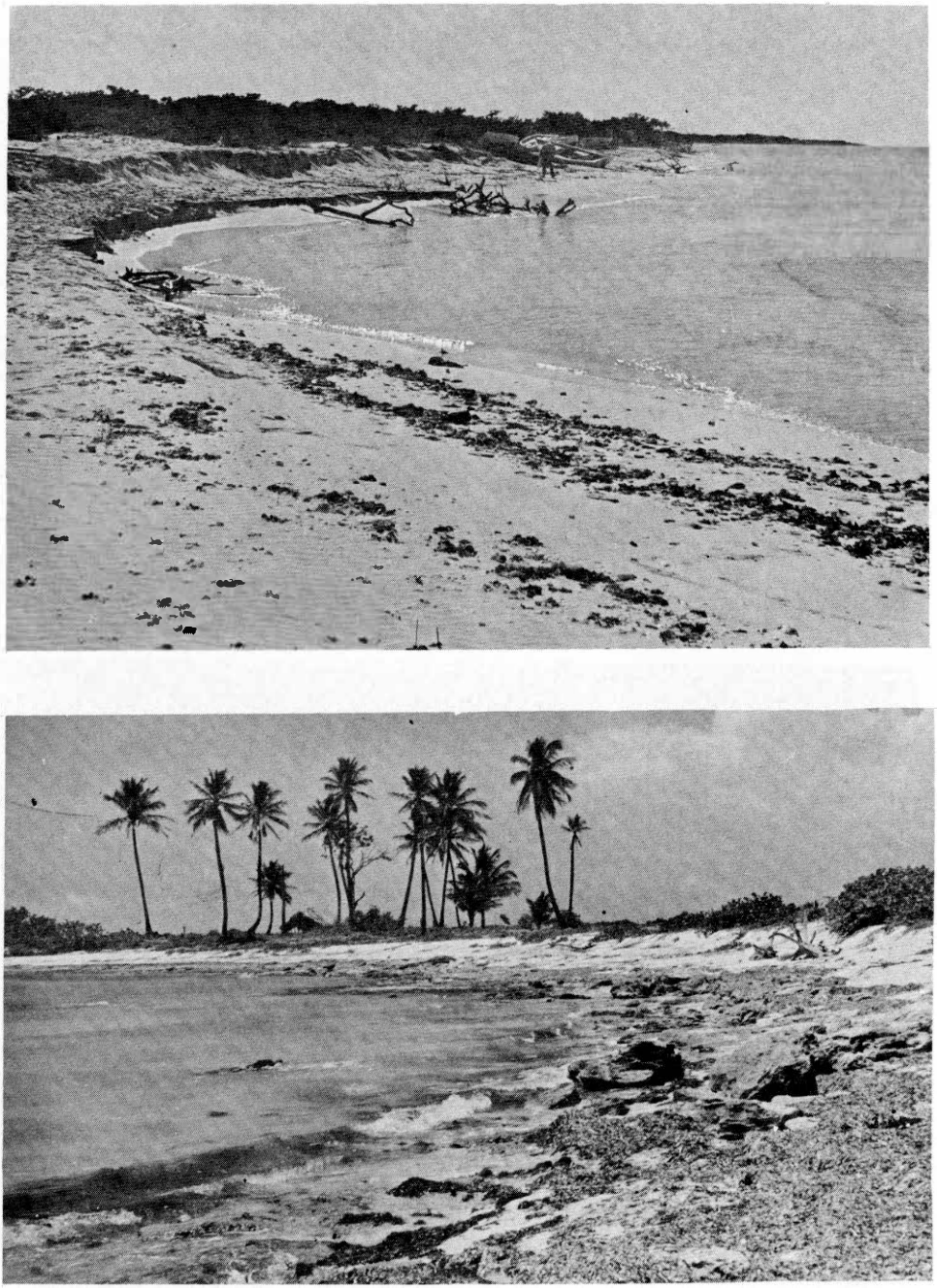


Figure 4. Yucatan Peninsula beaches. Above - a Siho Playa, Campeche type of beach. Below - end of beach at Sisal, Yucatan which is typical of the north Gulf Coast beaches. (Courtesy of H. and E. Vokes).

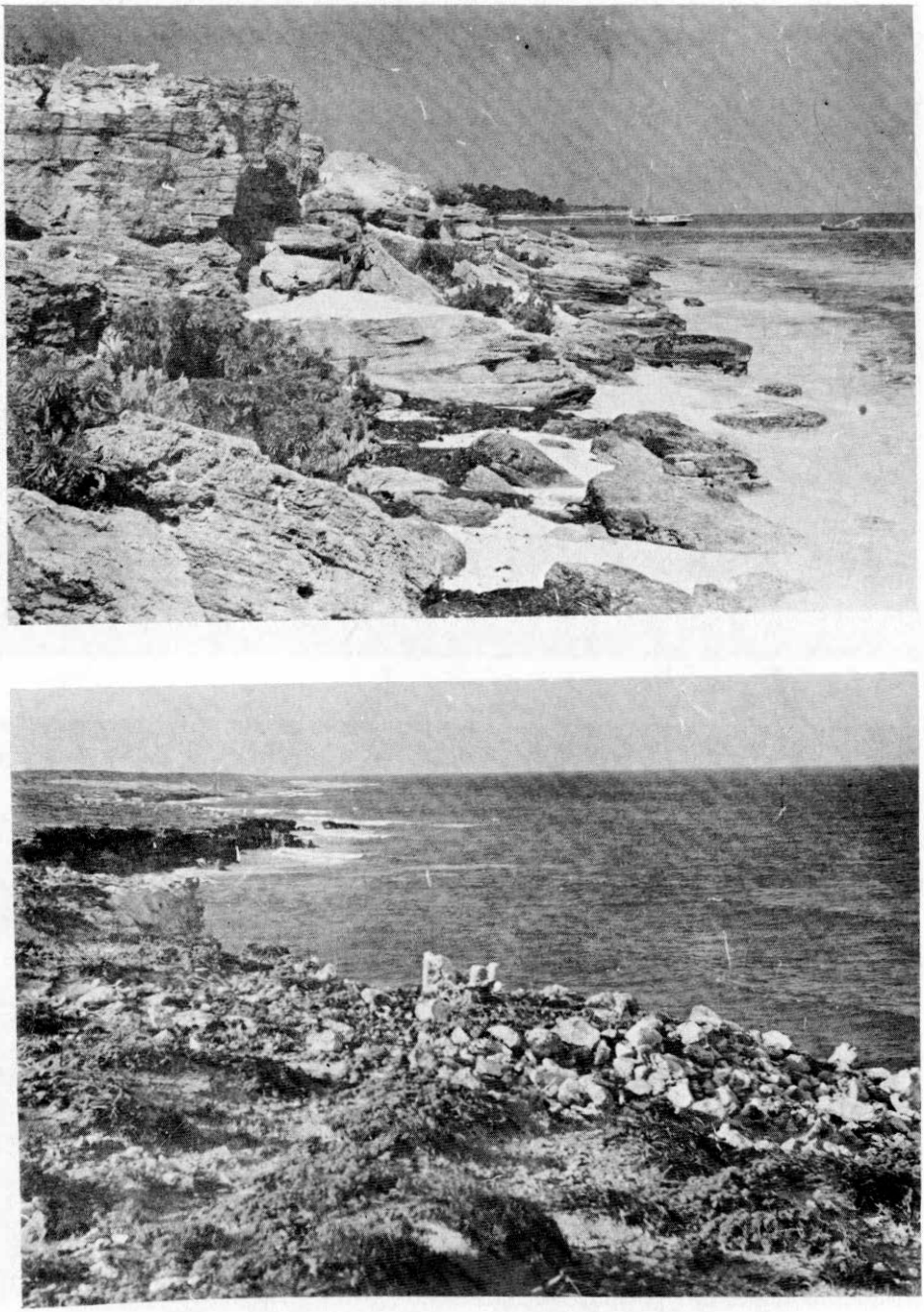


Figure 5. Yucatan Peninsula beaches. Above - Puerto Juarez, Quintana Roo with Pleistocene eolianites. Below - Isla Mujeres, Quintana Roo showing the windward coast on a calm day. (Courtesy of H. and E. Vokes).

Figure 6. Yucatan Peninsula beaches. Above - Joann Andrews collecting on the windward side of the southeastern tip of Isla Cozumel. Below - Detail of the same beach. Note the large number of disseminules in the flotsam and jetsam.

