MORPHOLOGY AND IDENTIFICATION OF THE SEEDLINGS OF SELECTED WOODY/SEMI-WOODY SPECIES OF DICOTYLEDONS SENSU LATO GROWING WILD IN SOUTH FLORIDA (U.S.A.). PART II. SPECIES WITH HYPOGEAL GERMINATION

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ABSTRACT

Herein, I describe and compare the seedlings of 23 species which have hypogeal germination and of an additional species having germination intermediate between hypogeal and epigeal. The species are of trees, shrubs, and woody vines of dicotyledons sensu lato which grow wild in South Florida. In those species the portion of seedling stem situated distal to the cotyledons consists of two main parts: the basal stem sector and the distal stem sector. The first-formed foliage leaves develop on the distal stem sector. The basal stem sector serves to position those foliage leaves sufficiently high aboveground to intercept adequate ambient light; thus, it is functionally equivalent to the elongated hypocotyl in species having epigeal germination. Certain of the studied species exhibit cotyledons that are entirely or partly connate and/or peltate, unlike the adult leaves. For each species I characterize the macroscopical features of the diaspores, cotyledons, basal stem sector, distal stem sector, and leaves, as well as the presence vs. absence of, the kinds of, and the distribution of trichomes. I conclude with a taxonomic key for identifying the seedlings of all considered species. Twenty-two and two of the species are native to, and exotic within Florida, respectively.

RESUMEN

Aquí, describo y comparo las plántulas de 23 especies con germinación hipogea y de una con germinación intermedia entre hipogeo y epigeo. Son especies de árboles, arbustos y enredaderas leñosas de dicotiledóneas sensu lato que crecen silvestres en el sur de Florida. En esas especies, la porción del tallo de la plántula situada distal a los cotiledones consta de dos partes principales diferenciadas: sectores basal y distal del tallo. La parte basal del tallo sirve para posicionar esas hojas de follaje lo suficientemente altas sobre el suelo para interceptar la luz ambiental adecuada; por lo tanto, es funcionalmente equivalente al hipocótilo alargado en especies que tienen germinación epigea. Algunas de las especies estudiadas exhiben cotiledones que son total o parcialmente connatos y/o peltatos, a diferencia de las hojas adultas. Para cada especie carácterizo los rasgos macroscópicos de las diasporas, cotiledones, sectores basal y distal del tallo y hojas, así como la presencia vs. ausencia de los tipos y la distribución de los tricomas. Concluyo con una clave taxonómica para identificar las plántulas de todas las especies consideradas. Veintidós especies son nativas y dos exóticas en Florida.

INTRODUCTION

This is the second of two papers about the morphology and identification of the seedlings of selected species of woody/semi-woody dicotyledons sensu lato which grow wild in South Florida (Wilder & Relish 2022). Wilder and Relish (2022) focused on 70 species having epigeal germination, whereas I consider 23 species having hypogeal germination and one species having germination intermediate between epigeal and hypogeal (*Sideroxylon foetidissimum*). Herein, I apply the classical definition of cotyledons rather than de Vogel's (1980) more restrictive definition (see Wilder & Relish [2022] concerning both definitions).

During epigeal germination the hypocotyl of a seedling elongates, carrying the cotyledons above ground (Fig. 1, C, H). Too, the cotyledons lose their surrounding diaspore wall (in most cases a fruit wall and/or seed coat), becoming exposed to light. By contrast, during hypogeal germination the hypocotyl elongates little or not at all (Fig. 2, H). The cotyledon(s) remain(s) at or below ground level and to the inside of the diaspore wall (Fig. 2, C, D).

The 24 presently considered species represent 11 families of dicotyledons sensu lato. Twenty-two and two of the species are native to, and exotic within Florida, respectively. South Florida as defined here and by

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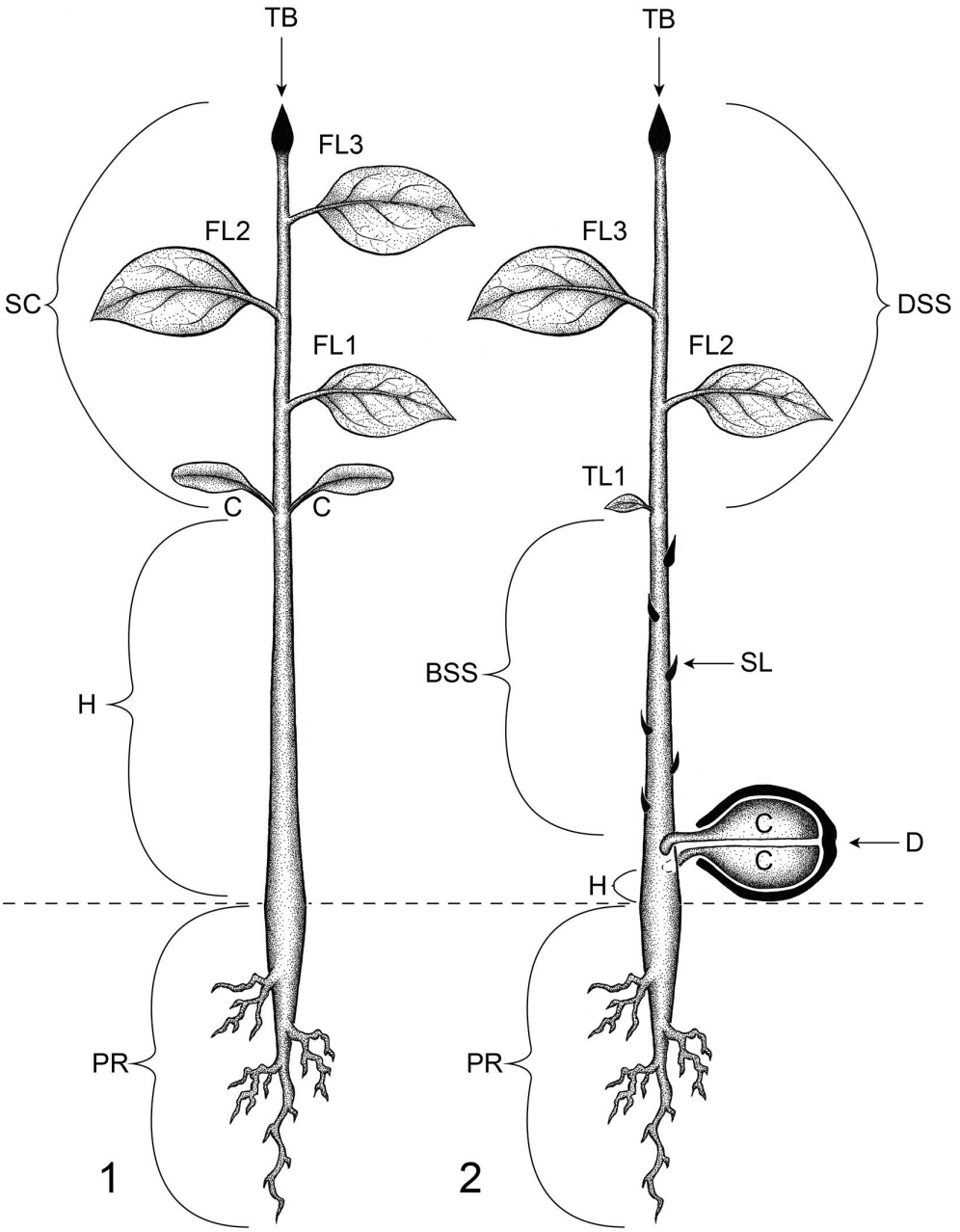

Figs. 1–2. Schematic drawings of two seedlings which developed via epigeal germination and hypogeal germination, respectively. Stipules and axillary buds are not indicated. **Fig. 1.** The hypocotyl is elongated, the two cotyledons are elevated considerably aboveground, and a diaspore is absent. The supra-cotyledonary leaves are numbered from 1 to 3, in accordance with the notation of Wilder and Relish (2022). **Fig. 2.** The hypocotyl is very short, the two cotyledons remain at ground level, and the wall of the parental diaspore encloses the cotyledonary laminae. Represented, is Suite a of characteristics of the cotyledonary petioles described herein (p. 487). The basal stem sector exhibits scale leaves, whereas the distal stem sector manifests a transitional leaf succeeded by two foliage leaves. In accordance with present notation, leaves of the distal stem sector are numbered in acropetal order from 1 to 3. The dashed horizontal line indicates ground level. **BSS**. Basal stem sector. **C**. Cotyledon. **D**. Section through the diaspore wall (drawn solid black). **DSS**. Distal stem sector. **FL1, FL2, FL3**. Foliage leaves. **H**. Hypocotyl. **PR**. Primary root bearing higher-order roots. **SC**. Supra-cotyledonary portion of the seedling. **SL**. Scale leaf. **TB**. Terminal bud. **TL1**. Transitional leaf. Drawings by Amanda Riley.

Gann et al. (2002) includes ten counties: Broward, Charlotte, Collier, Glades, Hendry, Lee, Martin, Miami-Dade, Monroe, and Palm Beach counties.

The Results section of this paper includes individual descriptions of the seedlings of the presently considered species. The Summary and Discussion section presents, in part, comparisons between the seedlings. An ensuing section provides a taxonomic key to the species, based on their seedlings. Appendices 1 and 2 include lists of species of woody/semi-woody dicotyledons which grow wild in South Florida, which I judge to have epigeal germination (Appendix 1) and hypogeal germination (Appendix 2), but which—because of insufficient study specimens—are/were not formally described presently or by Wilder and Relish (2022).

TERMINOLOGY

Terms are defined. The terms "basal stem sector" and "distal stem sector" apply solely to species with hypogeal germination, not to species having epigeal germination.

Diaspore: a unit of plant dispersal. Diaspores presently considered include whole fruits containing seed(s), mericarps, and isolated seeds. Herein, I follow previous workers' interpretations/identifications of the fruits of presently described species (see Results). For the drupes of certain species, I could not distinguish conclusively between the seed coat and a possible inner endocarp layer. For those cases I refer to a "presumptive seed coat."

Seedling axis: the primary root and main stem of the seedling, collectively.

Basal stem sector: the portion of the main stem which intervenes between the cotyledonary node and the base of the distal stem sector (Fig. 2, BSS).

Distal stem sector: the portion of the main stem situated immediately distal to, and contiguous with, the basal stem sector. The base of the distal stem sector is the basal-most node of the main stem to bear transitional leave(s) and or foliage leave(s) (Fig. 2. DSS).

Transitional leaves: These are transversely segmented into different parts, unlike scale leaves, but are conspicuously smaller than the foliage leaves (Fig. 2, TL1). One or more transitional leaves sometimes develop(s) on the distal stem sector, immediately basal to the first-formed foliage leaves (Figs. 3, 26).

Depauperate leaves: leaves which may accompany scale leaves on the basal stem sector. They are little, if at all, larger than the largest associated scale leaves and are considerably smaller than any distally formed transitional leave(s). They exhibit stipule(s), petiole, and lamina. Herein, depauperate leaves are reported solely for *Pithecellobium unguis-cati* and *Quercus laurifolia*.

Common petiole (or) **common cotyledonary petiole:** a pair of completely connate cotyledonary petioles or the connate portions of a distally connate pair.

On the main stem of a seedling with hypogeal germination, beginning at the basal-most node of the distal stem sector the nodes are numbered in acropetal order from 1 to 3, as are the first three internodes.

Seedlings and saplings comprise a developmental continuum. For species with hypogeal germination, I distinguish between seedlings and saplings arbitrarily, as follows. On the main stem of a seedling up to the first three nodes of the distal stem sector bear expanded leave(s) or the leaf scar(s), thereof (Fig. 2). By contrast, on the main stem of a sapling such leave(s) and/or leaf scar(s) accompany the first four or more nodes of the distal stem sector.

METHODS

I examined primarily seedlings, but young saplings were studied in addition to/instead of seedlings when they retained features, thereof (e.g., the cotyledons and/or the first-formed supra-cotyledonary leaves/leaf scars). I examined solely saplings of *Erythrina herbacea* and *Sideroxylon tenax*. Herein, I refer to as **specimens** all presently studied seedlings/saplings.

I collected almost all specimens growing wild either on natural land or, less often, in disturbed areas, from 17 May 2006 to 12 Aug 2020. Most specimens were acquired in South Florida, i.e., in Charlotte, Collier, Lee, and Monroe Counties; however, I obtained all specimens of *Sideroxylon tenax* and some of *Cupaniopsis*

anacardioides in Central Florida (Highlands County). Also, two of the presently studied specimens of *Erythrina herbacea* were grown in cultivation and obtained as gifts. Collecting was undertaken largely during fieldwork focused on other investigations (Wilder 2020; Wilder & McCombs 2006; Wilder & Roche 2009; Wilder & Barry 2012; Wilder et al. 2014, 2021; Wilder & Thomas 2016; Wilder & McCollom 2018). Collection numbers and collection dates are cited separately for each species, in the Results section of this paper.

Whenever possible I collected many specimens of a species, but for certain species I could only acquire few specimens. Herein, I describe the seedlings of the poorly represented, as well as of the amply represented species. I do so, because the limited data from the poorly represented species permit their identification and enhance our general understanding of seedlings. I identified specimens to species, using the methods of Wilder and Relish (2022). Like Wilder and Relish (2022) I was careful to distinguish seedlings from root sprouts.

Herein, I afford diaspores considerable attention because, as indicated, during hypogeal germination an expanding seedling and its parental diaspore (whether intact or degraded) temporarily remain associated with one another. By contrast, Wilder and Relish (2022) did not investigate diaspores because they are shed comparatively early during epigeal germination.

Collected specimens were pressed, dried, and affixed to herbarium sheets, using the methods of Wilder and Relish (2022; Figs. 27, 28). Diaspores/degraded diaspores which clung to specimens were problematical because they were easily crushed or dislodged during pressing and subsequent specimen storage. Thus, when pressing a specimen associated with a diaspore, I often placed most of the specimen to the inside of the press but positioned the attached diaspore and adjacent plant parts to the outside. Also, I glued spacers onto many herbarium sheets to prevent the weight of overlying plant specimens from crushing the diaspores during storage. Desirable as spacers, were "Everbilt™ heavy duty, self-adhesive felt pads" (Home Depot Co., distributor, Atlanta, Georgia, U.S.A.; Fig. 27); however, wooden clothes pins also sufficed. All specimens were deposited at SWF.

Unfortunately, it was destructive to study herbarium specimens because I had to dissect/remove some diaspores and/or the cotyledons within them. As well, to properly observe plant parts sideways I had to tilt the herbarium sheets at extreme angles, sometimes inadvertently causing portions of a specimen to rupture or break away. Wilder and Relish (2022) reviewed the advantages and other shortcomings of herbarium specimens.

Measurements

It was sometimes difficult/impossible to measure the length of the basal stem sector, i.e., **a.** when it was naturally curved or bent, and **b.** when on older specimens leaves were missing from the seedling or sapling stem, precluding recognition of the distal end of the basal stem sector. Because of problem a, some measurements of the basal stem sector (but not of other structures) are approximate.

Herein, measurements of diaspore widths do not include splits present in the diaspore walls.

Drawings

I represent the seedling of each species with drawing(s) of representative herbarium specimen(s). Because specimens were flattened during pressing, the drawings are silhouettes rather than more lifelike renderings. Certain drawings represent specimens which initially manifested adherent diaspores, but from which the diaspores were removed for study.

Figures 3–26 are drawings (silhouettes) of pressed and dried seedlings and young saplings (most with attached diaspores) of the species considered herein. Because of their small sizes scale leaves are either not illustrated or are barely perceptible. All drawings by Julio Gonzalez Batista.

RESULTS

I consider the described species individually, in alphabetical order of the names of the families they represent. For each family I consider the species in alphabetical order of their scientific names. Each species description includes twelve or thirteen sections. **Section 1** presents the currently accepted scientific name (sometimes

together with synonym(s) [Wunderlin et al. 2022]), family name, common name, a statement of whether the species is native or exotic, and the number of specimens studied. **Section 2** provides information about the adult plants, i.e., about their growth habit and the phyllotaxy of and the kind of foliage leaves. Information is mainly from personal observations, but also from the descriptions of Barrett (1956), Nelson (1994, 1996) and Tomlinson (2001). **Section 3** indicates the type of fruits produced. **Section 4** describes aspects of the pericarp and/or seed coat, if present, adherent to the seedling. **Section 5** describes the cotyledons. **Section 6** indicates the range of measurements of length of the basal stem sector. **Section 7** indicates the kinds of leaves, where present, borne by the basal stem sector and the distal stem sector. **Section 8** characterizes the leaves (i.e., scale leaves and, where present, depauperate leaves), if any, of the basal stem sector. **Section 9** describes the foliage leaves of the seedling. **Section 10** characterizes the phyllotaxy at node nos. 1 to 3 of the distal stem sector. **Section 11** describes the trichomes, if any, of the seedling shoot. **Section 12** provides the collection number(s) and collection dates of the studied specimen(s). **Section 13,** where present, offers additional information.

Hippocratea volubilis L.; **Celastraceae**
Medicine Vine. Native
no. specimens studied: 17

Adult morphology
Vine with opposite, simple leaves.

Seedling morphology (Fig. 3).

Fruit type: tricarpellate, combining features of a schizocarp and a capsule. The fruit is deeply divided into three thinly lenticular segments which separate from one another as mericarps. Each mericarp manifests loculicidal dehiscence (Croat 1978; Godfrey & Wooten 1981; Wunderlin & Hansen 2015).

Pericarp after germination: absent.

Seed coat after germination: flattened, rigid, smooth, brown to black. The two flattened surfaces of the seed coat are thin and connected by its much thicker edges, which are contiguous distally. The seed coat is ruptured solely by/at its basal end where, commonly, both flattened surfaces are ruptured. In the latter case the seedling stem and primary root may extrude through separate surfaces of the seed coat. The cotyledonary petioles remain entirely, or partly, hidden within the seed coat, and the cotyledonary laminae are completely hidden. **Dimensions of seed coat after germination**: 21.5–26 mm × 7–10 mm (n = 10 [each parameter]).
Ma's (1916) report of "seeds 1.3–2.5 × 4–7 mm" long is puzzling, given the considerably larger seeds reported herein. Croat (1978) reported even larger seeds than those presently indicated, i.e., "seeds … mostly 3.5–5 cm long."

Cotyledons. Distal to their basal ends the paired cotyledonary laminae are connate along their adaxial surfaces (as ascertained both in surface view and in thick cross sections at 50×); the cotyledonary petioles are distinct. **Number of cotyledons:** 2 (n = 6 seedlings). **Connate laminae:** minimally thickened and much flattened parallel to their abaxial surfaces; also flattened parallel to the same plane as are the pericarp and seed coat. **Lamina surface:** smooth; cream-colored. **Petiole length:** 1.5 to 2 mm (n = 11). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 36–96.5 mm (n = 11).

Leaf types situated distal to the cotyledons. Basal stem sector: scale leaves (up to several) were observed on some but not all seedlings. After foliage leaves have expanded on the distal stem sector the scale leaves of the basal sector are brown, black, or dull green. **Distal stem sector:** either with **a.** solely green foliage leaves, **b.** transitional leave(s) and then green foliage leaves, or **c.** green foliage leaves and then scale leaves.

Scale leaves of basal stem sector: Length: 0.4–12.8 mm (n = 9). **Phyllotaxy:** one or two leaves per node (64% and 36% of 11 nodes, respectively). When the nodes are single-leaved, phyllotaxy is alternate or subopposite. **Stipules:** two stem-borne stipules are sometimes present.

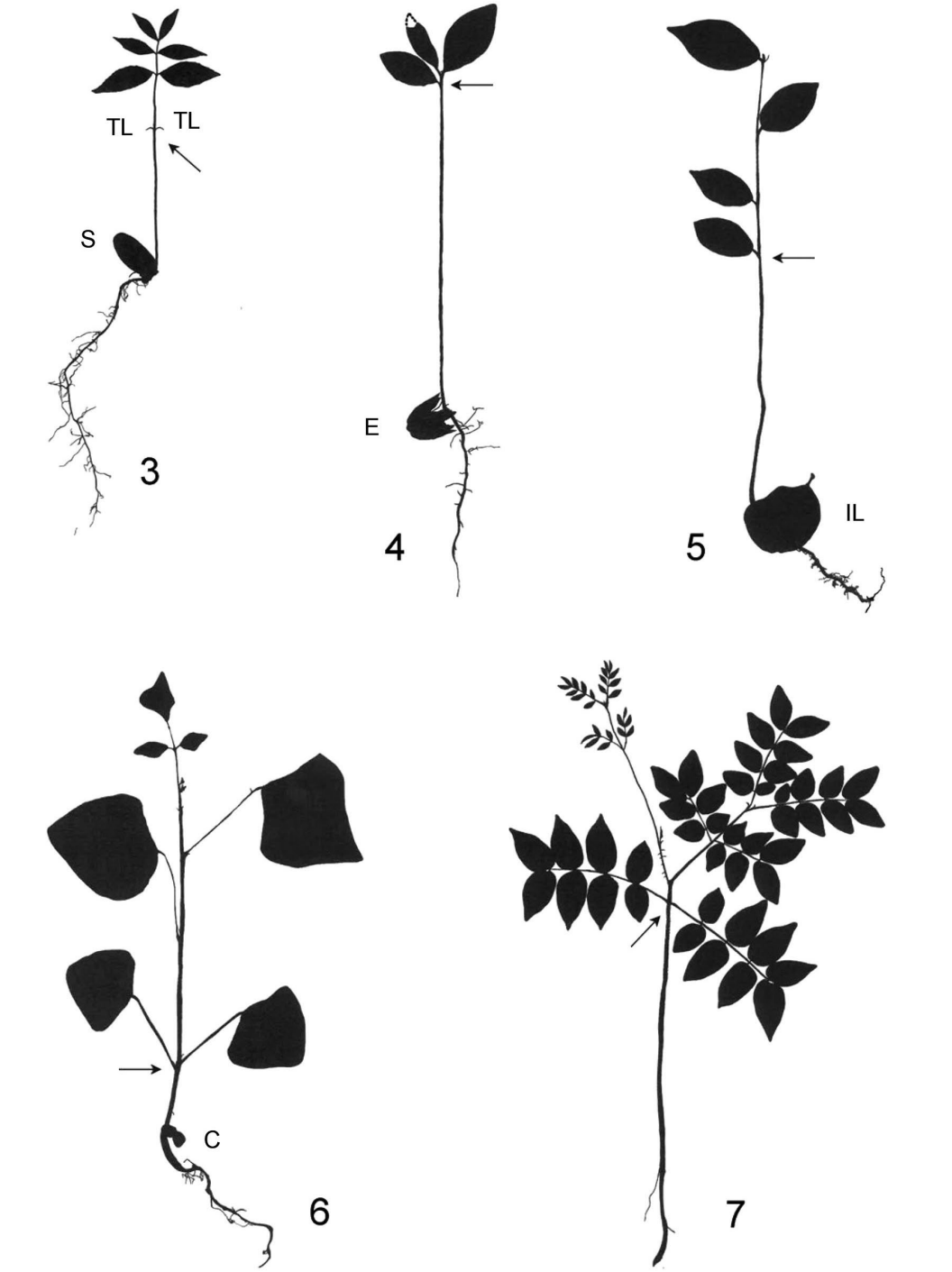

Fig. 3. *Hippocratea volubilis*. Sapling. On this individual a pair of transitional leaves indicates the base of the distal stem sector. × 0.37. **Fig. 4.** *Chrysobalanus icaco*. Seedling. × 0.40. **Fig. 5.** *Dalbergia ecastaphyllum*. Sapling. × 0.39. **Fig. 6.** *Erythrina herbacea*. Sapling. × 0.46. **Fig. 7.** *Guilandina bonduc*. Sapling. × 0.26. For the specimen depicted in each figure an arrow indicates the boundary between the basal stem sector and the distal stem sector. **C**. Cotyledon. **E**. Endocarp. **IL**. Indehiscent legume. **S**. Seed coat. **TL**. Transitional leaf.