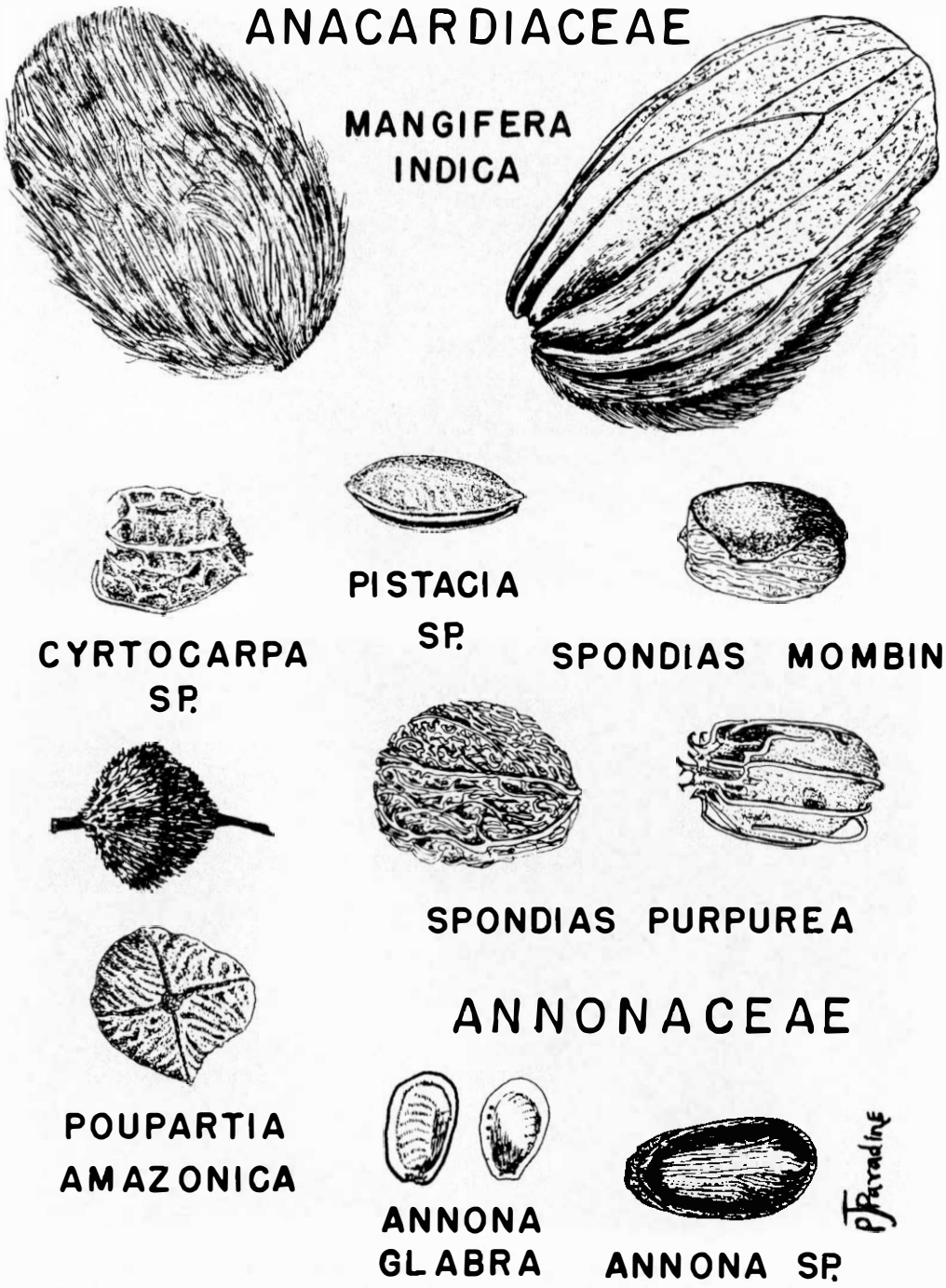
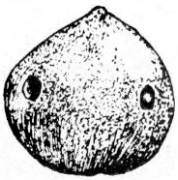


Figure 7. Stranded disseminules of the Yucatan Peninsula.

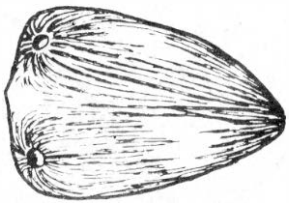
ARECACEAE

COCOID PALMS



ACROCOMIA MEXICANA

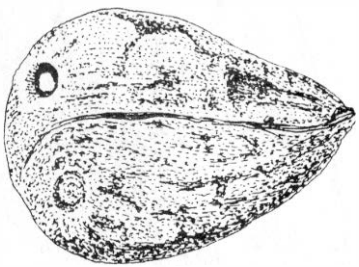
ALFONSIA OLEIFERA



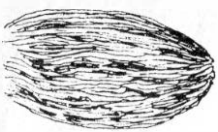
ASTROCARYUM SP.

BACTRIS SP.

MAXIMILIANA CARIBAEA



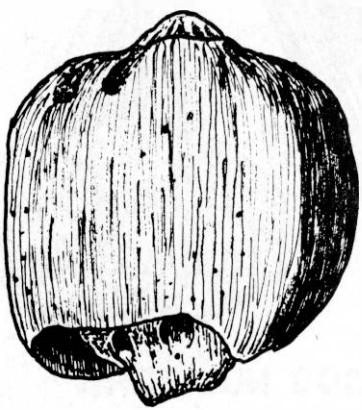
ASTROCARYUM ALATUM



XC-8

SYAGRUS SP.

TA-76



ORBIGNYA COHUNE

P.J. Pavadine

Figure 8. Stranded disseminules of the Yucatan Peninsula.

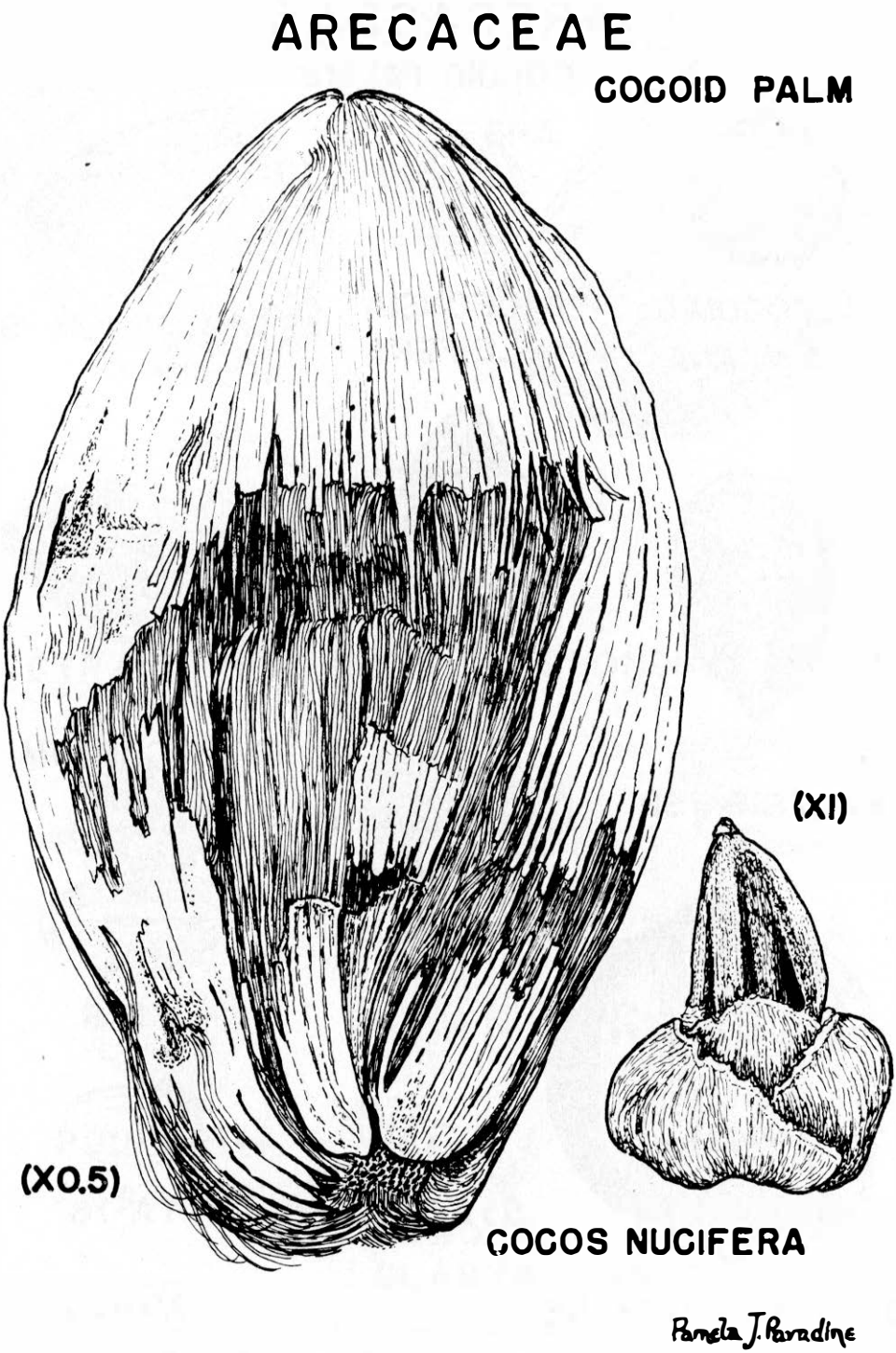


Figure 9. Stranded disseminules of the Yucatan Peninsula.