Foliage leaves. Lamina. Shape: simple and unlobed; narrowly elliptic, elliptic, lanceolate-ovate to ovate, oblanceolate-obovate to obovate. **Lamina margins:** serrulate, the teeth being mucronulate to apiculate. **Lamina apex:** mostly acuminate to acute; sometimes subacute; commonly simultaneously mucronulate to apiculate. **Lamina base:** mostly cuneate; sometimes sub-cuneate or narrowly cuneate. **Petiole:** short. **Stipules:** two stem-borne stipules border the base of each petiole. When foliage leaves are opposite, as is normal in *H. volubilis*, there are four stipules per node.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: two leaves per node (100% of 12 cases of node no. 1). Node no. 2: one or two leaves per node (12.5% and 87.5% of 8 cases, respectively, of node no. 2). Node no. 3: one or two leaves per node (33% and 67% of 3 cases, respectively, of node no. 3). Where there was one leaf per node, this was a scale leaf.

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** glabrous/essentially glabrous. **Distal stem sector:** glabrous. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: glabrous. Petiole: glabrous.

Dates of collection and collection numbers of examined specimens.
28068, 16 Mar 2008; 28565, 17 May 2008.

Chrysobalanus icaco L.; **Chrysobalanaceae**
Coco Plum. Native
no. specimens studied: 10

Adult morphology
Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 4).

Fruit type: a one-seeded drupe (Cronquist 1981; Wunderlin & Hansen 2015).

Pericarp after germination: This persists in degraded form over the ruptured seed coat. Exocarp and mesocarp are absent or fragmentary and dark. The endocarp is persistent, hard, dark and/or stramineous, and manifests **a.** thick, regularly spaced, protruding main longitudinal veins, **b.** intervening, protruding, dense reticula of narrower minor veins, and **c.** interveinal tissue. The endocarp is split along each major vein, from the basal end of the endocarp to a point a little basal to its distal end. Splitting divides all but the distal-most portion of the endocarp into approximately equal, triangular sectors which spread apart from one another and delimit a sizeable opening at the basal end of the endocarp. The cotyledonary laminae remain to the inside of the endocarp, whereas the cotyledonary petioles suspend the basal ends of the seedling stem and primary root within the opening. **Dimensions of pericarp after germination:** 15–18 mm × 10–13 mm (n = 9, 7 [for length and width, respectively]).

Seed coat after germination: Somewhat thickened, smooth, and brown.

Cotyledons. Number of cotyledons: 2 (n = 1 seedling). **Lamina:** thickened, albeit, flattened parallel to its adaxial/abaxial surfaces. **Lamina surface:** Replete with minute, densely arranged, irregular, curved ridges. **Petiole length:** ca. 0.5 mm long (n = 1). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 62–161 mm (n = 8).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves. After foliage leaves have expanded on the distal stem sector the scale leaves of the basal sector appear brown or black. **Distal stem sector:** with solely green foliage leaves.

Scale leaves of basal stem sector. Length: 1.0–3.9 mm (n = 17). **Phyllotaxy:** normally one leaf per node, rarely two per node (97% and 3% of 29 nodes respectively). **Stipules:** absent.

Foliage leaves. Lamina. Shape: simple and unlobed; narrowly elliptic-elliptic to elliptic, oblanceolate to obovate. **Lamina margins:** entire. **Lamina apex:** mostly subacute to rounded, sometimes emarginate; also, sometimes simultaneously minutely mucronulate. **Lamina base:** cuneate to sub-cuneate. **Petiole:** short. **Stipules:** two stem-borne stipules border the base of each petiole.

Phyllotaxy of leaves at node nos. 1–3 of the distal stem sector: one leaf per node (100% of 6, 6, and 6 cases of node nos. 1, 2, and 3, respectively). Phyllotaxy was alternate (as opposed to subopposite) on all six seedlings examined.

Trichomes. Cotyledons. Lamina: glabrous and non-ciliate. Petiole: densely hairy. **Basal stem sector:** with hairs varying from minute and papilla-like to 0.5 mm long, which are transparent to brown, straight to moderately curved, sharp-tipped, and spreading to appressed. Those hairs immediately distal to the cotyledonary node, collectively, simulate a pincushion, being densely concentrated, maximally long, and appearing rigid. Hairs situated elsewhere on the basal stem sector vary from sparsely to moderately concentrated. **Distal stem sector.** Comparable hairs occur but comprise two rather discrete size classes: **a.** short narrow hairs ca. 0.05 to 0.1 mm long, and **b.** longer, thicker hairs. The short hairs are the most abundant and are more often straight and oriented perpendicular to the stem long axis. The longer hairs are more often conspicuously curved and are more variably oriented. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: glabrous/essentially glabrous overall, but sometimes with sparsely concentrated hairs on the basal-most portion of the lamina and/or along the midvein. Petiole: sparsely to densely pubescent with varying proportions of both types of hairs, aforementioned; the longer hairs are generally antrorse.

Dates of collection and collection numbers of examined specimens.
26585, 1 Apr 2007.

Dalbergia ecastaphyllum (L.) Taub ; **Fabaceae**
Coinvine. Native
no. specimens studied: 17

Adult morphology
Vine or shrub with alternate, essentially simple (unifoliate) foliage leaves.

Seedling morphology (Fig. 5).

Fruit type: indehiscent legume (Wunderlin & Hansen 2016).

Pericarp after germination: The tough pericarp persists well after germination, is conspicuously flattened, and encloses the seed coat. The pericarp and seed coat cover the cotyledonary laminae, petioles, and the hypocotyl-primary root junction. At least commonly the seedling stem and primary root protrude at different points through each of the seed coat and pericarp. **Dimensions of pericarp after germination:** 23–31 mm × 18–23 mm (n = 11 [each parameter]).

Seed coat after germination: chartacous, smooth, brown, and flattened in the same plane as the pericarp.

Dimensions of seed coat after germination: 10 mm × 15 mm (n = 1).

Cotyledons. Number of cotyledons: 2 (n = 2 seedlings). **Lamina:** thickened, albeit, flattened parallel to its adaxial/abaxial surfaces; also flattened parallel to the pericarp and seed coat. One side of the cotyledonary lamina may exhibit a basal lobe (n = 2 cotyledons). **Lamina surface:** initially mainly smooth, albeit roughened toward the cotyledonary margins; shriveling with age. **Petiole length:** 0.2 to 1 mm (n = 3). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 34.5–72 mm (n = 7).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves (possibly, sometimes only one). After foliage leaves have expanded on the distal stem sector the scale leaves of the basal sector are generally brown. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** a transitional leaf followed by green foliage leaves.

Scale leaves of basal stem sector. Length: 0.5–2 mm (n = 11). **Phyllotaxy:** normally one leaf per node, rarely three per node (96% and 4% of 27 nodes respectively). When the nodes are single-leaved phyllotaxy is alternate. **Stipules:** mostly absent; occasionally present.

Foliage leaves. Lamina. Shape: simple and unlobed; ovate, elliptic, obovate. **Lamina margins:** entire. **Lamina apex:** acute or acuminate to narrowly rounded; sometimes simultaneously mucronulate to apiculate. **Lamina base:** cuneate to rounded. **Petiole:** short. It exhibits an evident to poorly defined **terminal pulvinus. Stipules:** two stem-borne stipules border the base of each petiole.

Phyllotaxy of leaves at node nos. 1–3 of the distal stem sector: one leaf per node (100% of 10, 10, and 10 cases of node nos. 1, 2, and 3, respectively). Phyllotaxy was alternate.

Trichomes. Cotyledons. Lamina: glabrous and non-ciliate except for a few short marginal hairs. Petiole: glabrous. **Basal stem sector:** with hairs essentially confined to, or most prominent on, its distal portion, which are ephemeral and at most moderately concentrated; the hairs being minute and papilla-like to 0.25 mm long, narrow, white to brown, straight to moderately curved, sharp-tipped, appressed, and primarily antrorse. **Distal stem sector:** with comparable, likewise ephemeral hairs. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina (abaxial surface): essentially glabrous or with comparable, moderately concentrated hairs which are primarily antrorse or directed toward the nearest margin. Lamina (adaxial surface): essentially glabrous. Petiole: glabrous to densely pubescent with comparable hairs which often are primarily antrorse.

Dates of collection and collection numbers of examined specimens.
29505, 10 Feb 2009; 34413, 10 Jan 2013; 34626, 34627, 27 Dec 2012.

Erythrina herbacea L.; **Fabaceae**
Coralbean. Native
no. specimens studied: 4

Adult morphology
Tree or shrub with alternate, trifoliolate, once-compound foliage leaves.

Seedling morphology (Fig. 6).

Fruit type: dehiscent legume (Wunderlin & Hansen 2016).

Pericarp after germination: absent.

Seed coat after germination: Somewhat thickened, hard, smooth, and brown. It appears curved and is split along an irregular line not extending through the hilum. The seed coat loosely covers the cotyledons (n = 1 seed). **Dimensions of seed coat after germination:** length = 11 mm (n = 1); width not determinable.

Cotyledons. Number of cotyledons: 2 (n = 1 seedling). **Lamina:** thickened, albeit flattened overall parallel to its adaxial/abaxial surfaces. At least one side of the cotyledonary lamina is sagittate, exhibiting a basally directed basal lobe (n = 2 cotyledons). **Lamina surface:** large areas are replete with minute, densely arranged, irregular, curved ridges and differently configured projections. **Petiole length:** ca. 0.2 mm (n = 1). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 18 mm (n = 2).

Leaf types situated distal to the cotyledons. Basal stem sector: leaves absent. **Distal stem sector:** solely with foliage leaves.

Foliage leaves. Lamina. Shape: simple and unlobed; comparatively wide but very variable, i.e., widely depressed trullate, very widely trullate-very widely ovate, transversely depressed obtrullate-depressed obovate, and shallowly deltate. **Lamina margins:** entire; sometimes sinuate. **Lamina apex:** rounded to truncate; often simultaneously minutely mucronulate to apiculate. **Lamina base:** mostly comprising an angle of a little less than 180°. **Petiole:** long and narrow; the petiole includes a **basal pulvinus** and a **terminal pulvinus. Stipules/stipels:** two stem-borne stipules border the base of each petiole; two stipels sometimes subtend the terminal pulvinus.

Phyllotaxy of leaves at node nos. 1–3 of the distal stem sector: one leaf per node (100% of 2, 2, and 2 cases of node nos. 1, 2, and 3, respectively). The leaves at node nos. 1 and 2 were subopposite; the leaf at node no. 3 was alternate with those at node nos. 2 and 4.

Trichomes. Cotyledons. Lamina: glabrous and non-ciliate. Petiole: glabrous. **Basal stem sector:** glabrous. **Distal stem sector:** essentially glabrous. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: glabrous. Petiole: essentially glabrous, albeit on some leaves several hairs arise at the base of the terminal pulvinus.

Dates of collection and collection numbers of examined specimens.
28151, 28152, 25 Apr 2008; 30419, 22 Aug 2009.

Guilandina bonduc L. (*Caesalpinia bonduc* [L.] Roxb.); **Fabaceae**
Gray Nicker. Native.
no. specimens studied: 10

Adult morphology
Vine or shrub with alternate, twice-pinnately compound foliage leaves.

Seedling morphology (Fig. 7).

Fruit type: a tardily dehiscent legume (Wunderlin & Hansen 2016).

Pericarp after germination: represented by many small, orange-brown fragments adherent to the seed coat. The fragments lack prickles and, apparently, represent inner pericarp (n = 1 seed coat).

Seed coat after germination: broadly ellipsoidal, thick, hard, and gray; the outer surface appearing smooth to the naked eye but conspicuously and minutely cancellate at 50X. A few splits of different lengths (none long as the seed coat) converge at one end of the seed coat, defining an opening thereat. The cotyledonary laminae are partly hidden within the seed coat; the cotyledonary petioles suspend the seedling stem and primary root along the outer surface of the seed coat (n = 1 seed coat). **Dimensions of seed coat after germination:** 22 mm × 18 mm (n = 1).

Cotyledons. Solely the two cotyledons of one seedling were available for study. Inspection indicated that the cotyledonary laminae were at least very close together. Although, their abaxial surfaces faced outward, their adaxial surfaces appeared either appressed or connate. Two opposite linear, laterally situated, apparent sutures were visible in surface view, which traversed the entire lengths of the laminae. By being laterally situated, each apparent suture occupied the position of, and was interpreted as representing a pair of lamina margins (i.e , each margin of the pair would be from a different one of the two cotyledons). I attempted, and failed, to separate the two cotyledonary laminae by forcing a razor blade into each suture. Thus, I concluded that the cotyledonary laminae are connate along their adaxial surfaces. The two cotyledonary laminae manifested two and three basally directed, basal extensions, respectively. Those extensions, collectively, had a pipelike configuration and enclosed the distal portions of the cotyledonary petioles. The petioles were distinct. **Connate laminae:** thickened but also flattened, both collectively and individually, parallel to their abaxial surfaces; the abaxial surfaces are convex and ca. widely obovate. **Lamina surface:** abaxially, each lamina manifests broad ridges on its distal two-thirds, as well as a roughened surface; different areas are purple-brown or tan. **Petiole length:** 8 mm (n =2). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 110–285 mm (n = 10).

Leaf types situated distal to the cotyledons. Basal stem sector: leaves absent. **Distal stem sector:** solely with green foliage leaves.

Foliage leaves. Herein a leaf is considered twice-compound if at least one pinna bears pinnules. Pinna shape is indicated solely for pinnae lacking pinnules. **Lamina:** At node no. 1: once-pinnately compound (n = 100% of 10 nodes). At node no. 2: once or twice-pinnately compound (n = 60% and 40% of 10 nodes, respectively). At node no. 3: once or twice-pinnately compound (n =22% and 78% of 9 nodes, respectively). **Pinna/pinnule shape:** generally ovate; sometimes lanceolate-ovate or elliptic. **Pinna/pinnule margins:** entire. **Pinna/pinnule apex:** normally acute or acuminate, sometimes narrowly rounded or emarginate; often simultaneously mucronate or apiculate. **Pinna/pinnule base:** variable, i.e., truncate, rounded, cuneate, or retuse; simultaneously varying from symmetrical to considerably oblique. **Petiole:** present. **Stipules:** at least one (sometimes two) stem-borne stipule(s) border(s) the base of each petiole. Stipule dehiscence could account for the observations of solitary stipules. At least sometimes four stipules belong to two opposite leaves.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one or two leaves per node (20% and 80% of 10 cases of node no. 1, respectively). Node nos. 2 and 3: one leaf per node (100% of 10 and 9 cases of node nos. 2 and 3, respectively). Where node no. 1 is single-leaved, node nos. 1 and 2 are subopposite. Node nos. 2 and 3 are alternate.

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** essentially glabrous or sparsely pubescent by its distal end. **Distal stem sector:** glabrous or up to moderately

pubescent with narrow, transparent or light brown, sharp-tipped, appressed to spreading, variously curved (particularly uncinate) hairs measuring up to 0.3 mm long. **Foliage leaves of node nos. 1–3 of distal stem sector:** with comparable hairs. Rachis: with moderate to densely concentrated pubescence, this at least often one-sided. Laminar portions of pinnae/pinnules: conspicuously ciliate; glabrous elsewhere, except for the pubescent midrib on the adaxial surface. Petiole: with sparsely to densely concentrated pubescence, this at least often one-sided.

Additional information. Prickles are absent from the cotyledons and basal stem sector, but may occur sparsely on the distal stem sector, petiole, or rachis. One or two prickles are sometimes localized at the bases of a pair of pinnae.

Dates of collection and collection numbers of examined specimens.
28063, 28064, 28066, 11 Mar 2008; 29194, 23 Aug 2008; 34959, 16 Jul 2013.

Pithecellobium unguis-cati (L.) Benth.; **Fabaceae**
Catclaw. Native
no. specimens studied: 22

Adult morphology

Tree or shrub with alternate, twice-pinnately compound foliage leaves each having two pinnae and four pinnules.

Seedling morphology (Fig. 8).

Fruit type: dehiscent legume (Wunderlin & Hansen 2016).

Pericarp after germination: absent.

Seed coat after germination: somewhat flattened, moderately thickened, rigid, mostly smooth, jet-black, with a curvilinear scar on each surface, this scar resembling the outline of a shield. The seed coat ruptures along irregular lines of varying lengths which converge to a point along its edge. After splitting the seed coat retains its overall form, enclosing the cotyledonary laminae and sometimes the cotyledonary petioles. The cotyledonary petioles suspend the remainder of the seedling to the outside of the seed coat. **Dimensions of seed coat after germination:** 7–8.5 mm × 5.5–8 mm (n = 9 [each parameter]).

Cotyledons. Distal to their basal lobes the two paired cotyledonary laminae are connate along their adaxial surfaces (as ascertained both in surface view and in a thick cross section at 50X); the cotyledonary petioles are distinct. **Number of cotyledons:** 2 (n = 10 seedlings). **Connate laminae:** minimally thickened and much flattened parallel to their abaxial surfaces; also flattened parallel to the same plane as is the seed coat; sagittate. **Lamina surface:** replete in places with minute, shallow, irregular, flat protuberances; stramineous. **Petiole length:** 3 mm (n = 2). **Flattening/orientations of the paired cotyledonary petioles:** commonly each petiole is flattened parallel to the associated stem surface. Commonly, too, the petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; then the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 6–51 mm (n = 11).

Leaf types situated distal to the cotyledons. Basal stem sector: leaves either absent or there develop(s) one leaf or a series of leaves. Included are scale leaves and tiny depauperate leaves, the latter manifesting stipules, petiole, and lamina. Once foliage leaves have expanded on the distal stem sector the leave(s) of the basal sector **a.** is/are dead, appearing stramineous, and **b.** have often abscinded their median (nonstipular) portions, albeit the dead stipules are commonly more persistent. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** a transitional leaf followed by foliage leaves.

Scale leaves and depauperate leaves of basal stem sector. Length: 0.5–2.3 mm (data solely for scale leaves [n = 2]). **Phyllotaxy:** one leaf per node (n = 100% of 26 nodes). **Stipules:** present on both leaf types.

Foliage leaves. Lamina. Shape: twice compound, each leaf normally with two opposite pinnae. Each pinna consisting of a petiolule bearing two opposite pinnules by its distal end (the lamina, therefore, having four pinnules altogether). On a leaf: **a.** generally, one, but sometimes two stipels are inserted between the pinnae, and **b.** one higher-order stipel is inserted between the two pinnules of each pinnule pair. **Pinnule margins:** generally entire; sometimes partly and slightly sinuate. **Pinnule apex:** commonly acute or rounded, sometimes retuse; simultaneously mucronulate or mucronate. **Pinnule base:** sessile or minutely petiolulate, oblique, and simultaneously ca. broadly cuneate to rounded. **Petiole:** present.

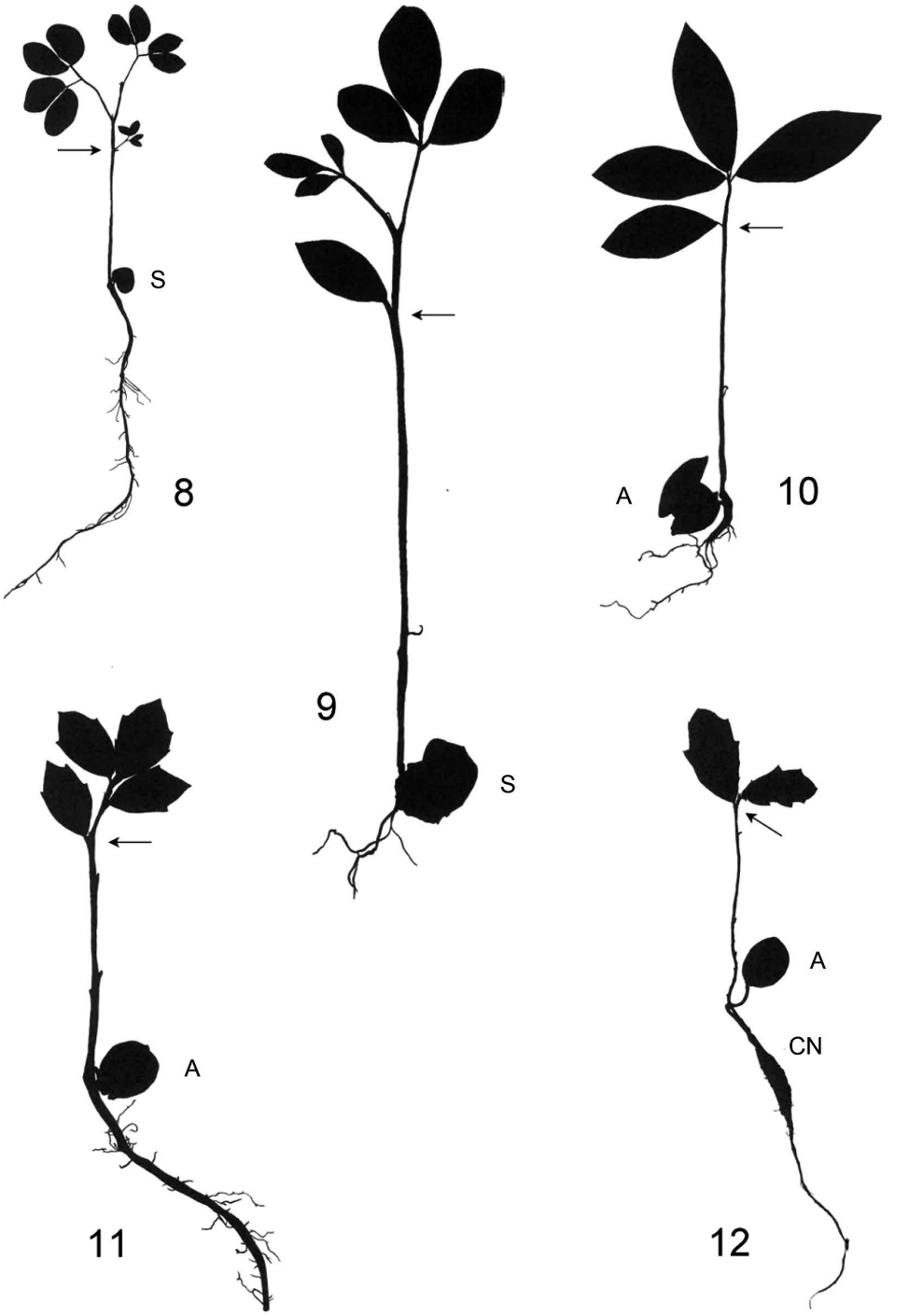

Fig. 8. *Pithecellobium unguis-cati*. Seedling. × 0.48. **Fig. 9.** *Sophora tomentosa.* Seedling. × 1.3. **Fig. 10.** *Quercus laurifolia*. Sapling. 0.64. **Fig. 11.** *Quercus myrtifolia*. Sapling. × 0.77. **Fig. 12.** *Quercus virginiana*. Seedling. × 0.42. For the specimen depicted in each figure an arrow indicates the boundary between the basal stem sector and the distal stem sector. **A.** Acorn. **CN**. Cotyledonary node. **S**. Seed coat.