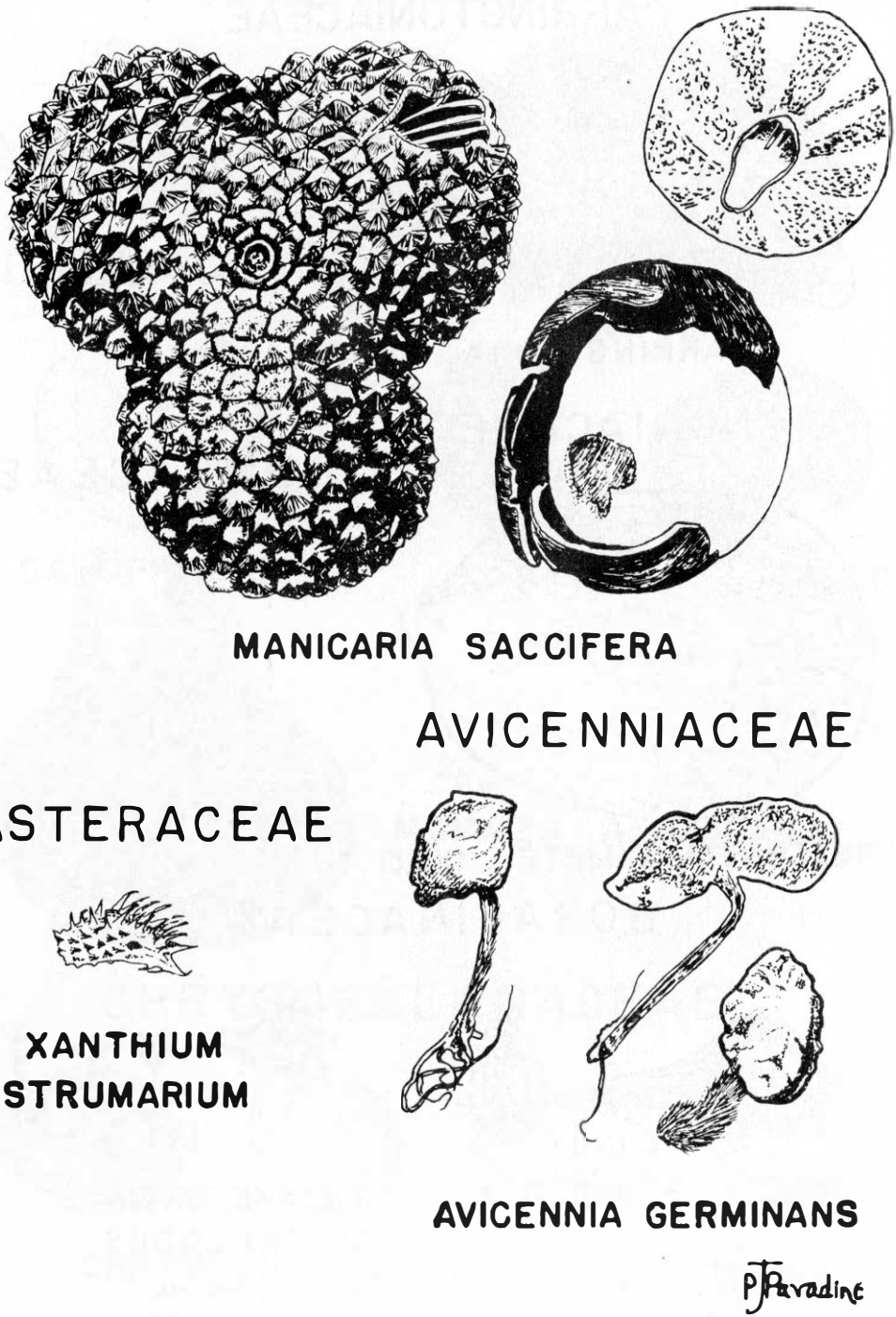
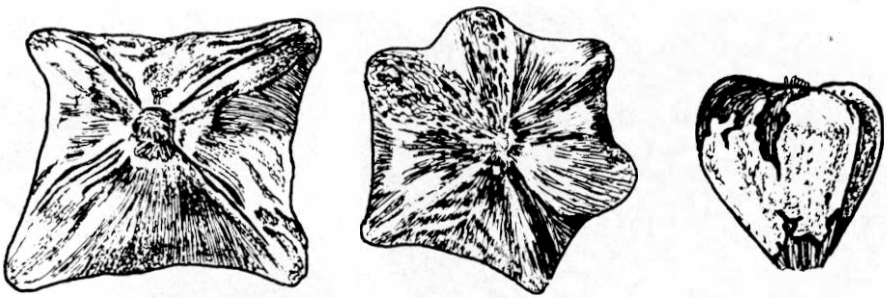


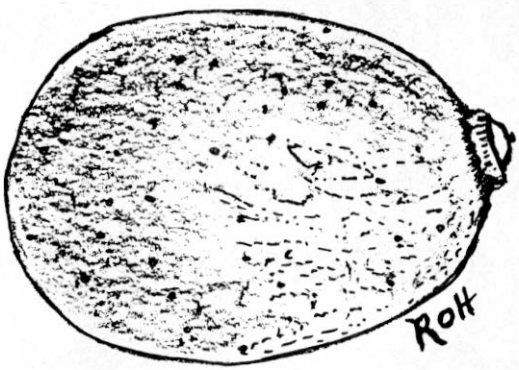
Figure 10. Stranded disseminules of the Yucatan Peninsula.

BARRINGTONIACEAE



BARRINGTONIA ASIATICA (X0.5)

BIGNONIACEAE

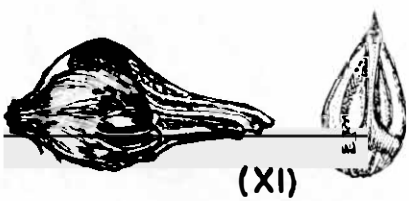


CRESCENTIA CUJETE (X0.5)

BOMBACEAE

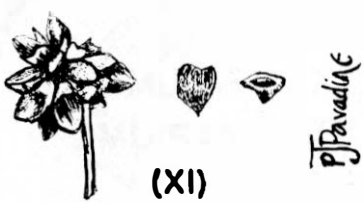
PACHIRA SP. (XI)

BORAGINACEAE



(XI)

CORDIA SEBASTENA



(XI)

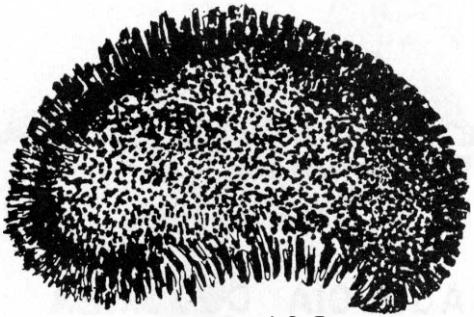
TOURNEFORTIA GNAPHALODES

Figure 11. Stranded disseminules of the Yucatan Peninsula.