Stipules: two stem-borne, frequently spinous stipules border the base of each petiole. **Stipels:** present (see p. 491 herein).

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one or two leaves per node (94% and 6% of 18 cases, respectively, of node no. 1). Node nos. 2 and 3: one leaf per node (100% of 14 and 12 cases of node nos. 2 and 3, respectively).

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** either glabrous/essentially glabrous throughout or glabrous solely basally and bearing sparsely to moderately concentrated hairs, distally; the hairs sharp-tipped, white, often uncinate but varying to straight, and generally 0.1 to 0.2 mm long. **Distal stem sector:** glabrous or with sparsely to moderately distributed, comparable hairs. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: the petiolules of the pinnae glabrous to moderately pubescent with comparable hairs; the pinnules glabrous or manifesting sparse marginal hairs. Petiole: glabrous to sparsely pubescent with comparable hairs.

Dates of collection and collection numbers of examined specimens.
31855, 5 Dec 2010; 31884, 4 Dec 2010; 35229, 20 Aug 2013; 37235, 28 Apr 2015.

Sophora tomentosa L. (variety not determined); **Fabaceae**
Yellow Necklacepod. Native
no. specimens studied: 10

Adult morphology
Tree or shrub with alternate, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 9).

Fruit type: indehiscent legume (Wunderlin & Hansen 2016).

Pericarp after germination: not found associated with seedlings despite indehiscence of the fruits.

Seed coat after germination: mostly absent. Moderately thin and two-layered, the outer layer being thicker than, and being partly exfoliated from the inner layer; both layers are initially tan, but the outer layer becomes black-mottled. The seed coat develops lengthy splits and the resulting, separated pieces of seed coat are spread apart, revealing much of the cotyledonary laminae and petioles. The cotyledonary petioles suspend the seedling stem and primary root immediately to the outside of the seed coat. **Dimensions of seed coat after germination:** 9 mm × ca. 8 mm (the second measurement is approximate because of splitting of the seed coat; n = 1).

Cotyledons. Number of cotyledons: 2 (n =10). **Lamina:** thickened; the abaxial and adaxial surfaces are convex and concave, respectively; the lamina base is sometimes minutely auriculate. **Lamina surface:** replete with minute, densely concentrated tubercles and short ridges; yellow (n = 4 seedlings) or black, shrunken, and apparently older (n = 1 seedling). **Petiole length:** 0.5 mm to 2.5 mm (n = 4). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 10–54 mm (n = 7).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves (up to three per seedling), these being detectable solely on young seedlings because of ageing/degradation of peripheral stem tissues. Once foliage leaves have expanded on the distal stem sector the individual scale leaves of the basal sector appear green, yellow, yellow and brown, or brown. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** a green transitional leaf followed by green foliage leaves.

Scale leaves of basal stem sector. Length: 0.7–3.4 mm (n = 11). **Phyllotaxy:** one or two leaves per node (n = 92% and 8% of 13 nodes, respectively); when the nodes are single-leaved phyllotaxy is alternate. **Stipules:** absent.

Foliage leaves. Lamina. Shape: at node no. 1: simple and undivided (n = 100% of 5 leaves). At node no. 2: simple and undivided, compound with two pinnae, or compound with three pinnae (n = 43%, 14%, and 43% of 7 leaves, respectively). At node no. 3: simple and undivided or compound with three pinnae (n = 17% and 83% of 6 leaves, respectively). *Simple leaves*. **Shape:** elliptic, elliptic-obovate, and obovate. **Lamina margins:** entire. **Lamina apex:** acute or rounded; sometimes simultaneously minutely mucronulate or mucronate. **Lamina base:** cuneate to rounded. *Compound leaves*. **Pinna**

shape: elliptic, elliptic-obovate, obovate-oblanceolate, obovate. **Pinna margins:** entire. **Pinna apex:** subacute or rounded; sometimes simultaneously minutely mucronulate. **Pinna base:** cuneate. **Petiole:** present. On the simple leaves pulvini sometimes occur at the basal and distal ends of the petiole; on compound leaves they sometimes occur at the base of the petiole and are generally present on the petiolules of the pinnae. **Stipules:** absent.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node nos. 1, 2: one leaf per node (100% of 7 and 7 cases of node nos. 1 and 2, respectively). Node no 3: one or two leaves per node (83% and 17% of 6 cases of node no. 3, respectively). When the nodes are single-leaved, phyllotaxy is alternate.

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** glabrous/essentially glabrous basally; becoming moderately pubescent progressing distally, with long and narrow, transparent, sharp-tipped, appressed to spreading, straight to variously curved hairs which are mostly antrorse and measure up to 0.4 mm long. **Distal stem sector:** with moderately to densely concentrated, comparable hairs; occasional hairs may be yellow-tinged. **Foliage leaves of node nos. 1–3 of distal stem sector:** with comparable hairs. Lamina: sparsely to moderately pubescent; ciliate. Petiole: moderately to densely pubescent; petiolules: moderately pubescent.

Quercus laurifolia Michx.; **Fagaceae**
Laurel Oak. Native
no. specimens studied: 17

Adult morphology
Tree with alternate, simple foliage leaves.

Seedling morphology (Fig. 10).

Fruit type: tricarpellate, one-seeded nut (acorn; Cronquist 1981; Gleason and Cronquist 1991; Wunderlin & Hansen 2015).

Pericarp after germination: moderately thickened, hard, smooth, dull brown, and having a broad, basal abscission scar with circular outline. The pericarp is open/ruptured at its distal end, where short-to-long longitudinal splits converge from more basal portions of the pericarp. The pericarp and seed coat enclose the cotyledonary laminae. The cotyledonary petioles extend through the opening in the pericarp, suspending the seedling stem and primary root to the outside of the opening. **Dimensions of pericarp after germination:** 11–13 mm × 11–12 mm (n = 5 [each parameter]).

Presumed seed coat after germination: chartaceous, smooth, brown, and appressed to the inner surface of the pericarp.

Cotyledons. Number of cotyledons: 2 (n = 7 seedlings). **Lamina:** thick and planoconvex (the flat [adaxial] surfaces of the two cotyledonary laminae are appressed). At least sometimes the cotyledonary lamina is sagittate and may even exhibit three basally directed basal lobes, i.e., a medial lobe and one lobe to each side, thereof. **Lamina surface:** with broad, low ridges abaxially; concomitantly minutely roughened (at 50X) and sometimes locally tuberculate; brown-purple or also partly yellow plus brown. **Petiole length:** 7 to 8 mm long (n = 2). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. The cotyledon is hypo-peltate. Also, the petiole extends parallel, rather than perpendicular to the lamina. **Stipules:** not recognized.

Length of basal stem sector: 56.5–198.5 mm (n = 11).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves (at least six occurred on one seedling) or with scale leaves succeeded by depauperate leaves, the latter being little if at all larger than the largest scale leaves and manifesting stipule(s), petiole, and lamina. Once foliage leaves have expanded on the distal stem sector the individual scale leave(s) of the basal sector appear either brown or both brown and black. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** transitional leave(s) followed by green foliage leave(s).

Scale leaves and depauperate leaves of basal stem sector. Length (not including stipules): 0.4–3.6 mm (data solely for scale leaves [n = 17]). **Phyllotaxy:** one or two leaves per node (n = 93% and 7% of 27 nodes, respectively). When the nodes are single-leaved, phyllotaxy is mostly alternate but sometimes subopposite (data for scale leaves and depauperate leaves). **Stipules:** present on depauperate leaves and on a minority of scale leaves.

Foliage leaves. Lamina. Shape: simple and unlobed; narrowly elliptic to elliptic, elliptic-ovate, elliptic-obovate, lanceolate-ovate, obovate. **Lamina margins:** mostly entire; sometimes sinuate. **Lamina apex:** mostly acute to narrowly rounded, sometimes more broadly rounded, truncate, or retuse; also, often simultaneously mucronulate to mucronate. **Lamina base:** cuneate to sub-cuneate. **Petiole:** present and short, some leaves being virtually sessile. **Stipules:** two stem-borne stipules normally border the base of the petiole.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one leaf per node (100% of 13 cases of node no. 1). Node no. 2: one or two leaves per node (85% and 15% of 13 cases of node no. 2, respectively). Node no. 3: one or two leaves per node (55% and 45% of 11 cases of node no. 3, respectively). The opposite leaves sometimes develop immediately basal to the first terminal winter bud of the distal stem sector, where especially short internodes occur.

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** varying from essentially glabrous to sparsely pubescent with simple hairs and basally branched, stellate hairs; the hairs of both types sharp-tipped, appressed, and individually either solely transparent or transparent and brown-tinged. The hairs measuring 0.1 to 0.65 mm long (simple hairs) and 0.1 to 0.35 mm long (stellate hairs [as measured from the hair base to the tip of a branch-hair]). The simple hairs often antrorse. **Distal stem sector:** with sparsely to moderately concentrated, comparable hairs of both types. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: essentially glabrous or with comparable hairs sparsely to moderately concentrated on the midrib, lamina base, and/or margins. Petiole: essentially glabrous to densely pubescent with comparable hairs.

Dates of collection and collection numbers of examined specimens.
23724, 11 Mar 2009; 29309, 20 Dec 2008; 29506, 26 Jan 2009; 29595, 3 Mar 2009; 29626, 11 Mar 2009; 30583, 6 Apr 2009.

Quercus myrtifolia Willd.; **Fagaceae**
Myrtle Oak. Native
no. specimens studied: 22

Adult morphology
Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 11).

Fruit type: tricarpellate, one-seeded nut (acorn; Cronquist 1981; Gleason & Cronquist 1991; Wunderlin & Hansen 2015).

Pericarp after germination: like that of *Quercus laurifolia*. The pericarp is open/ruptured at its distal end, where up to several short-to-long longitudinal splits converge from more basal portions of the pericarp. The pericarp and seed coat enclose the cotyledonary laminae. The cotyledonary petioles extend outward through the opening in the pericarp, suspending the seedling stem and primary root a short distance away therefrom. **Dimensions of pericarp after germination:** 11–13 mm × 9.5–12 mm (n = 4 [each parameter]).

Presumed seed coat after germination: chartaceous, smooth, brown, and appressed to the inner surface of the pericarp.

Cotyledons. Number of cotyledons: 2 (n = 6 seedlings). **Lamina:** thick and planoconvex (the abaxial and adaxial surfaces being convex and ca. flat, respectively). The adaxial surfaces of the paired cotyledonary laminae are appressed to one another. Two laminae each manifested two basal lobes; on at least one of those laminae the lobes were pointed (the lamina thus being sagittate). **Lamina surface:** with narrow, low ridges abaxially; concomitantly minutely roughened (at 50X); brown and purple. **Petiole length:** ca. 6 mm (n = 2). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. Commonly, the petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; then the adaxial surface of each petiole clasps the stem. The cotyledon is hypo-peltate. Also, the petiole extends parallel, rather than perpendicular to the lamina. **Stipules:** not recognized.

Length of basal stem sector: 11.5–65 mm (n = 11).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves (at least 12 on one seedling). Once foliage leaves have expanded on the distal stem sector the individual scale leave(s) of the

basal sector appear either brown or both brown and black. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** transitional leave(s) followed by green foliage leave(s).

Scale leaves of basal stem sector. Length (not including stipules): 1.0–2.1 mm (n = 14). **Phyllotaxy:** one or two leaves per node (n = 89% and 11% of 28 nodes, respectively). When the nodes are single-leaved, phyllotaxy is mostly alternate but sometimes subopposite. **Stipules:** present on a minority of scale leaves.

Foliage leaves. Lamina. Shape: simple and unlobed; mostly oblanceolate-obovate to obovate, sometimes elliptic. **Lamina margins:** entire to serrate or dentate; if teeth are present, these often being very short and one to two per margin; the teeth mucronate or mucronulate (the teeth sometimes consisting solely of a mucro). **Lamina apex:** generally acute to broadly rounded; sometimes retuse; normally simultaneously mucronate or mucronulate; **Lamina base:** generally cuneate; sometimes rounded. **Petiole:** very short to absent (the leaf then sessile). **Stipules:** two stem-borne stipules normally border the base of the petiole.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one or two leaves per node (80% and 20% of 15 cases of node no. 1, respectively). Node no. 2: one or two leaves per node (92% and 8% of 13 cases of node no. 2, respectively). Node no. 3: one or two leaves per node (67% and 33% of 9 cases of node no. 3, respectively). The opposite leaves sometimes develop immediately basal to the first terminal winter bud of the distal stem sector, where especially short internodes occur.

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** varying from essentially glabrous to densely pubescent with simple hairs and basally branched, stellate hairs; the hairs of both types sharp-tipped, appressed, and individually either solely transparent or brown-tinged at the center (some stellate hairs). The hairs measuring 0.1 to 0.5 mm long (simple hairs) and 0.05 to 0.4 mm long (stellate hairs [as measured from the hair base to the tip of a branch-hair]). **Distal stem sector:** essentially glabrous to having densely concentrated, comparable (albeit, almost entirely stellate) hairs. **Foliage leaves of node nos. 1–3 of distal stem sector:** hairs, where present, comparable to those described above. Lamina: essentially glabrous overall, or essentially glabrous except for the midvein and sometimes the lateral veins (where sparsely to moderately pubescent), or sometimes with additional sparse pubescence elsewhere. Petiole: moderately pubescent.

Dates of collection and collection numbers of examined specimens.
29508, 6 Mar 2009; 32074, 19 Feb 2011.

Quercus virginiana Mill.; **Fagaceae**
Live Oak. Native
no. specimens studied: 30.

Adult morphology
Tree with alternate, simple foliage leaves.

Seedling morphology (Fig. 12).

Fruit type: tricarpellate, one-seeded nut (acorn; Cronquist 1981; Gleason & Cronquist 1991; Wunderlin & Hansen 2015).

Pericarp after germination: moderately thickened, hard, smooth, dull brown, and having a broad, basal abscission scar with circular outline. The pericarp is open/ruptured at its distal end, where short-to-long longitudinal splits converge from more basal portions of the pericarp. The pericarp and seed coat enclose the cotyledonary laminae. The common cotyledonary petiole extends outward through the opening in the pericarp. Because the cotyledonary petioles (including the common petiole) are long, the seedling stem and primary root may be situated remote from the opening. **Dimensions of pericarp after germination:** 16–25 mm × 11.5–13 mm (n = 6 [each parameter]).

Presumed seed coat after germination: chartaceous, smooth, brown, and appressed to the inner surface of the pericarp.

Cotyledons. The cotyledons are connate from a point partway along their petioles to the distal ends of their laminae. **Number of cotyledons:** 2 (n = 14 seedlings). **Connate laminae:** appearing terete, collectively, and exhibiting basally directed basal lobes. **Lamina surface:** with broad, low ridges; concomitantly minutely roughened (at 50X) and locally tuberculate; black or black plus brown. **Petiole length** (including the common petiole): 17.5–40 mm (n = 8). **Flattening/orientations of the paired**

cotyledonary petioles: each petiole is flattened parallel to the associated stem surface. Generally, the bases of the petioles extend acropetally and in parallel with the seedling stem (rather than abaxially or laterally); distally, the petioles may diverge therefrom. The connate cotyledons are peltate via their common petiole; however, the distal end of the common petiole is oriented parallel to, rather than perpendicular to the connate laminae. **Stipules:** not recognized.

Length of basal stem sector: 55.5–112 mm (n = 10).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves (at least 15 on one seedling). Sometimes a short region of congested scale leaves occurs part-way along the length of the basal stem sector, which might indicate a pre-existing winter bud at that point. Once foliage leaves have expanded on the distal stem sector the individual scale leave of the basal sector appear brown or both brown and black. **Distal stem sector:** either with **a.** solely green foliage leaves, **b.** a transitional leaf followed by two green foliage leaves, or **c.** two green foliage leaves succeeded by a stipulate scale leaf. That scale leaf might signify the end of a growing season because it abuts short internodes, whereas the subjacent foliage leaves are separated by long internodes.

Scale leaves of basal stem sector. Length (not including stipules): 0.9–2.0 mm (n = 16). **Phyllotaxy:** one or two leaves per node (n = 97% and 3% of 32 nodes, respectively). When the nodes are single-leaved, phyllotaxy is mostly alternate but sometimes subopposite. **Stipules:** present or absent.

Foliage leaves. Lamina. Shape: simple and unlobed; generally oblanceolate-obovate to obovate, sometimes elliptic; **Lamina margins:** mostly serrate, dentate, or cleft, with one to five teeth per margin; the teeth simultaneously mucronate (a few minute teeth consisting solely of mucro); sometimes entire. **Lamina apex:** acute (mostly broadly acute) to rounded; also, simultaneously mucronulate to mucronate. **Lamina base:** cuneate to rounded. **Petiole:** mostly present and short but the leaves sometimes sessile. **Stipules:** two stem-borne stipules normally border the base of the petiole.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one leaf per node (100% of 14 cases of node no. 1). Node no. 2: one or two leaves per node (64% and 36% of 14 cases of node no. 2, respectively). Node no. 3: one leaf per node (100% of 5 cases of node no. 3). The opposite leaves develop immediately basal to the first terminal winter bud of the distal stem sector, where especially short internodes occur.

Trichomes. Cotyledons: Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** densely to sparsely pubescent with basally branched, stellate hairs which are sharp tipped, appressed, transparent (except at the center, where often brown tinged), and mostly 0.05 to 0.2 mm long (as measured from the hair base to the tip of a branch-hair). **Distal stem sector:** with moderately concentrated, comparable hairs. **Foliage leaves of node nos. 1–3 of distal stem sector:** with comparable hairs. Lamina. *Away from the midrib and margins*: essentially glabrous to sparsely pubescent. *Midrib and margins*: sparsely to moderately pubescent (especially basally on the midrib). Petiole: moderately pubescent.

Dates of collection and collection numbers of examined specimens.
28118, 7 Apr 2008; 28119, 4 Mar 2009; 29433, 29434, 15 Feb 2009; 29509, 29510, 4 Mar 2009.

Damburneya coriacea (Sw.) Trofimov & Rohwer
(*Ocotea coriacea* [Swartz] Britton; *Nectandra coriacea* [Sw.] Griseb.); **Lauraceae**
Lancewood. Native
no. specimens studied: 25.

Adult morphology
Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 13).

Fruit type: a drupe (Van der Werff 1997, 1997a; Wofford 1997); see p. 481, herein.

Pericarp after germination. On some seedlings an endocarp devoid of the soft outer portion of pericarp encloses the cotyledons. The endocarp is thin, brittle, and exhibits a smooth, brown outer surface. It is ruptured, having an opening at one end. The opening is small and pore-like or larger and then accompanied, partly, by irregular splits which extend up to ca. half the length of the endocarp. The endocarp completely/almost completely encloses the cotyledonary laminae; the cotyledonary petioles occur by the opening, suspending the seedling stem and primary root immediately to the outside of the opening. **Dimensions of endocarp after germination:** 10 mm × 8–8.5 mm (n = 3 [each parameter]).

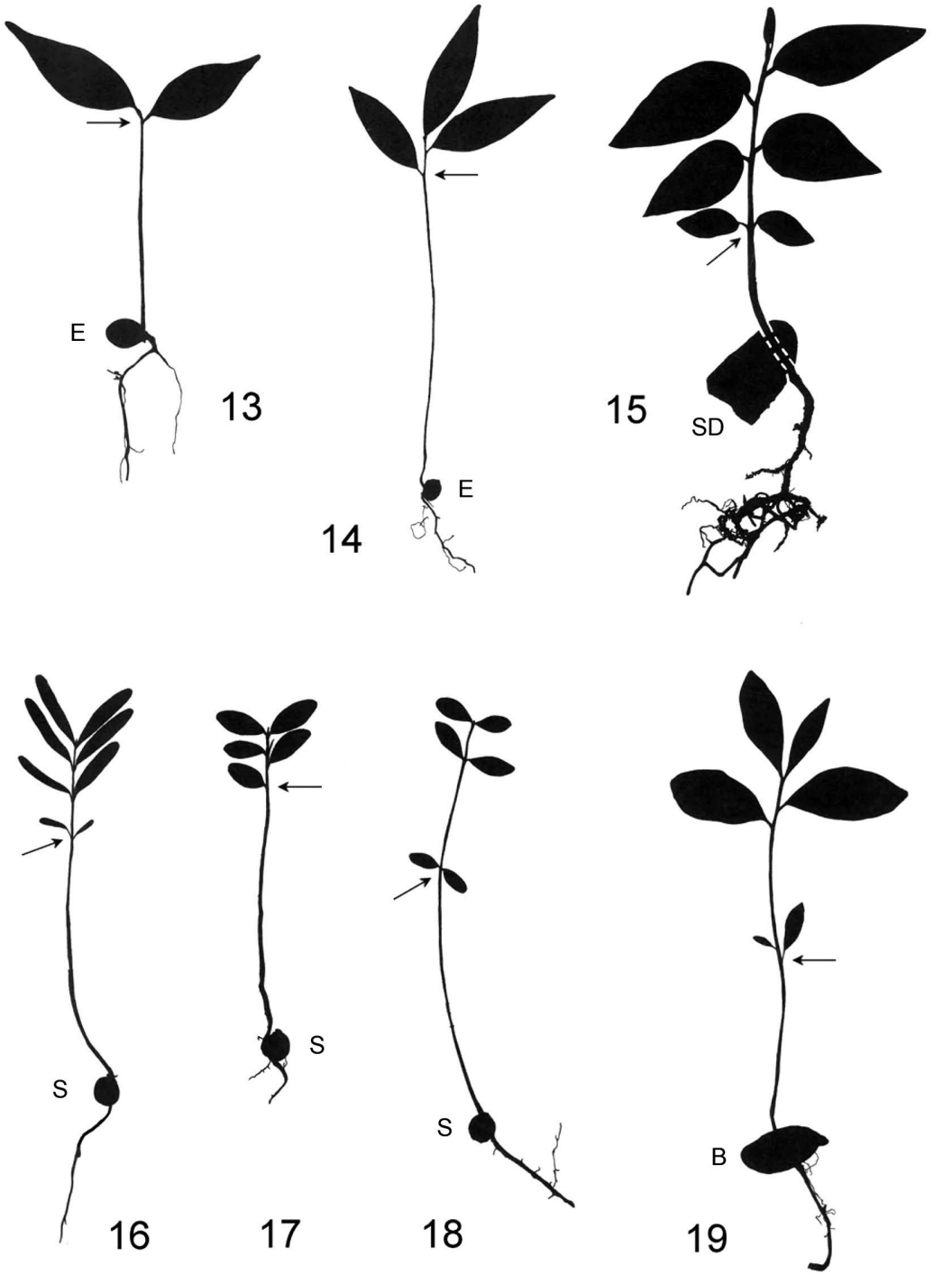

Fig. 13. *Damburneya coriacea*. Seedling. × 0.54. **Fig. 14.** *Persea palustris*. Seedling. × 0.32. **Fig. 15.** *Swietenia mahagoni*. Sapling. × 0.76. **Fig. 16.** *Eugenia confusa*. Sapling. × 0.83. **Fig. 17.** *Eugenia foetida*. Sapling. × 0.75. **Fig. 18.** *Myrcianthes fragrans*. Seedling. × 0.68. **Fig. 19.** *Syzygium cumini*. Sapling. × 0.47. For the specimen depicted in each figure an arrow indicates the boundary between the basal stem sector and the distal stem sector. **B**. Berry. **E**. Endocarp. **S**. Seed coat. **SD**. Remaining distal portion of seed coat.