CARICACEAE

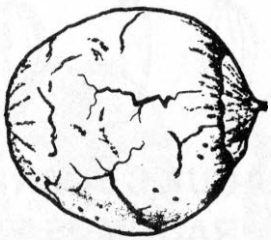
CARICA PAPAYA

CARYOCARACEAE



AK-102

CLUSIACEAE

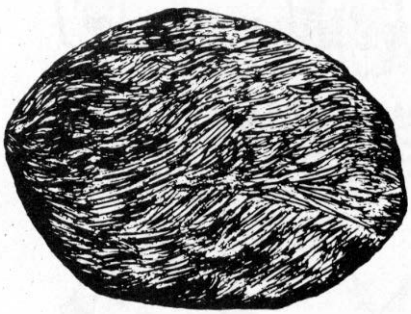


CALOPHYLLUM CALABA

CZ-50

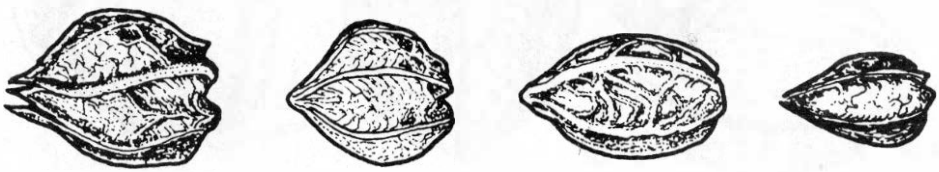
TA-96

CARYOCAR SPP.



MAMMEA AMERICANA

CHRYSOBALANACEAE

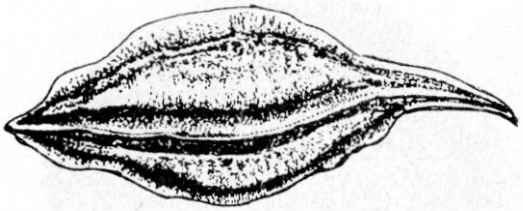


CHRYSOBALANUS ICACO

P. J. Paradine

Figure 12. Stranded disseminules of the Yucatan Peninsula.

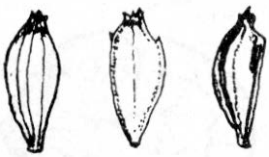
COMBRETACEAE



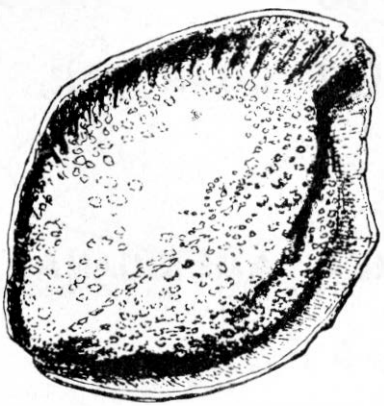
CACOUCIA COCCINEA

COMBRETUM LAXUM

CONOCARPUS ERECTUS

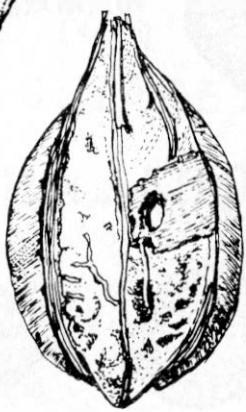


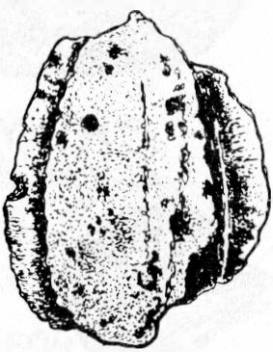
LAGUNCULARIA RACEMOSA

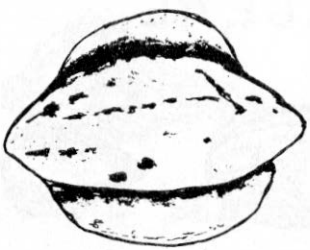


TERMINALIA SP.

AK-106







TERMINALIA CATAPPA

P.J. Paradine

Figure 13. Stranded disseminules of the Yucatan Peninsula.

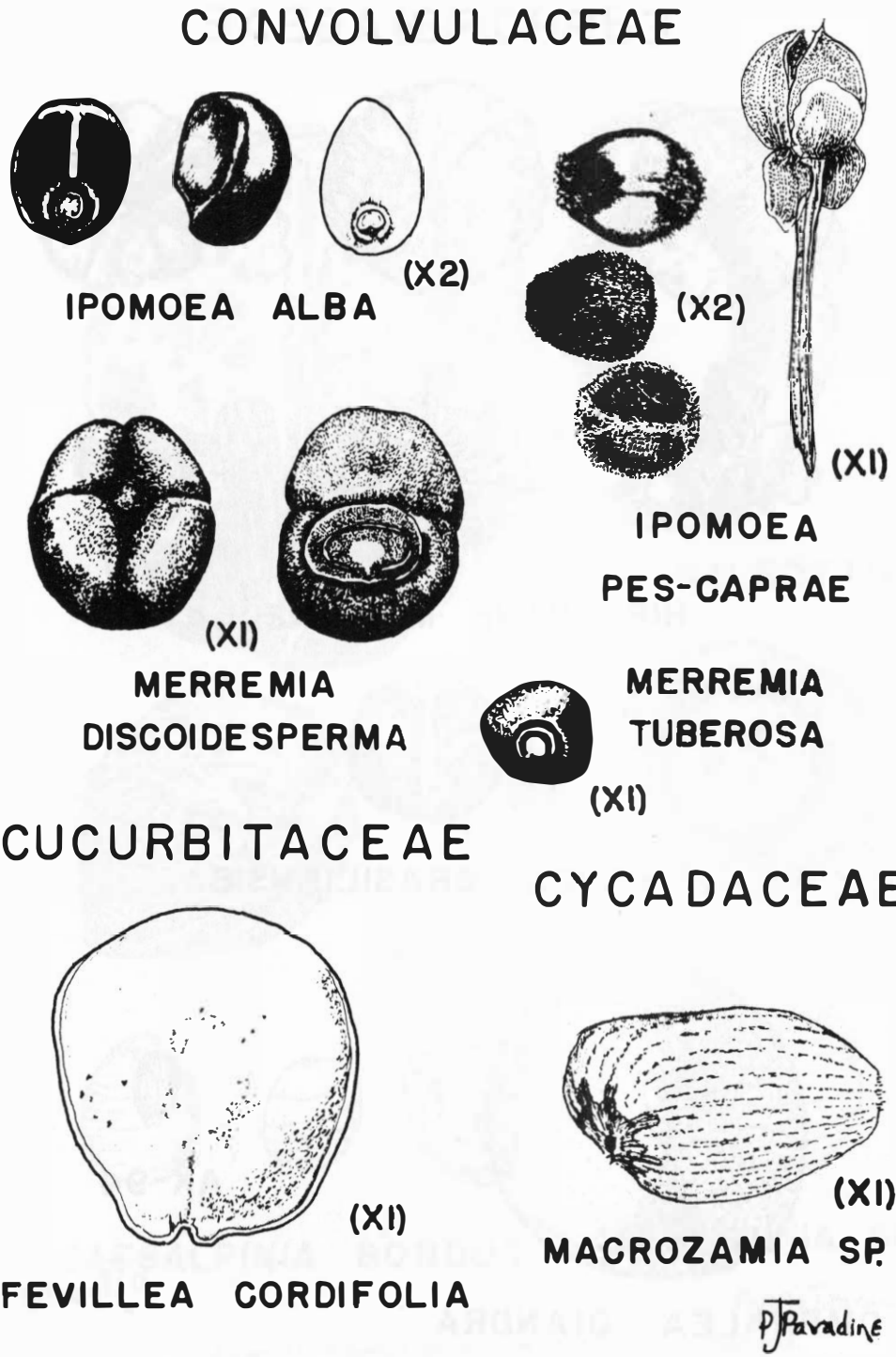
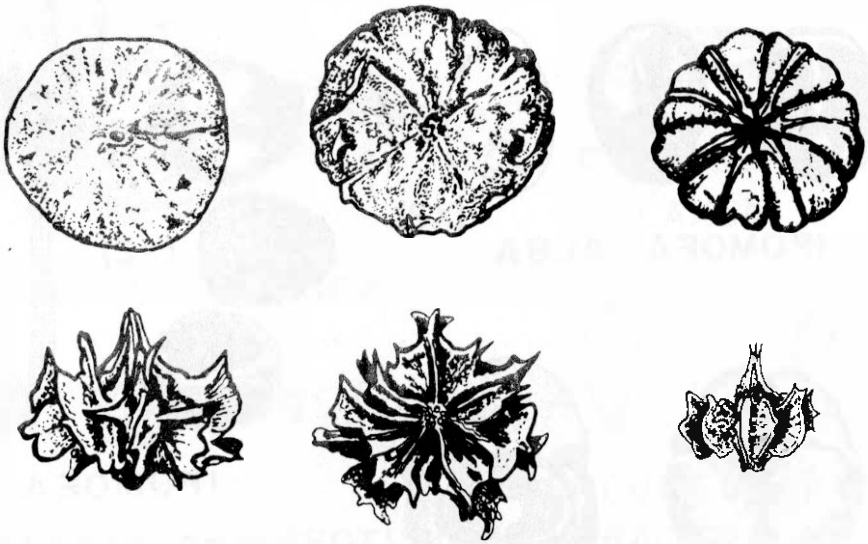


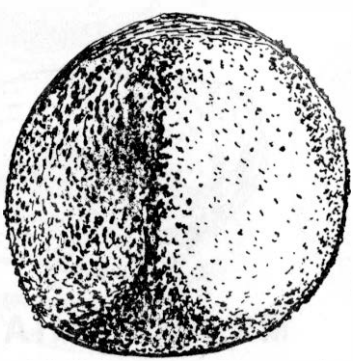
Figure 14. Stranded disseminules of the Yucatan Peninsula.

EUPHORBIACEAE



HIPPOMANE MANCINELLA

HEVEA BRASILIENSIS



AK-94

P.J. Pavadine

OMPHALEA DIANDRA

Figure 15. Stranded disseminules of the Yucatan Peninsula.

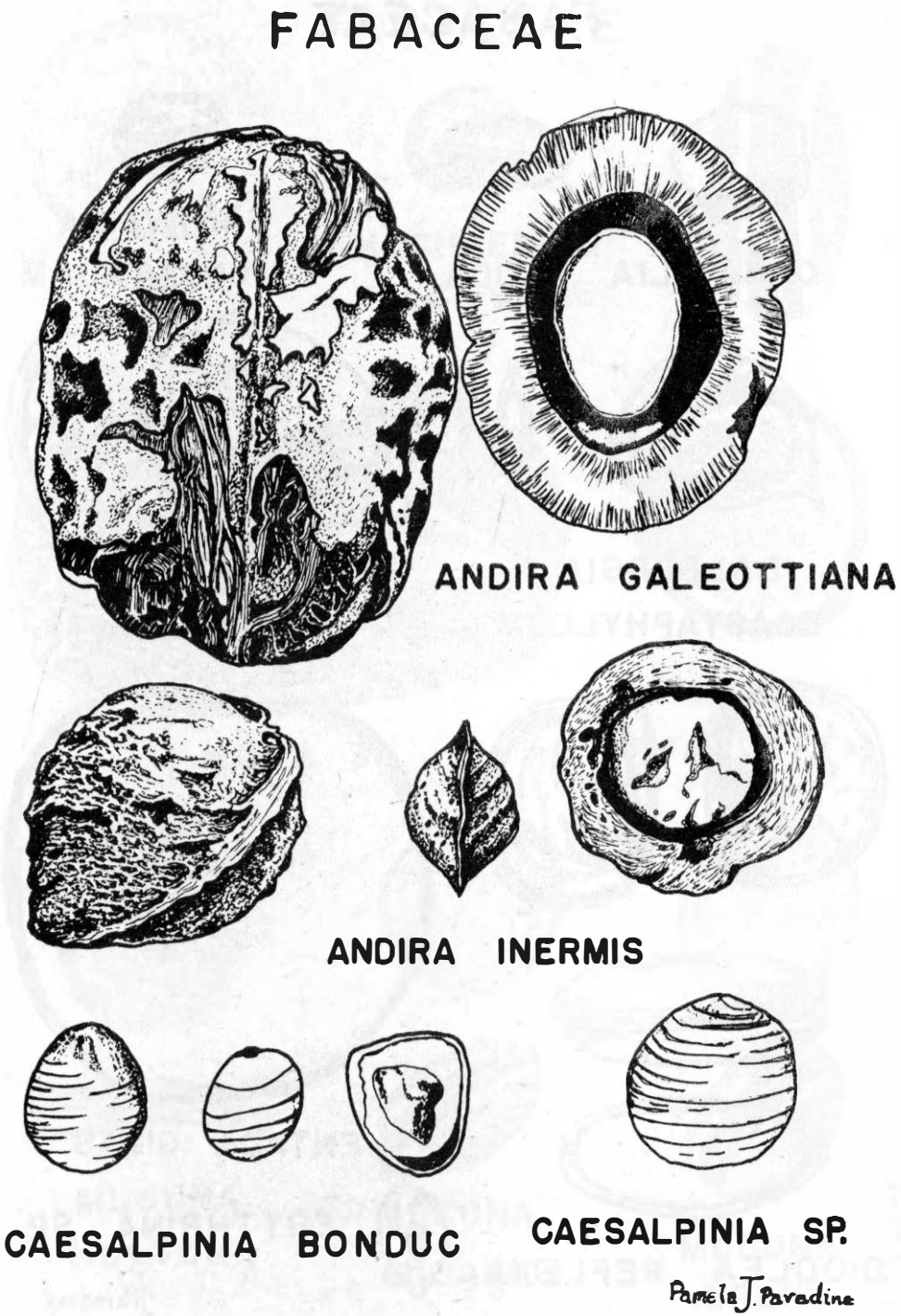


Figure 16. Stranded disseminules of the Yucatan Peninsula.

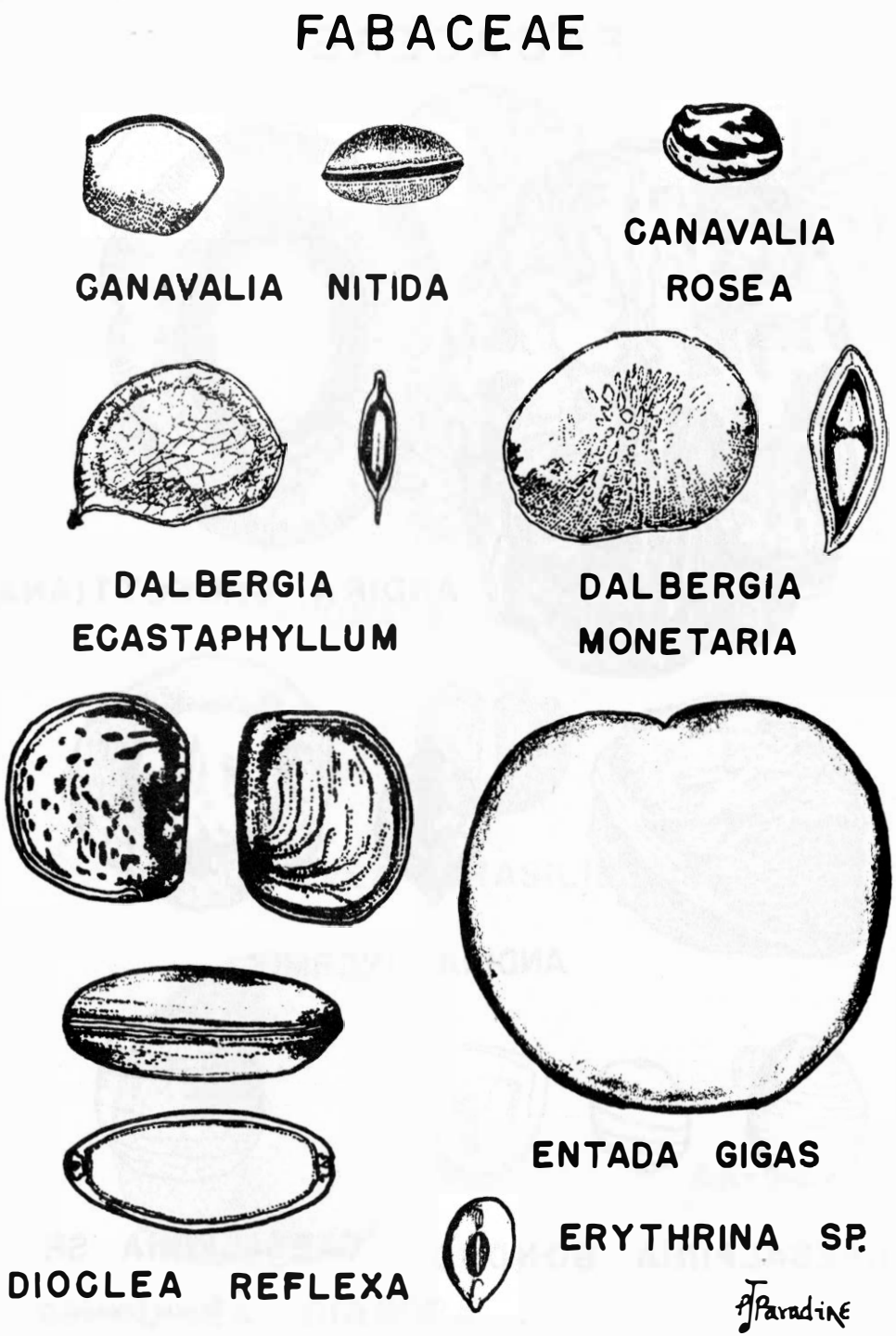


Figure 17. Stranded disseminules of the Yucatan Peninsula.