Cotyledons. The two paired cotyledonary laminae are connate along their adaxial surfaces (as ascertained in surface view and in a thick cross section at 50X); the cotyledonary petioles are distinct. **Number of cotyledons:** 2 (n = 3 seedlings). **Connate laminae:** thickened but also somewhat flattened, both collectively and individually, parallel to their adaxial/abaxial surfaces; the abaxial surfaces are convex. **Lamina surface:** replete with minute, irregular, variously curved ridges; black. **Petiole length:** 1.5 to 2 mm (n = 4). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 50–84 mm (n = 10).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves (at least 13 on one seedling). After foliage leaves have expanded on the distal stem sector the scale leaves of the basal sector are brown and/or black. **Distal stem sector:** with green foliage leaves. In addition to those leaves, on some seedlings the distal stem sector manifested leaf scars derived from leaves of undeterminable kinds.

Scale leaves of basal stem sector. Length: 0.4–1.7 mm (n = 17). **Phyllotaxy:** one, two, or three leaves per node (n = 93.1%, 3.4%, and 3.4% of 29 nodes, respectively). The single records of each of two and three leaves per node are from the bases of stems, where scale leaves may be concentrated. When the nodes are single-leaved, phyllotaxy is mostly alternate but is sometimes subopposite. **Stipules:** absent.

Foliage leaves. Lamina. Shape: simple and unlobed; lanceolate to lanceolate-ovate. **Lamina margins:** entire. **Lamina apex:** acuminate to caudate. **Lamina base:** cuneate. **Petiole:** present. **Stipules:** absent.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector: one leaf per node (100% of 18, 16, and 5 cases of node nos. 1, 2, and 3, respectively).

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** glabrous. **Distal stem sector:** glabrous. **Foliage leaves of node nos. 1–3 of distal stem sector:** Lamina: glabrous. Petiole: glabrous.

Dates of collection and collection numbers of examined specimens.
29505, 10 Feb 2009; 34413, 10 Jan 2013; 34626, 34927, 27 Dec 2012.

Persea palustris (Raf.) Sarg.; **Lauraceae**
Swamp Bay. Native
no. specimens studied: 18

Adult morphology
Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 14).

Fruit type: a drupe (see p. 481, herein).

Pericarp after germination: solely endocarp is present (albeit it was damaged in presently studied material). It is thin, brittle, and manifests a smooth, brown outer surface.

Cotyledons. Number of cotyledons: 2 (n = 6 seedlings). **Lamina:** thickened but also flattened parallel to its adaxial/abaxial surfaces; the abaxial surface is convex; the adaxial surfaces of the cotyledon pair are appressed. **Lamina surface:** replete with minute, irregular, variously curved ridges and/or projections of different shapes; purple and/or black. Also, the surface of one cotyledon exhibited apparent cuticular fragments (perhaps, a result of shrinkage of the cotyledonary surface). **Petiole length:** minute (n = 4). **Flattening/orientations of the paired cotyledonary petioles:** difficult to ascertain with present material; at least sometimes a cotyledonary petiole extends abaxially away from, rather than laterally from the cotyledonary node. The cotyledon is hypo-peltate; also, the petiole joins the lamina near its basal end (n = 4). **Stipules:** not recognized.

Length of basal stem sector: 69.5–182 mm (n = 11).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves. After foliage leaves have expanded on the distal stem sector the scale leaves of the basal sector are light brown to black. **Distal stem sector:** either with **a.** solely green foliage leaves, **b.** a transitional leaf followed by green foliage leaves, or **c.** two green foliage leaves followed by a brown scale leaf.

Scale leaves of basal stem sector. Length: 0.5–4.7 mm (n = 14). **Phyllotaxy:** one leaf per node (n = 100% of 21 nodes). Phyllotaxy is alternate. **Stipules:** absent.

Foliage leaves. Lamina. Shape: simple, unlobed and quite variable; narrowly elliptic to elliptic, narrowly elliptic-lanceolate, narrowly elliptic-ovate, lanceolate, ovate, narrowly oblong, oblanceolate, oblanceolate-obovate. **Lamina margins:** generally entire; sometimes crenulate or undulate. **Lamina apex:** often narrowly rounded; sometimes acute or acuminate. **Lamina base:** generally cuneate; sometimes attenuate or almost rounded. **Petiole:** present. **Stipules:** absent.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one or two leaves per node (94% and 6% of 16 cases of node no. 1, respectively). Node no. 2: one leaf per node (100 % of 16 cases of node no. 2). Node no. 3: one or two leaves per node (94% and 6% of 16 cases of node no. 3, respectively).

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. **Basal stem sector:** essentially glabrous throughout or bearing short hairs (these sometimes absent basally) which vary from sparsely to moderately concentrated and are narrow, sharp-tipped, transparent or brownish, generally up to 0.25 mm long, mostly moderately curved, and often appressed. **Distal stem sector:** bearing sparsely to moderately distributed, comparable hairs. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: essentially glabrous to moderately pubescent with comparable hairs, these sometimes being most evident on the midrib and margins. Petiole: essentially glabrous to moderately pubescent with comparable hairs.

Dates of collection and collection numbers of examined specimens.
26486, 22 Mar 2007; 26532, 23 Mar 2007; 26600, 8 Apr 2007; 28162, 13 Apr 2008; 29395, 20 Jan 2009; 29409, 27 Jan 2009; 29439, 31 Jan 2009; 29507, 26 Jan 2009.

Swietenia mahagoni (L.) Jacq.; **Meliaceae**
West Indian Mahogany. Native.
no. specimens studied: 15

Adult morphology
Tree with alternate, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 15).

Fruit type: a five-carpellate capsule (Wunderlin et al. 2017).

Pericarp after germination: absent.

Seed coat after germination. The distal part of the seed coat accompanies the seedling, but the basal, largely winged portion of seed coat is often broken away. The distal part appears flat (thus exhibiting two faces and two edges), moderately thick, relatively soft (being composed largely of parenchymatous tissue), mainly smooth when unmagnified (but appearing minutely roughened at 50X because of structural irregularities in the epidermis), and brown. A small opening (rupture) occurs along one edge of the seed coat, situated by or somewhat removed from its distal end. The cotyledonary laminae and the distal portions of the cotyledonary petioles are situated to the inside of the seed coat; the cotyledonary petioles suspend the seedling stem and primary root to the outside of the opening. **Dimensions of seed coat after germination** (measurements are especially variable because of the breakage, aforementioned): 13.5–32.5 × 8.5–12 mm (n = 10 [each parameter]).

Cotyledons. The two cotyledonary laminae are connate, a circumstance ascertained by surficial study, thereof, and by viewing transections made at their junctions with the cotyledonary petioles. The cotyledonary petioles are distinct. **Number of cotyledons:** 2 (n = 10 seedlings). **Connate laminae:** collectively, extremely flat; the plane of flattening paralleling that of the seed coat. **Lamina surface:** each abaxial surface manifests a dense, farinaceous, adherent cover comprised of numerous, white, partially contiguous, minute particles. Underneath that cover the abaxial surface is roughened and exhibits many small, intermixed, contiguous flecks of brown and green. **Petiole length:** 2 to 4 mm (n = 2). **Flattening/orientations of the paired cotyledonary petioles:** generally, each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. The two cotyledonary petioles extend distally through a small opening between the connate laminae and are inserted submarginally upon them, collectively. Thus, the connate cotyledons are peltate. **Stipules:** not recognized.

Length of basal stem sector: 15–49.5 mm (n = 10).

Leaf types situated distal to the cotyledons. Basal stem sector: leaves absent. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** one or two small, green transitional leave(s) followed by green foliage leaves.

Foliage leaves. Lamina. Shape: simple and unlobed; generally, lanceolate and ovate, sometimes elliptic, sometimes falcate. **Lamina margins:** entire. **Lamina apex:** acuminate to acute; sometimes simultaneously mucronate. **Lamina base:** mostly rounded or rounded-retuse; sometimes broadly cuneate. **Petiole:** present. **Stipules:** absent.

Phyllotaxy of leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one or two leaves per node (82% and 18% of 11 cases of node no. 1, respectively). Node nos. 2, 3: one leaf per node (100% of 11 and 11 cases of node nos. 2 and 3, respectively). Alternate and subopposite phyllotaxy are both common.

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** glabrous. **Distal stem sector:** glabrous/essentially glabrous or with sparse, extremely short, sessile or short-stalked, broad-tipped, pink or transparent hairs less than 0.05 mm long. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: glabrous/essentially glabrous. Petiole: glabrous to sparsely pubescent with comparable hairs.

Eugenia confusa DC.; **Myrtaceae**
Redberry Stopper. Native
no. specimens studied: 25

Adult morphology
Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 16).

Fruit type: bicarpellate berry (Wunderlin et al. 2017).

Pericarp after germination: degraded and eventually disappearing, exposing the more persistent seed coat.

Seed coat after germination: moderately thin, readily fractured, smooth, either white or becoming darkened by environmental exposure. Germination induces seed-coat rupture solely at one point. The cotyledonary petioles, which protrude at that point, **a.** are essentially the only exposed portions of the cotyledons, and **b.** suspend the seedling stem and primary root along the outer surface of the seed coat. **Dimensions of seed coat after germination:** 4.5–5 mm × 4 mm (n = 2 [each parameter]).

Cotyledons. Number of cotyledons: 2 (n = 7 seedlings). **Lamina:** thickened, albeit, flattened parallel to its adaxial/abaxial surfaces; the abaxial surface convex; the adaxial surfaces of the cotyledon pair being tightly appressed. **Lamina surface:** replete with minute, irregular bulging areas. **Petiole length:** 1 mm (n = 3). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 33–72 mm (n = 10).

Leaf types situated distal to the cotyledons. Basal stem sector: with persistent scale leaves. After transitional leaves and/or foliage leaves have expanded on the distal stem sector the scale leaves of the basal sector are generally brown. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** green transitional leave(s) followed by green foliage leaves.

Scale leaves of basal stem sector. Length: 0.25–1.5 mm (n = 15 scale leaves). **Phyllotaxy:** one or two leaves per node (n = 75% and 25% of 32 nodes, respectively). When the nodes are single-leaved phyllotaxy is commonly alternate or subopposite. **Stipules:** absent.

Foliage leaves. Lamina. Shape: simple and unlobed; narrowly elliptic to narrowly oblong, oblanceolate, oblanceolate-linear, oblanceolate-oblong, obovate-oblong. **Lamina margins:** entire. **Lamina apex:** subacute to narrowly rounded. **Lamina base:** narrowly cuneate or sessile. **Petiole:** very short or absent. **Stipules:** absent.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one, two, or three leaves per node (40%, 50%, and 10% of 10 cases of node no. 1, respectively). Node no 2: one, two, or three leaves per node (30%, 60%, and 10% of 10 cases of node no. 2, respectively). Node no. 3: one, two, or three

leaves per node (25%, 63%, and 13% of 8 cases of node no. 3, respectively). One of the 10 seedlings investigated exhibited all three of the indicated nodes having three leaves apiece.

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** with densely arranged, short hairs which are transparent, white, light-tan, or brown, generally 0.1 to 0.2 mm long, commonly uncinate, and vary from spreading to appressed. **Distal stem sector:** with comparable hairs. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: glabrous or essentially glabrous. Petiole: glabrous to moderately pubescent with hairs like those described above.

Additional information. Gland dots are present (terminology from Tomlinson 2001). In top view they vary from circular to short-elliptical and are generally ca. 0.05 to 0.1 mm in diameter. They form on the cotyledons, basal stem sector, distal stem sector (where they are difficult to find and apparently sparse), scale leaves, transitional leaves, and foliage leaves.

Dates of collection and collection numbers of examined specimens.
34216, 17 Nov 2012; 35289, 26 Oct 2013.

Eugenia foetida Pers.; **Myrtaceae**
Spanish Stopper. Native
no. specimens studied: 37

Adult morphology
Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 17).

Fruit type: bicarpellate berry (Wunderlin et al. 2017).

Pericarp after germination: degraded and eventually disappearing, exposing the more persistent seed coat.

Seed coat after germination: moderately thin, readily fractured, smooth, cream-colored (or perhaps whiter), but becoming darkened by environmental exposure. Germination induces seed-coat rupture more-or-less at one point. The seed coat encloses the connate cotyledonary laminae and all, or all but the base of, the common cotyledonary petiole. The common cotyledonary petiole suspends the seedling stem and primary root along the outer surface of the seed coat. **Dimensions of seed coat after germination:** 6 mm × 5.5–6 mm (n = 2 [each parameter]).

Cotyledons. Connation and number of cotyledons. Seemingly there is one cotyledon (n = 3 seedlings); however, I interpret the apparent single cotyledon as two completely connate cotyledons. The connate cotyledonary petioles exhibit one broad line of insertion on the seedling stem, which faces the connate cotyledonary laminae. That configuration contrasts with those of species having two distinct cotyledons; in them there are two separate, smaller lines of insertion situated on different sides of the cotyledonary node. **Connate laminae:** much thickened but also somewhat flattened, both collectively and individually, parallel to their abaxial surfaces. At/by their junction with the common petiole there is a ca. semi-circular ligule-like ridge that parallels the adjacent stem surface and that, at its midpoint, extends perpendicular to the long axis of the connate cotyledons. **Lamina surface:** replete with minute, irregular bulging areas; olive colored. Also, the cotyledonary lamina is covered by many minute, thin, transparent fragments (apparently, shed cuticle) which exhibit cellular outlines. **Common petiole length:** 0.5 mm (n = 2). **Flattening/orientation of the common cotyledonary petiole:** each side of the common petiole clasps and appears flattened parallel to the associated stem surface; however, the entire common petiole manifests a continuous, extended, more-or-less transverse line of insertion upon the cotyledonary node. **Stipules:** not recognized.

Length of basal stem sector: 23.5–66.5 mm (n = 10).

Leaf types situated distal to the cotyledons. Basal stem sector: with numerous, sometimes persistent, scale leaves. After foliage leaves and/or transitional leaves have expanded on the distal stem sector the scale leaves of the basal sector (and of the distal sector [see below]) are generally brown. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** two green transitional leaves followed by green foliage leaves. Also, at least three seedlings each bore both foliage leaves and scale leave(s) on the distal stem sector. On one seedling node no. 1 bore a foliage leaf and two scale leaves. On another seedling a more distally situated node bore solely one scale leaf.

Scale leaves of basal stem sector. Length: 0.2–0.8 mm (n = 16). **Phyllotaxy:** one or two leaves per node (n = 78% and 22% of 23 nodes, respectively). When the nodes are single-leaved phyllotaxy is alternate or subopposite. **Stipules:** absent.

Foliage leaves. Lamina. Shape: simple and unlobed; narrowly elliptic, elliptic, oblanceolate-obovate, obovate, ovate. **Lamina margins:** entire. **Lamina apex:** subacute to narrowly rounded. **Lamina base:** narrowly cuneate or cuneate. **Petiole:** short. **Stipules:** absent; however, varying numbers of minute, brown-to-black scales (trichomes) suggestive of stipules commonly occur at the base of the petiole.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one, two, or three leaves per node (28%, 56%, and 17% of 18 cases of node no. 1, respectively). Node no 2: one, two, or three leaves per node (29%, 57%, and 14% of 14 cases of node no. 2, respectively). Node no. 3: one, two, or three leaves per node (22%, 67%, and 11% of 9 cases of node no. 3, respectively).

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** with densely arranged, short hairs which are transparent, white, or light brown, generally 0.05 to 0.3 mm long, straight, moderately curved, or uncinate, and which are often spreading but also vary to being appressed. **Distal stem sector:** with comparable hairs. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: glabrous or essentially glabrous. Petiole: sparsely to densely pubescent with hairs like those described above.
In addition to hairs, and as indicated above, small numbers of minute, brown-to-black scales (trichomes) suggestive of stipules commonly occur at the base of the petiole of foliage leave(s).

Additional information. Gland dots are present (terminology from Tomlinson 2001). In top view they vary from circular to elliptical and are generally ca. 0.05 mm in diameter. They were observed on the basal stem sector, scale leaves, transitional leaves, and foliage leaves.

Dates of collection and collection numbers of examined specimens.
29392, 12 Jan 2009; 34576, 7 Mar 2013.

Myrcianthes fragrans (Sw.) McVaugh; **Myrtaceae**
Simpson's Stopper. Native
no. specimens studied: 22

Adult morphology
Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 18).

Fruit type: bicarpellate berry (Wunderlin et al. 2017).

Pericarp after germination: absent or degraded and fragmentary.

Seed coat after germination: moderately thin, readily fractured, smooth, and brown (possibly because of exposure to the environment). Germination induces seed-coat rupture solely at one point. The seed coat encloses the connate cotyledonary laminae and all but the base of the common cotyledonary petiole. The common cotyledonary petiole suspends the seedling stem and primary root along the outer surface of the seed coat. **Dimensions of seed coat after germination:** 6–6.5 mm × 5.5 mm (n = 2 [each parameter]).

Cotyledons. Connation and number of cotyledons. Seemingly there is one cotyledon (n = 3 seedlings) but, as for *Eugenia foetida* (Myrtaceae) and for like reasons I interpret the apparent cotyledon as two completely connate cotyledons. **Connate laminae:** collectively, much thickened. **Lamina surface:** replete with minute, irregular protuberances; olive colored. **Common petiole length:** 1 mm (n = 2). **Orientation/flattening of the common petiole:** the common petiole manifests a single area of insertion on the cotyledonary node. The central portion of that area faces the connate cotyledonary laminae. Each side of the common petiole clasps and appears flattened parallel to the associated surface of the cotyledonary node. **Stipules:** not recognized.

Length of basal stem sector: 20.5–55 mm (n = 5).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves (at least 13 on one seedling). After foliage leaves have expanded on the distal stem sector the scale leaves of the basal sector are black. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** a green transitional leaf followed by green foliage leaves.

Scale leaves of basal stem sector. Length: 0.2–0.7 mm (n = 11). **Phyllotaxy:** one or two leaves per node (61% and 39% of 23 nodes, respectively). When the nodes are single-leaved, phyllotaxy is commonly either alternate or subopposite. **Stipules:** absent.

Foliage leaves. Lamina. Shape: simple and unlobed; lanceolate-ovate, elliptic-narrowly elliptic, oblanceolate to obovate. **Lamina margins:** entire. **Lamina apex:** narrowly rounded to rounded. **Lamina base:** cuneate to sessile. **Petiole:** short to absent (the leaf then sessile). **Stipules:** absent.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one or two leaves per node (14% and 86% of 7 cases of node no. 1, respectively). Node no. 2: one or two leaves per node (14% and 86% of 7 cases of node no. 2, respectively). Node no. 3: one or two leaves per node (50% and 50% of 2 cases of node no. 3, respectively). The records of one leaf per node represent cases where phyllotaxy was closely subopposite.

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** with hairs that are densely arranged, narrow, sharp-tipped, often light brown (but sometimes transparent or white), generally 0.03 to 0.4 mm long, mostly moderately curved, appressed to spreading, and conspicuously antrorse. **Distal stem sector:** with comparable hairs. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: the surfaces glabrous, the margins sparsely hairy when young. Petiole: with sparsely to moderately concentrated hairs.

Additional information. Gland dots are present (terminology from Tomlinson 2001). In top view they vary from circular (especially on the laminae of the foliage leaves) to short-elliptical and are generally ca. 0.05 to 0.2 mm in diameter. They were observed on the basal stem sector, distal stem sector (where they were difficult to find), scale leaves, transitional leaves, and foliage leaves.

Dates of collection and collection numbers of examined specimens.
28121, 28122, 7 Apr 2008; 29024, 20 Oct 2008.

Syzygium cumini (L.) Skeels; **Myrtaceae**
Java Plum. Exotic
no. specimens studied: 40

Adult morphology
Tree with opposite, simple foliage leaves.

Seedling morphology (Fig. 19).

Fruit type: in *Syzygium* species, overall, a 2 to 4 carpellate/loculate, one-seeded berry (Wunderlin et al. 2017).

Pericarp after germination: more-or-less degraded and often absent or fragmentary; black, rather thin (appearing chartaceous when dry) and with a smooth or rough outer surface (in the latter case, apparently because of wear). At least sometimes the seedling stem and primary root each grow outward through a different point within the pericarp; growth outward is ca. midway along, and perpendicular or oblique to, the long axis of the pericarp. **Dimensions of relatively intact pericarp after germination:** 17.5–24 mm × 9.5–12.5 mm (n = 2 [each parameter].

Seed coat after germination: torn and fragmentary, thin, white or stramineous, and fibrous; its dimensions essentially equaling those of the pericarp.

Cotyledons. Number of cotyledons: difficult to ascertain with dried material; however, one seedling bore two cotyledons and two seedlings each bore three cotyledons. **Lamina:** much thickened and variable in size and shape, sometimes on the same seedling; sometimes deeply lobed; sometimes terete. The abaxial surface is frequently convex. The adaxial surface may appear concave, approximately planar, or otherwise. **Lamina surface:** replete in places with minute, densely concentrated tubercles or short ridges; brown or purple-brown. **Petiole length:** 0.5 mm (n = 2). **Orientations of the two or three cotyledonary petioles:** they diverge in opposite/different directions from the cotyledonary node. The cotyledons are hypo-peltate. **Stipules:** not recognized.

Length of basal stem sector: 35.5–65 mm (n = 10).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves (at least six on one seedling). Once foliage leaves have expanded on the distal stem sector the scale leaves of the basal sector appear black, brown, ca. gray, yellow, or green. Also, immediately distal to the cotyledonary node there may occur a tight cluster of up to twelve brown-to-black, minute, scale-like structures (possibly emergences) which measure ca. 0.1 mm or more long. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** a green transitional leaf followed by green foliage leaves.

Scale leaves of basal stem sector. Length: 0.7–3.3 mm (n = 16). **Phyllotaxy:** one or two leaves per node (n = 86% and 14% of 21 nodes, respectively). When the nodes are single-leaved, the leaves are alternate or subopposite. **Stipules:** absent.