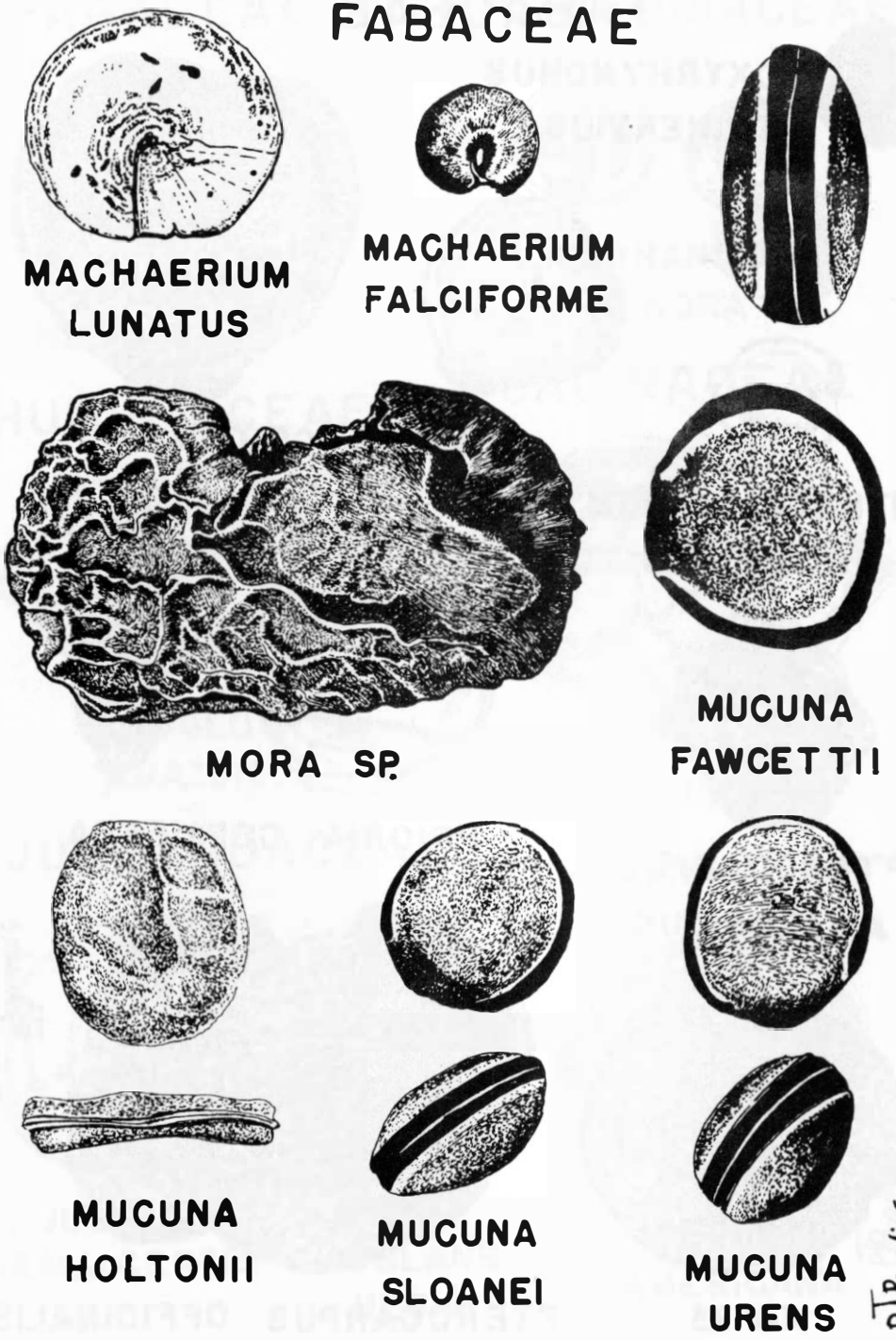


Figure 18. Stranded disseminules of the Yucatan Peninsula.

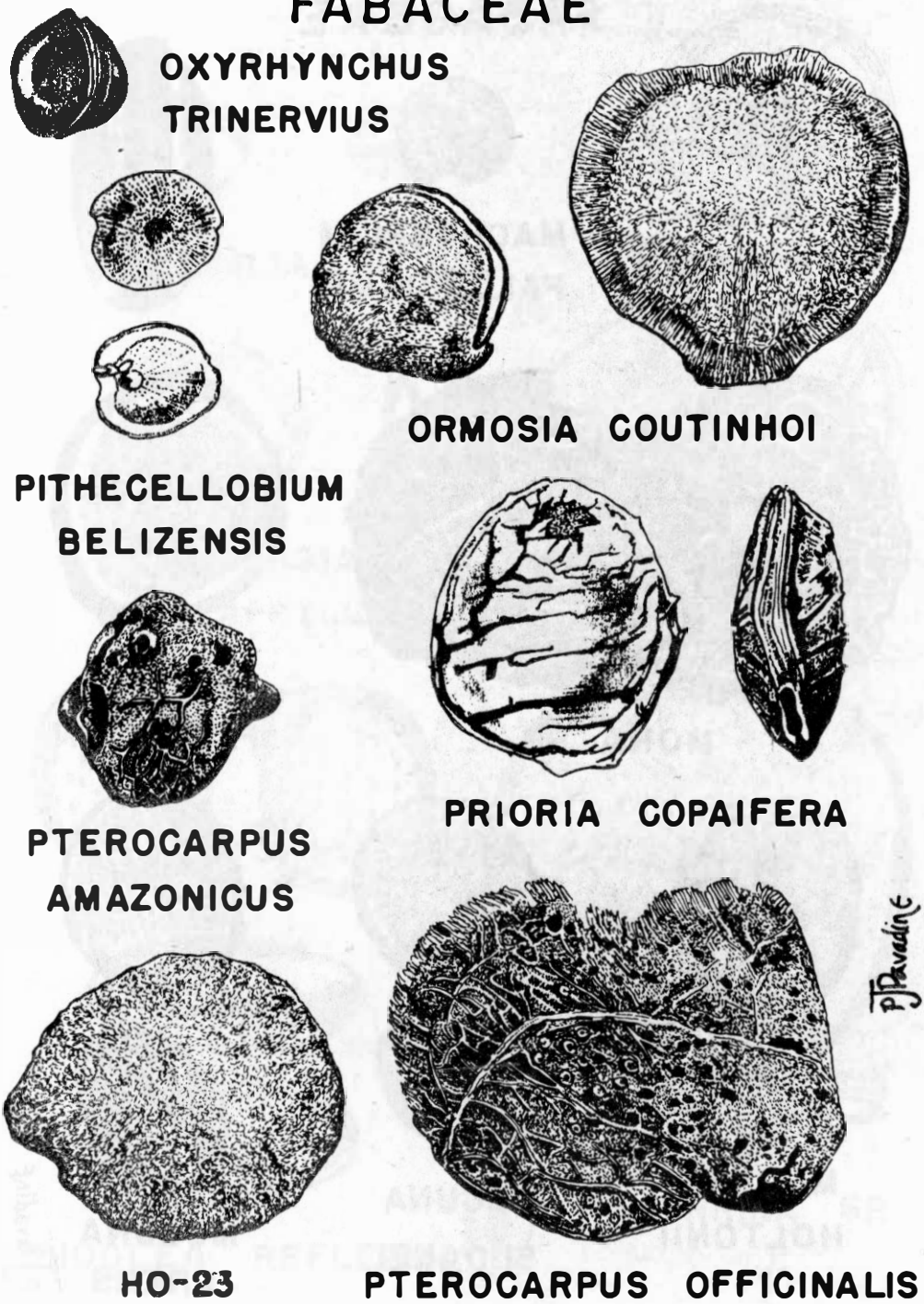
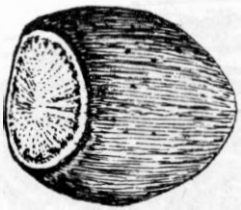


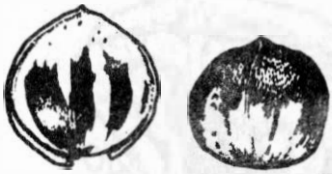
Figure 19. Stranded disseminules of the Yucatan Peninsula.