Foliage leaves. Lamina. Shape: simple and unlobed; ca. narrowly elliptic to elliptic, oblanceolate to obovate. **Lamina margins:** entire. **Lamina apex:** generally acute to narrowly rounded; sometimes emarginate. **Lamina base:** narrowly cuneate to cuneate. **Petiole:** mostly present and short; however, the petiole may be winged and can then appear nearly indistinct from the lamina. **Stipules:** absent; however, often minute, black or brown scale-like structures (comparable to the possible emergences aforementioned) occur in the positions of stem-borne stipules or more medially in the leaf axil.

Phyllotaxy of leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one or two leaves per node (71% and 29% of 24 cases of node no. 1, respectively). Node: no. 2: one or two leaves per node (75% and 25% of 20 cases of node no. 2, respectively). Node: no. 3: one or two leaves per node (58% and 42% of 12 cases of node no. 3, respectively). Where the nodes are single-leaved, alternate and subopposite phyllotaxy are both common.

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** glabrous. **Distal stem sector:** glabrous. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: glabrous. Petiole: glabrous.

Additional information. Gland dots are present (terminology from Tomlinson 2001). In top view of the foliage leaves they vary from circular to short-elliptical and are generally ca. 0.05 to 0.15 mm in diameter. They were observed on the cotyledons, basal stem sector, distal stem sector, scale leaves, transitional leaves, and foliage leaves (where they were most obvious and commonly appeared yellowish).

Dates of collection and collection numbers of examined specimens.
25268, 17 May 2006; 26856, Apr 2007; 28170, 11 Apr 2018; 29164, 27 Oct 2008; 40108, 3 Apr 2017.

Reynosia septentrionalis Urb.; **Rhamnaceae**
Darlingplum. Native
no. specimens studied: 22

Adult morphology
Tree or shrub with opposite, simple foliage leaves.

Seedling morphology (Fig. 20).

Fruit type: bicarpellate, one-seeded drupe (Tomlinson 2001; Wunderlin & Hansen 2016).

Pericarp and seed coat after germination: absent from studied material.

Cotyledons. Only cotyledon scars and one fragment of each of two petioles were observed. **Number of cotyledons** (based on counts of cotyledon scars and petiole fragments): 2 (n = 15 seedlings). **Lengths of petiole fragments:** 2 mm, 6.5 mm.

Length of basal stem sector: 15.5–61.5 mm (n = 11).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves (nine on one seedling). Once foliage leaves have expanded on the distal stem sector the individual scale leaves of the basal sector appear either **a.** largely black, albeit with either brown margins or a brown tip, or **b.** gray. **Distal stem sector (of seedlings and saplings, collectively):** with alternating, superposed zones of green foliage leave(s) and black/brown scale leaves. These zones are indicated in acropetal order of their occurrence on the distal stem sector. **Zone 1:** with one to three foliage leaves (the third foliage leaf may be paired with a scale leaf) (n = 10 seedlings). **Zone 2:** with three to at least seven scale leaves (n = 10). **Zone 3:** with one to two foliage leaves (n = 8). **Zone 4:** with four to 19 scale leaves (n = 3). **Zone 5:** with one or two foliage leaves (n = 3).

Scale leaves of basal stem sector. Length (not including stipules): 1.0–1.8 mm (n = 16). **Phyllotaxy:** one or two leaves per node (n = 98% and 2% of 49 nodes, respectively). When the nodes are single-leaved, phyllotaxy is mostly alternate but sometimes subopposite. **Stipules:** present or absent; there is one stipule per leaf.

Foliage leaves. Lamina. Shape: simple and unlobed; oblanceolate-obovate to widely obovate, elliptic. **Lamina margins:** entire. **Lamina apex:** broadly rounded or retuse; simultaneously mucronate to apiculate. **Lamina base:** cuneate or rounded. **Petiole:** short. **Stipules:** there occurs one axillary stipule which is partly adnate to the petiole (see above).

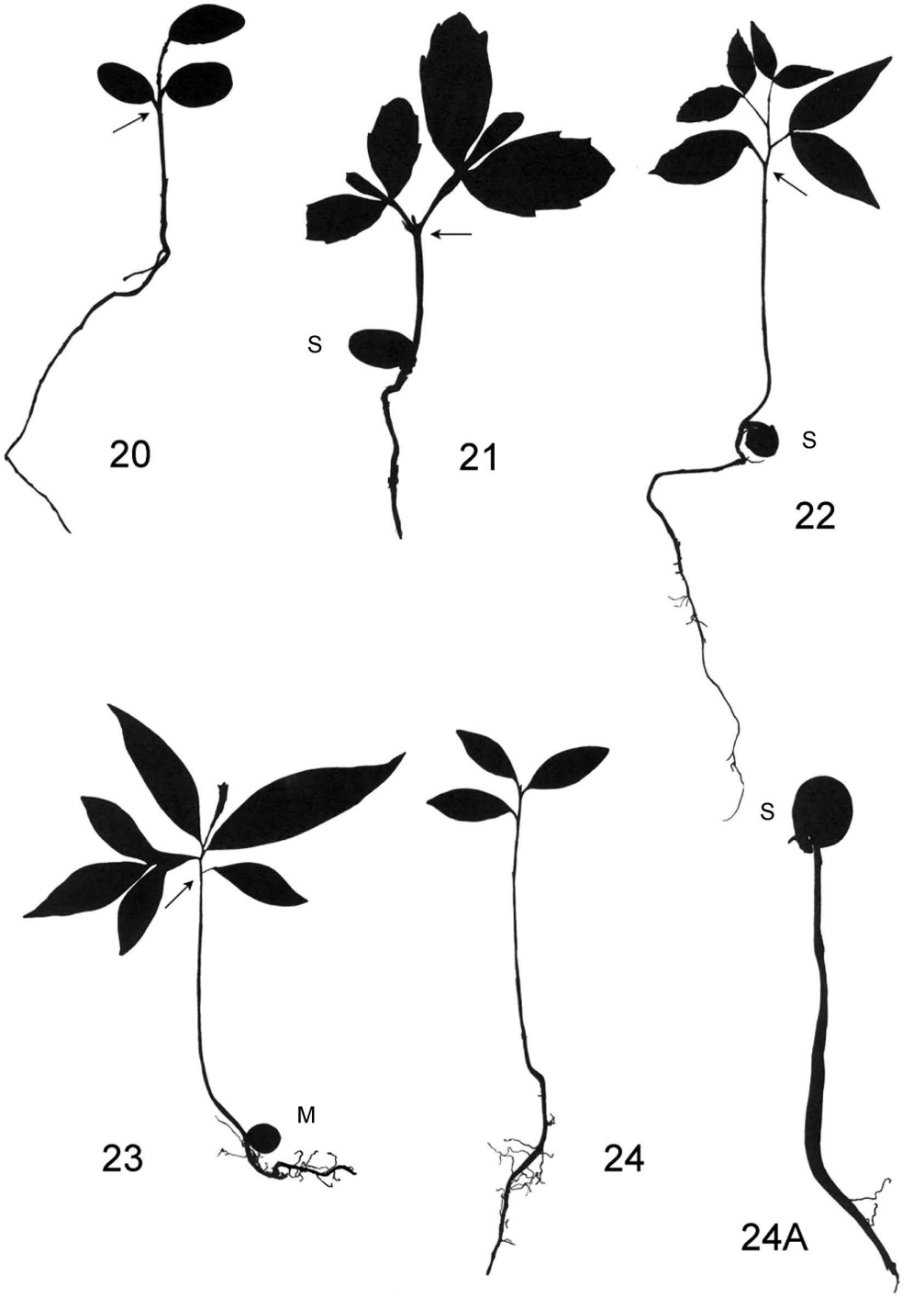

Fig. 20. *Reynosia septentrionalis*. Sapling. × 0.58. **Fig. 21.** *Cupaniopsis anacardioides*. Seedling. × 0.97. **Fig. 22.** *Exothea paniculata*. Sapling. × 0.49. **Fig. 23.** *Sapindus saponaria*. Seedling. × 0.37. **Figs. 24, 24A.** *Sideroxylon foetidissimum*. Seedling and a younger seedling capped by a seed coat. × 0.43, × 0.67. For the specimens depicted in Figs. 20–23 an arrow indicates the boundary between the basal stem sector and the distal stem sector. **M**. Mericarp. **S**. Seed coat.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one or two leaves per node (78% and 22% of 18 cases of node no. 1, respectively). Node no. 2: one or two leaves per node (76% and 24% of 17 cases of node no. 2, respectively). Node no. 3: one or two leaves per node (59% and 41% of 17 cases of node no. 3, respectively).

Trichomes. Cotyledons: unavailable for study. **Basal stem sector:** essentially glabrous or moderately pubescent with very short and narrow, transparent, sharp-tipped, spreading hairs ca. 0.05 mm long. **Distal stem sector:** with sparsely to moderately concentrated, comparable hairs. **Foliage leaves of node nos. 1–2 of distal stem sector.** Lamina: glabrous/essentially glabrous. Petiole: glabrous to sparsely pubescent with comparable hairs.

Dates of collection and collection numbers of examined specimens.
34578, 5 Mar 2013; 35297, Oct 2013.

Cupaniopsis anacardioides (A. Rich.) Radlk.; **Sapindaceae**
Carrotwood. Exotic
no. specimens studied: 14

Adult morphology
Tree with alternate or subopposite, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 21).

Fruit type: capsule with loculicidal dehiscence (Wunderlin et al. 2017).

Pericarp after germination: absent.

Seed coat after germination: hard, smooth, dark brown to black. The seed coat is split longitudinally (at least sometimes along two lines), the resulting split(s) extending distally from the hilum. Splitting creates an opening at the hilar end of the seed. The seed coat covers the cotyledonary laminae. The cotyledonary petioles are exposed, suspending the seedling stem and primary root to the outside of the seed coat. **Dimensions of seed coat after germination:** 8.5–10 mm × 5–6 mm (n = 6 [each parameter]).

Cotyledons. Number of cotyledons: 2 (n = 5 seedlings). **Lamina:** thickened, convex abaxially, concave over part of its adaxial surface; overall, somewhat flattened parallel to its adaxial/abaxial surfaces. **Lamina surface:** replete with minute, irregular bulging areas. **Petiole length:** 2.5 to 3 mm (n = 4). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 17–66 mm (n = 12).

Leaf types situated distal to the cotyledons. Basal stem sector: leaves absent. **Distal stem sector:** with solely foliage leaves.

Foliage leaves. Lamina. Shape: once compound. At node no. 1: each leaf with either two opposite, well-developed pinnae or with two opposite and one terminal well-developed pinnae (n = 30% and 70% of 27 leaves, respectively). At node no. 2: the leaf with two opposite well-developed pinnae (n = 1). At node no. 3: the leaf with two opposite and one terminal well-developed pinnae (n = 1). **Pinna margins:** entire or coarsely serrate with one to four teeth confined to the distal three-quarters or less of each margin. **Pinna apex:** rounded, truncate, broadly acute, or retuse and simultaneously mucronate to apiculate. **Pinna base:** sessile. **Petiole:** present. **Stipules:** absent.

Phyllotaxy of the foliage leaves at node nos. 1–3 of the distal stem sector. Node no. 1: one or two leaves per node (7% and 93% of 14 cases of node no. 1, respectively). In the single case with one leaf, the leaves at node nos. 1 and 2 were slightly subopposite. Node nos. 2, 3: one leaf per node (n = 1 case for each of node nos 2 and 3).

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** with sparsely to moderately concentrated, narrow, sharp-tipped trichomes which are transparent, white, or light brown, generally 0.1 to 0.5 mm long, straight or curved, appressed (then sometimes predominantly antrorse) to spreading. **Distal stem sector:** with comparable hairs. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: glabrous or essentially glabrous with sparse hairs like those described above, mainly on the midvein. Petiole: sparsely to moderately pubescent with hairs like those described above.

Dates of collection and collection numbers of examined specimens.
28887, 5 Aug 2008; 29066, 6 Oct 2008; 29235, 20 Nov 2008; 41290, 18 Sep 2018.

Exothea paniculata (Juss.) Radlk.; **Sapindaceae**
Inkwood. Native
no. specimens studied: 27

Adult morphology
Tree with alternate, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 22).

Fruit type: a one-seeded berry (Tomlinson 2001; Wunderlin et al. 2017).

Pericarp after germination: absent.

Seed coat after germination: thin but rigid, smooth, light- to dark brown. The seed coat ruptures along irregular line(s) and continues to enclose the cotyledonary laminae. The remainder of the seedling, including the cotyledonary petioles, is suspended to the outside of the seed coat. **Dimensions of seed coat after germination:** 10–11 mm × 8.5–9.5 mm (n = 2 [each parameter]).

Cotyledons. Number of cotyledons: 2 (n = 5 seedlings). **Lamina:** thickened; the abaxial surface convex. **Lamina surface:** replete with minute, irregular, often curved ridges. **Petiole length:** 6 mm (n = 1). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 65.5–112 mm (n = 12).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves. After foliage leaves have expanded on the distal stem sector the scale leaves of the basal sector appear cream-colored, brown, or black. **Distal stem sector:** generally, with solely green foliage leaves; however, occasionally a scale leaf develops in place of a foliage leaf at node no. 2 of the distal stem sector. In the latter case single green foliage leaves still develop at node nos. 1 and 3, thereof.

Scale leaves of basal stem sector. Length: 0.3–1.1 mm (n = 13). **Phyllotaxy:** normally one leaf per node, rarely two per node (94% and 6% of 16 nodes, respectively). **Stipules:** absent.

Foliage leaves. Lamina. Shape: once compound. The leaves manifest an abortive tip separate from the expanded pinna(e) even when there is solely one expanded pinna. At node no. 1: the leaf with either one, two, three, or four well-developed pinnae (n = 19%, 74%, 4%, and 4% of 27 leaves, respectively). At node no. 2: the leaf with two, three, or four well-developed pinnae (n = 91%, 5%, and 5% of 22 leaves, respectively). At node no. 3: the leaf with two or three well developed pinnae (n = 92% and 8 % of 12 leaves, respectively). **Pinna margins:** either entire (sometimes on all three foliage leaves of a seedling) or serrate; when serrate, having one to six teeth per margin, the teeth being either on the distal portion or on all but the basal portion, thereof. **Pinna apex:** generally, acute to acuminate; sometimes subacute. **Pinna base:** oblique and concomitantly cuneate or both cuneate and sessile. **Petiole:** present. **Stipules:** absent.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector: one leaf per node (100% of 25, 25, and 13 cases of node nos. 1, 2, and 3, respectively).

Trichomes. Cotyledons. Lamina: essentially glabrous, non-ciliate. Petiole: sparsely pubescent. **Basal stem sector:** with moderately to densely concentrated, sharp-tipped hairs which are transparent or faintly yellow, generally 0.05 to 0.3 mm long, curved, and mostly spreading. **Distal stem sector:** with comparable hairs. **Foliage leaves of node nos. 1–3 of distal stem sector.** Lamina: the pinnae are essentially glabrous except for moderately concentrated hairs like those described above, which are situated basally on the midrib and on the petiolule, Petiole: with moderately to densely concentrated hairs like those described above, which are sometimes conspicuously antrorse.

Dates of collection and collection numbers of examined specimens.
34552, 16 Feb 2013.

Sapindus saponaria L.; **Sapindaceae**
Soapberry. Native
no. specimens studied: 7

Adult morphology
Tree with alternate, once-pinnately compound foliage leaves.

Seedling morphology (Fig. 23).

Fruit type: a schizocarp with drupe-like mericarps (Wunderlin et al. 2017). Fruits collected intact on living branches were studied in addition to those associated with seedlings. The intact fruits exhibited two to four lobe-like mericarps apiece, the mature mericarps being essentially globose (Wilder & McCombs 28917).

Wall of mericarp after germination. Individual seedlings either were accompanied by a globose mericarp or lacked mericarp remnant(s). The outer soft layer of pericarp is sometimes missing, having split away from the underlying endocarp. When intact, the soft layer is black and manifests numerous anastomosing, elevated ridges (veins?) not evident on the non-abscinded fruits. The endocarp is relatively persistent, smooth, brownish black, moderately thick, and extremely hard (virtually impervious to a fresh razor blade). It is open at one end, where short longitudinal splits converge from other portions of the endocarp. The pericarp and presumed seed coat enclose the cotyledonary laminae and parts of, or the entire, cotyledonary petioles. The cotyledonary petioles suspend the seedling stem and primary root immediately to the outside of the opening in the pericarp. **Dimensions of endocarp after germination:** 10.5–12 mm × 10–11.5 mm (n = 3 [each parameter]).

Presumed seed coat after germination: chartaceous, light brown, and appressed to the inner surface of the pericarp.

Cotyledons. Number of cotyledons: 2 (n = 4 seedlings). **Lamina:** thickened but also somewhat flattened parallel to the adaxial/abaxial surfaces. **Lamina surface:** tightly adherent to the presumed seed coat; with large, irregularly curved ridges; yellow. **Petiole length:** 6 mm (n = 2). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 65–133 mm (n = 6).

Leaf types situated distal to the cotyledons. Basal stem sector: with early-caducous, narrow scale leaves (at least 3 on one seedling). Once foliage leaves have expanded on the distal stem sector the scale leaves of the basal sector appear stramineous or white basally and green distally. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** a short, narrow, green transitional leaf followed by two green foliage leaves.

Scale leaves of basal stem sector. Length: 2–5.5 mm (n = 6). **Phyllotaxy:** one leaf per node (n = 9 nodes). The leaves alternate. **Stipules:** absent.

Foliage leaves. Lamina. Shape: At node no. 1: simple and undivided (n = 100% of 3 leaves). At node no. 2: simple and undivided or simple and divided into 3 segments (n = 80% and 20% of 5 leaves, respectively). At node no. 3: simple and undivided (n = 100% of 5 leaves). The simple, undivided laminae are oblanceolate, oblanceolate-obovate, narrowly elliptic, or narrowly elliptic-lanceolate. **Lamina margins:** entire. **Lamina apex:** acuminate, acute, or rounded; sometimes simultaneously mucronulate. **Lamina base:** cuneate; narrowly cuneate. **Petiole:** mostly present and short but the leaf sometimes sessile. **Stipules:** absent.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector: one leaf per node (100% of 6, 6 and 6 cases of node nos. 1, 2, and 3, respectively). Phyllotaxy was alternate (excluding some cases of node nos. 3 and 4, which were subopposite).

Trichomes. Cotyledons. Lamina: mostly glabrous but with very localized, small, transparent hairs; non-ciliate. Petiole: glabrous. **Basal stem sector:** glabrous basally, pubescent distally with moderately concentrated hairs which are sharp-tipped, transparent or white, generally between 0.2 and 0.5 mm long, slightly curved to uncinate, and mainly appressed and antrorse. **Distal stem sector:** with moderately to densely concentrated, comparable hairs. **Foliage leaves of node nos. 1–3 of distal stem sector:** with comparable hairs. Lamina: glabrous to sparsely pubescent with hairs on/primarily on the midrib. Petiole: sparsely to moderately pubescent.

Dates of collection and collection numbers of examined specimens.
31656, 21 Aug 2010; 31737, 31739, 25 Sep 2010.

Sideroxylon foetidissimum Jacq. (*Mastichodendron foetidissimum* [Jacq.] H.J. Lam.); **Sapotaceae**
False Mastic. Native
no. specimens studied: 24

Adult morphology
Tree with alternate, simple foliage leaves.

Seedling morphology (Figs. 24, 24A).

Germination is intermediate between epigeal and hypogeal (see p. 492 herein).

Fruit type: a four-to-six carpellate, one-seeded berry (Tomlinson 2001; Wunderlin et al. 2018).

Pericarp after germination: absent (apparently rotted away).

Seed coat after germination: moderately thin, hard, smooth, and brown. The seed coat is unusual among those of presently studied species, by being carried aboveground on top of, and by simultaneously enclosing, the apical portion of the elongating stem. Except for the apical portion, the entire stem-primary root axis protrudes from the center of a large, single slit which partially encircles the seed coat. (Fig. 24A). **Dimensions of seed coat after germination:** 12–13 mm × 10–12 mm (n = 5 [each parameter]).

Cotyledons: absent from studied specimens (even on a young seedling on which a portion of lower stem sector only 12 mm long was visible outside the seed coat). Cotyledon scars occur 13 to 20 mm aboveground (the length of the apparent hypocotyl; n = 6; see above). The cotyledons are clearly ephemeral, thereby resembling those of *Sideroxylon salicifolium* (a congener having epigeal germination [Wilder in press]).

Length of basal stem sector: 62–96.5 mm (n = 11).

Leaf types situated distal to the cotyledons. Basal stem sector: with narrow scale leaves (at least four on one seedling). Once foliage leaves have expanded on the distal stem sector the individual scale leaves of the basal sector appear either green or green plus brown or purple. **Distal stem sector:** with green foliage leaves.

Scale leaves of basal stem sector. Length: 1.4–4.5 mm (n = 16). **Phyllotaxy:** one leaf per node (n = 100% of 18 nodes). The leaves alternate. **Stipules:** absent.

Foliage leaves. Lamina. Shape: simple and unlobed; generally, more-or-less narrowly elliptic to elliptic, sometimes oblanceolate-obovate to obovate. **Lamina margins:** entire. **Lamina apex:** generally, acute or acuminate to narrowly rounded; sometimes retuse. **Lamina base:** cuneate. **Petiole:** present. **Stipules:** absent.

Phyllotaxy of the leaves at node nos. 1–3 of the distal stem sector: one leaf per node (100% of 11, 11, and 4 cases of node nos. 1, 2, and 3, respectively).

Trichomes. Cotyledons: unavailable for study. **Basal stem sector:** commonly essentially glabrous basally and becoming increasingly pubescent progressing distally, with a combination of T-shaped hairs and unbranched hairs; the two branches of a T-shaped hair generally being **a.** appressed, **b.** antrorse and retrorse, respectively, on the stem long axis, and **c.** sharp tipped. Each T-shaped hair is transparent, brown-tinged, or dark brown. **Distal stem sector:** with sparsely to densely concentrated, comparable hairs; the hairs composing a dense, brown mat over the terminal bud. **Foliage leaves of node nos. 1–2 of distal stem sector:** with comparable hairs. Lamina: glabrous/essentially glabrous except for the midrib which varies from essentially glabrous to moderately pubescent. Petiole: moderately pubescent.

Additional information. On seedlings the primary root develops into a taproot.

Dates of collection and collection numbers of examined specimens.
30421, 24 Aug 2009.

Sideroxylon tenax L.; **Sapotaceae**
Tough Bully. Native
no. specimens studied: 6

Adult morphology
Tree or shrub with alternate, simple foliage leaves.

Seedling morphology (Fig. 25).

Fruit type: a five-carpellate berry (Wunderlin et al. 2018).

Pericarp after germination: absent (apparently rotted away).

Seed coat after germination: thin, hard, smooth, dull brown, and having a broad, basal abscission scar (hilum) with circular outline. One to several short to long, irregular, more-or-less longitudinal splits converge to an opening situated near the abscission scar. The cotyledonary laminae and the distal portions of the cotyledonary petioles remain to the inside of the seed coat, whereas the rest of the cotyledonary petioles, the seedling stem, and primary root are suspended to the outside of the opening. **Dimensions of seed coat after germination:** 8.5–11 mm × 7 mm (n = 3 [each parameter]).

Cotyledons. The two cotyledonary petioles are almost completely distinct but become connate immediately basal to their junction with the connate cotyledonary laminae. The cotyledonary laminae, collectively, appear ca. terete for most of their lengths. The connate laminae terminate basally in a short, basally directed, hollow-cylindrical, pipelike extension. The cotyledonary petioles extend through the space within that extension, basal to their junction with the connate laminae. The cotyledon pair is peltate. **Number of cotyledons:** 2 (n = 6 seedlings). **Lamina:** see description of cotyledons, above. **Lamina surface:** coarsely wrinkled (with folds reminiscent of those of the human brain) and sometimes tightly adherent to a surrounding, brown, chartaceous layer. Two cotyledon pairs exhibited the following coloration. Pair no. 1: entirely white. Pair no. 2: mostly dull black, but partly stramineous or white (including the whole basal extension). **Petiole length:** 2.5 mm (n = 2). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 18.5–33 mm (n = 2).

Leaf types situated distal to the cotyledons. Basal stem sector: with scale leaves (at least four on one seedling). Once foliage leaves have expanded on the distal stem sector the individual scale leaves of the basal sector appear more-or-less brown or yellow-brown. **Distal stem sector:** with green foliage leaves.

Scale leaves of basal stem sector. Length: 0.4–1.5 mm (n = 7). **Phyllotaxy:** one or two leaves per node (n = 88% and 12% of 17 nodes, respectively). When the nodes are single-leaved, the leaves are alternate. **Stipules:** absent.

Foliage leaves. Lamina. Shape: simple and unlobed; obovate, widely elliptic, widely ovate; **Lamina margins:** entire. **Lamina apex:** acute, rounded, or retuse. **Lamina base:** cuneate. **Petiole:** short. **Stipules:** absent.

Phyllotaxy of leaves at node nos. 1–3 of the distal stem sector: one leaf per node (100% of 2, 2, and 2 cases of node nos. 1, 2, and 3, respectively).

Trichomes. Cotyledons. Lamina: glabrous, non-ciliate. Petiole: glabrous. **Basal stem sector:** either essentially glabrous overall or glabrous basally; in the latter case with T-shaped hairs distally. The two branches of a T-shaped hair are generally **a.** appressed, **b.** antrorse and retrorse, respectively, on the stem long axis, and **c.** sharp tipped. Each T-shaped hair is transparent, brown-tinged, or dark brown. **Distal stem sector:** essentially glabrous or with moderately concentrated, comparable hairs. **Foliage leaves of node nos. 1–3 of distal stem sector:** with comparable hairs. Lamina: glabrous/essentially glabrous to sparsely pubescent. Petiole: sparsely to moderately pubescent.

Additional information. On their basal and distal stem sectors some seedlings exhibit minute, multicellular, mound-shaped papillae, which may be densely concentrated.

Dates of collection and collection numbers of examined specimens.
41478, 4 Oct 2018.

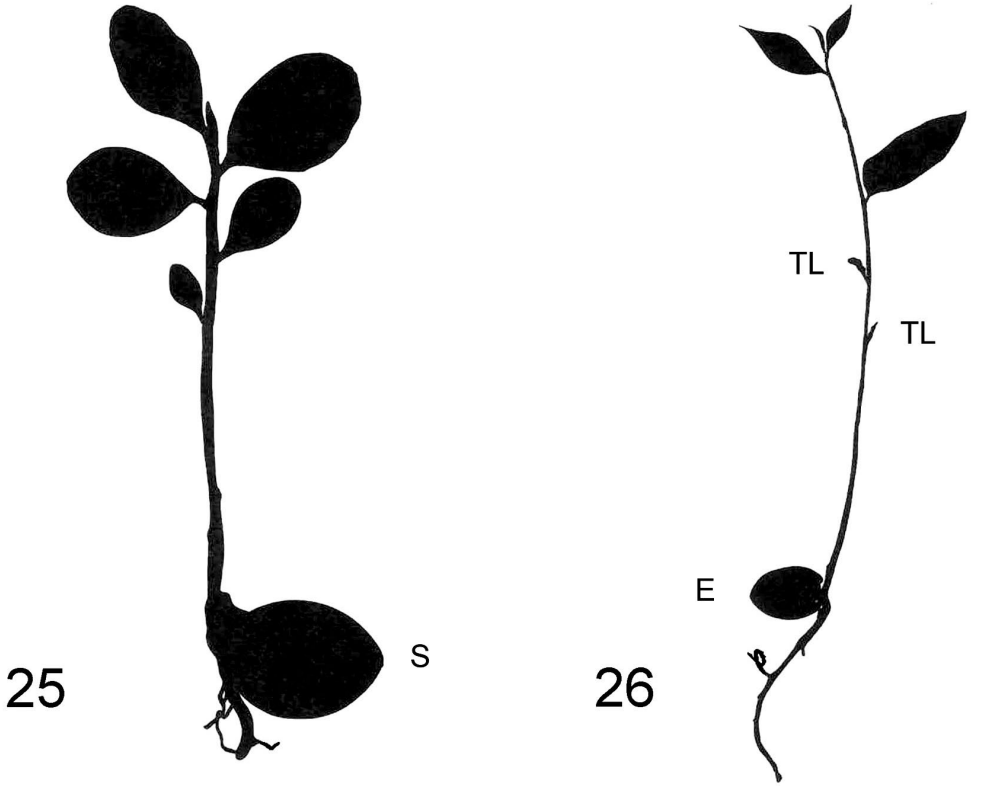

Fig. 25. *Sideroxylon tenax*. Sapling. × 1.5. **Fig. 26.** *Ximenia americana*. Sapling. × 0.38. **E.** Endocarp. **S.** Seed coat. **TL.** Transitional leaf.

Ximenia americana L.; **Ximeniaceae**
Hog Plum. Native
no. specimens studied: 10

Adult morphology
Tree or shrub with alternate, simple leaves.

Seedling morphology (Fig. 26).

Fruit type: a four-carpellate, one-seeded drupe (Wunderlin et al. 2017).

Pericarp after germination: Solely, or virtually solely endocarp remains, this being ellipsoidal, relatively persistent (Fig. 28), moderately thick and hard, and exhibiting a smooth, generally brown outer surface. More-or-less longitudinally oriented splits, none long as the endocarp, converge and define an opening at one end of the endocarp. Too, a portion of endocarp may break away, enlarging that opening. The cotyledonary petioles and laminae are hidden/largely hidden to the inside of the endocarp; the cotyledonary petioles suspend the seedling stem and primary root along the outer surface of the endocarp. **Dimensions of endocarp after germination:** 18–22 mm × 12.5–16 mm (n = 7 and 6, respectively).

Presumed seed coat after germination: dull brown, chartaceous, easily fragmenting, adherent to the inner surface of the endocarp and sometimes to the cotyledonary laminae.

Cotyledons. The two cotyledonary petioles are distinct from their bases almost to their distal ends, where they are connate. The cotyledonary laminae are connate and, jointly, terminate basally in a basally directed, hollow-cylindrical, pipelike extension. The cotyledonary petioles extend through the space within that extension, basal to their junction with the connate laminae. The cotyledon pair is peltate. **Number of cotyledons:** 2 (n = 9 seedlings). Sometimes a basally situated scale leaf of the basal stem

sector grows downward between the cotyledonary petioles, then being mis-construable as a third cotyledon. **Connate laminae:** thickened, yet somewhat flattened (perhaps because of ageing and shrinkage). **Lamina surface:** replete with minute, curved ridges; brown or purple-brown; sometimes also with interspersed yellow color; the pipelike extension may be partly white. **Petiole length:** 6 mm (n =2). **Flattening/orientations of the paired cotyledonary petioles:** each petiole is flattened parallel to the associated stem surface. The petioles extend ca. laterally (rather than abaxially) and in parallel away from the cotyledonary node; thereby the adaxial surface of each petiole clasps the stem. **Stipules:** not recognized.

Length of basal stem sector: 67–146 mm (n = 5).

Leaf types situated distal to the cotyledons. Basal stem sector: with persistent scale leaves (eight on one seedling). Once foliage leaves have expanded on the distal stem sector the individual scale leaves of the basal sector appear black and brown, tan, or green. **Distal stem sector:** either with **a.** solely green foliage leaves, or **b.** two green transitional leaves followed by a green foliage leaf.

Scale leaves of basal stem sector. Length: 1.0–7.1 mm (n = 12). **Phyllotaxy:** one or two leaves per node (n = 97% and 3% of 32 nodes, respectively). When the nodes are single-leaved, the leaves are alternate. **Stipules:** absent.

Foliage leaves. Lamina. Shape: simple and unlobed; narrowly elliptic-elliptic, lanceolate, lanceolate-ovate. **Lamina margins:** entire. **Lamina apex:** acuminate, acute, sometimes rounded; simultaneously mucronate to apiculate. **Lamina base:** cuneate. **Petiole:** present, sometimes very short. **Stipules:** absent.

Phyllotaxy of leaves at node nos. 1–3 of the distal stem sector: one leaf per node (100% of 5, 5, and 5 cases of node nos. 1 to 3, respectively).

Trichomes. Cotyledons. Lamina: pubescence not determinable. Petiole: glabrous. **Basal stem sector:** glabrous. **Distal stem sector:** glabrous. **Foliage leaves of node nos. 1–3 of distal stem sector:** Lamina: glabrous. Petiole: glabrous.

Dates of collection and collection numbers of examined specimens.
25269, 25270, 17 May 2006; 26541, 27 Mar 2007; 29163, 27 Oct 2008.

SUMMARY AND DISCUSSION

DIASPORES

Diaspores merit attention in species with hypogeal germination because they persist temporarily during seedling/sapling development, enclosing and protecting the cotyledons and sometimes more of the seedling. Too, diaspores facilitate seedling identification.

Species with hypogeal germination, collectively, produce diverse kinds of diaspores. Presently studied diaspores included whole fruits (*Chrysobalanus icaco*, *Dalbergia ecastaphyllum*, *Damburneya coriacea*, *Eugenia confusa*, *Eugenia foetida*, *Exothea paniculata*, *Myrcianthes fragrans*, *Persea palustris, Quercus laurifolia*, *Quercus myrtifolia*, *Quercus virginiana*, *Sideroxylon tenax*, *Ximenia americana*, *Sophora tomentosa*, and *Syzygium cumini*), mericarps (*Hippocratea volubilis* and *Sapindus saponaria*), and abscinded seeds (*Cupaniopsis anacardioides*, *Erythrina herbacea*, *Guilandina bonduc*, *Pithecellobium unguis-cati*, and *Swietenia mahagoni*).

The fruit types were themselves diverse, including berries (*Eugenia confusa*, *Eugenia foetida*, *Exothea paniculata, Myrcianthes fragrans*, *Sideroxylon tenax*, and *Syzygium cumini*), capsules (*Cupaniopsis anacardioides* and *Swietenia mahagoni*), drupes (*Chrysobalanus icaco*, *Damburneya coriacea*, *Persea palustris*, *Reynosia septentrionalis*, and *Ximenia americana*), dehiscent and indehiscent legumes (*Dalbergia ecastaphyllum*, *Erythrina herbacea*, *Guilandina bonduc*, *Pithecellobium unguis-cati*, and *Sophora tomentosa*), nuts ([acorns] *Quercus laurifolia*, *Quercus myrtifolia*, and *Quercus virginiana*), and schizocarps (*Hippocratea volubilis* and *Sapindus saponaria*).

Previous workers have disagreed about the kind of fruits present in *Damburneya coriacea*, *Persea palustris*, and other species of Lauraceae. Herein, I follow Van der Werff (1997a, 1997b) and Wofford (1997) in attributing drupes to the first two species; however, fruits of the Lauraceae are sometimes called berries (e.g., by Wunderlin & Hansen 2015) because, according to Little et al. (2009), their endocarps are solely a thin

Fig. 27. Herbarium sheet with multiple specimens of *Exothea paniculata*. Seedlings and a sapling (upper left) with attached seed coats. Circular spacers are affixed to the herbarium sheet (see p. 452, herein). Photography by Jay Staton.

Fig. 28. Herbarium sheet with multiple specimens of *Ximenia americana*. Three saplings. The sapling at left exhibits the intact, remaining portion of diaspore (endocarp); the middle sapling has the endocarp and cotyledons almost entirely removed; on the right sapling the endocarp has been removed, exposing the cotyledons. Photography by Jay Staton.

monolayer of sclerenchymatous cells. I examined dried fruits from herbarium specimens of mature individuals of *D. coriacea* and *Persea palustris*. Their pericarps included a soft outer portion and, apparently, an endocarp. A chartaceous layer which I interpreted, at least partly, as seed coat was tightly appressed against the inner surface of the apparent endocarp.

Diaspores after germination

Consider whole fruits. In four presently studied species, after germination all pericarp layers remain essentially intact (*Dalbergia ecastaphyllum*, *Quercus laurifolia*, *Quercus myrtifolia, Quercus virginiana)*; however, in most species with drupes the outer fleshy portion of the pericarp becomes degraded or disappears. Thus, largely/solely endocarp persists (*Chrysobalanus icaco*, *Damburneya coriacea*, *Persea palustris*, *Ximenia americana*). In *Sapindus saponaria*, which produces drupe-like mericarps, the soft outer sector of the pericarp may disappear, leaving behind endocarp. In species with berries the pericarp becomes degraded or disappears entirely, leaving behind the more persistent seed coat (*Eugenia confusa*, *Eugenia foetida*, *Exothea paniculata*, *Myrcianthes fragrans*, *Sideroxylon tenax*, and *Syzygium cumini*).

During germination, the hard, outermost remaining portion of a diaspore becomes split/ruptured, often yielding one or, less often, two common opening(s) therein. In certain species the outermost portion develops relatively long splits which converge to a common opening. Examples include the whole pericarp of *Quercus laurifolia*, the endocarp of *Ximenia americana*, and the seed coat of *Guilandina bonduc*. However, in *Eugenia confusa*, *Eugenia foetida*, and *Mrycianthes fragrans*, in which the seed coat is outermost, only a small rupture develops at one point therein. Whether an opening is large or small, the cotyledonary petioles extend therethrough, suspending the seedling axis to the outside of the diaspore (e.g., *Cupaniopsis anacardioides*, *Quercus myrtifolia*, *Sapindus saponaria*, and *Sideroxylon tenax*; Fig. 2). In *Quercus virginiana,* the cotyledonary petioles become unusually long, positioning the seedling axis remote from the pericarp (see below; Fig. 12).

I speculate that two reasons account for why certain diaspores form convergent splits. First, the outer intact layers of such diaspores likely manifest parallel longitudinal cell files, and the splits likely form in-parallel along the cell files. Second, the presumed cell files, and hence the splits, likely converge and culminate at a rounded end of the diaspore. To envision that circumstance, imagine as splits the lines of longitude on the surface of a globe and how those lines – which begin in parallel at the equator—necessarily converge at the poles.

Three species are atypical. At least commonly therein the seedling stem and primary root each grow outward through a separate point within the pericarp (*Dalbergia ecastaphyllum*, *Syzygium cumini*) or seed coat (*Hippocratea volubilis*).

The findings, aforementioned, suggest that seedlings with hypogeal germination utilize either of two kinds of growth to expand through the diaspore wall: **a.** intercalary growth of the cotyledonary petioles (in species in which the mature petioles extend through a common opening within the wall), and **b.** apical growth of the seedling stem and primary root (in species in which those organs penetrate the wall separately at two points).

In *Chrysobalanus icaco* the diaspore is a drupe. The endocarp—the sole layer of the pericarp which persists after germination—splits along predetermined lines (i.e., the major veins), yielding a large common opening at one end of the endocarp (Fig. 4). The cotyledonary petioles suspend the basal ends of the seedling stem and primary root within that opening. Splitting occurs after the fruit is abscinded from its parent tree. Because it splits along predetermined lines, the fruit qualifies as a dehiscent drupe. This is significant because drupes overall are considered indehiscent (Judd et al. 2008) or "usually indehiscent" (Lawrence 1955; Swartz 1971).

COTYLEDONS

I observed intact cotyledons in 22 of the 24 presently considered species (i.e., all species but *Reynosia septentrionalis* and *Sideroxylon foetidissimum*). Except for *Syzygium cumini* the seedlings of all 22 species exhibited solely two cotyledons. Those of *S. cumini* had either two or three cotyledons.

Distinct vs. connate cotyledons

It was sometimes difficult to judge whether the cotyledons of a pair were distinct but tightly appressed and difficult to pry apart (as may occur in *Quercus laurifolia*) or connate. Perhaps, if cotyledonary connation is post-genital (see below) certain seedlings, collectively, would constitute a continuum between those conditions.

Ten (45%) of the 22 species exhibited partly or entirely connate cotyledons: *Damburneya coriacea*, *Eugenia foetida*, *Guilandina bonduc*, *Hippocratea volubilis*, *Myrcianthes fragrans*, *Pithecellobium unguis-cati*, *Quercus virginiana*, *Sideroxylon tenax, Swietenia mahagoni,* and *Ximenia americana*. The ten species represented eight families of dicotyledons: Celastraceae, Fabaceae, Fagaceae, Lauraceae, Meliaceae, Myrtaceae, Sapotaceae, and Ximeniaceae. I identified connation by examining cotyledons in surface view and, for some species, by also viewing thick cross sections thereof at 50×. Also, for *Guilandina bonduc* I assessed the cotyledons as being connate, partly by attempting and failing to separate the paired cotyledonary laminae with a razor blade.

The species with connate cotyledons compose three groups. **Group 1.** A cotyledon pair has connate laminae but distinct petioles (*Damburneya coriacea*, *Guilandina bonduc*, *Hippocratea volubilis*, *Pithecellobium unguis-cati*, and *Swietenia mahagoni*). **Group 2.** A cotyledon pair exhibits connate laminae and partly connate petioles (*Quercus virginiana*, *Sideroxylon tenax*, and *Ximenia americana*). In *S. tenax* and *X. americana* the petioles are distinct from their bases almost to their distal ends, where they are connate. In *Q. virginiana* the basal portions of two associated petioles are likewise distinct, but considerably more of their distal portions are connate (Fig. 12). **Group 3.** The paired cotyledonary laminae and petioles are completely connate (*Eugenia foetida* and *Myrcianthes fragrans*). Thus, the connate petioles manifest solely one, rather than two, line(s) of insertion at the cotyledonary node. In *Eugenia foetida*, at/by the junction between the connate laminae and the common petiole there exists a ca. semi-circular, ligule-like ridge which parallels the adjacent stem surface and which, at its midpoint, extends perpendicular to the long axis of the connate cotyledons.

The considerable percentage of presently studied species with connate cotyledons begs the question of how many dicotyledonous species, overall, manifest connate cotyledons. De Vogel (1980) stated that connate cotyledonary petioles are "…extremely rare in woody plants." Drawing from previous literature, he indicated connate cotyledonary petioles in three species of *Combretum* and in *Quercus semecarpifolia*. He also characterized connate cotyledonary petioles as "rare" in temperate herbaceous plants, citing the following examples thereof from previous literature: Apiaceae (in *Bunium*, *Chaerophyllum*, *Ferulago*, *Prangos*, and *Smyrnium*), Cucurbitaceae (*Marah),* Polygonaceae (*Polygonum*), Primulaceae (*Dodecatheon*), Ranunculaceae (*Aconitum*, *Anemone*, *Clematis*, *Delphinium,* and *Eranthis*), and Asteraceae (*Serratula*). He added that "enclosed cotyledons" (i.e., cotyledons remaining within the seed coat and/or pericarp) are normally not connate, but that partial to entire fusion has been recorded in the Anacardiaceae (in *Gluta*), Fagaceae (*Lithocarpus*), Lauraceae (*Eusideroxylon*), and Myrtaceae (*Eugenia*).

Clearly, de Vogel's (1980) account contrasts with the current report of connation in almost half of the 22 presently considered species; however, his citation of connation in certain species of *Quercus* and *Eugenia* corresponds with the present report of connation in *Quercus virginiana* and *Eugenia foetida*.

Present findings raise four additional questions. **1.** Are connate cotyledons advantageous? One possible answer is that connation serves to fit maximal biomass within the limited space of the seed. Too, by yielding reduced surface area, after germination connation would: **a.** slow desiccation of the cotyledons, and **b.** better protect the cotyledons from minute herbivores (e.g., insects and nematodes) and agents of decay (fungi). **2.** Might connate cotyledons, overall, have evolved by parallel/convergent evolution? Supporting one or both possibilities are the present findings of connate and distinct cotyledons: **a.** in different genera of the same family (Fabaceae; *Guilandina bonduc* [cotyledons connate] vs. *Erythrina herbacea* [cotyledons distinct]), and **b.** in different species of the same genus (e.g., *Eugenia foetida* [cotyledons connate] vs. *Eugenia confusa* [cotyledons distinct]; *Quercus virginiana* [cotyledons connate] vs. *Quercus laurifolia* and *Quercus myrtifolia* [cotyledons distinct]). As well, de Vogel (1980) stated that connate and non-connate cotyledonary petioles both occur in each of the following additional genera: *Aconitum*, *Anemone*, *Bunium*, *Chaerophyllum*, *Clematis*, *Delphinium*,

Dodecatheon, *Ferulago*, *Polygonum*, *Prangos*, and *Serratula*. **3.** Does connation derive from congenital and/or post-genital fusion of cotyledons (i.e., are the cotyledons, or portions thereof, connate from the outset or are they initially distinct and become connate by appression later)? **4.** If post-genital fusion occurs, is it delayed until or after germination? Developmental study could answer the last two questions.

Because cotyledonary connation defines a considerable percentage of the presently examined species with hypogeal germination, it is striking that Wilder and Relish (2022) observed solely distinct cotyledons in all 70 species of dicotyledons with epigeal germination which they examined.

Peltate cotyledons

Dicotyledons, overall, produce two types of peltate leaves: hypo-peltate leaves and epi-peltate leaves. In those two leaf-types the petiole is inserted upon the adaxial surface of, and upon the abaxial surface of the lamina, respectively (Goebel 1932). For cotyledons I apply the terms "peltate" and "hypo-peltate" both where the cotyledonary laminae are distinct and where they are connate. Depending on the species, either two distinct cotyledonary petioles or one common cotyledonary petiole may attach in peltate fashion to a pair of connate cotyledonary laminae.

Eight (36%) of the 22 species having cotyledons available for study exhibited peltate cotyledons. Five species manifested hypo-peltate cotyledons (*Quercus laurifolia*, *Quercus myrtifolia*, *Persea palustris*, *Swietenia mahagoni*, and *Syzygium cumini*), whereas I could not ascertain whether the cotyledons of three species were hypo-peltate or epi-peltate (*Quercus virginiana, Sideroxylon tenax* and *Ximenia americana*). In four species the cotyledons were simultaneously peltate and connate (*Q. virginiana*, *S. mahagoni*, *S. tenax*, and *X. americana*). All three presently considered *Quercus* species had the distal portions of their cotyledonary petioles oriented parallel, rather than perpendicular, to their associated cotyledonary laminae, whether the cotyledons were distinct (*Q. laurifolia, Q. myrtifolia*) or partially connate (*Q. virginiana*).