FAGACEAE



QUERCUS HUMBOLDTII

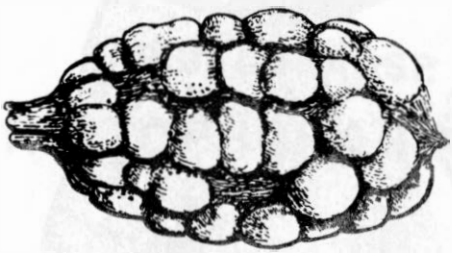
HERNANDIACEAE



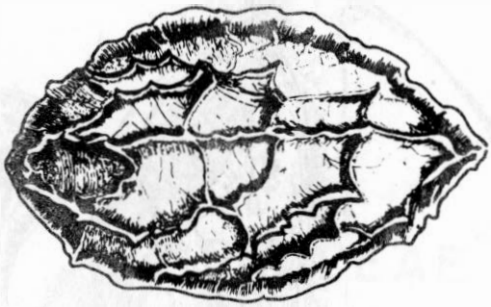
HERNANDIA SONORA

ICACINACEAE

HUMIRIACEAE



SACOGLOTTIS AMAZONICA



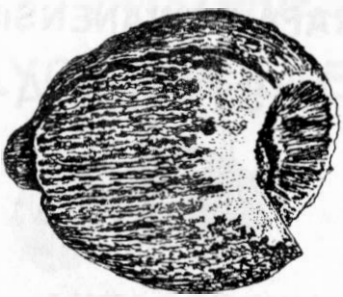
CALATOLA COSTARICENSIS

JUGLANDACEAE

LAURACEAE

JUGLANS JAMAICENSIS

JUGLANS REGIA



PERSEA AMERICANA

Figure 20. Stranded disseminules of the Yucatan Peninsula.

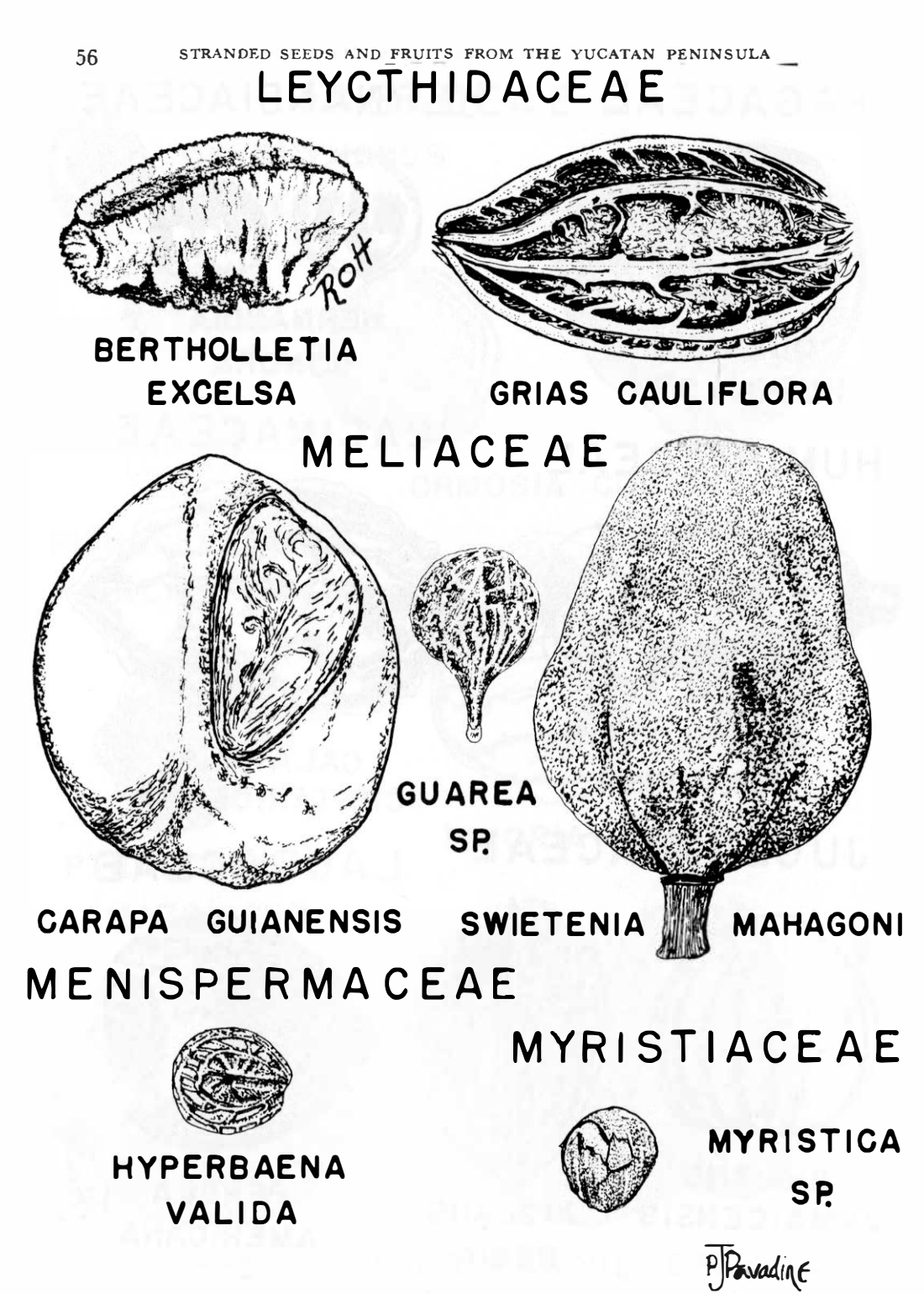


Figure 21. Stranded disseminules of the Yucatan Peninsula.