Noteworthy, is that that all eight presently studied species with peltate cotyledons exhibited non-peltate adult leaves. Striking, too, is that Wilder and Relish (2022) observed solely non-peltate cotyledons in 70 species of dicotyledons with epigeal germination. Possibly, peltate cotyledons represent yet another accommodation for limited space to the inside of the seed coat. De Vogel (1980), who classified seedlings into 16 types and additional subtypes, reported peltate cotyledons in *Dysoxylum* (Meliaceae) and "… usually peltate food-storing cotyledons…" in species composing his *Endertia* type and *Cynometra ramiflora* types.

Basally directed lobes/extensions of cotyledonary laminae

The distinct or connate cotyledonary laminae of ten species may exhibit one or more basal, basally directed lobes/extensions (*Dalbergia ecastaphyllum*, *Erythrina herbacea*, *Guilandina bonduc*, *Pithecellobium unguis-cati*, *Quercus laurifolia*, *Quercus myrtifolia*, *Quercus virginiana*, *Sophora tomentosa*, *Sideroxylon tenax, Ximenia americana*). The lobes are rounded (in some laminae of *S. tomentosa*) or sharp-tipped (e.g., in *Q. laurifolia*). In the latter species the lamina may be sagittate (with one lobe to each side of the lamina base) or manifest three basal lobes (appearing sagittate but with an additional, medial, basally directed basal lobe). In *G. bonduc* the paired, connate laminae may jointly exhibit two or three basally directed, basal extensions which, collectively, have a pipelike configuration and enclose the distal portions of the two cotyledonary petioles. *Sideroxylon tenax* and *X. americana* are similar, except that the paired connate laminae jointly manifest one basal, basally directed, hollow, cylindrical, pipelike extension which likewise encloses both cotyledonary petioles. In *Syzygium cumini,* the cotyledonary laminae are sometimes deeply lobed.

Thickness of cotyledonary laminae

The laminae of a cotyledon pair vary considerably in thickness. They are thin, either individually (in *Dalbergia ecastaphyllum* [where they are distinct]) or collectively (in *Hippocratea volubilis* and *Swietenia mahagoni* [where they are connate]). In those three species the cotyledonary laminae are flattened parallel to the same plane as are the pericarp and/or seed coat. In contrast, in other species the cotyledonary laminae are much thickened (sometimes being more-or-less terete), either individually (e.g., in *Quercus laurifolia*, *Quercus myrtifolia*, *Syzygium cumini* [where they are distinct]) or collectively (e.g., in *Eugenia foetida*, *Quercus*

virginiana, *Sideroxylon tenax* [where they are connate]). However, I concomitantly observed in various species with thickened cotyledonary laminae that the individual distinct laminae or the paired connate laminae, jointly, are more-or-less compressed dorsiventrally. As expected, with relatively few exceptions the presently studied species have thicker cotyledonary laminae than do most of the previously studied species with epigeal germination (Wilder & Relish 2022).

Surficial characteristics of cotyledonary laminae

Although smooth in *Hippocratea volubilis,* the cotyledonary surfaces of most presently studied species are roughened. Commonly, they are replete with minute, densely arranged projections which vary in shape according to species, e.g., being irregularly curved ridges and/or tubercles (e.g., *Chrysobalanus icaco*, *Cupaniopsis anacardioides*, *Damburneya coriacea*, *Erythrina herbacea*, *Eugenia confusa*, *Eugenia foetida*, *Exothea paniculata*, *Myrcianthes fragrans*, *Persea palustris*, *Pithecellobium unguis-cati*, *Sophora tomentosa*, *Syzygium cumini*, and *Ximenia americana*). In certain species, collectively, the cotyledons manifest broad ridges, sometimes together with minute projections (*Guilandina bonduc*, *Quercus laurifolia*, *Quercus myrtifolia*, *Quercus virginiana*, and *Sapindus saponaria*). The cotyledons of *Sideroxylon tenax* appear coarsely wrinkled, recalling the surface of the human brain.

Most presently studied species exhibit non-green cotyledons, but the cotyledons are olive-colored in *Eugenia foetida* and *Myrcianthes fragrans* or flecked with green and brown in *Swietenia mahagoni*. Depending on the species the cotyledons are either cream-colored (*Hippocratea volubilis*), yellow or stramineous (*Sapindus saponaria* and *Pithecellobium unguis-cati*, respectively), purple or with purple and brown variously combined (e.g., *Guilandina bonduc*, *Quercus myrtifolia*, *Syzygium cumini*), or black (e.g., *Damburneya coriacea*). In *Sideroxylon tenax*, different seedlings exhibited either white or mostly dull-black cotyledons, suggesting that in *S. tenax* (and possibly other species) the cotyledons might change color with age.

In *Swietenia mahagoni* a dense, farinaceous layer of numerous, white, partially contiguous, minute particles adheres to the external surface of the connate cotyledons. Also, in *Eugenia foetida* and sometimes *Persea palustris* the cotyledonary lamina is covered by many minute, thin, transparent fragments (shed cuticle) which in *E. foetida* exhibit cellular outlines.

Cotyledonary petioles

Cotyledons were petiolate in all 22 presently considered species for which cotyledons were available for study. Those species are divisible into three groups, based on the lengths of their cotyledonary petioles. **Group 1** (eight species). The petioles are 1 mm or less long (e g , *Chrysobalanus icaco*, *Dalbergia ecastaphyllum*, *Eugenia confusa*, and *Eugenia foetida*). **Group 2** (thirteen species). In these species, collectively, the petioles exceed 1 mm long and range to 8 mm long (e.g., *Guilandina bonduc*, *Quercus laurifolia*, *Exothea paniculata,* and *Sapindus saponaria*). **Group 3** *Quercus virginiana*, the sole species of this group, manifests long petioles measuring from 17.5 to 40 mm long.

I observed two suites of characters among the species having distinct/basally distinct cotyledonary petioles. **Suite a.** For each pair of cotyledons, slightly distal to their levels of insertion on the seedling stem the cotyledonary petioles diverge ca. laterally (rather than abaxially) and in parallel from the cotyledonary node (Fig. 2, C); thereby, basally the adaxial surface of each cotyledonary petiole clasps the seedling stem. Too, the adaxial surfaces of the cotyledonary laminae face each other. **Suite b.** The cotyledonary petioles diverge from the cotyledonary node in opposite or different directions and do not clasp the cotyledonary node. Too, the cotyledonary laminae are situated opposite/across from, rather than facing, each other.

A considerable majority (17) of the presently studied species exhibits/commonly exhibits Suite a of characteristics (*Chrysobalanus icaco*, *Cupaniopsis anacardioides*, *Dalbergia ecastaphyllum*, *Damburneya coriacea, Erythrina herbacea*, *Eugenia confusa*, *Exothea paniculata, Guilandina bonduc, Hippocratea volubilis*, *Pithecellobium unguis-cati*, *Quercus laurifolia, Quercus myrtifolia, Sapindus saponaria, Sideroxylon tenax, Sophora tomentosa*, *Swietenia mahagoni*, and *Ximenia americana*), whereas solely *Syzygium cumini* clearly represents Suite b. Available material of *Persea palustris* was damaged, precluding knowledge of that species. In *Quercus virginiana* each cotyledonary petiole is flattened parallel to the associated stem surface, but the bases

of the cotyledonary petioles generally extend acropetally and in parallel along the seedling stem (rather than abaxially or laterally). Distally, the (connate) petioles may diverge from the stem (Fig. 12; here the cotyledonary petioles, inserted at the cotyledonary node [CN], do not outwardly appear discrete from the stem basal to their point of divergence).

Based on Wilder and Relish's (2022) study of species of dicotyledons with epigeal germination, those species are generally in strong contrast to the species with Suite a of characteristics, aforementioned. In the species with epigeal germination, except for *Avicennia germinans* (in which the cotyledons sometimes remain folded at maturity[1]), the petioles of a cotyledon pair extend abaxially (rather than laterally) and in opposite directions (rather than in parallel) away from the seedling stem, thereby orienting the cotyledonary laminae remote from (rather than facing) each other (Fig. 1, C; Wilder 2022). The differences between the species with epigeal germination and those manifesting Suite a of characteristics are understandable, given that the cotyledonary laminae of the two groups: **1.** become free of and remain confined within the seed coat and/or pericarp, respectively, and **2.** are photosynthetic and non-photosynthetic, respectively.

Cotyledonary stipules

None was recognized during the present study, in contrast to Wilder and Relish's (2022) report of stipulate cotyledons in 14% of studied species with epigeal germination.

Concluding remarks about cotyledons

The presence of generally thick, non-green cotyledons in most presently studied species accords with conventional understanding that in species with hypogeal germination the cotyledons are either specialized in food storage or haustorial, rather than primarily photosynthetic. The roughened surfaces (and, hence, greater surface areas) prevalent among presently studied cotyledons would facilitate absorption of endosperm within the seed and/or of ambient water during/after germination.

COTYLEDONARY BUDS

In eleven species I inconsistently observed a solitary bud axillary to one or to each member of a pair of cotyledons or cotyledon scars (*Cupaniopsis anacardioides, Dalbergia ecastaphyllum, Exothea paniculata*, *Hippocratea volubilis*, *Pithecellobium unguis-cati*, *Quercus laurifolia*, *Quercus myrtifolia*, *Reynosia septentrionalis, Sideroxylon foetidissimum*, *Sideroxylon tenax*, and *Swietenia mahagoni*). However, it was difficult to locate cotyledonary buds in my dried/glued herbarium specimens, suggesting that they might be more prevalent than presently noted.

On individual seedlings of four species, I observed expanded vegetative branch(es) which had developed from cotyledonary bud(s), apparently after partial death of the main seedling stem (*Quercus laurifolia*, *Swietenia mahagoni*, *Syzygium cumini*, and *Ximenia americana*). Consider *Quercus laurifolia*. On one seedling the main stem had died, except basally; however, it exhibited two cotyledon scars, each scar subtending a separate branch. On another seedling the main stem had likewise died, except basally. Again, there were two cotyledon scars; they subtended an expanded, living branch and an axillary bud, respectively.

HYPOCOTYL

In dicotyledons generally, the hypocotyl and primary root differ from one another primarily according to differences in internal anatomy; thus, it is often difficult/impossible to distinguish between them in surface view (Wilder & Relish 2022). Indeed, the seedlings of ca. half of presently studied species lacked an outwardly apparent hypocotyl–primary root boundary (e.g., *Chrysobalanus icaco*, *Eugenia confusa*, *Myrcianthes fragrans*, *Pithecellobium unguis-cati*, *Swietenia mahagoni*).

However, in certain species persistent root hairs served to locate the hypocotyl-root boundary. On individual seedling axes of *Syzygium cumini*, persistent root hairs extended up to 2 mm from, or even up to, the

[1] Wilder and Relish (2022, pp. 82, 149, 159) stated that the cotyledons of *Avicennia germinans* remain "folded at maturity"; however, on 30 Aug 2022, I found certain seedlings of *A. germinans* growing in water in mangrove swamp, which differed from the seedlings of *A. germinans* characterized by Wilder and Relish (2022). In those newly found seedlings the margins of the outer cotyledons were spread completely apart, thereby exposing the inner cotyledons (*Wilder & McCombs 44111*).

cotyledonary node. In *Ximenia americana* long hairlike outgrowths (possibly, root hairs and/or mycorrhizal hyphae) extended up to 3 mm from, or even up to the cotyledonary node. Also, for the following species, on one or more seedling/sapling axes persistent root hairs extended up to 4 mm (*Hippocratea volubilis*), up to 3.5 mm (*Sapindus saponaria*), and up to 1 mm (*Sideroxylon foetidissimum*) from the cotyledonary node. Thus, among presently studied species the hypocotyl may be very short or even absent. The data above conform with the general understanding that the hypocotyl elongates minimally in species with hypogeal germination.

In certain species, areas presumed to be hypocotyl and primary root differ in color and/or texture from one another. For example, in *Sideroxylon foetidissimum* the apparent hypocotyl is a different shade of brown than, and appears smoother than, the primary root.

BASAL STEM SECTOR

Presently studied species compose three groups based on the maximum lengths of the basal stem sector. For each species listed below, indicated between parentheses is the range of lengths of this sector. **Group 1** [17 species]. The sector is less than 100 mm long (e.g., *Damburneya coriacea* (50–84 mm), *Cupaniopsis anacardioides* (17–66 mm), *Dalbergia ecastaphyllum* (34.5–72 mm), *Eugenia foetida* (23.5–66.5 mm), *Pithecellobium unguis-cati* (6–51 mm), *Quercus myrtifolia* (11.5–65 mm), *Sideroxylon tenax* (18.5–33 mm), *Sophora tomentosa* (10–54 mm), *Swietenia mahagoni* (15–49.5 mm), and *Syzygium cumini* (35.5–65 mm)). **Group 2** [four species]. The sector has a maximum length of 100 to 150 mm (*Exothea paniculata* (65.5–112 mm), *Quercus virginiana* (55.5–112 mm), *Sapindus saponaria* (65–133 mm), and *Ximenia americana* (67–146 mm). **Group 3** [four species]. The maximum length exceeds 150 mm (*Chrysobalanus icaco* (62–161 mm), *Guilandina bonduc* (110–285 mm), *Persea palustris* (69.5–182 mm), and *Quercus laurifolia* (56.5–198.5 mm).

The basal stem sector either **a.** always bears scale leaves (17 species, e.g., *Eugenia foetida*, *Quercus virginiana*, *Reynosia septentrionalis*, and *Ximenia americana*), **b.** bears scale leave(s) either alone or together with depauperate leaves (*Pithecellobium unguis-cati* and *Quercus laurifolia*), **c.** is either leafless or bears scale leaves (*Hippocratea volubilis*), or **d.** lacks leaves entirely (*Cupaniopsis anacardioides*, *Erythrina herbacea*, *Guilandina bonduc,* and *Swietenia mahagoni*).

In certain species the basal stem sector may bear many scale leaves, e.g., *Damburneya coriacea* (13), *Myrcianthes fragrans* (13), *Quercus myrtifolia* (12), *Quercus virginiana* (15), *Reynosia septentrionalis* (9), and *Ximenia americana* (8) (after each species name above, listed between parentheses is the maximum number of scale leaves observed for that species). Those maximum numbers might be understated because scale leaves could have been overlooked on the glued surfaces of the studied herbarium specimens.

In most presently studied species the scale leaves of the basal stem sector are, apparently, dead once the distal stem sector has produced expanded transitional leave(s) and/or foliage leaves. Frequently, they then appear black and/or brown (e.g., in *Chrysobalanus icaco*, *Damburneya coriacea*, *Myricanthes fragrans*, *Persea palustris,* and all presently studied *Quercus* species), but they may be stramineous (*Pithecellobium unguis-cati*) or other colors. In six species some scale leaves exhibit two stem-borne stipules (*Dalbergia ecastaphyllum*, *Hippocratea volubilis*, *Pithecellobium unguis-cati*, and all three *Quercus* species). In *Reynosia septentrionalis*, individual scale leaves are sometimes stipulate, but they then bear solitary (rather than paired) stipules (see below). Also, in certain species the scale leaves or their non-stipular portions are abscinded relatively early (e.g., *P. unguis-cati*).

In ten species adventitious roots may develop basally on the basal stem sector (*Chrysobalanus icaco*, *Eugenia foetida*, *Guilandina bonduc*, *Hippocratea volubilis*, *Myrcianthes fragrans*, *Persea palustris*, *Quercus laurifolia*, *Quercus myrtifolia*, *Quercus virginiana*, and *Sideroxylon tenax*). Depending on the species, they vary from rare (*Quercus myrtifolia*) to more common (*Quercus virginiana*). In *Q. virginiana* one or more such roots were noted on 60% of the seedlings examined (n = 15 seedlings).

DISTAL STEM SECTOR

Species in which the mature plants exhibit simple foliage leaves (17 species)

Those species compose two groups. **Group 1** (12 species). In these species, collectively, the distal stem sector bears either **a.** solely simple foliage leaves, or **b.** one or two transitional leave(s) followed by simple foliage leaves (*Chrysobalanus icaco, Dalbergia ecastaphyllum*, *Damburneya coriacea, Quercus laurifolia*, *Quercus myrtifolia*, *Swietenia mahagoni*, *Eugenia confusa*, *Myrcianthes fragrans*, *Syzygium cumini*, *Sideroxylon foetidissimum*, *Sideroxylon tenax*, and *Ximenia americana*). **Group 2** (five species). In these species the distal stem sector sometimes exhibits scale leave(s) together with simple foliage leave(s) (*Eugenia foetida*, *Hippocratea volubilis*, *Persea palustris, Quercus virginiana*, and *Reynosia septentrionalis*); however, in these species, collectively, the distal stem sector also may bear solely simple foliage leaves or exhibit both transitional leave(s) and simple foliage leaves.

Reynosa septentrionalis is an unusual example of Group 2. On the seedlings/saplings of this species, collectively, the distal stem sector exhibits alternating, superposed zones of green foliage leave(s) and black/brown scale leaves. Generally, within a zone of scale leaves long internodes separate at least some of the leaves/leaf pairs, in contrast to the condensed internodes between the bud scales of a terminal bud. Below, the zones are characterized in acropetal order of their occurrence on the distal stem sector. **Zone 1** has one to three foliage leaves (the third foliage leaf may be paired with a scale leaf) (n = 10 seedlings); **zone 2** has three to at least seven scale leaves (n = 10); **zone 3** has one to two foliage leaves (n = 8); **zone 4** has four to nineteen scale leaves (n = 3); and **zone 5** has one or two foliage leaves (n = 3). **Zone 2** of scale leaves is represented in Figure 20, intervening between the uppermost and the next lower of the three foliage leaves illustrated; however, because of their small size the scale leaves are not visible therein or barely so.

Species in which the mature plants exhibit compound foliage leaves (seven species)

In six species, collectively, the distal stem sector bears either solely foliage leaves or a transitional leaf followed by foliage leaves (*Cupaniopsis anacardioides*, *Erythrina herbacea*, *Guilandina bonduc*, *Pithecellobium unguis-cati*, *Sapindus saponaria*, and *Sophora tomentosa*). In *Exothea paniculata* the distal stem sector may bear solely foliage leaves or foliage leaves together with a scale leaf.

Indicated, for each of the six species are the kinds of foliage leaves present at node nos. 1 to 3 of the distal stem sector. *Erythrina herbacea* and *Sapindus saponaria* bear solely simple foliage leaves, although, in *S. saponaria* the leaves are either undivided or divided (Figs. 6, 23). In *Sophora tomentosa* the foliage leaf/leaves at node no. 1 is/are always simple and undivided, whereas those at node nos. 2 and 3, collectively, are simple and undivided or once compound (Fig. 9; the [single] foliage leaves at node nos. 2 and 3 are trifoliolate). In *Cupaniopsis anacardioides* and *Exothea paniculata* the foliage leaves at node nos. 1 to 3 are once compound; however, in *E. paniculata* the number of well-developed pinnae thereat varies from one to four (Figs. 21, 22; see p. 476 for additional details). In *Guilandina bonduc* the foliage leaf/leaves at node no. 1 is/are once-pinnately compound, whereas those at each of node nos. 2 and 3 are either once-pinnately compound or twice-pinnately compound (Fig. 7). In *Pithecellobium unguis-cati*, the foliage leaves are twice-compound at all three nodes (Fig. 8).

Stipules

The foliage leaves of the distal stem sector are stipulate in ten (42%) of the presently investigated species. Too, nine of those species normally exhibit two stem-borne stipules per leaf (*Chrysobalanus icaco*, *Dalbergia ecastaphyllum*, *Erythrina herbacea*, *Guilandina bonduc*, *Hippocratea volubilis*, *Pithecellobium unguis-cati*, *Quercus laurifolia*, *Quercus myrtifolia,* and *Quercus virginiana*). In *P. unguis-cati* the stipules are frequently spinous. In *G. bonduc* and *H. volubilis*, at least sometimes four stipules belong to two opposite leaves.

Reynosia septentrionalis is unique because its foliage leaves (and, as indicated, some of its scale leaves) bear solitary stipules. The stipules of both leaf types are similar to one another. Each stipule is inserted, partly, upon the seedling stem and—in the case of foliage leaves—partly on the petiole of its associated leaf.

On stems the stipule is inserted along an imaginary transverse line which is centered adaxial to, and

immediately distal to the non-stipular portion of its associated leaf and which continues laterally to each side of the non-stipular portion. The stipule is bicarinate, each of its halves manifesting a separate, abaxially situated, longitudinally aligned carina. On the stipules of foliage leaves the base of each carina is particularly thickened and winglike, thus extending to and arising partly from an articulation (abscission zone) of the associated petiole. Because that articulation is situated distal to the basal end of the petiole, each carina is clearly adnate to the petiole. The stipule has membranous margins which culminate basally on the seedling stem and which—together with the carinae—converge toward, and terminate by, the distal end of the stipule. At least some of the stipules are bifid.

I interpret each stipule of *R. septentrionalis* as two connate stipules ("constituent stipules") because **a.** it is bicarinate (i.e., each carina would represent the median of a separate constituent stipule), and **b.** it is at least sometimes bifid (i.e., each of the two stipule tips would represent the apex of a separate constituent stipule).

Based on its position the stipule of *R. septentrionalis* resembles the ocrea of the Polygonaceae, albeit the ocrea is inserted completely around its parent stem, unlike the stipule of *R. septentrionalis*. Relevant, is that the polygonaceous ocrea is also interpreted as two fused stipules (Cronquist 1991). The stipule of *R. septentrionalis* also manifests a strong outward resemblance to the solitary prophyll (first leaf of a lateral bud) of monocotyledons overall, which **a.** is generally a scale leaf, **b.** is centered adaxially relative to the leaf subtending the bud, **c.** is bicarinate, **d.** may have two tips, and **e.** has similarly been interpreted as two connate prophylls (Eames 1961).

Stipels of *Pithecellobium unguis-cati*

In this species a typical foliage leaf exhibits two pinnae, each pinna having two pinnules (Fig. 8; the distal stem sector exhibits three foliage leaves). Furthermore, a foliage leaf on the distal stem sector manifests stipels of two orders. **Order no. 1.**—Generally, one but sometimes two stipels arise between the two pinnae. **Order no. 2.**—A higher order stipel is inserted between the two pinnules of each pinnule pair.

Contrary to the present interpretation, Tomlinson (2001), in describing the foliage leaves of Florida species of *Pithecellobium*, referred to the "apex" of the petiole, the "apex of [the] secondary rachis", and to "terminal appendage[s] of both primary and secondary leaf axes" (language between brackets is mine). Based on Tomlinson's (2001) descriptions/illustrations, some/all those structures are, apparently, stipels. The stipels described herein are identified as such, rather than as appendages or apices, because **a.** they are inserted immediately basal to, rather than distal to, their associated pinnae or pinnules, **b.** they manifest dorsiventral and bilateral symmetry throughout, **c.** they themselves exhibit apices, midribs, and obvious membranous margins, **d.** they are well-developed (unlike the abortive tips of the compound leaves of various species of Fabaceae), and **e.** they are morphologically comparable to the stipules of the same species. However, like the interpetiolar stipules of various other species, the stipels of *Pithecellobium unguis-cati* often occur singly rather than in pairs.

TWO DIFFERENT STRATEGIES FOR ACHIEVING THE SAME OUTCOME

Seedlings must position their first-formed foliage leaves high enough aboveground to intercept sufficient ambient light. Epigeal and hypogeal germination represent different strategies for achieving that end. Seedlings with epigeal germination do so via elongation of the hypocotyl, which elevates aboveground the photosynthetic cotyledons, the shoot apex, and the incipient foliage leaves (Fig. 1, H). Too, such seedlings lack a basal stem sector, generally producing foliage leaves immediately distal to the cotyledons (Wilder & Relish 2022). By contrast, seedlings with hypogeal germination manifest no or minimal elongation of the hypocotyl. Instead, immediately distal to the cotyledons the presently studied species produce a variously long basal stem sector which terminates basal to the node bearing the first-formed transitional leave(s) or foliage leave(s) (Fig. 2, BSS).

Given their common role in situating the first-formed foliage leaves sufficiently high aboveground the hypocotyl of species with epigeal germination and the basal stem sector of species with hypogeal germination are functionally equivalent. Functionally equivalent, too, because they both bear the first-formed foliage

leaves, are the supra-cotyledonary stem sector of species with epigeal germination (Fig. 1, SC) and the distal stem sector of species with hypogeal germination (Fig. 2, DSS; Wilder and Relish 2022).

In species with hypogeal germination the basal stem sector, apparently, contributes minimally to photosynthesis because it either lacks leaves or produces solely/mainly reduced scale leave(s) rather than foliage leaves (Fig. 2, SL). Aside from their small size, the scale leaves are minimally photosynthetic because: **a.** they commonly soon turn brown, black, or other colors, and **b.** in certain species they or their non-stipular portions are sometimes abscinded early (e.g., *Pithecellobium unguis-cati*). As well, in species with hypogeal germination the cotyledon(s) —which are generally nongreen and enclosed within the seed coat and/or fruit wall—photosynthesize minimally, if at all.

The production of scale leaf/leaves immediately after the cotyledons constitutes a major difference between most of the presently studied species having hypogeal germination and the 70 species having epigeal germination previously studied by Wilder and Relish (2022). Of those previously studied species none produced scale leaves immediately after the cotyledons.

SIDEROXYLON: AN INTERESTING CASE

Sideroxylon is unique among the genera studied presently and by Wilder and Relish (2022), because its species, collectively, exhibit three types of germination: epigeal germination (in *S. salicifolium;* Wilder & Relish 2022), hypogeal germination (in *S. celastrinum, S. reclinatum* [both species listed in Appendix 1], and *S. tenax*), and germination intermediate between those main types (in *S. foetidissimum*). That variability is noteworthy, based on the decisions of certain previous workers to apportion the three species groups among three different genera, viz., *Dipholis*, *Bumelia*, and either *Sideroxylon* sensu stricto or *Mastichodendron*, respectively (Small 1972; Tomlinson 2001).

I interpret germination in *Sideroxylon foetidissimum* as intermediate, for these reasons. As in epigeal germination the hypocotyl lengthens, albeit minimally. As in hypogeal germination (at least as noted for most presently studied species), the seedling exhibits basal and distal stem sectors which manifest scale leaves and foliage leaves, respectively. Also, the cotyledons are ephemeral, contributing minimally (if at all) to photosynthesis. Too, the apical portion of the seedling stem and its unexpanded leaves remain enclosed within, and protected by, the seed coat long after germination (Fig. 24A).

PHYLLOTAXY OF SEEDLINGS IN SPECIES HAVING ALTERNATE/SUBOPPOSITE PHYLLOTAXY ON MATURE PLANTS

The presently described species vary according to how late in seedling/sapling ontogeny phyllotaxy becomes stabilized.

On the basal stem sector and/or the distal stem sector, certain species exhibit solely one leaf per node, whereas other species vary according to the number of leaves produced per node. Supporting data are summarized, below. In the following paragraph (and in paragraph no. 2 of the ensuing account of phyllotaxy in species with opposite adult leaves), indicated between parentheses after each species name are either **a.** the total number of nodes examined, or **b.** the percentage of nodes that bore one leaf and the total number of nodes examined, respectively. Each count of nodes represents more than one seedling.

Phyllotaxy on the basal stem sector

The species which bear scale leaves on the basal stem sector compose two groups. **Group 1.**—On the basal stem sector these species exhibit solely one leaf per node (*Persea palustris* (21), *Pithecellobium unguis-cati* (26), *Sapindus saponaria* (9), *Sideroxylon foetidissimum* (18), and *Sideroxylon tenax* (18)). **Group 2.**—In each species, on the basal stem sector a large percentage of the nodes manifest one leaf, but remaining nodes each manifest two or rarely three leaves (*Chrysobalanus icaco* (97%, 29), *Dalbergia ecastaphyllum* (96%, 27), *Damburneya coriacea* (93%, 29), *Exothea paniculata* (94%, 16), *Quercus laurifolia* (93%, 27), *Quercus myrtifolia* (89%, 28), *Quercus virginiana* (97%, 32), *Sophora tomentosa* (92%, 13), and *Ximenia americana* (97%, 32)).

Phyllotaxy on the distal stem sector

The species compose three groups. **Group 1.** In 100% of seedlings, on the distal stem sector these species each manifest one leaf at each of node nos. 1 to 3 (*Chrysobalanus icaco*, *Dalbergia ecastaphyllum*, *Damburneya coriacea*, *Erythrina herbacea*, *Exothea paniculata*, *Sapindus saponaria*, *Sideroxylon foetidissimum*, *Sideroxylon tenax*, and *Ximenia americana*). **Group 2.** In these species, on the distal stem sector the leaves mostly – but not always—develop singly at each of node nos. 1 to 3 (*Persea palustris*, *Pithecellobium unguis-cati*, *Quercus laurifolia*, *Quercus myrtifolia, Quercus virginiana*, *Sophora tomentosa*, and *Swietenia mahagoni*). For example, in *Q. virginiana* node no. 1 bore one leaf in 100% of seedlings (n = 14), node no. 2 bore one or two leaves in 64% and 36% of seedlings, respectively (n = 14), and node no. 3 bore one leaf in 100% of seedlings (n = 5). **Group 3.** Each species exhibits entirely/mostly two leaves at node no. 1, but one leaf at each of node nos. 2 and 3 (*Cupaniopsis anacardioides* and *Guilandina bonduc*). For example, in *G. bonduc* node no. 1 bore one or two leaves in 20% and 80% of seedlings, respectively (n = 10), whereas node nos. 2 and 3 each bore one leaf in 100% of seedlings (n = 10 and 9 seedlings for node nos. 2 and 3, respectively).

PHYLLOTAXY OF SEEDLINGS IN SPECIES HAVING OPPOSITE PHYLLOTAXY ON MATURE PLANTS

In each species examined, phyllotaxy varies both on the basal stem sector and on the distal stem sector.

Phyllotaxy on the basal stem sector

The species each manifest one or two scale leaves per node of the basal stem sector: *Eugenia confusa* (75%, 32), *Eugenia foetida* (78%, 23), *Hippocratea volubilis* (64%, 11), *Myrcianthes fragrans* (61%, 23), *Syzygium cumini* (86%, 21), and *Reynosia septentrionalis* (98%, 49).

Phyllotaxy on the distal stem sector

The species compose two groups. **Group 1.** In these species each of node nos. 1–3 of the distal stem sector manifests two leaves in 50% or more of seedlings (*Eugenia confusa*, *Eugenia foetida*, *Hippocratea volubilis*, and *Myrcianthes fragrans*). In the remaining seedlings the nodes, collectively, each exhibit one or three leaves. **Group 2.** In these species each of node nos. 1 to 3 of the distal stem sector exhibits two leaves in fewer than 50% of seedlings (*Reynosia septentrionalis* and *Syzygium cumini*). For example, in *S. cumini* node nos. 1 to 3 manifested one leaf per node in 71%, 75%, and 58% of cases, respectively, and two leaves per node in 29%, 25%, and 42% of cases, respectively (n = 24, 20, and 12 cases of node nos. 1 to 3, respectively).

TUBEROUS THICKENINGS OF THE SEEDLING/SAPLING AXIS

In *Erythrina herbacea, Quercus virginiana*, and *Sideroxylon foetidissimum* a sector of the seedling/sapling axis may become disproportionately thickened. In *S. foetidissimum* that sector belongs to the primary root, which thus becomes a taproot; however, in *E. herbacea* and *Q. virginiana* the thickened sector is long and extends basipetally from the cotyledonary node. Based on its length and position that sector would include both the hypocotyl (if present) and primary root.

BENT SEEDLING AXES

The seedling axis sometimes appears markedly bent, commonly at two places, at/near the cotyledonary node (e.g., in *Chrysobalanus icaco*, *Dalbergia ecastaphyllum*). Apparently, bending transpires when: **a.** an embryo has been rendered non-vertical because of the position in which its abscinded diaspore has landed on the substrate, and **b.** the main stem and primary root manifest different tropisms. In other words, if an embryo is rendered non-vertical, then negative geotropism and/or positive phototropism would induce the nascent seedling stem to bend upward, and positive geotropism and/or negative phototropism would cause the primary root to bend downward. Relevant, is that when young seedlings of *Zea mays* are experimentally oriented horizontally, their seedling axes become bent like those presently observed (Hopkins 1995, p. 370).

By such reasoning, during germination a vertically oriented embryo would yield a linear (non-bent) seedling axis.

TRICHOMES

Enumerated, are highlights of present findings.

1. The studied seedlings are glabrous/essentially glabrous in *Damburneya coriacea*, *Erythrina herbacea*, *Hippocratea volubilis*, and *Syzygium cumini*. The seedlings of *Ximenia americana* are at least mostly glabrous, but I could not assess the cotyledonary laminae.
2. The seedlings of remaining species manifest hairs which vary (both within individuals and between species) from sparsely to densely concentrated. For example, *Swietenia mahagoni* manifests sparse pubescence, i.e., the cotyledons and the basal stem sector are glabrous, and the distal stem sector and the petioles of the foliage leaves vary from glabrous to sparsely hairy. By contrast, in *Eugenia confusa*, *Eugenia foetida*, and *Myrcianthes fragrans* both the basal stem sector and distal stem sector exhibit densely concentrated, appressed to spreading hairs.
3. The cotyledons are glabrous in at least 17 (81%) of 21 species in which they were available for study; however, in *Chrysobalanus icaco*, *Exothea paniculata*, *Persea palustris*, and *Sapindus saponaria* they were pubescent to different degrees.
4. *Chrysobalanus icaco* is unusual among the studied species because the hairs on the distal stem sector and on the petioles of the foliage leaves comprise two size classes: **a.** short narrow hairs ca. 0.05 to 0.1 mm long, and **b.** longer, thicker hairs. The short hairs are the most abundant ones; they are more often straight and oriented perpendicular to the stem long axis than are the long hairs. The longer hairs are more frequently conspicuously curved and are more variably oriented.
5. *Quercus laurifolia*, *Quercus myrtifolia*, and *Quercus virginiana* are the sole presently studied species with stellate hairs. Those hairs are basally branched and, in the first two species they develop together with simple hairs.
6. *Sideroxylon foetidissimum* and *Sideroxylon tenax* are the sole presently studied species with T-shaped hairs. On the basal and distal stem sectors of those species, the two branches of a T-shaped hair are generally **a.** appressed, **b.** antrorse and retrorse, respectively, and **c.** sharp tipped. Each T-shaped hair is transparent, brown-tinged, or dark brown. In *S. foetidissimum* the T-shaped hairs develop together with unbranched hairs.
7. In *Quercus virginiana*, abaxially the laminae of the foliage leaves of the seedling differ pronouncedly from the laminae of adult plants. In seedlings, away from the midrib and leaf margins the abaxial lamina surfaces vary from essentially glabrous to sparsely pubescent. Likewise, based on fieldwork undertaken before the present study, on young plants of *Q. virginiana* developed considerably beyond the seedling stage the abaxial lamina surfaces may exhibit minimal pubescence (Wilder, unpublished observations). By contrast, on the foliage leaves of adult trees the abaxial lamina surface is densely pubescent.
8. I observed epidermal scales solely in *Eugenia foetida*. That species, in addition to having hairs, commonly exhibits small numbers of minute, brown-to-black scales at the bases of the petioles of the foliage leave(s).

KEY TO THE SEEDLINGS

Below, is a taxonomic key to the seedlings of the presently considered species. The key refers to macroscopical characteristics of the seedlings and diaspores and to microscopical characters (e g , features of trichomes). Because microscopical characters are included the key should be used together with a stereoscopic microscope.

Phyllotaxy is not considered because it often varies among seedlings of the individual species. Also, I was hard-pressed to distinguish in writing between the seedlings of *Eugenia foetida* and *Myrcianthes fragrans*. Future workers should test whether the distinction employed here (presence vs. absence of a transverse ridge on the connate cotyledons) works consistently for many individuals of those species.

The key is primarily artificial but is also partly natural because some related species key-out together, i.e , all species of *Quercus* (*Q. laurifolia*, *Q. myrtifolia*, *Q. virginiana*), certain species of Fabaceae (*Dalbergia ecastaphyllum*, *Guilandina bonduc*, *Pithecellobium unguis-cati*), and certain species of Myrtaceae (*Eugenia foetida*, *Myrcianthes fragrans* [early in the key], and *Eugenia confusa*, *Syzygium cumini* [later in the key]).

1. The foliage leaves stipulate.
   2. The entire seedling shoot glabrous/essentially glabrous.
      3. The lamina margins of the foliage leaves serrulate, the teeth being mucronulate to apiculate; the cotyledonary laminae connate distal to their basal ends _____ **Hippocratea volubilis** (Fig. 3)
      3. The lamina margins of the foliage leaves entire or sometimes sinuate; the cotyledonary laminae distinct _____ **Erythrina herbacea** (Fig. 6)

2. The non-cotyledonary portion of the seedling shoot pubescent.
   4. The basal stem sector, distal stem sector, and foliage leaves with basally branched, stellate hairs (these sometimes intermixed with simple hairs).
      5. The cotyledonary laminae and distal portions of the cotyledonary petioles connate _____ **Quercus virginiana** (Fig. 12)
      5. The cotyledonary laminae and petioles distinct.
         6. The foliage leaves with entire (sometimes sinuate) lamina margins _____ **Quercus laurifolia** (Fig. 10)
         6. The foliage leaves having entire to serrate or dentate lamina margins; if marginal teeth are present, these are often very short and one to two per margin; the teeth mucronate or mucronulate _____ **Quercus myrtifolia** (Fig. 11)
   4. The seedling without stellate hairs.
      7. The foliage leaves each with two stem-borne stipules.
         8. The foliage leaves at node nos. 1 to 3 simple.
            9. The adherent diaspore a dehiscent endocarp manifesting thick, regularly spaced, protruding main longitudinal veins plus intervening, protruding, densely arranged reticula of narrower minor veins together with interveinal tissue; the endocarp not conspicuously flattened _____ **Chrysobalanus icaco** (Fig. 4)
            9. The adherent diaspore an indehiscent, relatively smooth, conspicuously flattened legume (one seeded in our material) _____ **Dalbergia ecastaphyllum** (Fig. 5)
         8. The foliage leaves at node nos. 1 to 3 compound.
            10. The foliage leaf at node no. 1 once compound; that at node no. 2 once or twice compound; the twice compound leaves frequently having more than two pinnules per pinna _____ **Guilandina bonduc** (Fig. 7)
            10. All foliage leaves at node nos. 1 to 3 twice compound, manifesting two pinnae—each pinna bearing two pinnules _____ **Pithecellobium unguis-cati** (Fig. 8)
      7. The foliage leaves, apparently, each with a single stipule, this being partly stem-borne and partly adnate to the subtending petiole _____ **Reynosia septentrionalis** (Fig. 20)

1. The foliage leaves estipulate.
   11. The cotyledons ephemeral; the seed coat being carried aboveground on top of, and simultaneously enclosing, the apical portion of the elongating stem; the seedling with T-shaped hairs _____ **Sideroxylon foetidissimum** (Figs. 24, 24A)
   11. The cotyledons not ephemeral; the seed coat not being carried aboveground; the seedling either with or without T-shaped hairs.
      12. The cotyledons of a cotyledon pair completely or partially connate.
         13. The cotyledons completely connate.
            14. A semi-circular, transverse, ligule-like ridge present adaxially at the junction of the connate cotyledonary laminae and the common petiole _____ **Eugenia foetida** (Fig. 17)
            14. Such a ridge absent _____ **Myrcianthes fragrans** (Fig. 18)
         13. The cotyledons partially connate.
            15. The cotyledonary petioles distinct from their bases almost to their distal ends, where they are connate; the connate cotyledonary laminae with a basal, basally directed, hollow, cylindrical pipe-like extension enclosing both cotyledonary petioles.
               16. The basal stem sector, distal stem sector, and foliage leaves with T-shaped hairs _____ **Sideroxylon tenax** (Fig. 25)
               16. The seedling without T-shaped hairs _____ **Ximenia americana** (Fig. 26)
            15. The cotyledonary petioles completely distinct; the connate cotyledonary laminae without a basal extension.
               17. The cotyledons with a dense, white, farinaceous covering and being very flattened (flattening being parallel to the same plane as are the pericarp and/or seed coat) _____ **Swietenia mahagoni** (Fig. 15)
               17. The cotyledons lacking such a covering and less flattened, manifesting convex abaxial surfaces _____ **Damburneya coriacea** (Fig. 13)
      12. The cotyledons of a cotyledon pair distinct.
         18. Gland dots (0.05 to 0.15 mm in diam.) visible in surface view of the following plant parts: cotyledons, basal stem sector, distal stem sector, scale leaves, transitional leaves, and foliage leaves.
            19. The adherent diaspore (a seed coat) ca. 4.5–5 by 4 mm; the cotyledons with Suite a of characteristics (see p. 487 herein) _____ **Eugenia confusa** (Fig. 16)
            19. The adherent diaspore (a pericarp) ca. 17.5–24 by 9.5–12.5 mm; the cotyledons with Suite b of characteristics (see p. 487 herein) _____ **Syzygium cumini** (Fig. 19)
         18. Gland dots absent.
            20. The basal stem sector leafless _____ **Cupaniopsis anacardioides** (Fig. 21)
            20. The basal stem sector with scale leaves or leaf scars.
               21. The cotyledons hypo-peltate _____ **Persea palustris** (Fig. 14)
               21. The cotyledons non-peltate.
                  22. The foliage leaf at node no. 1 simple, undivided, and without an abortive apex ___ **Sophora tomentosa** (Fig. 9)
                  22. The foliage leaf at node no. 1 once compound, manifesting either one, two, three, or four well-developed pinnae. Regardless of whether the leaf exhibits one or more well-developed pinna(e), it manifests an abortive apex separate from those pinna(e) _____ **Exothea paniculata** (Fig. 22)

APPENDIX 1[1]

Nineteen species of woody/semi-woody dicotyledons presently determined to exhibit epigeal germination, which grow wild in South Florida but were not formally treated by Wilder and Relish (2022). Epigeal germination was identified, using herbarium specimens of seedlings and saplings collected by George Wilder and coworkers, on deposit at SWF. Listed, after each species name are the collection number(s), collection date(s), and the corresponding family name.

Ardisia elliptica Thunb.: 23304, 5 Jun 2005; 28150, 11 Apr 2008; Myrsinaceae.
Chamaecrista nictitans (L.) Moench (variety not determined): 38311, 16 Jan 2016; Fabaceae.
Heterosavia bahamensis (Britton) Petra Hoffm.: 35624, 5 Mar 2014; Phyllanthaceae.
Hibiscus grandiflorus Michx.: 39859, May 2017; Malvaceae.
Hippomane mancinella L.: 34961, 20 Jul 2013; Euphorbiaceae.
Hypericum tenuifolium Pursh: 32143, 13 Apr 2011; Hypericaceae.
Kosteletzkya pentacarpos (L.) Ledeb.: 39801, 19 Apr 2017; Malvaceae.
Lyonia lucida (Lam.) K. Koch: 32582, 5 Jul 2011; Ericaceae.
Mikania scandens (L.) Willd.: 24011, 22 Sep 2005; Asteraceae.
Palafoxia feayi A. Gray: 28973, 8 Oct 2008; Asteraceae.
Petiveria alliacea L.; 32009, 22 Jan 2011; Petiveriaceae.
Rhabdadenia biflora (Jacq.) Müll. Arg.: 29958, 29959, 13 Jul 2009; 29960, 14 Jul 2009; Apocynaceae.
Ricinus communis L.: 23415, 23416, 12 Jun 2005; Euphorbiaceae.
Scaevola plumieri (L.) Vahl: 43010, 2 May 2020; Goodeniaceae.
Senna ligustrina (L.) H.S. Irwin & Barneby: 35013, 8 Jun 2013; Fabaceae.
Sesbania herbacea (Mill.) McVaugh: 39802, 2 May 2017; Fabaceae.
Solanum lycopersicum L.: 43127, 10 Oct 2020; Solanaceae
Tamarindus indica L.: 35077, without collection date; Fabaceae.
Urena lobata L.: 29394, 21 Jan 2009; 29691, 7 Feb 2009; Malvaceae.

[1]Ms. Martha McCombs contributed importantly to SWF; hence, on the label of each herbarium sheet from SWF George Wilder's name and Martha McCombs' name precede the collection number of each specimen, a circumstance not duplicated in this appendix or in APPENDIX 2.

APPENDIX 2

Eight species of woody/semi-woody dicotyledons presently determined to exhibit hypogeal germination, which grow wild in South Florida but are not formally described herein. Hypogeal germination was identified, using herbarium specimens of seedlings and saplings collected by George Wilder and coworkers, on deposit at SWF. Listed, after each species name are the collection number(s), collection date(s), and the corresponding family name.

Carya aquatica (F. Michx.) Nutt.: 26527, 26 Mar 2007; 29541, 29542, 17 Mar 2009; Juglandaceae.
Citrus sp.: 32090; 9 Feb 2011; Rutaceae.
Eugenia axillaris (Sw.) Willd.: 42709, 23 Jan 2020; Myrtaceae.
Myrcia neopallens A.R. Lourenço & E. Lucas: 34693, 6 Apr 2013; Myrtaceae.
Persea borbonia (L.) Spreng. (variety undetermined); 28163, 25 Apr 2008; 29233, 20 Nov 2008; Lauraceae.
Quercus geminata Small: 25494, 19 Mar 2006; 29465, 25 Feb 2009; Fagaceae.
Sideroxylon celastrinum (Kunth) T.D. Penn.: 28486, 12 Jun 2008; Sapotaceae.
Sideroxylon reclinatum Michx.: 26699, 17 Apr 2007; 29414, 27 Jan 2009; Sapotaceae.

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