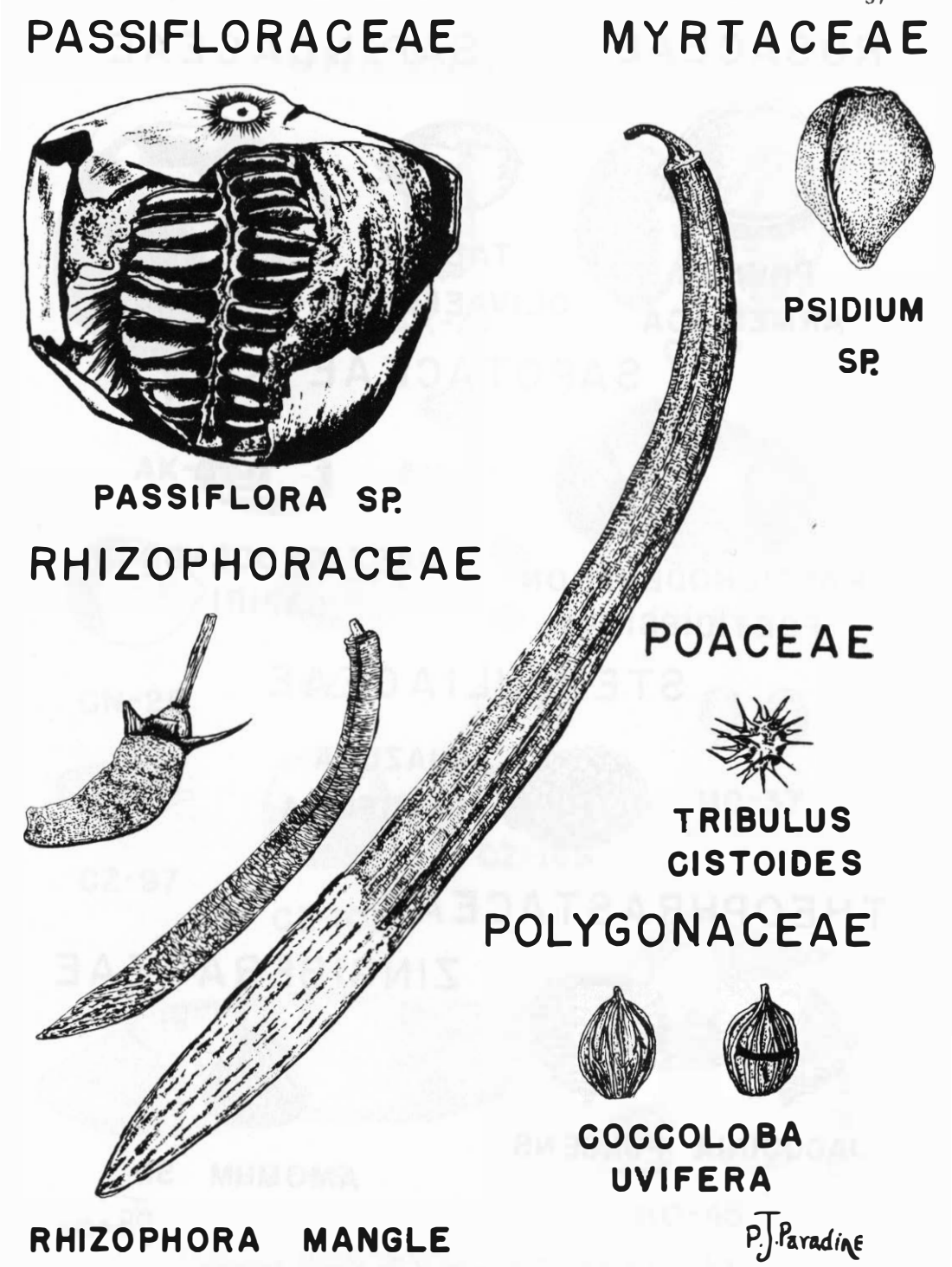


Figure 22. Stranded disseminules of the Yucatan Peninsula.

Figure 23. Stranded disseminules of the Yucatan Peninsula.

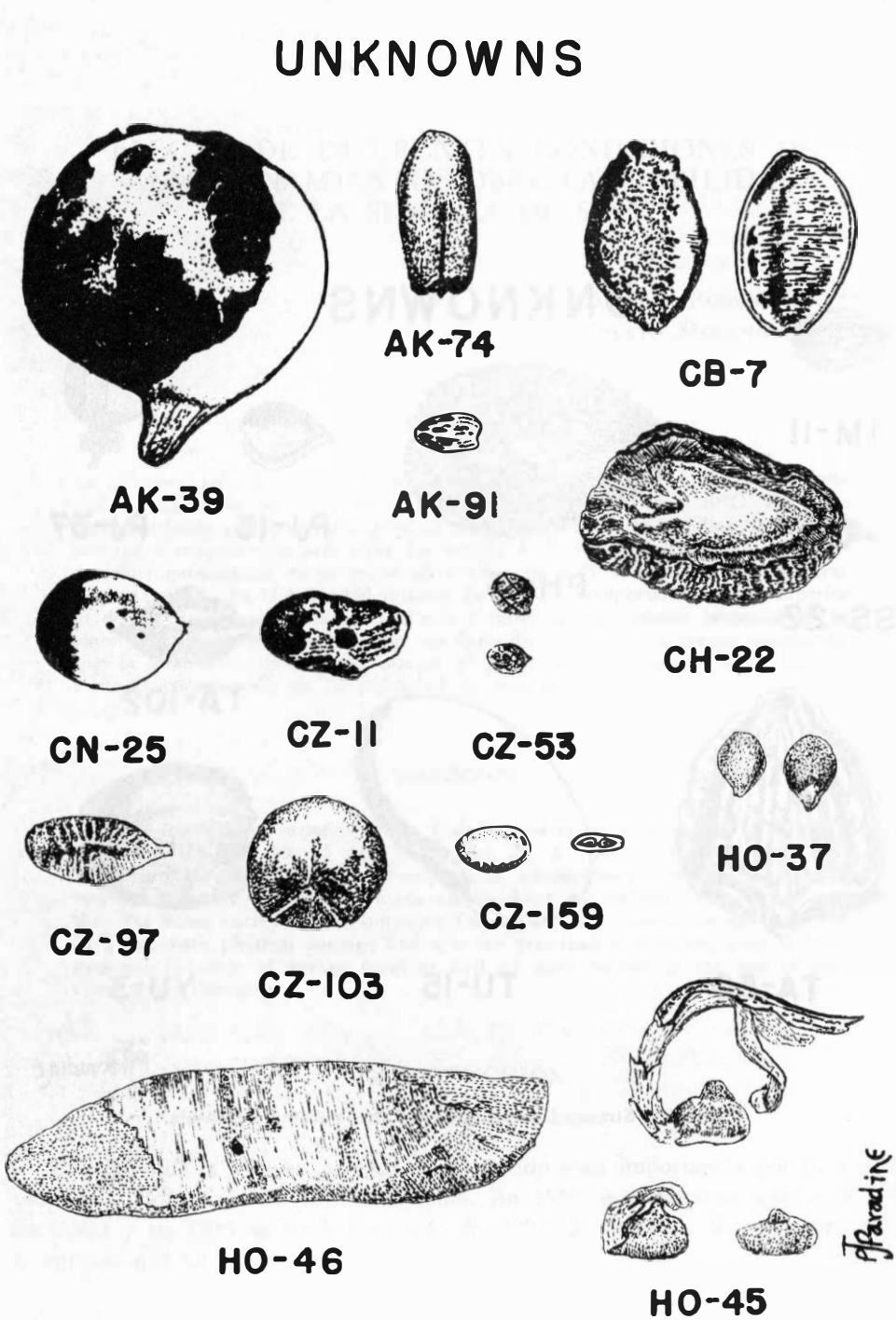


Figure 24. Stranded disseminules of the Yucatan Peninsula.

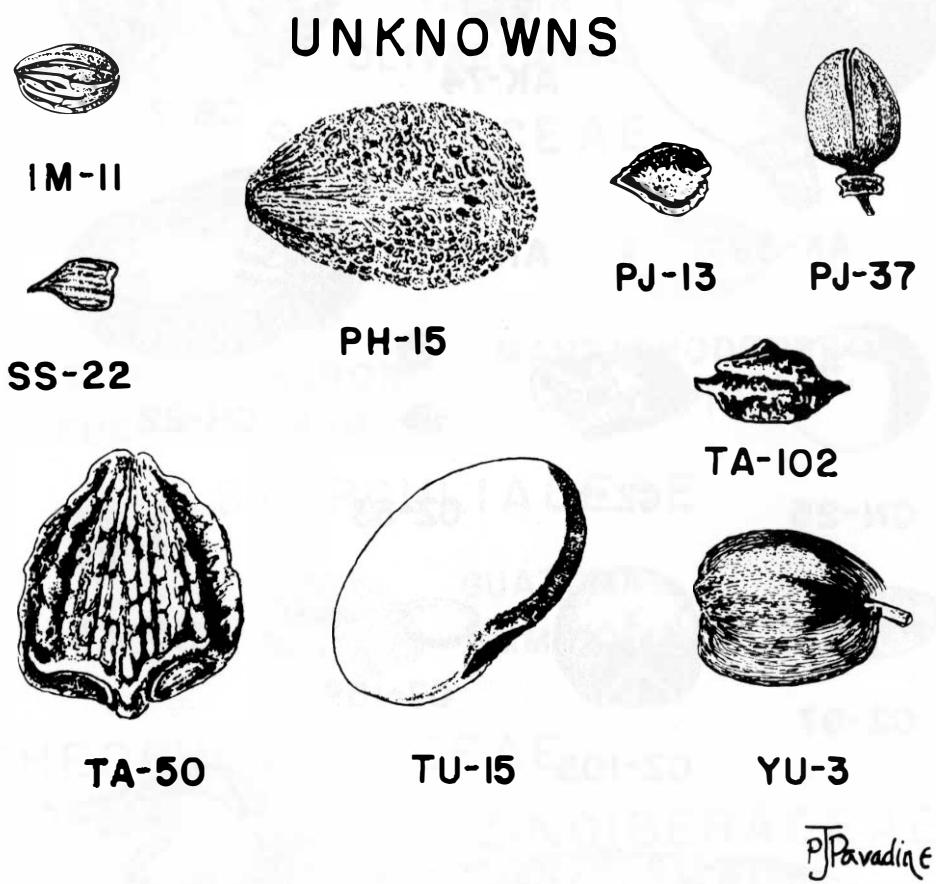


Figure 25. Stranded disseminules of the Yucatan Peninsula.